

## 1. Adaptive Management and Monitoring

### 1. A STORY OF ADAPTIVE MANAGEMENT: BALANCING THE PRAGMATIC AND THE SCIENTIFIC TO ADVANCE THE CONSERVATION OF EXPLOITED SEAHORSES.

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Ongoing adaptive management of resources, using best available data, is critical for effective conservation. For seahorses (genus *Hippocampus*), we show how three iterations of targeted demographic and life history research were used to advance conservation of these exploited fishes. In 2002, all seahorses were listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Upon implementation in May 2004, the CITES Animals Committee recommended a 10 cm minimum size limit (MSL) for de facto management of data-poor populations. We contextualize the use of this first MSL as a pragmatic interim step towards conservation in the face of imperfect knowledge. Subsequent measurements from >1500 seahorses of 14 species at 26 trading facilities in Asia and North America were then used to revise the MSL and generate a corresponding "trade height" for use by Customs agents. Recent population viability analysis has now compared the potential effects of different size-based and time-based openings on the persistence of seahorses in an active fishery in the Philippines. The latter represents the type of regional management options that could be evaluated by scientific authorities tasked to implement CITES obligations for signatory countries. This multi-year progression is a strong example of pragmatic management beginning in the face of imperfect scientific information, with iterative research used to inform ongoing conservation needs.

### 2. ADAPTIVE MANAGEMENT FOR ENDANGERED SPECIES RECOVERY: MAKING HABITAT RESTORATION COUNT

*\*Tim Tear, The Nature Conservancy*

Despite three decades of implementing the Endangered Species Act, there are few examples of feasible monitoring plans that evaluate the progress of recovery efforts. We propose a new approach that draws heavily from adaptive management in other areas of conservation. This relatively simple framework links recovery criteria in recovery plans directly to a monitoring plan designed to incorporate multiple, habitat and population-based attributes to gauge progress toward defined recovery goals. The proposed framework may be most appealing when species' persistence depends on human interventions to demonstrate that restoration actions are having the intended effect. This approach is a notable departure and improvement from the binary evaluation emphasized by the Endangered Species Act, where listed species are either recovered or not recovered. We present a case study that evaluates the restoration progress for a species on the brink of extinction, the Karner blue butterfly. We use this case study to illustrate emphasis on habitat-based recovery criteria may improve endangered species monitoring efforts that have historically biased in favor of population-based attributes. We propose that by improving the transparency and decision-making process in endangered species recovery efforts via an increased emphasis on adaptively managed projects, our investments in endangered species recovery will have greater efficiency, impact, and acceptability in society.

## 3. CHALLENGES OF ADAPTIVE MANAGEMENT AND MONITORING AT SCALES ABOVE THE LANDSCAPE LEVEL

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As conservation NGOs manage projects at scales beyond the landscape level, questions arise as to the functionality of current program management tools across all scales. We examined the scale-independence of the Open Standards for Program Management in the Congo basin, the Himalayas and regarding international fishing practices. We found that the processes for developing a program's conservation vision, scope, team composition, conceptualization of direct and indirect threats and slate of key stakeholders and partners remain consistent across scales. However, selecting biodiversity targets; assessing current status and viability thereof; and establishing program objectives and effectiveness indicators varies when moving from landscape to multi-ecoregion scales. These results highlight the need for large-scale conservation planning to be grounded in ecological theory (e.g., metapopulations) and to employ sophisticated sampling and statistical protocols.

### 4. ESTIMATING ECOLOGICAL TREND: WHICH MODEL SHOULD I USE?

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Regression of log-abundance of a population versus time is often used to estimate the population's trend. It is not widely realized that such regression carries implicit assumptions about how the trend and the variability in the population abundances arise. If the statistical model does not adequately describe the process by which the data are produced, the trend estimate can be seriously in error. Here we describe three models for estimating population trend. The three are different stochastic versions of the exponential growth model: (1) observation error only, (2) environmental process noise only, and (3) a state space model which combines both observation error and process noise. We describe the statistical methods for obtaining parameter estimates, including estimates of trend, for time series abundance data under each of the three models. Log-abundance regression turns out to correspond to deterministic exponential growth with observation error only, that is, model (1).

### 5. IS MY POPULATION RECOVERING, DECREASING, OR STATIONARY? IMPROVING THE STATUS QUO FOR ESTIMATING EXPONENTIAL TREND FROM COUNT DATA

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An estimate of the trend, or population growth rate, is perhaps the most fundamental piece of information necessary for diagnosing and recovering any species of concern. Managers and researchers commonly use simple series of abundance data collected over time, without count covariates and ignoring density dependence, to address the question: "How well is my population doing?". We use simulations to evaluate two commonly-used and one new method to estimate trend parameters (mean and standard error). Surprisingly, we find that the most-commonly used method -- a linear regression of

log-transformed count values plotted against time - shows mediocre performance under realistic conditions with both environmental noise and observation error affecting the trend in the time series. The new state space model, which accounts for both forms of variation, performs well in all cases, no matter whether observation error only, environmental variation only, or both are present. These results hold even with missing observations in the time series. We conclude that the dominant paradigm for estimating simple exponential growth through a log-linear regression be strongly tempered by a more thoughtful consideration of its fundamental assumptions. Further, for a fixed budget for field data collection to estimate trend, we recommend directing more effort into fewer, better estimates of abundance, even if some years of sampling must be skipped.

## 6. SCIENCE AND MANAGEMENT IN THE IBERIAN LYNX (LYNX PARDINUS) CONSERVATION BREEDING PROGRAM

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The Iberian Lynx Conservation Breeding Program aims at: (1) Maintaining a genetically and demographically-managed hedge population and (2) Creating new Iberian lynx free-ranging populations through reintroduction programs. To achieve the first goal, the Program aims at maintaining 85% of the genetic diversity found in the wild for a period of 30 years. This involves maintaining a stock of 60/70 breeders. Growth projections indicate that the Ex-situ Program should achieve such population target by the year 2010. Subsequently, reintroduction efforts will begin. Captive propagation is based on multidisciplinary knowledge acquired through research on the species' behavior, nutrition, veterinary medicine, genetics, reproductive physiology, endocrinology, and ecology. Research topics include: reproductive behaviour and cub development, using triatomine bugs to obtain stress-free blood samples, reproductive health of male and female breeders, developing non-invasive pregnancy tests, fecal hormone profiles, bio-security protocols, genotyping founders and making paring recommendations, etc. Over the past 3 years, a total of 8 pregnancies have resulted in the birth of 19 offspring, of which 11 survive to date. Rearing success is directly related to mother's age and experience. This presentation will emphasize how results from multidisciplinary life science research can be integrated into an adaptive management approach to help recover the world's most endangered felid

## 7. USING OCCUPANCY MODELS OF FOREST INTERIOR BIRDS TO PRIORITIZE CONSERVATION PLANNING

*\*Amielle A DeWan, Cornell University*  
 Monitoring the distribution and abundance of non-game species has become a priority for many federal, state and local agencies. For large-scale monitoring, presence/absence surveys

have become an attractive alternative to more intensive and expensive abundance estimation designs. As such, the problems associated with traditional presence/absence data have gained serious management attention and consideration. Recent research has demonstrated that detectability, or the ability of a survey method to detect all individuals present, can pose serious problems that could compromise the strength and validity of conclusions when not accounted for in presence/absence studies. Occupancy modeling is a new technique that offers a rigorous and feasible approach to address these challenges. We utilized an occupancy modeling approach to develop robust models for the distribution of forest interior breeding birds in the Hudson River Valley, New York. These predictions will provide baselines for future monitoring and management, while offering sound scientific criteria for open-space protection and conservation planning in this region.

## 2. Advances in Freshwater Conservation Planning

### 1. INFLUENCES OF STREAM NETWORK CONNECTIVITY AND HABITAT QUALITY ON THE DISTRIBUTION AND ABUNDANCE OF IDAHO GIANT SALAMANDERS, DICAMPTODON ATERRIMUS

*\*Adam Sepulveda, University of Montana; \*Winsor Lowe, University of Montana*

Species distribution and abundance depend on a balance between landscape processes and local processes. To successfully manage populations in areas with human disturbance, an understanding of important processes at each spatial scale is important. We used a model selection approach to identify the best spatial scale to manage a stream salamander species, *Dicamptodon aterrimus* (Idaho Giant salamander) in the Lochsa River subbasin, Idaho. We used data from field surveys to compare evidence of support for landscape and local-scale models that explain *D. aterrimus* patch occurrence and relative density data. Landscape-scale models included covariates that reflect metapopulation theory assumptions, while local-scale models included covariates that reflect patch quality. Our results suggest that landscape-scale processes are important controls on *D. aterrimus* occupancy. Specifically, we found that *D. aterrimus* occurrence was greatest in roadless drainages and lowest in isolated stream networks. In addition, we found that *D. aterrimus* relative density was greatest in streams with a high proportion of embedded substrate and fine sediment. These results suggest that *D. aterrimus* patches are spatially structured within stream networks and that *D. aterrimus* has broad habitat requirements within a patch. We suggest that management efforts focus on protecting roadless areas and restoring stream connectivity in human-impacted areas, rather than on improving habitat quality within a stream.

### 2. DETERMINATION OF FRESHWATER FISH CONSERVATION AREAS IN A DATA-POOR CONTEXT: AN INITIAL FRESHWATER CONSERVATION PLAN FOR BELIZE, CENTRAL AMERICA

*\*Peter C Esselman, University of Michigan, School of Natural Resources and Environment; \*J. David Allan, University of Michigan*

Much of the planet's freshwater biodiversity is located in tropical developing countries where species distributions are poorly documented. However, a suite of tools are available to leverage limited existing data for biodiversity protection. We

utilized limited fish species occurrence data together with landscape-scale habitat data to generate biogeographic models for all freshwater fish species with MaxEnt modeling software. Predicted species occurrences were aggregated in GIS to create fish richness maps for different target groups (migratory species, primary/secondary freshwater fishes, estuarine species). These richness surfaces were combined in the MARXAN software package with a synthetic environmental risk surface representing cumulative upstream influence of human activities, to optimize the selection of freshwater fish conservation areas. The simulated annealing site optimization algorithm was used to explore scenarios in which subsets of the 36,000 catchments in the study area were identified that effectively encompassed each of the target groups in an efficient manner, while also meeting general criteria of reserve design (e.g., connectivity, minimal fragmentation). Scenarios then were compared to existing protected areas networks. Our results demonstrate that freshwater conservation planning in information-poor contexts can be undertaken successfully by integrating existing biotic data with GIS, biogeographic modeling approaches, and site optimization software.

### 3. EVALUATING CONFIGURATIONS OF RIPARIAN MANAGEMENT AREAS ALONG HEADWATER STREAMS FOR CONSERVATION OF AMPHIBIANS AND SALMONIDS

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Headwater stream channels in forested, montane ecosystems provide habitat for numerous species and can influence conditions and processes downstream. Efforts to quantify differences among headwater channels as a potential framework for prioritizing freshwater conservation actions have generally targeted a single species or resource. In this study, we synthesize understanding about the characteristics of headwater channels that may control their relative value both as amphibian habitat and as a source of materials to downstream salmon habitats. In this context, the potential effects were evaluated of streamside management zones aimed at different proportions and spatial configurations of the headwater channel network. Headwater channels were ranked across western Oregon, USA, based on estimated probabilities of being affected by debris flows that deliver to salmon-bearing channels downstream. The ranks were used to delineate alternative streamside management zones encompassing 25%, 50%, and 75% of these debris-flow susceptible headwater channels. The highest debris-flow probabilities were contained in a relatively small area. Thus, focusing streamside management zones along these most debris-flow susceptible headwater channels may be sufficient to provide essential functions for salmon-bearing channels. But, the resulting area and spatial configuration in streamside management zones may be insufficient to meet the habitat needs of headwater-dependent amphibians.

### 4. AN INVESTMENT-BASED FRAMEWORK TO PRIORITISING CONSERVATION ACTION IN RIVERINE LANDSCAPES

*\*Simon Linke, University of Queensland, eWater CRC; \*Hugh Possingham, university of queensland*

This paper will introduce a new method in riverine conservation planning. The steps in this framework are:

1. Setting conservation targets - as is the case in almost every framework for systematic conservation planning.
2. Achievability of these targets is subject to the environmental

conditions in the subcatchment they are located in. In our example from New South Wales, Australia, this is achieved using empirically determined tolerance values. 3. In order to achieve or maintain these environmental conditions, investments will have to be made. To keep a catchment in good condition, some investments of conservation or stewardship are needed. Otherwise, money and effort needs to be invested in catchment restoration. 4. We will demonstrate an optimization algorithm that finds multiple alternative scenarios under either budgetary or target constraints. This proved to be computationally intensive, as intervention anywhere in the catchment upstream affects everything downstream. 5. The final section of the paper is a sensitivity analysis: How robust are outcomes and recommendations to uncertainty of cost and restoration success.

### 5. ARE TERRESTRIAL RESERVE NETWORKS SUFFICIENT TO PROTECT AQUATIC BIODIVERSITY?

*\*David Allan, University of Michigan; \*Robin Abell, WWF; \*Patrick Doran, The Nature Conservancy - Michigan; \*Matt Herbert, The Nature Conservancy - Michigan; \*Peter McIntyre, University of Michigan*

The global coverage of freshwater resources within protected areas is poorly known due to a shortage of geographically-explicit data. Some have suggested that the protected status of 12% of the Earth's land surface likely protects an equivalent fraction of freshwater resources, but this claim is largely untested. Coarse analyses relying on modeled freshwater habitat types have revealed gaps in protection, but corresponding species distribution data are lacking. We use well-developed databases for the State of Michigan to test the hypothesis that existing reserve networks, most which were designed to conserve terrestrial habitats and species, also offer adequate protection of aquatic resources. Terrestrial protected areas included State and National Forests, State and National Parks, National Wildlife Refuges, and holdings of The Nature Conservancy and other land trusts. Freshwater protected areas included waters covered by wild and scenic river statutes. To evaluate coverage of aquatic resources within terrestrial reserves, we used databases on fish and mussel species richness, aquatic fauna of special concern, priority aquatic habitats, and ground water recharge zones. Our analyses show that terrestrial reserves often protect important freshwater resources where aquatic considerations played a role in site selection. However, there is poor correspondence in many areas, especially in heavily-settled parts of southern Michigan.

### 6. MULTIVARIATE LANDSCAPE CLASSIFICATION OF HEADWATER CATCHMENTS FOR AQUATIC RESEARCH AND CONSERVATION

*\*Tyler Vaughn Bax, Duke University; \*Christian Torgersen, USGS; \*Dean L Urban, Duke University*

Paired watershed studies provide valuable scientific understanding of the effects of disturbance on aquatic resources. Recently, the Watersheds Research Cooperative in western Oregon initiated three paired watershed studies in order to investigate the effects of contemporary timber management practices on aquatic ecosystems. We used geographic information system (GIS) tools, combined with principal components and cluster analyses, to develop a landscape classification of forested headwater basins in order to support these paired watershed studies. Spatial and statistical analyses were applied to landform, geologic texture, forest cover, and climate variables that describe the biophysical and climatic setting of forested headwater catchments (300 - 58,000

km<sup>2</sup>) in western Oregon. The first and second principal component axes correlate most strongly to differences in average elevation and precipitation, and percent slope and forest cover, respectively. Our results provide a landscape context for interpreting and extrapolating the findings of paired watershed studies and are useful for prioritizing site locations for future paired watershed studies in the region. Partners including the Bureau of Land Management, Oregon Department of Forestry, and private landowners will use this information to better understand the broader implications of contemporary timber harvest techniques on watershed processes and aquatic biota.

## 7. INCORPORATING HUMAN THREAT ASSESSMENTS INTO FRESHWATER CONSERVATION PLANNING: PAST, PRESENT AND FUTURE.

*\*Scott Sowa, University of Missouri*

Conservation planning seeks to develop spatially-explicit conservation strategies that promote persistence of biodiversity, often in human-dominated landscapes. Traditionally, conservation planning has focused on representation of species, habitats, or ecosystem processes with limited attention to threats posed by human disturbances. However, increasing emphasis has been placed on incorporating quantitative assessments of threats into conservation planning. Such analyses are particularly important to freshwater ecosystems due multitude of human disturbances affecting these ecosystems and their diffuse and cumulative nature. Ideally, threat assessments would incorporate the full range of human threats within the region of interest and account for those factors affecting the degree to which ecological processes that sustain biodiversity might be altered. These factors include the type of threat and a host of interrelated measures such as the magnitude, spatial extent, distance, frequency, and timing of each threat. Data and analytical limitations as well as limitations in ecological understanding currently prevent us from performing comprehensive threat assessments. However, significant advancements are being made, particularly with regard to spatial considerations. This presentation will highlight some these advancements using examples from the Midwestern United States and illustrate the utility of these data for conservation planning.

## 8. PRIORITIZING SALMONID CONSERVATION AREAS THROUGH BASIN-SCALE PREDICTIONS OF NETWORK CONNECTIVITY AND DISTURBANCE SEVERITY IN STEEP MOUNTAIN STREAMS

*\*Christine L. May, James Madison University*

A basin-scale perspective of network connectivity and the severity of pulsed disturbance is needed for prioritizing salmonid habitat conservation areas. Topographic indexes derived from a process-based characterization of river profiles provide a useful context for identifying basins that express different habitats and responses to debris flows. Rivers with strongly concave profiles have an abundance of low-gradient reach morphologies, favored by many salmonids. Complex population structures can develop within these networks because fish distribution expands into tributaries, allowing for a spatial spreading of risk. The severity of pulse disturbances is also reduced because debris flows typically form discrete deposits at tributary junctions. In contrast, less concave profiles indicate that high-gradient reaches morphologies are more extensive and most tributaries are too steep to provide habitat, confining fish to mainstem channels. Furthermore, debris flows continue to travel down mainstem channels and alter aquatic

habitats for long distances. The combined influence of a limited spatial distribution and the increased severity of debris flows may result in more extreme fluctuations in population abundance. Conservation planners can use these indexes to identify basins with the most potential to support high density populations that are resilient to pulsed disturbance, combined with networks that offer the greatest availability of productive habitat.

## 9. TARGETING AQUATIC CONSERVATION MANAGEMENT WITH SPATIALLY-EXPLICIT PREDICTIVE MODELING USING LIMITED DATA

*\*Seth Wenger, UGA River Basin Center*

Much of the world's freshwater biodiversity occurs within watersheds experiencing rapid land use change. Uncertainty regarding the nature and severity of land use impacts to aquatic fauna can make it difficult to institute effective management actions, even when there is potential urgency. Here we describe one such case in the Etowah River Basin of Georgia, USA, in which 3 imperiled fish species are threatened by increasing urbanization and suburbanization. In order to guide management actions, we established statistical relationships between species occurrence/abundance and a key indicator of urban impact, effective impervious area. For one narrowly distributed species, we used a surrogate species to estimate the relationship. We then applied these relationships in a spatially explicit manner to predict the future consequences of alternative management scenarios on the imperiled species populations. We used a rudimentary population viability analysis informed by expert opinion to evaluate the scenarios. The results were used to set levels of stormwater management policy, a key impact control strategy, for different regions of the basin. Adaptive management will be used to adjust these levels in the future as additional data are collected and model predictions are refined. This case study demonstrates the potential to develop appropriate land use management policies for aquatic species protection even in the face of limited data and considerable uncertainty.

## 10. THE ACTIVE RIVER AREA: A FRAMEWORK FOR RIVER CONSERVATION AND RESTORATION

*\*Mark P. Smith, The Nature Conservancy; \*Roy Schiff, Milone and MacBroom, Inc; \*Arlene Olivero, The Nature Conservancy; \*James MacBroom, Milone and MacBroom, Inc.*

The Active River Area (ARA) is a conceptual framework for designing protected areas for freshwater ecosystems and for guiding river restoration and management efforts. Using a systematic approach for identifying the 'active' areas within which the dynamic and disturbance-driven riverine processes occur we describe an approach that allows the key physical and ecological processes associated with rivers to be factored into the design of freshwater protected areas and restoration projects. We identify six key components of the ARA, including the material contribution zone, meander belt, active low floodplain, riparian wetlands, high floodplain, and terraces. These spatially explicit areas correspond to areas where energy and material inputs and hydrologic and sediment transport processes occur, each of which are integral to the ecological character and ecological health of a river system. We demonstrate how existing geographic information system (GIS) techniques allow for spatially identification of the ARA at the scale of watersheds or multiple watersheds. Finally, we demonstrate how these techniques can be used as the basis for designing comprehensive freshwater protected area networks,

for identifying and planning restoration activities, and for informing river management policies.

#### 11. PROTECTED AREAS: MYTH OR REALITY?

*\*Jonathan Vernon Higgins, The Nature Conservancy*

There are several key attributes that require adequate security through protection or management to maintain the integrity of freshwater ecosystems and sustain biodiversity. These key attributes include hydrologic regime, physical habitat, biotic composition, connectivity, and a suite of attributes of water quality. Classically defined protected areas range in their size, position in a drainage network, and the types of protection and management activities that take place within them. Because of these differences, there is a range of security offered to key attributes by protected areas. Some protected areas provide adequate security for all key attributes. Most protected areas offer security for only a subset of them. Evaluating the key attributes secured by existing protected areas provides a framework for freshwater gap analysis by identifying attributes that need to be addressed through additional protection or management strategies. In order for many protected areas to function adequately and truly be declared freshwater protected areas, additional strategies employed within and outside their boundaries are often necessary. Through implementing this framework, more specific and organized information can be used to strengthen current freshwater gap analyses and better assist the development of future freshwater conservation strategy scenarios.

#### 12. STREAM FISH DISPERSAL AS A SPATIAL FRAMEWORK FOR FRESHWATER RESERVES

*\*Nathaniel P Hitt, Department of Fisheries and Wildlife Sciences, Virginia Tech; \*Paul L Angermeier, US Geological Survey and Virginia Tech*

Population persistence depends on local habitat quality as well as connectivity to resources and source populations within a landscape. In this presentation, we develop connectivity criteria for freshwater reserves based on evidence for fish dispersal in stream networks. First, we present alternative spatial models of fish dispersal based on life history expression and metapopulation dynamics. Second, we use data from the USEPA's Environmental Monitoring and Assessment Program to evaluate the effects of regional connectivity on local stream fish assemblages in the mid-Atlantic highlands, USA. Third, we propose spatial criteria for freshwater reserves by relating the spatial grain of fish population structure to dispersal models in stream networks. Partial Mantel tests revealed that (a) local fish species richness is influenced by connectivity to areas up to 10 fluvial km distant in the stream network; (b) connectivity to large rivers (i.e., upstream basin areas > 250 km<sup>2</sup>) influences fish assemblage structure and mediates fish assemblage relations to stream volume; and (c) connectivity to downstream areas affects fish assemblage resiliency to environmental stressors. We conclude that freshwater conservation reserves should encompass at least 10 fluvial km and that connectivity to downstream rivers may influence the success or failure of stream fish conservation strategies.

#### 13. FOUR BIOLOGICAL QUANTA; A CONCEPTUAL FRAMEWORK FOR CONSERVATION OF STREAM ECOSYSTEMS

*\*Christopher A. Frissell, Pacific Rivers Council; \*Nathaniel P Hitt, Department of Fisheries and Wildlife Sciences, Virginia Tech*

Since the 1980s, stream ecologists have embraced hierarchical concepts of stream ecosystem organization. Although past

work has emphasized the physical template, effective conservation rests on joint understanding and scaling of physical and biotic processes. A review of empirical and conceptual advances leads us to posit that stream ecosystems can be usefully conceived as comprising four biotic quanta. The first quantum spans 1-2 kilometers of perennial stream habitat, defining a threshold for persistence of small-bodied headwater stream species. The second quantum spans a dendritic network with 1 or more nodes, spanning stream lengths of 2-20 kilometers; this scale confers redundancy and internal refugia, and provides habitat and connectivity for persistence of larger organisms such as fishes and amphibians. The third quantum spans stream network distances of 10-30 km, the scale of active fluvial fish dispersal and invasion, across which edge or source effects mediate assemblage structure. The fourth quantum spans distances up to 1000s of km, terminates at the marine interface, and defines large river networks that sustain riverine obligates, e.g., sturgeons. No reserves in the conterminous US encompass unfragmented networks at the scale of the 4th quantum, and few span the 3rd; pristine examples are nonexistent. Endangerment and homogenization of stream fish assemblages will further increase without restoration of ecological integrity at the 3rd quantum scale.

#### 14. PLANNING FOR FRESHWATER PROTECTION IN THE DEMOCRATIC REPUBLIC OF CONGO: INTEGRATING FRESHWATER AND TERRESTRIAL CONCERNS IN PRIORITY AREA SELECTION

*\*Michele Thieme, World Wildlife Fund; \*Andre Kamdem Toham, WWF DRC; \*Aurelie Camille Shapiro, World Wildlife Fund; \*Nikolai Sindorf, World Wildlife Fund; \*Allard Blom, World Wildlife Fund*

In 2002, the government of the Democratic Republic of Congo committed to increase its protected area coverage to 15% from just over 8%. In 2007 World Wildlife Fund and partners supported the effort by identifying regions of high biological priority through a process combining expert assessment and a computer-assisted Decision Support System. Unlike planning efforts that have focused either on representing only terrestrial targets or terrestrial and freshwater targets separately, we provided recommendations for expanding the current system to meet protection goals for both terrestrial and freshwater system types. A first-ever freshwater habitat classification for the country provided coarse-filter targets - a critical component of the process, considering marked gaps in data describing freshwater species distributions. Designated priority areas cover about 30% of the area of DRC and represent nearly all system types. We use this experience to explore the advantages and disadvantages of different methods for integrating freshwater and terrestrial targets into gap analyses, as well as implications for adoption of results within the policy arena.

#### 15. DESIGNING FRESHWATER RESERVES IN THE GUADIANA BASIN (PORTUGAL): HOW FAR ARE WE FROM EFFECTIVE MANAGEMENT?

*\*Ana Filipa Filipe, Faculdade de Ciências da Universidade de Lisboa; \*Maria Joao Collares-Pereira, Faculdade de Ciências da Universidade de Lisboa*

Guadiana River Basin (Iberian Peninsula, southwestern Europe) has been considered a relevant hotspot of biodiversity around the world; particularly it embraces a high rate of

peninsular endemic freshwater fish species. Characterized by a semi-arid climate and located in a multiple water-demanding region, waters are shared by Portugal and Spain. Here we present current and proposed freshwater conservation areas for the drainage by means of landscape scale biological and environmental factors. Next we evaluate the efficiency of current administrative conservation areas versus the proposed ones on achieving conservation goals established at the national and European Union organizational levels. Finally, by using this case-study, we evaluate how assessments of freshwater conservation areas by European directives of Water Framework (WDF), Habitats and Birds Directives (Natura 2000 network), national protected areas (NPA), and regional assessments can be integrated. As we face a dramatic shift for an ecologically orientated water management at a landscape scale around the globe, the integration of European WDF, Natura 2000, and national and regional assessments, with similar or at least complementary objectives, methods, and concepts, must be implemented without contradictions, if we want to successfully accomplish the established goals.

### 16. IMPROVING IMPERILED FISH RECOVERY THROUGH SPATIALLY-EXPLICIT BAYESIAN BELIEF NETWORKS

*\*Kevin T McAbee, University of Georgia; \*Nathan P Nibbelink, University of Georgia*

High uncertainty and few historic data currently hinder comprehensive management of many imperiled aquatic species. As a consequence, recovery plans often lack measurable quantitative goals, and subsequent land management is based heavily on expert opinion. While expert opinion is a practical place to begin, improved recovery planning must focus on reducing structural uncertainty over time through a well designed adaptive resource management (ARM) program. We developed the framework for such a program to manage recovery of the federally threatened blackside dace (*Phoxinus phoxinus*). We employed a Bayesian belief network (BBN) to house this framework because BBNs conceptually parallel the ARM process by providing a flexible tool to incorporate expert opinion and empirical data quantitatively, communicate ecological influences clearly, and update management decisions and/or predictions based on new data. The completed blackside dace model describes key anthropogenic and ecological influences affecting short term (5 year) population persistence. When applied to individual watersheds, this model offers predictions regarding the cumulative affect of varying land use decisions on the local population. Spatially-explicit monitoring data collected to support this model will update these predictions through Bayesian inference. Consequently, over time, the model will be based less on belief and more on ecological data, representing true adaptive management.

## 3. Alien and Invasive Species

### 1. AN ECOLOGICAL ASSESSMENT OF INVASIVE PLANT SPECIES IN A CONSTRUCTED WETLAND IN MARKHAM, ONTARIO, CANADA.

*\*Antonia Capotorto, Ryerson University; \*Michal Bardecki, Ryerson University*

It is generally assumed that increased plant biodiversity will enhance the efficiency and effectiveness of the pollutant removal processes in wetlands constructed for stormwater management and that plant diversity will provide ancillary benefits in terms of wildlife attraction and aesthetics. However, the development of a diverse plant community may be

jeopardized by colonization by invasive species. This study reports on a detailed assessment of the changes in plant species composition in a wetland complex constructed for stormwater management in Markham, Ontario, Canada. Shortly following construction, ten years ago, this site was predominantly a monoculture of *Typha latifolia*. Today, the vegetation diversity of the wetland remains extremely poor. Over the past decade, there has been significant establishment of invasive *Typha angustifolia* and *Phalaris arundinacea*. Despite the complexity of the site, the low diversity, in part, reflects a lack of variation in soil and water chemistry. The research presented focuses on the relationship between the presence of invasive plant species, the lack of development of native plant species richness and diversity, and the environmental factors that may be associated with the presence and distribution of the invasive plants. The management implications of the results are discussed.

### 2. EFFECTIVENESS OF FLEA BEETLES (APTHONA SPP.) IN LEAFY SPURGE CONTROL INTERACTS WITH SOIL TYPE AT FOUR SITES IN THE NORTHERN TALLGRASS PRAIRIE

*\*Peter J. Bauman, The Nature Conservancy; \*Meredith Cornett, The Nature Conservancy; \*Cynthia Lane, Ecological Strategies, LLC; \*Carolyn Carr, Ecological Strategies, LLC*

Leafy spurge (*Euphorbia esula*) has emerged as a major threat to grasslands over the last 50 years. Anecdotal reports suggest that flea beetles (*Apthona* spp.) are a promising biological control for *E. esula* throughout the Northern Tallgrass Prairie Ecoregion. The purpose of our study was three-fold: to evaluate the efficacy of flea beetles (*Apthona* spp.) in controlling *E. esula* across a variety of site conditions; identify the soil conditions under which biocontrol for *E. esula* is most effective; and assess the response of native vegetation. We sampled at 40 locations across four sites in Minnesota, North Dakota, South Dakota and Iowa. Established in 2001, results are reported here for the last three years of the study. Results indicated that *E. esula* stem density decreased by as much as 65% over the three-year study period for sites at which fine textured soils predominated ( $t=2.25$ ,  $df=10$ ,  $p=0.05$ ), but appeared to increase over time in settings with coarse-grained soils (+15%, not significant). We did not detect differences in native plant species richness over the study period. *Apthona* sp. appears to be an effective biological control in grasslands infested by *E. esula* where biophysical conditions are conducive to survival of the biocontrol agent.

### 3. INVASION OF THE EXOTIC PAULOWNIA TOMENTOSA AT LINVILLE GORGE AND CHANGES IN ITS HABITAT DISTRIBUTION OVER TIME

*\*Dane Kuppinger, University of the South*

*Paulownia tomentosa* (*Paulownia*), a native of Asia, began invading xeric forests of the southern Appalachians following wildfires in the 1980's and heavily invaded Linville Gorge (Pisgah National Forest) following a wildfire in 2000. *Paulownia* habitat models were developed for the Gorge utilizing Classification Tree models and survey data from 5 fires across the Southern Appalachians. Resurveys of the plots at Linville Gorge, allowed for an analysis of changes in *Paulownia* habitat over time. In 2002, these models predicted *Paulownia* habitat to exist over 6.57km<sup>2</sup> of the Gorge. That shrank to 2.43km<sup>2</sup> of habitat in 2004 and to 1.79km<sup>2</sup> of habitat in 2006. *Paulownia* habitat losses were particularly concentrated on more mesic sites, at lower elevations, on flatter slopes, and in areas that burned with lower severity as measured by the variables Topographic Convergence (TCI),

elevation, slope, and difference in the Normalized Burn Ratio (dNBR) respectively. Lack of significant habitat restriction on the steepest, driest portions of the landscape suggests that although *Paulownia* may suffer range restriction, it is not likely to be expatriated from the Gorge during the course of succession. That these areas are also habitat to two rare endangered species, *Liatrix helleri* and *Hudsonia montana*, leaves open the potential for impact to these species' populations within Linville Gorge.

#### 4. INVASIVE TRAMP ANTS CAUSE COLLAPSE OF UNDERSTORY FOOD WEB IN AN AFRICAN RAINFOREST

*\*Amy E Dunham, Rice University, Dept Ecology and Evolutionary Biology; \*Alexander S. Mikheyev, University of Texas at Austin*

Understanding the ecosystem level impacts of invasive species is crucial for both the conservation and successful restoration of communities and ecosystem function. Tropical rainforest ecosystems are threatened worldwide by development and deforestation and invasive species present an additional threat by altering ecological processes through direct alteration of the environment or indirectly through changes in communities and trophic structure. The tramp ant, *Wasmannia auropunctata*, a native of Central and South America has been spreading invasively throughout central African rainforests and elsewhere as a result of anthropogenic activities such as logging and oil extraction. Little is known about the effect of this invasive species on native invertebrate communities or on ecosystem processes. We examined how fire ant invasion affects invertebrate communities, herbivory levels, leaf chemistry, and nutrient cycling in 19 separate invasion fronts spreading from forest clearings within an oil concession in the rainforest of Gabon. Results suggest that presence of this exotic ant dramatically alters abundance and diversity of native invertebrates on the forest floor and changes herbivore communities with consequences for both nutrient regimes and herbivory levels.

#### 5. MIKANIA MICARANTHA: THREAT TO SPECIES CONSERVATION IN LOWLAND PROTECTED AREA MANAGEMENT IN NEPAL

*\*Kanchan Thapa, WWF Nepal*

Invasive species is an emerging threat and concern to low land protected areas in Nepal. Linear propagation and on going colonization of *Mikania micarantha* (Asteraceae) is concurring damage to both native plant species and fauna as well in protected areas. This paper highlights threats incurred through rapid colonization of *Mikania micarantha* to native ecosystem with special focus in species conservation in particular. Given the biology of the invaders, high organic rich, moisture, and humidity favor their proliferation in the riparian zone of Chitwan national park (CNP). CNP harbors the only founder population of one horned rhinoceros (*Rhinoceros unicornis*) in Nepal. Their preference to riverine and floodplain grassland communities within riparian zone is conceiving lack of palatable species for these pachyderms and other native fauna. Increasing human wildlife conflict in surrounding areas is a direct threat perceived from increasing invasion by invaders in their native habitat in CNP. Habitat management remains an opportunity as well as challenging task for curbing invasion by *Mikania micrantha* in CNP.

#### 6. POTENTIAL IMPACTS OF IMPLEMENTING A WEED RISK ASSESSMENT SYSTEM ON THE HORTICULTURAL INDUSTRY

*\*Doria R Gordon, The Nature Conservancy;*

*\*Crysta A Gantz, University of Florida*

Retroactive tests of the Australian Weed Risk Assessment system (WRA) across several geographies show that major invaders are correctly identified 90%, and non-invaders 70% of the time, on average. Inclusion of a secondary screening tool on species requiring further evaluation reduces the species in that outcome to 10%. However, these results do not indicate the potential impact to importers of new plant species if such a screening system were implemented in the U.S. Results from Australia (not using the secondary tool) suggest that over 70% of novel species will be accepted or require further evaluation, with fewer than 30% of the species rejected as having high probability of becoming invasive. We tested the hypothesis that similar results would be found for 100 plant species introduced to the U.S. since 1995. These species are unlikely to have already expressed any invasive potential. We selected the species with assistance from the horticultural industry, botanic gardens, and other importing entities, purposely varying life form, family, and location of origin. Data used to address the 49 WRA questions were from occurrences outside of the continental United States. Results indicate that over 70% of these species would be accepted for import, 20% require further evaluation, and fewer than 10% would be rejected as likely to become invasive in the U.S. More species than hypothesized would be accepted for import if this system were implemented.

#### 7. THE EFFECT OF THE INVASIVE SHRUB LIGUSTRUM SINENSE ON SOIL MICROBIAL PROCESSES IN RIPARIAN SURFACE SOILS OF THE TENNESSEE RIVER GORGE.

*\*Henry G. Spratt, University of Tennessee at Chattanooga; \*Colette D. Huntley, University of Tennessee at Chattanooga*

The shrub *Ligustrum sinense* (Chinese privet) is recognized as a threat to natural ecosystems throughout the Southeastern USA. This study focused on the impact privet has had on Tennessee River Gorge riparian soil microbial communities and select processes they catalyze. Soils were collected from plots with high densities of privet and from plots where privet was removed five years earlier. Microbial carbon transformations were quantified using <sup>14</sup>C-lignocellulose (from *Quercus alba*) mineralization. Element pools (CNS) were measured by elemental analysis. Exchangeable cations, Ca<sup>2+</sup>, Mg<sup>2+</sup>, and K<sup>+</sup> were determined by AA. Soil moisture content was also measured. Rates of cellulose mineralization were approximately 87% greater than those of lignin. Lower rates of cellulose mineralization were observed for soils from plots with no privet. The same trend was not observed for lignin mineralization. Ca<sup>2+</sup> and Mg<sup>2+</sup> concentrations were lower in soils from plots with privet, while K<sup>+</sup> was unaffected. Total C was lower in the litter of plots containing privet and total S was higher. Moisture content was lower in soils of plots with privet. This data suggests that *Ligustrum sinense* growing in Tennessee River Gorge riparian soils has an impact on soil microbial communities and several key soil nutrient pools found there.

#### 8. LANDSCAPE MODELS OF CHEATGRASS INVASION TO TARGET RESTORATION AND CONSERVATION PRIORITIES IN NORTHERN ARIZONA

*\*Brett G Dickson, Northern Arizona University; \*Christine Albano, The Grand Canyon Trust; \*Ethan Aumack, The Grand Canyon Trust; \*Thomas D Sisk, Northern Arizona University*

In the Southwest, invasive plant species, such as cheatgrass (*Bromus tectorum*), pose a significant threat to areas where the structure and composition of native vegetation has been affected by fire, fire suppression policies, or livestock grazing. Following the purchase of the vast Kane and Two-Mile Ranch allotments by the Grand Canyon Trust in 2005, we initiated a baseline ecosystem assessment to characterize existing conditions and to identify restoration priorities across more than 450,000-ha of the Kaibab and Paria Plateaus in northern Arizona. We measured vegetation, physiographic, climatic, and anthropogenic features at 606 random plot locations using ground-based surveys and landscape models implemented in a GIS. We used multiple logistic regression and a multi-model inferential approach to frame competing hypotheses, rank important plot- and landscape-scale variables, and construct probabilistic spatial models of cheatgrass invasion. Cheatgrass occurred on 41% of the plots. Seasonal climate, topographic complexity, and soil texture were important predictors of cheatgrass occurrence at multiple spatial scales. Soil chemistry variables had substantial support at the plot scale, and fire and road effects were important predictors at the landscape scale. These results and spatial products are informing stakeholders in the restoration of degraded habitat for wildlife and contributing to integrated conservation planning efforts on one of America's most visible landscapes.

#### 4. Amphibian and Reptile Conservation

##### 1. A GLOBAL STRATEGY FOR AMPHIBIAN CONSERVATION

*\*Robin Drummond Moore, Conservation International*

Amphibians are frequently cited as canaries in the coalmine, obliging us an early warning of deteriorating environmental health. The canary has been dying for too long. The Amphibian Conservation Action Plan (ACAP) has been developed as a call to action. Compiled by over 80 leading amphibian experts, it outlines actions necessary to stem an extinction wave driven by a lethal cocktail of threats. While novel threats such as climate change and emerging disease are alarming, habitat loss remains the biggest threat to the survival of amphibians, impacting nine out of 10 threatened species, and should not be overlooked. We have been addressing the root of the problem by helping to protect critical amphibian habitat. The Sierra Nevada de Santa Marta in Colombia contains six threatened amphibian species found nowhere else. The Alliance for Zero Extinction - a coalition of some 70 conservation organizations - identified this as the second highest global priority for conservation action globally. Upon learning that the area was slated for development, we assisted a local NGO in acquiring and safeguarding the site. Replicating such efforts will be critical in the long-term battle to save amphibians. Without habitat, after all, the survivors will have nowhere to live.

##### 2. AMPHIBIAN DECLINES: THE PET INDUSTRY LEAPS FORWARD THROUGH SCIENTIFIC COLLABORATION

*\*Jamie Kristine Reaser, Ecos Systems Institute/PIJAC*

Amphibian conservation requires collaboration across sectors. At least 26 million amphibians were imported into the US from 2000-2004, the majority of which were intended for the pet trade. Approximately, 4% of US households (4.4 million) have at least one amphibian and of all herptiles maintained as pets in the US, 26% are anurans and 3% are caudates. Although the maintenance of amphibians as companion animals brings joy to many people and may encourage their interest in wildlife

conservation, there are also negative externalities. For example, the trade in amphibians can facilitate the spread of amphibian diseases (e.g., *Batrachochytrium dendrobatidis*, ranavirus) and parasites and unwanted pets that are released into the natural environment can become invasive species. Working together, scientists and the pet industry have developed proactive, science- and partnership-based initiatives to minimize the industry's role in amphibian population declines. Examples of such programs include: Habitattitude™, Bd-Free 'Phibs, The National Reptile Improvement Plan (NRIP), and Codes of Conduct for Water Gardens. The Pet Industry Joint Advisory Council's Science Scholars initiative offers opportunities for collaborative research and reporting on pet trade/conservation related issues.

##### 3. CONSERVATION EFFORTS FOR THE HELLBENDER, *CRYPTOBRANCHUS ALLEGANIENSIS* IN MISSOURI

*\*Jeff Ettl, Saint Louis Zoo; \*Mark Wanner, Saint Louis Zoo*

Over the last 30 years extensive data has been collected on the Missouri populations of both the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) and Ozark hellbender (*Cryptobranchus a. bishopi*). These studies indicate that there has been an approximately 80% decline in hellbender populations with a major shift in the age structure to one composed of larger, older animals. The lack of young in these populations indicates either reproductive failure or high mortality of juvenile hellbenders. In addition, researchers have been finding increasing numbers of adult hellbenders with missing toes, limbs and eyes as well as open lesions and tumors. The Saint Louis Zoo and the Ozark Hellbender Working Group have undertaken a number of research projects that range from an evaluation of health conditions of free-ranging hellbenders to developing a captive breeding program for hellbenders. In 2008 forty juvenile Ozark hellbenders being head-started at the Saint Louis Zoo will be outfitted with radio-transmitters and released at the site where the eggs were collected in south-central Missouri. This project will evaluate the survival and movements of released captive-raised hellbenders, which will help to assess the feasibility of augmenting of wild populations with the release of captive-raised specimens.

##### 4. KIHANSI SPRAY TOADS OF TANZANIA: AN EXAMPLE OF AN EX SITU AMPHIBIAN CONSERVATION PROJECT.

*\*Jennifer Pramuk, Bronx Zoo/Wildlife Conservation Society*

The Kihansi spray toad (*Nectophrynoides asperginis*) is a small toad native to the Kihansi gorge of Tanzania. In 2000, at the invitation of the Tanzanian government, scientists from the Wildlife Conservation Society (WCS) transferred a founder group of 499 critically endangered Kihansi spray toads to the Bronx Zoo in New York. Kihansi spray toads have since become extinct in the wild due to construction of a hydroelectric dam and related activities. In cooperation with the United Republic of Tanzania and the Toledo Zoo, WCS is leading a captive propagation initiative on behalf of these endemic toads. The plan is to breed toads for eventual release while navigating the problems of small population and colony management. In addition, Bronx and Toledo zoos, in conjunction with the Association of Zoos and Aquariums are involved in capacity building through training of Tanzanian experts on amphibian husbandry techniques. After an intensive training session in the United States, these experts will help build a breeding facility in Tanzania to prepare toads for return

to their native wetland habitat. This project is an example of how zoos collaborating with a suite of political and scientific partners can work to solve an environmental crisis.

## 5. MERGING THE MISSIONS OF RESEARCH AND CONSERVATION BREEDING PROGRAMS FOR AMPHIBIANS

*\*Joseph R. Mendelson III, Zoo Atlanta*

The amphibian crisis has changed the rules of conservation biology. In the face of extinctions directly caused by disease, it is no longer sufficient to conserve habitat, control harvest and trade, and educate people. Basic research is needed to help block disease-related extinctions and understand and prevent future disease emergence. While studies of wild populations are crucial, so are simple captive studies of a phylogenetically broad array of live amphibians. We cannot limit studies to model organisms, such as *Xenopus*. Similarly, captive studies are necessary to further our knowledge of the direct and synergistic effects of chemical contaminants and also climate change. Thus, ongoing amphibian conservation efforts in zoos, aquariums, botanical gardens, museums, and universities are called upon to expand and merge their traditional roles to meet the pressing research demands called for by the crisis. Captive colonies must produce the animals needed to meet long-term research needs and to provide animals for the ultimate goal of reintroduction to natural habitats.

## 6. RESPONDING TO THE CALL: ZOOS AND AQUARIUMS TAKE ACTION IN THE FACE OF GLOBAL AMPHIBIAN DECLINES

*\*Shelly Grow, Association of Zoos and Aquariums*

The World Conservation Union has determined that ex situ conservation may be the only hope for the survival of many amphibian species because the threats leading to their population declines cannot be abated in time to save them in the wild. In response, the global zoo and aquarium community is taking a multi-pronged, strategic approach to amphibian conservation. Calling on decades of population management and animal care expertise, institutions accredited by the Association of Zoos and Aquariums (AZA) are working together at unprecedented levels to increase their amphibian conservation capacity and to build and expand capacity internationally. AZA and its members are also leveraging partnerships with local and international conservation partners, government agencies, and other zoological organizations to collaborate on holistic research, reintroduction, and habitat restoration efforts worldwide. Finally, AZA institutions are tapping into their extensive network of outreach and education professionals to raise public awareness of amphibian declines. The goal of these efforts is to engage AZA zoos' and aquariums' 150 million annual visitors in conservation action on behalf of amphibians and their habitats. The results of these efforts have already led to innovative conservation and research commitments, changes in zoological collection priorities, and leadership in a global awareness and fundraising campaign, "2008: Year of the Frog."

## 7. SCIENCE AND MANAGEMENT OF AMPHIBIAN CHYTRIDIOMYCOSIS

*\*Deanna H Olson, USDA Forest Service*

Amphibian chytridiomycosis (*Batrachochytrium dendrobatidis* = Bd) is an emerging infectious disease implicated in amphibian losses worldwide. Bd experts convened in November 2007 to consolidate science findings and develop management recommendations. Our understanding of the scope of Bd is advancing due to the global Bd mapping project. Bd occurs in: 53.5% (38 of 71) of the countries for which we have

data; 233 of 425 (55%) anuran species sampled, and; 24 of 36 (67%) salamander species sampled. Knowns and unknowns were compiled, including: 1) it is known that impact varies with species, strain, geography and life stage; 2) it is unknown how it spreads so quickly or why some animals appear to be resistant. Break-out groups focused hygiene standards to reduce Bd spread, conservation plans for affected areas, fish hatchery issues, and continuing the mapping effort. The Partners for Amphibian and Reptile Conservation (PARC) website ([http://www.parcplace.org/Bd\\_conference.html](http://www.parcplace.org/Bd_conference.html)) is serving as the portal for post-Bd-conference updates, and documents will be posted there such as conference abstracts, maps, break-out group notes, factsheets, disinfection protocols, and other management guidelines.

## 8. STATE WILDLIFE ACTION PLANS AND AMPHIBIANS: A COLORADO PERSPECTIVE

*\*Tina Jackson, Colorado Division of Wildlife*

To continue receiving federal Wildlife Conservation and Restoration Program funds, each state fish and wildlife agency was required to submit a Wildlife Action Plan to the US Fish and Wildlife Service by 10/1/2005. The Colorado Division of Wildlife coordinated involvement of various conservation organizations, agencies, and private citizens in the development of the Colorado Wildlife Action Plan. This important statewide document has identified 9 amphibians and 14 reptiles on the species of greatest conservation need lists. These numbers represent 60% of the native amphibians and 28% of the native reptiles in the state. I will discuss the various threats and conservation actions addressed in the plan.

## 9. STEMMING LATIN AMERICAN AND CARIBBEAN AMPHIBIAN DECLINES: STATUS, THREATS AND POLICY RECOMMENDATIONS

*\*Heidi Ruffler, Defenders of Wildlife*

Since the First World Congress of Herpetology in 1989, the global decline of amphibian populations has reached crisis magnitude. According to the Global Amphibian Assessment, nearly one-third of all amphibian species are endangered or threatened with extinction. Amphibians represent the most endangered taxon of animals in the world with an extinction rate 200 times higher than in the past. The tropics are home to the highest species diversity of amphibians and, particularly in Latin America and the Caribbean, also include some of the areas most severely affected by amphibian declines. Amphibians face a myriad of risks, including loss of habitat, pollutants and diseases such as *Batrachochytrium dendrobatidis* (Bd), the amphibian chytrid fungus. This presentation will assess key aspects of the current status of Latin American amphibians. Focusing on species currently suffering from population declines, the presentation will review the impacts of international trade and the related threat of *B. dendrobatidis* that these species face, and will assess the international legal protections presently offered to them. Recommendations will be made to prevent future amphibian population declines by enhancing international protected species listings and taking measures to prevent the spread of *B. dendrobatidis* through trade.

## 10. SYSTEMATIC CONSERVATION PLANNING FOR POOL-BREEDING AMPHIBIANS ON PRIVATE LANDS: APPLYING THE LANDSCAPE SPECIES APPROACH

*\*Robert Fritz Baldwin, Clemson University*

Landscape species utilize multiple habitats over a large enough spatial scale to be relevant for multiple conservation planning goals. Pool-breeding amphibians use multiple habitats and their

movements require a great deal of space relative to local-scale conservation planning. The Landscape Species approach offers a means to integrate recently-developed, spatially-explicit models to (1) identify regional priority areas, (2) within those areas select priority ecosystems and map critical habitats, and (3) identify where habitat needs conflict with current or planned human infrastructure. We examined the utility of this conservation planning framework, performing gap and threat analyses for two-species landscapes at the region scale. Regional priority focused on 1km<sup>2</sup> blocks of remaining unprotected forests with a high density of wetlands, in rapidly developing towns. While only 1.5% of the study region was determined to be high-value/high-threat, nearly half was intermediate. We used local-scale gap analysis and habitat ecology to map critical habitats and conflicts within priority areas. At the local scale, mapping of critical habitats enabled up to 2/3 cost savings over a widely accepted "core terrestrial habitat" approach. In regions where development pressure is high, private land expensive, and pool-breeding amphibian habitat widespread (e.g., much of the Eastern United States), spatially explicit conservation planning may optimize achieving policy goals.

#### 11. THE CONSERVATION PUZZLE: EDUCATION, RIVERINE TURTLES AND PEOPLE

*\*Christopher Manis, University of Tennessee at Chattanooga; \*Thomas Wilson, University of Tennessee at Chattanooga*

In 2003, the University of Tennessee at Chattanooga began a collaborative effort to develop a comprehensive environmental program that focuses on native freshwater turtles. One of the major goals was to establish an Environmental Awareness Program that would disseminate information to the public about the diverse ecological research conducted by students and scientists. Today, the Environmental Awareness Program has established two distinct and regionally recognized programs that cater to wide variety of ages and socioeconomic classes. These programs have reached over 1500 individuals and include middle school, high school and international students. In general, the Environmental Awareness Program is making local citizens aware of the rich and diverse ecosystems that are found throughout the region, and assists those citizens in developing the necessary background to make sound environmental decisions.

#### 12. THE PARC MODEL FOR APPLIED CONSERVATION BIOLOGY

*\*Jeffrey N. Holmes, Partners in Amphibian and Reptile Conservation*

Scientists engage in research with the intention of influencing on-the-ground conservation, but they are infrequently able to see their recommendations through to implementation. Recognizing this need, Partners in Amphibian and Reptile Conservation (PARC), a multi-disciplinary collaboration that forges partnerships among scientists, educators, policy makers, resource managers, and private citizens, has developed a model for applied conservation biology. This model is a flexible adaptive management process built on the following steps: 1) Identify and prioritize issues; 2) Engage stakeholders; 3) Develop and distribute tools, products, incentives and other resources for implementation; 4) Monitor success; and 5) Adapt previous steps based on monitoring results and emerging science. Following identification of a high priority issue for conservation action, multi-institutional, interdisciplinary task teams are impaneled to execute the remaining steps in the process. The size, composition and life span of each task team

varies according to the skill sets and resources required to thoroughly address each issue. The sequence, relative emphasis and investment of resources may also be adjusted to optimize the impact of conservation actions on the targeted taxa. Results of this model range from informational fact sheets and pamphlets to comprehensive literature syntheses, inventory and monitoring techniques and trainings.

#### 13. USING MODEL-BASED MONITORING IN A NATIONAL AMPHIBIAN MONITORING PROGRAM

*\*Lianne C Ball, USGS; \*Susan Claire Walls, USGS-Florida Integrated Science Center*

Often the purpose of monitoring is to track species over time until the population decreases or increases, at which point management may occur. Many programs could be more informative, however, with small adjustments. Unfortunately, when it is time for managers to act, there is little information because the goal of monitoring was not to learn about the species' ecology, but its status. An alternative approach is to monitor so that learning about the ecology of the species occurs while status data are collected. In this model-based approach, multiple models are proposed about factors that may affect the species' status. Learning occurs as models are evaluated for how well data support them. A second limitation of much monitoring is that not all individuals are detected perfectly during surveys. Therefore, it is not known if a species' density actually varied across habitats, treatments, or time, or only appeared to do so because detection of individuals varied. There are ways to estimate detection probability and produce unbiased estimates of density or distribution. The USGS Amphibian Research and Monitoring Initiative uses model-based monitoring to study amphibians across public lands. We have tested models to learn about ecology and management of amphibians while estimating status.

#### 14. USING TEMPORALLY EXPLICIT POPULATION VIABILITY SIMULATIONS TO IDENTIFY HOT MOMENTS IN ROAD MORTALITY RISK FOR BLANDING'S TURTLES

*\*Frederic Beaudry, University of Maine; \*Phillip deMaynadier, Maine Department of Fisheries and Wildlife; \*Malcolm Hunter, University of Maine*

Threats to the persistence of declining species vary in both space and time. Just as "hot spots" describe locations where threat processes operate at a higher rate than in surrounding areas, "hot moments" refer to periods when threat rates are highest. However, the identification of hot moments can be challenging because the temporal complexity of some threat processes makes their effects on population viability difficult to predict. Declining throughout much of their range, Blanding's turtle (*Emydoidea blandingii*) populations are especially vulnerable to road mortality where road densities and traffic volumes are high. To examine the temporal variability in road mortality risk faced by Blanding's turtles in southern Maine, viability simulations were used to estimate the relative risk for 14 two-week periods during the turtles' active season. These simulations were based on a population viability analysis model where temporally-explicit roadkill probabilities were integrated with demographic parameters informed by local and rangewide studies. We identified early July as a road mortality hot moment for Blanding's turtles, because of an increase in female movement length and frequency during this period. Our findings provide guidance for the implementation of temporally-explicit conservation measures such as cautionary road signage, traffic management, and public outreach that, if timed strategically, could mitigate population impacts from

road mortality.

## 15. WHAT EVER HAPPENED TO MALFORMED AMPHIBIANS?

*\*Brian D. Todd, University of Georgia / Savannah River Ecology Lab*

Amphibian malformations, including bizarre instances of frogs with multiple or missing legs, are one of many problems currently facing amphibians. Parasites were the first causal agent conclusively linked to amphibian malformations but they only explained a portion of the observed cases of malformations. Nevertheless, public media took this as an indication that the unexplained mystery of malformations had been solved and that any discussion of possible grave threats to human health had been overwrought. Although the subject of amphibian malformations has faded from public consciousness, alarming malformations continue to occur across North America and in many cases they remain unexplained. Subsequent research has continued to support the role of parasites in malformations but ultraviolet light and pesticides have also been implicated, suggesting possible repercussions for environmental health. I provide a brief overview of the history of amphibian malformations and the current status of research in this area. I also discuss the important resource known as the North American Reporting Center for Amphibian Malformations operated by the Southern Appalachian Information Node of the USGS National Biological Information Infrastructure that serves as an online repository for reporting and viewing amphibian malformation occurrences (<http://www.nbi.gov/narcam>).

## 5. Assessing Ecosystem Service Values for Marine and Coastal Ecosystems: Melding the Natural and Social Sciences

### 1. INTEGRATING ECONOMIC AND ECOLOGICAL MODELS

*\*Stephen Polasky, University of Minnesota*  
Ecology and economics are sister disciplines, though they have not always been perceived as such. Both disciplines analyze complex systems composed of individuals pursuing objectives given resource constraints. In both, individuals compete for resources as well as cooperate with others (on occasion) for mutual benefit. The collective actions of individuals impact on system level processes with consequent feedback to individuals. Economists have focused on human affairs often with little attention to ecological constraints or impacts. Ecologists have focused heavily on understanding pristine ecological systems largely unaffected by direct human influence. With increased recognition of the importance of ecosystems as the foundation of human well-being, and the large-scale impacts that humans have on ecosystems, there has been increased interest on the part of both economists and ecologists to understand the functioning of the joint human-ecological system. In this talk, I present two examples of integrated economic and ecological models. The first example analyzes spatial land management with both economic and ecological objectives. The second example analyzes the provision of ecosystem services on private lands under alternative policy scenarios. I conclude with some general lessons drawn from these examples, and other, on promising ways to proceed with integrated economic-ecological modeling.

### 2. COASTAL ECOSYSTEM-BASED MANAGEMENT WITH NON-LINEAR

## ECOLOGICAL FUNCTIONS AND VALUES

*\*Edward Barbier, University of Wyoming*

This presentation will be based on a recent article in *Science* (Barbier et al. *Science* 319:321-323), and will include further material and follow-up in addition to that article. A common assumption is that ecosystem services respond linearly to changes in habitat size (e.g., area). This assumption leads frequently to an "all or none" choice of either preserving coastal habitats or converting them to human use. However, our survey of wave attenuation data from field studies of mangroves, salt marshes, seagrass beds, nearshore coral reefs, and sand dunes reveals that these relationships are rarely linear. By incorporating non-linear wave attenuation in estimating coastal protection values of mangroves in Thailand, we show that the optimal land use option may instead be the integration of development and conservation consistent with ecosystem-based management goals. This result suggests that reconciling competing demands on coastal habitats should not always result in stark preservation versus conversion choices.

### 3. AN INTEGRATED APPROACH TO ECOSYSTEM MANAGEMENT IN THE CALIFORNIA CURRENT

*\*Phillip S Levin, NOAA Fisheries; \*Isaac Kaplan, NOAA Fisheries*

Ecosystem-based management requires tools to examine how suites of management actions influence the status of the ecosystem. Recently, a formal approach, Management Strategy Evaluation, has been developed to examine potential impacts of management actions. In this approach a simulation model is used to generate 'true' ecosystem dynamics. Data are then sampled from the model to simulate surveys, and these data are passed to assessment models. Based on this assessment of the simulated ecosystem, a management decision is simulated. Human response to this simulated decision is modeled, and potentially influences the simulated ecosystem state. By repeating this cycle, one can simulate the full management cycle. This approach allows us to test the utility of modifying assessments, monitoring plans, management strategies, or decision rules. Within this framework, economics and ecology interact in two ways. First, accurately representing human reactions to regulations is critical to determining the impact of regulations on future ecosystem state. Secondly, evaluating what management actions might be imposed requires a consideration of trade-offs among ecosystem services. We explore these links between ecology and economics using the California Current marine ecosystem as an example. Specifically, we focus on management actions that consider the potential effect of individual transferable fishing quotas on the structure and function of the California current ecosystem.

### 4. ECOSYSTEM SERVICES PROVIDED BY THE NEARSHORE IN PUGET SOUND: AN ANALYSIS OF CHANGE THROUGH AN ECOLOGICAL LENS

*\*Anne D Guerry, National Marine Fisheries Service; \*Mark Plummer, National Marine Fisheries Service; \*Mary Ruckelshaus, National Marine Fisheries Service; \*Jeremy R. Davies, NOAA Fisheries, NW Fisheries Science Center; \*Jason J. Miller, NOAA Fisheries, NW Fisheries Science Center; \*Krista K. Bartz, NOAA Fisheries, NW Fisheries Science Center*

In principle, the framework of ecosystem services can inform ecosystem approaches to managing coupled social-ecological

systems. However, the transition from theory to practice is challenging. Making ecosystem services a useful concept to Puget Sound ecosystem management requires basic research on how valuable services are produced by the underlying ecological system and how those services might be affected by alternative management schemes. Our interdisciplinary collaboration examines a diverse suite of ecosystem services that are derived from nearshore marine habitats across the Puget Sound region and how changes in the nearshore are likely to affect the flows of those services. First, we will outline the scope of our program, summarizing the range of services within our purview and the ways in which we are modeling them. Then, we will discuss model results from some key services (e.g. the provisioning of harvest and carbon sequestration by eelgrass). Throughout we will emphasize three key themes: 1) the utility of modeling change in ecosystem services under alternative management scenarios, rather than tallying static ecosystem services and their values, 2) the importance of incorporating spatially-explicit information into ecosystem-service modeling, and 3) the benefit of close interdisciplinary collaboration between economists and ecologists. This talk is a companion talk to the next talk in the symposium, an economist's perspective on the same work.

## 5. ECOSYSTEM SERVICES PROVIDED BY THE NEARSHORE IN PUGET SOUND: AN ANALYSIS OF CHANGE THROUGH AN ECONOMIC LENS

*\*Mark Plummer, National Marine Fisheries Service; \*Anne D Guerry, National Marine Fisheries Service; \*Mary Ruckelshaus, National Marine Fisheries Service; \*Jeremy R. Davies, NOAA Fisheries, NW Fisheries Science Center; \*Jason J. Miller, NOAA Fisheries, NW Fisheries Science Center; \*Krista K. Bartz, NOAA Fisheries, NW Fisheries Science Center*

Ecosystems are the source of a wide variety of valuable goods and services. Some are as obvious as a marketable commodity, such as salmon fillets and clam chowder. Others are less obvious but still valuable, such as shoreline stabilization and carbon sequestration. The concept of ecosystem services captures the full extent of this natural bounty. In principle, these services can be incorporated into an ecosystem approach to managing natural systems such as Puget Sound, but making the transition from theory to practice is challenging. Simply knowing that such services exist might inspire decision makers to strive for more conservation, but that knowledge alone provides no guidance on where and how much conservation should take place. This presentation examines the economic side of an assessment of ecosystem services for Puget Sound, focusing on the harvest of commercial and recreational species. While the value of this service is substantial, the more important issue is the incremental value associated with changes in the ecological condition of Puget Sound. Our current results illustrate how management of nearshore habitat is likely to produce an increase in the potential harvest of important commercial and recreational species.

## 6. Beneath the Surface - The Freshwater Mollusks of the Southeastern United States

### 1. THE [FORMER] DIVERSITY AND ZOOGEOGRAPHY OF SOUTHEASTERN FRESHWATER MUSSELS

*\*John Joseph Jenkinson, Retired from Tennessee Valley Authority*

As the streams on the southeastern part of North America flow from the mountains to the sea, they form a wide variety of habitats and support some of the most diverse temperate aquatic communities on Earth. One component of these communities, the freshwater mussels, is represented in southeastern streams by approximately 200 species -- more species of these mussels than occur on any of the other continents. These animals exhibit extremely wide ranges of shell sizes, shapes, colors, and ornamentation. Their distribution patterns also include wide variations, with some species restricted to single drainage basins, some occurring over large areas, and some apparently found associated with broad, and ancient, physiographic regions. This talk will introduce the diversity represented by southeastern freshwater mussels and start our exploration into the biology and ecology of this unique faunal group. Unfortunately, the natural character of many southeastern streams has been severely degraded by human activities and this talk also needs to introduce the critical status of many freshwater mussel species.

### 2. WONDERS DOWN UNDER: ADAPTATIONS TO LARVAL PARASITISM IN FRESHWATER MUSSELS

*\*Chris Barnhart, Missouri State University*

Native freshwater mussels are a marvelous group of economically, ecologically, and scientifically important animals that are, nonetheless, nearly unknown to the general public. Mussels live in an intricate symbiosis with fish that support their larval development. This unique life history is essential to understanding both the evolutionary success of the group and the present conservation crisis. The parasitic larval stage was a key adaptation of the mussel ancestor, permitting upstream dispersal in freshwater. The diversity of mussels is associated with exploitation of particular adaptations for parasitizing hosts. Female mussels attract their fish hosts with an amazing variety of lures, baits, nets, traps and behaviors. Who can be unimpressed by a blind shellfish that angles for bass with a minnow-like lure on a transparent line? Or captures small fish like a Venus' flytrap and then sets them free with larvae attached? These adaptations are associated with varying degrees of host specificity and related specializations of life history and ecology as diverse as fecundity, reproductive season, habitat, and geographic distribution. The relationships between mussels and fish are easily disrupted and thus contribute to the imperilment of many mussel species, yet they also fascinate us and can help to compel conservation efforts.

### 3. A BIODIVERSITY ASSESSMENT OF NORTH AMERICAN FRESHWATER GASTROPODS.

*\*Paul David Johnson, Alabama Department of Conservation and Natural Resources*

North American contains the richest freshwater gastropod fauna on the planet. This diversity is organized into 13 families, 96 genera, and nearly 700 species described thus far. As with other riverine groups, zoogeographic patterns of species diversity are focused around major drainage basins. Although freshwater snails show exceptional diversity in areas outside the southeast, the Alabama River drainage is the epicenter of North American species richness. Endemism is exceptionally high in some families making many species vulnerable to extinction from localized impacts. An initial conservation assessment determined 68 species of freshwater snails are likely Extinct (GX) and at least 352 additional species rank as Endangered or Threatened (G1 or G2). Another 68 species considered Vulnerable (G3). Fully 70% of currently recognized species are extinct, endangered, threatened, or vulnerable. This is the highest imperilment rate for any major freshwater group

in North America, including freshwater mussels. However, only 23 species are currently recognized nationally by the US Fish and Wildlife Service as Threatened or Endangered. Conservation planning and on-the-ground recovery efforts with freshwater snails are underway in Alabama including an artificial propagation and culture program for some of the rarest riverine snails.

#### 4. THE FUNCTIONAL ROLE OF FRESHWATER MUSSELS IN ECOSYSTEMS.

*\*Caryn C. Vaughn, University of Oklahoma*

Freshwater mussels (Bivalvia: Unionoida) are long-lived, burrowing filter feeders that act as natural biofilters by linking benthic and pelagic compartments in lakes and rivers. Living mussels and their spent shells provide or improve habitat for other organisms by providing physical structure, stabilizing and bioturbating sediments, and influencing food availability directly and indirectly through biodeposition of organic matter and nutrient excretion. Effects of mussels on ecosystem services are context-dependent and vary with mussel abundance, species composition, and environmental conditions. Mussel effects extend across trophic levels influencing both primary producers and consumers. Healthy mussel communities occur as multispecies assemblages in which species interactions are likely very important. Mussels are declining globally and community structure is changing in response to human activities. This will likely impact the ecosystem services provided by mussels.

#### 5. PROPAGATION AND CULTURE OF ENDANGERED FRESHWATER MUSSELS

*\*Richard Joseph Neves, Virginia Tech; \*Dan Hua, Virginia Tech; \*Jess Jones, U.S. Fish and Wildlife Service; \*William Henley, Virginia Tech*

The U.S. Bureau of Fisheries established the first freshwater mussel propagation facility at Fairport, IA, in 1914, in response to over-harvest of shells for the pearl button industry, but was unable to develop reliable methods for culturing mussels for release. Propagation efforts were reinitiated for the now 70 federally endangered and threatened mussel species about 11 years ago, with the successful culture and release of endangered tan riffleshells by the Freshwater Mollusk Conservation Center (FMCC) at Virginia Tech. Using recirculating aquaculture systems, the FMCC has focused on the 37 protected species in the Tennessee River system and has successfully propagated 25 of those species. About 100,000 juveniles are released each year. In recent years, an additional 14 federal and state-operated facilities have implemented propagation projects and released more than 10 million juveniles of rare species into rivers of the U.S. Each facility uses available water resources and culture systems designed or modified at their locale, to accommodate available space, personnel, and budget. Diets include a variety of cultured unicellular algae as well as commercially available micro-algae concentrates used by the marine shellfish industry. The rapid success of varied culture methods and technology now provides the capability to propagate most mussel species in need of conservation or restoration in state and federal waters.

#### 6. CHEMICAL IMPACTS TO FRESHWATER MUSSELS: A COMPARISON OF LIFE STAGE EXPOSURE AND SENSITIVITY

*\*W. Gregory Cope, North Carolina State University; \*Teresa J. Newton, US Geological Survey; \*Christopher G Ingersoll, US Geological Survey*  
Freshwater mussels (superfamily Unionoidea) are in serious global decline and in urgent need of protection and

conservation. We evaluated the routes and pathways of exposure for all 4 life stages (free glochidia, encysted glochidia, juveniles, adults) of native mussels to environmental pollutants in a life history context and found that each life stage has both common and unique characteristics that contribute to observed differences in exposure and sensitivity. Free glochidia are typically exposed only briefly (e.g., seconds to days) through surface water, whereas adults have sustained exposure over years to decades through surface water, pore water, sediment and diet. In contrast, juveniles reside largely burrowed in the sediment for the first 0-4 y of life and thus sediment, pore water, and diet are the predominant exposure routes for this life stage; however, surface water may also contribute to exposure of juvenile mussels during certain periods and environmental conditions. The exposure route for the obligate parasitic stage (encysted glochidia stage) on a host fish may be from surface water while partially encysted, or from toxicants contained in host fish tissue while fully encysted. Additional research is needed to understand the interactions of life history, habitat, and long-term exposure of mussels to contaminants through water, pore water, sediment, and diet so that the risks of environmental exposures can be properly assessed and managed.

#### 7. FRESHWATER MUSSEL ASSEMBLAGE CHANGE IN RESPONSE TO HABITAT ALTERATION

*\*Wendell R. Haag, U.S. Forest Service*

Freshwater mussel declines due to habitat alteration are well documented but patterns of assemblage change have received less attention. Assemblage changes depend on the type of alteration and species life history traits. Acute stressors, including pollution or drought, often affect all species similarly, regardless of life history, resulting in an overall decrease in mussel abundance; in these cases, assemblage change occurs primarily by the loss of rare species due to a random sampling effect. This results in species being falsely perceived as either "tolerant" or "intolerant", even though both groups declined at similar rates. In contrast, major habitat transformation results in consistent patterns of assemblage change related to species life histories. For example, in impounded streams that retain riverine characteristics, most species may survive impoundment, but only species whose host fishes persist in the altered habitat can reproduce. In severely destabilized streams, only short-lived, early maturing species persist, even though host fishes for other mussel species are present. The concept of tolerant or intolerant species is useful only in the context of a specific type of habitat alteration. Patterns of assemblage change can be used to infer past insults to streams and to develop strategies for correcting them.

#### 8. TENNESSEE'S DUCK RIVER: A RARE GEM OF AQUATIC DIVERSITY

*\*Leslie Colley, The Nature Conservancy*

The Duck River in Tennessee remains one of the most biologically diverse rivers on the North American continent and is an outstanding national resource. The Duck River rises up on the Eastern Highland Rim and flows west 270 miles to the Tennessee River. Contained almost solely within the larger Interior Low Plateau ecoregion, the Duck River watershed is characterized by a large, complex karst geologic system. The total number of riverine fauna currently documented in the Duck River watershed exceeds 650 species and includes 151 species of fish, 54 species of freshwater mussels, and 22 freshwater snail species. The most pressing threats to this remarkable ecosystem are associated with incompatible agricultural practices, wastewater management practices, urbanization, and water supply management practices. The

Nature Conservancy opened an office in the Duck River watershed in 1999 and is working with a wide array of partners to abate these threats. Ongoing work with the agricultural community, collaborative land use planning efforts with local decision makers, a multi-year mussel recovery plan and bringing sound science to bear in managing the resource for water supply are current strategies for conserving this last refugia for several Tennessee-Cumberland mussel species.

## 7. Biofuels and Biodiversity: An Assessment of Potential Effects on Species and Ecosystems

### 1. QUANTIFYING TRADE-OFFS BETWEEN PLANT PRODUCTIVITY AND BIODIVERSITY IN LANDS ALLOCATED TO GROWING BIOFUEL

*\*David James Flaspohler, Michigan Technological University; \*Chris Webster, Michigan Technological University; \*Amber Roth, Michigan Technological University*

Growth in foreign and domestic demand for automotive fuels and recent high crude oil prices have focused renewed attention to alternative sources of fuel such as plant-based ethanol. Lignocellulosic biomass from aspen (*Populus* spp.) forests and native grasslands provide an opportunity to produce a transportation fuel with high net energy yield, while sustaining diverse plant and wildlife communities and reducing greenhouse gas emissions. The management of native vegetation for such purposes will require an evaluation of trade-offs between plant productivity and wildlife habitat quality. For two years we have quantified productivity and diversity for vegetation and wildlife in aspen forests and native grass plantings in the Midwestern U.S. Preliminary results suggest that retaining structural attributes from pre-harvest stands (i.e., legacy trees) of aspen results in greater diversity of bird species of conservation concern and higher densities of golden-winged warblers (*Vermivora chrysoptera*) in particular. In restored grass lands, preliminary results suggest that insect abundance (the food base for many grassland birds during the breeding season) increases with plant species richness. Over the next few years, these companion studies will furnish a clearer view of the trade-offs associated with biomass production and possibly, alternatives to balance the impacts of intensive vegetation management on biodiversity.

### 2. THE FULL COST OF ETHANOL VERSUS GASOLINE

*\*Stephen Polasky, University of Minnesota*

Concerns about the negative environmental consequences of burning fossil-fuels, high prices, long-term availability, and energy security have spurred interest in the production of liquid biofuels for transportation as an alternative to gasoline and diesel. Biofuels offer potential advantages over fossil fuels but whether they generate greater net benefits to society depends on how biomass is grown and converted into biofuel. We conduct a life-cycle assessment of ethanol production and consumption, including inputs to, and emissions from, growing biomass, the conversion of biomass to biofuel, and tailpipe emissions. We analyze different biomass feedstocks (corn, stover, switchgrass and prairie biomass) and energy sources for the biorefinery (coal, natural gas, stover, switchgrass and prairie biomass). We combine the life-cycle assessment with an economic assessment of the direct market costs of production and the damages associated with emissions of criteria air pollutants and net greenhouse gas emissions. Producing ethanol from corn using coal as the energy source at the refinery, which

has the lowest direct cost, generates higher environmental costs than gasoline. Cellulosic ethanol, particularly using biomass grown with low inputs, is more environmental beneficial, but will be cost competitive with gasoline only if gasoline prices rise further and cellulosic production costs fall.

### 3. PRINCIPLES FOR PROMOTING "GREENER" BIOFUEL PRODUCTION

*\*Martha Groom, University of Washington, Bothell;*

*\*Elizabeth Marie Gray, The Nature Conservancy;*

*\*Patricia Townsend, University of Washington*

The surge to promote biofuels as a "green" alternative to petroleum based fuels is already having some negative consequences for biodiversity. We advocate greater involvement among conservation biologists in identifying and developing guidelines for "biodiversity-friendly" biofuels. Guidelines that should be part of any policy that promotes biofuel production should include (1): biofuel feedstocks should be grown with environmentally-safe and biodiversity-friendly agricultural practices; (2) the ecological footprint of a biofuel should be minimized; and (3) the entire production life cycle should have a negative or zero carbon balance. We urge aggressive pursuit of alternatives that are not currently in the forefront of biofuel policies, particularly microalgal and perennial feedstocks, and agricultural practices that support, rather than destroy, biodiversity. Conservation biologists can broaden and deepen such efforts through their research and participation in policy setting.

### 4. BIOFUELS AND BIODIVERSITY: INTERNATIONAL RESPONSES TO POTENTIAL CONFLICTS

*\*Jeffrey McNeely, IUCN-The World Conservation Union*

Biomass has long been the primary source of energy for humans, along with solar power driving photosynthesis and wind power driving windmills and sail boats. Fossil fuels have been an historical anomaly that enabled industrialized, globalization and a significantly expanded human population. Now that the problems of fossil fuels are becoming evident, governments in all parts of the world are looking for alternative sources of energy, of which biomass has received considerable attention. Brazil has been a leader, but many other countries are also making significant investments in biofuels, with impacts on biodiversity seldom receiving appropriate attention, if any. The impact of forest clearance in Southeast Asia for oil palm is one dramatic example, but many others can be cited. Many efforts to ensure sustainability, which includes conservation of biodiversity, have yielded sound policy advice which, if followed, could enable biodiversity conservation to be incorporated as part of energy development. This paper will discuss some of the international agreements that are being reached to ensure that biofuel development does not undermine biodiversity conservation, and indeed helps to support it. Remaining challenges and research priorities will also be discussed.

### 5. ECOLOGY, ETHICS, ECONOMICS, AND ETHANOL: PUTTING BIOFUELS IN A CONSERVATION CONTEXT

*\*Curt Meine, Aldo Leopold Foundation/Center for Humans and Nature*

Conservation biologists are accustomed to considering the complex chains of cause and effect that affect the status of biological diversity, ecological processes, ecosystem health, and human communities; understanding those relationships

within in a landscape context; and weighing those connections in terms of sustainability. However, over the last several years, the rapid expansion of the biofuels industry—and the boom in corn-based ethanol in the United States in particular—has played out with little more than token consideration of its conservation consequences. As ethanol production has ramped up, the impacts on soils, on water quality and quantity, and on biological diversity have received little attention. How do we as conservation biologists and ecologists frame this issue? How can and should we engage this growing force on the landscape? At its core, the issues associated with development force us to ask whether we will be effective in promoting a more integrated, ecosystem-based approach to land management and stewardship.

## 8. Biogeography

### 1. ARE EASTERN SMALL-FOOTED BATS FACING AN ECOLOGICAL TRAP?

*\*Reese M. Arh, University of Toronto*

The eastern small-footed bat, *Myotis leibii*, is found in southern Ontario and the adjacent part of Quebec, south to Oklahoma in the United States. It is not known to migrate and instead stays year round close to its hibernaculum. A major threat to this species is disturbance during hibernation that can lead to depletion of fat reserves required to survive the winter. Some hibernacula in North America have shown a 95% decrease in bat populations due to human disturbance. Of the 33 known caves in Ontario and Quebec, fifteen are available for year round access by cavers and four have organized tours. The increased interest in caving has led to greater disturbance in caves that were once able to support bat populations prior to the availability of abandoned mines. Abandoned mines increased the number of available hibernacula, however a mining act created in 1990 required owners to close up hazardous, abandoned mines on their properties. This has led to 64% of all known mines abandoned since 1900 to be closed between 1996 and 2000. Less than 1% of the mines were closed using bat friendly gates, majority were backfilled with debris or capped with cement. This shift from disturbed caves to abandoned mines and the recent increase in abandoned mine closures has led to an ecological trap for bats.

### 2. CONSERVATION, GENETICS AND THE SPATIAL SCALE OF POPULATION CONNECTIVITY IN CORAL REEF FISH

*\*Josh Drew, Boston University; \*Paul Henry Barber, Boston University*

Understanding the spatial scales over which populations of coral reef fishes are connected is important in setting conservation priorities. Here we compare patterns of genetic connectivity of several common coral reef fishes over multiple spatial scales. On the finest scale, between the islands of Fiji we see broad scale genetic homogenization with most, but not all of the species we examine. On the next highest spatial scale (between Fiji and the rest of Melanesia) we see evidence for regional endemism within five species of fishes. Expanding further, we investigate two species of fish whose species ranges are entirely within Melanesia and Indonesia. Here we see evidence for restricted gene flow across the Indo-West Pacific archipelagos ultimately leading to the evolution of peripheral populations into reproductively isolated monophyletic clades. Finally at the largest spatial scales we use the widely distributed species *Halichoeres hortulanus*, to investigate gene flow across the Indian and Pacific oceans, and discover significant barriers to gene flow between these oceans occurring in the Indonesian archipelago. Our results

demonstrate that despite having pelagic larvae and the ability to distribute genes over broad geographic differences, some coral reef fish populations are geographically structured, but the magnitude of that structure depends on the spatial scale considered.

### 3. DOES SIZE MATTER? HUMAN PERCEPTIONS OF SPECIES ENDANGERMENT

*\*Christopher A. Lepczyk, University of Hawai'i at Manoa; \*Rebecca A Christoffel, Prairie Biotic Research, Inc.; \*Daniel T Rutledge, Manaaki Whenua Landcare Research NZ Ltd*

Species endangerment has been attributed to a host of ecological factors, but it is also a function of what we know about a species, i.e. our knowledge or perception of its status. However little research has examined the influence of human perception to species endangerment. We explored the influence of human perception by evaluating the trends of two related indicators, body mass and geographic range, of endangered species listed in the U.S. from 1967 to 1999. We hypothesized that both indicators would correlate negatively with time of detection, or the year a species was listed. We tested our hypothesis with consideration of taxonomic grouping and geographic context (continental USA vs. Hawai'i). Over time species listed under the U.S. Endangered Species Act decreased in mass and geographic range, with differences arising among taxonomic groups. All groups exhibited a negative relationship with mass, but four groups (birds, fish, crustacea, and snails) exhibited a positive relationship with geographic range. Hence smaller species were listed more recently compared to larger species. Overall our findings suggest that human perceptions have changed over time. We have increased the magnification of our efforts over time, such that future species in need of listing will likely have smaller sizes and ranges.

### 4. ESTABLISHING THE STATUS OF THE AMERICAN BLACK BEAR (*URSUS AMERICANUS*) IN MISSOURI

*\*Lori S. Eggert, University of Missouri; \*Kaitlyn M Faries, Division of Biological Sciences, University of Missouri*

The Missouri Department of Conservation estimates that there are approximately 300 black bears in the southern part of the state, based on the distribution of reported sightings, visitation rates to bait-station survey routes, and nuisance complaints. Although there were anecdotal accounts of bears in the Missouri Ozarks after they were believed to be extirpated in the 1930's, it is likely that today's Missouri bears originated from a small Minnesota population relocated to Arkansas in the 1950's-1960's. The Arkansas population has since grown, possibly resulting in migration to the southern region of Missouri. Despite the fact that nuisance complaints have risen rapidly in Missouri during recent years, no recent studies have been done to confirm the number and origin of Missouri's black bears or to determine if they may represent a sustainable, reproducing population. Determining their status, however, is problematic because black bears are typically found at low densities and are elusive in nature. Our study used non-invasive sampling of hair to obtain DNA to estimate the relatedness between individuals, the sex ratio, and the source of Missouri's bears. The information gained from our study will be crucial in designing conservation strategies for minimizing the conflict between humans and bears and for long term conservation in Missouri.

### 5. PREDATION RISK EXERTS PRIMARY CONTROL OVER THE DISTRIBUTION OF LOW

## DENSITY ANTELOPE SPECIES

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Distribution ranges in the Kruger National Park were estimated from EAS data (1980-1993) using local nearest-neighbour convex-hull (k-NNCH) techniques (Getz and Wilmsers 2004). The four low density antelope species, sable, roan, eland, and tsessebe, showed substantial reductions in abundance but little changes in range extent. There were no consistent associations between sable occurrences with geology or vegetation types. Sable presence was positively associated with that of buffalo and zebra, suggesting no avoidance of these potential competitors at broader scales, but core areas of the distributions overlapped less. Sable showed a negative association with wildebeest, suggesting preference for different habitats. The spatial distribution of predation risk was estimated from the product of population density, carcass mass and relative kill likelihood for lions, summed over all prey species. Core areas in the sable distribution were associated with regions of the park where this predation index was low. The distribution of roan, tsessebe and eland was concentrated in the north of the park where predation risk appeared generally lower than elsewhere. Findings suggest that risk of predation by lions is the primary factor governing the restricted distribution of the low density antelope species in Kruger Park.

## 6. TELLTALE SIGNATURES OF A DYNAMIC PAST AND UNCERTAIN FUTURE: THE FRAGMENTED CARNIVORE POPULATIONS OF THE NORTH PACIFIC COAST

\*Natalie Gwen Dawson, *University of New Mexico*;  
\*Joseph A Cook, *University of New Mexico*

The North Pacific Coast of North America supports the largest remaining tracts of temperate rainforest in the world that are spread across two large island archipelagos. Alaska's Alexander Archipelago consists of over 18,000 islands under the management of the Tongass National Forest, while the Haida Gwaii Archipelago of British Columbia consists of over 150 islands. Our investigations spanning over 17 years have uncovered a suite of insular populations of mammals that are evolutionarily distinct. This study examines three carnivores (black bears, marten and ermine) to explore molecular signatures of endemism, connectivity, and hotspots of diversity using mtDNA sequences and nuclear microsatellite and SNPs. Marten (*Martes americana* and *Martes caurina*, n=320) are old-growth forest obligates, ermine (*Mustela ermine*, n=190) provide evidence for Pleistocene refugia on some islands, and black bears (*Ursus americanus*, n= 300) provide a model framework for the geographic influence of an island archipelago on vagile species. The dynamic geologic history of the region combined with an extremely fragmented landscape (natural and human induced) provides a background for understanding evolutionary and ecological processes such as colonization, population bottlenecks, incipient speciation, hybridization and possible extinction of island endemics. This system highlights the importance of reinvigorated cohesion between modern conservation and the science of evolutionary biology.

## 7. WE CANNOT LET IT GO: CONSERVATION EFFORTS IN ALBERTINE RIFT IN WESTERN TANZANIA

\*Shadrack Mkolle Kamenya, *The Jane Goodall Institute*; \*JANE GOODALL, *The Jane Goodall*

*Institute*; \*Emmanuel Mtimi, *The Jane Goodall Institute*; \*Sood Ndimuligo, *The Jane Goodall Institute*

Western Tanzania is biodiversity-rich hotspots harbouring endangered, threatened, rare and vulnerable species of flora and fauna. It is a refuge for endemic flora and fauna including; chimpanzees, elephants, lions, ungulate species, many birds and endemic fishes. The health of Lake Tanganyika, which is a major source of livelihood and protein to the human community, also depends on the health of its catchment forests, rivers and streams. This ecosystem is facing many threats mainly due to human activities, resulting from lifestyle, poverty, and lack of education, and there is further need of tapping natural resources from this region. The region also has high movements of people moving into previously unoccupied areas, especially preferring forested lands. The region has had recent human population increase as much as 4.8% per year, but at the same time deforestation rate of 2.5% compared to the national rate of 1%. This paper will show that most agricultural practices in the region threaten both the wildlife and people's livelihood. The Jane Goodall Institute has been in the region for the past 48 years practicing research and conservation efforts. This paper discusses the threats and challenges to the region's biodiversity and livelihood and describes ongoing efforts in conservation of natural resources in the region. The paper shows the significance of quantitative and qualitative data justifying the urgency of conservation needs and efforts.

## 8. WILDERNESS AREAS PROTECT POSITIVE PRODUCTIVITY-DIVERSITY RELATIONSHIPS BECAUSE OF THEIR LOCATION IN ECOREGIONS WITH COMPLEX TOPOGRAPHY

\*Travis Belote, *Virginia Tech, Biological Science*;  
\*Stephen P. Priskey, *Virginia Tech, Forestry*

Understanding relationships between ecosystem productivity and species diversity may lead to improved management for carbon sequestration and biodiversity. Few ecologists have yet investigated whether land management alters the relationship between productivity and diversity. We collected productivity and tree diversity data in five southeastern states using MODIS-derived productivity estimates and Forest Inventory and Analysis data, respectively. Data were analyzed across the study area to investigate regional relationships between productivity and diversity. To investigate how land management might alter relationships, we analyzed data within four separate land management categories including privately-owned, Forest Service, National Park Service, and wilderness areas. We also investigated how the productivity-diversity relationship might differ between physiographic areas and thus analyzed data within thirteen separate ecoregions. We found that relationships were commonly negative across the region and within many management areas and ecoregions. However, wilderness areas exhibited a positive productivity-diversity relationship. This pattern is likely due to the fact that wilderness is limited to mountainous ecoregions that also exhibit positive relationships caused by complex topography where resources and diversity correlate spatially. These results suggest productivity-diversity relationships depend on ecological variation within regions and possibly land management.

## 9. Biogeography (2)

### 1. BIOGEOGRAPHIC RELATIONSHIPS AND THREATS ASSOCIATED WITH MARINE FISH FAUNAS AT FOUR WORLD HERITAGE SITES

## IN THE EASTERN TROPICAL PACIFIC

*\*Graham Edgar, Conservation International;*  
*\*Stuart Banks, Charles Darwin Foundation; \*Sandra Bessudo, Fundacion Malpelo; \*Monica Calvopiña, University of Tasmania; \*Jorge Cortes, CIMAR;*  
*\*Hector Guzman, Tropical Research Institute; \*Scott Henderson, Conservation International*

Marine conservation efforts largely comprise two strategies: (i) threat amelioration at the individual level for large charismatic species, and (ii) development of marine protected area (MPA) networks as an umbrella safeguard for other species. We here assess whether this second strategy provides an adequate safeguard for fishes at the level of individual species.

Quantitative underwater visual censuses of reef-associated fishes were undertaken at multiple localities within four island groups in the eastern tropical Pacific—Galapagos (Ecuador), Cocos (Costa Rica), Malpelo (Colombia) and Coiba (Panama). These island groups are all nationally designated as marine protected areas and included on the IUCN list of World Heritage sites. Differences in ichthyofaunas between the four sites reflected both biogeographic affinities and also patterns of human usage. Although regarded as the most pristine locations in the eastern tropical Pacific, all four sites contained multiple threatened fishes. The number of threatened fishes, type of threat, and urgency of management response needed, varied within and between island groups.

## 2. ENDEMISM, EVOLUTIONARY HISTORY, AND THREATENED SPECIES IN BIODIVERSITY HOTSPOTS

*\*Will Turner, Conservation International; \*Russell Mittermeier, Conservation International; \*Thomas Brooks, Conservation International; \*Gustavo A. B. da Fonseca, Global Environment Facility; \*Michael Hoffmann, IUCN-World Conservation Union; \*John Lamoreux, Texas A&M University; \*John Pilgrim, BirdLife International; \*Ana Rodrigues, University of Cambridge*

Global conservation prioritization strategies such as biodiversity "hotspots" are derived from data on irreplaceability (for example, numbers of endemic species, often of a single taxon) and vulnerability (for example, proportionate habitat loss). However, it is debated whether such priorities serve as useful surrogates for other taxa, or for evolutionary history, which would maximize their option value and evolutionary potential. We use new data on the global distribution of 27,767 mammal, bird, reptile, and amphibian species and recent randomization and optimization techniques for measuring surrogacy to test how effectively hotspots capture multi-taxon species-level endemism and whether hotspots are useful surrogates for evolutionary history. For terrestrial vertebrate species, we show that hotspots generally harbor not only considerably more endemic species than expected were the same land area sampled at random, but more endemic higher taxa as well. Only 8-28% of this improvement is due to the clustered nature of hotspots; the remainder is due to the particular arrangement of priority regions around the globe. These results are more marked if we consider only threatened taxa. Global conservation priorities such as hotspots appear to be useful targets for both the efficient conservation of irreplaceable species diversity and the overall evolutionary value of biodiversity.

## 3. INVESTIGATING DATA QUALITY WHEN MAKING RANGE PREDICTIONS FOR ALIEN

## PLANT INVADERS

*\*Rene Wolmarans, Zoology and Entomology*

Models predicting the potential distribution of alien species can be used to identify areas at risk of invasion and priority areas for monitoring and management of these species. Predictions can be made using a model calibrated with native range records which quantifies the species-environment relationship.

However, the available records may only sample a subset of the climatic niche of a species, resulting in an underestimation of the potential distribution in the adventive range. To test the impact on model performance when using occurrence records from only a part of a species' native range, adventive range predictions were made for certain Australian plant species invading South Africa and vice versa. For each species, predictions made with records that represented the full native range were compared to predictions made with six different partial range datasets. Preliminary results indicated that model performance did not differ significantly between range treatments. This suggests that the potential distribution of a species in its adventive range is not greatly underestimated when occurrence records used only represent a proportion of a species native range, and hence only a subset of the species' climatic niche.

## 4. NULL MODEL SOFTWARE FOR INFORMING CONSERVATION POLICY

*\*Joshua Ladau, Santa Fe Institute; \*Sadie Ryan, Stanford University, McGill University*

In order to preserve ecosystems, it is necessary to understand the structure and function of communities. Null model tests comprise a key tool for inferring the determinants of community structure from observational data, for instance allowing inferences about macro-scale effects of competition, facilitation, and habitat filtering from species distributions. In this talk, we will first show that existing null model tests are usually robust and powerful (i.e., reliable) only under limited circumstances. We will describe a new test that is generally robust and uniformly most powerful in general circumstances. We will conclude by presenting user-friendly software that allows the reliability of existing tests to be assessed on a case-by-case basis. We will also present software for implementing the robust, uniformly most powerful test, making it accessible to ecologists and practitioners. Illustrative results from applying the software to data on South African megafauna indicate effects of interspecific interactions only in a few instances. By permitting strong inferences about the structure and function of communities, this software will be important in informing conservation policy.

## 5. PARASITE DIVERSITY AND HOST DIVERSITY: A CASE STUDY FROM NORTH AMERICAN CARNIVORES

*\*Nyeema Harris, North Carolina State University*

Parasites are a major conservation concern because of their ability to cause disease in their host populations. Understanding determinants of parasite diversity and distribution may assist in mitigating their effects on populations of conservation or management concern. My objectives were to: determine the relationship between parasite diversity and carnivore diversity, explore spatial variation in parasite species diversity, and evaluate whether species of conservation concern and host geographic range affected the diversity of parasites. I obtained parasite-host data from a systematic review of the literature and distribution maps for 32 terrestrial carnivores in North America. There was a strong positive, curvilinear relationship between parasite diversity and carnivore diversity, and a latitudinal gradient in the average number of parasites per

carnivore host (i.e. alpha diversity). There was no significant difference in parasite diversity between carnivore species of concern and species of no conservation concern, but parasite host-specificity increased with the geographic range of the host species. This study clearly demonstrates that the spatial variation in parasite species diversity is a direct function of carnivore species diversity. Therefore, emphasizing the need to conserve areas of high biological diversity and to employ disease surveillance to stimulate prospective, preventive conservation actions.

## 6. SEEK AND YE SHALL FIND THE MISSING BIRDS IN THE AMAZON

*\*Mariana M Vale, Universidade do Estado do Rio de Janeiro; \*Clinton N Jenkins, Duke University;*

*\*Stuart L Pimm, Duke University*

We evaluated how spatial collecting bias affects patterns of bird richness, endemism, and conservation in the Amazon. We then compared these results with similar analyses for the relatively well-collected Brazilian Atlantic Forest. As data inputs, we used the Ornithological Gazetteers of the Neotropics and distribution maps from NatureServe. Collection density in the Atlantic Forest was five times greater than in the Amazon. In both, collection localities were significantly closer to access points than expected at random. The richness at collection localities was significantly higher than expected at random. This greater richness in collected areas was associated with a higher proportion of species with small geographical ranges. This suggests that there are small-ranged species awaiting discovery in uncollected areas. These small-ranged species are of special conservation value, as they have a greater risk of extinction. Finally, Endemic Bird Areas in Amazon had significantly more collection localities than expected at random, leading to an increase in apparent bird richness in these areas. These biases in collections have serious implications for selecting priority areas for biodiversity conservation. We generally select among areas to find those that maximize a conservation goal, while minimizing the total cost. It is impossible to maximize species richness, though, unless you know where the species are.

## 7. THREAT, VULNERABILITY AND RANGE COLLAPSE IN WIDE-RANGING MAMMAL SPECIES

*\*Charles Brandon Yackulic, Columbia University;*

*\*Eric W Sanderson, Wildlife Conservation Society*

Understanding the processes underlying range contraction remains a central challenge to conservation biology. Specific case studies of range collapse often stress what may be idiosyncratic details. Studies across taxa often focus on choosing between either underlying demographic factors (i.e. a demographic hypothesis) or anthropogenic disturbances (i.e. a contagion hypothesis) as a predictor of range collapse patterns. Many studies have concluded that the contagion hypothesis is better supported without actually linking some proxy for disturbance to areas of loss of range and have rarely accounted for spatial autocorrelation in residuals. Using the Human Influence Index (HII) as a proxy for disturbance, we examined range contraction in 46 wide-ranging mammal species, and asked: 1) Is the HII a good predictor of range dynamics? 2) Are populations of a species less likely to persist at a given HII if they are located near the edge of their historical range? 3) Do protected areas provide benefits besides simply lowering the HII? We conclude that patterns of anthropogenic disturbance play a major role in determining patterns of range collapse in the 20th century; however, underlying demographic variation and management can also play important roles depending on

the distribution of disturbance within a species' range. Furthermore, we do not believe the demographic hypothesis and contagion hypothesis are mutually exclusive as previously suggested.

## 8. THREATENED BIRDS IN THE AMAZON: WHICH WILL BE NEXT AND WHERE WILL THEY BE?

*\*Mariana M Vale, Universidade do Estado do Rio de Janeiro; \*Mario Cohn-Haft, Instituto Nacional de Pesquisas Amazônicas; \*Scott Bergen, Wildlife Conservation Society; \*Stuart L Pimm, Duke University*

Studies predict that new infrastructure development will sharply increase the rate and extent of deforestation in the Brazilian Amazon. There are no predictions, however, of which species it will affect. We used a spatially explicit model that predicts the location of deforestation in the Brazilian Amazon by 2020 based on historical patterns of deforestation following infrastructure development. We overlaid the predicted deforested areas onto bird range maps to estimate the amount of habitat loss within species ranges. We also estimated the amount of habitat loss within modified ecoregions, which were used as surrogates for areas of bird endemism. We then used the extent of occurrence criterion of the World Conservation Union to predict the future conservation status of birds in the Brazilian Amazon. We predicted that at current rates of development at least 16 species would qualify as threatened or would lose more than half of their forested habitat. We also identified several subspecies and isolated populations that would also qualify as threatened. Most identified taxa are not currently listed as threatened. The majority are associated with riverine habitats, which have largely been ignored in bird conservation in Amazonia. These habitats and the species they hold will be increasingly relevant to conservation as Brazil continues to alter river courses and construct hydroelectric dams in the region.

## 10. Biogeography and Landscape Conservation

### 1. A CONTRIBUTION TOWARDS AN UNDERSTANDING OF THE BIOGEOGRAPHY OF A MOUNTAIN GALAGO, GALAGOIDES ORINUS

*\*Charles Leonard Massawe, Africa Section*

Five forest dependent galago species are known to occur in the globally recognised biodiversity hotspot of the Eastern Arc and coastal forests of Tanzania and Kenya. I present recent distributional data on one of these species; the mountain galago *Galagoides orinus* which was only recently recognised as a species. Initially recognised from one specimen taken in the 1930s from the Uluguru Mountains, *G. orinus* was subsequently found to occur in the East Usambara Mountains in 1996. This fragmented distribution led to the assumption that *G. orinus* was an EA endemic species. Nocturnal surveys were conducted in 10 out of 13 EA mountain blocks which detected and identified galagos both visually and from comparative vocal analysis. The surveys revealed five previously undetected populations in the EA in sub-montane and montane forests. *G. orinus* was not detected in two of the mountain blocks surveyed. Surveys in the Taita Hills, Kenya and the Udzungwa Mountains detected *Galagoides* forms which did not resemble typical *G. orinus*, suggesting levels of interpopulation variation. Surveys in the surrounding non-EA mountains and coastal forests did not detect *G. orinus*.

Biogeographically these findings supports the claim that *G. orinus* is an EA endemic species. The limited distribution (ca. 3000km<sup>2</sup>) within the EA, and interpopulation variability, has implications for the conservation of this species.

## 2. A GEOGRAPHIC ANALYSIS OF ECOSYSTEM AND BIODIVERSITY HAZARD FROM OBSOLETE CHEMICAL STOCKPILES IN TUNISIA

*\*Brian Blankespoor, The World Bank Group;*

*\*Susmita Dasgupta, The World Bank Group;*

*\*Abdelaziz Lagnaoui, The World Bank Group;*

*\*Craig Meisner, The World Bank Group*

Obsolete pesticides stockpiles pose a serious threat to biodiversity, environmental health, and water quality. As part of the Africa Stockpiles Programme effort to clean up and safely dispose of pesticides in Africa, this case study examines approximately 1 400 tonnes of obsolete pesticides in Tunisia. In a Geographic Information System (GIS) automated with a Python script, The World Bank overlaid geo-located stockpiles; global habitat ranges of several thousand species of amphibians, birds, fish, and mammals; and population data. After a characterization of the chemicals in the stockpiles, The World Bank assigned hazard-weighted indicators with regards to species and public health in Tunisia. The results are a database of hazard indicators associated with the pesticide stockpiles and a series of maps identifying areas of high hazard indicators and high ecological importance based upon WWF ecoregions and the threatened status and representation of the species. These results will assist policy makers for effective solutions to prioritize interventions and allocate limited resources for safe disposal.

## 3. CONTRACTION OF MAASAI LANDS AS WILDLIFE DISPERSAL AREAS AND IMPLICATIONS FOR CONSERVATION IN AMBOSELI ECOSYSTEM, KENYA

*\*MOSES MAKONJIO OKELLO, School for Field Studies, Kenya*

Maasai group ranches are critical wildlife dispersal areas between Amboseli and Tsavo parks in Kenya. However, human activities are decreasing the quality and quantity of these dispersal lands. This study sought to establish the area and spatial location of all human activities by mapping and spatial analysis in relation to wildlife distribution in group ranches. In Kimana Group Ranch, the actual area covered by human activities was 57.83 km<sup>2</sup> (23%), but increased 55.74% with wildlife displacement. In Kuku Group Ranch, there were eleven clusters of human activities covering 24.4% of the ranch. The actual area was 38.31 km<sup>2</sup> (4%) but increased to 23.3% with wildlife displacement. In Mbirikani, human activities occupied an actual area of 16.85 km<sup>2</sup> (1.37%), which increased to 22.97% with wildlife displacement. Eight clustered of human activities covered 20.38% of the group ranch. In all group ranches, Maasai homesteads displaced more wildlife, followed by roads, and electric fences. The threat in Kimana was both the area taken as well as the spatial blocking of wildlife movements. For Kuku and Mbirikani, the main threat was spatial arrangement of human activities. Wildlife dispersal area is increasingly shrinking due to human activities and changing land uses, making the future of conservation in the area compromised. Key words: Amboseli Ecosystem, contraction of corridors, Kenya, wildlife dispersal

## 4. DEFORESTATION ON AN ELEVATIONAL GRADIENT IN THE EASTERN ARC

## MOUNTAINS OF TANZANIA

*\*Jaclyn Marie Hall, University of Florida; \*Neil*

*Burgess, WWF; \*Jon Lovett, University of York;*

*\*Boniface Mbilinyi, Sokoine University of*

*Agriculture*

An understanding of altitudinal variation is important for conservation. Elevation is a main environmental gradient, with rapid turnover of species with change in altitude. Newly compiled datasets of species distribution and forest extent were used to estimate the altitudinal distribution of forest area and forest loss (1955 - 2000) in the Eastern Arc Mountain of Tanzania and investigate the impact of the pattern of forest loss on altitudinally restricted endemic species. As an ecosystem, the Eastern Arc has lost 44% of forest area since 1955 and has suffered an estimated 80% total loss of historical forest area. However, this forest loss has not been even across all elevations. Although lower montane forests contain a high richness and endemism, they are not properly represented in the government reserve system for their area. The lower montane habitat (800-1200 m) has lost close to 93% of its historical extent, and 9 of 12 mountain ranges have lost 96-100% of forest in this zone. Linking deforestation trends to available information on the altitudinal preferences of endemic tree species illustrates the severe pressure and extinction risk posed on this and likely other taxa. Half of the endemic tree species have lost more than 90% of forest habitat in their altitudinal range. Conservation efforts should target protection, corridors, and restoration in the entire range of altitudes of Eastern Arc forests.

## 5. INTEGRATED MULTI-USE OCEAN MANAGEMENT: ROLE OF SCIENCE

*\*Robbin Peach, UMass/MOPF*

Massachusetts's marine ecosystem is under siege from an increasing number of proposed uses of the Commonwealth's coastal ocean waters, many not anticipated by existing management regimes. These demands pose coordination challenges for management agencies responsible for reviewing and approving proposals - how to balance intensified development pressure on the marine ecosystem while also taking advantage of the opportunities the ocean offers for energy and food production, climate control, recreation and commercial transportation? Our current management systems are fragmented by sector and activity, spatially not aligned with ecosystems or their time frames. The most severe consequences of these governance problems can be overcome if we switch from managing one thing in many places (sectoral management) to managing many things in one place (area-based management). The Massachusetts Ocean Partnership Fund and its partners seek to have an integrated multi-use ocean management plan in place within the next five years. This speed presentation proposes to outline their plans to support an area-based approach to management that's integrated across sectors and ecosystems, makes the best use of available science and information for decisions, reduces user conflicts, fosters sustainable uses, promotes conservation where appropriate, and protects the public trust of our commonly held marine resources.

## 6. MEXICAN GAP ANALYSES: MULTISCALE ASSESSMENT TO IDENTIFY PRIORITY SITES FOR CONSERVATION

*\*Patricia Koleff, CONABIO; \*Tania Urquiza,*

*CONABIO; \*Melanie Kolb, CONABIO; \*Jesús*

*Alarcón, CONABIO*

It is essential to establish conservation priorities, particularly in megadiverse countries such as Mexico that faces threats to the

vast biodiversity of the country. Mexico decided to generate with solid technical criteria and updated data a complete assessment of the gaps and omissions within the protected area system. Terrestrial analyses show that priority planning units (256 km<sup>2</sup>) detected cover 30.36% of the continental territory, but only 12.9% of this area is under the protection of federal, state and municipal PA. However, it is of key importance to group priority planning units into biologically meaningful clusters to define priority areas of adequate size to maintain important ecological processes. We conducted an ordination and cluster analysis using biological data to characterize and group priority planning units. As a next step we identified key priority sites using irreplaceability criteria to adequately preserve a representative and viable fraction of Mexico's biodiversity. It will be necessary to downscale biological and pressure factors so as to get to a more detailed level of analysis to effectively address the limited conservation resources. Priority areas may then be assessed at a local scale by researchers, technical experts, and other sectors of society to promote local conservation actions integrating social data and planning opportunities.

## 7. MODELING THE EFFECT OF URBANIZATION ON THE RISK OF VECTOR-BORNE ZOOSES

*\*Christopher Brooks, Department of Biological Sciences, Mississippi State University; \*Jeff Achter, Department of Mathematics, Colorado State University*

The emergence of wildlife diseases in human populations is a growing global problem. Almost 3 of every 4 of the human diseases that are classified as 'emerging' (those which are expanding their geographic or host range) are derived from wildlife (zoonotic diseases). The process of emergence is generally thought to result from changes in some aspect of the host-pathogen association. Among the potentially important factors are changes in the diversity of wildlife host communities as a function of each host's epidemiological capacity and the consequences of those changes on human risk. To date there have been few general theoretical treatments of the hypothesized biodiversity-disease relationships for vector-borne zoonoses. Here we develop a network model describing the rates and routes of interaction between a community of wildlife hosts, their vectors and humans. Using both simulation and analytical techniques, we quantify the changes in human risk as a function of changes in the richness of host and vector communities. Not surprisingly, reducing the richness of potential vectors always reduces risk. However, non-random removal of hosts can cause strongly non-linear amplification or dilution of human risk. Accurate prediction of both the direction and magnitude of changes in disease risk associated with land use change will ultimately require knowledge of the relative capacity of potential reservoir species.

## 8. PREDATOR-DEPENDENT SPECIES-AREA RELATIONSHIPS

*\*Wade Alan Ryberg, Washington University in St. Louis; \*Jon Chase, Washington University in St. Louis*

In addition to having a positive effect on species richness (species-area relationships [SARs]), habitat area can influence the presence of predators, which can indirectly influence prey richness. While these direct and indirect effects of area on richness occur simultaneously, no research has examined how predation might contribute to SAR variation. We extend MacArthur and Wilson's equilibrium theory of island biogeography by including predation induced shifts in prey

extinction and predict that predators will reduce slopes of prey SARs. We provide support for this with data from two insular ecosystems: orthopteran richness in Ozark glades (rocky herbaceous communities within a forested matrix) with and without insectivorous lizards and zooplankton richness in freshwater ponds with and without zooplanktivorous fishes. Our results emphasize that anthropogenic activities yield simultaneous changes in processes altering diversity and that it is critical that we understand how these components of anthropogenic change interact to impact diversity.

## 9. PRIORITIZATION OF THREATENED MEDICINAL FLORA - A KEY TO CONSERVE SACRED FORESTS IN WESTERN GHATS *\*RAGHAVENDRA SHIVALINGAIAH, FOREST RESEARCH INSTITUTE, DEHRADUN*

Sacred forests are unique landscapes in the Kodagu district of Central Western Ghat region managed by local community. These are having their own role in conserving the biodiversity of a region apart from their religious and cultural values. The conservation of these sacred forests is necessary to preserve the valuable resources for next generations. Hence, we made an attempt to assess the population status of threatened medicinal tree species in large and small sacred forests under different vegetation types of Kodagu. The simple random sampling technique has been followed to assess the population status of threatened medicinal tree species. There were 27 threatened species were recorded from both the vegetation types. The Shannon-Weaver diversity, &#946;-diversity and also structural parameters such as density, basal area size class distribution and mean height were computed. The result indicates that though there is no significant difference with respect to the diversity between the two vegetation types there was significant difference between large and small sacred forests. The density of the RET medicinal tree species in sacred forests of semi-evergreen vegetation was significantly different from that of moist deciduous vegetation. The conservation strategies recommended are species specific and location specific. Key words: Sacred forests, anthropogenic pressure, threatened medicinal tree species, structural parameters, and conservation strategies

## 10. PROTECTED AREAS REDUCE LANDSCAPE TRANSFORMATION IN THE TRANSBOUNDARY NORTHERN APPALACHIANS

*\*Stephen Christopher Trombulak, Middlebury College; \*Matthew Landis, Middlebury College; \*Gillian Woolmer, Wildlife Conservation Society Canada; \*Robert Fritz Baldwin, Clemson University; \*Mark G. Anderson, The Nature Conservancy; \*Justina Ray, Wildlife Conservation Society*

An on-going question in conservation is the extent to which protected areas actually limit transformation of natural landscapes. To investigate this, we evaluated the magnitude of site-specific human transformation as a function of protection in the Northern Appalachian ecoregion of the U.S. and Canada. The entire ecoregion was assessed at a 90-m resolution, resulting in over 43 million separate locations. At each location, we calculated a relative index of human transformation using the Human Footprint methodology. Protection levels were based on GAP categories, ranging from 1 (full permanent ecological protection) to 4 (no permanent protection). Additionally, at each site we measured elevation, topography, and substrate. We performed multiple regression analyses on a randomly selected subset of 4000 locations

(0.01% of the total) that incorporated GAP category, environmental variables, and spatial variables (to account for spatial autocorrelation) as potential influences on Human Footprint scores. Despite significant spatial autocorrelation, both GAP category and elevation had significant effects on the extent of human transformation: as elevation increased and GAP category decreased (i.e., increased levels of protection for biodiversity), the amount of transformation decreased. The strength of these effects varied within the ecoregion, however, ranging from strong (e.g., New York) to non-existent (Maine).

## 11. THE BIOGEOGRAPHIC ADEQUACY OF THE NIGERIAN PROTECTED AREA SYSTEM

*\*Francis Ebuta Bisong, University of Calabar;*  
*\*Phillip Mfon, University of Calabar;* *\*Elizabeth Esekong Andrew-Essien, University of Calabar;*  
*\*Pius Utang, University of Port Harcourt*

This study assesses the extent to which the biogeographic regions and ecosystems in Nigeria are adequately represented in the existing protected area system. Adopting the ecosystem approach, it delineated and classified ecosystems on the basis of the following parameters: bio-climate, geology/geomorphologic formations, surface hydrology/ wetlands and natural/ human modified ecosystems. The distribution of these ecosystems were evaluated against the network of protected area (PA) systems to identify those adequately or poorly represented in the existing PA systems in order to highlight optimal conservation sites which maximizes the biodiversity conservation potentials in the country. Data collected for the study include maps of ecosystems along the parameters identified and maps of existing protected area systems namely National Parks, Forest Reserves and Wildlife Sanctuaries. Gap analysis technique was employed in identifying ecosystem types not adequately represented in the existing P.A network. A 10% threshold is adopted to determine the adequacy of coverage of specific ecosystems within the existing PA network. A significantly skewed coverage of the specific ecosystems was observed in the existing network of Protected Areas. The wetlands comprising of the fresh and swamp water mangrove forests and the montane ecosystems are critically under-represented. It is imperative that the under-represented ecosystems be brought under specific protective arrangement.

## 12. THE IMPACT OF INSTITUTIONAL CHANGES ON FOREST RESOURCES: A SPATIAL ANALYSIS

*\*Evelyn Lwanga Namubiru-Mwaura, Indiana University*

In the past decade or so, international attention has focused on the plight of forests, resource degradation, declining biodiversity and the impact of decreasing forest resources on the lives of many people. One effort to address this problem has been the promotion of institutional changes with the aim of ensuring sustainable forest management. Unfortunately, very little is known about how these institutional changes affect resource use and management. In Uganda, the institutions governing forest management have been changed several times in an effort to curb deforestation. Within a period of only 8 years forest resource management was decentralization, recentralization and again decentralized. This study assesses the impact of back and forth institutional changes on forest resources in Mpigi District, Uganda. Through analyses of remotely sensed images, landscape metrics, and field data, the transformations occurring in 8 forest sites are examined and compared for the period between 1986 and 2002. The results show that in the time period that had political insecurity and many back and forth changes in institutions, 28% of the forest

area was lost while only 8% was lost in the period that had fewer policy changes.

## 13. THE VIRGINIA CONSERVATION LANDS NEEDS ASSESSMENT: VIRGINIA NATURAL HERITAGE PROGRAM'S GIS TOOLS FOR MULTI-SCALE CONSERVATION PLANNING

*\*Jason Bulluck, Virginia Natural Heritage Program*

One thing is clear for Virginia: inevitable population growth will collapse our ecological support systems, further degrade environmental health and permanently damage our natural resources, unless Conservation Planning becomes socially and economically fundamental. The Virginia Conservation Lands Needs Assessment (VCLNA), recently completed by the Virginia Natural Heritage Program, provides a GIS model-based toolset to streamline the Conservation Planning process for decision makers at multiple levels. Guided by Virginia's Green Infrastructure Advisory Workgroup, the VCLNA is a suite of seven statewide GIS models: Ecological Integrity, Cultural Assets, Recreational, Forest Economics, Agricultural, Watershed Integrity and Vulnerability, or threat of land consumption by development. These models provide quantitative spatial data summaries of these Green Infrastructure assets and a tool to analyze how they may fare in the coming years. The VCLNA was developed with versatility to provide resource models for state and federal agencies, while also fulfilling the planning needs of local governments, planning district commissions, land trusts, and other non-profit conservation groups, who seek comprehensive ways to balance land use and prioritize conservation. Through our conservation partner-specific and multi-media approach to implementation, we are also working to assure that these tools are most useful to diverse Conservation Planning efforts throughout the Commonwealth.

## 11. Bird Conservation

### 1. ANTHROPOGENIC NOISE INFLUENCES AVIAN NESTING RICHNESS AND SUCCESS.

*\*Clinton David Francis, University of Colorado;*  
*\*Catherine P Ortega, San Juan Institute of Natural and Cultural Resources, Fort Lewis College*

Anthropogenic noise has been implicated as a cause of declines in avian species diversity and densities; however, these patterns are not conclusive because noise has not been uncoupled from the many potential confounding variables that accompany noisy human activities, such as physical alteration of habitat, edge effects, or moving traffic or equipment. During the summers of 2005-2007, we isolated noise experimentally through use of natural gas wells with noisy compressors as experimental treatment sites and wells without compressors as control sites. Noise significantly reduced nesting species richness; however, species tolerant of nesting in areas with high noise levels benefited from increased nest success due to lower levels of predation. In areas with high amplitudes of anthropogenic noise, predators may be present, but unable to locate nests, or they are in lower densities or absent - thereby benefiting species tolerant of anthropogenic noise through an increase in nest success. Species intolerant of noise may suffer two-fold: through exclusion from noisy habitats that may otherwise be suitable, and because they are subject to more natural levels of nest predation when nesting in less noisy habitats. This disparity between the higher nesting success of noise tolerant species and lower nest success of noise intolerant species may further contribute to declines in species richness and diversity in and around human-altered landscapes.

## 2. BREEDING BIOLOGY OF FODIA MADAGASCARIENSIS LINNE, 1766 AND FODIA OMISSA ROTHSCHILD, 1912 RANOMAFANA NP

*\*RASAMISON SOLOHERY*

*ANDRIANARIVELOSOA, Student*

The both species in the genus of Foudi are endemic to Madagascar, most of them feed the rice paddy during their mating period. 629 birds are captured at Ranomafana National Park from November 2003 to April 2004, 366 nests of *F. madagascariensis* and 7 nests of *F. omissa* were located during this survey. Nest building can be divided into four stages. The male starts to make a nest up to stage 2 before the couple gathering. Then the female partner continues and finishes the nest building till stage 4. Incubation lasts 13 to 17 days and the number of eggs varies from 1 to 5 per brood. Males of the both species seem to be like polygamous, they can get more than 3 partner in one's period; they protect their territory containing the nests and feed rarely their chicks. The females do all the incubation, nest cleaning and chick rearing. The nestlings fledge under their parents help after 13 to 15 days. All of these data are considered as a discovery because any reserch didn't focuse on their nest bulding, incubation, chicks rearing before.

## 3. CONSERVATION OF THE CRITICALLY ENDANGERED NEGROS BLEEDING-HEART PIGEON GALLICOLUMBA KEAYI ON THE ISLAND OF NEGROS, PHILIPPINES

*\*Apolinario Bernardo Cariño, Wildlife Researcher; \*Angelita Morales Cadelina, Instructor; \*Rene Villalon Vendiola, Research Assistant; \*Jose A. Baldado, Public Servant*

On Negros Island and elsewhere in the Philippines, where over 90% of its original forest has been removed and implementation of existing wildlife laws remain weak, populations of many wildlife species including birds, are rapidly declining and may eventually become extinct. Among these birds is the Critically Endangered Negros Bleeding-heart Pigeon *Gallucolumba keayi*. Field surveys revealed for the first time the current distribution and population of the species on the Island. The species distribution showed it to be very restricted on lowland areas with forests. It is also shown to survive in areas with agricultural development. Breeding and feeding areas and food plants were documented in Calinawan, Mantikil, Twin Lakes and Mt. Talinis areas. The initiative of the Province in coming up with a province-wide environmental public awareness campaign on the protection of this and other wildlife species has given way to a sustainable conservation program of the species all throughout the Island of Negros. It is hoped that these efforts may lead to activities that could be done to mitigate the threats to the sustainability of its population and the preservation of its habitat.

## 4. DOES VARIATION IN FEMALE BROWN-HEADED COWBIRD FECUNDITY HELP EXPLAIN OBSERVED DIFFERENCES IN HOST PARASITISM FREQUENCY?

*\*Matthew Reetz, University of Florida; \*Kathryn E. Sieving, University of Florida; \*Scott K. Robinson, Florida Museum of Natural History*

Brown-headed Cowbirds (*Molothrus ater*) were first documented breeding in Florida in the 1950s and are now confirmed breeding through most of the state. Despite relatively high breeding season abundance of cowbirds (3-10 birds per Breeding Bird Survey route) currently in north-central

Florida, we documented very low frequency of parasitized nests (13 of 1120) or family units feeding cowbird fledglings (17 of 272) in 32 potential host species. To determine if observed parasitism frequency is partially due to reduced fecundity of female cowbirds, we compared reproductive condition of Florida cowbirds to those from central Texas, where cowbirds are actively controlled to reduce parasitism. We examined the condition of the oviduct and the size and number of ovarian pre-ovulatory and post-ovulatory follicles in 47 Florida and 71 Texas specimens. Fecundity was estimated using the proportion of birds in breeding condition that had oviducal eggs. For both Florida and Texas, a female cowbird laid an average of 35 eggs per breeding season. Average clutch size was also similar between Florida and Texas cowbirds at 3-4 eggs/clutch with a non-laying interval of 2-3 days. Our estimates are similar to other published studies showing high fecundity of cowbirds. These results indicate that the low parasitism frequencies we have observed across the host community in north-central Florida are not explained by limited fecundity of female cowbirds.

## 5. EFFECTS OF HAEMOPARASITE INFECTIONS ON A NATURAL POPULATION OF WHITE-CROWNED SPARROWS (ZONOTRICHIA LEUCOPHRYS).

*\*Johannes Foufopoulos, University of Michigan*

Avian haemoparasites (*Plasmodium*, *Haemoproteus*, *Leucocytozoon*) are widespread in free-ranging bird populations. Although most of these avian parasite taxa do not infect humans, understanding host-parasite interactions in such systems is important both for wildlife conservation reasons and to elucidate principles of infectious disease dynamics in natural ecosystems. Early researchers claimed that these microparasites had little effect on their hosts, but more recent work, in part from island ecosystems, suggests otherwise. Here we attempt to understand the effects of such infections on continental bird populations by studying natural populations of Mountain white-crowned sparrows (*Zonotrichia leucophrys oriantha*) in the mountains of the western U.S.. Over the course of a 8-year study, we identified a diversity of dipterans (including several mosquito and blackfly species) that are probable vectors at least 6 taxa of apicomplexan blood parasites (2 spp. of *Plasmodium*, 2 spp. of *Haemoproteus* and 2 spp. of *Leucocytozoon*) in the study population. To assess the impact of these pathogens on their hosts we manipulate haemoparasite loads by administering antiprotozoal agents. Our results indicate that impacts on the host depends crucially on parasite species identity and that infections can have a variety of effects on the hosts, including significant reductions in reproductive output.

## 6. GOATS AND THE MAINTENANCE OF KIRTLAND'S WARBLER WINTER HABITAT IN THE BAHAMAS

*\*Joseph M. Wunderle, International Institute of Tropical Forestry, USDA Forest Service; \*Jennifer D. White, Puerto Rican Conservation Foundation & International Institute of Tropical Forestry; \*Ewert N Ewert, The Nature Conservancy; \*David Currie, Puerto Rican Conservation Foundation & International Institute of Tropical Forestry*

The endangered Kirtland's Warbler (*Dendroica kirtlandii*) winters exclusively in the Bahamas archipelago where it faces several conservation challenges. One challenge, associated with the KW's consumption of fruit in early successional habitats, is its need to track fruit patches, which vary in space and time and may become rarer and more widely dispersed as the winter

proceeds especially during late winter droughts. The importance of tracking changing resource distributions is evident in the KW's body condition, which may decline from mid to late winter. This decline in body condition could be detrimental during late winter droughts when the need to store fat is highest prior to spring migration. Failure to store sufficient fat may contribute to mortality or delay departure resulting in negative breeding consequences. Thus as droughts intensify in dry winters, KWs concentrate in habitat patches with relatively abundant food supplies. Another challenge is associated with the KW's use of fruit-rich early succession habitats, indicating a need for habitat management. One means of managing winter habitat is to use goats because they retard plant succession and favor KW fruit plants by cropping competing plants, while ignoring KW fruit plants. Thus a network of fruit-rich early successional habitat patches, some including goat farms, spread across several kilometers in island landscapes could ensure appropriate winter habitat for the KW.

## 7. NEST SITE SELECTION AND SURVIVAL BY THE GREY-CRESTED HELMET-SHRIKE PRIONOPS POLIOLOPHUS AND THE IMPLICATIONS FOR CONSERVATION IN NAIVASHA, KENYA.

*\*Philista Adhiambo Malaki, National Museums of Kenya*

Understanding habitat usage by species is fundamental to knowing their conservation status and providing adequate management. The present investigation examined how the Grey-crested Helmet-shrike selected nest sites at different habitat levels. Nest sites were selected randomly and habitat variables in immediate vicinity and areas surrounding the nests measured. These were done both for nests that were successful and those that failed. Habitat attributes associated with successful nests differed from those of unsuccessful nest sites with high values for variables recorded at the successful nest sites. This suggests that choice of habitat features influence reproductive success for the birds at different levels. Results also showed that cover and density of vegetation are important parameters determining nesting success. Nest site characteristics were related to nesting success. The results of the present investigation have implications for the conservation and management of the species. Management should focus on improving habitat conditions, particularly availability and suitability of nest sites based on habitat attributes surrounding nests at a range of scales. To enhance nesting success and productivity of the bird species, management should focus on manipulating, increasing and maintaining habitat features that increase reproductive success as these have direct fitness consequences. Key words: Habitat, Selection, Nest Survival, Management.

## 8. STATUS AND CONSERVATION OF CRITICALLY ENDANGERED GYPS VULTURES (GYPS TENUIROSTRIS AND G. BENGALENSIS) IN ASSAM, INDIA

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The population of three species of Gyps vultures have been declined steeply in their ranges in recent years as a result of a veterinary drug (Diclofenac) used to treat domestic cattle. As an attempt to know the status and to initiate a long term conservation process for two Critically Endangered vultures (G. tenuirostris and G. bengalensis) found in Assam, a rapid

survey was carried out in early 2004 and a detail one in 2004-05. Surveys were carried out along roads and paths in the villages and countryside on foot and bicycle, interviewed villagers, monitored nests and birds and surveyed nests of the previous year to see whether any one is continued, abandoned or tree cut by villagers. We found that when the population of a widely distributed species steeply goes down and exists in some small pockets, some local factors such as destruction of nesting trees and nests, scarcity of food, poisoning become critical to the survival of the species. In order to ensure the long-term conservation of both species in wild in Assam, the following have been proposed: awareness campaigns among local communities in each nesting sites to protect nests, nestlings and nesting trees; awareness programmes to use other safer drug, encouraging people to leave carcasses of domestic animals in open areas, establishments of vulture restaurants and survey and monitoring.

## 12. Bird Conservation (2)

### 1. ADVANCED AUTUMN MIGRATION DATES OF AVIAN PASSAGE MIGRANTS IN SINAI, EGYPT

*\*Nico Dauphine, Warnell School of Forestry and Natural Resources, University of Georgia*

The timing of avian migration appears to be changing in response to climate change. Many spring migrants are arriving earlier on their breeding grounds, while the trend in autumn departures is less uniform, with both early and delayed departures reported. I report advanced autumn migration dates for 5 species of Palearctic birds observed along a major biannual bird migration route. I conducted surveys for birds in and around the St. Katherine Protectorate Important Bird Area (IBA) in Sinai, Egypt, between June and August 2006. I made c. 270 field hours of transect and point counts to estimate bird abundance and distribution in regional wadis (ephemeral river beds), mountains, plains, and oases from elevations of 645 to 2650 m a.s.l. I detected a total of 63 individuals of 9 non-resident species, all of which were passerines. First autumn record dates of 5 passage migrant species were 2-4 weeks earlier than those documented 20 years previously. Both migratory and resident birds in the St. Katherine Protectorate face unprecedented conservation threats, the most important of which appear to be global warming and increasing anthropogenic pressure on the environment.

### 2. COMPARING TIME-SERIES OF ABUNDANCE AND PRESENCE-ABSENCE DATA AS INPUT TO AREA SELECTION - WHICH IS A BETTER PREDICTOR OF FUTURE PERSISTENCE?

*\*Christopher Grouios, Department of Ecology and Evolutionary Biology, University of Toronto; \*Lisa L. Manne, supervisor*

Most reserve selections identify a network of areas to represent all chosen units of biodiversity, hoping to ensure their long term persistence, while minimizing costs. In the eastern North American forests, we compared two selection criteria, which directly incorporate different types of persistence information in order to predict an area's longer term suitability for a species, using data from the North American Breeding Bird Survey. For each species, over a historic time period (1970-1979), we used 1) time-series point-count data to calculate average abundance and 2) time-series presence-absence data to calculate permanence, a measure of consistent occupancy over time. We used sensitivities of the abundance and permanence criteria

from the historic period to perform complementarity-based reserve selections, and then used a contemporary period (1997-2006) to evaluate the reserve networks for effectiveness at maintaining species populations and efficiency in land use. Abundance and permanence were equally good predictors of future extirpations in the selected networks, but abundance was significantly better than permanence at selecting enduring high quality species habitat. The relatively larger financial and temporal costs of collecting a time-series of point-count abundance data are thus justified, as abundance proved to be a better predictor of: future locations of local persistence, and further, future locations of higher abundances on average across all species.

### 3. EXURBAN DEVELOPMENT INFLUENCES WOODLAND BIRD COMMUNITY COMPOSITION

*\*Adina M. Merenlender, University of California, Berkeley; \*Sarah E Reed, University of California, Berkeley & The Wilderness Society*

One of the fastest growing types of land-use change is exurban development - low- density housing outside urban service boundaries. However, impacts of exurban development on terrestrial biodiversity remain relatively unknown. We monitored birds for five years across three housing density levels in northern California oak woodlands. We compared community and species responses to exurban development (4-16 ha parcels) with suburban and undeveloped natural areas. We found that individual species and groups of species exhibited variable responses to exurban development. For example, the proportion of the bird community composed of tree and shrub feeders was similar between exurban and natural areas, whereas proportions of ground feeders and temperate migrants showed similar reductions at both suburban and exurban sites. Similarly, Northern Flicker, Hutton's Vireo, and Orange-crowned Warbler were equally rare in exurban and suburban sites, making large, undeveloped parcels essential for their conservation. Our results indicate that some species and guilds are impacted by exurban development to the same extent as suburban development, while others are less sensitive to this type of land use. This research demonstrates the importance of protecting privately-owned woodlands from exurban development, as some sensitive species are losing suitable habitat to exurban sprawl at rates averaging 10 - 15% per year nationwide.

### 4. IMPLICATIONS OF LARK SPARROW BREEDING HABITAT REQUIREMENTS FOR MIDWEST SAND BARREN CONSERVATION

*\*Melanie Coulter, Bowling Green State University; \*Karen V Root, Bowling Green State University*

Woody invasion due to fire suppression degrades many early-successional plant communities, including globally rare Midwest sand barrens. Managers in Northwest Ohio's Oak Openings Region use prescribed burns and mowing to restore and maintain Midwest sand barrens. In NW Ohio, state-endangered Lark Sparrows (LASP) rely on Midwest sand barrens for nesting. Since LASP abandon degraded barrens, we consider sites that support breeding LASP as healthy sand barrens. Our objective was to determine LASP's breeding habitat requirements in Oak Openings and use our results to: 1) create a predictive model of healthy sand barrens, and 2) evaluate the effectiveness of sand barren restoration techniques. Our methods included on-the-ground measurements of vegetation structure and GIS analyses of landscape characteristics for two categories of sites: sites currently used by LASP and sites abandoned by LASP. LASP use sites with

low vegetation density, 8% shrub cover, and 9% tree cover, on average. Landscape analyses indicate that sandy soil and sand barrens larger than 1.9 ha are important predictors of Lark Sparrow presence. We compared sites' management histories and found that currently used sites were mowed annually and burned every few years. Abandoned sites were not managed. These results imply that annual management is necessary to maintain Midwest sand barrens that can support ground-nesting birds; type of management (burn vs. mow) may be less important than frequency.

### 5. MAPPING AND EXPLORING THE DISTRIBUTION OF A THREATENED BIRD, GREY-WINGED COTINGA

*\*Maria Alice S. Alves, Universidade do Estado do Rio de Janeiro; \*Stuart Pimm, Duke University; \*Alline Storni, Ph D; \*Marcos Raposo, Departamento de Vertebrados, Museu Nacional/UFRJ; \*Michael de L. Brooke, Department of Zoology, Cambridge; \*Grant Harris, USDA Forest Service; \*Andy Foster, bird guide; \*Clinton N Jenkins, Duke University*

The grey-winged cotinga (Tijuca condita) was first described in 1980 from an old specimen, misidentified as a congener. Field observations came later, from two remote, high-elevation forests in the mountains of Rio de Janeiro, Brazil. Both involved only a few pairs of birds at best, making this species one of the least known in the world. Accurately defining the locations this species inhabits is an obvious prerequisite for designing conservation strategies to protect it. Using remotely sensed data on elevation and forest cover, we mapped this species' habitat and predicted six more sites where it might occur. Field surveys confirmed two of them, doubling the known range of the species. The two easternmost predicted sites did not have the species, but these areas have less annual rainfall than other sites, which may explain the absences. This research serves as an important guide to conservation actions, for it uncovered biologically important areas for this species previously overlooked. It has also measured the remaining habitat of the species so that any future losses can be detected.

### 6. POTENTIAL FLAGSHIPS FOR CONSERVATION OF HIGH ANDES WETLANDS: ANDEAN FLAMINGOS MODULATE ALGAL GROWTH AND PRIMARY PRODUCTIVITY IN A BOLIVIAN LAKE

*\*Marita Adela Davison, Cornell University*

Of the five extant species of flamingos, those restricted to wetlands of the high Andes (Andean flamingo, *Phoenicoparrus andinus* and James flamingo, *P. jamesi*) are the rarest least studied. As dominant primary consumers, flamingos may have considerable effects on stocks of primary producers and overall benthic community structure as well as impacts on pathways of energy and nutrients. Few studies have addressed the influence of flamingos on ecosystem processes; none have attempted to link flamingo activities to primary productivity and community structure. I conducted a flamingo exclusion experiment to assess the influence of *P. andinus* and *P. jamesi* on algal biomass and primary productivity in an hypersaline lake in southwestern Bolivia. Plots from which flamingos had been excluded exhibited significantly higher algal biomass but reduced rates of productivity than control plots to which flamingos had free access. These results suggest that, when abundant, flamingos can modulate an important ecosystem process at the base of the food web. Consequently, flamingos of the high Andes may exert far-reaching impacts on the

functioning and composition of their lake habitats, potentially making them flagships for conservation of high Andes wetlands.

## 7. PRIORITY CONSERVATION AREAS FOR BIRDS IN RIO DE JANEIRO, BRAZIL

*\*Clinton N Jenkins, Duke University; \*Maria Alice S. Alves, Universidade do Estado do Rio de Janeiro*

The state of Rio de Janeiro has the highest concentration of endangered birds in the entire Americas. It is a hotspot within a global biodiversity hotspot. Across the state though, there is significant heterogeneity in the landscape, with some species found throughout the state and others in only scattered locales. We analyzed the distributions of all bird species in the state that are listed as either globally threatened, threatened at the national or state level, or that are endemic to the Atlantic Forest ecosystem of which Rio de Janeiro is a part. More than 200 species were included, of which at least 36 are globally endangered according to the IUCN. The results include measures of the amount of habitat remaining for each species, how much of that habitat has formal protection, and the level of that protection. Using a systematic reserve selection tool, we then identified a set of priority areas that, if protected, would substantially improve the coverage of bird diversity within the state's protected area system.

## 13. Climate Change

### 1. CAN CARBON CONCERNS SAVE BORNEO'S FOREST WILDLIFE?

*\*Oscar Venter, University of Queensland; \*Kerrie Wilson, The Nature Conservancy; \*Hugh Possingham, university of queensland; \*Erik Meijaard, The Nature Conservancy*

Global concern about climate change may both help and hinder the persistence of tropical wildlife. Payments for reducing (CO<sub>2</sub>) emissions from deforestation and degradation (REDD) might contribute to conservation. Alternatively, incentives to substitute fossil fuels with biofuels derived from tropical plantation crops threaten to increase habitat destruction. In Kalimantan (Indonesian Borneo) as in much of South East Asia, plantations of African oil palm (*Elaeis guineensis*), a potentially important source of biofuel, are already replacing forests. This poses a severe threat to Borneo's biodiversity, especially the Bornean orang-utans (*Pongo pygmaeus*) which have declined precipitously in recent decades. Might REDD payments halt this trend? In this study we estimate the CO<sub>2</sub> emissions and financial profits associated with the conversion of Bornean forests into oil palm. We find that if avoided CO<sub>2</sub> emissions are financially compensated at current market levels, then the conservation of tropical forests, especially peat forests, could financially compete with conversion to oil palm. This could save most of Kalimantan's peat forests, and ~21,000 orang-utans that occur there, or about 45% of all Bornean orang-utans. But on mineral soils, where oil palm remains considerably more profitable than conservation, the survival of ~7,400 orang-utans is threatened.

### 2. FIRST PASS GLOBAL ASSESSMENT OF BIODIVERSITY CONSEQUENCES OF SEA LEVEL RISE MEDIATED BY CLIMATE CHANGE

*\*Shaily Menon, Grand Valley State University; \*Jorge Soberon, The University of Kansas; \*Xingong Li, University of Kansas; \*A. Townsend Peterson,*

## *The University of Kansas*

Considerable attention has focused on the effects of global climate change on biodiversity, but few analyses and no broad assessments have evaluated the effects of sea level rise on biodiversity. We took advantage of new maps of marine intrusion under scenarios of 1 m and 6 m sea level rise to calculate areal losses for all ecoregions globally. Areal losses for particular ecoregions ranged from nil to complete. We estimated likely numbers of extinction caused by sea level rise under a set of assumptions regarding responses to reduced distributional area by species endemic to ecoregions. These estimates complement recent estimates of biodiversity losses owing to changing climatic conditions. Despite its limitations, a first-order estimate is worth exploring to assess the relative importance of sea-level changes as an additional threat to global biodiversity.

### 3. POPULATION CONSEQUENCES OF OCEAN CLIMATE CHANGE FOR A SENSITIVE CLIMATE INDICATOR, THE SEABIRD CASSIN'S AUKLET *PTYCHORAMPHUS ALEUTICUS*

*\*Shaye Wolf, University of California Santa Cruz; \*Mark Snyder, University of California Santa Cruz; \*William Sydeman, Farallon Institute for Advanced Ecosystem Research; \*Donald Croll, University of California, Santa Cruz*

Forecasting the ecological effects of anthropogenic climate change is critical for developing conservation strategies that increase population resilience under changing climate conditions. We examined the population consequences of ocean climate change in the California Current upwelling system on the planktivorous seabird Cassin's auklet (*Ptychoramphus aleuticus*), a demographically sensitive indicator of marine climate change. We forecast changes in the population growth rate of the Cassin's auklet population at the Farallon Islands, central California, in the late 21st century using regional climate model projections and relationships between auklet demography and oceanography developed from a long-term dataset. We also evaluated future ocean climate change across California auklet colonies. The Farallon auklet population growth rate decreased by 8%-49% when demographic rates were modeled as a function of sea surface temperature and by 0.5%-2.5% when modeled as a function of upwelling intensity, suggesting significant future population declines. Projected seasonal changes in upwelling timing and intensity were heterogeneous across California auklet colonies. The Farallon auklet population has declined by ~6%/year over three decades and climate change will likely accelerate these declines. Conservation strategies should increase population resilience by protecting colonies across the range, reducing non-climate stressors, and facilitating movement and colony establishment.

### 4. POTENTIAL IMPACTS OF SEA LEVEL RISE ON TIGER HABITAT IN BANGLADESH'S SUNDARBANS MANGROVE ECOSYSTEM

*\*Colby Loucks, World Wildlife Fund - US; \*Abraham Hossain, Bangladesh Forest Department*

The Sundarban mangrove ecosystem of India and Bangladesh is a globally recognized priority site for conservation, and is the last remaining refuge for tigers (*Panthera tigris*) in mangrove habitat. Mangrove ecosystems provide a vast array of ecosystem services to humanity such as buffering the impacts of cyclones, providing nursery habitat to fish and other species, and sequestering atmospheric carbon. Due to the low elevation

of the Sundarbans mangroves, they are potentially threatened by increasing sea level rise associated with climate change and other forces such as reduced sedimentation and a subducting landmass. Using elevation point data (mm above sea level) collected on the Bangladesh portion of the Sundarbans, we were able to develop an elevation surface for Bangladesh's Sundarban ecosystem. We combined our elevation surface with data on land cover, protection, and tiger distribution. We then used several estimates of sea level rise to analyze the potential impact of sea level rise on remaining tiger habitat. We found that modest sea level rise will likely destroy and fragment the Sundarbans, and jeopardize the long term efficacy of viable tiger populations.

## 5. PROJECTING THE IMPACT OF FUTURE CLIMATE CHANGE ON BIODIVERSITY AND PROTECTED AREAS OF THE WESTERN UNITED STATES

*\*Elizabeth Marie Gray, The Nature Conservancy;*  
*\*Joshua Lawler, University of Washington*

Future climatic changes are projected to alter fire regimes, hydrology, and species' distributions and phenologies worldwide. These changes will have cascading effects on ecological systems, greatly altering the natural landscape. Because climate change may undermine many current management strategies, understanding how species and systems are likely to respond to climate change is critical for robust conservation planning and natural resource management. To address climate change impacts to biodiversity, we have initiated a comprehensive, multi-year study to develop climate change analyses that are directly applicable to on-the-ground conservation and management. We are developing a spatially explicit database of climate-change sensitivities for key species and systems throughout the Pacific Northwest and Northern Rockies regions of the United States. We have begun a risk assessment, based on projected changes in climate, vegetation, and shifts in the distribution of focal species, to determine which areas are most likely to change. Launching this study has resulted in a better understanding of how traditional biodiversity and land protection strategies must change to ensure ultimate success. We illustrate how conservation programs are restructuring to account for potential climate change impacts by including adaptation to climate change as a core focus of their work.

## 6. RESPONSE OF SIAMANG AND AGILE GIBBONS TO CLIMATE FLUCTUATIONS IN INDONESIA.

*\*Timothy G. O'Brien, Wildlife Conservation Society;*  
*\*Margaret F. Kinnaird, Mpala Research Centre;*  
*\*Anton Nurcahya, Australian National University;*  
*\*Meyner Nuslawo, Wildlife Conservation Society Indonesia Program*

Indonesia is home to 6 greater and lesser ape species that may respond to increased temperature and frequency of ENSO droughts over the next 100 yrs. We examined demographic data based on annual censuses for siamang (385 group-years) and agile gibbons (60 group-years) between 1997-2007 to assess the response changes in annual rainfall and temperature. Temperature and rainfall were negatively correlated during this time but rainfall exceeded 2 m/yr. Average agile gibbon group size remained constant at 2.6 individuals because few infants were produced and few infants or juveniles survived during years of high temperature. Consequently, agile gibbons had problems maintaining territories. Five groups colonized the area but four disappeared. Among the siamang we did not detect strong climate effects, except for a tendency for new

groups to colonize during cooler, wetter years. The 1997 ENSO fire, affected 13 of 45 groups. Group size in the burn area remained constant for a decade at 3.6 individuals, whereas group size in undamaged forest increased from 3.6 to 4.3. Differences in survival of infants and juveniles results significantly lower survival to age 5 in groups in the burned area, reducing capacity for long term persistence. These results show how two closely related species at the southern limit of their ranges may respond differently to the impact of climate change.

## 7. TEMPERATURE FLUCTUATIONS LINKED TO ANNUAL GROWTH RATES OF TROPICAL TREES IN ASIA

*\*Margaret F. Kinnaird, Mpala Research Centre;*  
*\*Timothy G. O'Brien, Wildlife Conservation Society;*  
*\*Iqbal Muhammad, Wildlife Conservation Society Indonesia Program;* *\*Nurul L. Winarni, Wildlife Conservation Society Indonesia Program*

Growth rates of tropical trees have important consequences for projections of carbon sequestration in tropical forests. Studies of effects of increasing CO<sub>2</sub> and temperature on tropical tree growth rates conflict. We measured annual growth rates of 2,940 trees in Indonesia 1997-2007 in relation to temperature, rainfall, irradiance, tree size, wood density and disturbance. We analyzed relative growth rates in basal area increments (RGRba) at the stand level (100 tree plots), and community level (140 species). Stand level RGRba was negatively correlated with maximum temperatures ( $r = -0.64, P < 0.01$ ), but not with irradiance or rainfall. Analysis of undisturbed plots strengthened the relationship ( $r = -0.815, P < 0.01$ ). The distribution of stand level regression slopes (RGRba vs. temperature) was significantly skewed negative. At the community level RGRba was again negatively correlated with maximum temperatures ( $r = -0.702, P < 0.05$ ), but not irradiance or rainfall. The distribution of slopes of RGRba vs. temperature was significantly skewed negative. Tree in plots that burned in 1990s grew faster than trees in undisturbed plots. Small trees (10-20 cm DBH) grew faster than large trees but growth declined with temperature for all sizes. Low density woods grew faster than medium and high density woods. High temperatures may exceed optimal ranges of photosynthesis causing stomates to close to reduce evapotranspiration, reducing rates of CO<sub>2</sub> diffusion and photosynthesis.

## 8. THREATS OF CLIMATE CHANGE ON MOUNTAIN BIODIVERSITY IN NEPAL

*\*Babu Kaji Shrestha, Team for Nature and Wildlife(TNW) Nepal*

Climate change is increasingly recognized as a threat to mountain biodiversity for mountainous countries like Nepal. Relatively little research has been conducted, yet devastating impacts on the communities downstream in the past determines the threats to Protected Areas(PAs) set up for biodiversity conservation. I tried to explore two PAs; Sagarmatha National Park(SNP) and Kanchanjungha Conservation Area(KCA) having world's largest glacial lakes that threaten biodiversity of the areas. Based on the literature, interviews, discussions with climatologists and biodiversity experts, field visit, analysis of published and unpublished data: my study reviews the real threat to mountain biodiversity. Several patterns emerge: \*In the face of global warming due to glacial retreat, lakes form behind the newly exposed terminal moraines and could grow startlingly quickly \*Breaching of the unstable natural dams cause Glacial Lakes Outburst Floods(GLOFs) having more catastrophic effects in the form of "Mountain Tsunamis" putting biodiversity and countless communities downstream at

risk. These aspects appear responsible in inviting threats to biodiversity like forest destruction, vegetation damage, habitat loss. These findings provide 1) a need of an early mitigation measures for GLOFs as "Imja Tsho", one the potentially more dangerous glacial lakes in Mt. Everest region still lacks mitigation measures putting SNP at greater risk. And, 2) a need for further research.

## 14. Climate Change (2)

### 1. AN ANALYTICAL TOOLBOX FOR ASSESSING POTENTIAL IMPACTS OF CLIMATE CHANGE ON CONSERVATION PRIORITY AREAS

*\*Evan Girvetz, University of Washington; \*Carolyn A.F. Enquist, The Nature Conservancy; \*Chris Zganjar, The Nature Conservancy; \*George Raber, University of Southern Mississippi; \*Peter Kareiva, The Nature Conservancy; \*Joshua Lawler, University of Washington*

While future climate-change projections are abundant, these data are difficult for conservation planners to access, interpret, and analyze. We have developed a climate change analysis toolbox that can be easily used by conservation planners and land managers to assess how climate change may be affecting specific conservation priority areas. This toolbox provides a climate change impact assessment and ranking of conservation areas by analyzing trends in historic-observed and future-projected precipitation and temperature maps. We demonstrate the utility of this toolbox for The Nature Conservancy's conservation priority areas in the state of New Mexico. We found a wide range of climate-change impacts between priority areas within this relatively small geographic region. A climate-change ranking of the priority areas shows that while most priority areas analyzed have become warmer and wetter, some priority areas have become drier and some have become colder. Moreover, we identify the priority areas that have experienced the greatest amount of climate change over the past century, and those that are likely to experience the greatest climate change in the next century. Finally, we demonstrate how this web-based and user-friendly tool can be applied globally for assisting in the prioritization of management actions in response to climate change impacts at specific priority areas.

### 2. ASSESSING CLIMATE CHANGE FOR BIODIVERSITY IN NEW MEXICO: CONSERVATION IMPLICATIONS AT REGIONAL AND LOCAL SCALES

*\*Carolyn A.F. Enquist, The Nature Conservancy; \*Evan Girvetz, University of Washington; \*David F. Gori, The Nature Conservancy*

There is a paucity of information linking the physical impacts of climate change with effects on biodiversity and practical guidance for adaptive conservation planning and management. Progress has been made with the development of newly available analysis tools. We used these to analyze the impacts of climate change on watershed scale hydrological units (HUC250) in New Mexico. Most HUCs have experienced increases in temperature with varying magnitude over the past century, with the remainder experiencing slightly cooler or no changes. Precipitation changes were more spatially heterogeneous, but variance in precipitation change showed a positive relationship with elevation. Analysis of species richness showed that watersheds with higher richness were among those becoming warmest and driest. Warmer-drier trends are occurring concurrently with forest dieback, alteration

of fire regimes, declining snow pack, and species population declines in the Jemez Mountains, a priority conservation area in north-central New Mexico. With future projections suggesting these climate trends will continue, we conclude that this area is particularly vulnerable to ongoing climate change. To assist land managers, we have initiated a case study of the Jemez focused on the identification of optimal adaptation strategies. Together, these analyses provide a framework for conducting an assessment of climate change at scales appropriate for regional to local conservation planning and management.

### 3. ECUADOR'S YASUNI-ITT INITIATIVE: FORGOING OIL DEVELOPMENT FOR BIODIVERSITY CONSERVATION

*\*Max Christian, Friends of Yasuni*

The Government of Ecuador formally announced its intention leave the country's largest oil reserves permanently off-limits to exploitation in June 2007 under the Yasuni-ITT Initiative. The nearly 1 billion barrel Ishpingo-Tambococha-Tiputini (ITT) oilfields reside under the eastern third of Yasuni National Park, an area of high biodiversity and home to two indigenous tribes that live in voluntary isolation from the outside world. Ecuador depends on oil exports for one third of government revenue, and per capita GDP is approximately \$7100 USD. In exchange for forgoing the projected revenue from oil exploitation, Ecuador has sought financial commitments from the international community to support its transition toward a more sustainable economy. This presentation will highlight climate change and development assessments, and economic modeling of petroleum extraction and environmental impacts, as well ecosystem services valuation, performed in support of the Yasuni-ITT Initiative by a coalition of academics, non-governmental organizations and government agencies.

### 4. ESTIMATING RESILIENCY TO CLIMATE CHANGE AND PRIORITIZING BIODIVERSITY CONSERVATION ACTION AMONG SITES IN MADAGASCAR

*\*David Knox, Conservation International; \*LUCIANO ANDRIAMARO, CONSERVATION INTERNATIONAL; \*Radhika Dave, Conservation International; \*Lee Hannah, Conservation International/Center for Applied Biodiversity Science; \*James MacKinnon, Conservation International--Madagascar; \*Zo Lalaina Rakotobe, Conservation International; \*Harison Randrianasolo, Conservation International--Madagascar; \*Marc Steininger, Conservation International; \*Will Turner, Conservation International*

In 2003, the government of Madagascar announced the Durban Vision, a bold commitment to treble the protected area network of an island nation with exceptional endemism. Here, we evaluate the resiliency to climate change of sites of global conservation significance—171 Key Biodiversity Areas (KBAs), including 47 current and 119 proposed protected areas. Using current global land cover data and the IPCC business-as-usual global climate model for 2050, we estimate the current extant habitat and the future predicted extant habitat in each 0.75 km<sup>2</sup> cell holding a KBA. Our data show considerable vulnerability to climate change amongst Malagasy KBAs, especially in the extreme northeast and in the far southwest. Further, we use these data to prioritize conservation action by assessing site vulnerability amongst Malagasy KBAs. Site prioritization requires three metrics. Species vulnerability

is measured according to the presence of threatened species according to the IUCN Red List, and always increases priority. Site irreplaceability is based on the range sizes of the cell's species, and again always increases priority. However, site vulnerability, for which we derive an index based on current deforestation levels and climate change threat, increases priority for irreplaceable sites, but decreases it for sites holding mainly widespread species. Example top priority sites for implementation of the Durban Vision in the face of climate change include Daraina and the Mahafaly Plateau.

## 5. HOW TO INCORPORATE CLIMATE CHANGE INTO GLOBAL SITE PRIORITIZATION?: A THEORY OF SYSTEMATIC CONSERVATION PLANNING WITH THE IMPACTS FROM CLIMATE CHANGE

*\*Takuya Iwamura, The University of Queensland;*  
*\*Kerrie Wilson, The Nature Conservancy; \*Hugh Possingham, university of queensland*

Our research incorporates the effect of climate change on ecosystems into the systematic conservation planning at the global scale. We quantified the vulnerability to climate change for the WWF's 826 Ecoregions and used them as one of the criteria for global conservation site selection. For each ecoregion, we developed observed and forecasted climatic envelopes as 2-dimensional convex hulls after mathematical compression of the five climate variables (temperature, precipitation, etc) from IPCC website. Since Ecoregions are defined by homogeneous environments, it is reasonable to use the discrepancy between the current and future climate envelopes as a measure of ecological degradation. These measurements were then related with the WWF's vertebrates dataset to calculate the predicted rate of biodiversity loss. We compared different forecast from four GCMs (US, UK, Canada and Australia) and four IPCC climate scenarios (A1fi, A2, B1, and B2). To allocate resources yearly under annual budgets, we performed dynamic resource allocation developed by Wilson (Wilson 2006) to examine the impact of climate change on site prioritization. We confirmed considering climate change has an impact on priorities, and that some of these priorities are robust to the climate change scenario used. By comparison between the selected sites with and without the impacts of climate change, we also found the variability in elevation has statistically significant effect on the site selection.

## 6. PREDICTING EXTINCTION RISKS UNDER CLIMATE CHANGE: INTEGRATING STOCHASTIC METAPOPULATION MODELS WITH DYNAMIC BIOCLIMATIC HABITAT MODELS

*\*H. Resit Akcakaya, Stony Brook University; \*David Keith, NSW Department of Environment and Climate Change; \*Wilfried Thuiller, Laboratoire d'Ecologie Alpine, UMR-CNRS 5553, Université J. Fourier, Grenoble, France; \*Guy Midgley, South African National Biodiversity Institute; \*Richard Pearson, American Museum of Natural History; \*Steven Phillips, AT&T Labs; \*Helen M. Regan, University of California, Riverside; \*Miguel B. Araújo, Department of Biodiversity and Evolutionary Biology, National Museum of Natural History, CSIC, 28006, Madrid, Spain; \*Tony Rebelo, SANBI*

Current approaches to predict the impact of global climate change on biodiversity include bioclimatic modeling to predict

potential shifts and contractions in species' ranges. In reality, the species response to climate change is likely also involve population processes, species interactions, and interactions between demographic and landscape dynamics. In this study we used a novel mechanistic approach to predict the impacts of climate change on plant population viability in South African fynbos, one of the world's biodiversity hotspots. We linked dynamic habitat suitability models with spatially explicit stochastic population models to determine how variations in plant life history, disturbance regime and distribution patterns influence the viability of populations under stable and changing climate scenarios. Results indicate that complex interactions between life history, disturbance regime and distribution pattern mediate whether particular species will be exposed to increased extinction risks under climate change. Our mechanistic approach allows more realistic prediction of future biotic responses than do static bioclimatic niche modeling approaches, and will ultimately support the development of more effective conservation strategies to mitigate biodiversity losses due to climate change.

## 7. PREDICTING THE EFFECTS OF FUTURE CLIMATE AND LAND USE CHANGE ON CALIFORNIA AVIAN SPECIES DISTRIBUTIONS

*\*Dennis Jongsomjit, PRBO Conservation Science;*  
*\*Diana Stralberg, PRBO Conservation Science;*  
*\*Chrissy Howell, PRBO Conservation Science*

Using an ecologically comprehensive suite of avian focal species as upper trophic level indicators of ecological change, we evaluated the effects of climate and land use change on avian communities in California ecosystems. Species occurrence data were obtained from monitoring projects encompassing thousands of records and covering all major geographic regions of the state. Future climatic conditions were derived from 40-km regional climate model outputs, with change values added to current 800-m PRISM datasets, allowing for a relatively high resolution of California's spatially diverse climates. Current climate relationships were used to predict distributions under future climate scenarios. Comparing two distribution modeling approaches, Maxent and GAMs, we evaluated several biologically relevant bioclimatic variables and their effect on both current and future predictions of occurrence. We also compared climate-only models to models that included vegetation. Future land use projections were overlaid on predicted future distributions to identify areas of potential conservation concern. Species and avian communities at highest risk from the combined effects of climate and land use change were identified. Responses to climate change varied depending on species life-history characteristics and vegetation associations. Future models proved far more sensitive than current models to changes in parameters, deeming caution when selecting variables used for future predictions.

## 8. VULNERABILITY OF THE WORLD PROTECTED AREAS NETWORK TO CLIMATE CHANGE

*\*Sandy J Andelman, Conservation International;*  
*\*Jenny Hewson, Conservation International; \*Jan Dempewolf, University of Maryland; \*Erica Ashkenazi, Conservation International*

Protected areas are the center piece of current conservation strategies. We establish reserves, and we assume that if the land is protected, then the plants and animals living there will persist. Given what we now know about climate change, this may be wishful thinking. More than 60% of the World's protected areas are at risk from climate change in the next 50 years, according to the first global analysis of the World

Protected Areas Database using ten Global Climate Models and three scenarios drawn from the Intergovernmental Panel on Climate Change. According to these models, current climatic conditions may disappear entirely from several critical Biodiversity Hotspots, such as the Tropical Andes, Mesoamerica, the Cape Floristic Region, the Himalayas, the Philippines and Wallacea, and from Tropical Wilderness Areas such as the Amazon. The likely result is increased risks of extinction and the disruption and disaggregation of extant ecological communities, even within protected areas. Climate change is happening, and reserves are not immune. The current repertoire of conservation strategies and policies falls short of the arsenal required to safeguard biodiversity. We identify key elements for an action plan to make the World Protected Areas Network robust to climate change.

## 15. Climate Change (3)

### 1. CONSEQUENCES OF SNOWPACK VARIATION AND EPHEMERAL PONDS ON COLUMBIA SPOTTED FROG (*RANA LUTEIVENTRIS*) POPULATIONS IN HIGH ELEVATION ECOSYSTEMS

*\*Rebecca Marie Wahl McCaffery, University of Montana; \*Bryce Maxell, Montana Natural Heritage Program*

Long-term changes in snowpack levels and resulting hydrological changes may have profound impacts on amphibian populations dependent upon ponds and wetlands in alpine ecosystems. We conducted a mark-recapture study of a Columbia spotted frog (*Rana luteiventris*) population in the Bitterroot Mountains from 2000–2007. Using pond-specific batch marks, we tracked size, dispersal rate, and survival of metamorphs emerging from ephemeral ponds and permanent ponds each year. Additionally, we estimated survival in juvenile and adult frogs and related it to annual peak snowpack levels. Metamorphs from ephemeral ponds were smaller in mass than metamorphs from permanent ponds ( $p=0.023$ ), but these differences were not apparent at one year ( $p=0.11$ ). Metamorphs from ephemeral ponds showed higher rates of dispersal than those from permanent ponds. There was no correlation between pond type of origin and apparent survival to 1 year. Although metamorphs from temporary ponds were smaller, they had similar survival rates and may contribute disproportionately to dispersal among ponds. Juvenile and adult annual survival estimates were positively correlated with snowpack levels (0.70 for juvenile and 0.63 for adult frogs). In alpine ecosystems, loss of ephemeral wetlands and systematic reductions in snowpack due to climate change may adversely impact both recruitment and frog survival.

### 2. EFFECTIVENESS OF EUROPEAN PROTECTED AREAS FOR CONSERVING BIODIVERSITY UNDER CLIMATE CHANGE

*\*Miguel B. Araújo, Department of Biodiversity and Evolutionary Biology, National Museum of Natural History, CSIC, 28006, Madrid, Spain; \*Diogo Alagador, Department of Biodiversity and Evolutionary Biology, National Museum of Natural History, CSIC, Madrid, Spain; \*Mar Cabeza, Department of Biodiversity and Evolutionary Biology, National Museum of Natural History, CSIC, Madrid, Spain; \*David Nogués-Bravo, Department of Biodiversity and Evolutionary Biology, National*

*Museum of Natural History, CSIC, Madrid, Spain; \*Wilfried Thuiller, Laboratoire d'Ecologie Alpine, UMR-CNRS 5553, Université J. Fourier, Grenoble, France*

Despite evidence that climate change is altering species' ranges at unprecedented rates in the historical record, biodiversity conservation strategies still assume that species change relatively slowly, unless they are directly affected by human activities. Using an ensemble of bioclimate models under different dispersal/emission scenarios for 2050 and 2080, we assess the potential impacts of climate change on European plant and terrestrial vertebrate species and measure the protected areas' (PAs) ability to conserve them. Our results show that heterogeneous responses are expected among both taxa and regions. In the more optimistic scenario for 2050 a substantial proportion of species losing protection within current PAs is expected. In a worst-case scenario substantial losses of species from protected areas are expected, particularly in 2080. A few species projected to expand their ranges within Europe are predicted to lose high proportions of their range that is protected. Patterns vary for taxa and regions; for example, herptiles will lose much protected range in the Iberian Peninsula, while eastern-central Europe PAs are expected to lose many populations of bird and mammal species. Our study supports the need for changes in the current conservation paradigm that assumes static species ranges, and opens the door for proactive planning where corridor design, sustainable development, expansion of PAs and species' assisted-migration are considered in parallel.

### 3. HOW FAR CAN THE FROGG LEAP? - NEW APPROACHES FOR IDENTIFYING PRIORITY CONSERVATION AREAS IN THE FACE OF CLIMATE CHANGE

*\*Heini Kujala, University of Helsinki; \*Mar Cabeza, Department of Biodiversity and Evolutionary Biology, National Museum of Natural History, CSIC, Madrid, Spain; \*Atte Moilanen, University of Helsinki*

Conservation planning is facing new challenges as species shift their ranges due to climate change. We present a novel method that assists the identification of priority conservation areas to cope with changing distributions. The method not only identifies those sites important for future and present distributions but it also focuses on source sites, those sites important today, but also well connected to important future locations. This connectivity is related to species' dispersal ability. Importantly, the approach accounts for different sources of uncertainty: model-based uncertainty and uncertainty due to factors ignored in modelling species distributions. We demonstrate the method by identifying priority areas for 108 amphibian and reptile species in Europe, based on distributions today and in 2050. The future distributions have been produced by using combinations of two different climate models, four response scenarios, and four bioclimatic modelling approaches. We illustrate the use of consensus approaches to summarize the projections across models and deal with uncertainty by discounting predictions at locations where projections exhibit large variation. In summary, the aim of our approach is to identify regions that robustly either allow the local persistence of species or make dispersal between present and future areas plausible. The proposed method is implemented using the distribution interactions feature of the conservation prioritization software Zonation.

### 4. PREPARING ECOSYSTEMS FOR CLIMATE

## CHANGE USING A CONSERVATION AND ADAPTATION FRAMEWORK

*\*Dominick A DellaSala, National Center for Conservation Science & Policy; \*Marni Koopman, Rocky Mountain Research Station; \*Cindy Deacon Williams, National Center for Conservation Science & Policy; \*Erica Fleishman, National Center for Ecological Analysis and Synthesis; \*Bob Doppelt, University of Oregon; \*Roger Hamilton, University of Oregon*

Warming of the planet's surface and corresponding changes in the global climate are stressing ecosystems beyond their capacity, with adverse consequences to both biodiversity and human communities. While regionally specific, climate-related changes compound stressors to ecosystems primarily through temperature-related shifts in species distributions across elevational and latitudinal gradients, more severe storms and wildland fires, displacement of native species by invasives, reductions in ecosystem productivity, reduced snow pack, and increased droughts and floods. Thus, conservation scientists are faced with an unprecedented challenge regarding how best to adapt fundamental conservation strategies - like reserves and connectivity - to rapidly changing climates. Specifically, how do we prepare ecosystems and sensitive species for climate change effects and how can a conservation biology framework be adapted to address climate change preparation strategies? We provide suggestions for marrying conservation strategies with climate change adaptation approaches and offer general principles to aid decision makers in adaptation strategies under development for various states in the western U.S.

## 5. SEASONAL VARIATION IN SIZE-DEPENDENT SURVIVAL OF BROOK TROUT: EFFECTS OF TEMPERATURE AND FLOW

*\*Cailin Xu, The Nature Conservancy; \*Ben Letcher, Conte fish research centre of USGS; \*Keith Nislow, U.S. Forest Service*

This study examines the effect of climate factors such as temperature and flow as well as seasonality on survival of stream-dwelling brook trout in a stream network of the eastern United State. We use Program M-surge to fit multistate capture-mark-recapture models with individual fish capture history and climate data. Model selection is based on Akaike's Information Criterion to identify the cause-effect relationship between climate factors and brook trout survival. We discover that how temperature and flow influence brook trout survival is fish size dependent and varies among seasons. Specifically, survival of bigger fish is found to be negatively influenced by low summer flow. We hypothesis that this is because low summer flow leaves bigger fish more opportunity be exposure to predators. In summer, brook trout survival decreases with mean temperature but increase with mean flow. Our study plays the groundwork for further study of consequences of climate change on persistence of this important native species.

## 6. TAKING STEPS FOR DEMOCRACY: USING NEW COMMUNICATION MEDIA TO REVITALIZE CITIZEN PARTICIPATION IN CLIMATE CHANGE ACTIVISM

*\*Jodi M Minion, Texas A&M University; \*Chad O'Neil, North Carolina State University; \*William J. Kinsella, North Carolina State University; \*Tarla Rai Peterson, Texas A&M University*

Public participation in the United States is compromised in a

post 9-11 context due to increased emphasis on homeland security, threatening democracy's vitality by removing legitimate venues for dissent. New media suggest ways activists may adapt to contemporary political constraints by inventing new forms of participation that may reach audiences who are insulated from traditional protests. We used Step It Up 2007 (SIU 07) as a case study to examine what it means to participate in web-based activism, and how climate change activists have used new media to build a movement. Step It Up 2007 asked ordinary citizens to organize climate action rallies on April 14th, 2007. We used Critical Discourse Analysis to examine information provided to citizens on the SIU 07 website; we also attended SIU 07 events in San Antonio, Texas and Raleigh, North Carolina. We found SIU 07 organizers successfully used new media to increase agitation and to shift power away from the federal government to the local grassroots level. We recommend activists can use new media as a unifying tool, to provide a fragmented and apathetic citizenry with the same message that can be used to affect change. The relative success of SIU 07 suggests that organizers can use new media to help negotiate the fragmented political landscape in the following ways: 1) Cast a wide net; 2) Provide a safety net; 3) Provide simple and clear instructions; 4) Establish media relationships; 5) Empower leaders at the local level.

## 7. TEMPORAL AND SPATIAL CHANGES OF PRIMARY PRODUCTIVITY IN THE SEA OF MARMARA OBTAINED BY REMOTE SENSING

*\*Didem Ikis, Department of Biological Sciences at Middle East Technical University; \*Sargun Ali Tont, Department of Biological Sciences at Middle East Technical University; \*Mehmet Lütüfi Süzen, Department of Geological Engineering at Middle East Technical University*

Monitoring marine pollution in polluted regions is of utmost importance due to its massive impact on primary productivity. Remote sensing provides us with necessary data to assess the magnitude of this damage and establish the necessary guidelines for conservation of phytoplankton in any part of the globe. Temporal and spatial variations in the Sea of Marmara based on monthly averages of chlorophyll a, which is the major indicator of phytoplankton biomass and primary production, recorded by SeaWiFS and MODIS-Aqua sensors at nearly 100 stations have been analyzed for the period of 1997-2007. Majority of phytoplankton blooms occur during the winter and spring seasons, followed by a smaller secondary bloom during the fall season. The majority of high magnitude blooms occur at the Eastern part of the Sea which may be attributed to an increase in the amount of industrial discharge. The correlations between monthly averages of sea surface temperature and corresponding chlorophyll a values are statistically significant (inverse) at 1% level, where  $r = -0.53$  and the equation of the fitted model is:  $\text{Chlorophyll a} = 7.09199 - 0.215402 * \text{SST}$  This correlation is expected because a relative decrease in SST is an indicative of upwelling and vertical mixing which cause phytoplankton blooms.

## 8. THE END OF REMOTE: CLIMATE, OIL, AND ARCTIC MIGRATORY SHOREBIRDS

*\*Steve Zack, Wildlife Conservation Society; \*Joe Liebezeit, Wildlife Conservation Society*

The coastal plain of arctic Alaska is the breeding home of millions of shorebirds migrating from all over the world. Dramatic climate change and expanding energy development are disrupting wildlife in manifold ways. We have been monitoring nesting patterns of shorebirds in both the Prudhoe Bay oilfields (6 years) and at a remote site near Teshekpuk

Lake (4 years). With partners (USFWS, oil companies, and others) we have examined, using a modified Cox proportional hazards regression, whether oil infrastructure affects nesting success in birds since it has led to increases in nest predators. Our results indicated some effects, yet natural between-year and between-site variation was great. Separately, we monitored a subset of nests in the oil fields with remote cameras and found that arctic fox are the most important predator despite being the least common of nest predators. Our data from Teshekpuk suggest this region has high nest productivity, nesting density, and species richness in comparison to Prudhoe Bay and other coastal areas, demonstrating another distinction of this region meriting protection. Finally, a changing climate is associated with earlier nesting (ca. 10 days over a 20 year period) by shorebirds and suggests a possible disruption of migratory calendars. Steve Zack and Joe Liebezeit, Wildlife Conservation Society, 718 SW Alder Street, Suite 210, Portland, OR, 97229 USA. Phone: 503/241-3743 szack@wcs.org and [jliebezeit@wcs.org](mailto:jliebezeit@wcs.org)

## 16. Communications, Outreach, and Education

### 1. A THEORETICAL FRAMEWORK FOR EXPLORING COMPLIANCE WITH MINIMUM-IMPACT VISITOR EDUCATION GUIDELINES

*\*Wade Vagias, Department of Parks, Recreation and Tourism Management, Clemson University; \*Robert Powell, Department of Parks, Recreation and Tourism Management, Clemson University*

Leave No Trace (LNT) is a conservation education program and tool designed to lessen the ecological and sociological impact human powered recreationalists have on the natural environment. The program has been promoted within the US National Park Service (NPS) since 1994, however there is limited knowledge regarding the effectiveness of the program for influencing visitors' behaviors and protecting natural resources. Based upon Ajzen's Theory of Planned Behavior (1991), this research effort evaluated a model hypothesized to be predictive of US NPS overnight backcountry users' compliance with promoted LNT guidelines. Data were collected via a self-administered questionnaire from overnight backcountry users in two NPS Units; Glacier National Park, MT (n=278) and Olympic National Park, WA (n=313). This presentation focuses on the theoretical underpinning of the conceptual model and presents results regarding the structural viability of the model. For the practitioner or manager, considerations for improving the effectiveness of the LNT message and targeting specific attitudes and behaviors will be presented so as to mitigate the potential impacts on biodiversity caused by visitation.

### 2. ASSESSING BEACH USER ATTITUDES AND KNOWLEDGE OF BEACH-NESTING BIRDS

*\*Alison Ormsby, Eckerd College Environmental Studies; \*Elizabeth Forys, Eckerd College; \*Sarah Lockhart, Eckerd College*

Beach-nesting birds in Florida, including American oystercatchers, black skimmers, least terns, snowy plovers and Wilson's plovers, have declined due to habitat loss, increases in predators, and human activities. The goals of this multi-year research project include: assessing the knowledge and attitudes of beach users in Pinellas County, Florida, toward beach-nesting birds; evaluating municipal government beach

management practices; and addressing beach user perceptions of beach-nesting birds through a multi-faceted education campaign. While portions of Florida's coastline are protected and managed for preservation of biodiversity, many beaches are under the jurisdiction of county and municipal governments and are primarily managed for human recreation. Municipal beach management has the potential to increase the number of suitable nesting locations and thereby the number of individuals of the species. In the summer of 2007, 400 interviews were conducted with beach users at five Pinellas County beaches, using a semi-structured survey guide. Results indicate that beach users, whether local residents or not, support beaches as a place for birds to nest. The majority of beach users could not identify any of the five focal species of beach-nesting birds. An education campaign is being implemented to address gaps in beach user knowledge of beach-nesting birds.

### 3. DEVELOPING EDUCATIONAL TOOLS TO PROMOTE MARINE CONSERVATION IN THE BAHAMAS: LINKAGES AMONG RESEARCH, EDUCATION, AND CONSERVATION

*\*Meg Domroese, American Museum of Natural History, Center for Biodiversity and Conservation*

Education is critical for management of marine protected areas, particularly where resources for official enforcement are limited and compliance with regulations is largely determined by local communities. This presentation will describe how education has been linked with multi-disciplinary research on marine protected areas in The Bahamas. In addition to participation of students and faculty in fieldwork, the research provided the impetus for a complementary educational initiative to strengthen marine education across The Bahamas. The recently published guide, "Treasures in the Sea: Our Bahamian Marine Resources," provides educators with scientific information and engaging, hands-on activities to incorporate marine conservation concepts into their curriculum. The process of developing this resource involved a survey of existing educational materials, consultation with scientists on concepts to cover and accuracy of information, and extensive discussion with teachers to adapt activities for the Bahamian context and ensure that educational goals are addressed. Following initial training workshops in July 2007, teachers have led subsequent workshops for others in their schools and are implementing activities with students. The evaluation process includes collecting feedback from teachers and examining learning outcomes.

### 4. DEVELOPMENT OF A CONSERVATION BIOLOGY PROGRAM AT THE AMERICAN UNIVERSITY OF NIGERIA

*\*Janette Wallis, American University of Nigeria*

Today, more than ever, Africa needs well-trained and highly-motivated conservationists. As conservation biologists, we must be involved in the education of Africa's youth and guide them toward professions that preserve and protect the continent's wildlife and wild lands. This is the primary goal of the new Conservation Biology Program of the American University of Nigeria (AUN). Created in partnership with American University (Washington, D.C.), AUN is the only "American-style" university in sub-Saharan Africa. Established in 2005, AUN brings quality higher education to Africa's most populous nation. Several of the courses offered in the Conservation Biology Program also serve as basic science requirements for all students at AUN. In this way, the message of conservation may reach many students regardless of career choice. For example, business majors may choose to

incorporate environmentally responsible attitudes in their careers and political science majors may adopt conservation policies in service to the country. Of course, the main aim of the Conservation Biology Program at AUN is to attract students who will fully embrace conservation biology as a career. Participation in research projects and internship opportunities supplement the coursework required for completion of the Bachelor of Science degree program. This presentation will describe the progress and challenges of establishing such a program - and offer advice to others involved in similar endeavors.

## 5. ROLE OF TRANSLATED LITERATURE IN DISSEMINATION OF KNOWLEDGE AND CREATING AWARENESS ON GLOBAL CHANGE

*\*Ghazala - Nasim, University of the Punjab;*

*\*Rukhsana - Bajwa, Department of Mycology and Plant pathology, Punjab University,*

Global change is impacting humans in all walks of life all over the world knowingly and unknowingly. Various international and national organizations are involved in research activities, the results of which yield some highly significant conclusions. The documentation is fairly quick and literature is therefore mounting rapidly with the passage of time. However most of the literature is in English and thus is of a limited benefit in countries like Pakistan where English is not the national language. It has therefore been worthwhile not only to produce vital documents in Urdu-the national language of the country, but also to translate the existing literature in English into Urdu to make it accessible and understandable to non-English speaking Pakistani people. The present paper highlights the efforts of a group of scientist at The Department of Mycology and Plant pathology, University of the Punjab, Lahore Pakistan, to translate IGBP literature into Urdu. One of the document (Executive summary of "Global Change and the earth system-A planet under pressure") has been published in 2007 and another one (IGBP report #55) is in press. The present paper reviews the impact of translated mater in highlighting the issue of global change and to create awareness of the phenomenon in the general public.

## 6. THE COALITION OF PRESCRIBED FIRE COUNCILS: PARTNERING TO PROMOTE UNDERSTANDING OF PRESCRIBED FIRE AND ADDRESS MANAGEMENT, POLICY AND REGULATORY ISSUES

*\*Johnny Stowe, SC Department of Natural Resources; \*Mark A. Melvin, Joseph W. Jones Ecological Research Center; \*Dale Wade, Rx Fire Consultant*

As North America continues to experience rapid changes in land use and demographics, and to suffer from the resulting loss and degradation of ecosystems and landscapes, prescribed fire managers face increasingly complex challenges that limit or threaten the use of this ancient conservation tool. Across the continent, common prescribed fire issues related to public health and safety, ecological stewardship, liability, public education, air quality regulation and the wildland urban interface (WUI) concern the prescribed fire community. Networking existing state and provincial prescribed fire councils' efforts is proving synergistic in increasing communication, effectiveness of public education, participation in fire policy decisions, and representation in forums dealing with regional, national and international regulatory issues. In November 2006, a diverse group of private, federal and state

agency, and non-governmental organization leaders collaborated to form a Coalition of Prescribed Fire Councils. This group has since then coalesced by developing its mission statement, purpose, and goals and by manifesting them in a strategic plan. Concomitant with the Coalition's advent has been a closely related flurry of newly developed state and provincial fire councils. The Coalition of Prescribed Fire Councils serves on regional, national and international platforms to ensure that the ecological values, and other public benefits of prescribed fire, are secure for the future.

## 7. WAKING THE SLEEPING GIANT - MOBILISING THE CHRISTIAN CHURCH IN KENYA TO CONSERVATION ACTION

*\*Ronwyn Jackson, A Rocha Kenya; \*Craig Sorley, Care of Creation Kenya; \*Shelly Thomas, Eastern Mennonite University*

Although it has been a focus of conservation work, Kenya continues to suffer serious environmental degradation. With much of the country directly dependent on local ecosystems (from farming to ecotourism), this degradation results in increased poverty and decreased human health. Caring for the environment is a key biblical principle that has largely been ignored by the Christian church in Kenya and indeed worldwide. Kenya has a population of 35.5 million people, with approximately 80% identifying as Christian. An environmentally-informed and mobilised population of this size could be a substantial force on the conservation front. Care of Creation Kenya and A Rocha Kenya, two Christian conservation organisations, are working with an extensive network of Kenyan churches to challenge leaders and members on the biblical mandate to care for the environment. Over a thousand national church leaders from many different denominations have taken part in seminars, conferences and applied training; this has led to positive changes in attitudes and behaviours towards the environment. Practical outgrowths of these educational programs include reforestation and establishment of indigenous tree nurseries, use of appropriate technologies, practice of sustainable agriculture, reduction of pollution, and more sustainable living. These initial results have demonstrated the vast potential for the Christian church to be a critical agent of change in reversing environmental degradation in Kenya.

## 17. Community-driven Conservation

### 1. A CONSERVATION AND DEVELOPMENT MODEL IN ECUADORIAN COASTLINE: THE CASE OF FOREST AND COASTLINE ECOSYSTEMS IN MANTA AND MONTECRISTI

*\*Jaime Ernesto Camacho, Fundacion Natura/The Nature Conservancy*

The forest and coastline ecosystems of Manta and Montecristi are part of the coastal ridge in Ecuador, a conservation priority spot for the country due to its contribution to biodiversity conservation. These ecosystems sustain the life of more than 30,000 inhabitants that use their resources such as water, fishing, tagua, coffee, bamboo and recreational opportunities. The place is very important because of the interrelationship between marine and terrestrial ecosystems. Since 2007 a group of local organizations including local governments, local communities, non governmental organizations, local university have come together to develop a conservation and development process in the area. So far, there have been effort to foster local capacities and create a local management committee, an formal alliance between two local governments is being created, a

local conservation area was created that includes part of the area and a management plan is being designed with local and national participation. We consider this effort can be a conservation and development model to manage interacting marine and terrestrial ecosystems because there is an outstanding biological context and an important political will in local authorities.

## 2. AGE AND INTENSITY OF URBANIZATION EFFECTS ON FUNCTIONAL AND TAXONOMIC HOMOGENIZATION OF NEARBY FARMLAND BIRD COMMUNITIES

*\*Fiippi-Codaccioni Ondine, French Museum of Natural History; \*Vincent Devictor, MNHN;*

*\*Romain Julliard, MNHN*

As consequence of urban sprawl urban territory is taking the place of other habitats like agricultural areas. As farmland biotic communities are already reported as declining, it seems necessary to assess the urbanization impact on them. We conducted a bird survey on 92 a priori chosen plots of 1x1 km in respect to their differing proportion of urban area on farmland habitat. Two aspects of urbanization were studied: its intensity and its age. Bird species contacted in farmland were categorized in farmland and non-farmland species in order to enlighten complementary mechanisms. We found that the most specialized farmland birds were less abundant in the more urbanized and old urbanized plots, whereas non farmland specialist species tended to be more abundant in more recently urbanized plots. The urbanization intensity explained more variance in bird densities than its age. We also found that, the more urbanized and recently urbanized the plots, the more similar bird communities. A strong gap between farmland bird's communities' compositions was found between 0% and 25% of urbanization, whereas no distinction was found between 50% and 75%. Those urbanization thresholds and their consequences on communities' composition can have interesting implications for conservation strategies in urban planning decisions. Our study enlightened both static and dynamic processes, which can lead to a better understanding of urbanization induced homogenization processes.

## 3. ASSESSMENT OF RESIDENT WELLBEING IN THE PADAMPUR RESETTLEMENT, ROYAL CHITWAN NATIONAL PARK, NEPAL

*\*Narayan Prasad Dhakal, University of Minnesota; \*Kristen Nelson, University of Minnesota; \*J. L.*

*David Smith, University of Minnesota*

People's plight as a result of forced resettlement and displacement during the creation and maintenance of national parks and protected areas in many African and Asian countries has been a genuine concern for conservation scientists and professionals. We investigate resident's social and economic wellbeing following a citizen-initiated resettlement program in Nepal. Findings are based on a household survey (n=322) designed to compare respondents' evaluation of wellbeing factors in old and new Padampur. Mixed outcomes were found regarding respondents' evaluations of their wellbeing, but many were considered positive (e.g. improved access to health services, secure land title, reduced landlessness and continued strong social ties after the resettlement). Anticipated marginalization was reduced through increased support services and women's empowerment programs. However, respondent evaluated that there were losses of traditional Tharu cultural activities, fewer farm-based jobs, a scarcity of water, and lower food production. Of particular concern in Padampur is the need to increase off-farm economic opportunities and water availability. This study suggests conservation related

resettlement should be reconsidered in light of the Padampur model.

## 4. COMMUNITY-BASED WILDLIFE CONSERVATION PROGRAMS CONTRIBUTES TO ALTERNATIVE LIVELIHOOD SUPPORT FOR SAMBURU PASTORALISTS IN NORTHERN KENYA

*\*Nicholas Otienoh Oguge, Earthwatch Institute Kenya; \*Caleb Mireri, Kenyatta University; \*Esther Mwele, Kenyatta University*

In Samburu District, communities are increasingly embracing wildlife as a land use thus benefiting from wildlife-based tourism. We undertook a survey on socio-economic impacts of such programs among five communities. We report on the contribution of wildlife conservation to community development, community perception and participation, and negative effects of co-existence with wildlife. A stratified random sampling was used to identify 50 households in each community for interviews using semi-structured questionnaires. In addition, focus group discussions and interviews of resource persons were conducted. Our findings show that community-based wildlife enterprises contribute substantially towards education, communication and security. However, there is a weak community participation or understanding of conservation activities, a situation that may threaten sustainability. These are due to cultural attachment to livestock, low literacy levels and poor information flow. Communities also associate wildlife with a number of negatives such as competition for water and pasture, disease transmission to livestock, depredation, and injury or death to human. Lack of or inadequate compensation for damages caused by wildlife is a further disincentive. We recommend development of local institutions and personnel, increased community awareness and participation in decision making, and an integrated structure in resource allocation for sustainable programs.

## 5. CONSERVATION UNDER ATTACK IN UGANDA: WINNERS AND LOSERS OF THE RECENT MABIRA FOREST RESERVE GIVE AWAY CONFLICT.

*\*Abdou Karekoona, Makerere University Institute of Natural Resources; \*Raymond Katebaka, Makerere University Institute of Natural Resources*

Mabira rain forest is home to several endangered species like the Nahan's Francolin *Francolinus nahani* and the newly discovered Crested Mangabey *Lophocebus ugandae*. In late 2006 the government of Uganda announced it was giving one-third (~7186 ha) of the forest to Sugar Corporation of Uganda Limited for sugarcane growing, the deforestation plans were disputed within and outside Uganda most notably by surrounding communities, environmental activists. In February 2007 the conflict escalated and was widely covered by the press and supported around the globe. Government argues that degazettment would result into numerous direct, indirect and multiplier economic benefits. On the other hand, the pro-conservation groups and the local communities that are opposed to the degazettment have to date dwelt on the potential loss of the rich biodiversity of the forest, potential breaches of the public trust doctrine and international and regional agreements especially multilateral environmental agreements. A debate continues between the community and the Ugandan central Government about the fate of the forest. In this paper, we examine the biophysical attributes of Mabira rain forest, analyze the conflict and predict the most likely winners.

## 6. CUSTOMARY LAND TENURE AND COMMUNITY-BASED PROTECTED AREAS IN THE SOLOMON ISLANDS.

*\*Christopher Filardi, American Museum of Natural History*

Complex customary systems of land tenure have often impeded conservation initiatives in the Solomon Islands, presenting serious challenges to protected areas design and implementation. At the same time, some sectors of extractive industry have exploited vulnerabilities in traditional decision-making processes, and poorly regulated timber operations have escalated across the country. Paradoxically, these same traditional land tenure systems that have permitted industry exploitation in the past may provide opportunity for biodiversity conservation and more sustainable development in the future. Through an international partnership, we are designing initiatives that provide development incentives to landholding communities interested in alternatives to large-scale resource extraction. Our approach relies on Community Conservation Agreements (CCAs) that link development assistance to biodiversity conservation and support traditional decision-making and land tenure systems. We are now developing a pilot network of community-based protected areas that provide an indication of the potential for this approach in the Solomon Islands. Efforts to date highlight the importance of securing long-term sustainable funding and the establishment of transparent community-based partnerships. Additionally, CCAs can catalyze the stewardship of culturally appropriate social contracts that enable the necessary compromises associated with successful conservation efforts in the Solomon Islands.

## 7. SPECIES DIVERSITY AND COEXISTENCE IN AN OLD-GROWTH TEMPERATE FOREST IN NORTHEASTERN CHINA

*\*Zhanqing Hao, Institute of Applied Ecology, Chinese Academy of Sciences*

To ultimately understand of the mechanisms of species coexistence, the Chinese Academy of Sciences, in collaboration with the Center for Tropical Forest Science (CTFS) of the Smithsonian Tropical Research Institute, has recently initiated an ambitious large-scale, long-term forest dynamics and diversity plots network. Following the protocols of the CTFS forest dynamics plots, the China Network has been designed to establish four 20-25 ha plots along the latitudinal gradient from north to south China. The Changbaishan plot, the northernmost plot of the China Network, is established for the benefit of understanding temperate forest ecosystem. In the plot, all free-standing individuals with DBH > 10 cm were stem-mapped and identified to species. We found that: (1) There are 38902 genotype individuals, belonging to 52 species, 32 genus and 18 families. Fourteen species comprise 95.2% of all individuals, while other thirty-eight species comprise fewer than 5% of all individuals. (2) The size-class structure of main species in the overstory layer showed nearly normal or bimodal distribution, while the species in the midstory and understory layers showed invert "J" distribution. (3) Scale is an important role for shaping community structure. Spatial distribution patterns of species changed with size-class and scales.

## 8. WOMEN PARTICIPATION AND EMPOWERMENT IN COMMUNITY-BASED WILDLIFE MANAGEMENT: THE CASE OF SERENGETI REGIONAL CONSERVATION PROJECT, TANZANIA

*\*Alexander Nyangero Songorwa, Sokoine University*

*of Agriculture; \*Anna Nyamtondo Sikira, Sokoine University of Agriculture*

Community-Based Wildlife Management is currently a popular approach to wildlife conservation. It involves local communities who are regarded as homogenous groups. However, the communities have different needs and interests. The problem of natural resource degradation is perceived differently by men and women. These differences emanate from customary laws and cultural practices entrenched in the local cultures. CBWM was introduced in Tanzania to stop the decrease of wildlife populations. Although the approach seeks to involve both men and women, the role of women is not clearly elaborated. This triggered the current study in the Serengeti Regional Conservation Project using a cross-sectional design in four villages in two districts. The villages were purposively selected while 30 households from each were randomly selected. Findings indicate that women's participation in leadership was low. Majority of those few worked as treasurers. Only few women participated in project planning and implementation and reasons included high workload and cultural perception that wildlife-related activities are men's. Women were found to concentrate on scaring wild animals from crop fields, adding the workload they already had. We recommend that gender mainstreaming in wildlife-related projects should go hand in hand with women empowerment to enable them to have full access and control over natural resources. The projects should reflect needs of all community groups, including women.

## 18. Community-driven Conservation (2)

### 1. CALAYAN RAIL PROJECT II: BUILDING LOCAL STAKEHOLDERS CAPACITY TO PROTECT AN ISLAND ENDEMIC SPECIES

*\*Carl Oliveros, Isla Biodiversity Conservation; \*Elson Aca, Isla Biodiversity Conservation; \*Miguel Ferido, Isla Biodiversity Conservation; \*Harvey Garcia, Isla Biodiversity Conservation, Inc.; \*Karina Javier, Isla Biodiversity Conservation, Inc.; \*Cynthia Adeline Amoyo Layusa, Isla Biodiversity Conservation, Inc.; \*Michael Angelo Morales, Isla Biodiversity Conservation*

Subsequent surveys after the 2004 discovery of the island-endemic Calayan rail *Gallirallus calayanensis* in the island of Calayan, Babuyan Group of Islands, northern Philippines, showed a Vulnerable species (IUCN 2006) threatened by habitat loss and hunting. Under the Calayan Rail Project I, a conservation plan was created with local stakeholders to address these environmental issues. This project, the Calayan Rail Project II, focuses on parts of the conservation plan aimed to build the capacities of stakeholders to conserve the rail and the island's natural resources - the island group being an Important Bird Area in the Philippines (IBA Code: PH001). Specifically, this aims to increase the awareness, knowledge, and involvement of local stakeholders in conservation work through trainings on ecologically sound reforestation and agroforestry practices, environmental laws and ordinances, and monitoring of the status of the Calayan rail. Lastly, the project aims to assist the locals in establishing a wildlife sanctuary through a participatory process. The following activities were done to reach these objectives: pride campaign, teacher-training activity, law enforcement training, small island reforestation training, rail monitoring training, and participatory resource mapping to help establish a local wildlife sanctuary. The outcome reinforces the effectiveness of community-based conservation anchored on capacity building to enable local

ownership of and support for the project.

## 2. CONSERVATION AND SCIENCE: HUMAN-LEOPARD CONFLICT STUDY IN JAMMU AND KASHMIR, INDIA, TO BRIDGE THE GAP BETWEEN COMMUNITY AND WILDLIFE

*\*Usham Somarendro Singh, Wildlife SOS; \*Rohit Singh, Wildlife SOS; \*Kartick Satyanarayan, Wildlife SOS; \*Geeta Seshamani, Wildlife SOS*

Frequent attack on humans by the leopard *Panthera pardus*, occurs in Jammu and Kashmir. Locals have poor understanding about the leopard which resulted to the death of humans and thus, leads to the retaliation. Investigation was carried out in 2007 and 60 victims were examined. Attacks peaked during 2005, 2006 and 2007. Leopards attacked more females ( $\chi^2=4.8$ ,  $p<0.05$ ) and children below 15 yrs. 75 % of the victim died and leopards optimized attack during the evening. Attacks varied seasonally ( $\chi^2=11.3$ ,  $p<0.01$ ) and occurred more during winter. Kupwara district, North Division of Jammu and Kashmir was identified as high-conflict zone, accounting for 55 % of the total attack. Habitat use by leopards during the attack showed no significant difference. A case was examined where leopard was chased by the people. It resulted to the attack of two persons before being killed. Two leopards turned occasional man-eater, which leads to the elimination of one. General assumption was that population of leopards is increasing as poachers stopped intruding into the forest due to militancy problem. Capacity building programme was conducted to impart training to the staff of the Wildlife Protection Department, Jammu and Kashmir. Workshops were organized in high conflict zones and still proceeding in various regions. We further recommended for habitat restoration, changing of land use pattern, management of dogs and research on ecology and behaviour of the leopard.

## 3. FUNGAL CONSERVANCY INITIATIVE-THE PAKISTAN CHAPTER

*\*Rukhsana - Bajwa, Mycology and plant pathology, University of the Punjab; \*Ghazala - Nasim, University of the Punjab*

Fungi are an essential component of the ecosystem. With a rapid progress in technology our reliance on fungi is increasing day by day. We have become dependent on fungi for their ability to recycle a variety of wastes and to render services in biotechnology. However this group of miraculous organisms is suffering from the consequences of climate change. Many of the fungi have become locally extinct due to a rapid shift in the ecological niche of these microbes. To conserve the fungal biodiversity of Pakistan an initiative has been taken in terms of launching a project under the title of "First Fungal Culture Bank of Pakistan" at the Department of Mycology and Plant pathology, University of the Punjab, Lahore, Pakistan. The bank has an honour to have over 700 local fungal accessions. The bank is also serving as a diagnostic plant pathology Lab. It is providing fungal cultures on request to teaching and research organizations of the country. Further more it has been holding training workshops for college teachers and young scientist for the identification of micromycetous fungi. The present paper presents an overview of activities of the very first fungal culture collection and preservation centre in Pakistan.

## 4. IMPACT OF NATURAL FLOW REGIME ON ECOSYSTEMS AND LIVELIHOODS OF RIPARIAN PEOPLE - CASE OF MASSILI RIVER, BURKINA FASO.

*\*Birguy Mainoumata Lamizana-Diallo, University of Ouagadougou; \*Jeanne MILLOGO-*

## *RASOLODIMBY, University of Ouagadougou*

This is a case study on the impact of flow regime on ecosystems and livelihoods of people living alongside the Massili River. The river and its resources are the main means of sustaining livelihood among the majority of the people living by. The government of Burkina Faso decided to pave the national road n°22 which passes across the River. The enterprise embanked the River to have water for the construction, without an Environmental Impact Assessment. This leads to a drastic change in the flow regime. To assess the impact, a socio-economic survey comprising focus group discussions, semi-structured interviewing and mapping was conducted. The survey illustrated the highly dependency of people's production systems on the functions and services of natural ecosystems. Thus, the alteration of the flow regime hurts the population and emphasized how a local land use decisions result in environmental damages that impact on people livelihoods. The lesson learnt is that a free flowing river generally has benefits attached to it, and it is a mistake to assume the opportunity costs of altering the natural flow of a river to be zero. Ecosystem needs must be synchronised with the needs of people whose livelihoods are largely based on flood-dependent activities.

## 5. INFLUENCE OF LONG-TERM NUTRIENT ENRICHMENT AND A SINGLE FUNGICIDE TREATMENT ON THE DENSITY AND NUTRIENT COMPOSITION OF PLETHODONTID SALAMANDERS

*\*Joseph Milanovich, University of Georgia; \*John C Maerz, University of Georgia; \*Amy D Rosemond, University of Georgia*

Many aquatic and terrestrial systems are experiencing increases in nutrient inputs. These increases can lead to significant changes in ecosystem function within streams; however, little is known about the effects of increased nutrient load on detrital-based systems, especially top predators. We examined the response of a five year Nitrogen and Phosphorus enrichment and one time fungicide treatment on the density and nutrient composition of larval and recently metamorphic plethodontid salamanders. Density and nutrient (C, N and P) data was collected in one experimental and five reference headwater streams located at the Coweeta Hydrological Laboratory in southwestern North Carolina. Presumably, the one time fungicide treatment reduced production of metamorphic plethodontid salamanders in the experimental stream when compared to five reference streams. We are in the process of conducting nutrient analysis to examine if long-term enrichment caused differences in the nutrient composition and stoichiometry of plethodontids. These analyses will reveal if nutrient enrichment resulted in variation of nutrient composition or stoichiometry of plethodontids, which in turn can provide an opportunity to investigate top down nutrient effects on detrital systems. Our results will demonstrate how a reduction in density of plethodontids could alter nutrients pathways in detrital streams.

## 6. LOCAL PARTICIPATORY IN WILDLIFE CONSERVATION: CASE OF THE MANAMBOLOMATY RAMSAR SITE, MADAGASCAR

*\*Lily ARISON René De Roland, The Peregrine Fund, Madagascar Program; \*Zo Lalaina Rakotobe, Conservation International*

Since 2001, two local associations have been signed an agreement to manage three lakes and forest surrounding at

Manambolomaty complex areas, with 14,700ha. This one of the first Ramsar sites serves as habitat of some endemic and critical species such as the Madagascar fish eagle *Haliaeetus vociferoides* and turtle *Erymnochelys madagascariensis*. The objectives of this management program are to protect and manage Manambolomaty wetland and its biodiversity, and to improve rural economics. Different approaches have been applied such as building capacity of these two local associations in terms of wildlife management and improving rural livelihood. The local people respect the fishing season and applied the approaches for sustainable use of natural resources. All local people surrounded the lake are members of the associations. To control the management of these areas, the associations limited the number of camp as 8 of which only three are permanent. All fishermen weighted their collected fish at each camp president. Like in 2006 season, the number of fishermen was 265 and they collected 67 tons. All dead trees used to dry a fish were controlled and they took a permit from these associations before cutting a wood for canoe. As the destruction of habitat has been controlled by the associations, the number of Madagascar fish-eagle pairs increased from 8 pairs in 2001 to 12 pairs in 2007. Due to the management of these areas, the rate of poverty in this area decreased.

## 7. NO CONSENSUS ON CONSENSUS: THE STRENGTHS AND WEAKNESSES OF CONSENSUS IN DEFINING AND IMPLEMENTING A COLLABORATIVE CONSERVATION PROGRAM

*\*Anna Maria Muñoz, Department of Wildlife and Fisheries Sciences, Texas A&M University; \*Tarla Rai Peterson, Texas A&M University*

The Edwards Aquifer is a primary water source for municipal, agricultural, and industrial users in central Texas. It also supports 8 federally listed threatened or endangered species and is the subject of immense conflict. In 2006, the United States Fish and Wildlife Service (USFWS) provided stakeholders an opportunity to participate in a collaborative process that strives to balance the human need for water and the needs of the listed species through the development of a Recovery Implementation Program (RIP). The program, as described by the USFWS is to be consensus-based and recent state legislation requires the program's steering committee and science subcommittee to use a consensus-based decision making process. There is, however, no consensus on whether consensus is the appropriate tool to use in these situations. Further, if it is appropriate, there is no consensus on what consensus means and how it should be applied. Although program participants have expressed a commitment to consensus and have defined the term in a memorandum of agreement, meeting observations reveal that individual participants apply the term in many different ways. In addition, the proposed usage of a voting system when consensus cannot be achieved has shifted the focus of some participants away from consensus. This misinterpretation and differing expectations of what constitutes a consensus-based process have led to potential substantive, procedural, and relationship barriers to success.

## 8. SPECIALIZATION SHAPES SPECIES DISTRIBUTION IN RESPONSE TO LANDSCAPE FRAGMENTATION AND FARMING INTENSITY

*\*Fiippi-Codaccioni Ondine, French Museum of Natural History; \*Vincent Devictor, MNHN; \*Romain Julliard, MNHN*

The increase in the intensity of farming practices as well as landscape fragmentation are two well known threats for many farmland bird species. Nevertheless, the effects of these two

drivers may differ strongly among species. Here, we propose to use the specialist-generalist concept to assess which bird species are the most affected by these two factors. Bird density and the intensity of farming practices were assessed within 30 farms across the Seine-et-Marne region in France using point counts and a standardised farmer survey. Local abundance of 46 species was related to pesticide applications and landscape fragmentation using generalized least-square models which account for spatial autocorrelation. Fragmentation had more effect than farming practices on most bird species. The more specialized species were more negatively affected by both fragmentation and intensity of farming practices regardless of the group they belonged to (farmland or non farmland). In contrast, generalist species responded positively to both perturbations. The positive responses found for some generalist species to the intensity of farming practices may not be due to the competition relaxation from the more specialized species which are more affected. Combining both research on life-history traits involved in species' vulnerability to perturbations and explanatory power of those perturbations can enhance conservation plans in helping to narrow-down specific actions for particular target species.

## 19. Connecting Ecological and Socioeconomic Monitoring to Management for Marine Protected Areas in California's Channel Islands

### 1. HAS FISHING ALTERED COMMUNITY STABILITY & SPECIES INTERACTION STRENGTHS IN SOUTHERN CALIFORNIAN KELP FORESTS?

*\*Anne K Salomon, Marine Science Institute; \*Nick Shears, Marine Science Institute; \*Steve Katz, Channel Islands National Marine Sanctuary; \*David Kushner, Channel Islands National Park*

Growing evidence suggests that fishing can dramatically alter marine community structure, however, the effects of fishing on trophic dynamics and community stability are more difficult to detect and quantify. This is in part because food webs are complex, dynamic and influenced by multiple drivers of change, both consumer-driven (top-down) and resource-driven (bottom-up). To assess the effects of fishing on Californian kelp forest community stability, we analyzed a thirty year, multi-species time-series collected at 11 fished and 2 reserve sites surrounding the Channel Islands, CA with first-order multivariate autoregressive (MAR-1) models. This approach allowed us to identify dynamically important interactions between species and quantify various properties of community stability. We focused on key ecosystem players - habitat forming kelp species of the order Laminariales, the influential grazers *Strongylocentrotus purpuratus* and *S. franciscanus*, and their main predators *Panulirus interruptus*, *Semicossyphus pulcher*, and *Pycnopodia helianthoides*. Species interaction strengths varied among sites likely reflecting the strong variation in oceanographic context and predator assemblage. Community stability properties differed among sites regardless of fishing pressure. Given the call for ecosystem-based management and the recent impetus to build resilience into marine management, a pressing need exists to assess the effects of fishing on community stability.

### 2. CAN MARINE RESERVES PROTECT BOTH HARVESTED PREDATORS AND THEIR PREY?

*\*Nick Shears, Marine Science Institute, University of*

*California Santa Barbara; \*David Kushner, Channel Islands National Park; \*Laura Rogers-Bennett, Bodega Marine Laboratory; \*Anne K Salomon, Marine Science Institute*

The recovery of exploited predatory species in no-take marine reserves can have cascading effects on kelp forest ecosystems. Subsequently marine reserves may not represent a viable conservation and fisheries management tool for important lower trophic level species that also support fisheries (e.g. sea urchins). We used a 26 yr time series from reserve and fished sites at California's Channel Islands to investigate the relative effects of reserve protection, urchin harvesting and other environmental factors on the population structure, biomass and reproductive output of the commercially harvested red sea urchin (*Strongylocentrotus franciscanus*). While there was no clear difference in the density of red urchins between reserve and fished sites, the two reserve sites consistently supported populations of larger urchins with greater biomass and reproductive output compared to any of the fished sites. These differences are likely to be manifested by behavioral changes whereby urchins occupy crevices and feed on drift kelp in the presence of predators. In contrast at fished sites urchin populations appear to be limited by harvesting, food availability and competition with the unfished purple sea urchin (*S. purpuratus*). These results demonstrate that marine reserves may provide a valuable role as harvest refugia for sea urchins despite also protecting higher abundances of their predators.

### 3. CHANGES IN FISH POPULATIONS AND COMMUNITIES IN CALIFORNIA MARINE RESERVES

*\*Satie Airame, PISCO-UCSB; \*Jenn Caselle, PISCO-UCSB; \*Scott Hamilton, PISCO-UCSB; \*Konstantin A. Karpov, California Department of Fish and Game*

One of the primary objectives of monitoring marine reserves in California's Channel Islands was to observe and evaluate changes in abundance, size, and biomass of species of interest. Scientists using SCUBA surveys observed higher average densities and bigger fish in marine reserves than in surrounding waters for species that are targeted by fishing, such as kelp bass and California sheephead. Scientists using remotely operated vehicles observed greater densities for 8 of 12 species in reserves relative to fished areas. Species that exhibited greater densities in reserves were residential species that are targeted by fishing, such as copper, gopher and vermilion rockfish. Additional surveys are needed to determine if these differences are due to protection from fishing or characteristics of the reserves. Another priority for monitoring was to evaluate changes in communities and ecosystem function in marine reserves. Scientists observed higher biomass of predatory fishes, such as rockfishes, inside marine reserves as compared to surrounding waters. Predatory fishes, including those at the Channel Islands, are targeted frequently by commercial and recreational fishing. Density of one prey species was higher outside marine reserves relative to inside, suggesting that indirect effects due to larger numbers of predators may depress prey populations in reserves.

### 4. USING SCUBA MONITORING DATA FROM THE CHANNEL ISLANDS TO INFER METRICS FOR FISHERIES MANAGEMENT

*\*Elizabeth A Babcock, Pew Institute for Ocean Science; \*Jenn Caselle, PISCO-UCSB*

Since before the 2003 inception of a network of no-take marine reserves at the Channel Islands, California, PISCO divers have

been conducting visual surveys of the abundance and lengths of fish at transects both inside and outside the no-take reserves. After four years of MPA protection, there is larger proportion of fish larger than the legal minimum size limit inside the MPAs for two common species: kelp bass *Paralabrax clathratus* and California sheephead *Semicossyphus pulcher*. Fishery independent estimates of fishing mortality rates based on the SCUBA survey length frequency data could provide a useful check on the results of stock assessments, and could potentially be used directly to inform fisheries management. Standard fisheries methods such as cohort analysis can be used to estimate the total mortality rate both inside reserves (equal to the natural mortality rate) and outside reserves (natural mortality plus fishing mortality rates). The fishing mortality rate is the difference between the two. However, because the fish lengths were estimated visually, it was necessary to develop a statistical estimation method that models the expected precision of the diver estimates of length. We examine the sensitivity of the mortality rate estimates to alternative models of measurement error.

### 5. COMMUNITY-BASED COLLABORATIVE FISHERY RESEARCH: ASSESSING IMPACTS OF THE CHANNEL ISLANDS MPAS

*\*Matthew C. Kay, Bren School of Environmental Science and Management, UC Santa Barbara; \*Hunter S. Lenihan, Bren School of Environmental Science and Management; \*Chris Miller, VP California Lobster and Trap Fishers Association*

Marine reserves provide a promising tool for conserving biodiversity, maintaining ecosystem services, and providing areas of scientific and recreational interest. Whether and how reserves can be integrated in the development of ecosystem-based fishery management is of great interest to fishermen, scientists, resource managers, and the general public. Standard ecological theory predicts that reserves can influence nearby fisheries through the build up of biomass within reserves and subsequent export of propagules and/or spillover of adults. Newer ideas linking reserves to fishery management focus on the comparisons of demographics, population dynamics, and spatially-explicit patterns of productivity in target species inside vs. outside of reserves, as well as subsequent use of that information in both traditional and more "rapid-response" stock assessment models. We will present ideas and results from a collaborative research effort among university scientists, Southern CA Lobster and Trap Fishermen, and fishery managers (see [www.calobster.org](http://www.calobster.org)) designed to explore the effects of Channel Island marine reserves on CA spiny lobster populations, fishery yield, and development of community-based stock assessment. Our project is linked to a companion project designed to assess the socio-economic impact of the Channel Islands reserves on the local lobster fishery.

### 6. SOCIOECONOMIC CHANGES IN THE CALIFORNIA SPINY LOBSTER COMMERCIAL LOBSTER FISHERY AROUND THE CHANNEL ISLANDS AND ALONG THE SANTA BARBARA COAST

*\*Carla Marie Guenther, Marine Science Graduate Program and the Bren School at UC Santa Barbara; \*Hunter S. Lenihan, Bren School of Environmental Science and Management*

Marine Protected Areas (MPAs) have become a popular marine management tool in response to global declines in fishery species. However, there are few empirical studies of fishery responses to MPAs and the debate between fisheries scientists,

fishermen and conservationists regarding MPA applicability in fishery management ensues. This study of the Santa Barbara regional commercial spiny lobster fishery employs fishery dependent catch and effort logbook data and individual fisherman interviews to assess short term socioeconomic impacts of the 2003 Channel Islands State Marine Reserves. We use multi-level regression models to evaluate the role of marine reserves in predicting effort, catch and profits amid climatic and ecological variability. Individual and reef-specific effort and catch data for 69,120 fishing events over 8 fishing seasons (5 before and 3 after reserve establishment) provide the basis for the regression models. Ecological variables are reef-specific such as bottom type, distance from reserve, and kelp density. Additional social and economic variables include fishing experience, dependency, and daily market price. We test hypotheses regarding changes in fishing effort, catch and profits after marine closures for recommendation and application in future MPA planning and managing fisheries affected by marine protected areas.

## 7. DESIGNING CALIFORNIA'S MPAS WITH WEB-BASED TOOLS

*\*Will McClintock, University of California Santa Barbara; \*Matt Merrifield, The Nature Conservancy; \*David Greenberg, University of California Santa Barbara*

California's 1999 Marine Life Protection Act (MLPA) directed the state to design and manage a network of marine protected areas (MPAs); its goals are (a) to protect marine life, habitats, ecosystems, and natural heritage, and (b) to improve recreational, educational and study opportunities. A public / private partnership, the MLPA Initiative (MLPAI), was formed and charged with establishing this network of MPAs for the state. Extensive monitoring data have since been collected from the regions being considered for protection, but they have been largely unavailable to the primary decision makers in the MPA design process - the stakeholders. As the MLPAI expands its focus from Northern to Southern California in 2008, however, newly-developed tools will improve access to rich monitoring datasets and facilitate stakeholder participation in the design of new MPA networks. We will describe a web-based, geospatial decision support system with which MLPAI stakeholders and scientists now visualize and analyze monitoring data to assess potential MPA sites and geometries. We will then discuss potential enhancements to this MLPAI decision support system that may further improve the MPA design process in California.

## 20. Conservation Funding and Capacity Building

### 1. LAND ACQUISITIONS FOR RAINFOREST CONSERVATION

*\*Daniel Spring, Australian Centre for Biodiversity, Monash University*

Concern about habitat loss and global warming has resulted in new organizations buying up land in tropical forests. A recent well publicized example is Cool Earth, but similar organizations have been buying up rainforest for many years. We survey current land acquisition programs and evaluate their likely cost-effectiveness in terms of several criteria, including: the permanence of private forest reserves, their social acceptability and the prevention of illegal uses of such reserves. The potential role for a supra-national organization to facilitate internationally financed rainforest acquisition programs also is discussed.

### 2. QUANTITATIVE ANALYSIS OF THE SCIENTIFIC CAPACITY FOR CONSERVATION IN AUSTRAL AND NEOTROPICAL AMERICA

*\*Jon Paul Rodriguez, Centro de Ecologia, IVIC; \*Maria Oliveira-Miranda, ecoSIG, Centro de Ecologia, IVIC; \*Kathryn M. Rodriguez-Clark, Centro de Ecologia, IVIC; \*Alejandro Grajal, Chicago Zoological Society*

The magnitude of the challenge of developing scientific capacity for conservation in Austral and Neotropical America (ANA) is proportional to biodiversity present. Our goal was to quantify the required scientific capacity in ANA, in terms of the per-species institutional intensity, considering the level currently existing in the developed world. Our approach of biodiversity was the number of species of birds, amphibians, mammals, and vascular plants. To quantify scientific output, we used the words conservation and country (SCI, 1994-2006, 16 journals), focusing on ANA countries and five developed countries (Australia, Canada, France, Germany, Spain and USA). This search produced 6,595 articles. Brazil and Mexico are the leaders in institutional capacity in ANA. On average, there are 1.3, 0.8, 4.8, and 1.0 institutions/100 species of birds, amphibians, mammals, and vascular plants, respectively, involved in conservation research, in ANA. The equivalent figures in the developed countries are 4-25 times larger. In order to achieve a scientific capacity equivalent to the level that currently exist in the developed world, institutional capacity in ANA must increase between 4-25 times, according to the country and taxonomic group used for comparison. At least 42 programs for teaching conservation biology in ANA are currently known to exist. Increasing institutional capacity four-fold and 25-fold would correspond to create 168 and 1,050 new academic programs, respectively

### 3. THE BIODIVERSITY CRISIS REDEFINED: CONNECTING CONSERVATION BIOLOGY TO HUMAN WELL-BEING

*\*Paul L Angermeier, US Geological Survey and Virginia Tech*

Biodiversity continues to decline rapidly worldwide despite impressive advances in the sophistication and scientific credibility of conservation biology. The inability of conservationists to widely conserve biodiversity reflects their lack of political currency, not their lack of scientific know-how. Conservation progress is limited by pervasive public ignorance and apathy regarding biodiversity loss and by the secondary importance of science in formulating environmental policy. The biodiversity crisis is more about biodiversity's disconnection from the concerns of most people than about biodiversity loss per se. To enhance effectiveness, conservationists should reconfigure their communicated rationales for conservation and the relative importance of their professional activities, and launch a concerted effort to solidly connect biodiversity to human well-being. In particular, conservation biology should strive for parity in promoting intrinsic versus anthropocentric values of biodiversity and in emphasizing research versus education activities. Conservation biologists are charged with producing new objective knowledge and with changing the prevailing societal attitudes that make massive biodiversity loss politically and socially acceptable. This transformation to political relevance will require basic changes in the schedules of individual conservation biologists, the roles of scientific societies, and the interactions between conservation biology and other disciplines.

### 4. THE CONSERVATION FOCUS OF

## NATIONAL GEOGRAPHIC SOCIETY CRE GRANTS: 1914-2000

*\*Devra Kleiman, Zoo-Logic LLC*

The National Geographic Society (NGS) maintains an extensive database of grants from the end of the 19th century, funded by their Committee for Research and Exploration (CRE). The CRE grants never had an explicit conservation focus. The purpose of this study was to capture some of the significant conservation impacts of the NGS CRE grants through two approaches: 1) a keyword search of the database up through 2000 to determine how many projects had conservation as part of their objective and 2) a grantee survey to determine actual conservation impact. Using 19 keywords, 1526 potentially conservation-focused projects emerged from the database search, of which 429 distinct projects had obvious conservation intent. Such projects dramatically increased in the 1980s; in the 1990s, nearly 50 % of the total projects emerging from the search were coded as conservation-oriented. A review of the CRE Principal Investigators (PIs) suggests that NGS has supported many individuals whose contributions not only have covered the full discipline of conservation biology, but who have epitomized conservation for the general public, students and budding conservationists worldwide. NGS-funded PIs have clearly been at the forefront of the conservation movement. The vast majority of survey respondents believe that their CRE-funded research has had a positive conservation impact, even though effects may not be seen for > 10 years.

## 5. TRANSFORMING 'WICKED' ENVIRONMENTAL DISPUTES: BOOSTING THE POWER OF NEGOTIATION FOR MORE EFFECTIVE CONSERVATION

*\*Fiona Nagle, University of Minnesota*

Public environmental disputes are notoriously complex and intractable. Consequently, transformative negotiations (consensus-based processes that change destructive disputing into constructive problem-solving) are used to improve disputant relationships and understanding of the issues. Yet transformative negotiations often produce high emotional satisfaction with few or poor substantive results. Hawaii's Kona/Kohala Natural Resources Roundtable (KKRT), convened to resolve a dispute over watershed protection, embodied such a process. Transformative steps included educational workshops and a proven negotiation strategy. Ultimately, the KKRT shifted from a hostile and polarized dispute to a productive and unprecedented partnership. Yet despite the KKRT's success, resulting decisions were unimplemented and largely ineffectual for the watershed. Using the analytical lens of authenticity, I diagnose the strengths and weaknesses of the KKRT that led to specific outcomes. Authenticity, as outlined in the Authentic Arena Theoretical Framework, fosters empowered capability and concrete action in decision-making arenas such as roundtables. Analysis of the KKRT suggests transformative negotiation alone is insufficient to fully resolve environmental disputes. I suggest the gap between dispute transformation and effective conservation can be addressed by incorporating authenticity into arenas for transformative negotiation, thus leading to more operative and enduring conservation decisions.

## 6. WHY DON'T MORE STUDENTS OF COLOR BECOME CONSERVATION BIOLOGISTS? THE RESULTS OF A SURVEY AND A 'SIGNIFICANCE OF BARRIERS' MODEL

*\*Michael J. Foster, Center for Biodiversity and Conservation, American Museum of Natural History;*

*\*Jennifer Phillips, Bard Center for Environmental Policy, Bard College; \*Eleanor J Sterling, CBC, AMNH*

To identify why there is a lack of racial and ethnic diversity in the U.S. conservation biology profession we surveyed undergraduate science majors from historically underrepresented racial and ethnic groups (HUGs) and non-HUGs at six Eastern U.S. colleges in 2007, three of which are Minority Serving Institutions. A survey assessing the factors influencing their choice of whether to attend a conservation biology graduate program within the next five years was administered. Total survey response rate was 59%. Students from HUGs made up 47% (n=22) of total respondents (n=69), and African-Americans were the largest group among HUGs respondents (68.2%). Regression analysis revealed that stated membership in a HUG was significantly negatively correlated with intention to enter conservation biology, as was majoring in Biology as opposed to other relevant majors. Overall, students from HUGs (SHUGs) were more than a third less likely to choose conservation biology than were students from non-HUGs. Interestingly, SHUGs were just as likely to have a pro-environmental worldview, as measured by the New Ecological Paradigm. The greatest barriers to becoming conservation biologists as identified by SHUGs were lack of awareness of conservation biology as a career option and lack of related educational nurturing. We conclude that if we wish to make the conservation biology profession more diverse it will require increased encouragement of and resource investment in SHUGs.

## 21. Conservation Genetics

### 1. ASSESSING GENETIC STATUS OF GYMNACRANTHERA CANARICA AN ENDANGERED SWAMPY SPECIES IN PROTECTED AND NON-PROTECTED AREAS: IMPLICATIONS FOR CONSERVATION

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Freshwater *Myristica* swamps are special type of wetlands that harbors a number of unique taxa. They usually occur at lower altitudes in evergreen forests of Western Ghats, India and form an ideal habitat for the cultivation of several commercial crops. Hence, in last few decades these swamps have been extensively encroached and destroyed. Consequently, many species obligatory to these habitats show reduced genetic diversity and fitness. In this study an attempt was made to assess the genetic status of an obligate swampy species in protected (n=3) and non-protected areas (n=5). The results indicated that disturbance indices (number of cut and broken stems per quadrat) was significantly higher in non-protected areas (NPAs) ( $3.21 \pm 3.10$ ) compared to protected areas (PAs) ( $1.67 \pm 2.60$ ). Genetic data revealed from 10 Inter-Simple-Sequence-Repeat (ISSR) markers indicated that swamps in PAs maintain significantly higher ( $0.12 \pm 0.03$ ) genetic diversity (Dice's Index) than NPAs ( $0.10 \pm 0.04$ ). Further, frequency distribution of Dice's dissimilarity index was negatively skewed for PAs whereas it was skewed positively for NPAs. In summary, it appears that PAs with low disturbance facilitates random mating thereby increasing the population genetic diversity. Our study plays an important role in developing conservation strategies for the swamps as well as their

obligatory species.

## 2. CHANGES IN PACK STRUCTURE OF EASTERN WOLVES IN ALGONQUIN PARK AFTER HARVEST BAN IMPLEMENTED

*\*Linda Yvonne Rutledge, Natural Resources DNA Profiling and Forensic Centre, Trent University;*  
*\*Ken Mills, Ontario Ministry of Natural Resources Wildlife Research and Development Section; \*Brent Patterson, Ontario Ministry of Natural Resources Wildlife Research and Development Section; \*Brad White, Natural Resources DNA Profiling and Forensic Centre, Trent University*

The eastern wolf (*Canis lycaon*) is listed as a species of special concern with the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and Canada's Species at Risk Act (SARA). The largest protected area for eastern wolves is Algonquin Provincial Park in Ontario, Canada, where considerable human-related wolf mortality was documented when resident wolves temporarily left the park to hunt in nearby deer wintering areas. In December 2001, the Government of Ontario imposed a wolf harvest ban that applied to all the contiguous townships surrounding the park. Prior to the ban, frequent pack splitting, pack fusion, and adoption of unrelated individuals characterized the structure of wolf packs in Algonquin Park. We used maternal, paternal, and bi-parental DNA profiles to assess the kinship of 114 animals sampled in 12 packs over a 5-year period after the ban was implemented (2002 - 2007). Parentage analysis and pairwise comparisons of relatedness ( $r$ ) suggest that pack adoption of unrelated individuals is infrequent in contemporary packs. When compared to pre-ban data, these results indicate a more family-based pack structure has developed, suggesting that harvest policy outside protective areas can affect social behavior of wolves within park boundaries. These results have implications for wolf conservation policy in North America, and can likely be extended to policy affecting other mammal populations that suffer high human-related mortality beyond refuge borders.

## 3. CHESTNUT AND CHINQUAPIN HYBRIDS ARE CONFOUNDING TAXONOMY: A DNA SEQUENCE-BASED INQUIRY INTO A PUTATIVE HYBRID POPULATION

*\*Meagan Alessandra Binkley, University of Tennessee at Chattanooga; \*Hill Craddock, University of Tennessee at Chattanooga; \*Joey Shaw, University of Tennessee at Chattanooga*

In North America, *Castanea L.* (Fagaceae) consists of three morphologically variable species: *C. dentata*, *C. pumila* and *C. ozarkensis*. In the southeastern United States, botanists have traditionally recognized a naturally occurring *C. pumila* x *C. dentata* hybrid (*C. neglecta* Dode); however, it is possible that these putative hybrids could be a disjunct population of *C. ozarkensis* or North American-Eurasian *Castanea* hybrids introduced during a breeding program in the mid 1900's. We are using sequences from intergenic spacer regions of chloroplast DNA to test a morphologically confounding population in northwestern Georgia and to compare these data to a population in western North Carolina where morphologically distinct *C. pumila* and *C. dentata* occur in sympatry. Preliminary results indicate that chestnut and chinquapin chloroplast haplotypes are not confined to species. Future work will include the addition of sequences from other *Castanea* populations across the southeast and the exploration of other regions of the chloroplast.

## 4. EVOLUTIONARY DISTINCTIVE SPECIES ARE WEIRD

*\*David Redding, Simon Fraser University, Burnaby, BC; \*Travis Ingram, University of British Columbia; \*Arne Mooers, Simon Fraser University*

Every time a species goes extinct, the interacting complex of genes that it embodies, its evolutionary history, dies with it. Some species have many close relatives and so there is a lot of redundancy for this history, e.g. mice species, while others, so called distinctive species, are the sole conveyers of this genetic information, e.g. the Ostrich and the Platypus. If society chooses to protect species that are evolutionary distinctive, e.g. the EDGE program, US Endangered Species Act, it is important to understand what characteristics they share. One view is that distinctive species are "weird". In two disparate taxonomic groups, Primates (Order: Primata) and Rockfish (Genus: *Sebastes*), we show that evolutionary distinctiveness is positively related to how different a species is to all others in its clade, over a wide range of morphological and ecological traits. We test this relationship against traits simulated under Brownian motion and show it is stronger than expected, if random trait evolution were occurring. If evolutionary distinctive species are, when compared to other species in their clade, both morphologically different and play unusual roles in their local communities, then they become strong candidates for greater conservation attention.

## 5. HIGH GENETIC DIVERSITY IN A RARE AND ENDANGERED SUNFLOWER AS COMPARED TO A COMMON CONGENER

*\*Jennifer Ellis, Vanderbilt University*

Determining the genetic structure of isolated or fragmented species is of critical importance when planning a suitable conservation strategy. In this study, we use nuclear and chloroplast SSRs to investigate the population genetics of an extremely rare sunflower, *Helianthus verticillatus* Small, which is known from only three locations in North America. We investigated levels of genetic diversity and population structure compared to a more common congener, *H. angustifolius* L. using both nuclear and chloroplast SSRs. We also investigated its proposed hybrid origin from *H. grosseserratus* Martens and *H. angustifolius*. Twenty-two nuclear SSRs originating from the cultivated sunflower (*H. annuus* L.) expressed sequence tag (EST) database, and known to be transferable to *H. verticillatus* and its putative parental taxa, were used in this study thereby allowing for statistical control of locus-specific effects in population genetic analyses. Despite its rarity, *H. verticillatus* possessed significantly higher levels of genetic diversity than *H. angustifolius* at nuclear loci and equivalent levels of chloroplast diversity. Significant levels of population subdivision were observed in *H. verticillatus* but of a magnitude comparable to that of *H. angustifolius*. Finally, we conclude that *H. verticillatus* is not of hybrid origin as it does not exhibit a mixture of parental alleles at nuclear loci, and it does not share a chloroplast DNA haplotype with either of its putative parents.

## 6. INTEGRATING ECOLOGICAL GENETICS AND CONSERVATION: AN APPEAL AND APPROACH FOR EXPLORING PATTERNS OF VARIATION AND DIVERSITY AT "GENES THAT MATTER"

*\*Sacha Nicole Vignieri, Harvard University and UCSD; \*Hopi E Hoekstra, Harvard University*  
Adaptive potential to changing environmental conditions is of

paramount conservation concern. Such potential has generally been measured using neutral markers, however, these loci are not necessarily relevant to survival and fitness. To truly understand how environmental changes might impact a species, we must understand how the environment influences adaptive traits. The recent surge in genomics is providing information about a large number of adaptive genes in an increasing number of species. Examining patterns at these genes will allow for exploration of the influence of environmental conditions on adaptation both within natural populations and within a conservation context. In this presentation the methods and value of this approach for conservation are explored through examination of on-going research in the Choctawhatchee beach mouse, a subspecies which has evolved cryptic coloration in response to its dune habitat. In this study characterizations of patterns of inheritance and variation at two loci involved in the generation of pelage phenotype ( Mc1r and Agouti) are being used in conjunction with phenotype data, GIS-based landscape representations, and field collected ecological data to quantify the ecological genetics of pelage in this endangered species. Similar approaches employed across taxa will vastly increase our ability to understand the dynamics of adaptation in the face of rapid environmental change.

## 7. SAVANNA ELEPHANTS OUTSIDE THE BOUNDARIES OF TRADITIONAL PROTECTED AREAS

*\*Marissa Anne Ahlering, University of Missouri;*

*\*Lori S. Eggert, University of Missouri*

Conservation of the African savanna will require conservation of its keystone species, savanna elephants (*Loxodonta africana*). The two greatest threats to elephant populations are habitat loss and human-elephant conflict. Addressing these two issues and conserving elephants will require involving local communities in conservation strategies and protecting elephants outside of traditional park boundaries. We are working with a Maasai community in southern Kenya that has created a community-sponsored wildlife sanctuary that elephants have recently recolonized. The goal of this research is to determine whether the groups are traditional family groups or groups of unrelated individuals as well as to document their level of stress in the new habitat. We use non-invasive genetic techniques to determine the genetic relationships of the colonizing elephants and fecal glucocorticoid metabolite levels to measure stress. Preliminary results suggest that elephants in the community conservation area have low stress levels. If colonizing elephants are family groups with low stress levels that are not likely to increase conflict, this information could be used to persuade more communities to join conservation efforts.

## 8. STRATEGIES FOR GENETICALLY MANAGING CAPTIVE POPULATIONS WITH INCOMPLETE PEDIGREES

*\*Jamie Rudnick, Chicago Zoological Society (Brookfield Zoo); \*Robert C. Lacy, Chicago Zoological Society (Brookfield Zoo)*

The goal of many captive breeding programs is to establish a demographically secure, self-sustaining population that retains genetic diversity while experiencing limited inbreeding. Research has demonstrated that the best breeding strategy for meeting this goal is one that minimizes the overall kinship in a population. Captive breeding programs generally utilize pedigree-based estimates of kinship for determining breeding recommendations, which means that pedigrees must be both accurate and complete for breeding strategies to be effective. Unfortunately, all captive populations have some uncertainty

associated with their pedigrees. Founders are generally assumed to be unrelated, many populations have missing information deep in their pedigrees, and cases of unknown parentage continue to arise. We used computer simulations to quantify how the retention of genetic variation and the accumulation of inbreeding in captive populations were affected by four different strategies for managing incomplete pedigrees. Briefly, the four strategies included estimating kinship from only the known part of the pedigree, assuming unknown parents were founders, and two different methods of estimating pair-wise kinship by averaging the values obtained from the first two strategies. Results suggested that the two methods using average values of kinship were the most robust, but the best method for managing incomplete pedigrees varied across scenarios.

## 22. Conservation Genetics (2)

### 1. ASSESSING THE GENETIC RECOVERY OF ANACAPA ISLAND DEER MICE FOLLOWING RAT ERADICATION

*\*Fusun Ozer, University of Illinois at Chicago;*

*\*Mary V. Ashley, University Of Illinois at Chicago*

In 2002, Channel Islands National Park began a program to eradicate rats, *Rattus rattus*, from Anacapa because nonnative rats threatened several native species. The program included the capture and reintroduction of an endemic subspecies of deer mouse on three Anacapa islets. Our objective was to monitor deer mouse demographic and genetic recovery. DNA microsatellite genotyping was used to compare genetic variability levels and population differentiation pre and post-reintroduction. Measures of genetic variation, including gene diversity, were fairly high among founders and remained at similar levels during the recovery. The exception is East population where heterozygosity and allelic diversity increased as a result of mixing founders. Despite high levels of variation in recovered populations, shifts in allele frequencies indicate genetic drift occurred during the recovery phase, suggesting only a subset of reintroduced mice reproduced. The recovered populations do not, however, show evidence of inbreeding (non significant FIS values) FST values indicated that the three islands were genetically different before reintroductions. After reintroductions, East population became more similar to Middle and West populations, again as a result of mixing founders. *P. m. anacapae* is highly differentiated from mainland deer mice. Our results show that the reintroduction plan has been successful in terms of reestablishing genetically diverse populations of Anacapa Island deer mice.

### 2. COMBINING GENETICS AND NICHE MODELING TO PRIORITIZE LAND PURCHASES FOR THE FEDERALLY THREATENED RED HILLS SALAMANDER (PHAEOGNATHUS HUBRICHTI).

*\*Joseph J. Apodaca, The University of Alabama*

The loss of biodiversity is of global concern, and amphibians are ranked as the most threatened group of vertebrates on the planet. In fact, according to the Global Amphibian Assessment (2004) thirty-two percent of assessed amphibians are threatened with extinction. The southeastern United States is one of the world-centers of salamander biodiversity. The Red Hills salamander (*Phaeognathus hubrichti*) is a rare, endemic fossorial plethodontid salamander and the sole member of its genus. Currently *P. hubrichti* is a federally threatened species and listed as endangered under the current IUCN Red List of Threatened Species due to their restricted range of under 500

Km<sup>2</sup>, severely fragmented habitat and continuing decline in extent and quality of habitat (iucnredlist.org). Their restricted range and fragmented habitat makes them extremely vulnerable to the loss of genetic variability and extinction due to inbreeding and the susceptibility to demographic, environmental, and genetic stochasticity. This project combines biotic surveys, ecological genetics and GIS modeling in order to provide necessary information directly relevant for planning the long-term persistence and recovery of this threatened species.

### 3. FENCE-ROWS AS BIOLOGICAL CORRIDORS: AN IMPORTANT TOOL FOR PRIMATE CONSERVATION IN THE COLOMBIAN LLANOS

*\*Xyomara Carretero Pinzón, Master Student of Pontificia Universidad Javeriana; \*Thomas Defler, Associate Professor of Universidad Nacional de Colombia; \*Manuel Ruiz-Garcia, Associated Professor of Pontificia Universidad Javeriana*

Primate presence and permanence in forest fragments depends on their skills using the matrix around forest patches. As part of ecological study of squirrel monkeys (*Saimiri sciureus albigena*) in gallery forest fragments in Eastern Colombian Llanos, I recorded the time of fence row use by my study group, fruit production inside of forest fragments and presence of other primates using fence rows and wire fences. Fence rows were used by my study group 22% of the time, with highest percentages in May, June and August. These months corresponded to decreasing values in fruit production inside the forest fragments and to an increment in number of fruiting trees observed along the fence rows. Four primate species were observed using live fence-rows and wire fences (*Alouatta seniculus*, *Cebus apella*, *S. s. albigena* and *Callicebus ornatus*) as part of their home ranges and as biological corridors between gallery forest fragments. In this area increased deforestation due to oil palm crops has increased pressure on primate populations in forest fragments resulting in more isolated fragments with local extinction, especially of *S. s. albigena*, an endemic Colombian subspecies with high space requirements. Use of fence rows as corridors between gallery forest fragments is an important tool for conservation programs for this primate species.

### 4. GENETIC AND PHENOTYPIC POPULATION STRUCTURE OF THE WOOLLY MOUSE OPOSSUM, *MICOUREUS PARAGUAYANUS* (DIDELPHIDAE), IN AN ATLANTIC FOREST FRAGMENT, BRAZIL.

*\*Isabela MG Dias, AMNH; \*George Amato, AMNH; \*Heitor M Cunha, UFMG; \*Rob DeSalle, AMNH; \*Ana Paula S Madureira, Fundação Osvaldo Cruz; \*Adriano P. Paglia, Conservation International Brazil; \*Cleusa Graça Fonseca, UFMG*

The purposes of this study were to define population genetic and phenotypic structure of the woolly mouse opossum, *Micoureus paraguayanus*, from the state park of "Rio Doce"-PERD, an area of Atlantic Forest in Minas Gerais state in Brazil, to find out if this population is divided into sub-populations and to estimate heritability values for morphological traits. Were analyzed with 12 microsatellite loci and five repeated measures of body size: body length, tail length, tarsal length, ear size and body weight. To assess population subdivision and to estimate heritability values for morphological traits, individuals were captured-marked-

recaptured between the years 2000 and 2006. The mean heterozygosity found for the park population was 0.67. Both sub-populations, Vinhático and Campolina, had significant values of heterozygote deficit. The estimated average of pairwise relatedness coefficient ( $k$ ) was 0.045 ( $0 < k < 0.55$ ). The morphological differentiation between subpopulations was not significant. The heritability values estimated for body length  $h^2 = 0.232$  and for body weight  $h^2 = 0.092$  followed Ritland (1996). These results will assist conservation managers in determining if this small population is viable and likely to persist as a conservation unit into the future, as well as provide a model for viability analysis of similar small, fragmented populations of mammals.

### 5. GENETIC ASSESSMENT OF HUMPBACK CHUB FROM THE LITTLE COLORADO RIVER

*\*Connie Keeler-Foster, Dexter National Fish Hatchery and Technology Center; \*Krista Heideman, Dexter National Fish Hatchery and Technology Center; \*Sherri Baker, Dexter National Fish Hatchery and Technology Center*

Humpback chub are of concern in the Colorado River as overall, the species has experienced a decline for the past decade. Population estimates vary, but the most recent indicate the Little Colorado River may have a population of about 6,000 adults. Our objective was straightforward: characterize the current genetic status of humpback chub from the Little Colorado River, and compare them to a captive population and a translocated population in the Little Colorado River. A total of 333 fish were assessed at 8 microsatellite loci. Two analyses were performed, with the first comparing the Little Colorado River population with the captive population and the mainstem population. The overall  $F_{st}$  value was 0.007 while AMOVA analysis suggests that within population variance accounts for 97% of genetic diversity, with only 3% between populations. A second analysis focused on the structure within the Little Colorado River and compared the captive stock, the mainstem population and 5 sampling sites including the translocated population. Captive fish and translocated fish had fewer alleles indicating slightly lower levels of genetic diversity. However, both populations provide an excellent foundation for the development of additional stocks to reflect the current Little Colorado River population.

### 6. IS THE GULF OF CALIFORNIA POPULATION OF CALIFORNIA SEA LIONS GENETICALLY DISTINCT? IMPLICATIONS FOR CONSERVATION

*\*Manuela Gonzalez-Suarez, Arizona State University; \*David Aurioles-Gamboa, CICIMAR-IPN; \*Philip Hedrick, Arizona State University; \*Leah R. Gerber, Arizona State University*

California sea lions (*Zalophus californianus*) are polygynous pinnipeds distributed along the Pacific coast of North America. The species has been subdivided into 3 stocks based on differences in mitochondrial DNA, but an accurate understanding of population structure also requires exploring nuclear genetic variation. We used microsatellite loci to study genetic subdivision within the Mexican sea lion populations, which are currently divided into 2 stocks: a Pacific coast of Baja California (PBC) stock and a Gulf of California (GoC) stock. Comprehending population subdivision in this area is particularly critical in light of recent population declines observed in some areas of the GoC. We obtained tissue samples from 5 colonies distributed among the GoC and 1 colony located on the central PBC ( $N=357$ ). Genetic subdivision was

explored using the programs STRUCTURE and BAPS with data from 10 polymorphic microsatellite loci. Results generally suggested a pattern of isolation by distance, but both programs also identified 2 groups: a PBC-South GoC group, and a North-Central GoC group. Our results challenge the current stock assignment of Mexican sea lion populations, and reveal the existence previously undetected genetic admixture among Mexican colonies. Future research should explore genetic subdivision between Mexican and US sea lion populations, and consider the remaining Mexican colonies not included in this research.

## 7. LANDSCAPE GENETICS OF THE THREATENED GOPHER TORTOISE (GOPHERUS POLYPHEMUS)

*\*Rachel A Wallace, University of New Orleans;*

*\*Nicola Anthony, University of New Orleans*

The main aim of this study is to use a landscape genetics approach to identify the major determinants of population structure in the federally threatened gopher tortoise (*Gopherus polyphemus*). Previous ecological studies on habitat suitability and movement patterns indicate features such as rivers and major highways may impede gene flow, while upland ridges, may function as dispersal corridors. Identifying potential migration corridors is important for maintaining natural gene flow between populations and managing disease transmission. This project will utilize several analytical approaches recently introduced to the field of landscape genetics including partial Mantel tests and least cost path analysis to test for a significant correlation between landscape features and population differentiation. Results showed no evidence that rivers were significantly correlated with genetic distance indicating that rivers may not be major barriers to dispersal. In contrast major roads were significantly correlated with genetic distance suggesting that recent rather than historical barriers are shaping current population structure. Information from this study will be used to improve species management by providing guidelines for relocation and the delineation of management units. Results from this study will improve the management of diseases through better understanding of tortoise movement.

## 8. NON-INVASIVE GENETIC MONITORING AS A TOOL TO ESTIMATE ABUNDANCE AND GROUP COMPOSITION IN WILD WESTERN LOWLAND GORILLAS

*\*Mimi Arandjelovic, Max Planck Institute for Evolutionary Anthropology; \*Josephine Head, Max Planck Institute for Evolutionary Anthropology; \*Christophe Boesch, Max Planck Institute for Evolutionary Anthropology; \*Martha M Robbins, Max Planck Institute for Evolutionary Anthropology; \*Linda Vigilant, Max Planck Institute for Evolutionary Anthropology*

Good abundance estimates of western lowland gorillas (*Gorilla gorilla gorilla*) are more important than ever, now that the species has been classified as critically endangered by the IUCN. However, these estimates are currently lacking or are imprecise, and designing accurate census methods for these elusive mammals has been problematic. Here we present an estimate of the abundance of gorillas in the 80 km<sup>2</sup> Yatouga region of Loango National Park, Gabon, using a genetic analysis of non-invasively collected fecal samples. A total of 403 samples were collected opportunistically from March 2005 to September 2007 during the ongoing habituation process for research and tourism in the Yatouga area. A subset of 324 samples were genotyped at 16 autosomal microsatellite loci and

males at an additional 11 microsatellite loci on the Y-chromosome. Using samples found at multiple nests sites, we estimated the number of groups in the area, the numbers of individuals in those groups, as well as patterns of relatedness of individuals within and between social groups. We discuss whether similar collection and genotyping methods can be used for large scale ape surveys, so that high priority ape populations can be evaluated and identified across central Africa.

## 23. Conservation Genetics (3)

### 1. AN ASSESSMENT OF GENETIC DIVERSITY AND GENE FLOW AMONG SWIFT FOX POPULATIONS IN THE UNITED STATES

*\*Donelle Schwalm, Texas Tech University*

Habitat fragmentation has been shown to decrease gene flow rates in populations. Swift fox (*Vulpes velox*) are native to the short and mixed grass ecosystems of the Great Plains region in the United States. These grasslands are highly fragmented; current estimates indicate less than 10% of native grassland remains intact. Factors influencing fragmentation may be naturally occurring or anthropogenic in origin, and the degree of fragmentation is not uniform throughout the region. As a result, the swift fox population exhibits varying levels of connectivity. Research indicates that swift fox are capable of dispersing large distances, but these data were generated from within-population studies or translocation studies. Individual behavior is expected to be altered in the latter of these 2 scenarios, and may not reflect natural dispersal behavior. We are unaware of any data for between-population dispersals. Thus, the level of genetic interchange between populations is unknown. We collected 556 blood, hair, scat and tissue samples from individual swift fox with the assistance of 9 state, federal, tribal and non-profit entities. Samples underwent both microsatellite and mitochondrial DNA analysis. We used both spatial and aspatial statistical programs to assess the relationship between habitat fragmentation and genetic structure in the current swift fox distribution.

### 2. ASSESSING THE EXTENT OF HYBRIDIZATION BETWEEN SYMPATRIC RED WOLVES (*CANIS RUFUS*) AND COYOTES (*CANIS LATRANS*) IN COASTAL NORTH CAROLINA

*\*Justin Howard Bohling, University of Idaho;*

*\*Lisette Waits, Department of Fish and Wildlife Resources, University of Idaho*

Aggressive adaptive management has been established for the reintroduced red wolf (*Canis rufus*) population in eastern North Carolina to limit genetic introgression from invasive coyotes (*Canis latrans*). This management is implemented over a 6000 km<sup>2</sup> peninsula and has thus far been successful in limiting coyote introgression. Beyond this region, however, management is not implemented despite documented red wolf dispersal out of the core population. The frequency of wolf dispersal into areas devoid of management and their subsequent interactions with other canids is unknown. We will use non-invasive genetic sampling in the region surrounding the current red wolf population to evaluate the distribution of red wolves and coyotes within this region and the extent of hybridization between them. Fecal material collected in this area will be genotyped using eight polymorphic microsatellite loci to identify individual canids. Genetic assignment tests will evaluate the origin and ancestry of each individual compared to reference canid populations. Results will indicate whether coyotes and red wolves exhibit assortative mating in a natural

setting or intermix to form a panmictic population. Understanding interactions among these two species sans management is critical for future red wolf recovery and management.

### 3. CLASSIFYING ENDANGERED GILA ELEGANS INTO FAMILIES BASED ON MICROSATELLITE DNA GENOTYPES

*\*Allan Strand, College of Charleston; \*Connie Keeler-Foster, Dexter National Fish Hatchery and Technology Center*

Transformations in the Colorado River system during the 20th century have resulted in dramatic population declines in at least four warm, turbulent-water species. Of greatest concern is Bonytail (*Gila cypha*) which appears to have been effectively extirpated from the Colorado and which now exists as a captive population at Dexter National Fish Hatchery and Technology Center. Five unrelated pairs of wild-caught Bonytail were bred in captivity in the mid 1980s. The resulting families were subsequently mixed in a single rearing pond at DNFHTC. As a first step in considering breeding fish for reintroduction, we determined that it was necessary to identify F1 families. Subsequent breeding efforts can use this information to reduce breeding within closely related families. We used 9 microsatellite loci to genotype 261 fish. There was substantial variation at these loci; the average number of alleles per locus was 9.8, with one locus segregating for 16 alleles. We classified individuals into five groups corresponding to offspring of the original pairs using two approaches: clustering of relatedness values and model-based clustering using STRUCTURE. The power of each of these techniques was then assessed using an individual-based simulation. Based on simulation results, clustering relatedness significantly underperformed the approach using STRUCTURE. Using STRUCTURE we were able to recover the correct family assignment in simulated F1s 90% of the time.

### 4. CONSERVATION, CONFLICTS AND COMPROMISE; RECOVERY OF THE VULNERABLE BANKOUALÉ PALM LIVISTONA CARINENSIS FROM DJIBOUTI, SOMALIA AND YEMEN.

*\*Alison Shapcott, University of the Sunshine Coast; \*John L Dowe, Australian Centre for Tropical Freshwater Research, James Cook University,; \*Henry Ford, consultant*

The Bankoualé Palm, *Livistona carinensis* is the only species of *Livistona* occurring in Africa and is currently classed as vulnerable (IUCN 2004). Being an extreme outlier of the genus, the species is restricted to Yemen, Somalia and Djibouti, where all populations are in rapid decline. This study used microsatellite markers to investigate the genetic diversity and relationships within the species. *Livistona carinensis* contained very low genetic diversity. Most variation was due to the variation between the samples from Yemen and Somalia compared with those in Djibouti. The Djibouti populations were almost monomorphic across nine loci. Given the lack of genetic diversity both within and among *L. carinensis* populations in Djibouti, plants could be cultivated for recovery programs from any available seed within Djibouti with no significant provenance mismatch. This study strongly indicates that the populations in Yemen and Somalia are highly significant for the conservation of the species genetic diversity. The populations from Djibouti, Somalia and Yemen are clearly different genetic provenances. However, given the recent history of conflict and instability coupled with land use

conflicts in Yemen and Somalia and the contrasting support to conserve the species in Djibouti, should individuals be introduced into the Djibouti populations as a means to conserve what genetic diversity remains across the entire species?

### 5. EFFECTS OF INBREEDING UNDER VARIOUS ENVIRONMENTAL CONDITIONS IN A WILD POPULATION OF NEW ZEALAND ROBINS

*\*Rebecca Laws, University of Otago; \*Ian Jamieson, University of Otago*

Inbreeding depression can severely affect the viability of small populations, however, little is known about how environmental stressors impact the expression of inbreeding in wild populations. This study examined the effects of inbreeding under different environmental conditions and at different life history stages, to determine when and under what conditions inbreeding affects survival. A reintroduced island population of South Island Robins (*Petroica australis*) was monitored over seven years, providing a complete pedigree from which inbreeding coefficients could be calculated. The survival of individuals and nesting success were monitored along with environmental and population variables. General linear modelling was used to determine the effects of inbreeding and interactions with environmental factors affecting survival. The population was most sensitive to inbreeding during the incubation stage, with the female's inbreeding co-efficient having a significant effect on hatching success, particularly at low temperatures. Inbreeding did not have a significant effect at the nestling stage or on first year survival. We observed that environmental factors have a significant impact on the expression of inbreeding depression in South Island robins but only at one of the studied life history stages. This suggests that evaluation of inbreeding should always be considered in the context of environmental pressures when determining its impact on small populations.

### 6. LOSS OF LOCAL ADAPTATION IN WILD SALMON RESULTING FROM INTERBREEDING WITH ESCAPED FARMED SALMON

*\*Dylan John Fraser, Department of Biology, Dalhousie University; \*Jeffrey Hutchings, Department of Biology, Dalhousie University*

Growing concerns are being raised that interbreeding between artificially-selected organisms and their wild relatives can have negative fitness consequences for the latter. In the Northwest Atlantic, farmed Atlantic salmon recurrently escape into the wild and enter rivers where small, declining populations of wild salmon breed. Virtually all farmed salmon in the region derive from an ancestral source population that occupies a non-acidified river. Yet many wild populations with which escaped farmed salmon might interbreed inhabit acidified rivers. Here, using common garden experimentation, and examining two early-life history stages across two generations of interbreeding, we show that: (i) wild salmon populations inhabiting acidified rivers have local adaptations to acid tolerance; (ii) regional farmed salmon are not acid tolerant; (iii) interbreeding leads to a reduction in acid tolerance in the farmed-wild hybrids most likely to be generated in the wild (F1, backcrosses); and, similarly, (iv) interbreeding results in maladaptive (i.e. survival-reducing) changes to the reaction norms for acid tolerance in farmed-wild hybrids. These results suggest that repeated farmed-wild interbreeding may lead to a dilution of adaptive genetic variation and negatively affect the persistence of depleted wild populations.

### 7. POPULATION GENETICS AND

## CONSERVATION OF ROANOKE LOGPERCH (PERCINA REX), AN ENDANGERED STREAM FISH

*\*James H. Roberts, Virginia Tech; \*Daniel J. Dutton, Virginia Institute of Marine Science; \*Joanne E. Davis, Virginia Tech; \*Paul L. Angermeier, US Geological Survey and Virginia Tech; \*Eric M. Hallerman, Virginia Tech*

The Roanoke logperch (*Percina rex*) is an endangered fish endemic to several widely separated stream systems in Virginia and North Carolina, USA. Its conservation is hampered by lack of knowledge about the structure, demographics, and genetic relationships of logperch populations. We developed 12 microsatellite genetic markers for Roanoke logperch and used them to screen individuals sampled throughout the species' range for genetic variability. Genetic diversity was high within but variable among the eight studied populations. Effective population sizes varied by a factor of 10 or more, and were generally consistent with prior beliefs about population sizes based on field surveys. There was little population structure within uninterrupted stream-segments, indicating that logperch dispersal is extensive. Significant population structure was evident among isolated river-systems and major basins, but genetic differentiation was driven primarily by drift, not mutation, and was only weakly related to hydrologic distances. This indicates that the species' genetics are in disequilibrium and that fragmentation occurred relatively recently, likely due to habitat degradation and construction of major dams. We recommend that opportunities to restore connectivity between logperch populations, through barrier removal, habitat restoration, or translocations, be pursued.

## 24. Conservation Modeling

### 1. AGENT-BASED MODELING, FUNCTIONAL CONNECTIVITY, AND DISEASE TRANSMISSION FOR FELIDS IN FRAGMENTED LANDSCAPES

*\*Jeff Tracey, Colorado State University; \*Sue Vandewoude, Colorado State University; \*Sarah Bevins, Colorado State University; \*Kevin Robert Crooks, Colorado State University*

Human-caused changes in landscapes typically result in the loss, degradation, and fragmentation of animal habitats. These landscape changes alter functional landscape connectivity and, potentially, patterns of disease transmission within and among species. Our ability to anticipate the consequences of human-caused landscape change on both connectivity and disease transmission depends in part on how our ability to model animal movement behavior in response to landscapes. We present agent-based models for visual perception and movement by animals and their applications in conservation. We describe approaches to model evaluation including parameterization, model selection by AIC, and goodness-of-fit testing and present results from such evaluations using radio and GPS tracking data for puma and bobcats. We illustrate simulations from parameterized models on models of the coastal southern California landscape, and methods for visualizing simulation results. In addition, we describe the application of these agent-based models to evaluating functional landscape connectivity and studying disease transmission among puma, bobcats, and domesticated cats in coastal southern California, USA.

### 2. CONSERVATION PLANNING FOR

## PRIORITY SILVICOLOUS BIRDS IN THE CENTRAL HARDWOODS BIRD CONSERVATION REGION

*\*D. Todd Jones-Farrand, University of Missouri; \*Jane A. Fitzgerald, American Bird Conservancy; \*Frank R. Thompson, U.S. Forest Service; \*Lee E. O'Brien, U.S. Fish and Wildlife Service*

The North American Landbird Conservation Plan established continental population objectives as a preliminary step towards creating landscapes capable of sustaining bird populations range-wide. The Plan encourages the establishment of regional population objectives by conservation partnerships within each of 67 Bird Conservation Regions (BCR). Setting realistic regional objectives requires knowledge of the quantity, quality, and spatial configuration of available habitat, an explicit linkage between habitat condition and population response, and expectations of future conditions. In the Central Hardwoods BCR, we developed multi-scale Habitat Suitability Index models for 40 priority forest and shrubland species. Models estimated relative habitat quality based on site and landscape conditions derived from national geospatial datasets. We generated model predictions at two points in time, and linked these to bird abundances measured by the Breeding Bird Survey, to track how temporal changes in habitat affected populations. Further, we created a decision support tool that linked model outputs to the proportion of forest community types within subsections of the BCR. This tool allows partners to examine effects of planning alternatives on populations in the currency of their planning objectives. Our process generates a science-based approach to ecoregional planning, and provides an adaptable framework for incorporating new knowledge and addressing shifting planning needs.

### 3. FISHING FOR NOVEL APPROACHES TO ECOSYSTEM SERVICE FORECASTS

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The ecosystem service concept provides a powerful framework for conserving species and the environments they depend upon. Describing current distributions of ecosystem services and forecasting their future distributions have therefore become central objectives in many conservation and management efforts. For example, the U.S. Environmental Protection Agency (EPA) is currently testing methods that will allow it to forecast the productivity of multiple inland and estuarine fisheries, and to anticipate their associated services. One approach within EPA is to combine independently developed models of water quality, physical habitat, and fish production within a common computing environment, and to use the linked systems to assess a variety of alternative futures scenarios. This mechanistic, integrated approach facilitates rigorous sensitivity and uncertainty analyses, but its applicability is constrained by the data-intensive parameterization process. Alternatively, a pattern-based, macroecological strategy is being used to characterize fisheries at broad spatial and temporal scales. This empirical approach is less powerful than the mechanistic one, but can be readily implemented in any area of interest with existing, national-coverage datasets. To illustrate the benefits, tradeoffs, and mechanics of the latter method, I present a fisheries services model of the Albemarle-Pamlico River System in eastern Virginia and North Carolina (USA).

### 4. HABITAT, CONFLICTS, AND POACHING-FACTORS LIMITING ASIATIC BLACK BEARS IN CENTRAL CHINA

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Direct measures of population size and change are often impossible to achieve for secretive large mammals. We used distributional data as a surrogate measure of abundance for Asiatic black bears (*Ursus thibetanus*) in Sichuan Province, China. We conducted a province-wide (485,000 km<sup>2</sup>) survey using local interviews and sign transects to obtain presence-absence data (2005-2007). We divided the province into 15×15 km<sup>2</sup> cells and stratified the cells based on percent forest cover, mean elevation, and road density. We selected 479 cells, interviewed 1816 villagers, and verified reports of bear presence from sign. We used logistic regression to build occupancy models in three separate physiographic regions. Ecologically relevant combinations of variables were tested and ranked using AIC scores. The model indicated that bears occupied 49% of the province, with the core range in three mountain ranges, and a surprisingly strong presence along the Tibetan plateau, sympatric with brown bears (*Ursus arctos*). Interviews yielded information on historical presence, human-bear conflicts, direct killing, and local assessment of population trend. Bears were thought to be increasing in 32% of occupied cells, stable in 10%, and decreasing in 58%. Poaching of bears, damage to crops and livestock, and attacks on people were commonly reported. Considering the prevalence of direct killing, conflicts, and limited protected area, more conservation attention to this species is needed.

## 5. LINKING CHANGING HABITAT TO PVA MODELS: EFFECTS OF SPATIAL PATTERN OF LANDSCAPE CHANGE ON VIABILITY, STABILITY, AND FUNCTIONALITY OF 3 BIRD SPECIES

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Conservation of species and their habitats requires an understanding of how the spatial patterns of landscape change are likely to impact species at the population level. We investigated the effects of two different scenarios of habitat loss on populations of Red-shouldered Hawk (*Buteo lineatus*), Pileated Woodpecker (*Dryocopus pileatus*), and American Bittern (*Botaurus lentiginosus*) within an area of the Eastern Ontario Model Forest using spatially-explicit metapopulation models. In the 'small fragment loss' scenario, we modeled small fragments of remnant habitat as being vulnerable to conversion to other land uses. In a second scenario ('edge erosion') we modeled habitat lost through a process of degradation from patch edges and openings. Results show variability of response to habitat loss among the three species. However, in general, the 'small fragment loss' scenarios resulted in greater declines in suitability than the 'edge erosion' scenarios. We also noted a non-uniform effect on fragmentation between the two scenarios. These models demonstrate how the spatial pattern of habitat loss can influence metapopulation structure and vulnerability of populations in changing landscapes.

## 6. THE POWER OF WRIGHT'S FST TO DETECT SUDDEN CHANGES IN CONNECTIVITY USING A MULTIFACTORIAL MODELING FRAMEWORK

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Wright's *F<sub>st</sub>* is the classic measure of population differentiation that is used to assess levels of connectivity among populations. It has also been suggested for detecting changes in connectivity resulting from habitat fragmentation. However, because *F<sub>st</sub>* integrates over evolutionary time it may be slow to detect recent or sudden shifts in genetic connectivity. We examined the power of *F<sub>st</sub>* to detect changes in connectivity and the level of sampling required to detect such effects of fragmentation using a multifactorial modeling framework. We systematically varied population size and number, numbers of loci, allelic richness, migration rates, mutation rates, and sample size. Migration proceeded for 50 generations and then was stopped but within population processes continued. We measured *F<sub>st</sub>* for the next 1000 generations and assessed rates at which populations diverged and the sample sizes necessary to detect the divergence. We found that *F<sub>st</sub>* is ineffective at detecting recent and sudden shifts in genetic connectivity. Additionally, the large sample sizes required to capture the changes is likely to be prohibitive.

## 7. USE OF EIGENVECTOR ANALYSIS IN THE QUANTIFICATION OF KEYSTONE SPECIES

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The keystone species is an important concept in conservation biology. There is a need for metrics to quantify the importance of individual species, within environmental networks, that recognize the distributed nature of interactions in networks, and also the importance of indirect effects. Keystone species may be viewed as the biological equivalent to the node of "centrality" as described in social networks. We propose a method for the quantification of the keystone species of a network using Network Environ Analysis. Direct interactions in non-weighted networks determine the structure and distribution of potential indirect pathways in any system. Given a matrix of direct interactions, indirect pathways and their relative distribution can be analyzed through the use of eigenvectors. Standardizing the eigenvectors of indirect pathway matrices yields the relative total connectivity for any node in the system. In some cases, species experiencing few direct observable links are found to have the greatest indirect connectivity.

## 8. USING SPATIALLY-EXPLICIT HABITAT-RESISTANCE MODELS TO GUIDE MITIGATION OF ROAD-EFFECTS ON AMPHIBIAN AND REPTILE POPULATIONS

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As road networks and traffic volumes increase, road-effects on animal populations are becoming more prevalent. We document a collaborative effort between ecologists and the New York State Department of Transportation to mitigate the effects of roads on populations of herpetofauna. The goal of the project was to identify herpetofaunal crossing hotspots on roads

in New York State, and to use this information to prioritize deployment of mitigation efforts. To this end, we synthesized available literature to predict patterns of habitat use by 12 species of herpetofauna. Using geographic information systems, we developed resistant-kernel models based on habitat resistance at both the local and regional population level. Using values from these models we calculated three output metrics: 1) hotspots of herpetofaunal abundance on roads, 2) hotspots of mortality, and 3) locations important for connectivity between local populations. Models were evaluated using Atlas-derived field data. Our results highlighted the importance of understanding the habitat use of species when predicting species-specific locations of hotspots on roads. We also identified factors that predicted hotspots for all species such as the proximity of wetlands to roads. Developing multiple metrics to measure hotspots and working closely with a management authority will help the recommendations from our study to be adopted by transportation managers looking to mitigate the effects of roads on herpetofauna.

## 25. Conservation at the Land-water Interface

### 1. A GLOBAL PERSPECTIVE ON THE EVOLUTION AND CONSERVATION OF TERRESTRIAL VERTEBRATE SPECIES IN MANGROVES

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The rapid loss of mangroves in recent decades has made them one of the most threatened ecosystems in the world, as demonstrated by the loss of 35% of the world's mangrove area since the 1980s. This crisis endangers species that are adapted to these ecosystems. Botanical surveys, culminating in the World Mangrove Atlas, have documented the extent of mangrove habitat and the floral diversity of mangroves around the world. However, there have been no similar assessments of terrestrial vertebrates that inhabit mangroves. We surveyed the literature and found that while mangroves support a relatively low diversity of nonaquatic vertebrate species, a high proportion of these inhabitants are restricted to or have subspecies restricted to mangroves. Southeast Asia and Australia have the most endemic terrestrial vertebrates, followed by the Americas and Africa. Our initial analysis suggests that the ecological correlates of terrestrial fauna endemic to mangroves are proximity of structurally similar habitat, the presence of competitors in these habitats, and specialization on food sources novel to mangroves. This global study of species restricted to mangroves will aid conservation efforts to protect mangrove areas rich in threatened and endemic species.

### 2. CONSERVATION VALUES OF SEEPAGE SLOPE WETLANDS ON THE US SOUTHEAST COASTAL PLAIN

*\*Daniel Tufford, University of South Carolina; \*Stephen Bennett, SC Department of Natural Resources; \*Norman Brunswig, Audubon South Carolina; \*John Nelson, University of South Carolina*

Wetlands are conservation targets for many reasons relating to the importance and breadth of ecosystem services they provide. Large or high profile wetlands or wetland types are frequently the objects of ecological and resource management research, but there are types that receive much less attention. Seepage

slope wetlands on the southeastern US Coastal Plain can be dominant features of the landscapes on which they occur. However they are typically small and frequently occur in association with larger wetlands such as floodplains. The result is that they are largely overlooked when assessing potential degradation. Seepage wetlands are hydrologically dependent on an upslope contributing area suggesting sensitivity to land management activity that may not adequately consider the down-slope effects. We studied eight wetlands at four locations in two ecoregions in South Carolina. Flow is persistent even during drought conditions making them stable habitat for aquatic and semi-aquatic species. There may be biogeographic significance as well. Our results further suggest a significant function for water quality improvement. Despite their small size, seepage wetlands may be important to a wide range of plants and animals, including some uncommon species. These results indicate a strong need to develop a better understanding of the ecological functions and values and potential vulnerabilities of these ecosystems, and to make their conservation a priority in areas where they occur.

### 3. INTERACTIONS OF SALINITY, MARSH FRAGMENTATION AND SUBMERGED AQUATIC VEGETATION ON RESIDENT COASTAL MARSH NEKTON.

*\*Alan Hitch, Auburn University; \*Paul Leberg, University of Louisiana at Lafayette*

Global climate change and subsequent sea level rise are major factors contributing to the fragmentation of coastal marshes, with inundation, saltwater intrusion and subsidence causing conversion of vegetated surface to open water, decreasing the amount of habitat available for small fishes and crustaceans. Emergent and submerged aquatic vegetation (SAV) are critical for the persistence of resident marsh nekton. We quantified the effects of SAV and fragmentation on nekton densities in three major marsh types along a salinity gradient in coastal southeastern Louisiana. We found that in fragmented marsh with low amounts of emergent vegetation, nekton densities were significantly lower than in areas with high percentages of emergent vegetation. Furthermore, the influence of emergent vegetation on the densities of many species increased with marsh salinity. Total nekton abundance was positively correlated with SAV cover; however, as in the case of emergent vegetation, SAV seemed to be more important to many species as salinities increased. Our results suggest that as salinities increase, both emergent and submerged vegetation become more important as habitat components for resident marsh nekton. The consequences of marsh fragmentation, and loss of vegetation for nekton varies across salinity; in the face of rising sea levels, efforts to preserve and restore marsh vegetation will become increasingly important.

### 4. LANDHELP: USE ONE INTERNET SITE TO PLACE AND RETRIEVE INFORMATION

*\*Delwin Eugene Benson, Colorado State University*  
LandHelp, ([www.LandHelp.info](http://www.LandHelp.info)), is an Internet natural resources library and first-stop solution for storing and retrieving educational links and files to help trained and untrained persons understand and manage resources and people. LandHelp assists at local, community and national levels about land stewardship including soil, water, air, plants, animals, sustainability, and people. LandHelp provides a common portal for emerging issues such as sustainability, small acreage management, leadership and getting youth involved with nature. Users do not need to know whether they should search broadly for environmental information on the Internet or seek specific assistance from one of the many federal agencies, 50 state agencies, NGOs, industries, universities, Extension, etc. Users start at one site: LandHelp. LandHelp is limited only

by the users who place information within it or who retrieve information. A small number of professionals evaluate and place information into LandHelp. The goal is to have many inputs. LandHelp is under review for major changes that enable it to be used by more persons in more interactive ways. With help from new funding sources and personnel, the site will become a portal where producers and users collaborate. Conservation biologists are encouraged to be part of the evolution.

## 5. LARVAL SPILLOVER OF A HARVESTED MUSSEL FROM SOUTH AFRICAN MARINE RESERVES

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Marine reserves may enhance harvested populations outside their boundaries through spillover -- the movement of either adults or planktonic larvae from reserves to fished areas. Fisheries enhancement through adult spillover is documented near several reserves, but the ability of reserves to subsidize fished areas through larval spillover remains speculative, despite the fact that most marine species produce young that disperse as larvae in the plankton. In the face of mounting evidence that the production of larvae may be dramatically higher in reserves than in adjacent fished areas, the fate of this extra production is largely unknown. We measured larval production and recruitment of a harvested mussel, *Perna perna*, inside and a range of distances outside three reserves in South Africa, and used the pattern of recruitment with increasing distance from the reserves to determine the spatial scale of dispersal and larval spillover. Mussels were more abundant and larger inside two of the reserves, with significantly higher expected production. Recruitment was highest inside these reserves and declined exponentially with distance. In the third reserve, where poaching inside and effective co-management outside reserve boundaries reduce differences in fishing pressure, we found no differences in production or recruitment. Our results provide evidence that increased production in well-protected reserves may enhance populations in adjacent fished areas through larval spillover.

## 6. RESILIENCE OF FISH ASSEMBLAGES TO THERMALLY-ALTERED HABITATS

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The common deterministic view of fish community assemblage suggests that environmental factors drive a community to a characteristic state. A key feature of biological communities is resilience (the ability to maintain compositional integrity following a disturbance). A disturbance exceeding the threshold at which a community maintains its structure results in a shift to an alternative state (e.g., a community dominated by brook trout and sculpin shifts to a community dominated by creek chub and blacknose dace). Alternative states are inherently stable, making it difficult for a community to

recover once a disturbance threshold has been breached. We present evidence of habitat-specific reference states in freshwater stream fish communities and differential responses to urbanization across the physiographically diverse state of Maryland. We found that communities are sensitive to different habitat-scale disturbances associated with water quality and riparian integrity, specifically altered thermal regimes, which suggests that habitat-specific assessments of degradation are preferable to region-based assessments. Defining the relative resilience of fish communities to landscape-scale disturbances can offer clues as to the potential pressures that drive a shift away from reference, and alert managers to site-specific vulnerabilities.

## 7. TRADEOFFS IN ACHIEVING FRESHWATER CONSERVATION GOALS IN A BIODIVERSITY HOTSPOT

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The Cape Floristic Region (CFR), situated in South Africa is a global biodiversity hotspot, well known for its high level of plant diversity and endemism. It is home to more than nine thousand vascular plant species, with more than 60% endemic to the region. In terms of freshwater biodiversity it is less diverse compared to the terrestrial ecosystem; however it also exhibits a very high level of endemism, with 16 out of 19 fish species endemic to the region. The conservation of freshwater biodiversity in the CFR has lagged behind terrestrial ecosystems, because most protected areas in the region were designed for terrestrial biodiversity. We carried out a systematic conservation plan for the region to identify the gaps prevalent in the protection of freshwater ecosystems. The results showed that in order to secure adequate protection of freshwater ecosystems in the CFR, 17% of the area must be set aside for conservation in addition to the current network of protected areas. It was also found that lowland river systems are the most impacted by anthropogenic disturbances, and yet they contribute a whopping 8% towards achieving conservation targets. There is thus an urgent need to redesign the current network of protected areas in the region to meet freshwater conservation goals; however this may involve a trade off between freshwater and terrestrial biodiversity priority areas, as they do not often overlap.

## 8. WATERBIRD USE OF WATER HYACINTH (EICHHORNIA CRASSIPES), AN INVASIVE AQUATIC PLANT IN LAKE CHAPALA, MEXICO

*\*Amy Marie Villamagna, Virginia Polytechnic Institute and State University; \*Brian Murphy, Virginia Polytechnic Institute & State University*  
Lake Chapala is an important resource for more than 10 million people in the central highlands of Mexico. Since the early 1900s *Eichhornia crassipes*, a highly mobile floating invasive plant, has been found in its nutrient-rich waters. Although much has been written about the ecological effects of *E. crassipes* in general, it is currently unknown how this plant affects the waterbird community. We investigated how waterbirds use *E. crassipes* by conducting seasonal surveys at sites with varying *E. crassipes* coverage. At each site, we identified birds and counted individuals present in each habitat type, including *E. crassipes*. We calculated the percent coverage of *E. crassipes* during each site-visit and compared it to proportional use for every recorded species. We found significant differences in the use of *E. crassipes* with respect to

availability; however, the magnitude and direction of these differences varied by season and species. We found a preference (use exceeds availability) for *E. crassipes* by *Ardea alba* during fall and winter, *Egretta thula* during fall, and *Fulica Americana* during winter. Other species showed no preference or preferred other habitats. Birds do not appear to be avoiding areas with *E. crassipes*, therefore it is possible that birds are benefiting indirectly from its presence.

## 26. Conservation in Hotspots

### 1. ARMED CONFLICT AND BIODIVERSITY CONSERVATION: A CASE STUDY OF BARDIA NATIONAL PARK, NEPAL

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Nepal has set several examples of success stories on conservation programs and contributed towards global biodiversity conservation. However, it suffered nearly a decade long armed conflict bringing adverse effects on its conservation activities and wildlife. The present study was carried out to evaluate the impacts of armed conflict on the biodiversity conservation with case study at Bardia National Park and Buffer Zone in western Nepal. During insurgency, life became miserable as majority of the populace (73%) in adjoining villages dependent on agriculture and collecting fuel-wood and fodder was difficult. Tourism was badly hit, the number of visitors plummeted to below 2,000, which was over 10,000 during good years. It was found out that there was 80% reduction in revenue to the national park. In effect this reduced the budget to buffer zone severely constraining the conservation and development activities. The expenses on conservation activities by user committees decreased by 50%, while on income generation program plummeted to zero. The reduction of security posts from existing 15 to seven and abandoned patrolling in peripheral areas facilitated illegal logging and wildlife poaching. The number of Rhinoceros unicornis was reduced from 104 to 31 with no sighting in Babai Valley, the prime habitat of the animal. The total loss of physical properties totaled NPR 7.95 million while the conservation efforts were badly set back that may take several years to recover.

### 2. DETERMINATION OF BASELINE ECOLOGICAL CONDITIONS IN THE GALAPAGOS ISLANDS

*\*Emily Elizabeth DeFrees Coffey, Oxford University Centre for the Environment*

The Galápagos Islands represent an outstanding showcase of biodiversity and are globally valued for their importance in scientific enlightenment and ecological value. However in the past five hundred years, during which humans have been visiting the islands, the introduction of non-native species and habitat degradation have been changing the islands' natural ecosystems. Through the use of sedimentary analysis vegetation changes over the last 5,000 years have been examined using a multi-proxy approach. This approach includes plant macrofossil and pollen fossil analysis to determine vegetation changes. Findings from this study address the substantiation of 'doubtful' native and introduced invasive

species. The results include an Asteraceae which was previously believed to be introduced, however after careful investigation has been found in the fossil record over 1,000 years prior to human arrival. The findings of this study combine long-term historical data with modern data to provide an ecological baseline - information that is fundamental to the conservation and restoration of native biodiversity in Galápagos.

### 3. DYSFUNCTIONAL HOTSPOTS? PAN-TROPICAL CHANGES IN DUNG BEETLE COMMUNITIES AND DECLINING ECOSYSTEM FUNCTIONS.

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Insects are crucial for maintaining globally important ecosystem functions, but our understanding of the functional consequences of insect declines remains limited. Dung beetles provide a suite of critical ecosystem functions and services and face multiple conservation threats, particularly from landscape conversion. We conducted a quantitative meta-analysis across 31 studies to investigate changes in community biomass, a key functional trait of dung beetle communities in response to tropical forest modification. Along a gradient of 9 modified forest habitat types that spanned intact forests to cattle pastures, all modified habitats supported significantly lower community biomass than intact forests and a predictable pattern of decline was measured from the less - to more-modified ends of the gradient. Based on known empirical relationships between total dung beetle community biomass and waste removal, we developed a GIS-based model of the global functional consequences of tropical forest modification that suggests global patterns of tropical forest modification are leading to predictable reductions in waste removal functions. Using other field-based datasets on additional dung beetle ecosystem functions, we project that declines of dung beetles in tropical landscapes will lower the capacity of those ecosystems to provide the ecosystem services required by a growing human population.

### 4. IMPACT OF ENVIRONMENTAL DEGRADATION ON WILDLIFE IN THE COASTAL ZONE OF BAYELSA STATE, NIGERIA

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There is an obvious environmental degradation in the coastal zone of Nigeria as exhibited by the negative effect of deforestation, oil spillage and gas flaring, among others which accompany oil exploration production on flora and fauna ecosystem. The coastal zone of Bayelsa state which is a state in the Niger Delta was used as a case study. It was observed that the concentration of the total hydrocarbon unit of soil and sediment was very high with values of 70.00 microgramme/gramme and 63.00 microgramme/gramme respectively. Hydrocarbon markers such as nickel, lead and chromium were very high in concentration which is an indication of the presence of petrogenic hydrocarbon. The result of the survey compared to the past conditions revealed that both the flora and fauna of the study area have been devastated due to deforestation arising from oil exploration and exploitation. The red mangrove of the brackish swamp forest

has been reduced by 55%. The depletion affected about 95% of *Hippopotamus amphibius*, *Richchus senegalensis*, *Panthera pardus*, *Procolons badius*, *Colous verus*, *Loxodonta africana* and *Syncerus caffa*. There is a need on the part of policy makers and administrators to approach the management of the coastal zones with all seriousness.

## 5. IN HOT SOUP: SHARKS CAPTURED IN ECUADOR'S WATERS

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Sharks never stop growing and neither has the Asian demand for their fins for soup. Ecuador is one nation of many that feeds the demand for fins and fishers there catch more than 40 different shark species. But shark catches have been drastically underreported worldwide, which confounds the management of shark fisheries. Until the 2006 iteration of fisheries data, the United Nations Food and Agriculture Organization (FAO) did not report elasmobranchs for Ecuador. Using grey literature and national reports, this study conservatively reconstructs Ecuador's mainland shark catches from the bottom up from 1979-2004. Over this time span, shark catches for the Ecuadorian mainland were an estimated 7,000 tonnes per year, or nearly half a million sharks. Reconstructed shark catches were 3.6 times greater than those reported by FAO (1991-2004), which supports a study that estimated actual global shark captures are three to four times larger than the shark catch estimates presented by the FAO. The discrepancies in data support urgent adoption of the measures Ecuadorian law mandates: eliminating targeted shark captures, finning, and transshipments, as well as adoption of measures to minimize incidental capture. Most of all, a serious shark landings monitoring system and effective chain of custody standards are needed.

## 6. MONITORING THE EFFECT OF COASTAL DEVELOPMENT ON AVIAN MIGRATION STOPOVER HABITAT IN SIAN KA'AN BIOSPHERE RESERVE, QUINTANA ROO, MEXICO.

*\*Angeles Ana Paula Raymundo, University of Tennessee*

The eastern coastal ecosystem of the Yucatan Peninsula is one of the most important places for bird migration. Unfortunately, this ecosystem is under increasing development pressure. Conservation of this habitat is very important because at least half of all Nearctic Neotropical migrants depend on this region for stopover or wintering habitat. The effects of development on bird community have not been well documented. This information is necessary as a basis for developing a strategy for sustainable development practices that will incorporate habitat conservation. We selected six sites with three differing levels of coastal development (low, medium and high) in which we monitored fall migration in Sian Ka'an Biosphere Reserve, Quintana Roo, Mexico. We set up 10 mist-nets per site from September to December 2006-2007. We banded for a total of 39 or 40 days per site. We sampled for a total of 2180.75, 2633 and 2333.45 net-hours for the low, medium and high development sites, respectively. We caught 3.14, 10.62, and 13.81 ind/10 net hours for the high, medium and low

development levels, respectively. We captured a total of 109 species across all sites including 57 species for the high development level, and 72 species for medium and 69 for the low-level sites. This project is a pioneer study in that area, and it will provide well documented data about the effects of coastal development on migratory bird.

## 7. THE OIL PALM CONUNDRUM: HOW OIL PALM AGRICULTURE AFFECTS TROPICAL BIODIVERSITY AND WHAT CAN WE DO ABOUT IT

*\*Lian Pin Koh, Princeton University*

Oil palm (*Elaeis guineensis*) agriculture is a major driver of land-use change in major oil palm-producing countries (e.g., Malaysia). In this presentation, I address the following questions: (1) Is oil palm agriculture really destroying tropical biodiversity? I compiled FAO data on relative changes in extent of cropland and forests to show that 54-79% of oil palm expansion in Malaysia, and at least 51% of that in Indonesia had occurred on forests during 1990-2005. Furthermore, the conversion of either old-growth forests or secondary forests to oil palm plantations results in significant biodiversity losses. (2) Can oil palm plantations be made more hospitable for biodiversity? Results from a correlative field study show that species richness of forest butterflies and birds in oil palm plantations could be marginally enhanced by modifying management practices at the local scale (e.g., retaining epiphytes on palm trees), and by increasing the extent of forests at the landscape scale. (3) Do insectivorous birds provide any ecosystem service for oil palm agriculture? Results from a field experiment show that bird exclusion significantly increased herbivory rates compared to control treatments, and that the effect size of bird exclusion (i.e., magnitude of pest control) increased with relative abundance of insectivorous birds.

## 8. THE ROLE OF CULTIVATION HISTORY ON THE CARBON SEQUESTRATION POTENTIAL OF REGENERATING FORESTS IN THE EASTERN ARC MOUNTAINS, TANZANIA

*\*Tuyeni Heita Mwampamba, University of California Davis*

While tree plantations are a well-established approach to carbon sequestration, few farmers/land-owners in developing countries have the resources or capital to undertake such a venture. Field abandonment/natural forest regeneration is thus a worthwhile low cost alternative that has the added benefit of restoring natural habitat. Very few studies, however, have assessed the potential of natural regeneration of abandoned farmland as carbon offset projects, especially in high biodiversity hotspots. Moreover, the question remains as to what human and environmental factors impact the success of regeneration both as a conservation tool and as an effective means for carbon storage. I conducted vegetation and soil surveys of 143 plots in the Eastern Arc Mountains, Tanzania, to assess the effects of cultivation history on the woody biomass and soil carbon pools of regenerating farmland. The study spanned an elevational gradient of 300 - 1500 metres and across three forest types surveying abandoned farms with cultivation histories ranging from 0 to 30 years, having variable cultivation regimes. The findings shed important light onto how carbon offset projects could work in the Eastern Arc Mountains and identifies national and international policy changes that are needed to facilitate the inclusion of natural regeneration in discussions about climate change mitigation.

## 27. Conservation on Private Lands

## 1. ASSESSING THE SUCCESS AND CHALLENGES OF CONSERVATION EASEMENTS IN LATIN AMERICA

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In the United States, conservation easements are a popular private lands conservation tool, protecting an estimated 2.5 million hectares. Their use in Latin America, however, is rather recent, dating back to 1992. Conservationists in Latin America have adopted and adapted the tool, but, until now, they had not attempted to formally document its effectiveness in Latin America. With this in mind, a group of leading Latin American conservation organizations and professionals worked collectively to better understand conservation easements and the conditions under which they have been successful or not and why. This learning initiative entitled, "Conservation Easements: Progress through Learning" (SEPA, by its Spanish acronym) involved identifying and systematically testing assumptions about how conservation easements have worked in Mexico, Costa Rica, and Ecuador. Although the easements reviewed in these countries appear to have reduced threats to easement properties, their overall contribution to conservation and their relevance to conditions in Latin America were less clear.

## 2. BIODIVERSITY REPRESENTATION AND TARGET ACHIEVEMENT BY PRIVATE CONSERVATION AREAS IN THE LITTLE KAROO, SOUTH AFRICA

*\*John Gallo, Nelson Mandela Metropolitan University; \*Richard Cowling, Nelson Mandela Metropolitan University; \*Belinda Reyers, NRE, CSIR; \*Lorena Pasquini, University of Sheffield*

It is getting increasingly difficult to manage and expand formally protected areas. Emerging opportunities merit closer examination. This research examines the extent to which private conservation areas (PCA) are contributing to biodiversity conservation. Gap analyses were performed for a region with a comprehensive database of PCAs. The amount of private conservation area and statutory conservation area (SCA) was determined for the entire study area as well as for several landscape categories-- biome type, elevation class, ecological process, and endangerment. A complementarity metric was employed to determine if PCAs were representing different classes of landscape category or were being redundant to SCAs. The attainment of conservation targets for 344 habitats was also examined. Formal and informal PCAs combined to cover 24% of the region, and significantly complemented the different habitat conserved by SCAs. PCAs conserved significantly more of the lower elevation habitat, and nine times as much critical and endangered habitat as SCAs. PCAs nearly tripled the number of targets met. Many of the results are expected to transfer to other regions, indicating that the phenomenon of private lands conservation deserves an increased allocation of research and institutional resources. Further research is called for regarding the characteristics of private lands conservation, how to integrate it into conservation planning, and how to strengthen its dependability and quality.

## 3. BUSINESS AS A FORCE FOR CONSERVATION: IDENTIFYING KEY

## APPROACHES AND DESIGN CRITERIA TO LINK PRIVATE SECTOR PARTNERSHIPS WITH CONSERVATION OUTCOMES

*\*Bambi L. Semroc, Conservation International; \*Marielle Canter Weikel, Conservation International; \*Conrad Savy, Conservation International; \*John Buchanan, Conservation International; \*Ashton Carter, Conservation International; \*Jamie Sweeting, Conservation International*

Effective conservation requires actions at the site and landscape scales. Achieving broad scale conservation often necessitates partnering with the private sector to safeguard biodiversity targets, and major conservation organizations have begun to partner with industry to achieve such outcomes. These partnerships often focus on developing and implementing standards of good practice and/or engaging industry in landscape-level planning, but often face challenges in demonstrating effective contributions to conservation. A review of partnerships between conservation organizations and the private sector in the agriculture, mining, oil and gas, and tourism sectors was conducted to identify approaches meeting certain design criteria. Twelve partnerships were reviewed representing a range of environmental NGOs across the 4 industry sectors. Each partnership was assigned an approach category (standards; land-use planning; both) to identify the most common approach by industry. The partnerships were then assessed based on design criteria (e.g. conservation targets and threats identified, project baseline established; monitoring program implemented) to identify approaches meeting the highest number of criteria. Results showed partnerships focusing on land-use planning met the highest number of criteria and were most often implemented by the mining and oil and gas sectors. Implications for leveraging assessment and monitoring work by conservation biologists are discussed.

## 4. CONSERVATION DEVELOPMENT AND ITS ECOLOGICAL OUTCOMES: A FRAMEWORK AND RESEARCH AGENDA FOR AN EMERGING CONSERVATION STRATEGY

*\*Jeffrey Charles Milder, Cornell University, Department of Natural Resources*

Suburban, exurban, and rural development is a leading cause of biodiversity loss and natural resource degradation in the United States. In response to this threat, conservation development has been advanced as a way to combine land development with functional protection for conservation resources. This presentation will provide a review, analysis, and ecological critique of the four principal types of conservation development: (1) conservation buyer projects, (2) conservation and limited development projects, (3) conservation subdivisions, and (4) conservation-oriented planned development projects. Each approach can contribute to landscape-scale conservation, with benefits that include reducing the off-site impacts of development, buffering and connecting protected areas, and conserving imperiled species and ecosystems. However, empirical evidence indicates that the benefits of these approaches vary greatly, depending on project density, design, and context. Accordingly, this presentation will provide a framework for differentiating and analyzing these approaches to conservation development for the purposes of research, land-use planning, public policy, and conservation practice. It will also identify key scientific questions that must be answered before conservation development can realize its full potential as a conservation strategy.

## 5. CONSERVING WOODLAND BIRDS IN ETHIOPIAN AGRICULTURAL LANDSCAPES: THE BENEFITS OF TREES AND COFFEE

*\*Aaron Gove, Stockholm University; \*Kristoffer Hylander, Stockholm University; \*Sileshi Nemomissa, Addis Ababa University; \*Anteneh Shimelis, Addis Ababa University*

In Ethiopia, coffee is often grown in small home gardens where it is frequently shaded by individual trees. As cultivation of other common crops in the region is not reliant upon shade trees, we firstly hypothesised that the level of coffee cultivation at the farm-scale could influence the density of trees preserved on farms. Secondly, we predicted that an increase in tree density would promote use of farms by woodland birds. Hence coffee cultivation in home gardens would lead to higher levels of woodland bird conservation in countryside Ethiopia. We surveyed 19 farm-scale plots in SW Ethiopia, using point counts for bird species and an inventory of all food crops and tree species within a 100 x 200 m plot. Using linear models, we found that coffee cultivation was not associated with increased tree density, but was associated with an increase in tree species richness and the similarity of the tree assemblage to local woodlands. Tree species richness on farms was associated with the species richness of birds, including that of woodland birds, and associated with a bird assemblage more similar to local woodlands. We therefore suggest that coffee cultivation in small home gardens, through its promotion of a woodland-like tree assemblage on farms, indirectly leads to the increase in woodland bird persistence in countryside habitats.

## 6. ECOTOURISM FINANCES BIODIVERSITY PROTECTION IN THE PERUVIAN AMAZON

*\*Christopher Alexander Kirkby, University of East Anglia (UEA); \*Douglas W. Yu, University of East Anglia (UEA); \*Brett Day, University of East Anglia (UEA); \*Kerry Turner, University of East Anglia (UEA); \*Britaldo Silveira Soares-Filho, Universidade Federal de Minas Gerais; \*Hermann Oliveira-Rodrigues, Universidade Federal de Minas Gerais*

It has long been hypothesised that private ecotourism businesses can sustainably finance biodiversity protection in developing countries, which has justified the inclusion of ecotourism initiatives within billions of dollars worth of Integrated Conservation and Development Projects. However, clear evidence for large-scale conservation benefits resulting from ecotourism has been so lacking that there are now calls to eliminate ecotourism as a conservation financing mechanism. We used a commercially sensitive financial and land-use dataset to identify the factors that have allowed an ecotourism destination in Amazonian Peru to finance large-scale habitat protection. High profits generated from millions of dollars in annual revenues (US\$5.99 million in 2005), coupled with new land-use legislation and targeted international conservation finance, have to date allowed ecotourism businesses to put 48,636 ha of rainforest under private management and to begin shielding public protected areas from the deforestation that will result from the paving of the nearby Interoceanica highway. In Amazonian Peru, ecotourism has resulted in conservation benefits because the introduction of a new set of land tenure rights has aligned the interests of the conservation community with those of a competitive but financially viable ecotourism industry.

## 7. INVASIVE PLANTS IN PRIVATE

## NEIGHBORHOODS: DOES NEIGHBORHOOD GOVERNANCE MAKE A DIFFERENCE?

*\*Sarah Jean Cech, College of Charleston; \*Joel M. Gramling, The Citadel; \*Patrick T. Hurley, The College of Charleston; \*Norman S. Levine, College of Charleston; \*Angela C. Halfacre, College of Charleston*

When ecologists study invasive plants, they usually focus on natural areas that do not have a recent history of human disturbance. This approach to invasive plant studies excludes built human environments such as subdivisions or private neighborhoods. Often, human environments are considered sources of plant invasions because of the high amount of disturbance. This study examines the open spaces within 9 private neighborhoods in the Lowcountry of South Carolina and compares the richness of non-native invasive species across a gradient of neighborhood environmental governance. Each neighborhood inventoried was classified as having strict, medium or not strict environmental regulations. Neighborhoods with strict governance are expected to have the fewest number of non-native invasive species because they have fewer disturbances than neighborhoods without strict environmental regulations. Preliminary results indicate that neighborhoods in the strict and medium governance categories have similar non-native richness, but neighborhoods in the not-strict governance category have a higher non-native richness. Further explanations for these findings may involve comparisons of plant community types regardless of neighborhood governance.

## 8. MOTIVATIONS FOR USING CONSERVATION EASEMENTS AS LAND PROTECTION TOOLS: A QUALITATIVE STUDY

*\*James R Farmer, Indiana University; \*Burnell C Fischer, Indiana University; \*Charles Chancellor, Indiana University*

Conservation easements are a land protection tool employed by private land owners in order to protect and preserve land from future development. This study examined the motivations landowners cited for placing conservation easements on their property. We sampled 20 property owners from across Indiana, who own either agricultural and forestland and who had utilized a conservation easement as a land protection tool. Our findings indicate that the desire to limit development stems from encroaching development trends in one's area, ecological motivations, appreciation of nature, and the desire to protect farmland for personal, cultural, and historic reasons, as well as for the public good. Furthermore, an emerging dichotomy emerged between the motivations cited by the owners agricultural and forest land, respectively. The findings also indicated that a spectrum of marketing mechanisms attracted individuals to the use of a conservation easement. A final theme to emerge identified early-life experiences in nature as the foundational element that promoted the study's participants sense of environmental ethics. This presentation will highlight the necessity to engage in social science research to understand conservation behavior, a viable method for garnering and analyzing qualitative data, the study's findings, the theoretical underpinnings for each emergent theme, continued steps in the research process, and the implications for both academics and practitioners.

## 28. Conserving the World's Great Lakes: Lessons and Opportunities in an Era of Increasing Water Scarcity

## 1. AQUATIC ANIMAL DIVERSITY IN THE WORLD'S GREAT LAKES

*\*Peter Biek McIntyre, University of Michigan;*

*\*Yvonne Vadeboncoeur, Wright State University;*

*\*M. Jake Vander Zanden, University of Wisconsin*

The great lakes of the world are known for high diversity of particular taxa, but their collective role as storehouses of biodiversity has been poorly quantified. We used literature data and expert opinion to evaluate the diversity and distribution of fishes, mollusks, crustaceans, and insects in 14 of the world's largest freshwater lakes. Fish species in these lakes represent approximately 15% of global freshwater fish diversity. The African rift lakes exhibit particularly high richness and endemism, including hundreds of undescribed species. Most fish species are associated with littoral or benthic habitats. Even though zoobenthos lists were incomplete for most lakes, 80-98% of invertebrates occurred in the littoral zone and only 1-10% of invertebrate species were strictly pelagic. The available data clearly show that great lakes are critical repositories of global freshwater biodiversity, and our review highlights faunal inventories and coastal protection as key needs for conservation. Comprehensive sampling of benthic invertebrates and further taxonomic work on both fish and benthic invertebrates are sorely needed. Such efforts are expected to amplify the fact that a large majority of great lakes species are restricted to the littoral zone. Coastlines are the nexus of human-lake interactions, and conserving great lakes biodiversity will require greater efforts to protect nearshore aquatic and terrestrial habitats.

## 2. VALUING ECOSYSTEM SERVICES OF GREAT LAKES

*\*Stephen Polasky, University of Minnesota*

Ecosystems provide a broad range of goods and services of value to people, collectively called ecosystem services. Guiding human decisions in ways that sustain multiple ecosystem services requires integrating spatially explicit data and models from ecology, economics, and other disciplines. Modeling ecosystem services requires knowledge of "ecological production functions" to determine the provision of ecosystem services. Determining the value of ecosystem services requires integration of services with information about prices for marketed goods and non-market valuation methods for non-marketed services. Lakes provide ecosystem services in the form of commercial and recreational fishing, climate regulation, water provision, tourism, aesthetics and cultural value. Existing literature is reviewed to summarize estimates of the value of ecosystem services for the Great Lakes in the US and Canada and for the great lakes of Eastern Africa. Differences in values and in institutions governing management of these lakes are highlighted.

## 3. IMPACTS OF FISHING ON BIODIVERSITY AND ECOSYSTEM STABILITY IN GREAT LAKES

*\*Disma Mbabazi, National Fisheries Resources Research Institute; \*Oliva Charles Mkumbo, Lake Victoria Fisheries Organization, Jinja Uganda;*

*\*John Casselman, Queen's University, Department of Biology; \*William Oweke Ojwang, Kenya Marine & Fisheries Research Institute*

The Great Lakes of the world support large, important freshwater fisheries. Among the North American Great Lakes, Lake Erie is the largest fish producer but all five lakes support substantial fisheries. By the 1960s, yields of many large-bodied fish had declined dramatically, and fisheries reverted to small-

bodied, mainly invasive species. Stocking and continued species introduction have further affected biodiversity and ecosystem stability. In Africa, Lake Victoria is the largest inland fishery, and supports a major export market. Overfishing occurred as early as the 1920s, and subsequent species introductions and fishing pressure have resulted in profound ecological changes. The decline of native fish species has impacted the trophic and ecological status of the lake. Lake Tanganyika also supports major fisheries. Mechanized industrial fisheries boomed in the 1980s but collapsed due to overfishing, directing attention toward smaller species. This study explores how fisheries exploitation has changed fish communities, and subsequently primary producers and eutrophication patterns, in these and other large lakes. We emphasize management and conservation strategies for sustaining fisheries and healthy ecosystems.

## 4. CHEMICAL CONTAMINATION AND IMPLICATIONS FOR THE GREAT LAKES OF THE WORLD.

*\*Linda Campbell, Queen's University*

The Great Lakes of the world, together, comprise a range of unique ecosystems and conservation challenges. In addition, they are a significant source of freshwater globally, enable transportation and contain the world's most valuable freshwater fisheries. The Great Lakes issues are not restricted to aquatic environments, but also must incorporate terrestrial components. As such, chemical contamination of the world's Great Lakes has directly impacted upon the biodiversity and conservation of those ecosystems. The biomagnification and bioaccumulation of contaminants such as mercury and organochlorines in those very large lakes also is concern world-wide particularly for consumers of fish. We review data and case studies collected from Great and very-large lakes across latitudes, including the African Great Lakes, Laurentian Great Lakes, Lake Baikal and others. We discuss spatial and temporal trends for mercury and organic contaminants across latitudes and the implications for the natural (and not-so-natural) Great Lakes ecosystems.

## 5. INVASIVE SPECIES: GREAT IMPACTS IN GREAT LAKES

*\*David M Lodge, University of Notre Dame*

Invasive species are a major driver of changes in freshwater community structure, ecosystem function, and ecosystem services. This applies not only to small lakes but also to the Laurentian and African Great Lakes. Until recently, however, ecologists had little capacity to forecast—and therefore prevent—the introduction, spread and impact of species likely to cause net financial or environmental harm. Forecasting capacity is now well developed for some stages of invasions, some ecosystems, and some taxonomic groups. This is especially true for intentional pathways (e.g., pet and horticultural industries). Forecasting capacity for introductions via unintentional pathways (e.g., ship ballast water or hull fouling) is also growing rapidly, but many logistical and technical challenges remain in research. Finally, management decisions and policy frameworks must incorporate costs and benefits, but financial quantification of ecosystem goods and services—and especially how these are affected by invasive species—is poorly developed for most of the world's lakes. Recent progress in more fully accounting for costs and benefits of some pathways of species introduction into the Laurentian Great Lakes suggest however that invasion-induced losses of ecosystem goods and services may outweigh benefits of transportation-related pathways.

## 6. GLOBAL WARMING EFFECTS ON GREAT LAKES FISH COMMUNITIES: COMMON

## CAUSE, COMMON IMPACTS

*\*Robert E. Hecky, University of Minnesota-Duluth*

Great lakes in North America and Africa have warmed over the last century, and the rate of warming has accelerated since 1980 in approximate synchrony with global air temperatures.

Although current water temperatures still fall within optimal temperature ranges of endemic species (where known), there is cause for concern about projected increases for the future.

Summer warming of surface water is most dramatic in the Laurentian Great Lakes which still retain cold, deep hypolimnia as a result of strong winter circulation to all depths. Warming of the surface mixed layer is also occurring in the deep African Great Lakes which do not mix throughout their depths annually and so record a slow warming over all depths through the last century. Although temperature changes are still relatively small and unlikely to directly extirpate species through exceedance of upper optimal temperatures in the near future, warming temperatures are likely already affecting the productivity of the deep lakes due to reduced vertical mixing. In the unique and spectacular species flocks of the African Great Lakes, lowered production may increase competitive interactions in the nearshore where species richness is highest. However, over the near term, anthropogenic eutrophication remains the greatest threat to the diverse species flocks of the AGL.

## 7. POLICY OPPORTUNITIES AND STRATEGIES FOR CONSERVATION: ANALYZING APPROACHES TO SUSTAINABILITY IN GOVERNANCE OF AFRICAN AND NORTH AMERICAN GREAT LAKES

*\*Tracy A Dobson, Department of Fisheries and Wildlife, Michigan State University*

Degradation and depletion have significantly diminished some of the world's great lakes (Aral Sea, Lake Chad) and threaten the health of others. What can be done to conserve them? What policy opportunities and related strategies could be used to change course to lead to sustainable great lakes? A variety of approaches have been employed with varying degrees of success. I will compare conservation actions in the Laurentian Great Lakes and Lakes Victoria and Malawi. With many similar problems (e.g., overfishing, toxic pollution, alien invasions) but with differing levels of resources and governing cultures, the strategies adopted to achieve sustainability of these seven great lakes are alike in some ways and different in others. Analysis of their cases indicates which elements promoted and which elements impeded or had no effect on conservation success. I examine conservation organizations (e.g., Great Lakes Fishery Commission, Lake Victoria Basin Commission, Alliance for the Great Lakes), legislation and regulations (e.g., Malawi's Fisheries Conservation and Management Act), cooperative agreements (e.g., Joint Strategic Plan for Management of Great Lakes Fisheries), and U.N. resources (e.g., FAO, Global Environmental Facility) to outline some successful approaches such as multi-jurisdictional collaboration, and greater inclusion of local stakeholders in management. Their successes (and failures) point to future conservation opportunities.

## 8. MANAGEMENT OPPORTUNITIES AND STRATEGIES IN GREAT LAKES

*\*Tim Eder, Great Lakes Commission; \*Katherine Glassner Shwayder, Great Lakes Commission;*

*\*Erika Jensen, Great Lakes Commission*

Great lakes present unique challenges and opportunities for resource management, often involving several jurisdictions.

Multijurisdictional management can be arduous, but may also generate advantages such as leveraging political action and investment. The need for cooperation and coordination among jurisdictions is illustrated in the context of aquatic invasive species (AIS) management. AIS are a global issue especially acute in the North American Great Lakes. Environmental and economic problems caused by AIS transcend jurisdictional boundaries, often involving interstate commerce. Success in AIS management is achieved by overcoming transboundary issues and coordinating jurisdictional efforts. Cooperation with federal leadership can provide the authority, technical expertise and funding needed to support management. In coordinating AIS management, experience from the Great Lakes is demonstrated in areas of ballast water, state management plans and rapid response. Despite significant progress, a uniform approach that effectively prevents AIS introduction and spread and harmonizes management among two federal and ten state/provincial governments has not been realized. Lessons learned in the Great Lakes are transferable to other great lake regions facing similar challenges. Cooperation and coordination are fundamental to the successful management of great lakes which is critically needed to protect the world's freshwater resources from AIS, climate change and other stressors.

## 29. Ecological Restoration

### 1. CONSERVATION STATUS AND RECOVERY MEASURES OF NINE ECONOMICALLY IMPORTANT PLANTS OF THE HINDU RAJ MOUNTAINS

*\*Habib Ahmad, Hazara University, Mansehra Pakistan*

Extensive surveys were conducted to record conservation status of nine economically important species of the Hindu Raj Mountains, Northern Pakistan. The species included *Colchicum luteum*, *Ephedra gerardiana*, *Litsea monopetala*, *Neolitsea cuipala*, *Podophyllum emodi*, *Quercus glauca*, *Rhododendron arboreum*, *Ulmus chumlia* and *Ulmus wallichiana*. Data was collected from almost all the habitats, of the historical range of the species; broadly falling into the subtropical scrub temperate and alpine ecosystems. It was concluded that *Quercus glauca* is completely vanished from its natural habitat viz. the lower Hindu Raj. Genetic diversity of *Ulmus chumlia* and *Litsea monopetala* is squeezed to the extent of Critically Endangered. *Neolitsea cuipala*, *Ulmus wallichiana*, *Rhododendron arboreum*, *Ephedra gerardiana*, *Podophyllum emodi* and *Colchicum luteum* are entered into the range of Endangered Category. Root causes for the genetic erosion of each species were worked out and measures for their recovery/ rehabilitation have been elaborated. The paper identifies 14 hotspots areas in Hindukush Region for rehabilitation and recovery of these species.

### 2. ENVIRONMENTAL FACTORS INFLUENCING RESTORATION OF AMERICAN CHESTNUT TO THE FORESTS OF MAMMOTH CAVE NATIONAL PARK

*\*Albert Jon Meier, Biology, Western Kentucky University; \*Jason Taylor, Biology, Western Kentucky University*

Recent efforts to restore the American chestnut (*Castanea dentata*) have produced strains of blight-resistant trees. However, we have for three years experienced 50% per year mortality in under-planted seedlings at Mammoth Cave National Park. We have analyzed the relationship between

mortality and numerous environmental parameters. Soil calcium appears to be most closely related to mortality. We expect that light availability influences chestnut growth and perhaps survival. American chestnut saplings have been observed to grow extremely rapidly in nurseries, but saplings in the lower light conditions of forests seem to grow slowly. The rate of photosynthesis was measured for both chestnuts and oaks under a wide range of levels of light. This data was used to compare the light compensation and saturation points and light response curves of chestnuts and oaks. Under nursery conditions, we have found similar values for oaks and chestnuts.

### 3. ERADICATION OF INVASIVE SPECIES AND HABITAT/SPECIES RESTORATION TECHNOLOGY

*\*Thomas Kryzak, Environmental Lunch Box Technology LLC*

Thomas J. Kryzak, tkryzak24@nycap.rr.com Eradication of Invasive Species and Habitat/Species Restoration Technology Oral Presentation Topic Areas: Ecology Restoration, Alien and Invasive Species, Ecological Restoration and Reconstruction Aquatic alien and invasive species are overtaking native species/habitats and threaten ecological stability of aquatic environments. Improved technology to control the spread and eradication with habitat/species replacement/ reintroduction and monitoring through developments in underwater restoration technologies. Using an apparatus, system and method for eradication of invasive species with a structure comprising an elongated flexible bladder blanket divider. A method of using the apparatus having variable volume first and second compartments separated and introducing agents through openings in the bladder to control the growth or kill invasive organisms. Habitat/species introduction through the bladder repopulates the site with species/growth packets and soil replacement. Identifying and sharing this new technology prevents the spread and kills aquatic invasive species with habitat/species repopulation in a controlled environment. New patented and patent pending technology is available for inclusion in aquatic projects (US Patent # 7,264,713). Thomas J. Kryzak Environmental Lunch Box Technology LLC 341 Settles Hill Rd, Altamont, NY 12009 ([tkryzak24@nycap.rr.com](mailto:tkryzak24@nycap.rr.com))

### 4. IMPACT OF ENGINEERING INTERVENTIONS ON THE CONSERVATION OF THE ECOLOGY OF THE AREA

*\*ajay sehgal, government*

This study was carried out within the framework of World Bank forestry project to maintain essential ecological processes and life support systems, to preserve genetic diversity and to ensure the sustainable utilization of species and eco-systems in a degraded land. The paper discusses the impact of engineering interventions on the reclamation and conservation of the biodiversity of large manmade wetland situated in the shadow of ecologically sensitive & geologically unstable Shivalik foothills forming a part of fragile Himalayan eco-system. It establishes the linkages of hill denudation with environment and poverty in the area. Commercially sensitive and economically exploitative attitudes of locals subjected this ecosystem to stress, leading to alteration and hampering of its functions and then lead to ultimate destruction. The study highlights how the engineering interventions helped in the conservation of the ecology of the area and also improved ground water recharge and moisture regime apart from providing food security, forage security, energy security, flood security and social security. The paper apart from critically assessing the performance of engineering interventions also

attempts to focus on the ecological principles that are real tangible parameters of sustainability of an area.

### 5. MUIR WEBS: A NEW MEANS OF CONSERVING THE INTERACTIONS THAT BIND ECOSYSTEMS TOGETHER

*\*Eric W Sanderson, Wildlife Conservation Society*

John Muir wrote: "When we try to pick out anything by itself we find that it is bound fast by a thousand invisible cords that cannot be broken, to everything in the universe." This double observation - both that all parts of nature are connected, but those connections are invisible - provides a major conundrum to conservation biologists and restoration ecologists alike: how are we to conserve what we can not see? what are the connections we seek to restore? In this presentation, I describe a new grammar for describing habitat entities and their interconnections across taxa using an analogy to language. This grammar can be used to write "sentences" relating one ecosystem entity to a series of others, as in resource selection functions that predict the distribution of a "subject" with respect to other "elements." These sentences can also be combined into larger network structures ("Muir webs") that can be analyzed using modern network analysis tools, with implications for the resiliency of natural systems. For example, I identify super-connected elements key to ecosystem conservation and suggest how natural connections to groups of related elements stabilize ecosystems under threat, using an example of the plants, amphibians, reptiles, birds and mammals from a well-described nature reserve in suburban Westchester County, New York, in the mixed-deciduous forests of the eastern United States.

### 6. THE GARDENING CONCEPT AS APPLICABLE TOOL FOR ACTIVE REEF RESTORATION IN TANZANIA

*\*Nsajigwa Emmanuel Mbije, Sokoine University of Agriculture*

Coral reefs are facing the greatest threats of all times. Until recently, most studies on the coral reef restoration have proved to be destructive, too costly or labor intensive. To overcome this, a two steps coral gardening concept was introduced. The first step involves gardening small colonies on mid-water nurseries, upon reaching a suitable size a second step is to transplant them on the pre-surveyed the damaged areas. Two mid-water nurseries, each with 9000 fragments of average initial sizes of 1.3 cm, were established at six meters depth of high tide in Zanzibar and Mafia Islands in September 2007. Each nursery comprises six species namely; *Acropora formosa*, *A. nasuta*, *A. hemprichii*, *Pocillopora verrucosa*, *Porites cylindrica* and *Millepora* sp. A significant difference between species survival and growth rates was evident, with *Acropora* species and *Millepora* sp having better success than *Pocillopora verrucosa* and *Porites cylindrica*. Furthermore, growth and survival rates were higher for species in Zanzibar (89%) compared to (73%) in Mafia. High sedimentation rate at a site in Mafia could explain the observed differences in the two sites. These positive initial results indicate that coral gardening could be used to generate large quantities of coral forms for restoration of damaged.

### 7. THE IMPACT OF PRESCRIBED FIRE AND SEASON OF BURN ON AMPHIBIAN AND REPTILE BIODIVERSITY PATTERNS IN NORTHERN LONGLEAF ECOSYSTEM RESTORATION

*\*Walter Smith, University of Alabama; \*Leslie J.*

Rissler, *Department of Biological Sciences, University of Alabama*; \*James Stiles, *University of Alabama*; \*Sierra Stiles, *University of Alabama*

Understanding how biodiversity responds to management techniques is a vital component of monitoring ecosystem restoration. We used multiple trap arrays and GIS techniques to examine herpetofaunal responses to prescribed burning in the previously unstudied northern longleaf pine (*Pinus palustris*) ecosystem currently undergoing restoration in the Talladega National Forest of central Alabama. A two-year sampling effort of 2,170 individuals and 45 species indicated significantly lower diversity in recently burned stands than those burned more than twenty years ago. We found no significant relationship between diversity measures and season of burn (dormant versus growing). Additionally, our data suggest a strong landscape component of herpetofaunal diversity, with distance to longleaf stand edge serving as an important covariate in our analyses. The herpetofaunal community sampled in this study does not correspond closely to that typically encountered in longleaf pine ecosystems of the lower Coastal Plain; this suggests that management regimes designed in southern longleaf communities may not be adequate surrogates to understand the dynamics in northern longleaf communities. Our results provide the first recorded inventory of herpetofauna in the northern longleaf ecosystem, as well as key community metrics to aid forest managers in monitoring the restoration of this and other longleaf ecosystems in the Southeast.

## 8. TO FEED OR NOT TO FEED? A DILEMMA IN EUROPEAN BISON CONSERVATION IN BIALOWIEZA FOREST, POLAND.

\*Bogdan Jaroszewicz, *University of Warsaw, Poland*

Increasing numbers of European bison *Bison bonasus* L. and their conflict with wood production is the major conservation management issue in Bialowieza Forest (Poland). Supplementary winter feeding (ca 250 tonnes of hay p.a.) is used to reduce damage in tree stands, but it has many unwanted side effects. The germinable seed content of bison dung and the colonization success of dispersed plant species have been studied in greenhouse and field experiments. The influence of feeding on the bison population, and ecosystem conservation was analyzed from the published data. European bison in Bialowieza Forest disperse 160 plant species, with 26% of segetal or ruderal, and 2% of alien species. Close to 20% of them are able to become established in the field. Decreased bison winter mortality accelerates the growth of bison numbers and increases year-round pressure on the forest. High population density is advantageous for pathogenic organisms, increasing their dispersal possibilities. Supplementary feeding, which was expected to solve conflicts, has drawbacks: an increased risk of invasion by alien species and increased pressure from bison on forest ecosystems. Thus, supplementary feeding methods must be revised. Only fodder prepared in immediate proximity of the area should be used. The amount of hay should be limited to ensure population survival during severe winters, allowing natural mortality to occur. The project received support from Polish Science Budget (project 2P04F03530).

## 30. Economic Growth and Biodiversity: The Elemental Arguments

### 1. THE HUMAN 'ECOLOGICAL FOOTPRINT' AND COMPETITIVE EXCLUSION: WHY THE EXPANDING ECONOMY NECESSARILY

## MEANS BIODIVERSITY LOSS

\*David Trauger, *Virginia Tech*; William Rees, *University of British Columbia*

From the perspective of far-from-equilibrium thermodynamics, the human enterprise is a far-from-equilibrium dissipative structure. This means that it can grow and maintain itself in a highly developed, complex, 'far-from-equilibrium' (low-entropy) state only by consuming resource gradients found in nature and by dissipating degraded energy and matter ('entropy', a.k.a waste and pollution) back into the ecosystem. Non-human species and entire ecosystems (e.g., forests, grasslands) are among the gradients of available energy/matter that people consume and dissipate to grow their economies and accumulate the artifacts of civilization. Since approximately the late 1980s, the aggregate human 'ecological footprint' has exceeded important dimensions of the productive and assimilative capacity of the planet and is still expanding. Since people share the bio-productive capacity of Earth with millions of non-human consumer organisms, primary production diverted from global totals to support humanity is irreversibly unavailable to support other species. This problem is exacerbated by the human appropriation of wildlife habitat, habitat fragmentation, increasing 'edge effects' and toxic contamination. Better pricing of nature's 'goods and services' can only slow the process in a growth-based economy. Biodiversity can be maintained only if humans halt population growth, strive for greater social equity, and abandon the myth of perpetual material expansion.

## 2. MACRO POLICY LEVEL SOLUTIONS, INCLUDING TAXATION, BANKING, FISCAL, MONETARY, AND TRADE POLICY, AND THEIR IMPACT ON BIODIVERSITY

\*Michael A Larson, *Minnesota Dept of Natural Resources*; \*Philip Lawn, *Flinders University*

To successfully achieve biodiversity conservation, the scale of macroeconomic systems must remain within the limits imposed by the need to preserve critical ecosystems and the regenerative and waste assimilative capacities of the ecosystem as a whole. These limits are determined by biophysical criteria, but macroeconomics involves the use of economic instruments which are designed to meet economic criteria. Macroeconomic policy cannot, therefore, directly solve the biodiversity erosion crisis. The crisis can only be solved by explicitly precluding human-beings from the direct use of a relevant portion of the total ecosystem and imposing quantitative restrictions on the rate of matter-energy transferred from the ecosystem to the macroeconomy and back to the ecosystem as high entropy wastes. However, ensuring that macroeconomic systems operate as effectively as possible within sustainable limits does require good macroeconomic policy. Good macroeconomic policy is also necessary given that bad macroeconomy policy is likely to reduce human well-being and therefore increase the likelihood of social upheaval that could undermine conservation efforts. Herein I demonstrate: (a) what might best be introduced to impose the throughput constraints necessary to meet biodiversity conservation needs, and (b) what implications this will have for macroeconomic policy setting.

## 3. THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND BIODIVERSITY CONSERVATION: A HISTORICAL REVIEW OF THE ECOLOGICAL ECONOMICS PERSPECTIVE

\*Robert Dietz, *Center for the Advancement of the Steady State Economy*

Ecological economists have strived to infuse knowledge from

other fields of study into the theoretical foundation of economics and its application to policy. Most notably, ecological economics draws from the fields of physics and ecology to tie economic theory to the natural world in which human economies operate. For more than a century, economists have undertaken truly trans-disciplinary research to build a body of work on the relationship between the economy and the natural world. It is difficult to describe the interaction between the increasingly complex and growing global economy and the global ecosystem (a system so complex that scholars spend lifetimes studying tiny facets of it). To develop a framework for understanding this interaction, therefore, it is instructive to review the work of trans-disciplinary economists who have explicitly studied the interplay between economic growth and nature. A timeline of economists who have produced principal theories about the relationship between economy and ecosystem includes the likes of John Stuart Mill and William Stanley Jevons in the 19th century, Nicholas Georgescu-Roegen in the 20th century, and contemporary scholars such as Herman Daly. The aggregated work of these economists underscores the need to broaden neoclassical economic growth theory and include sustainability considerations in economic policy.

#### 4. PROSPECTS FOR RECONCILING THE CONFLICT BETWEEN ECONOMIC GROWTH AND BIODIVERSITY CONSERVATION WITH TECHNOLOGICAL PROGRESS

*\*Brian Czech, Virginia Tech*

The basic conflict between economic growth and biodiversity conservation is widely understood, but many economists and politicians argue that the conflict may be resolved with technological progress. The purposes of this talk are to review the conflict between economic growth and biodiversity conservation in the absence of technological progress, to explore the prospects for technological progress to reconcile that conflict, and to provide linguistic suggestions for describing the relationships among economic growth, technological progress, and biodiversity conservation. The conflict between economic growth and biodiversity conservation is based upon principles of ecology such as trophic levels and competitive exclusion. Reconciling the conflict via technological progress is infeasible because surplus production in existing economic sectors is required for conducting the research and development necessary for bringing new technology to market. Technological regimes also reflect macroeconomic goals, and if the goal is economic growth, reconciliatory technologies are less likely to come online. As the economy grows, the loss of biodiversity may be partly mitigated with end-use innovation that increases productive efficiency, but this type of technological progress requires policies and politics that are unlikely if the conflict between economic growth and biodiversity conservation (and other aspects of environmental protection) is not acknowledged.

#### 5. UNDER- AND OVER-GROWN: ECONOMIC GROWTH, BIODIVERSITY, AND THE GLOBAL NORTH AND SOUTH

*\*Jon Rosales, St. Lawrence University*

Economic growth is an appropriate goal for some countries and not others, the difficulty is in deciding for whom it is appropriate. The global North and South are commonly differentiated by their social needs and abilities to meet those needs. Differentiating 190+ countries, 6.5 billion people, and innumerable species and habitats into two groups - North and South, or developed and developing - clearly has its problems. A useful metric to use with non-discrete variables

such as North/South is scale. A scale that has proven to be helpful in relation to climate change is greenhouse gas per capita emissions. Since greenhouse gases mix evenly in the atmosphere, they can be used as an indicator from which to differentiate the relative contribution to climate change by differing groups of people around the world. Since per capita emissions are inextricably linked to economic growth they can be used to determine levels of under- or over-consumption and, by association, under- and over-grown economies. Per capita emissions can then be used to determine whether economic growth is an appropriate goal for particular countries. Based on this indicator, this paper applies a set of ethical principles that is emerging in civil society in order to deepen the argument on the appropriateness of economic growth for different countries.

#### 6. THE VALUATION SOLUTION

*\*Joshua Farley, The University of Vermont; \*David Richards, EcoAnalysts, Inc.*

Most economists and a growing number of ecologists claim that if we estimate monetary values of ecosystem services and feed these signals back into the marketplace, the free market economic system will lead to the efficient allocation of all resources. The fact is however that all economic production requires raw materials and energy. The raw inputs to economic production otherwise serve as the structural building blocks of ecosystems. When we remove structure, we damage function, including habitat for biodiversity. Since all economic production has an impact on biodiversity, internalizing externalities would require an army of valuation technocrats feeding information to a central authority that would then set prices, the exact opposite of a free market system. Furthermore, prices are based on marginal values. Economists recognize that when resources are essential and have no substitutes, small changes in quantity lead to large changes in marginal value. When we are close to ecological thresholds, marginal changes in activities threatening biodiversity can lead to non-marginal impacts, and marginal valuation becomes entirely inappropriate. Under these circumstances, conservation is essential, which is to say amount of ecosystem structure available for conversion to economic production must be determined by conservation needs. In other words, conservation needs will determine prices instead of prices determining conservation.

#### 31. Ecosystem / Conservation Area Management

##### 1. CONTRIBUTE TO THE UNDERSTANDING OF THE RELATIONSHIP BETWEEN CHERRY ORCHARD MANAGEMENT AND THE CONSERVATION OF AN ENDEMISM (ASPHODELUS BENTO-RAINHAЕ)

*\*Fabiola Sabino Gil, University of Azores; \*Isabel Maria Rodrigues, Escola Superior Agrária - Instituto Politécnico de Castelo Branco; \*Tomaz Ponce Dentinho, University of Azores*

As cherry production increases in the northern slope of Serra da Gardunha (Beira Interior region, Portugal) conflicts arise between farmers and environmentalists. The expansion of the orchards promises enhanced income and a considerable socioeconomic impact on the region, but it also threatens the endemism *Asphodelus bento-rainhae* P. Silva. This study aims at finding the trade-off between cherry yields (tonne/hectares) and the area covered by *Asphodelus bento-rainhae* (%) for a given plot of land, thus generating the needed information to find and promote a suitable and sustainable equilibrium

between economic development and natural resource conservation. The method of removal of spontaneous vegetation from the slopes between terraces, stood out in the analyses: when cutting was used, the area covered by *Asphodelus bento-rainhae* increased and the cherry yields decreased. However, when other methods were used to remove slope cover such as applying herbicides per se or accompanied by cutting, the cherry yields increased and the *Asphodelus bento-rainhae* diminished. The remaining management and environmental variables were not linked to significant effects either on cherry yields or on the *Asphodelus bento-rainhae* distribution. The results suggest that it is possible to increase cherry yields without decreasing the endemism distribution as long as slope management is not carried out with herbicides.

## 2. FROM WATER TO DESERT: UNDERSTANDING ELEPHANT PIOSPHERES TO MANAGE IMPACTS

*\*Marietjie Landman, Centre for African Conservation Ecology, Nelson Mandela Metropolitan University; \*Graham IH Kerley, Centre for African Conservation Ecology; \*Anthony J. Hall-Martin, Hall-Martin Consulting*

The distribution of surface water determines patterns of elephant use, and hence impacts, across landscapes. Providing artificial surface water reduces landscape heterogeneity, especially in small reserves with high elephant densities. Models that describe the spatial and temporal variations of elephant impacts across landscapes in relation to water are currently lacking. Using 30 years of data on shrub/tree structure in the Addo Elephant National Park, South Africa, we show that vegetation structure, a measure of landscape heterogeneity and ecological function, increases to an asymptote with increasing distance from water, a classic piosphere pattern. This expands over time or accumulated elephant density. The change, a shift from thicket to grassland, is associated with a collapse in the functionality of the landscape. These descriptive models can be used to estimate asymptotic distances of impacts in relation to water, and rates of accumulated change. We use these models to estimate the distance between water sources that will provide areas with imperceptible elephant impacts, and highlight that this changes over time. These findings can be used to make decisions about the provision of water, and emphasise the need to manage this at both the spatial and temporal scale, and in relation to elephant density.

## 3. GEO BON: A GLOBAL BIODIVERSITY OBSERVATION NETWORK

*\*Woody Turner, NASA*

The Group on Earth Observations (GEO) is a partnership of over 70 national governments, the European Commission, and a number of international organizations seeking to coordinate efforts to develop a Global Earth Observation System of Systems or GEOSS (<http://www.earthobservations.org/>). One of the observation systems GEO member countries and organizations are promoting is a global Biodiversity Observation Network, known as GEO BON. Plans for this network focus on biodiversity at the levels of ecosystems, species, and genes, as well as on the crosscutting theme of ecosystem services. For each of these, observations will seek to identify: changes in state over time, drivers of change, trends in these changes, and the impacts of changes. GEO BON will incorporate satellite, airborne, and in situ observations of terrestrial, freshwater, and marine systems in a framework uniting top-down global and regional scale assessments with bottom-up local and landscape/seascape scale assessments. Models will help fill in observational gaps and also provide

projections of possible future states. While national government agencies will likely initiate this network, GEO BON is open to participation by other government agencies, academia, nongovernmental organizations, and commercial entities.

## 4. LANDSCAPE UNITS REDUNDANCY IS NOT AN OPTION ACROSS A BORDER

*\*Uri Shanas, Department of Biology, Faculty of Science and Science Education, University of Haifa-Oranim*

In a world of growing economies and declining biodiversity, prioritizing land for conservation became a major challenge. The need to set guidelines for land conservation resulted in a wide spectrum of approaches, the majority of which focus on a global scale. However, contemporary land management and conservation decisions are made within geopolitical or, even more local, jurisdictional boundaries. We attempted to prioritize landscape units by studying diversity of reptiles, ground dwelling beetles, and spiders, taking into account proximity to agricultural fields and differing human societies across a geopolitical border. Congruence across taxa was low, questioning the practice of prioritizing land based on diversity measures of focal groups. Nevertheless, we found human cultural practices to affect patterns of diversity. Beetle species can be assembled, using ordination methods, according to landscape units, but within each landscape unit they further assembled by the geopolitical location. Spider species fail to assemble according to landscape units but cluster as a single group within a country. Therefore, loss of a habitat on one side of a border cannot be compensated with preservation of the same habitat across the border, due to fauna dissimilarity. This may hold true also for other biomes that inhabit different human cultures, emphasizing the need for cross border land protection zones that can provide a useful approach to preserve the overall diversity of a region.

## 5. PLANNING FOR REALITY - WHOSE REALITY? CONSERVATION PLANNING AND ACTION IN THE MALOTI DRakensBERG TRANSFRONTIER CONSERVATION AREA

*\*Brent Corcoran, Maloti Drakensberg Transfrontier Programme*

Lesotho and South Africa have established the Maloti Drakensberg Transfrontier Conservation Area (MDTFCA) to secure the biodiversity of this montane region, whilst contributing to its development imperatives. This paper explores the principle of "planning for implementation" as it was applied to the MDTFCA context, and thus highlights key lessons for future conservation efforts in the region. The MDTFCA, as with other regional conservation initiatives, is very complex. Its sheer size, population numbers, complex institutional environment and local-scale contextual differences resulted in a planning process that was designed to engage relevant stakeholders at key steps in the process. The premise was that if it was well-designed and implemented, it would facilitate consensus between this diverse set of programme partners. This consultation-based and data-driven planning process produced one product in the form of a long-term strategic framework and detailed programme of action for the next five years. However, despite the attempts to portray consensus, there are still a number of conflicting realities in the region. Most significantly, the conservation reality of "biodiversity under significant pressure" is in conflict with the contextual reality of "development imperatives and rapid land use change". Unless conservation efforts identify ways to bridge these reality "gaps", biodiversity realities will not

become mainstream, and biodiversity targets will not be achieved.

## 6. PROTECTED AREA MANAGEMENT EFFECTIVENESS, THE CASE STUDY OF RWANDA IN AFRICA

*\*Eugene RUTAGARAMA, International Gorilla*

### *Conservation programme*

The aim of assessing the effectiveness of protected area management is to identify gaps in management process and prioritize conservation efforts and funding (Dudley, et al., 1999). Despite its small size (26,338 Sq. km) and high population density (310 per Sq.km), Rwanda devotes 8.4% of lands to protected ecosystems (MINAGRI, 2003). The three major protected areas of Rwanda, the Akagera National Park (ANP: 90,000 Ha), the Nyungwe National Park (NNP: 97,000 Ha) and the Volcanoes National Park (VNP: 12,760Ha) have a very rich of biodiversity. The three parks have however suffered an important degradation and a reduction of 65% in 40 years (MINAGRI, 2003). One of the major threats includes the weakness of the political frameworks, gaps in the institutional framework and constraints relating to human resources (MINITERE, 2000). In order to assess the management effectiveness in these three national parks, I used two times (2002 and 2005) The Nature Conservancy method known as "Scorecards: consolidation criteria". During sessions gathering protected area managers and conservation organizations leaders, we defined management criteria and we evaluated the performance achieved for the criteria identified. Though commendable progresses were registered during the period from 2002-2005, overall, the management of protected areas in Rwanda needs a lot of improvement, and some specific areas are more alarming than others.

## 7. SHORT-TERM EFFECTS OF DISTURBANCE ON BREEDING BIRDS IN AN UPLAND PINE-HARDWOOD FOREST

*\*Jill Wick, Alabama A&M University; \*Yong Wang, Alabama A&M University; \*Callie Callie Schweitzer, USDA Forest Service*

We evaluated the changes in the bird community in relation to six disturbance treatments in the Bankhead National Forest, AL. The study design is randomized complete block with a factorial arrangement of three thinning levels (no thin, 11 m<sup>2</sup> ha<sup>-1</sup> residual basal area [BA], and 17 m<sup>2</sup> ha<sup>-1</sup> residual BA) and two burn treatments (burn and no burn), with three replications. Data were collected via pre- and post-treatment avian line-transect and microhabitat surveys. Canonical correspondence analysis (CCA) was used to evaluate relationships between bird community and microhabitat characteristics. Multivariate analysis of variance was used to test effects of treatment and change over time. Abundance of bird species and nesting guilds of birds were associated with ground cover and canopy cover. Abundance of tree and cavity nesting birds increased in burned plots and decreased in control and thinned plots. Abundance of foliage foraging birds and interior/edge habitat dwelling birds decreased in plots that were thinned and burned. Abundance of edge/open habitat dwelling birds increased in thinned plots. Abundance of Prairie warblers (*Dendroica discolor*), a species of high concern in Alabama, increased in number of detections on treated plots. In this study, tree thinning had more impact on the bird community than prescribed burning. This type of thinning can be used as a management tool to increase densities of birds associated with open habitat.

## 8. WHAT FACTORS DETERMINE HOW MARINE SPECIES RESPOND TO AREA-BASED

## MANAGEMENT?

*\*Sian Kristina Morgan, University of British Columbia; \*Hussein Alinda, World Wildlife Fund*

Species are useful for increasing public, government and business support for conservation and for delivery of protected areas. However, current flagship species tend to be large charismatic megafauna, that may or may not show notable responses to area-based management. Here our goal was to generate a scientifically defensible list of focal species to promote messaging around the need for spatial management. By reviewing the primary literature and consulting local experts, we generated a series of criteria, evaluating how species' respond to area-based management based on their demography, importance for trophic structure, sensitivity to anthropogenic threats and need for critical habitat. Then, we used a second tier of criteria that considered species' economic, social and cultural importance. Evaluated species spanned a range of life histories and habitats, from large migratory cetaceans to sessile beds of macrophytes. Results indicate clear benefits to taxa with rapid demographic rates (e.g. fast growth, early age at maturity and first reproduction, short lifespan) and with life stages that exhibit either exclusive habitat-requirements or aggregating behaviour. Relative rankings depended on weightings attributed to criteria, particularly in the second tier. Findings should be broadly applicable for predicting how marine species in other systems will respond to area-based management, and could be used to leverage public support for marine conservation.

## 32. Ecosystem Conservation

### 1. ASSESSING THE MUSSEL-HOST RELATIONSHIP FOR RECRUITMENT POTENTIAL AND CONSERVATION

*\*Todd Douglas Levine, Miami University; \*Brian K. Lang, New Mexico Department of Game and Fish; \*David J. Berg, Department of Zoology, Miami University*

A critical vulnerability in the life cycle of freshwater mussels is a period of obligate, larval parasitism on fish. Descriptions of mussel-host relationships are often based on laboratory studies that develop a list of host fishes physiologically capable of bearing glochidia (larval mussels) to metamorphosis. Effective conservation of unionid mussels relies on understanding this relationship. To better understand this relationship, we studied host infestation by an endangered mussel, *Popenaias popeii*, in the Black River, Eddy County, NM. Field sampling revealed substantially fewer fish species (5) infested than predicted by a previous laboratory study (25) where fishes were exposed to glochidia. Bottom-dwelling suckers (Catastomidae) exhibited the highest infestation rate (80% for *Carpionodes carpio*) and the highest number of infected individuals; substantially fewer individuals (proportionally and total) were infested in other families. Suckers accounted for 64% of all infested fishes and bore the greatest number of glochidia (up to 1330). This suggests that not all hosts identified in the laboratory were ecologically relevant. We suggest that field studies of prevalence and intensity, along with lab studies of glochidial transformation success, be used to evaluate the relative contributions of fish hosts to mussel recruitment. Such studies will identify host species that are essential for maintaining healthy populations of freshwater mussels.

### 2. ASSESSMENT OF PRIORITY SITES FOR FRESHWATER ENVIRONMENTS: A COMPARISON OF METHODS FOR

## CONSERVATION PLANNING

*\*Melanie Kolb, CONABIO; \*Verónica Aguilar, CONABIO; \*Tania Urquiza, CONABIO; \*Jesús Alarcón, CONABIO; \*Diana Hernández, CONABIO; \*Patricia Koleff, CONABIO*

In order to accomplish the CBD commitments and to contribute to the design of reserve networks, Mexico decided to generate an extensive gap analysis for different environments using updated data. The overall aim of this work was to explore the feasibility of assessing gaps in freshwater ecosystems based on hydrological regions. We organized an expert workshop to review and assess available environmental datasets and to establish criteria for different biodiversity elements and pressure factors. Criteria defined in this workshop were used to test the effects of applying two different prioritizing software packages for the Panuco watershed. The first was MARXAN which uses a simulated annealing algorithm, combining conservation targets and pressure factors in a iterative cost equation. The second was ResNet, based on a rarity-complementarity iterative selection; Results show that the two conservation scenarios are best used in combination. ResNet is able to cover all conservation targets in relatively clustered areas, meanwhile MARXAN includes a large number of parameters which allows to adjust local requirements for conservation planning. Accounting for regional specific relevant conservation priority criteria like pressure factors is extremely valuable in a country like Mexico with high land use conversion rates and fast socio-economic dynamics.

### 3. CLUSTERING HOUSING DEVELOPMENT MINIMIZES IMPACTS ON FOREST BREEDING BIRDS

*\*Sara Anne Gagné, Carleton University; \*Lenore Fahrig, Carleton University*

For a given human population and total area of forest, are the impacts to biodiversity minimized if we build at high density over a small portion of the total area, or at low density throughout the area? We address this question by comparing breeding bird abundances in development scenarios representing a gradient of increasing housing density and decreasing sprawl area. We counted breeding birds at 25 sites near Ottawa, Ontario, Canada. Sites were classified into seven housing density categories: forested, exurban, suburban, urban and three categories of forested sites adjacent to developments of these densities. We then used these data to predict and compare species, guild, and total abundances among dispersed, semi-clustered and clustered development scenarios, assuming a given initial area of forest. Forest birds, and in particular forest interior species, and long-distance migrants were significantly more abundant in the clustered scenario. In contrast, the dispersed scenario resulted in a significantly altered bird community with more forest edge and open woodland species, and more nest parasites and nest predators. These results suggest that clustering development (building at high density (>1000 dwellings/km<sup>2</sup>) over a small area) minimises impacts on forest birds because, for a given initial area of forest, a larger amount of continuous forest remains after development, resulting in more interior forest habitat, fewer edge species, nest predators and nest parasites.

### 4. COMPARATIVE ANALYSIS OF RIVER CONSERVATION IN THE UNITED STATES AND SOUTH AFRICA

*\*Brenda Rashleigh, U.S. Environmental Protection Agency; \*Dirk Roux, CSIR; \*Peter Ashton, CSIR; \*Nikki Brajevich, US Embassy Pretoria*

Both the United States and South Africa are recognized for their strong and innovative approaches to the conservation of river ecosystems. These national programs possess similar driving legislation and ecoregional classification schemes supported by comprehensive monitoring programs. Strengths of the South African system include management based on watershed boundaries, specific conservation targets, and a strong consideration of the role of instream flows and connectivity. Comparative strengths of the U.S. program include the involvement of nonprofit and volunteer organizations, the use of modeling and causal analysis to support the setting of conservation objectives, and extensive efforts directed at stream restoration and species reintroduction. These complementary strengths provide opportunities for cooperative improvement of both systems. As the future threats of climate change, invasive species, and water pollution exert increasingly adverse effects on aquatic resources in both countries, it will be necessary for programs to share ideas and learn from each other's experiences, so that national freshwater conservation objectives are both achievable and sustainable. This abstract has been reviewed in accordance with the U.S. EPA's peer and administrative review policies and approved for publication.

### 5. DEVELOPING ADAPTABLE INDIGENOUS STRATEGIES TO CONTROL ALIEN NYPA FRUTICANS TOWARDS CONSERVATION AND LIVELIHOOD ENHANCEMENT IN AFRICAN MANGROVE FORESTS

*\*Edem Archibong Eniang, Mekelle University, Ethiopia; \*Opeyemi Olajide, University of Ibadan; \*Richard Peters King, University of Uyo, Nigeria*

This article presents results of Mangrove Forest restoration project within Atlantic coast of West-Africa, which has been invaded by *Nypa*-palms, leading to concerns and efforts towards conservation. *Nypa* was introduced into study area to tackle coastal erosion in 1904 but became invasive following increased habitat disturbance, agriculture and transportation. The project identified, studied and developed indigenous strategies for control and utilization of *Nypa* towards livelihoods enhancement and forests restoration. Motorboats, Cameras, Maps and other equipment were employed for ground-trotting and broad-sweep of Atlantic coasts. Purposive surveys of invaded coastal communities was conducted between 2004-2006, with aid of Satellite images interpreted using ArcGIS/ERDAS software to map spread, indigenous control and utilization. Results show that invasion has changed the vegetation over large areas leading to disappearance of mangrove species within land-water interface. *Nypa* competes with native species for survival, thereby affecting livelihoods, and also displace native mangrove forests. Beach cleaning, seeds-collection, conversion, use in indigenous crafts and fuels are some indigenous strategies for control. Increased synergy among conservationists, research, monitoring and mangrove replanting are critical steps for ecosystem restoration. Governments and other stakeholders should integrate communities and indigenous knowledge, into ecosystems restoration strategies.

### 6. EXAMINING STAKEHOLDER PRIORITIES FOR RESTORATION OF LONGLEAF PINE ON THE NORTH CAROLINA COASTAL PLAIN

*\*Jennifer Costanza, University of North Carolina-Chapel Hill*

Longleaf pine (*Pinus palustris*) savannas and forests of the US Southeast comprise one of the most endangered ecosystems in the country, largely because they have experienced altered fire

regimes since European settlement. Prescribed burning is a common strategy that is used to conserve the plant and wildlife species that depend on longleaf. To maximize ecological effectiveness, burning should be done both to maintain remnant longleaf sites, and to restore degraded sites. However, prescribed burning priorities may be based on agency policies and risk-averse attitudes that may not maximize ecological benefit for longleaf pine ecosystems. Therefore, I investigated priorities for prescribed burning of longleaf pine in the Onslow Bight landscape, eastern North Carolina. I surveyed stakeholders from various agencies in the Onslow Bight to determine which characteristics make sites priorities for burning, as well as precisely why those characteristics are important. My results indicate that sites that have been burned recently and contain red-cockaded woodpeckers (*Picoides borealis*) are prioritized over other sites. Thus, sites that are in good condition are the focus of burning in the Onslow Bight, and restoration of degraded sites may not be accomplished often in practice. This study suggests that a key approach for conservation of the longleaf pine ecosystem in the Southeast may be to remove barriers such as agency policies that discourage burning in long-unburned sites.

### 7. FIRE, GRAZING, AND THE DECLINE OF PONDEROSA PINE FORESTS: FEDERAL AGENCY FAILURE TO RECOGNIZE AND ADDRESS THE CONNECTION

*\*Kirsten Eva Stade, Center for Science in the Public Interest*

The ponderosa pine (*Pinus ponderosa*) forest type occupies nearly 34 million acres across the Western United States, and is believed to be in significantly degraded condition across much of this extent. Historically maintained by low-intensity, high-frequency fire as open-canopied forests of diverse age structure, these ecosystems today form dense even-aged thickets prone to catastrophic fire. The United States Forest Service and Bureau of Land Management, responsible for managing nearly 19 million acres of these forests, continue the fire suppression and livestock grazing activities that have fostered the degradation of these ecosystems, despite a professed commitment to allow fire to regain its natural role in fire-adapted landscapes. We used Geographic Information Systems to determine the extent of ponderosa pine ecosystems across the western United States, and the amount of this ecosystem type that is actively grazed by domestic livestock on Forest Service and Bureau of Land Management grazing allotments. Our results show that over 80 percent of the ponderosa pine forests on public lands managed by these agencies are subject to grazing by domestic livestock, creating the high likelihood of conflicts with agency stated intentions of managing these forests to restore natural fire regimes.

### 8. HIGH CORRELATION BETWEEN GENETIC AND COMMUNITY SIMILARITIES IN ENDEMIC-RICH SPRINGS OF THE NORTHERN CHIHUAHUAN DESERT

*\*Makiri Sei, Department of Zoology, Miami University; \*David J. Berg, Department of Zoology, Miami University; \*Brian K. Lang, New Mexico Department of Game and Fish*

Species diversity and genetic diversity can show strong correlation due to a variety of reasons (parallel processes affecting both communities and populations, genotypes of a dominant species affecting the community composition, a species assemblage selecting for a particular genotype). We examined correlations between species and genetic diversity in four endemic-rich, isolated spring systems in the Northern

Chihuahuan Desert by comparing species richness of fish and benthic macroinvertebrate communities with allelic richness within populations of amphipods (*Gammarus* spp.) and mosquitofish (*Gambusia pecosensis*). We also compared pairwise community similarities and pairwise genetic identities of the populations among the same groups, and tested for correlations among diversity, similarity, environmental variables and spatial distances. We found strong correlations between invertebrate species richness and mosquitofish allelic richness. We found even stronger correlations among amphipod and mosquitofish genetic identities and fish and invertebrate community similarities; they were best explained by geographic distance rather than abiotic environmental factors. Our results suggest that drift and migration are the mechanisms that best explain our observations, and although alpha-diversity among genes and species may not be strongly correlated, the pattern of complementarity among those groups seems to be concordant at the regional level.

### 9. INDIGENOUS BELIEFS IN THE MANAGEMENT OF FRESHWATER LAKES, NIGER DELTA, NIGERIA

*\*EnoAbasi Deborah Anwana, Academia*

The relationship between communities of the Niger Delta and the wetland was assessed with the aim of characterizing the importance of this linkage to the conservation of biodiversity. Comparative multidisciplinary studies of four lakes, one sacred and one non-sacred, in each of two towns, Biseni and Osiana in Bayelsa state, were conducted. A combination of ecological field surveys, focus group discussions and structured questionnaires was used. Focus group interviews and visual estimates showed that reptiles such as the nationally threatened *Osteolaemus tetraspis* are more numerous in the sacred lakes than in open access lakes and rivers. Fish sampling was done in conjunction with local fishermen, using the available mesh sizes used traditionally of 35, 115 and 130mm. Simpson's diversity index showed that the sacred lake Adigbe had the highest diversity of fish species (0.61), followed by the sacred lake Efi (0.53) while the least diverse was the non-sacred Lake Obaa (0.29). Results obtained suggest that the open and closed fishing seasons in the sacred lakes contribute to the relative abundance of fish species. These culturally protected freshwater lakes open a window to tackling current rate of biodiversity loss as social norms act as a viable vehicle for involvement of indigenous people in the management of threatened biodiversity and watershed areas.

### 10. MACROTERMES MOUNDS AS SITE FOR TREE REGENERATION IN A SAVANNAH WOODLAND IN BURKINA FASO, WEST AFRICA

*\*Saran Ms Traoré, UFR/SVT, Université de ouagadougou; \*Mulualem Dr Tigabu, Forest Genetic and Plant Physiology, UPSC, SLU; \*Michel Dr Lepage, IRD, Ouagadougou*

This work was done in Sudanian zone, for comparing species richness and regeneration level of the ligneous component as related to the heterogeneity created by Macrotermes mounds. The rainy season is unimodal from May to October with a mean annual rainfall of 843mm. Soils are Lixisols with deep silty-clay. The vegetation is a tree and bush savannah with a grass layer dominated by the annual grasses *Andropogon pseudapricus* and *Pennisetum pedicellatum* and the perennial grass *A. gayanus*. Mimosaceae and Cesalpiniaceae dominate the woody vegetation with mean tree density of 542ha<sup>-1</sup>. Termitaria are a conspicuous feature in this woodland and play a key role in tree diversity: 54 species on mounds and 44

outside. Tree seedlings (less than 150cm) were recorded, identified by species from July to August 2003 in 8 subplots (50m x 50m) with annual prescribed fire applied for a decade and in 8 subplots with fire protection for the same period. Average density of species, 3 species/100m<sup>2</sup> and seedlings 362/100m<sup>2</sup>, were higher on mounds than the surrounding, 1 species/100m<sup>2</sup> and 72/100m<sup>2</sup> respectively. Seedling species, *Boscia senegalensis*, *Diospyros mespiliformis*, *Maerua angolensis* and *Tamarindus indica* had higher on mounds than surrounding and *Anogeissus leiocarpus* and *Tamarindus indica* successfully regenerate on the mounds. Therefore we concluded that *Macrotermes* mounds are important sites for ligneous regeneration and constitute biodiversity patches in this savannah woodland

#### 11. SPAWNING SEASON OF SNAPPERS (LUTJANIDAE) AND GROUPERS (SERRANIDAE) IN THE ABROLHOS BANK, EASTERN BRAZIL.

*\*Matheus Oliveira Freitas, Universidade Estadual de Santa Cruz; \*Rodrigo Leão Moura, Conservação Internacional do Brasil; \*Carolina Viviana Minte-Vera, Universidade Estadual de Maringá; \*Ronaldo Bastos Francini-Filho, Universidade Federal da Bahia - UFBA. Grupo de Pesquisas em Recifes de Corais e Mudanças Globais*

Groupers (serranidae) and snappers (lutjanidae) are important members of the reef community, also representing an important source of food for coastal populations in tropical countries. The Abrolhos Bank, Eastern Brazil, encompasses the largest and richest coral reefs in the South Atlantic Ocean. In the present study we characterized the reproductive biology of three serranidae (*Epinephelus morio*, *Mycteroperca bonaci* and *Cephalopholis fulva*) and five lutjanidae (*Lutjanus synagris*, *L. jocu*, *L. analis*, *Ocyurus chrysurus* and *Rhomboplites aurorubens*) from the Abrolhos region from May 2005 to October 2007. A total of 3802 gonads were collected and analyzed macroscopically. Temporal variability in spawning activity was evaluated using the Gonadosomatic Index (GSI). Peak of reproductive activity for the three serranidae species occurred between August and September. *R. aurorubens* reproduced between February and March. All other lutjanidae species showed two peaks of reproductive activity, one more intense between September and October, and another between February and March. All the abovementioned patterns were consistent among the two consecutive years. These results will help in locating the spawning aggregations sites of serranids and lutjanids within the Abrolhos Bank and subsidize important management measures, such as the restriction of fishing effort during peaks of spawning activity and the creation of marine protected areas on confirmed spawning aggregations sites.

#### 12. THE EFFECT OF LAND-USE ON MIXED-SPECIES FLOCKS OF BIRDS IN SRI LANKA.

*\*Eben Bowditch Goodale, Field Ornithology Group of Sri Lanka; \*Sarath W. Kotagama, Field Ornithology Group of Sri Lanka; \*Emily D. Silverman, U.S. Fish & Wildlife Service*

How do mixed-species bird flocks respond to disturbance? Are there nuclear species that play particularly important roles in these flocks and can be targeted in management plans? We sampled flocks along a land-use gradient at three locations in Sri Lanka: low (300-600 m), middle (900-1200 m) and high (1700-2000 m) elevations. At each location, we laid out eight transects of 2 km each: three transects in relatively undisturbed forest, three transects in 'buffer' habitat of degraded forest or

tree plantations, and two transects in areas of intensive agriculture. The transects were mapped to indicate specific land-uses. We recorded every bird encountered and whether it was inside or outside of a flock, as well as flock composition, size and density. An analysis of one year's data, which entailed visiting the 24 transects each on average 6.7 times and recording 194 flocks, demonstrated that flock density and size both decline from relatively undisturbed forest, to buffer habitat, to agriculture. Analysis of specific land-use types showed the importance of small forest fragments that remain in buffer areas. We then assessed several methods of measuring which species are nuclear to flocks, including traditional Chi-Square approaches and a novel regression method that relates species' propensity to flock (percentage of individuals in flocks) to the percentage of flocks in which a potential nuclear species is present.

#### 13. THE EFFECT OF PROVISIONING ON SEED DISPERSAL BY SYKES MONKEYS AT A KENYAN DRY COASTAL FOREST

*\*LUCY KIRIGO MUREU, Moi >University, Kenya*

We conducted a study to investigate the role of sykes monkeys *Cercopithecus mitis* in seed dispersal, seed predation and regeneration of a coastal dry forest at Gede near Malindi, Kenya. We examined the effect of provisioning by tourists and crop raiding on seed dispersal by sykes monkeys. We also investigated the role of sykes in dispersing seeds of invasive species. We studied two sympatric sykes groups, one provisioned by tourists and used to crop raiding and a free ranging one. The provisioned group spent more time resting, moving and less time feeding. Daily ranges also differed between the two groups with the provisioned group having a significantly greater daily range than the non-provisioned group. Although invasive species were more likely to be dispersed than native species, the effect of seasonality was confounding. The dispersal ability of sykes for each plant species depended on seed handling and treatment. Provisioning affects seed dispersal through reduced feeding time and is also associated with spontaneous clump defecation prior to a provisioning bout in unsuitable germination sites.

#### 14. TROPICAL MONTANE CLOUD FOREST (TMCF) DISTRIBUTION IN MEXICO: PAST AND FUTURE

*\*Rocio del Carmen Ponce-Reyes, University of Queensland; \*Bob Pressey, James Cook University*

Tropical montane cloud forests (TMCFs) are among the least studied vegetation types in the world. They are globally significant because of their biological richness and endemism, limited natural extent, and continuing threats to their existence. Natural isolation of TMCF fragments has oscillated with climate over millions of years, driving the evolution of many TMCF species. One objective of this project was to investigate natural fragmentation as a driver of evolution. A second objective was to predict likely responses of TMCF to future climate change as a basis for conservation planning. We modeled the distribution of Mexican TMCF in the Sierra Juarez in Oaxaca since the last glacial maximum (21,000 BP) to derive indices of isolation of fragments (e.g. frequency of separation, proportion of time separated). In a later part of the project, we will relate these indices of isolation to genetic distances between populations of microendemic species with low vagility. We also modeled the potential future distribution and connectivity of TMCF in the Sierra Juarez for different climate change scenarios and different times: 2020, 2050 and 2080. Our future projections identified climatic refugia for TMCF endemic species that represent priorities for conservation action. Our predictions also provide insights into the future

isolation of TMCF fragments and its possible influence on continuing genetic diversification of microendemics.

### 33. Ecosystems

#### 1. INTRAGUILD INTERACTIONS BETWEEN SUBSIDIZED PREDATORS AND NATIVE CARNIVORES: CONSERVATION IMPLICATIONS FOR ENDANGERED SPECIES OUTSIDE PROTECTED AREAS

\**Abi Tamim Vanak, University of Missouri;*

\**Matthew E Gompper, University of Missouri*

Human subsidized carnivores such as the domestic dog can have deleterious effects on wildlife through predation, disease spill-over, or intra-guild competition. We present results from the first comprehensive study of interactions between free-ranging dogs and native Indian foxes. Radio-telemetry data from 20 dogs and 35 foxes in a wildlife reserve in India over one year reveal low overlap in core home range areas between the two species. Dogs were found mainly in agricultural land, while foxes were in the surrounding grasslands. However, the interface between agriculture and grassland had the highest densities of rodents, a main component of fox but not dog diet. We predict that foxes are excluded from access to this high resource area due to interference competition with dogs. We tested this experimentally by comparing the behavioral responses of foxes when exposed to dog cues and controls at feeding stations. Foxes significantly reduced their food consumption and showed elevated vigilance behaviors when exposed to dog cues compared to neutral cues. These data indicate that even when subsidized predators such as dogs do not compete directly with wild carnivores for food, they can still influence the behavior of smaller predators by establishing a landscape of fear. The conservation implications deserve increased attention since dog populations in much of the developing world are large, un-owned and often free-ranging.

#### 2. MORTALITY OF VERTEBRATES ON A ROAD CROSSING THE BIEBRZA VALLEY (NE POLAND)

\**Jakub Gryz, Warsaw University of Life Sciences;*

\**Dagny Natalia Krauze, Warsaw University of Life Sciences*

Mortality of vertebrates was monitored on a local road situated within Biebrza National Park. The park offers protection to one of the largest and best-preserved marshes and peatlands in Europe, protected under the RAMSAR Convention and included within the NATURA 2000 network. We selected the road that cuts across the central, narrowest part of the Biebrza Valley (one of Poland's main ecological corridors) and ran our studies from August 2004 to July 2006, collecting data on foot on three to seven days each month. On the basis of distance from the river and surrounding habitats we divided the road (total length - 2510m) into three stretches. Altogether, the study period as a whole yielded 1892 separate remains (90.7% amphibians, 4.2% mammals, 3.1% birds, 2.0% reptiles) representing at least 47 species. Overall mortality was shaped by the number of road-kills of anurans and closer approaches by the road to the river were associated with greater humidity of the surrounding area, and hence a higher mortality. Two-peaked mortality was observable for anurans (spring and autumn) and single-peaked mortality for urodeles (autumn) which connects clearly with their migration patterns. All in all, our results showed that in case of amphibians conservation actions should not be focused on roads of high traffic volume, but rather on those surrounded by habitats of best quality for

these animals.

#### 3. NATIVE PLANT SPECIES DISTRIBUTION IN A HIGHLY-INVADED, NON-EQUILIBRIUM CALIFORNIA GRASSLAND

\**Sasha Gennet, University of California, Berkeley; The Nature Conservancy;* \**Guillermo Gea-Izquierdo, Departamento Sistemas y Recursos Forestales, CIFOR-INIA;* \**James W. Bartolome, University of California, Berkeley;* \**Michele Hammond, University of California, Berkeley;* \**Peter Hopkinson, University of California, Berkeley*

The Coast Range grasslands of Central California are among the most highly invaded terrestrial ecosystems, with >90% cover introduced Mediterranean annual plant species. Understanding the driving factors controlling distribution of remaining native species will aid in their conservation and restoration. We investigated the effects of biotic and abiotic variables, including livestock grazing, soil nutrients, micro-topography, and weather patterns on plant community composition and native species distribution, at nine regional parks during the period 2003-2006, using ordination, classification, and Generalized Models. Results show that grazing was a weak predictor of native species composition at the among-site level, and rainfall strongly influenced composition. In addition, native species richness was highest in soils with low available nitrogen, and *Nassella pulchra* (Purple Needlegrass) was strongly negatively correlated with phosphorus in sandy soils. These findings confirm expected results for a non-equilibrium, semi-arid ecosystem: abiotic factors appear to be more influential than biotic. In addition, zones of extremely low-fertility soils appear to provide functional refugia for native species from complete dominance by introduced annuals.

#### 4. PLATEAU PIKA (LAGOMORPHA: OCHOTONA CURZONIAE) DISTURBANCE ALTERS PLANT SPECIES DIVERSITY AND COMPOSITION IN PASTURELAND ON THE TIBETAN PLATEAU

\**Brigitte W. Hogan, Arizona State University;*

\**Andrew Smith, Arizona State University;* \**Yanming Zhang, Northwest Plateau Institute of Biology*

In conflicts between livestock grazing and biodiversity maintenance, native species typically lose out. Such is the case with the plateau pika (Lagomorpha: Ochotona curzoniae), a small mammal endemic to the high alpine grasslands of the Tibetan Plateau. In spite of mounting evidence pointing to their keystone status, plateau pikas are extensively poisoned throughout their range. The underlying assumption of this strategy is that eliminating pikas will improve forage quality for domestic yak and sheep. However, burrowing and foraging by pikas may also positively impact ecosystem health by stimulating plant growth, increasing species diversity, and providing habitat for rare fauna and flora. This study examines the ecological impact of pikas and their burrows on plant communities in eastern Qinghai Province, People's Republic of China. Results indicate that pika disturbance increases plant species diversity at the landscape level, and alters community composition across multiple spatial scales. These findings highlight the need for a more thorough analysis of pika impacts (both positive and negative) on rangeland resources before resorting to pest control measures.

#### 5. STRATEGIC PLANNING FOR

## CONSERVATION OF WETLANDS IN POBITORA WILDLIFE SANCTUARY -THE LAND OF HIGHEST DENSITY OF ONE HORNED RHINOCEROS IN THE WORLD.

*\*Arup Kumar Hazarika, Cotton College*

Pobitora wildlife Sanctuary, Assam (India), with its unique wetland eco-system, serves various important ecological roles. The wetlands are prime habitat for most endangered species the Rhinoceros (*Rhinoceros unicornis*). These wetlands also act as the roosting and nesting ground for migratory and indigenous water birds. However, this unique wetland eco-system are confronted with myriad of problems such as shrinkage in size and depth of water bodies due to heavy siltation and choking by water hyacinths. Research was undertaken through study, survey and mapping on various aspects of wetland eco-system such as its dynamics, siltation rate, effect on breeding of different faunal species due to change in wetland system, effect of water hyacinth etc. Study thus provided information on localized distribution pattern of Rhinoceros; information on biological composition of the wetlands and on threat factors like pollution in wetlands, which may in turn hamper the distribution of Rhinoceros. So, De-siltation work is of immediate necessity. Specific numbers of wetlands which are silted are to be identified and physical removal of silts from such degraded wetlands to be taken up. The accumulation of water hyacinth should be cleared. An effort may also be made to create new wetland areas.

## 6. THE IMPORTANCE OF TEMPORARY PONDS FOR THE CONSERVATION OF INSECTIVOROUS BATS IN DESERT ENVIRONMENTS

*\*Orly Nechama Razgour, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev; \*Carmi Korine, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev; \*David Saltz, Jacob Blaustein Institutes for Desert Research, Ben-Gurion University of the Negev*

Ponds are major contributors to regional biodiversity, yet temporary ponds are often neglected in conservation policy. Studies carried out in temperate environments have shown that despite their importance, temporary ponds tend to support lower levels of species richness than permanent ponds. We hypothesize that in desert environments, where water is a scarce resource, pond size will be more important than pond permanency in determining species richness. Using a combination of acoustic monitoring, video recording and an experimental approach, we studied the effect of pond permanency and size on the species richness and activity of insectivorous bats in the Negev Desert. Bat assemblage composition varied significantly between the different pond size categories. Multiple regression analyses showed that both bat species richness and activity levels significantly increased with pond size, but were not affected by pond permanency. Furthermore, a comparison of permanent and temporary ponds of similar sizes showed that unlike pond size, permanency did not affect bat species richness or activity. Experimental manipulation of pond size led to a reduction in bat species richness and changed the bat assemblage composition. Our results suggest that in desert environments, temporary ponds, in particular large ponds, support high levels of species richness, and therefore should be included in management plans to enhance bat populations and maximize bat diversity.

## 7. WINTERING HABITAT SELECTION OF SIBERIAN CRANES AT TWO SPATIAL SCALES

## WITHIN POYANG LAKE NATIONAL NATURE RESERVE

*\*James Burnham, International Crane Foundation*

This paper documents the ecological links driving habitat selection patterns at two spatial scales by wintering Siberian Cranes (*Grus leucogeranus*) and associated waterbirds in China's Poyang Lake National Nature Reserve (PLNR). PLNR occupies approximately 23,000 hectares of Poyang Lake and provides critical habitat for a variety of wintering migratory waterbirds, as well as a year-round human population of nearly 10 million. Changes in the last half-century in land and water use have converted over half of the lake basin from shallow, open-water wetlands to agriculture use. However, little data exist to document the extent, or magnitude, of these alterations. Since 1999, an ongoing monitoring program is in place within four study lakes at the reserve and looks at links between seasonal fluctuations of water levels and clarity, productivity and distribution of *Vallisneria spiralis* (a key food plant of many water birds), and the utilization of areas by feeding guilds of waterbirds. Additional monitoring established in two of the study lakes indicate differences in *V. spiralis* productivity and crane utilization patterns; both between the study lakes and within individual study lakes. While *V. spiralis* is a major driver of crane utilization, 76.6% of all sightings occur when water levels are between 14.5 and 15.5 meters above sea level, indicating habitat selection of Siberian Cranes is more complex than previously proposed.

## 34. Environmental Economics

### 1. A POST MORTEM ON THE GOVERNMENT OF CANADA'S DECISION NOT TO LIST PORBEAGLE SHARK AS AN ENDANGERED SPECIES UNDER THE SPECIES AT RISK ACT (SARA)

*\*Murray A. Rudd, Sir Wilfred Grenfell College*

In Atlantic Canadian waters, the abundance of porbeagle shark is estimated to be 12-15% of its pre-1961 unfished level. Despite the steep decline in abundance and ongoing directed fishing, the Government of Canada in 2006 recommended not listing porbeagle shark as an endangered species under SARA. The decision was justified based on the economic costs of listing to industry and communities, and on the loss of information for government scientists. In this paper, I highlight a number of key shortcomings in these arguments: (1) lenient definitions of population 'recovery'; (2) inadequate consideration of alternatives to fishery dependent data collection; (3) an over-emphasis on the direct economic costs of listing; and (4) an under-emphasis on the external costs imposed on Canadian society arising from ongoing exploitation of porbeagle shark. Arguments regarding the economic impacts of listing to the commercial sector were particularly weak as only two fishers in Atlantic Canada derived more than 25% of their gross fishing revenue from porbeagle shark landings. The porbeagle shark case provides a useful illustration of how quasi-economic arguments can be used to oppose the implementation of policies consistent with a precautionary approach to fisheries management. A balanced accounting of costs and benefits in Canada suggests that listing porbeagle shark as endangered under SARA would impose minimal costs on fishers and fishing communities, and may benefit society as a whole.

### 2. APPLIED ENVIRONMENTAL ETHICS (CRITICAL AND MISSING IN ACTION): A BLUEPRINT

*\*Kai M. A. Chan, University of British Columbia*

Environmental research has blossomed in recent decades with the proliferation of natural and social science devoid of connection to humanities, especially ethics. These researchers must assume that society can make appropriate use of this research through policymaking that is a combination of power politics and deliberative democracy, or they must not care about the application of their research or environmental decision-making. Such a stance is either ethical relativism, unconcern, or irresponsibility: either society cannot wrong future generations and non-human organisms, we do not care if it can, or we shirk responsibility if it does. In this essay/talk, I argue that (i) we have strong responsibilities to those who cannot speak for themselves (future generations and non-human organisms), (ii) we as a society will fail these responsibilities if we do not employ an applied environmental ethic in our decision-making, and (iii) we as individuals have a responsibility to develop this applied environmental ethic, which does not currently exist. This applied environmental ethic must both (1) motivate adherence to its prescriptions and (2) facilitate decision-making that effectively weighs diverse moral concerns. These two requirements suggest a suite of desired characteristics for a successful applied environmental ethic, upon which depends the future of biodiversity and the well-being of future generations.

### 3. IDENTIFYING HIGH-PAYOFF AREAS FOR RESTORATION INVESTMENTS: ASSESSING SPATIALLY HETEROGENEOUS COSTS AND BENEFITS OF ECOSYSTEM SERVICES

*\*Lisa A. Wainger, University of Maryland Ctr.*

*Environmental Science*

With limited resources to spend on restoration, it is important to ensure that limited funds are used to generate the highest level of social benefits and that such benefits are effectively communicated to decision makers. My group is developing decision support tools that offer a means to balance ecological and economic goals for ecosystems. To compare benefits, risks and costs associated with restoring sites, we use an approach that stresses the importance of location and the heterogeneity of effects due to location. We examine site characteristics and characteristics of the surrounding landscape that establish the cost-effectiveness of restoration based on 1) the relative value of ecosystem services at a particular location 2) the likelihood of management success and 3) costs of restoration. These data are combined to rate cost-effectiveness of options which can be compared within an optimization model to demonstrate where net benefits are maximized for a given level of spending. We apply the framework to an invasives case study to demonstrate how an approach aimed at maximizing multiple ecosystem services simultaneously may result in different restoration choices compared to those made when selecting superlative sites for a single ecosystem service.

### 4. INCORPORATING ECONOMIC FACTORS INTO CONSERVATION PLANNING: WHAT INDICATORS SHOULD WE BE USING?

*\*Vanessa M Adams, James Cook University; \*Bob Pressey, James Cook University*

With increasing demands on natural systems, realistic conservation plans must consider budgetary constraints and the dependence of economic growth on natural resources. Incorporating economic factors into conservation planning requires acceptable data and indicators, but consistent methods for developing these are lacking. We reviewed data commonly available to the public to identify proxies for economic goals and assessed these indicators with two methods. First, we

measured spatial correlations between indicators and areas selected for extractive uses. Possible measures of land value and desirability might be the distribution and density of resources as well as the accessibility of land, for example presence of roads. Correlations in these types of data would provide insight into what available data are appropriate for quantifying economic goals. Second, we mapped irreplacability of economic benefits, recognizing, for example, that measuring opportunity costs for extractive uses must consider possible alternative areas. Reserving an area for biodiversity values might shift, but not necessarily reduce, extractive uses. We used several economic indicators to map irreplacability for both conservation purposes and economic development. These methods can be widely used when considering economic factors in conservation planning. They illustrate both the potential conflicts and potential conservation opportunities that arise when considering both economic and biological goals.

### 5. PALM BIODIESEL PRODUCTION IN THE PERUVIAN AMAZON: ENERGY BALANCE AND CARBON EMISSIONS

*\*Marco Rojas, University of Maryland; \*Maria-Elena Gutierrez, University of Maryland*

Biofuels are booming in Latin America and Peru is no exception. A biofuel law was passed that mandates the mix of 5% of biodiesel in diesel fuel (B5) in Peru by 2010. Different sectors are looking for ways to invest in options such as ethanol and biodiesel. It has been proposed that restoring old oil palm (*Elaeis guineensis*) farms and planting degraded lands with oil palm will grant sustainable fuels for Peru (while reducing CO<sub>2</sub> emissions from fossil fuels), cut reliance on foreign oil, create options to illegal crops, and yield benefits from a carbon market. We calculated the Energy Returned On Energy Invested (EROEI) of producing palm biodiesel, and carbon emission reduction with the B5 law in degraded areas in the Peruvian Amazon. We assumed that all diverse operations are located in Tocache, Peru. We found a net energy ratio of 6.5:1 and an 11 % drop of CO<sub>2</sub> emission. If biodiesel were sent to Lima from Tocache, the new energy ratio would be 6.1:1, thus the energy balance would not be reduced greatly. However, the actual net energy value might be lower as we considered a fully mature plantation and excluded infrastructure and labor energy inputs. We also found that 40,509 hectares ought to be allocated in Peru to produce the biodiesel needed to comply with the B5 law by 2010. Also, this study discusses the assumptions and conditions involved in oil palm production and conversion to biodiesel, and gives recommendations concerning potential environmental and social impacts.

### 6. RECREATION BENEFITS OF NATURAL AREA CHARACTERISTICS AT THE CARIBBEAN NATIONAL FOREST

*\*Luis Santiago, University of Puerto Rico; \*John Loomis, Colorado State University*

When protecting existing natural areas used for recreation, it would be helpful for managers to know which natural features are most economically valuable to visitors. For example, it may be costly in terms of road or trail access to locate recreation areas where there are certain natural features (e.g., waterfalls), or there may be opportunity costs of foregone hydropower or logging to maintain free flowing streams or native old growth forests. We apply the Contingent Valuation Method using a survey of visitors to determine the value of a trip to free-flowing rivers on the Caribbean National Forest. Further, we statistically decompose the trip value into separate values for statistically significant natural features, and different

recreational activities occurring at different rivers. Sample data was obtained from 793 interviews conducted in 19 sites along the Mameyes and Espiritu Santo rivers during the summer months. The median net economic value of a visit to the two rivers without waterfalls or foot trails is \$96. Recreation at rivers with both waterfalls and foot trails has a median value of \$138 per trip. The presence of waterfalls accounts for \$23 and foot trails \$19 per trip. This information can be pertinent for managers in selecting where to locate recreation sites, as well as protecting sites from competing uses, such as locations with sufficient gradient for waterfalls, which are also coveted by others for hydropower development.

## 7. ESTIMATING COST OF ADAPTATION TO INUNDATION OF ISLANDS: CASE STUDY FROM INDIAN SUNDARBANS, A WORLD HERITAGE SITE

*\*RAJARSHI BANERJI, GLOBAL CHANGE PROGRAM, JADAVPUR UNIVERSITY, CALCUTTA, INDIA; \*INDRILA GUHA, Vidyasagar College For Women, Calcutta, INDIA*

Climate change induced sea level rise will exacerbate changes in landmass or vegetation pattern in coastal zone through inundation, storm surge, erosion etc. Vital infrastructure, settlements and facilities that support socio-economic well-being and livelihood of island and coastal communities will be threatened. To design adaptive actions, the costs and benefits from such actions must be known. This study makes such assessment based on past experiences of inundation. It focuses on the Sagar Block, a part of the Sundarban Biosphere Reserve, where two prominent islands have already disappeared. Other adjoining islands have also lost land. While this study does not probe into the reasons of inundation, the loss of property and consequent distress due to land loss is obvious and our objective is to trace and analyze the responses of the affected population. Past studies demonstrate that large number of people has migrated to Sagar Island. Reactive and proactive actions are analysed to assess private costs and social costs. The assessment and cost estimates are based on secondary information as well as field level information gathered through Focused Group Discussions and Rapid Rural Appraisal. Data on physical changes over time in the selected case study areas through conjunctive use of GIS technique and Survey of India topographic sheets have been used. The study uses the results to assess impact on poverty of predicted climate change induced risk of inundation

## 8. WOMEN AND WILDLIFE CONSERVATION - A CASE STUDY IN JALDAPARA WILDLIFE SANCTUARY, INDIA

*\*INDRILA GUHA, Vidyasagar College For Women, Calcutta, INDIA; \*RAJARSHI BANERJI, GLOBAL CHANGE PROGRAM, JADAVPUR UNIVERSITY, CALCUTTA, INDIA*

Biodiversity in general and species-diversity in particular is declining sharply across the world due to human interference. Although certain species are going extinct because of overexploitation, but the vast majority of them are at risk because of habitat destruction. Conservation of biodiversity depends on conservation of habitats. Areas of high biological value tend to get protected by acquiring some form of protected area status. In wildlife conservation, the real problem is the management of humans rather than handling of the animals. Human management calls for an overall socio-economic development of the residents of fringe and forest villages, in order to ensure successful implementation of wildlife

conservation policies. Based on primary data, the present study in a sanctuary of West Bengal, India that harbours Elephants, Indian Rhino, Tiger and Leopard, offers a gender-wise review of socio-economic structure of the people, their loss and benefit out of sanctuaries and their gender-wise concept of Willingness To Pay (WTP). An important finding of this study is the gender-wise attitude of the forest villagers towards conservation. The study details salient features of a recommended female oriented economic development programme as the female takes a pivotal position in the village-family and such development programmes are certain to have long lasting effect on the general attitude towards wildlife conservation.

## 35. Environmental Politics and Policy

### 1. BIODIVERSITY AND BIG BUSINESS: USING THE IUCN RED LIST TO GUIDE CORPORATE ENGAGEMENT STRATEGIES AT THE GLOBAL LEVEL

*\*Conrad Savy, Conservation International*

Large industries are increasingly seen as important strategic allies for global conservation. Many organizations are working in partnership with leading companies to design and implement improvements in business practices and supply chain management, and to mobilize corporate financial and technical support for protection of threatened species. Developing defensible transparent strategies for corporate engagement, as they relate to existing conservation priorities, is therefore key. As a first step, we analyzed the 2007 IUCN Red List for 15,871 birds and amphibians, subjects of the most recent and comprehensive global assessments. Industries were identified by corporate engagement experts using the IUCN Red List Threat Authority files (version. 2.1). Relative threat posed by large industries was investigated. 10% of birds and 34% of amphibians are threatened, wholly or in part, by large industry, representing 83% and 90%, respectively, of all threatened species in these taxa. Global industry priorities for engagement were identified based on relative number of species threatened in the IUCN categories. Using species range as a proxy, these were mapped to highlight regions and countries where corporate engagement opportunities should be pursued. Potential sources of error in the Red List assessment process are highlighted as well as the need for subsequent finer-scale national analyses to identify specific stakeholders for engagement within selected industries.

### 2. BOXING BIODIVERSITY: NATURAL AND DOMESTIC LIFE

*\*Eric Davies, University of Toronto; \*Mart R Gross, University of Toronto*

Conservation continues to be dominated by the concept of 'natural' biodiversity despite the fact that the earth's 'domestic' biodiversity is rapidly increasing. Here, it is argued that a formal expansion of the term biodiversity to include both natural and domestic life permits a broader opportunity for conservation. Using a Punnett square, we show how to define biodiversity in terms of its basic elements (structure and function) and its selection pressure (natural and domestic). Our model formalizes the inclusion of natural and domestic life into the definition of biodiversity, and exposes four unique types: (1) natural (e.g., wild fish in nature), (2) domestic (hatchery fish in farm), (3) domestic structure (hatchery fish in nature), and (4) domestic function (harvesting of wild fish). Explicitly recognizing these four types of biodiversity aids in formalizing conservation strategies aimed at naturalizing or domesticating biodiversity, and in achieving balance among natural and

domestic life.

### 3. CONFLICTS AND CONTROLS IN PROTECTED AREA MANAGEMENT: A STUDY OF THE CROSS RIVER NATIONAL PARK, NIGERIA

*\*Elizabeth Esekong Andrew-Essien, University of Calabar; \*Francis Ebuta Bisong, University of Calabar*

The paper assesses conflicts as an index to evaluating the conservation objectives of the Cross River National Park. It highlights the causes, nature, intensity and multi-dimensional attributes of conflicts between the Cross River National park and its host communities. Data employed were largely through the questionnaire administered to 500 randomly selected households in eight communities, as well as to the Management of the National Park. This elicited responses on conflict factors and available development options. A hypothesis delineating the multi dimensional character of conflicts is formulated for verification. Findings reveal that conflicts between the National Park and the Indigenous Communities are multi-faceted rather than singular in nature. They are largely due to lack of consultations between Park Management and Indigenous Communities. Such consultations, it is argued, could enlighten the members of the communities on the programmes of the Park as well as create discussion forums for the adoption of alternative means of livelihood for displaced community members. Intransigence and failure to adjust to developmental strides on the part of communities were also pointed out as being instrumental to conflicts. The study suggested that dialogue should be promoted between all stakeholders prior to initiating and at the point of implementing conservation programmes.

### 4. ECOLOGICAL DISCOURSE AND PARTICIPATORY SCIENCE: TOWARDS A STRONGER SOCIAL CONTRACT FOR CONSERVATION

*\*Thomas D Sisk, Northern Arizona University*

Over the past twenty years, conservation biologists have managed some impressive successes, but overall trends toward ecosystem degradation and biodiversity loss have been little altered. Meanwhile, environmental organizations and the concerned citizens that form them are viewed by many, including many public leaders, as representing "special interests", and their influence on public policy has declined. In part, this is due to the increasing complexity of scientific understanding, which places conservation scientists at the margins of mainstream public debate about environmental issues. The technical nature of scientific analysis has excluded much of the public from meaningful participation. Regaining the salience of conservation in pluralistic societies requires meaningful public discourse that is informed by ever-improving scientific understanding. Drawing on examples from integrated research and policy projects in arid North America, I will examine efforts to build broader, stronger coalitions for conservation via increased public participation in the conduct of science that supports an elevated level of public discourse. Scientists have a critical role to play in building a new social contract for conservation, but success depends on our ability to work effectively with a diverse array of engaged citizens.

### 5. LOGGING POLICY AND FOREST CONSERVATION IN PERU: A CRITIQUE

*\*Robin R Sears, The School for Field Studies; \*Miguel Pinedo-Vasquez, Columbia University*

The forestry law passed in Peru in 2001 was developed with substantial input from international conservation organizations. While the law incorporates the main principles of sustainable forest management, biodiversity conservation, and livelihood improvement, many inconsistencies remain between the intended regulatory mechanisms and actual practices and outcomes in the field. Through an analysis of the network of actors engaged in the logging sector in the Peruvian Amazon, coupled with interviews and site visits in key logging areas, we have come to understand why the bridges linking the science to policy and policy to practice have largely failed to effect forest conservation on the ground in Peru. Our main conclusion is that the environmental and social problems in the logging sector persist because current and previous laws were not constructed around existing local systems, norms and practices, which are rooted in complex social relationships. The local system appears to deal successfully with the challenges posed by multiple political, social and geographical characteristics of Amazonian society and environments, but until it is integrated as a concept and as practiced in the law, the conservation objectives of the new forestry law will not be realized.

### 6. MANAGEMENT OF FERAL HORSES AT THE NORTH CAROLINA NATIONAL ESTUARINE RESEARCH RESERVE

*\*John Taggart, University of North Carolina at Wilmington*

Feral horse (*Equus caballus* L.) populations are found on properties managed by governmental agencies in western states, the Missouri Ozarks and on several Atlantic coast barrier and estuarine islands. These animals are descendants of free-roaming horses introduced decades to centuries earlier. Public sentiment has influenced development of policies that have allowed the herds to remain. The North Carolina National Estuarine Research Reserve is a state program with federal support and oversight that manages four properties; two (Rachel Carson in Beaufort, NC and Currituck Banks near Corolla, NC) include feral horse populations. Current reserve policies include maintenance of these herds; however, impacts on salt marshes and other ecosystems represent a conflict with federal regulations. Among the Atlantic coast herds, conditions at the Rachel Carson site are least accommodating for the animals. With a combination of pertinent research results plus 20 years of site-specific management experience as a basis, I argue that feral horses of the Rachel Carson site should be removed for programmatic, ecological and humane reasons. To maintain estuarine reserve character, the Currituck Banks site should be protected from roaming horse impacts by creation of one or more delimited pastures outside reserve property.

### 7. MOVING BEYOND THE PRIVATE VS. PUBLIC DICHOTOMY: A MODEL FOR EFFECTIVE PROTECTED AREA MANAGEMENT

*\*Ignacio Jiménez, The Conservation Land Trust Argentina; \*Xavier Basurto, The Workshop in Political Theory and Policy Analysis, Indiana University. U.S.A*

We present a model for effective protected area management that can be implemented in both public and private reserves based on the analysis of three successful reserve management programs (RMP) implemented in three countries. Even though these reserves are sited in very different contexts, they share organizational attributes that help us build a model for effective protected area management that can be analyzed, discussed, and adapted to other protected areas. First, all three RMPs hold a clear and inspiring vision for their reserve that is known and

shared by most personnel. Second, there is long-term financial and administrative autonomy that promotes decision-making processes that is buffered from external political and financial interests. Third, there is a high organizational contextuality based on an on-the-ground decision-making structure that allows for rapid adaptation to local ecological, social and political conditions and changes. Fourth, we identified strong leadership coming from one or two individuals playing key roles as strategic visionaries, motivation agents, financial providers, political managers, diplomats, and communicators. Finally, the existence of professional prestige combined with external social and political support, promotes long-term survival from external attacks coming from other development and environmental groups or individuals. These five factors reinforce each other to establish a "virtuous circle" for effective reserve management.

## 8. THE GREAT CONSERVATION TRANSFORMATION? THE EFFECTS OF NEOLIBERALISM ON SOUTHERN AFRICAN TRANSFRONTIER CONSERVATION

*\*Bram Büscher, Vrije Universiteit Amsterdam*

Echoing Karl Polanyi's ideas about the "Great Transformation" of social relations during the 18th and 19th centuries due to capitalism, many social scientists currently argue that we are entering another 'great transformation'; this time due to the global influence of neoliberal ideology. Increasingly, it is becoming clear that neoliberal tendencies of competition, commercialisation and privatisation affect nearly all facets of contemporary life, including conservation of biodiversity. Exactly how these tendencies affect contemporary conservation science, policy and management, however, remain unclear. The paper tries to fill this gap. Based on recent extensive ethnographic field research in Southern Africa, the paper argues that conservation science, policy and management are increasingly subjected to three neoliberal pressures: those of consensus, anti-politics and marketing. The paper discusses and empirically illustrates these pressures and shows how conservation biologists and managers voluntarily subject themselves to them. The paper concludes by outlining the likely implications for biodiversity conservation in practice.

## 36. Environmental Politics and Policy (2)

### 1. ADAPTIVE GOVERNANCE IN TRANSBOUNDARY CONSERVATION: THE INFLUENCES OF SCALE, PATH DEPENDENCY AND INSTITUTIONAL EVOLUTION

*\*Michael L Schoon, Indiana University*

This study examines two transboundary protected areas in southern Africa, the Kgalagadi Transfrontier Park (KTP) in Botswana and South Africa and the Great Limpopo Transfrontier Park (GLTP) in Mozambique, South Africa, and Zimbabwe, in two ways. First, the author uses these complex social-ecological systems to better understand adaptive governance at various scales ranging from local to international. Testing the central hypothesis shows that the bottom-up institutional development and the slow, unforced evolution of governance in the KTP over the past 70 years has allowed governing bodies to learn how to adapt and respond to disturbances in the social-ecological system, resulting in more success in transfrontier conservation goal attainment. By contrast, institutional development in the GLTP has stagnated due to the top-down imposition of the park on local-level officials and the short time horizons permitted for goal attainment. The second focus of the study relies on research in

the resilience of social-ecological systems and institutional robustness to better understand transboundary conservation. The central thesis of this section is that the higher transaction costs of international coordination minimize the amount of institutional development at the international level relative to sub-national levels in transboundary conservation. Such lack of international cooperation leads to unexpected transformations and adaptations in the development of these parks.

### 2. EVALUATING THE PERFORMANCE OF THE ENDANGERED SPECIES ACT ON PLANTS

*\*Mark Schwartz, University of California, Davis*

Numerous authors have reviewed progress of the endangered species act (ESA) to find that time and funding may be the most important predictors of success. Most analyses either focus on vertebrates or include all taxa. This creates considerable potential for skewed results given that fewer than 10% of listed species garner over 90% of conservation spending, and that plants represent greater than 50% of listed taxa, receive less than 2% of total expenditures. I briefly review efforts to assess progress in endangered species recovery before focusing on plants as a particularly problematic aspect of endangered species conservation. Plants receive little funding and diminished protection on private lands. In addition, rare plants are considerably more urban than endangered vertebrates. As a consequence, effective expenditure allocations are critical. I compare expenditures, relative to recovery plan stated need, for plants listed at similar time intervals (1985-1987, n=90; 1991-92, n = 124, 1994, n=98) to test the hypothesis that ESA expenditures on plants predicts recovery. Initial population size and the fraction of habitat on public versus private land are added as covariates to examine the alternative hypothesis that recovery status primarily depends on public ownership and adequate population size. These results are related to the biogeographical distribution of rarity to suggest appropriate strategies for conserving plant diversity.

### 3. INNOVATION IN PROTECTED AREA SYSTEM MANAGEMENT: THE CASE OF THE AMAZON REGION PROTECTED AREAS (ARPA) PROGRAM, BRAZIL

*\*Ronaldo Weigand, Jr., Nave Terra - Sustentabilidade; \*Daniela Oliveira e Silva, Brazilian Ministry of Environment; \*Tatiany Barata Pereira, Brazilian Ministry of Environment; \*Danielle Calandino Silva, Brazilian Ministry of Environment; \*Marcos Araujo, Consultor; \*Kátia Adriana Souza, Brazilian Ministry of Environment; \*Eduardo Trazzi, Brazilian Ministry of Environment; \*Fábio H Leite, Fundo Brasileiro para a Biodiversidade (Funbio); \*Rejane Freitas Andrade, Brazilian Ministry of Environment*

In Brazil, implementing the Amazon Region Protected Areas (ARPA) Program, the largest effort to declare and implement protected areas in tropical forests requires innovation (institutional, managerial), strategic choice of conservation priorities, an effective monitoring system, and strong partnership between governments, NGOs, bilateral and multilateral institutions, and the private sector. A Conservation and Investment Strategy considers ecological representativeness. The financial model articulates with a new tool for evaluation of PA systems, created from an adaptation of GEF's tracking tool: the Protected Areas Evaluation Tool (PAET). An online system is used for PAET implementation: ARPA's Coordination and Management Integrated System (SISARPA, in Portuguese). PAs use PAET for planning of their

main targets, and the government agencies responsible for PA system coordination at the federal and state levels use SISARPA for PA supervision. Through SISARPA, PAs create workplans for the support they need from ARPA. SISARPA's public interface provides transparency. Through these innovations, inevitable conflicts have been negotiated and resolved. ARPA was created by the Brazilian government and have been implemented since 2003 through a partnership with donors (GEF/The World Bank, KfW, and WWF), seven state governments, and the Brazilian Biodiversity Fund (Funbio). Over 32 million hectares of PAs have been implemented by ARPA in the last five years.

#### 4. PROGRESS AND CHALLENGES IN THE IDENTIFICATION OF KEY BIODIVERSITY AREAS IN WILDERNESS REGIONS

*\*amy upgren, conservation international; \*Adrian Antonio Garda, Conservation International; \*Adriano P. Paglia, Conservation International Brazil; \*Adriana Paese, Conservation International; \*David Emmett, Conservation International; \*Thais Kasecker, Conservation International*

The identification of key biodiversity areas (KBAs) as targets for site level conservation is based on the core principles of systematic conservation planning: vulnerability and irreplaceability. KBAs have been identified in most countries over the past two decades, largely through work on the identification of Important Bird Areas (IBAs), but to date has focused more on heavily converted regions. More recent work on KBA identification in "wilderness" regions, where extensive natural habitat remains, uses the same criteria, but results and challenges differ. We review and draw lessons from three KBA analyses conducted in wilderness areas and parallel analyses conducted in heavily converted regions of the same continents. Our comparison of KBA progress and challenges in the Amazonia, Congo, and New Guinea wilderness areas with the Atlantic Forest, West Africa, and Indochina regions shows a general trend of fewer but larger KBAs in wilderness areas. For example, there are 29 IBAs in the Congo, with a mean size of 5,586 km<sup>2</sup> (0.32% of the region). By comparison, West Africa holds 91 IBAs, with a mean size of 660 km<sup>2</sup> (0.10% of the region). These differences result in part from the comparative uniformity of wilderness areas in terms of land use and ecology. These lessons from identifying site-scale conservation targets in wilderness areas will be useful as conservation planners seek to strategically protect the most important sites within the world's surviving wilderness areas.

#### 5. REQUIEM FOR THE ADDAX; AND HOW TO SAVE A CONTINENTAL FAUNA

*\*Michael Hoffmann, IUCN-World Conservation Union; \*Jonathan Kingdon, University of Oxford; \*David Happold, Australian National University; \*Tom Butynski, Bioko Biodiversity Protection Project*

The African mainland is home to one-quarter of the world's mammalian species, including an eclectic evolutionary radiation of unequivocally African mammals, the Afrotheria. Despite the existence of a network of protected areas that includes some of the largest in the world, and several significant conservation successes, converging lines of evidence indicate wholesale gaps in the current coverage of protected areas, and mounting extinction risks in the face of, especially, hunting and habitat loss. Here, we present the combined results of a decade-long project aimed at synthesizing all existing knowledge of the Mammals of Africa - the largest such initiative ever undertaken for a continental

mammalian fauna - together with revised conservation status assessments for the continent's mammals from the IUCN-led Global Mammal Assessment. We reveal new perspectives on patterns, status and trends, including fierce declines in population numbers exceeding 90% for some species, even within established reserves. We evaluate where existing conservation strategies are failing, particularly in terms of known gaps in protected areas coverage and management. We propose some explicit and immediately necessary priorities and solutions for the one-quarter of African mammals threatened with extinction. Our most provocative solution will demand a dramatic groundswell shift in current policies and conservation strategies.

#### 6. RISK TO BIODIVERSITY FROM ORTHODOXY IN THE REGULATION OF SPECIES

*\*Adam Novick, University of Oregon*

A review of works by others suggests society inadvertently risks exacerbating the loss of biodiversity on private land through orthodoxy in governmental restrictions on harm to imperiled species and their habitat. Recent statistical analysis offers empirical evidence that such regulation can worsen the fate of species it seeks to help, yet policies and discourse have routinely ignored that risk, often apparently based on the long discredited belief that species occurrences generally persist if undisturbed by humans. Such evidence suggests such regulation has been influenced by an orthodoxy that equates private land ownership with biodiversity loss and conservation with public ownership, which apparently serves to defend the power of individuals to use the presence of species to secure open space on the property of others. These findings imply that with constraints on public funding, the conservation of biodiversity might be improved by clarifying whether the primary goal of such regulation is to conserve biodiversity or open space, and by more fully considering an alternate strategy of restraint in such regulation on private land, such as for maintenance-dependent species. In the US, such a strategy might be possible through agency discretion, based on due process in constitutional law, which in principle protects individuals from irrational or arbitrary regulation. Such a strategy might be viewed as creating a right to use private investment to conserve biodiversity.

#### 7. THE NATIONAL BIODIVERSITY FRAMEWORK- AN IMPLEMENTATION TOOL TO MANAGE AND CONSERVE BIODIVERSITY ACROSS THE SOUTH AFRICAN LANDSCAPE

*\*Kiruben Naicker, National Government, South Africa*

The Convention on Biological Diversity, advocates that member countries should have in place a strategic action plan for the management and conservation of Biological Diversity. Strategy and action plans are now progressing into an implementation phase. South Africa has developed the first legal, implementation framework, known as the National Biodiversity Framework. The NBF is a short-term goal oriented framework that serves to align all conservation priorities in the country. The priority activities identified in the NBF are set out under 5 Strategic Objectives, and can be linked to the NBSAP and JPoI targets. In order to optimize and facilitate implementation, a strategic costing analysis, using environmental accounting principles is taking place simultaneously. The NBF has been through a widely consulted public participation process, including lead implementation agents, all stakeholders, provincial and local authorities. Listing of ecosystems, bioregional planning as well as a protected area

expansion strategy and the development of an environmental sector plan has been guided by this framework. An implementation tool of this sort that allows for cross sectoral reform, mainstreaming Biodiversity into all sectors has the potential to be used as a road map for the conservation and protection of biodiversity from the mountains to the sea.

## 8. UNITING U.S. OCEANS POLICY WITH A BLUE WATER PUBLIC TRUST DOCTRINE

*\*Mary Turnipseed, Duke University; \*Stephen Roady, Earthjustice; \*Raphael Sagarin, Nicholas Institute Duke University; \*Larry Crowder, Duke University*

The challenges U.S. oceans face stem from a haphazard approach to their governance. Though recent Congressional activity attests to the ripening of the U.S. political arena to an oceans management overhaul, a unifying framework remains elusive. We propose that the public trust doctrine, a much ignored, often-controversial common law, can be the driving force for comprehensive reform. At root, the doctrine asserts that submerged lands and tidal and navigable waters belong to the public, and state governments must manage these resources for the benefit of their citizens. In many states, the public trust doctrine has proved to be an invaluable tool in the protection of coastal habitats, beach access, and fisheries resources. Unfortunately neither the Congress nor federal courts have explicitly extended it to federal waters. Given the pressure to exploit ocean resources, there are sound reasons to secure the place of a federal public trust doctrine in future oceans governance. In implementing ecosystem-based and rights-based approaches, as well as ocean zoning, the doctrine would provide managers with a clear, affirmative duty to create sustainable policies. Addressing issues of common law, property rights, and sovereignty, we conclude: 1) there is basis for extending the public trust to include federal waters, and 2) establishing statutory authority for an expanded public trust doctrine would ultimately be the most robust route to a coherent U.S. oceans policy.

## 37. Environmental Sociology and Population Viability Analysis

### 1. BEYOND THE CATSKILLS: PRESCRIBING ECOSYSTEM SERVICE PROJECTS THAT ALIGN CONSERVATION AND DEVELOPMENT GLOBALLY

*\*Heather Tallis, Natural Capital Project; \*Rebecca Goldman, Stanford University; \*Melissa Uhl, Santa Clara University; \*Berry J Brosi, Stanford University*

Ecosystem services can provide a way to bridge biodiversity conservation and development needs, but we have few cases of joint success on the ground. Here, we document 100 projects implemented by The Nature Conservancy or the World Wildlife Fund that used an ecosystem service approach. These projects come from 38 countries throughout all major global regions. They have been used to abate all major threats to biodiversity and bring in high levels of funding from the private sector. Practitioners have used particular combinations of tools and actions consistently, revealing nine different types of projects, or prescriptions. The two organizations use different prescriptions, with TNC focusing more on rights transfers and WWF focusing more on market-based approaches. We identified several social, demographic and geophysical variables that predict which prescription will be used, giving us hypotheses about associations between project

design and national context that should be tested further.

### 2. EVIDENCE FOR A FUNDAMENTAL AND PERVASIVE SHIFT AWAY FROM NATURE-BASED RECREATION

*\*OLIVER R. W. PERGAMS, UNIVERSITY OF ILLINOIS AT CHICAGO; \*Patricia A. Zaradic, Environmental Leadership Program, Delaware Valley*

After fifty years of steady increase, per capita visits to US National Parks have declined since 1987. To evaluate whether we are seeing a fundamental shift away from people's interest in nature, we tested for similar longitudinal declines in: 1) visitation to various types of public lands in the US and National Parks in Japan and Spain, 2) number of various types of US game licenses issued, 3) indicators of time spent camping, and 4) indicators of time spent backpacking or hiking. Greatest per capita participation were in visits to Japanese National Parks, US State Parks, US National Parks, and US National Forests, with an average individual participating 0.74 to 2.75 times per year. All four time series are in downturns, with linear regressions showing ongoing losses of -1.0% to -3.1% per year. The longest and most complete time series tested suggest typical declines in per capita nature recreation began between 1981 and 1991, are proceeding at rates of -1.0% to -1.3% per year, and total to date -18% to -25%. Spearman correlation analyses were performed on untransformed time series as well as on transformed % year-to-year changes. Results showed very highly significant correlations between many of the highest per capita variables in both untransformed and in difference models, further corroborating the general downtrend in nature recreation. Unfortunately, all major lines of evidence point to an ongoing and fundamental shift away from nature-based recreation.

### 3. OIL AND GAS DEVELOPMENT IN TRINIDAD: A SURVEY OF FACTORS INFLUENCING ENVIRONMENTAL ATTITUDES WITHIN THREE RURAL WETLAND COMMUNITIES

*\*Brenda Nordenstam, Environmental Studies, SUNY-ESF; \*April Baptiste, SUNY-ESF; \*Richard Sardon, SUNY-ESF*

Wetlands constitute some of the most valuable yet threatened ecosystems in the world. Oil and gas development generates ecological consequences for wetlands and coastal ecosystems. Within the Caribbean region, rural communities depend heavily on wetland resources for livelihood strategies, yet the attitudes of these communities regarding the impacts of oil and gas drilling are not clear. A better understanding of the characteristics of attitudes and behaviors contributing to and resulting from environmental threats to these natural resources is needed. This study examined factors influencing beliefs, concerns, and behaviors among rural communities of the Nariva Swamp in Trinidad. Three predictor variables associated with environmental beliefs and behavior - proximity, gender, and livelihood - were utilized to examine these relationships. Using a quantitative approach, three rural wetland villages were surveyed over a two month period. Respondents living in closer proximity to the swamp demonstrated stronger levels of pro-environmental beliefs, concerns, and behaviors. The results for gender revealed higher levels of altruistic and egoistic concerns for females, while males showed higher levels of biospheric concerns. Livelihood was associated with variation in environmental behavior. Farmers engaged in the greatest number of environmental

behaviors involving wetlands, while government employees were most likely to engage in civic activities to protect wetlands.

#### 4. PROTECTED PATCHES: FARMERS AND CROP-RAIDING AROUND CYAMUNDONGO FOREST, RWANDA

*\*Rachel Kathryn Zapf McShane, Antioch University New England*

The aim of this project was to determine the amount of damage caused to farms around Cyamundongo Forest, in southwestern Rwanda, by crop-raiding and livestock predating animals, to determine factors increasing farmer vulnerability, and to assess attitudes about conservation and ecotourism efforts in the park. Data was collected through interviews with members of farming households in three villages around this small forest patch, which is home to many endangered birds and mammals, including chimpanzees. I determined that farmers were experiencing significant losses from crop-raiding and moderate losses from livestock predation, and have negative attitudes towards problem animals, in particular, baboons and jackals. However, contrary to my predictions, even local people who experience frequent raids did not express negative opinions of ecotourism or the park as a whole. This may be due to the new status of the park—it has only been a protected area since 2003, and local people are still adjusting to the changes. Despite overall positive attitudes towards the park, an overwhelming number of respondents expressed great concern about their ability to maintain their way of life, and increasing frustration over what they perceived to be a lack of involvement by local government and park officials. It is imperative that solutions be found to mitigate human-wildlife conflict in this area before public opinion turns and efforts to preserve biodiversity become threatened.

#### 5. MANAGEMENT PRIORITIES FOR 700 OF NEW ZEALAND'S MOST THREATENED SPECIES: A COST-EFFECTIVENESS APPROACH TO PRIORITY SETTING

*\*Liana N Joseph, The Ecology Centre, University of Queensland; \*Richard Maloney, Department of Conservation; \*Hugh Possingham, university of queensland*

The cost-effective management of threatened species is usually limited by the lack of a systematic framework for prioritising actions. The academic literature dedicated to systematic priority setting usually recommends ranking species on level of endangerment, evolutionary distinctiveness, ecological importance or social significance. These approaches make the unrealistic assumptions that all management actions cost the same and have equal likelihood of succeeding. These assumptions will result in the misallocation of scarce conservation resources and, potentially, unnecessary losses. Here, we present a formal and systematic framework to optimise resource allocation among threatened species where cost of management, the technical capacity to manage, and potential for species' recovery are considered simultaneously. We present the results of ranking management actions for 700 of New Zealand's threatened species. We demonstrate that efficiency in spending is substantially improved and, hence, the number of species managed and the expected overall benefit to threatened species is increased remarkably. In addition, we identify generalities in the management plans within taxonomic groups and threat categories. No work of this scale has been undertaken in any country using optimal resource allocation theory, yet all countries face similar issues in determining how to make best use of limited resources.

#### 6. DEVELOPMENT OF A SELF-SUSTAINING, VIABLE CAPTIVE POPULATION OF GIANT PANDAS

*\*Kathy Traylor-Holzer, IUCN Conservation Breeding Specialist Group; \*Jonathan D. Ballou, National Zoological Park, Smithsonian Institution; \*Xie Zhong, Chinese Association of Zoological Gardens; \*Zhang Zhihe, Chengdu Research Base of Giant Panda Breeding*

The giant panda (*Ailuropoda melanoleuca*) is classified as Endangered by the IUCN, with an estimated wild population of 1000 - 2000 animals. International collaboration and concentrated population management efforts have improved the status of the captive panda population substantially since the early 1990s, removing its need for demographic or genetic augmentation from wild-born stock. Improved reproductive success and higher cub survival have resulted in 10% annual population growth in recent years. The current global captive population of 241 pandas is comprised primarily of captive-born animals and is self-sustaining. Most captive pandas are maintained within China by the Chinese Association of Zoological Gardens or the State Forestry Administration, who work collaboratively to administer the cooperation breeding program. Genetic management has maintained a high level of gene diversity with little inbreeding and is accomplished through an annual population analysis and breeding strategy. Planned natural matings as well as successful artificial insemination efforts have enabled the retention of additional founder lines from previously non-reproductive wild-caught animals. This captive population is demographically and genetically viable and is projected to reach its target size of 300 animals within the next few years, enabling it to maintain over 90% gene diversity for 100 years and to function as a backup against population decline in the wild.

#### 7. METAPOPULATION VIABILITY OF THE GOLDEN-CHEEKED WARBLER UNDER A CONSERVATION INCENTIVE PROGRAM

*\*Katherine Maureen Strickler, University of Idaho; \*Jon S Horne, University of Idaho*

Conservation incentive programs seek to balance the need to manage endangered species on private lands with concerns about private property rights and conservation costs. We conducted a metapopulation viability analysis to evaluate and inform a conservation incentive program initiated by the Department of Defense, the Recovery Credit System (RCS) for golden-cheeked warblers (GCWA, *Dendroica chrysoparia*) on Fort Hood, Texas. The RCS provides Fort Hood with recovery credits for funding conservation of GCWA habitat on private lands. Recovery credits accumulated by Fort Hood through contracts with private landowners would be used to offset any unanticipated loss of GCWA habitat within the boundaries of the installation. The success of the RCS hinges on the idea that any loss of habitat on Fort Hood can be offset by conserving off-post habitat of equal recovery value. Our objective for this analysis was to quantify the importance of off-post habitat patches for the GCWA metapopulation. We developed software to model metapopulation dynamics and apply recently introduced methods for sensitivity analysis of complex models. Using available demographic and habitat data, we quantified the relative importance of within- vs. among-patch parameters to population persistence as well as quantifying the relative importance of various patches within the metapopulation. Our results will help determine the recovery value of individual patches in the GCWA RCS.

## 8. THE ANATOMY OF A DISASTER: VOLCANOES, BEHAVIOR AND LIFE HISTORY OF THE SHORT-TAILED ALBATROSS (PHOEBASTRIA ALBATRUS)

\*Myra E. Finkelstein, University of California Santa Cruz; \*Shaye Wolf, University of California Santa Cruz; \*Mary Goldman, University of California Santa Cruz; \*Paul R Sievert, U.S. Geological Survey, Massachusetts Cooperative Fish & Wildlife Research Unit; \*Greg Balogh, U.S. Fish and Wildlife Service; \*Hiroshi Hasegawa, Toho University; \*Daniel Doak, University of Wyoming

Catastrophic events, either from environmental (e.g., hurricane) or human-induced (e.g., habitat destruction) processes, are well-known threats to wild populations. However, population-based models that assess species status (e.g., PVAs) have rarely examined the relative impact of catastrophic events on species survival with respect to chronic threats (e.g., fisheries bycatch, harvesting). We constructed a stochastic population-based model to examine the impacts of chronic and catastrophic mortality events on the population growth and persistence of the endangered short-tailed albatross (*Phoebastria albatrus*), whose primary breeding colony is on an active volcano, Torishima. We found that modest increases (1%) in chronic mortality had a 2.5-fold greater impact on mean stochastic population growth than did volcanic eruptions - occurring at historic eruption frequencies (annual probability of eruption 2.2%). Consequently, in contrast to chronic low-level mortality, catastrophic volcanic events, even those that reduced population size by 25%, did not affect the long-term persistence of short-tailed albatross. We conclude that catastrophic events have minimal impact on the long-term survival of the endangered short-tailed albatross when chronic mortality rates are low. Furthermore, we propose that chronic mortality, even at low levels, causes the greatest decline in persistence for wild populations that are highly sensitive to changes in adult mortality.

## 38. Fencing for Conservation: Restriction of Evolutionary Potential or a Riposte to Threatening Processes?

### 1. FENCING FOR CONSERVATION - KEEPING THINGS OUT OR IN: CASE STUDIES FROM AFRICA, AUSTRALIA AND EUROPE

\*Matt W. Hayward, Mammal Research Institute, Polish Academy of Science

7. Fencing a conservation area illustrates our failure to adequately conserve threatened species and ameliorate human-animal conflict, yet it is timely to consider the value of fencing for conservation. There are contrasting values of fencing: keeping things out or in. I will briefly introduce the topic, before exploring the use of fencing for conservation using case studies I have been involved in from 4 sites in 3 continents - Australia's northern jarrah forest, South Africa's Addo Elephant National Park and Dwesa/Cwebe Game reserves, and Poland's Bialowieza Primeval Forest. Issues addressed will be: how long can Australian threatened species, such as the marsupial quokka *Setonix brachyurus*, persist before introduced red foxes *Vulpes vulpes* develop tolerance to the 1080 poisons that currently keep them at bay; the benefits of fencing Addo with regards to minimizing human-wildlife conflict given the impacts of megafauna on surrounding communities and the value of fencing for successful predator reintroductions while

comparing these benefits to the costs direct financial costs and indirect costs associated with mortality of animals in the fence; the benefits of fencing to reducing bushmeat hunting in the temperate rainforests of Dwesa/Cwebe; and the metaphorical fence surrounding Bialowieza with regard to the small population sizes and spatial movements of European bison, wolves and lynx, and threats from semi-domestic dogs.

### 2. THE VALUE OF FENCING FOR SUCCESSFUL REINTRODUCTION OF FAUNA AND ECOSYSTEM RESTORATION IN NEW ZEALAND

\*Bruce Richard Burns, Landcare Research; \*John G Innes, Landcare Research; \*Tim D Day, Xcluder Pest Proof Fencing Ltd

Introduced mammals have fundamentally changed the nature of New Zealand natural ecosystems as predators and competitors. They have caused local extinction of many native species and continue to cause population declines in others. There has been a major surge in development of conservation fencing in the last decade in New Zealand as a tool to sustain dedicated mainland areas free of introduced mammals following their eradication. These areas are providing secure and accessible sites for existing rare species, for the reintroduction of other valued fauna, and for experiments in general ecosystem restoration. Currently about 100 km of conservation fences protect about 8000 ha in New Zealand. These fences have been designed as physical barriers to entry of 16 species of introduced mammals including rodents, brushtail possums, cats, and mustelids amongst others, and have so far proved highly effective. Several of the fences have been specifically built to protect existing populations of rare species, e.g., grey-faced petrel, Otago skink. However, they have also provided new reintroduction sites for 33 populations of 22 species, including 6 species restricted to off-shore islands for many decades. The release of the natural ecosystems within conservation fences from the effects of introduced mammals is causing some unpredicted changes in species composition and abundance as residual species adjust to long-lost or newly realized ecological interactions.

### 3. LOCALISED AND LANDSCAPE SCALE INTRODUCED PREDATOR CONTROL IN WESTERN AUSTRALIA - CAN IT DELIVER THE SAME RESULTS AS PREDATOR EXCLUSION FENCING?

\*Paul Jeffrey de Tores, Department of Environment and Conservation, Western Australia; \*Nicky Marlow, Department of Environment and Conservation, Western Australia

In Western Australia, use of the toxin sodium monofluoroacetate, or 1080, is considered relatively safe in terms of non-target effects and, when delivered in a dry meat or sausage bait, has been demonstrated to reduce population density of the introduced red fox, *Vulpes vulpes*. Baiting for fox control is advocated as essential for recovery of predation sensitive native fauna and for threatened species translocation programs. Unfortunately, it appears to be seen as a panacea for many wildlife management problems. Now data show its use needs to be more carefully considered and strategic. At a localised scale, baiting for fox control to protect translocated populations of the "threatened" arboreal marsupial, the western ringtail possum, *Pseudocheirus occidentalis*, has been shown to result in an increase in the level of predation by another introduced predator, the feral cat, *Felis catus*, and a native predator, the south-west carpet python, *Morelia spilota*

imbricata - clear evidence of mesopredator release. At a landscape scale in the northern jarrah forest of Western Australia (Operation Foxglove), there are also data to show a similar response by cats. It is hypothesised a mesopredator release response is more likely to occur at a landscape scale. Should we treat localised and landscape scale fox baiting programs the same way? In either case, the conservation outcomes are likely to be considerably different from those achieved by introduced predator exclusion fencing.

#### 4. FENCES OR FOXES? CONSERVATION OF NATIVE VERTEBRATES IN AUSTRALIA

*\*Christopher Richard Dickman, University of Sydney*

In Australia, fences for conservation are often constructed to provide security from predation by introduced predators such as the European red fox (*Vulpes vulpes*) and house cat (*Felis catus*). Here, I review the impacts of these predators and discuss the cost-effectiveness of the fences that are used to keep them at bay. In in-situ populations of small and medium-sized native mammals, population increases of 0 to 5-6 fold have been recorded following predator removal; foxes appeared to have the strongest impact, but effective removal of cats was achieved in only 2 of 23 studies reviewed. In reintroduction studies, native mammals that were returned to their original ranges persisted in just 20% of attempts where predator control had not been attempted (n = 10) but survived in 37% of attempts (n = 27) where predator populations had been reduced by poison baiting and in 69% of attempts (n = 16) where native species were reintroduced to fenced and predator-free enclosures. Given the pervasive and negative impacts of predators and the effectiveness of protective fences, why are national parks and nature reserves not fenced? Reasons range from biological to cultural and logistical, but are primarily financial: predator-proof fencing costs ca. Aust\$36,000 per kilometre to build and at least Aust\$1,000 a year to maintain. Thus, fences may work for small areas but are not cost-effective at large spatial scales.

#### 5. NEGOTIATING BARRIERS VIA METAPOPOPULATION MANAGEMENT

*\*Michael J Somers, University of Pretoria; \*Matt W. Hayward, Mammal Research Institute, Polish Academy of Science; \*Dave Druce, Nelson Mandela Metropolitan University; \*Harriet Davies-Mostert, Endangered Wildlife Trust*

Humans and large carnivores struggle to coexist amicably - conflict invariably arises unless they are kept separated. Large predators are only acceptable to neighbours if they are adequately fenced in. This has resulted in an increase in the quality and quantity of "predator proof" fencing such that all South African conservation areas housing dangerous animals are fenced. Although there have been exceptions, the increase in fences now restricts movement between conservation areas. Reintroductions and translocations are therefore crucial for the conservation management of these fragmented areas, particularly for large carnivores. Here we review translocations between small reserves for the purpose of overcoming the restrictions of fences and for managing them as a metapopulation. The movements of these large carnivores between reserves are normally done by reserve managers who try to maintain predator populations at an optimal size for their management goals and to avoid inbreeding. The degree of knowledge of the genetics and relatedness of individuals moved varies greatly.

#### 6. SCALING ECOSYSTEM PROCESSES IN

#### SMALL FENCED PARKS - CAN CLEVER MANAGEMENT COMPENSATE FOR SPACE?

*\*Sue Janse Van Rensburg, KZN wildlife; \*Sally Archibald, CSIR*

Managing small fenced parks while maintaining functioning ecosystem processes provides several challenges to conservationists. Many processes occur at scales larger than the protected areas, and are interrupted by the presence of fences. We present some ideas and lessons learned from managing a highly heterogeneous small park in Zululand, South Africa. The park itself has several characteristics that make it possible to maintain a range of habitats and a full compliment of herbivores and predators. Moreover research into key processes such as fire and tree recruitment has provided interesting ideas on how to scale such processes in small, isolated parks. We discuss how fire can be used to affect tree structure and create and maintain grazing patches, and whether localised herbivore removals can be used to simulate the effects of drought cycles on tree recruitment at smaller scales. Many of these ideas are currently being tested in the park. We discuss the effectiveness of the process-based management approach in small parks, how fences aid and limit management of such parks, and what conditions must be met before small fenced parks can be functioning conservation areas.

#### 7. FENCING OF ELEPHANTS: SHIFTING FROM EXTERNAL TO INTERNAL THREATS

*\*Graham IH Kerley, Centre for African Conservation Ecology; \*Katie F. Gough, Centre for African Conservation Ecology, Nelson Mandela Metropolitan University; \*Marietjie Landman, Centre for African Conservation Ecology, Nelson Mandela Metropolitan University; \*Rob Slotow, University of KwaZulu-Natal*

Fencing effectively reduces external threats to elephant populations and human-elephant conflicts, but may lead to the build-up of internal threats to both elephants and associated biodiversity. Unfenced elephant populations may show high mortality, typically associated with human-elephant conflicts, and small populations are particularly vulnerable. Fencing reduces these risks, but in small areas fencing leads to inbreeding and reduced genetic diversity and may increase bull mortality, skewing population structures and sex ratios. Elephants have high impacts in small fenced areas through their effects on vegetation and soils, including extirpation of plant species. Cascading effects cause a decline in foraging opportunities for browsers (e.g. black rhinoceros), and a decline in populations of herbivores, particularly those preferring dense cover (e.g. bushbuck). This changes the role of elephants from an umbrella species to one of conservation threat. Given the lag between elephant population responses and the effects of resource limitations, we hypothesize that fenced elephant populations will degrade their forage base, causing catastrophic declines in the elephant population, and other biodiversity. Experience across 80 reserves show that fencing requires intense management (e.g. movement for genetic management, culling, contraception) of elephant populations that may be seen as changing the problem rather than resolving it.

#### 8. FENCES AND THE CONSERVATION OF MIGRATORY UNGULATES

*\*Simon Thirgood, The Macaulay Institute; \*Grant Hopcraft, Frankfurt Zoological Society*

Fencing is an emotive issue in African conservation. In southern Africa, fencing to demarcate the hard edges between protected areas and community lands is considered essential -

both to keep animals in and to keep people out. In contrast, throughout much of East Africa, core protected areas are typically unfenced and surrounded by buffer zones often utilized for commercial hunting. In this talk we compare these two differing paradigms of African conservation in terms of their successes and failures in conserving migratory and resident populations of herbivores. We systematically review the conservation status and population trajectories of herbivore populations in major protected areas and intact ecosystems in Southern and East Africa in relation to the presence of fences. We conclude that whilst fencing may be locally appropriate in some circumstances, the prevailing East African paradigm of large, unfenced networks of core protected areas surrounded by buffer zones of commercial hunting reserves provides a sustainable model for the conservation of both resident and migratory ungulates. We suggest that commercial hunting in buffer zones around core protected areas provides a tool with which to reduce human-wildlife conflict to acceptable levels that may be more cost-effective than fencing.

#### 9. IS THE VASTNESS OF THE SERENGETI ENOUGH TO AVERT HUMAN-WILDLIFE CONFLICTS?

*\*Heribert Hofer, Leibniz Institute for Zoo and Wildlife Research; \*Marion Linda East, Leibniz Institute for Zoo and Wildlife Research*

Traditionally, Tanzania practises an open area policy, and in ecosystems dominated by large and migratory herbivores such as the Serengeti, fencing of protected conservation areas appears to be impractical because of their large size and the unpredictability of the movements of large and migratory herbivores. Is the sheer size of such an ecosystem (in excess of 24,000 km<sup>2</sup>) sufficient to protect it from human interference? The history over the past five decades of direct persecution and the links between pathogens in domestic animals and wildlife illustrate that there is a complex relationship between the conservation areas of the Serengeti and the surrounding land and its human population. Firstly, direct persecution has been a much stronger force than commonly recognized in shaping population dynamics and habitat use of herbivores and carnivores over much of the Serengeti. Secondly, the dynamics of pathogens inside and outside the conservation areas appear to be complex and not well understood. Careful, long-term research has provided a significant contribution to understanding the precise nature and consequences of these issues, and has repeatedly yielded results that are counter-intuitive or at variance with respect to standard conservation management thinking.

#### 10. TOWARDS A TRUE ECOLOGY: EXPLORING THE HUMAN AND SOCIAL DIMENSIONS OF FENCING FOR CONSERVATION IN THE SUBTROPICAL THICKET BIOME, SOUTH AFRICA

*\*Andrew Thomas Knight, Nelson Mandela Metropolitan University; \*Richard Cowling, Nelson Mandela Metropolitan University*

The Subtropical Thicket biome forms the south-western most portion of the Maputaland-Pondoland-Albany hotspot, and is recognised as of global conservation importance. Mega-herbivores, notably African elephants (*Loxodonta africana*) and black rhinoceros (*Diceros bicornis bicornis*), are fundamental drivers of the natural ecological functioning of this biome. Seven proposed conservation corridors, several of which are currently being implemented in various ways, aim to ensure the ecological and evolutionary processes essential for the persistence of species and habitats. However, the Subtropical

Thicket biome has been partially transformed through grazing, agriculture, urban expansion, and invasive alien plants, and its landscapes sub-divided into many fenced properties. Private game reserves commonly adjoin commercial rangelands, and so fencing is a prominent local issue. We outline the human and social issues associated with the removal of fencing for conservation beyond those of ecological and evolutionary importance for valued nature. Specifically, we examine cross-boundary approaches for fostering the relationships necessary for securing the common co-management of multiple properties at the landscape scale (i.e., social capital), the essential nature of these relationships for social learning and adaptive management, and the importance of grappling with these issues in the face of climate change.

#### 11. WHAT HAPPENS WHEN YOU LET THE CATS OUT OF THE BAG? LEOPARDS AND LYNX IN MULTI-USE LANDSCAPES

*\*John D. C. Linnell, Norwegian Institute for Nature Research; \*Morten Odden, Norwegian University of Life Sciences; \*John Odden, Norwegian Institute for Nature Research; \*Vidya Athreya, Kaati Trust*

Throughout Europe and Asia many conservation initiatives are focused on integrating human activities and megafauna conservation into multi-use landscapes, often far removed from protected areas and in areas with high human population densities. These projects represent the ultimate contrast to the fenced reserves of southern Africa. This paper explores two case studies involving large solitary felids - Eurasian lynx in Scandinavia and leopards in western India - and explores the issues surrounding their conservation. In both studies we document that the species are able to thrive in landscapes dominated by human activities even where the habitat is greatly modified. However, in both studies we also document a wide range of conflicts. In both studies there is widespread depredation on livestock. Lynx are also associated with competition with hunters for wild ungulates, whereas leopards are associated with attacks on humans. In addition, to the material conflicts there are a range of social conflicts that centre on fundamental values and the politics of power and influence over decision making. These case studies illustrate that the "coexistence" conservation model can work, but that complex dilemmas arise between biodiversity conservation and social issues such as risk to human life and the preservation of aboriginal cultures and traditional lifestyles.

#### 12. DO FENCES OR HUMANS INHIBIT THE MOVEMENTS OF WILDLIFE IN BIALOWIEZA PRIMEVAL FOREST?

*\*Rafal Kowalczyk, Mammal Research Institute; \*Włodzimierz Jedrzejewski, Mammal Research Institute; \*Krzysztof Schmidt, Mammal Research Institute; \*Matt W. Hayward, Mammal Research Institute, Polish Academy of Science*

Białowieża Primeval Forest (BPF) conserves the remnants of the forests that once covered most of Europe. Its 1500 km<sup>2</sup> of continuous woodland is located between Poland and Belarus. BPF supports populations of European bison, Eurasian lynx and grey wolf - all endangered in Europe. Cleared agricultural land and human settlements surround the forest and act as a metaphorical fence to keep large mammals inside. Free movement of the animals within the BPF has been additionally limited since 1981 by a border fence. Those "barriers" strongly influence spatial organization of bison and large carnivores, as well as an exchange of individuals, migration and possibilities of population increase and dispersal. It is especially important

to bison, which have increased from 7 individuals at the beginning of the 20th century to over 700 individuals today, but is characterized by low genetic variation. Also the BPF lynx are genetically impoverished with evidence of barriers inhibiting gene flow. Despite its capability of long distance dispersal, the lynx is sensitive to habitat fragmentation because it avoids traversing open areas. Radio-tracking studies showed that during dispersal lynx followed the distribution of forested habitats and changed direction upon reaching the forest edge. Wolves and bison are not as sensitive to habitat fragmentation but, when dispersing to open areas surrounding the BPF, are exposed to conflict with humans due to damage to crops (bison) and livestock (wolves).

### 13. PEOPLE IN PROTECTED AREAS: CAN HUMANS COEXIST AMICABLY WITH INDIA'S WILDLIFE?

*\*Ravi Chellam, Ashoka Trust for Research in Ecology & the Environment; \*NITIN DEVDAS RAI, Ashoka Trust for Research in Ecology and the Environment; \*Jagdish Krishnaswamy, Ashoka Trust for Research in Ecology & the Environment*

India has diverse populations of wild mammals living in close proximity to high density human populations. Most forest dwelling communities are poor and cut off from mainstream development and most protected areas (PAs) have people living within them. Local communities have dealt with wildlife in diverse ways including several examples of tolerance with very strong cultural links to several species. Over the last few decades there have been several changes including the Wild Life Protection Act (1972), Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act (2006), declaration of many PAs and most significantly, rapid economic development resulting in extensive fragmentation, degradation and loss of habitat and targeted market-led poaching of species (e.g., tiger, rhino, elephant). The impacts of such large scale changes have increased human-wildlife conflicts, decreased the tolerance of local communities to wildlife, decline in wildlife populations and there is a vocal demand by both conservationists and certain local communities for the construction of barriers to retain and restrict wildlife within PAs. We believe that isolating people from PAs in India is not a viable long term option due to the perceived loss of local ownership and participation. We describe this complex scenario and suggest more inclusive approaches that will ensure a better future for wildlife and enhanced livelihoods of forest-dependent communities in India.

### 14. FENCING FOR CONSERVATION: RESTRICTION OF EVOLUTIONARY POTENTIAL OR A RIPOSTE TO THREATENING PROCESSES?

*\*Eric Dinerstein, World Wildlife Fund; \*Matt W. Hayward, Mammal Research Institute, Polish Academy of Science*

An ambitious goal of the Terai Arc Landscape (TAL) project in southern Nepal and adjacent India is to recover endangered tiger, greater one-horned rhino, and elephant populations by managing them as meta-populations. A challenge in linking protected areas that contain source populations of these endangered vertebrates is that tigers are poor dispersers and croplands wider than 4 kilometers constitute a virtual fence, prohibiting dispersal. In 2000, we began a community forestry initiative to restore connectivity in six targeted bottlenecks between reserves. The restored corridors provided economic and livelihood benefits to local forest user groups while

allowing wildlife to use the habitat; since restoration, four of the six bottlenecks are occupied by tigers, two by rhinoceros, and three by elephants. Electric fencing around villages and agricultural areas minimize human-wildlife conflict, and at start-up, barbed wire fences prevented degradation by domestic livestock. Core areas remain largely unfenced and community forests around them also served as de facto 'fences' to deter encroachment by people. TAL illustrates how incentives aimed at village user groups can lead to corridor restoration, occupancy by large predators, and recovery of endangered wildlife, without fencing them in core areas in human-dominated landscapes in poor countries.

### 15. THE IMPACTS OF FENCING ON MAMMALS IN AFRICA: A REVIEW

*\*Michelle E Gadd, None*

Africa is crisscrossed by fences and new fences are built every day. These fences are constructed to fence wildlife in, to fence wildlife out, or to prevent spread of disease. The impact of fences on wildlife in Africa is contentious. Economic and political motives often outweigh environmental concerns. Damage is hard to quantify as impact assessments may be waived or ignored and post-construction monitoring is not often conducted. This paper summarizes available information from published and unpublished sources on the effects of fencing on wildlife in southern Africa. These documents provide evidence that fences have adverse effects on wild mammals at the individual, population, and species level. Fences disrupt individual daily movements and may lead to death by starvation, dehydration or entanglement. Fencing can divide populations, prevent recolonization and render sub-populations prone to the risks faced by small populations. While fences can reduce human-wildlife conflict, they can also worsen negative interactions between people and wildlife: examples show that fences facilitate poaching and that fencing which disrupts the movement of large mammals, especially carnivores and elephants, can increase conflict with local people. In light of current challenges and opportunities, fences should be considered carefully for their role in impeding or altering events essential to species persistence, like dispersal, seasonal movement, and range expansion.

### 16. SOME IMPACTS OF FENCING FOR CONSERVATION - WILDLIFE MORTALITY ALONG THE FENCE OF KRUGER NATIONAL PARK, SOUTH AFRICA

*\*Matt W. Hayward, Mammal Research Institute, Polish Academy of Science*

Fencing for conservation is not without its problems. Mass mortality events have been reported from the poorly planned veterinary fences in Botswana that have separated grazing lands of wildlife from drinking areas. Here, I illustrate the direct impact fencing has on wildlife by reporting on the mortality records along the fence surrounding Kruger National Park, South Africa.

### 39. Forest Conservation

#### 1. FOREST LAND-USE CHANGE BETWEEN THE 1960'S AND 1990'S ON THE LOWER MISSISSIPPI RIVER ALLUVIAL PLAIN, USA

*\*James F. Rosson, Jr., USDA Forest Service, Southern Research Station*

One of the greatest impacts to the bottomland forests of the Lower Mississippi River Alluvial Plain (LMRAP) has been the permanent clearing of forests. To determine the temporal and

spatial aspects of this clearing I used USDA Forest Service, Forest Inventory and Analysis data to track permanent plots from the 1960's to the 1990's on the LMRAP of Arkansas, Louisiana, and Mississippi. This land area encompasses 99,660 km<sup>2</sup>. There were 3,104,987 ha (C.I.  $\pm$ 43,780) of forests in the 1960's but by the 1970's, 627,060 ha had been cleared. By the 1990's an additional 375,300 ha had been cleared. Most of this cleared forest land was diverted to farmland (78 percent) while 14 percent went to urban, industrial, and various forms of rights-of-way. This degree of loss in bottomland forests on the LMRAP makes this forest ecosystem a conservation priority. Tracking permanent plots is extremely important in establishing historical baselines and providing valuable insights in establishing and implementing conservation policy.

## 2. INTERACTIONS OF BIODIVERSITY, SCALE DEPENDENCY, AND FOREST MANAGEMENT ALTERNATIVES IN THE SOUTHERN CUMBERLAND PLATEAU OF NORTHERN ALABAMA, USA.

*\*Yong Wang, Alabama A&M University; \*Zachary Felix, Alabama A&M University; \*Callie Callie Schweitzer, USDA Forest Service*

The Cumberland Plateau of Alabama is dominated by oak-hickory forests that host one of the most diverse wildlife communities in USA. Timber harvesting and other disturbances are changing the composition and structure at stand and landscape levels. Using a field experiment of various shelterwood methods and clearcutting for regenerating oak-hickory forests, we examined the habitat and environmental changes in relation to forest management practices, and the relationship between management practices and herpetofaunal and avian biodiversity at stand level and matrix (landscape) levels. Different forest management practices created variations of environment and wildlife habitat from open canopies with abundant herbaceous and woody vegetation and warm and dry daytime conditions on clearcuts to more closed canopy stands dominated by leaf litter with cool and more humid conditions on controls. At stand level, the intermediate shelterwood treatments had higher alpha diversity than that of controls and clearcuts; at matrix level, the beta diversity of the wildlife species increased with introduction of the various treatments. Changing forest stand structure introduced some species that did not occur on the control stands and affected relative abundance of different species. Using the Whittaker approach, we examined species rank and abundance relationships at both stand and landscape levels, and modeled the biodiversity changes based on different landscape matrix.

## 3. LIMITED COLD TOLERANCE MAY COMPLICATE AMERICAN CHESTNUT RESTORATION WITHIN THE NORTHERN U.S.

*\*Paul Gerard Schaberg, USDA Forest Service, Northern Research Station; \*Kendra Gurney, The University of Vermont, Rubenstein School of Environment and Natural Resources; \*Gary J. Hawley, The University of Vermont, Rubenstein School of Environment and Natural Resources; \*John B. Shane, The University of Vermont, Rubenstein School of Environment and Natural Resources*

The American chestnut (*Castanea dentata*) was once a major component of eastern U.S. forests but was functionally removed as an overstory species following the introduction of a fungal blight about 100 years ago. Hybrid-backcross breeding

that incorporates the blight-resistance of Chinese chestnut (*Castanea mollissima*) into American chestnut stock shows promise for achieving the blight resistance needed for species restoration. Limitations in tissue cold tolerance within breeding programs could restrict the restoration of the species in the northern limits of its historical range. We tested the winter cold tolerance of the shoots of American chestnut and hybrid-backcross chestnut saplings growing in two plantings in Vermont to assess their cold tolerance relative to two native competitors: northern red oak (*Quercus rubra*) and sugar maple (*Acer saccharum*). American and hybrid-backcross chestnuts were about 6°C less cold tolerant than red oak and sugar maples ( $P < 0.001$ ), with a slight tendency for hybrid-backcross chestnuts to be less cold tolerant than pure American chestnuts ( $P = 0.074$ ). Terminal shoots of American and hybrid-backcross chestnut also experienced more field freezing injury than oaks and maples ( $P < 0.001$ ), which appeared uninjured. Although limited cold tolerance could complicate species restoration within northern forests, cold tolerance levels could potentially be improved through cultural means and through selective breeding using hardier germplasm.

## 4. LOGGING OF SOUTHERN APPALACHIAN COVE FORESTS A CENTURY AGO LEAVES A LEGACY ON THE UNDERSTORY HERBACEOUS LAYER

*\*Julie L Wyatt, Wake Forest University*

This study addresses long term recovery of the diverse herbaceous understory of rich cove hardwood forests in the Southern Appalachians through assessment of both biotic and abiotic parameters in forests that have reached the allotted recovery period before subsequent logging. Many understory herbaceous species are indicators for disturbance due to slow growth, short dispersal distances and delayed reproduction. Three old growth forests and three forests that were logged ~100 years ago were surveyed for herbaceous diversity, abundance, spatial patterns, along with several environmental parameters including soil nutrients, soil and litter depth, canopy cover, tree diversity and tree basal area. Herbaceous diversity and most environmental parameters were similar between old growth forests and those logged ~100 years ago. However, old growth rich cove forests have more herbaceous species per plot, greater aggregation of species, greater tree basal area and greater abundance of herbaceous individuals than forests ~100 years old. Additionally, herbaceous species composition is more similar between old growth forests than between different aged forests closer in space. Soil nutrients also exhibited a significant age effect for organic matter, phosphorus, zinc, iron and nitrate. These results demonstrate that the legacy of logging persists a century later and diversity alone is a poor assessment of herbaceous layer recovery.

## 5. OAK REGENERATION ACROSS ENVIRONMENTAL GRADIENTS IN EASTERN US FORESTS AND IMPLICATIONS FOR MANAGEMENT AND RESTORATION

*\*Anita K. Rose, US Forest Service, Southern Research Station*

Oak species (*Quercus* spp. L.) contribute to the biological function of forest ecosystems and are valuable wildlife and economic resources. Because of their importance and widespread observed decline, oak ecosystems are a conservation priority. A comparison of oak regeneration across various site conditions is useful for establishing long-term objectives for the restoration and management of oak stands. USDA Forest Service data were used to describe the current status of oak regeneration across Virginia. Tree-sized stems

(&#8805;12.7cm d.b.h.) of several oak species were significantly correlated with site characteristics, such as elevation, slope, and aspect. This was not always true for sapling-sized oaks (2.5cm &#8804; d.b.h <12.7cm). Although tree density of chestnut oak and scarlet oak was correlated with elevation ( $p < 0.0001$ ), sapling density was not. Similarly, chestnut oak saplings were not correlated with aspect, but trees were. Potential oak-replacement species (red maple and blackgum) were not typically correlated with elevation or slope. These results suggest that saplings of certain oak species may be responsive to different factors than are tree-sized oaks, which has implications for effective management and restoration of oak. Complex habitat structures, unknown thresholds of concern, and differing ecological amplitudes of various oak species are important confounding issues.

## 6. THE IMPACT OF AGRICULTURAL LAND USE ON THE PATTERN AND SPREAD OF ALTERED FOREST HABITATS IN MABIRA FOREST RESERVE, UGANDA

*\*Robert Ddamulira Junior, Practicing Environmental Managers' Organization (PEMO)*

Millions of hectares of forest habitats around the world are converted into agricultural fields annually. In Uganda, forest habitats are lost at a rate of 7% per annum, at this rate, it is predicted that there will be no woody biomass outside forest reserves by 2025. This research assessed the impact of agricultural land use on the pattern and spread of altered forest habitats in Mabira forest reserve, Uganda. The study specifically described the nature of agricultural land uses and related habitat alteration as well as assessing the pattern and spread of altered habitats associated with specific agricultural practices in Buwoola enclave of Mabira forest reserve. Participatory Rural Appraisal (PRA) methods, interviews, observation, line transects and questionnaires were the main instruments in data collection. The research concluded that agricultural land use was associated with habitat alternation that spread as boundary and linear processes whose pattern was manifested in hotspots of reduced forest integrity based on forest structure, light indicators species and human intrusion indicators. It was therefore recommended that further forest conservation requires environmental education, increased mapping and monitoring as well as restoration of degraded areas.

## 40. Forest Conservation (2)

### 1. ABUNDANCE, DEMOGRAPHY, AND POPULATION GROWTH OF TERRESTRIAL SALAMANDERS AFTER EXPERIMENTAL FOREST HARVESTING

*\*Jessica Anne Homyack, Virginia Tech; \*Carola Haas, Virginia Tech*

Although the negative effects of clearcut harvesting on terrestrial salamanders has been demonstrated repeatedly, less information is available on either the length of recovery time or the specific factors limiting growth of salamander populations after a range of forest management practices. We quantified relative abundance and demographics of terrestrial salamanders before and after the experimental application of a gradient of silvicultural techniques designed to facilitate oak (*Quercus* spp) regeneration on 6 sites in central Appalachian forests, 1994-2007. In addition, we conducted sensitivity and elasticity analyses for the most common salamander in our study and modeled recovery times for salamander populations after perturbing vital rates and/or abundances. In general, all forest

harvests that disturbed the canopy negatively affected relative abundances of salamanders to 13-years post-harvest and these results were consistent across time and species ( $P < 0.001$ ). Population modeling indicated that changes to adult survival would have the greatest influence on the population growth rate and 60-80 years may be necessary for salamanders to recover to pre-harvest levels of abundance. Prior research has suggested that changes to habitat and microclimate limit survival and reproduction of terrestrial salamanders, but our investigation suggests that vital rates also contribute to long recovery times of populations post-disturbance.

## 2. BUILDING PARTNERSHIP WITH LOCAL COMMUNITIES AND LOCAL GOVERNMENT UNITS IN MANAGING THREATENED WILDLIFE AND HABITATS IN CEBU ISLAND, PHILIPPINES

*\*Lisa Marie Jamadron Paguntalan, Cebu Biodiversity Conservation Foundation; \*Philip Godfrey Cosep Jakosalem, Cebu Biodiversity Conservation Foundation, Inc.*

The forests in southern Cebu, Philippines hold at least nine threatened endemic species of wildlife of which four are restricted-range species. The forest is managed by organized local communities (Peoples Organization), each with co-management agreements with the Department of Environment and Natural Resources and receiving technical and financial support from non-government organizations and the local government units. The co-management structure is a result of five years of intervention and advocacy efforts, both at the community and at the provincial level. This paper explores the strengths and weaknesses of using a collaborative management mechanism and the impact of the initiative towards the conservation of the natural forest and threatened wildlife. Active participation of local government units, community involvement in protecting remaining forest fragments and in providing solutions to lessen the use of native trees for charcoal and fuel wood are also discussed.

## 3. FOREST DEVOLUTION IN TANZANIA: POLICY-DRIVEN DIFFERENCES IN LOCAL FOREST INSTITUTIONS, DISTURBANCE, AND FOREST CONDITION IN 4 AFRO-MONTANE FORESTS

*\*Lauren M. Persha, Indiana University*

This paper examines policy-driven differences in local forest institutions, disturbance, and ensuing changes in forest structure and species composition among 3 neighboring montane forests under centralized or devolved management. Outcomes are contrasted among a centralized, co-managed, and communally-managed forest. An adjacent research forest serves as an ecological reference for comparison. The forests are located in the West Usambara Mountains, part of a globally-recognized biodiversity hotspot in East Africa. Data was collected via 181 forest plots and semi-structured interviews. The communal forest, operating outside state-sponsored policy reforms, showed greater institutional autonomy and tenure security, and marginally more effective monitoring and rule enforcement. Local institutional robustness was negatively correlated with recent forest disturbance, while the principal form (illegal logging for cash vs. subsistence pole harvesting) differed on the basis of state and local management roles. In terms of forest condition, significant differences in abundance and diameter distribution of targeted species corresponded to harvesting intensity. The most disturbed co-managed forest was significantly degraded compared to the

ecological reference (lower mean DBH and biomass, higher stem density and dominance by disturbance species). Results highlight devolution challenges and suggest opportunities to better conserve forests in human-dominated landscapes.

#### 4. FUTURE OF THE WESTERN AMAZON: THREATS FROM HYDROCARBON PROJECTS AND ALTERNATIVES FORWARD

*\*Matthew Finer, Save America's Forests; \*Clinton N Jenkins, Duke University; \*Stuart Pimm, Duke University*

The Western Amazon (Bolivia, Colombia, Ecuador, Peru, and western Brazil) constitutes the most biologically rich and intact part of the Amazon basin, and unlike the eastern Brazilian Amazon, has a high probability of retaining stable climatic conditions in the face of global warming. The recent boom in hydrocarbon prices and the growing global demand, however, is leading to unprecedented levels of hydrocarbon exploration and development in the region. Previous hydrocarbon development in the Western Amazon has caused social conflict and environmental damage, including deforestation, illegal logging, and overhunting facilitated by new oil access roads. We compiled and synthesized information from government sources and present here a status overview of oil development in the Western Amazon. We found that over 140 oil and gas blocks now cover ~645,000 km<sup>2</sup> of the most species-rich part of the Amazon. We superimposed hydrocarbon block maps with biodiversity distribution maps to illustrate this point. Another principle finding is that in both Ecuador and Peru, more than two-thirds of the Amazon is now covered in hydrocarbon blocks. We then present an overview of the most pressing policy issues confronting the region along with science-based policy alternatives. These include the need for regional and sectoral Strategic Environmental Impact Assessments, the adoption of roadless extraction techniques, and the resolution of intense conflicts with indigenous peoples.

#### 5. HABITAT AND CLIMATE RELATIONSHIPS FOR THREE PLETHODONTID SALAMANDER SPECIES: IMPLICATIONS FOR CONSERVATION

*\*William Bradley Sutton, Alabama A&M University; \*Thomas K. Pauley, Marshall University; \*Jessica A. Wooten, Franklin University*

It is known that plethodontid salamanders inhabit moist, forested environments; however, habitat and climate information is lacking for terrestrial salamander species. We analyzed 30 years of salamander presence/absence data from 1300 sites throughout the Allegheny Mountains to create habitat and ecological niche models for Red-Backed Salamanders (*Plethodon cinereus*), Allegheny Mountain Dusky Salamanders (*Desmognathus ochrophaeus*), and Cheat Mountain Salamanders (*Plethodon nettingi*). Sites were surveyed based on area constrained searches. Encountered salamanders were identified to species and a series of 10 habitat variables were recorded for each site. We used logistic regression and analyzed salamander data to create habitat models. Akaike's information criterion was used to select the most parsimonious habitat model based on logistic regression results. Ecological niche models were constructed using Maxent (maximum entropy modeling technique), which estimates ecological niches using presence only data and WorldClim climate layers. Climate data for each locality was extracted using DIVA GIS. As predicted, *P. nettingi* was restricted to cooler sites dominated by red spruce (*Picea rubens*), while *P. cinereus* and *D. ochrophaeus* exhibited broad habitat and climate relationships. This study not only provides

habitat and climate data for plethodontid salamanders, but also information regarding conservation of threatened species such as *P. nettingi*.

#### 6. HABITAT USE AND REPRODUCTIVE ECOLOGY OF RUSTY BLACKBIRDS IN MAINE

*\*Luke Losada Powell, University of Maine; \*William Edward Glanz, University of Maine; \*Thomas L. Hodgman, Maine Department of Inland Fisheries and Wildlife*

The Rusty Blackbird (*Euphagus carolinus*) has shown one of the steepest declines in abundance of any bird in North America. The causes of its decline remain unknown and its breeding ecology has been largely unstudied. To address these problems, we examined the distribution, foraging site use, nest placement, and reproductive success of Rusty Blackbirds in Maine in relation to various habitat variables. In our study area, the species was rare and bred in wetlands, where it was often found at beaver ponds with exposed mud or numerous puddles, and near areas of dense, young conifers (*Picea* or *Abies* spp.). Our best-fit model indicated that the presence of puddles, a surrounding upland of primarily softwoods, and wetland area were positively correlated with habitat occupancy. Rusty Blackbirds foraged on aquatic insects (e.g. Odonata) while wading in shallow water and usually nested within 75 m of open water. Nests were placed in spruces or firs, often in dense, regenerating stands near wetlands. The widespread availability of such nest sites suggests that nesting habitat is not likely to be limiting, and that foraging requirements may be more important in defining breeding habitats. Egg viability and nest success were not unusually low in Maine and may not be major factors causing the species' steep decline. Studies are now needed to determine if adult or juvenile survival are limiting Rusty Blackbird population growth, and if so, when, where, and why these processes occur.

#### 7. THE CASE STUDY OF NATIONAL PARKS AND SANCTUARIES AND MAN-ANIMAL CONFLICT DUE TO LAND CONSTRAINT IN THE BRAHMAPUTRA VALLEY

*\*Rupali Devi Barua, formerly with Gauhati University; \*INDRILA GUHA, Vidyasagar College For Women, Calcutta, INDIA*

The Brahmaputra valley in Assam, a north eastern state in India is resplendent with varieties of flora and fauna and is considered as one of the most bio diversified regions in the world. Although it is considered as second most bio diversified region in India, the presence of larger kind of pachyderm in the region including rhino, elephant and also tiger, some of the most endangered animals in the world has made the man animal equation in the valley very crucial due to the growing pressure of ever increasing human population rapidly occupying the land areas around the reserved forest areas. Since larger animals require much larger territories, often for even a single species predominant in a single area, the necessity is for bigger areas and contiguous roaming areas. Besides the man created havoc due to illegal occupation, even natural calamities such as land erosion and endemic flood condition are also causing grievous constraint for the animals. In the face of growing problem of land areas, the conflict of man and animal is becoming more and more evident in recent time. All such conditions are leading to the constraint on the life of survival for the species, specially the rare and the endangered and threatened ones. Various measures, including application of stringent laws for conservation, social forestry etc. only can be the remedy for the situation.

## 8. DETECTING DEFORESTATION IN CENTRAL AFRICAN PROTECTED AREAS USING REMOTE SENSING

*\*Jessica Rogers, Columbia University*

Protected areas in the Congo Basin forest have had uneven levels of protection that have often led to deforestation. This study uses deforestation as a surrogate for measuring protected area effectiveness. Using remotely sensed images of protected areas from Landsat missions from the 1970s through 2005, deforestation was detected across a gradient of protected areas. GIS analyses were done to calculate the percentage of deforestation, as well as areas of reforestation, within protected areas. Roads, rivers, and other points of access contributed to increased deforestation in some protected areas. Analyses were done at local, country, and regional scales. Because these forests play a role in climate regulation, carbon sequestration and nutrient cycling they are economically and socially important at local, regional, and global levels. Understanding the causes and levels of deforestation over time can improve management decisions by local park managers and national governmental ministries.

## 41. Forest Conservation (3)

### 1. BROKEN LAWS AND PATCHY LANDSCAPES: ENFORCEMENT AUTHORITY AND VEGETATION CHANGE AT KUMBHALGARH WILDLIFE SANCTUARY, RAJASTHAN INDIA

*\*Paul F Robbins, University of Arizona*

Land cover change in protected areas is often associated with human use, especially illicit extraction, but the direction and spatial distribution of such effects and their drivers are poorly understood. We analyze and explain the spatial distribution of vegetation change at the Kumbhalgarh Wildlife Sanctuary in the Aravalli range of Rajasthan, India using remotely sensed data and observation of conservation institutions. Two satellite images are examined in time series over the 13 years following the founding of the sanctuary through a cross-tabulation technique of dominant classes of vegetation density. The resulting change trajectories are compared for their relative distance to high-traffic forest entrance points for local users. The results show 28% of the study area undergoing change, though in multiple trajectories, with both increasing and decreasing density of vegetation in discrete patches. Areas of change are shown to be closer to entrance points than areas experiencing no change. The patchiness of change results from complex issues in local enforcement authority for middle and lower-level officials in Forest Department bureaucracy, leading to further questions about the efficacy and impact of use restrictions in Protected Areas.

### 2. CHANGE IN UNDERSTORY PLANT COMMUNITIES OVER 30 YEARS IN HISTORICALLY LOGGED AND UNLOGGED FORESTS OF GREAT SMOKY MOUNTAINS NATIONAL PARK

*\*Windy A. Bunn, University of Tennessee; \*Michael*

*A. Jenkins, National Park Service, Great Smoky Mountains National Park; \*Claire B. Brown, University of Tennessee; \*Nathan J. Sanders, University of Tennessee*

Understanding whether and how ecological communities change over time is critical for biodiversity conservation.

However, there are few long-term studies that directly address decadal-scale changes in the ecological communities of protected areas. In this study, we take advantage of a network of permanent forest plots installed in Great Smoky Mountains National Park in 1978 to investigate temporal changes in plant communities with different disturbance histories. In 2007, we revisited 15 permanent plots that were clearcut-logged in the late 1920s, prior to the Park establishment, and 15 permanent plots that have no documented history of human disturbance. We found that logged plots had an average of 8 fewer understory plant species than unlogged plots 50 years after logging and an average of 9.5 fewer species than unlogged plots 80 years after logging. Species richness decreased by an average of 4 species over 30 years in the logged plots, while species richness remained unchanged in the unlogged plots. Plots at low elevation had larger changes in species composition over time than did plots at high elevation, and plots with higher soil pH had larger decreases in species richness over time than plots with lower soil pH. Our results indicate that human disturbance can affect plant diversity for decades following the disturbance event, but that change in communities over time may depend more on environmental conditions than disturbance history.

### 3. VENEZUELAN TROPICAL DRY FOREST EXTINCTION RISK, THREATS, AND FUTURE PROSPECTS

*\*Jon Paul Rodriguez, Centro de Ecologia, IVIC;*

*\*Jafet M. Nassar, Centro de Ecologia, IVIC;*

*\*Kathryn M. Rodriguez-Clark, Centro de Ecologia, IVIC; \*Irene Zager, Provita; \*Carlos A. Portillo-Quintero, Earth Observation Systems Laboratory, University of Alberta; \*Fabian Carrasquel, Provita;*

*\*Sergio Zambrano, Centro de Ecologia, IVIC*

Tropical dry forests may be among the world's most threatened ecosystems, but few studies have objectively quantified their status and threats. We examined Venezuelan dry forest at multiple scales, and assessed their extinction risk, along with their historical and present threats, and the policy context determining their future. First, we contrasted historical and current dry forest cover at national and local scales, and used a recently-developed set of quantitative criteria to estimate ecosystem extinction risk. We found that while forests were vulnerable nationally, in northern-central locations they were endangered. We then quantified human uses and policy challenges and opportunities, at national and regional scales, combining a map of recent land cover with interview data from major stakeholders. Clearing for cattle ranching and for intensive and subsistence agriculture have been the principal factors driving dry forest loss, but logging and forestry have increased in recent years. The main challenge we found was the lack of explicit policies for management and use. "Misión Árbol" was the most promising ongoing policy framework found, with its 2011 target of planting 150,000 ha with predominantly dry forest species. The scientific community can support positive policies in many ways, including identifying locations and protocols for ecological restoration, maintaining seed banks, quantifying baseline conditions, and monitoring genetic diversity and other indicators.

### 4. EXAMINING CHANGE IN FORESTS AND WETLANDS IN AND AROUND KIBALE NATIONAL PARK, UGANDA

*\*Joel Hartter, University of New Hampshire; \*Sadie Ryan, Stanford University, McGill University; \*Jane Southworth, Department of Geography*

Parks have long served as centerpieces of the conservation movement. However, their establishment can have lasting impacts on the landscape and livelihoods of people living near them. Kibale National Park in western Uganda contains considerable biodiversity and is nearly an island of forested land cover, surrounded by intensive small-scale agriculture, some large-scale tea plantations, and many smaller, interstitial wetlands and forest fragments that remain unprotected. Wetland and forests are of particular interest because they supply resources to support rural livelihoods as well as provide important ecological services and wildlife habitat. These areas are also problematic for local farmers, since primates and elephants from these fragments raid crops and this interaction can lead to zoonotic emergence through spillover and spillback events. We examine these diminishing resource bases in the context of increasing human population, potential climate change, and conservation value at the landscape level using discrete and continuous data analyses of satellite imagery and place the results within the social context of western Uganda and conservation. While park boundaries have remained relatively intact since 1984, the landscape surrounding the park has become increasingly fragmented. Forests and wetlands outside Kibale that remain are becoming smaller with increased edge, more isolated, and potentially have lower productivity.

#### 5. FOREST TREE AND FERN SPECIES AS INDICATORS OF AN UNNATURAL FIRE EVENT IN MULANJE MOUNTAIN FOREST RESERVE, MALAWI

*\*JAMESTONE SMION KAMWENDO, Scientific Officer*

FOREST TREE AND FERN SPECIES AS INDICATORS OF AN UNNATURAL FIRE EVENT IN MULANJE MOUNTAIN FOREST RESERVE, MALAWI JAMESTONE SMION KAMWENDO National Herbarium and Botanic Gardens of Malawi (NHBGM) P.O. Box 528 Zomba Malawi E-mail: jkamwendo3@yahoo.co.uk STUDENT

PRESENTATION ABSTRACT Afromontane forests in Mulanje Mountain in Malawi are typically surrounded by fire prone *Widdringtonia whytei* (Mulanje cedar). Although the impact of fire on Mulanje cedar has been extensively studied, little is known about the impact of fire on adjacent forest. Severe fire swept through a mountain forest in 1996 and 2004. Studies have shown that fires have changed a large proportion of *Hyphaene* palm trees in the margin from single stemmed to multi-stemmed trees and reduced the number of *Widdringtonia whytei* in the margin by 68%. Using these species as indicators, we argue that similar fires will reduce the structure and diversity of mountain forests as a whole. The 1996 fire was fuelled by abnormally high fuel loads associated with surrounding pine plantations. Further, the large areas of the mountain are afforested and that global climate change is likely to lead to an increase in the conditions favouring intense fires. We therefore, consider effective management of Afromontane mountain forests essential.

#### 6. MANAGING FOR FIRE AND BIODIVERSITY IN THE PACIFIC NORTHWEST: A COMPARISON OF FEDERAL AND FAMILY FOREST LANDS

*\*Susan Charnley, USDA Forest Service, Pacific Northwest Research Station; \*A. Paige Fischer, Oregon State University*

This paper compares forest conditions on federal and nonindustrial private forest lands and explores the compatibility of two forest management goals: hazardous fuels reduction and biodiversity conservation. The severe fire events of the past

decade in the American west have led to an emphasis on forest management to reduce hazardous fuels on federal and nearby private forest lands. Yet reducing hazardous fuels may have negative effects on biodiversity by removing some habitat types and structural conditions. We hypothesize that private nonindustrial forest lands have lower fuel loads than federal forest lands because owners engage in active and fine-scale management; but also have species compositions and structural conditions less characteristic of native forest types than occur on federal lands because of their management histories. Our analysis combines qualitative data from interviews with family forest owners and federal land managers, with data on forest structure from forest inventories and spatial models of forest structure. The forest structure data serve as indicators of fire risk and biodiversity. Our geographic focus is central Oregon. After presenting the results of the forest structure analyses, we discuss the variables that influence forest management decision-making by different owners. We discuss the policy implications of our findings for promoting the dual goals of managing for fire and forest biodiversity in the Pacific Northwest.

#### 7. SUCCESSES & FAILURES IN INTRODUCING ENERGY PLANTATION IN TWO VILLAGES FOR REDUCING PRESSURE ON NATURAL RESOURCES OF AYUBIA NATIONAL PARK-PAKISTAN

*\*Adnan Muhammad, Kohat University of Science and Technology, Pakistan*

Ayubia National Park (ANP) is situated in the Gallis Forest Division of Abbottabad District, NWFP-Pakistan. With an area of 1684 ANP's forest resources are under tremendous pressure of fuel wood, fodder and timber extraction by surrounding habitations to meet their subsistence needs. Sources of fuel wood and fodder like Guzara and private forests are in exhausted condition, and substitutes like natural gas, LPG, Kerosene oil, wood from linear plantations are either not available nor affordable. Social forestry can have again an essential role in addressing the demands of local people. Following results of the initial studies on use and management of firewood in and around Ayubia National Park, it was decided that one way to minimize the consumption of firewood from ANP is to promote plantation of fast growing firewood tree species in village lands as well as in Guzara forests. Two villages Malachh and Pasala were chosen for experimentation of tree nurseries. This study is an approach towards finding success and failures in the interventions taken by WWF-Pakistan's Ethnobotany Project for reducing pressure on ANP's forest.

#### 8. TEMPORAL AND SPATIAL VARIATIONS OF HABITAT ASSOCIATIONS OF FALL MIGRATING SONGBIRDS AT AN INLAND SITE IN NORTHERN ALABAMA USA

*\*Lisa Gardner Barillas, Alabama A&M University; \*Yong Wang, Alabama A&M University*

Songbird species show different habitat associations during the breeding season. Migratory songbirds are sensitive to food availability at stopover sites, when they need to gain energy stores to continue migration. We tested the hypothesis that songbird migrants show different habitat associations spatially and temporally during migration stopover in the fall. We captured songbird migrants at an inland stopover site within the Walls of Jericho Management Area of northeastern Alabama during the fall of 2006 and 2007. A total of 1776 individuals at the wetland site, and 1517 individuals at the forested site were captured. The wetland had higher species richness than the

forest. Omnivorous species such as American Goldfinch and Indigo Bunting were concentrated at the wetland, and species including Wood Thrush, Gray Catbird, and Swainson's Thrush showed stronger associations with the forest. Some warbler species were distributed relatively evenly across both sites. Neotropical migrants used the sites earlier than Temperate migrants. Some habitat use patterns are consistent with breeding habitat associations, and may be related to food availability and habitat structure. However, some species showed more flexibility in habitat use, which may be related to the need to gain energy stores quickly to continue migration. These patterns have important implications for the conservation of these migratory species, as competition becomes higher with more species using similar habitats.

## 42. Freshwater Conservation

### 1. COMMUNITY ENGAGEMENT IN THE SUSTAINABLE MANAGEMENT OF RIVERS: BAREKESE CATCHMENT AREA, KUMASI, GHANA.

*\*Tyhra Carolyn Kumasi, Kwame Nkrumah University of Science and Technology*

The Barekese reservoir which provides 80 percent of the total public water supply of the Kumasi locale is visaged with persistent degradation through anthropogenic activities along its catchment area which also raises concern on the deteriorating water quality. The objectives of this study were to highlight the attitudes of the catchment area inhabitants towards their involvement in the sustainable exploitation and management of the Barekese watershed as a natural resource and explore ways of sustainably managing the Barekese catchment area to ameliorate the deteriorating water quality. Survey data was collected by the application of qualitative methods which include in-depth questionnaire interviews, observations and focus group discussions. The study shows that the various human centered activities by the inhabitants in the Barekese catchment area have adversely reduced the vegetation cover and general sanitary conditions around the main and feeder streams of the reservoir. The individual residents in these communities have not been involved in the management of the watershed and as a result are adversely affecting the sustainable management of the watershed. Community participation in the sustainable management of the Barekese catchment area has not been considerable and most implementation problems stem from lack of involvement and social equity.

### 2. THE CASE OF THE DISAPPEARING MUSSEL: LESSONS IN ENDANGERED AQUATIC SPECIES CONSERVATION

*\*Brena Jones, North Carolina Wildlife Resources Commission*

Freshwater mussels are among our most imperiled fauna: over 70% of North America's native mussel species are imperiled or extinct. In North Carolina, the federally endangered Carolina heelsplitter (*Lasmigona decorata*) mussel is facing extirpation from large portions of its limited range. The North Carolina Wildlife Resources Commission spent ten years attempting to protect the heelsplitter in the Goose Creek watershed near Charlotte, once considered a stronghold for this species. Due to lack of effective coordination and support among federal, state, and local governments which limited ability to effect real improvement in the stream itself, and an unstoppable tide of urban development, this population continues its drastic decline and much of its habitat has been destroyed. However, valuable lessons in watershed management have been learned and

important life history and captive propagation information has been garnered as a result of this effort. These experiences have already been and continue to be applied in other priority conservation areas around the state in order to improve aquatic species management and prevent these losses from being repeated.

### 3. THE DESERT FISH HABITAT PARTNERSHIP: BUILDING FRESHWATER CONSERVATION FOR AT-RISK FISHES ON A REGIONAL SCALE

*\*Jon C Sjoberg, Nevada Department of Wildlife; \*Nathan Allan, Desert Fishes Council; \*Heidi Blasius, Bureau of Land Management; \*Kathryn Boyer, Natural Resources Conservation Service; \*Chris Cantrell, Arizona Game and Fish Department; \*Stephanie Carman, New Mexico Department of Game and Fish; \*Tom Collazo, The Nature Conservancy; \*Robin Schrock, US Geological Survey - BRD Fisheries*

Arid land aquatic habitats in the western and southwestern United States support a significant level of aquatic diversity with 175 endemic species and subspecies of non-salmonid fishes including 52% of freshwater fishes listed under the ESA. Widespread stressors including land use change, urbanization, water development, climate change and invasive species are severely impacting these species and aquatic habitats but the region has lacked comprehensive conservation planning and implementation to arrest the decline of these species assemblages and unique, often isolated habitats. The Desert Fish Habitat Partnership, patterned after other joint ventures and sport fish habitat partnerships, incorporates 20 State, Federal and NGO partners in the development of a range-wide conservation needs assessment and conservation strategy for desert fish species and habitats. Building on existing Wildlife Action Plans from 10 partner states, the DFHP uses those assessments to identify and prioritize regional threats and stressors, identify opportunities for cross-boundary conservation and partnership with other conservation efforts such as the Western Native Trout Initiative, and develop capacity building through stakeholder outreach to increase the flexibility of existing funding sources and enhance resources for conservation of priority "underserved and overlooked" desert fish species and habitats, emphasizing watershed level conservation and multi-species conservation implementation.

### 4. THE URBAN ECOLOGY OF A FRESHWATER TURTLE, CHELODINA LONGICOLLIS, IN THE AUSTRALIAN CAPITOL TERRITORY

*\*John Roe, University of Canberra*

Studies of turtles in urban environments have identified numerous threats to populations including roads, collection, and predation. While these challenges are unequivocally detrimental to some populations, urban environments may also provide some benefits. Using radio-telemetry and capture-recapture, we studied the behavior, growth, survival, and population demographics of the freshwater turtle *Chelodina longicollis* in an urban region and neighboring nature reserve in Australia. Urban turtles traversed larger home ranges and moved longer distances than those in the nature reserve. Extended terrestrial aestivation was common among female turtles in the nature reserve, but not in urban turtles. Survivorship and rates of inter-wetland movement were similar, but growth was higher in urban turtles. Sex ratios, relative abundance, and injury incidence were similar between

regions, but urban turtle populations were more biased towards larger adults. Although turtles in urban habitats experience higher incidence of "unnatural" mortality (e.g., roads, pets) we propose that stable hydroperiods and increased nutrients benefitted urban turtles. Urban turtles also utilized culverts to cross roads when moving between wetlands, allowing them to continue movements without suffering the expected mortality consequences. We demonstrate that turtles in urban and natural landscapes may behave differently, but that urban landscapes (if well-designed) can harbor healthy populations.

## 5. VARIATION IN ECOSYSTEM SENSITIVITY TO URBANIZATION BETWEEN PHYSIOGRAPHIC ECOREGIONS IN THE SOUTHEASTERN UNITED STATES

*\*Ryan Michael Utz, University of Maryland Center for Environmental Science; \*Robert H Hilderbrand, University of Maryland Center for Environmental Sciences*

The link between decline in stream biotic integrity and watershed urban land use is well established. However, much such work ignores potentially important variation in stream form diversity. Specifically, streams located within different ecoregions may respond differently to the same degree of urbanization within a watershed. We explore how stream biota and physiochemical parameters respond to urbanization between the Piedmont and Coastal Plain physiographic provinces using Maryland Biological Stream Survey (MBSS) data. For both communities and individual taxa, benthic macroinvertebrates appear to be more capable of tolerating urbanization in the Coastal Plain relative to the Piedmont. Analyses of fish taxa concur with macroinvertebrate trends. Among-region variation in physiochemical responses to urbanization between provinces also were explored as potential drivers behind the differential responses observed in the biota. Differences include nutrient and pollutant loads, sediment embeddedness, and shifts in hydrologic regime. Our findings highlight the importance of considering spatial variability when examining ecosystem sensitivity of streams to land use change, particularly in the southeastern United States where the Coastal Plain-Piedmont physiographic boundary extends from New Jersey to Alabama and intersects multiple metropolitan areas.

## 6. WHY THERE ARE MORE FISH DOWNSTREAM

*\*Gary D. Grossman, Warnell School Forestry & Natural Resources, University Georgia; \*Mark Farr, US Army Engineer Research Development Center; \*Michael Wagner, Fisheries & Wildlife, Michigan State University; \*J. Todd Petty, Division of Forestry, West Virginia University; \*Robert Ratajczak, Warnell School Forestry & Natural Resources, University Georgia*

Studies identifying mechanisms regulating biodiversity are uncommon, yet necessary for management of ecological systems. In stream fish assemblages worldwide, diversity generally increases as one moves downstream. Prior studies of this phenomenon focus on the downstream portions of the gradient, and infer that higher downstream fish diversity is produced by greater habitat diversity or food production in these reaches. We quantified assemblage structure 2X annually between 1991 and 2004 in a permanent 100m site, and experimentally quantified critical velocities for the dominant species. There was a highly significant positive relationship ( $r^2 = 0.73$ ) between drought (measured by Palmer Drought Index) and fish diversity. The high diversity in drought years was

produced by species moving upstream into the study site. Critical velocity estimates showed that residents could better withstand high flows than downstream migrants. Stream temperature differed less than 1C between drought and non-drought years in both upstream and downstream sites. Our study is one of the first experimental demonstrations of a mechanism capable of producing the downstream gradient in stream fish diversity. The relationship between drought and biodiversity is counter-intuitive and argues for the preservation of natural flow regimes in Appalachian streams.

## 43. Freshwater Conservation (2)

### 1. A FRESH LOOK AT THE WORLD: GLOBAL PATTERNS OF FRESHWATER SPECIES AND THREAT USING A NEW FRAMEWORK

*\*Robin Abell, WWF; \*Michele Thieme, World Wildlife Fund; \*Carmen Revenga, The Nature Conservancy; \*Paulo Petry, The Nature Conservancy; \*Rebecca Ng, World Wildlife Fund; \*Mark Bryer, The Nature Conservancy; \*Nikolai Sindorf, World Wildlife Fund; \*James Robertson, The Nature Conservancy; \*Jonathan Vernon Higgins, The Nature Conservancy; \*Eric Wikramanayake, World Wildlife Fund; \*Thomas Heibel, The Nature Conservancy*

A new framework, Freshwater Ecoregions of the World (FEOW), permits the most comprehensive global analysis to date of patterns of freshwater biodiversity and threats to it. Working with dozens of ichthyologists, we have divided the non-marine surface of the world into 426 biogeographically-informed freshwater ecoregions and synthesized freshwater fish, amphibian, and reptile species data for all units. Analyses of the species data confirm recognized freshwater 'hotspots' and identify new, previously overlooked systems. In the tropics we find large areas of overlap between areas of high biodiversity for both freshwater and terrestrial systems, but in higher latitudes in particular we identify freshwater systems that terrestrial prioritizations have missed. Global analyses looking at major threats specific to freshwaters, such as water stress and dams, draw attention to systems not normally considered highly imperiled by indexes like Human Footprint and underscore the need to introduce hydrographic networks into freshwater assessments. These and other FEOW products and datasets will enable a range of new global and regional conservation analyses and, for many of the world's lesser known freshwaters, will provide synthesized information describing those systems for the first time.

### 2. BEHAVIORAL AND PHYSIOLOGICAL RESPONSES OF FRESHWATER MUSSELS (BIVALVIA: UNIONOIDA) TO VARIATIONS IN STREAM DISCHARGE

*\*Samrat Saha, Tennessee Technological University; \*James B. Layzer, Tennessee Technological University*

The effect of increases in stream discharge on vertical movement of mussels was determined on the Duck River. Sampling consisted of visual counts of epibenthic individuals to determine proportions of epi- and endobenthic mussels immediately before and after spikes in the hydrograph. Discharges  $> 30 \text{ m}^3 \text{ s}^{-1}$  caused the majority of mussels to become endobenthic. Increase in discharge caused mussels to burrow irrespective of species, sex, or spawning and gravidity

periods. Mussels reappeared on the substrate surface 3 - 5 d after discharge stabilized. The effect of increases in stream discharge on mussel physiology was determined by comparing glycogen concentrations in mantle biopsies between epi- and endobenthic individuals of five species before and after discharge spikes in the Duck and Clinch Rivers. Although mean glycogen concentrations between epi- and endobenthic mussels were statistically similar, they tended to be slightly higher in epibenthic mussels than in endobenthic ones. Long-term burrowing can possibly affect energy reserves and reproduction of mussels. Discharge from dams should be regulated to minimize duration of burrowing in mussels, especially during reproductive season. A preliminary recommendation to minimize burrowing is to maintain depth at < 1 m and velocity at < 0.63 cm s<sup>-1</sup> for conservation of mussels in regulated streams.

### 3. EFFICACY OF REFUGES TO MAINTAIN GENETIC DIVERSITY WITHIN POPULATIONS OF THE DEVILS HOLE PUPFISH (CYPRINODON DIABOLIS).

*\*Gerard Zegers, N.M. Cooperative Fish and Wildlife Research Unit. NMSU Fishery and Wildlife Science; \*Sherri Baker, Dexter National Fish Hatchery and Technology Center; \*Connie Keeler-Foster, Dexter National Fish Hatchery and Technology Center*

Refuge populations of Devils Hole Pupfish, *Cyprinodon diabolis*, have been established to safeguard the species from extinction. The refuges were designed to replicate the conditions of Devils Hole. Regular introductions of fish from Devils Hole were planned (but not implemented) to counter genetic drift. The refuge populations have suffered from outright failure, dramatic fluctuations in population size, and hybridization with *Cyprinodon nevadensis*. There are no fish currently in the refuges. Nevertheless, refuges remain as a major component of the recovery strategy. We utilized twelve microsatellite loci to assess the genetic composition of pupfish from these refuges. Assignment tests of 226 pupfish (held at Willow Beach National Fish Hatchery, salvage, and historic samples) were used to determine if they classified as pure *C. diabolis*, *C. nevadensis*, or hybrids. Each fish was assigned to one of the three groups with 95 percent probability. Sixty-two were *C. diabolis*, 56 were from the Hoover Dam refuge. The remaining six formed a nested cluster. All six came from Devils Hole itself. Thirteen additional "historic" Devils Hole samples were identified from frozen archives. Those fish were intermediate between the six from the nested group and the Hoover Dam cluster. Our results confirm the hybridization event at Point of Rocks and suggest that the Hoover Dam refuge failed to maintain representative genetic variability from Devils Hole.

### 4. EVOLUTIONARY EXPERIENCE, NOT PHENOTYPIC PLASTICITY, DETERMINES SURVIVAL OF LOWLAND LEOPARD FROG TADPOLES IN THE PRESENCE OF INTRODUCED SUNFISH

*\*Amanda M. Lea, University of Texas; \*Martin Schlaepfer, SUNY-ESF*

Introduction of non-native predators can have devastating effects on populations of prey that have not evolved defensive mechanisms. Populations of *Rana yavapaiensis*, a frog native to Arizona, have declined in part due to predation of tadpoles by introduced sunfish. Some populations, however, have persisted for decades post-invasion. Previous studies have shown that *R.*

*yavapaiensis* tadpoles exhibit inducible antipredator defenses—decreased activity and deeper tailfins—when exposed to sunfish cues. Our goal was to determine if a population's evolutionary history (prior exposure to sunfish or not) confers greater plastic response and survival advantage. We raised tadpoles either in the presence or absence of sunfish and tested the magnitude of induced morphological traits between populations. We then measured survival of tadpoles when exposed to actual sunfish predation. Our results show that tadpoles from both experienced and naïve populations grow deeper tails and become less active when raised in the presence of sunfish. Surprisingly, survival correlated with evolutionary history but not treatment or tail morphology. Our study suggests that even a short evolutionary history with a novel predator enhances survival, while phenotypic plasticity per se does not. Understanding the evolution of antipredator defense is important to conservation because it may highlight mechanisms for favoring long-term persistence of native species in spite of introduced predators.

### 5. PERCHLORATE DISRUPTS GONADAL DEVELOPMENT IN FISH

*\*Richard R. Bernhardt, University of Alaska Anchorage; \*Frank Arthur von Hippel, University of Alaska Anchorage; \*Todd O'Hara, University of Alaska Fairbanks; \*William Cresko, University of Oregon*

Perchlorate is a persistent water-soluble contaminant that is pervasive in the United States. We found that exposure to perchlorate during development masculinizes both female and male stickleback fish (*Gasterosteus aculeatus*): perchlorate causes genotypic female stickleback to become functional hermaphrodites and to display male-typical courtship behavior, and it causes genotypic males to develop abnormally large testes in a dose-dependent manner. Perchlorate also prevents normal pigmentation (leading to visibility of internal organs), causes gross developmental abnormalities, reduces growth rates, prevents the development of calcium-based tissues like spines and bony lateral plates, and disrupts normal reproductive behavior and swimming performance. The results suggest that fish and other vertebrates in perchlorate-contaminated water bodies have a greater likelihood of dying before they reproduce, and therefore are unlikely to maintain healthy populations. Contaminated animals are also more likely to be preyed upon, thereby promoting the trophic transfer of perchlorate. However, impaired stickleback that reproduced in water without detectable levels of perchlorate produced offspring without the suite of abnormalities noted among perchlorate-treated fish. This result suggests that surviving populations can restore themselves following remediation of perchlorate-contaminated sites.

### 6. POPULATION ECOLOGY OF GROTTO SCULPIN (COTTUS CAROLINAE) IN CAVE AND RESURGENCE STREAMS

*\*Julie Lynne Day, University of Central Arkansas; \*Clint R Johnson, University of Central Arkansas; \*Joseph E Gerken, Kansas State University; \*Ginny Adams, University of Central Arkansas*

Grotto sculpin are a unique population of banded sculpin endemic to caves underlying Perry County, Missouri. These troglomorphs are currently state threatened in Missouri and a federal endangered species candidate. Given the paucity of comprehensive studies of non-game fishes, particularly benthic species, and the unstable nature of cave environments, collection of baseline data is crucial to examine population ecology. Grotto sculpin are highly susceptible to pollution via

runoff, so the goal of this study was to examine recolonization potential in case of a catastrophic event (e.g., contaminant spill) in two cave populations and their corresponding resurgence streams. Sites were divided into 10 m sections and fish tagged with unique elastomer combinations every four to eight weeks beginning August 2005. Presence of adult grotto sculpin was consistent throughout sampling for the two caves. In resurgence streams, there was a marked decline of adults in late winter (January-March) and a peak in abundance of young-of-year in May, which corresponds to the presence of larval sculpin drifting from resurgence springs. This late winter decline in adults may coincide with the subterranean movement of adult fish for reproduction. Nearly 90% of fish in caves moved less than 50 m between sampling intervals. Based on our data, the relatively sedentary nature of the grotto sculpin may limit their ability to recolonize habitats. Movement, morphology and evolution will be discussed.

## 7. ROAD RUNOFFS AND THEIR EFFECTS ON BIOLOGICAL SYSTEMS

*\*Achik Dorchin, Department of Evolutionary and Environmental Biology, Faculty of Science and Science Education, University of Haifa; \*Uri Shanas, Department of Biology, Faculty of Science and Science Education, University of Haifa-Oranim*

Road runoffs impose threat to the environment by adding toxic pollutants. Using bioassays rather than chemical analyses can assist elucidating the cumulative effect of the numerous pollutants within the runoff. We sampled road runoffs in Israel during the 2005-2006 and 2006-2007 rain seasons, and assessed their effects on aquatic bioindicators using controlled toxicity tests. The results show that road runoffs are potentially toxic to both toads and daphnids, and that their pattern of influence is constant, although different for each of the bioindicators, depending on the time of collection during the rainy season. We show for the first time that exposure to midseason runoffs from two major highways, after multiple rain events can have an adverse effect on growth and development rates of green toad (*Bufo viridis*) larvae, and can also lead to increased morphological deformation rate. *Daphnia magna* exposed to the first seasonal runoffs from the same roads died within 24-48 hours. Using artificial solutions containing corresponding concentrations of heavy metals to first seasonal flush we revealed a synergistic adverse effect of metals on the survival of *Daphnia* as well as an additive effect of non metal pollutants in the water. The high environmental contamination potential from road runoffs demonstrated in this study necessitates actions for the control and prevention of above ground water bodies as well as groundwater pollution from road runoffs.

## 8. THE EFFECTS OF HABITAT HETEROGENEITY ON MACROINVERTEBRATE COMMUNITY STABILITY AND FOOD WEB STRUCTURE

*\*Raven L. Lawson, Clemson University; \*Bryan L. Brown, Clemson University*

Previous research suggests that community stability increases with habitat heterogeneity. Understanding this relationship could be beneficial to stream restoration attempts. The objective of this study was to determine if high substrate heterogeneity would increase stability among a local benthic macroinvertebrate community, due to increased refugia from predators. We manipulated substrate heterogeneity in twenty enclosures placed along a 300m reach of Six Mile Creek in the Clemson University Experimental Forest. We used an analysis of covariance design with crayfish (*Cambarus bartonii*)

presence or absence as a fixed factor, and substrate heterogeneity as a continuous factor. Substrate heterogeneity ranged from plots of nearly homogeneous substrate composition to plots of extremely diverse substrate composition that included several different cobble sizes as well as sand, gravel, and CPOM. After an acclimation period of two weeks, we sampled the macroinvertebrate community weekly (for eight weeks) to track changes in community structure. We predicted that stability in enclosures containing crayfish would increase with substrate heterogeneity while there would be no change in stability with habitat heterogeneity in enclosures without crayfish. In this paper, we discuss the effects of habitat heterogeneity and predator presence/absence on macroinvertebrate community stability and food web structure using community composition, and effects on algal and detrital resources.

## 44. Human Impacts and Protected Areas

### 1. A CONSERVATION PLANNING TOOL FOR CALCULATING RETURN ON INVESTMENT AT THE RESOLUTION OF LAND PARCELS AND OTHER SMALL AREAS

*\*Doug Ward, University of Queensland; \*Bob Pressey, James Cook University; \*Daniel Segan, University of Queensland; \*Hugh Possingham, university of queensland*

Most conservation planning tools are target-based, and only recently have they included conservation costs as a selection criterion. A consequence of target-based approaches is that many parts of planning regions appear to have no conservation value because they contain biodiversity features for which targets have been achieved. Missing from the array of planning tools is a system that combines a continuous measure of conservation value with variable conservation costs, operates at the resolution of sites, and can be constantly updated as the conservation landscape changes. We developed a conservation planning tool that uses species-area relationships (SAR) as continuous benefit functions for representation units such as vegetation types or marine habitats. SARs can provide an explicit relationship between species number and conservation costs and can therefore be used to calculate species return on investment (ROI). Our conservation planning tool dynamically calculates species ROI for representation units, defined as the number of species potentially afforded protection divided by the cost of areas. This calculation considers species already occurring in conservation areas, compositional overlap between representation units, and the effects of species spatial autocorrelation. The tool dynamically updates ROI as decisions are made about conservation or development and is designed for planning practitioners working at regional scales or in local government.

### 2. CARNIVORES IN THE FARMLAND MATRIX: USE OF AVOCADO ORCHARDS DEPENDS ON NEIGHBORING LAND USE TYPES

*\*Theresa Nogeire, UCSB; \*Frank W. Davis, UCSB*

Conservation of wide-ranging carnivores is increasingly difficult as native habitats are replaced by urban and agricultural land use. However, research indicates that remnants of native habitat embedded within the agricultural matrix can support mammalian carnivores. Farmland can be useful for movement and, especially for omnivores like coyotes and bears, crops can provide food subsidies. Avocado orchards are an important land use in southern California and avocados

are a food resource for many omnivores, including coyote (*Canis latrans*), black bear (*Ursus americanus*), and gray fox (*Urocyon cinereoargenteus*). The orchards are also used by bobcats (*Felis rufus*). But agricultural landscapes present dangers for these animals including exposure to roads and vehicles and exposure to poisons such as rodenticides. We used CIRCUITSCAPE (<http://www.nceas.ucsb.edu/~mcray/software/circuitscape.htm>) to model landscape connectivity and movement pathways for bobcats and gray fox in a coastal California landscape of forest, rangeland, urban and agricultural land use. We are currently validating model predictions using remotely triggered cameras and scat surveys.

### 3. CLIMATE CHANGE IMPACT AND ADAPTATION IN CANADA'S NATIONAL PARKS

*\*Marlow Pellatt, Parks Canada*

The adaptation of ecosystems to the impacts of climate change is being experienced at a global level. The need to develop of policy and management actions to help mitigate and adapt to the effects of changing climate on ecosystems is imperative. Climate change issues in Canada's national parks are being examined at a number of levels ranging from regional bioclimatic envelope models to impact scenarios focussed on biomes throughout the national park system. Parks Canada has also identified the need to develop a "climate change adaptation strategy". The scope of this task includes ecosystem and heritage resource protection, visitor experience, and public education. It also encompasses terrestrial, fresh water, and marine environments. This paper will discuss examples of research and management actions in Canada's National Park (e.g., the development of bioclimatic envelope models to assess how western Canada's Garry oak ecosystems may respond to climate change, as well as discuss the role that national parks and marine protected areas may play in ecosystem conservation across the Canadian land and seascape. This paper will discuss the complex and sometimes conflicting aspects of global climate change impacts, mitigation and adaptation and how they may affect a protected area agency like Parks Canada.

### 4. CONSERVATION AND DEVELOPMENT TRADE-OFFS IN THE FACE OF GLOBAL CLIMATE CHANGE

*\*Daniel Miller, University of Michigan*

Human-induced climate change is exacerbating the intertwined problems of biodiversity loss and persistent poverty among rural communities, particularly in low-income tropical countries. The strategy of integrated conservation and development projects (ICDPs) has been developed over the past two decades to address these two issues simultaneously. Recent research has increased understanding of the factors that have inhibited ICDP success, emphasizing the need for explicit consideration of trade-offs between conservation and development goals at different spatial and temporal scales in future project implementation. However, this literature has largely ignored climate change. This paper analyzes how climate change reconfigures trade-off considerations. It identifies both opportunities and challenges that climate change presents for reconciling the twin objectives of conserving biodiversity and enhancing the well-being of local communities by drawing on research in the climate change field relating to the Clean Development Mechanism (CDM) of the Kyoto Protocol. Bridging these two domains of environmental policy, this paper argues that next generation ICDPs would benefit from understanding CDM experience. At the same time, attention to recent assessments of ICDP experience would strengthen CDM policy and project implementation,

particularly relating to efforts to use carbon trading for tropical forest conservation.

### 5. ECOLOGY AND CONSERVATION OF BATS IN AN URBAN LANDSCAPE IN ESPÍRITO SANTO STATE, SOUTHEASTERN BRAZIL

*\*Monik Oprea, Federal University of Espirito Santo; \*Thiago Bernardi Vieira, Federal University of Espirito Santo; \*Poliana Mendes, Federal University of Espirito Santo; \*Albert David Ditchfield, Federal University of Espirito Santo*

Urbanization causes habitat loss and fragmentation, leading to local extinctions and frequently eliminating native species. The effects of urbanization on bats are poorly understood, but scant evidence suggests declines in diversity and abundance. In urban landscapes, wooded streets may be regarded as corridors, improving connectivity among forest remnants (urban parks) embedded in the urban matrix. In order to test the hypothesis that wooded streets function as habitat corridors for bats, during one year we monthly mist-netted urban parks, wooded streets and non-wooded streets in the city of Vitória, southeastern Brazil. We captured a total of 10 bat species (174 captures of 172 individuals). Eight species were captured only in parks, two in wooded streets and only one in non-wooded streets. Abundance results are similar, with non-wooded streets accounting for only 3 captures. Jaccard's similarity index shows that wooded streets are more similar to non-wooded streets than to parks. Our results suggest that urbanization isolated most bat species in the remaining habitat patches (urban parks) and that only very few species are able to use wooded streets to move through the landscape and minimize isolation. Wooded streets have already been reported as potential corridors for birds in urban landscapes. However our results suggest that for bats, such streets are not providing the same degree of connectivity as observed for birds.

### 6. FLUID POPULAR DISCOURSE AND THE LOCATION OF WIND POWER FACILITIES IN WILDLIFE CONSERVATION AREAS

*\*j anthony abbott, stetson university*

The process of permitting new wind power projects reveals contrasting views of anticipated project impacts. When new facilities are contentious, debates are active and themes of environmental corruption frame the discussion. While environmental impacts of a wind power project will vary with its geographic context, conservation discourse for a specific project reflects less about materially defined conservation metrics than about imagined socioeconomic concerns. In Kittitas County, Washington, conservation discourse related to wildlife and landscape aesthetic charges public commentary for three wind power projects. While concerns for wildlife conservation and visual impact are shared among those contesting windmill placement, concerns for negative impacts manifest less when windmills are proposed for remote landscapes, such as wildlife management areas, illustrating discourse fluidity among locales. This portends increasing development of wildlife management spaces as landscapes of energy production.

### 7. INFLUENCES OF QUIET, NON-CONSUMPTIVE RECREATION ON PROTECTED AREA EFFECTIVENESS

*\*Sarah E Reed, University of California, Berkeley & The Wilderness Society; \*Adina M. Merenlender, University of California, Berkeley*

Protected areas around the world were created with the goals of

preserving biodiversity and providing nature-based recreation opportunities for millions of people. This dual mandate guides the management of the majority of the world's protected areas, but to date, little has been done to assess the compatibility of 'quiet', non-consumptive recreation and biodiversity protection. We combined non-invasive survey techniques and DNA verification of species identifications to survey 28 parks and preserves in northern California, and we used the distributions and densities of seven mammalian carnivores as indicators of the influences of recreation on protected area effectiveness. Carefully-selected paired comparisons revealed that the presence of quiet, non-consumptive recreation correlated with fivefold declines in the densities of native carnivores and a substantial shift in community composition from native to non-native species. Carnivore populations were not influenced by differences in dog management policy among recreation sites, but densities of bobcats and coyotes were negatively correlated with rates of recreational visitation. Demand for recreation and nature-based tourism is forecasted to grow dramatically around the world, and these results suggest a pressing need for new approaches to the designation and management of protected areas.

#### 8. INTRASPECIFIC COMPETITION IN THE INVASIVE, BIENNIAL GARLIC MUSTARD AND THE RESPONSE OF NATIVE VEGETATION TO GARLIC MUSTARD REMOVAL

*\*Jonathan Thomas Bauer, Illinois State University; \*Roger C Anderson, Illinois State University; \*M. Rebecca Anderson, Illinois State University*

We studied the effects of hand weeding of second-year garlic mustard plants (*Alliaria petiolata*) on first-year garlic mustard plants and native vegetation. Garlic mustard is a Eurasian biennial plant that has invaded the ground layer of deciduous forests in eastern North America. Our study took place in central Illinois and treatments consisted of early or late spring weeding of second-year garlic mustard plants and controls. Pretreatment data was collected in 2004. Plots were then treated or left as controls and sampled in 2005, 2006, and 2007. We found no significant effect of treatment in 2004 or 2005. In 2006 cover of first-year garlic mustard was higher in early weeding treatments than in late treatments or controls. In 2007 cover of first-year plants was lower in treatment than control plots. There was no significant effect of treatment on the total cover of native species, cover of the five most abundant species or bare ground. Our data shows that hand weeding of garlic mustard can effectively reduce infestations of garlic mustard and that late weeding may be more effective by allowing second-year plants more time to compete with first-year plants. Our results also indicate that competition between first- and second-year garlic mustard plants is responsible for the alternating dominance of first- and second-year plants.

#### 9. INVESTIGATION OF THE EFFECTS OF CLEARFELLING MANAGEMENT ON GREENHOUSE GAS FLUXES IN A SITKA SPRUCE FOREST PLANTATION, USING A CHRONOSEQUENCE APPROACH

*\*ELENI KARALI, UNIVERSITY OF EDINBURGH; \*OYOMOARE LOLADE ERUOGUN, UNIVERSITY OF BENIN*

Plantation forestry on drained peatlands has become a large land use category in temperate regions. It is projected that in the near future, when these forests reach their regeneration age, the rate of clear-felling (CF) will rapidly increase, which may contribute to climate change. In the present study, we

investigated the influence of CF on greenhouse gas (GHG) emissions from a Sitka spruce plantation (Eskdalemuir, Scotland) using a chronosequence approach. CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub> fluxes as well as edaphic properties were recorded from stands of 5 age classes; 0, 1, 6, 10 and 30 years after CF, in late spring and early summer. Also, using incubation experiments, we examined the effect of increased temperature and soil moisture levels, in line with the predicted changes in global climate, and that of N-deposition on GHG fluxes from harvested tree stands. Soil temperature, total carbon and dissolved organic carbon were significantly predicted by age class. Age class 1 gave the highest N<sub>2</sub>O fluxes (8.17 gN/ha/day), while age class 0 gave the highest CH<sub>4</sub> (10.36 gC/ha/day) and CO<sub>2</sub> fluxes (29.80 kgC/ha/day). The results of this study showed that changes in the edaphic properties of the recently harvested stands likely contributed to the observed increases in GHG emissions. Similarly, the results from the incubation experiments showed that the increased N-deposition and the projected climate change are likely to exacerbate the effect of tree CF, resulting in accelerated trace gas fluxes.

#### 10. LEAVE A TRACE - COLLABORATION IN ULITHI ATOLL, MICRONESIA LINKING ON-SITE EDUCATION OF ECOTOURISTS, LOCAL SEA TURTLE CONSERVATION, AND COMMUNITY NEEDS

*\*Wayne Sentman, Oceanic Society*

Oceanic Society organizes naturalist led ecotourism programs supporting local marine conservation efforts at Falalop Island, Ulithi Atoll. A Green Sea Turtle Research Project endorsed by village elders employing residents trained to monitoring and tag sea turtles is a highlight. Though visible, ecotourist motivation for travel and overall contributions are often not transparent to the community. In 2007 Oceanic Society won a SWOT grant helping sea turtle educational opportunities directed at ecotourists to incorporate local students and teachers. Separate fundraising efforts directed at prior years ecotourists established a Sea Turtle Scholarship Fund awarded to one high school student from the Ulithi community through another US non-profit Habele. Successful fundraising elevated by the grant award, facilitated Oceanic partnering with Habele, previously not perceived linked to marine conservation efforts. Combining on-site education forums with the new scholarship aided in a community-wide appreciation for current community efforts directed at sea turtle conservation, the local workers participating, and ecotourists arriving to learn about both. Through this collaboration local community leaders could point to real benefits for the Ulithi citizenry achieved via their commitment to sea turtle conservation and ecotourism. Now village members can identify links between their sea turtle conservation efforts, resultant ecotourism, and their community gaining from that merger.

#### 11. NOVEL FOOD WEBS WITH NOVEL SPECIES

*\*Dan Clarke, University of Toronto; \*Turner Blake, University of Toronto; \*Jim Bowlby, Ministry of Natural Resources; \*Eric Davies, University of Toronto; \*Mart R Gross, University of Toronto*

In recent decades, the dominant species in many ecosystems are novel (non-native) taxa. Conservation biologists have typically viewed novel species as destabilizing elements that give rise to unsustainable food webs. However, there is increasing anecdotal evidence to suggest that some ecosystems incorporate novel species into novel food webs that are sustainable. Here, we evaluate the hypothesis that the invasions of the novel round goby and zebra mussel into Lake Ontario

have produced a new food web which incorporates novel species. Stomachs from predacious adult salmonid were collected in the near-shore of Lake Ontario during spring 2007 and 2008 and analyzed for prey-species composition. Our results show a radical shift in the diet of these salmonid predators from the historical native prey species, to the novel alewife, to one now dominated by the novel round goby. The round goby itself preys heavily on the novel zebra mussel. Accordingly, these results lend support to the concept that ecosystems such as Lake Ontario may incorporate novel species into their food webs. As such, it may be necessary to re-evaluate the role of novel species to the future sustainability of ecosystems.

## 12. OPPORTUNITY COSTS IN CONSERVATION PLANNING - OF THE CASE OF EUROPEAN WETLAND SPECIES

*\*Kerstin Jantke, Research Unit Sustainability and Global Change, University of Hamburg; \*Uwe Schneider, Research Unit Sustainability and Global Change, University of Hamburg*

Protected areas in the European Union cover currently about 20 percent of the total land area. Preservation has often been done ad hoc and uncoordinated between countries, and despite increasing conservation efforts, biodiversity loss is still accelerating. Considering land scarcity and demand for alternative uses, efficiency in conservation strongly depends on the efficiency in land allocation. Systematic conservation planning provides tools to identify optimally located priority areas for conservation. Previous studies have minimized the costs for exogenously given conservation targets. However, these studies have assumed constant marginal costs of preservation. We follow and extend this cost minimization approach by also considering an endogenous representation of marginal costs. The more land is allocated to nature reserves, the higher are opportunity costs, i.e. the costs of forgone agricultural production. The increase in opportunity costs results from prices changes for agricultural commodities. We employ a deterministic, spatially explicit mathematical optimization model, which allocates species habitats by minimizing the opportunity cost for setting aside land for conservation purposes. Mixed integer programming is used to represent minimum habitat area thresholds for all included species. The analysis is done for European wetland species but can easily be adapted to other species, biodiversity features, or regions.

## 13. REPRESENTING BIODIVERSITY AND MINIMIZING IMPACT TO FISHERMEN: A COMPARISON OF TWO RESERVE DESIGN APPROACHES USED IN CALIFORNIA

*\*Carissa Joy Klein, university of queensland; \*Charles Steinback, Ecotrust; \*Astrid Scholz, Ecotrust; \*Hugh Possingham, university of queensland; \*Sarah A. Kruse, Ecotrust*

We compared the effectiveness of marine reserve networks designed using a numerical optimization tool with networks designed by stakeholders during the course of California's Marine Life Protection Act Initiative at representing biodiversity and minimizing negative impacts to fishermen. We used the same spatial data representing biodiversity and recreational fishing effort that was used by the stakeholders to design reserves. We also used existing commercial fishing data that was not explicitly available to the stakeholders. Reserves designed with numerical optimization tools represented the same amount of each habitat, or more, and had less of an

impact on commercial and recreational fisheries than networks designed by the stakeholders. The stakeholder's reserves could have represented 2-9.5% more of each habitat with the same impact on the fisheries as the reserves designed by the stakeholder groups. Of the four reserve proposals considered in the initiative, the proposal designed by fishermen was most efficient at representing biodiversity and minimizing impact to the fishing industry. These results highlight the necessity of using comprehensive information on fishing effort to design reserves that efficiently minimize negative socioeconomic impacts.

## 14. THE IMPLICATIONS AND CONSEQUENCES OF OVERLAPPING INDUSTRIAL AND CONSERVATION ZONING IN THE REPUBLIC OF CONGO

*\*Michelle Wieland, University of Minnesota*

Multiple land-use zoning, past and present, has had both drastic and subtle influences on the ways various stakeholders perceive and exploit protected areas. Nowhere are the challenges of industrial zoning more evident than in Central Africa, where the historical pervasiveness of industrial activity has had a strong influence on how stakeholders view conservation and protected area management. Conkouati National Park in the Republic of Congo exemplifies this; industrial concessions (or zoning) for timber, mining, and oil have existed since colonial times and continue to overlap with park boundaries today. To explore how this zoning impacts key stakeholder perceptions and use of the environment, two years were spent at Conkouati conducting in-depth stakeholder interviews and archival research. The findings suggest the overlap of industrial and conservation zoning have strong negative consequences for local buy-in of conservation initiatives. They also demonstrate the relatively low value that government places on conservation in Congo as compared to competing economic activities. It is unlikely that multiple zoning issues will be resolved by the government alone. Thus it is critical that conservationists identify zoning impacts on stakeholders and subsequently engage communities and industry to encourage conservation buy-in. Effective stakeholder communication may be the most viable conservation strategy for compromise and management of these zoning issues in Central Africa.

## 15. TRENDS IN WESTERN ROSS SEA EMPEROR PENGUIN CHICK ABUNDANCES AND THEIR RELATIONSHIPS TO CLIMATE

*\*Shannon Michelle Barber-Meyer, World Wildlife Fund; \*Gerald L. Kooyman, Scripps Institution of Oceanography; \*Paul J. Ponganis, Scripps Institution of Oceanography*

The emperor penguin (*Aptenodytes forsteri*) is extremely dependent on the extent and stability of sea ice, which may make the species particularly susceptible to environmental change. In order to evaluate the stability of the emperor penguin populations at six colonies in the western Ross Sea, we used linear regression analysis to evaluate chick abundance trends (1983-2005) and Pearson's *r* correlation to assess their relation to two local and two large-scale climate variables. We detected only one significant trend; the Cape Roget colony increased from 1983 to 1996 ( $n = 6$ ). Higher coefficients of variation in chick abundances at smaller colonies (Cape Crozier, Beaufort Island, Franklin Island) suggest that such colonies occupy marginal habitat, and are more susceptible to environmental change. We determined chick abundance to be most often correlated with local Ross Sea climate variables (sea ice extent and sea surface temperature), but not in consistent patterns across the colonies. We propose that chick abundance

is most impacted by fine scale sea ice extent and local weather events, which are best evaluated by on-site assessments. We did not find sufficient evidence to reject the hypothesis that the overall Ross Sea emperor penguin population has been stable during this period.

## 45. Indigenous Knowledge and Conservation

### 1. "LINKING HIMALAYAN AGRO-FORESTRY SYSTEM WITH TOURISM AND TRADITIONAL LIVELIHOOD: A CASE STUDY FROM SAGARMATHA (MT. EVEREST) NATIONAL PARK"

*\*Yuba Raj Subedi, Community Development Organization (NGO)*

Subsistence agriculture and livestock rearing are the main source of livelihood for most of the Himalayan people of Nepal. Sherpas, the dominant indigenous nationalities in the Mount Everest region are engaged in Yak farming and cultivation of essential crops for livelihood. Agricultural crops are planted in the terrace. In terracing method irrigation is well controlled and chances of soil erosion are less. Hedge row are planted with different varieties of cereal crops and forest crops that also curb erosion. Only one crop can harvest in one year. Wild species from SNP has affected economic returns from these crops. People use various indigenous methods to tackle the problem of crop raid. The prospering ecotourism is another important source of income. Locals including women are involved in business based on tourism. Himalayan farming system and Yak grazing has also become part of tourism now-a-days and contributes significantly on earning. Singi Nawa is the cultural system of agriculture, management and conservation of natural resources where each household take part in conservation on a rotation basis. The paper is based upon the study conducted in 3 buffer zone villages of Sagarmatha National Park. Semi structured questionnaires and observation were applied during information collection.

### 2. AN ETHNOBOTANICAL APPROACH TO WHITE OAK AND BUTTERNUT RESTORATION FOR TRADITIONAL CHEROKEE ARTS AND ECOLOGICAL DIVERSITY

*\*Sunshine Liberty Brosi, Frostburg State University;*  
*\*Scott E. Schlarbaum, The University of Tennessee,*  
*Tree Improvement Program*

Exotic forest insects and pathogens have been impacting Appalachian forests for over 150 years. Increasing trade has caused a progressive increase of exotic forest pest problems. Traditional Cherokee artisans are dependent upon many species that are threatened by overharvesting and exotic pests on the Qualla Boundary of western North Carolina. White oak basketry uses material from young, straight-grained trees, which have virtually been eliminated due to demand. White oak seedlings were planted increasing the supply of material and protect natural regeneration. Significant differences in two-year growth have occurred between genotypes, initial seedling sizes, and shelter heights providing protocols specifically for the basketry trade. Cherokee artisans also use butternut to produce dye for baskets. Southeastern populations of butternuts have been reduced by approximately eighty percent due to an introduced fungal pathogen. Artisans recorded that large roots were more effective dye material than fine roots, husks, and stems. Butternut plantations, resistance-screening tests, and a locally-adapted seed orchard have been established and monitored to develop a resistance breeding program. Five year results indicate some genotypes and initial seedling condition

are more resistant to disease development. These projects increase material available to artisans, protect the art and natural resources for future generations, and provide a model for protecting other species at risk.

### 3. BURNING THE SAVANNA: FIRE ETHNOECOLOGY IN SOUTHEASTERN MOZAMBIQUE

*\*L. Jen Shaffer, Dept. of Anthropology, University of Georgia*

Landscape managers in southern Africa use fire as a tool to maintain and conserve savanna. Many of these prescribed burn regimes are based on modeling using historic information and onsite experimentation. The long history of anthropogenic fire disturbance in southern Africa suggests that indigenous ecological knowledge could provide further insight into location-specific fire ecology and disturbance cycles. This study investigates the ethnoecology of fire and burn practices in two Ronga communities in southeastern Mozambique. Local knowledge of fire ecology and disturbance cycles, techniques for controlled burns, reasons for burning, and community fire policies were explored through oral histories, conversations with subsistence activity specialists, and targeted interviews about fire. Small, regular controlled burns, used to clear agricultural fields and improve animal forage, produce a patchy mosaic of grass and wooded habitat across the coastal savanna landscape. Oral histories indicate that fire was also used in the past for hunting. Prescribed burn regimes under development in South Africa for the southern end of this region parallel traditional burn practices used just over the border in Mozambique.

### 4. CORRESPONDENCE BETWEEN SCIENTIFIC AND TRADITIONAL ECOLOGICAL KNOWLEDGE: RAPID ASSESSMENT FOR FOREST BETA DIVERSITY IN THE COLOMBIAN ANDES

*\*Jhovana Catherine Gamba Trimiño, University of East Anglia*

The value of local knowledge has been historically ignored by scientists in the western tradition. We matched western science methodologies with the traditional ecological knowledge of Campesinos, to test their efficacy in cataloguing different habitats (beta diversity) in the North-Eastern Colombian Andes. Seven vegetation types were distinguished by one local collaborator. Two of these were ground-truthed in 7 plots (each 0.1ha) located geographically distant from each other. 1,104 individuals (woody plants &#8805; 2,5 cm DBH) and 57 morphospecies were sampled and tagged. Floristic composition, basal area, ground cover, canopy height, canopy openness, foliage density and soils were recorded in each plot. Non-metric Multidimensional Scaling (MDS) ordinations of the plots revealed two vegetation types that matched with the ones described by the local collaborator. Floristic composition patterns were also related with the ordination patterns showed by environmental data. Following an Indicator Species Analysis, *Hyeronima-Pallicourea-Quercetum humboldtii* (with poor soils) and *Vaccinium-Quercetum humboldtii* (with fertile soils) communities were described. Campesinos' ecological knowledge proved to be an effective shortcut to assess forest beta diversity. Rapid ecological assessments should include and test traditional ecological knowledge as a methodology, and a way to build alliances between conservationists and local communities

### 5. INDIGENOUS KNOWLEDGE AND SOCIO-ECOLOGY: A CASE STUDY FROM NYISHI

## TRIBE OF ARUNACHAL PRADESH.

*\*urvashi phukan, dibrugarh university*  
INDIGENOUS KNOWLEDGE AND SOCIO-ECOLOGY: A CASE STUDY FROM NYISHI TRIBE OF ARUNACHAL PRADESH. URVASHI PHUKAN, DEPARTMENT OF ECO-RESTORATION DIMORIA COLLEGE, KHETRI, ASSAM-782403, INDIA, email-urvashi\_phukan@yahoo.com Indigenous people's knowledge is invaluable for resource management. Their immediate contact and dependence on nature developed a curious knowledge which is ultimately reflected in their traditional culture, religion, local belief, folklore, taboos and dialects. Due to acculturation and upright tribal extinction, the indigenous knowledge system is gradually eroding. With a case study on one of the indigenous tribe of Arunachal Pradesh the present paper highlights the socio-ecological analysis with some suggestions for revitalising the indigenous knowledge and its application in ecological restoration.

## 6. LANDSCAPE FEATURES DETERMINE THE DISTRIBUTION AND SUSTAINABILITY OF UNGULATE HUNTING IN NORTHERN CONGO

*\*Miranda Mockrin, Columbia University; \*Robert R Rockwell, American Museum of Natural History;*

*\*Kent H Redford, Wildlife Conservation Society*

Overhunting in tropical forests has been the focus of increasing research for over 20 years, but understanding the spatial dimensions of hunting and prey population dynamics remains a challenge. We examined how hunting practices are distributed on the landscape surrounding the logging town of Kobo, Congo, assessing the sustainability of offtake for six different species at multiple scales. Previous studies of subsistence hunters in tropical forest use the central place foraging model, with distance from a village as the sole determinant of hunting pressure. We expanded upon past studies by investigating the role of the two predominant natural forest types, mixed forest and monodominant forest. Over nine months, we recorded over 1,500 hunting trips, with ungulates making up the majority of the species killed and the biomass harvested. The results differ from previous findings, showing: 1) vegetation composition was the primary factor determining how often hunters visited a zone; 2) within zones, hunting was concentrated in monodominant forest, leading to high, often unsustainable offtakes; and 3) for all species overharvested in monodominant forest, adjacent areas of mixed forest show much lower offtakes. We suggest that hunters create source-sink dynamics between mixed and monodominant forest in ungulate populations. Our findings have important implications for hunting management and conservation in Central Africa.

## 7. ROLE OF INDIGENOUS KNOWLEDGE IN PROMOTING CONSERVATION OF BIODIVERSITY; A KENYAN CASE STUDY

*\*Esther Bosibori Omosa, National Museums of Kenya; \*Patrick Munyao Maundu, National Museums of Kenya*

Indigenous knowledge (IK) refers to the unique, traditional, local knowledge existing within and developed around specific conditions by women and men indigenous to a particular geographical area. Often times this knowledge is given little or no attention by researchers when considering sustainable environmental conservation strategies. A project to document IK on traditional foods was carried out in rural Western Kenya in 2005-2006. The region was chosen due to its rich tradition of consuming local foods and particularly vegetables. IK on nutrition was documented through focus group discussions; this information was verified by key informants whereby it came out that traditional foods have higher health benefits than the

exotic ones in terms of nutrient density, fibre content and that some have perceived medicinal value. Utilization of traditional species promotes dietary diversity and ensures conservation of biodiversity. IK associated with the production (agronomy) and post-harvest handling (nutrition) of these foods is fast eroding together with the elderly members of this community thus it needs to be documented to prevent its loss as it is crucial for conservation and communities hold onto it. There are some aspects of IK that need to be improved and some adopted and promoted because these aspects make a lot of scientific sense.

## 8. VALUING INSECT AND PLANT DIVERSITY TO PRESERVE TRADITIONAL KASEPUHAN AGRICULTURE PRACTICE IN GUNUNG HALIMUN NATIONAL PARK

*\*Shinta Puspitasari, PEKA Indonesia Foundation*

Traditional Kasepuhan communities living in Gunung Halimun National Park (GHNK) have developed, and utilized indigenous knowledge to support traditional farming system, with sustainable use of natural resources. They use plants as medicine for the crops, and insects have important roles in the agriculture. They don't use chemical inputs and only grow plants once a year. However, the rampant use of pesticide and high input farming system has been threatening the long existing traditional system. We tried to identify the opportunities and challenges in the Kasepuhan traditional farming system, and use science to provide evidence of how it has been supporting biodiversity in GHNK. We conducted research focused on ecosystem services provided by insects: (1) The effect of distance-from-forest on the diversity of insect pollinators in 15 sites in GHNK, (2) The diversity of insect pollinators in different habitats in GHNK, (3) The correlation between the number of flowers and the abundance of insect pollinators, (4) The diversity of insect pollinators in 6 plots in the agroecosystem habitat. We presented the information from our research to the local community by listing all the pollinators and bio-pesticide plants, and their roles in the ecosystem. Chemical input impacts on the farming system was made available for Kasepuhan community. This information will be used to design "local information and learning center" to promote insect and plant conservation in GHNK.

## 46. Integrated Land-Sea Conservation Planning: Concepts and Case Studies

### 1. TOWARDS A CONCEPTUAL AND TECHNICAL FRAMEWORK FOR INTEGRATED CONSERVATION PLANNING IN COASTAL CATCHMENTS AND NEARSHORE MARINE WATERS

*\*Bob Pressey, James Cook University; \*Erica Fleishman, National Center for Ecological Analysis and Synthesis; \*Reed F. Noss, University of Central Florida; \*Ken Vance-Borland, The Conservation Planning Institute; \*Chuck Willer, Coast Range Association*

We are beginning a multidisciplinary research program to guide integrated coastal planning for the catchments of the Great Barrier Reef and the Oregon coast. We report here on progress in developing the conceptual and technical framework for this program, in collaboration with decision-making authorities and other stakeholders. The need for such a framework is underlined by the difficulty of balancing the local (within-catchment) benefits arising from conservation actions (mechanisms for protection or restoration) with the downstream

benefits for freshwater and marine systems. To find this balance, managers need, for terrestrial, freshwater and marine environments, spatially explicit data on: biodiversity (pattern and process); ecosystem services; models of future extractive activities and their local and downstream effects; and the cost, feasibility and relative effectiveness of alternative actions. They also need to refine qualitative goals into a complex set of quantitative objectives, understand the socio-economic implications of management actions, and develop strategies for involving stakeholders, managing uncertainty, and adapting their approaches as new information becomes available. There is presently no framework for integrating all of this information. Our framework will draw on published literature and the experience of scientists, planners and practitioners and serve as a foundation for application beyond our study regions.

## 2. INTEROPERATING DECISION SUPPORT TOOLS TO FACILITATE INTEGRATED PLANNING ACROSS ECOSYSTEMS: CASE STUDIES FROM PUERTO RICO AND TEXAS, USA

*\*Patrick Crist, NatureServe; \*Jessica Dyson, The Nature Conservancy; \*David Eslinger, NOAA Coastal Services Center; \*Douglas Walker, Placeways*

Integrating conservation assessment and planning across ecosystems is a highly complex endeavor requiring sophisticated modeling and decision support tools. Existing tools were developed typically to serve single sectors and ecosystems, however. Our objective was to explore and demonstrate how existing tools could be interoperated to support cross sector and cross ecosystem analysis and planning. Among demonstration sites, we interoperated a land use planning tool -- CommunityViz, a conservation planning tool - NatureServe Vista, and a non-point source pollution modeling tool - NOAA's N-SPECT software. These demonstration projects were conducted in realistic decision environments involving stakeholders, decision makers, local scientific organizations, and implementers. We developed an interaction model for the exchange of data and iterative analyses among the tools; populated a common database accessed by each tool; and conducted a series of analyses that integrated inputs and outputs among the tools. We concluded that the interoperability among these tools does substantially increase the decision capability necessary to conduct such cross sector/ecosystem planning and that interoperability is already well supported by their common GIS platform. However, we also identified a number of areas suitable for automating interoperability among the tools to make this process more accessible to local planners and resource managers.

## 3. INTEGRATING LOCAL LAND-USE DECISIONS WITH COASTAL ECOSYSTEM IMPACTS

*\*Dan Dorfman, Intelligent Marine Planning*

Through collaborations with local land-use planning organizations, methods have been developed which enable municipalities, councils of governments, planning commissions, developers, and communities to examine trade-offs in coastal development patterns and their impacts to natural resources. Rudimentary planning approaches fail to account for the cumulative impacts of planning decisions to degrade the value of near-shore ecosystem resource values. As a result, past land-use decisions have led to degraded coastal ecosystems and the broad societal losses associated with damaged ecosystems. Here, we demonstrate techniques which enable land-use planners and natural resource managers to

evaluate "downstream" impacts of individual land-use decisions and cumulative impacts of system wide ecosystem degradation. A collaborative project with the Wells National Estuarine Research Reserve, local partners along the coast of the Gulf of Maine, and the EBM Tools Network, has developed methods which provide information exchange between land-use planning tools and those which can monitor or estimate cumulative impacts in coastal ecosystems. We focus on tools which support geospatial analysis and information exchange across planning sectors.

## 4. DETERMINING PRIORITIES FOR CONSERVATION, RESTORATION, AND ADAPTATION IN HIGHLY DYNAMIC LAND-SEA INTERFACES

*\*Reed F. Noss, University of Central Florida; \*Tom Hoctor, Geoplan Center, University of Florida; \*Michael Volk, Department of Landscape Architecture, University of Florida*

Conservation at the land-sea interface is complicated by its dynamic nature, especially in low-lying regions. Coastal ecosystems are threatened by development, sea-level rise, and short-sighted political responses to sea-level rise. Prioritization of ecosystem types, landscapes, and in some cases species is required. Priority ecosystems can be identified as those that have declined most in area or quality since historic reference conditions, provide critical ecosystem services, possess other important ecological and cultural values, and are under greatest threat of loss. Maintaining these ecosystems in current locations is often impossible. Even areas considerably distant from the current land-sea interface, such as much of the Florida Everglades, will be inundated by the year 2100 under the conservative assumption of a 1-m rise in relative sea level. The only hope for the persistence of coastal biodiversity in low-lying regions is to allow coastal ecosystems to migrate inland as they have during past episodes of sea-level rise. Seawalls, bulkheads, and other structural barriers will thwart adaptive responses and ultimately prove futile in protecting human structures and property. Identification and design of broad coastal-inland and south-north corridors, which in many cases will need to be restored, provide the only hope for persistence of coastal ecosystems.

## 5. CROSSING JURISDICTIONAL BOUNDARIES: ECOSYSTEM MANAGEMENT CHALLENGES IN THE CONTEXT OF COASTAL COMMUNITY PLANNING

*\*Susan R Crow, PlaceMatters*

Achieving ecosystem management requires a perspective regarding humans as part of the ecosystem, a holistic planning approach, a regional database, multi-criteria decision support and adaptive management. US land use decisions are made by local governments, guided by comprehensive plans having 5 to 10 year update cycles and frequently adjusted by ad hoc actions. Few local governments have access to regional databases. Day to day land use decisions have few requirements, incentives or formal mechanisms for multi-jurisdictional cooperation; though decisions upstream may significantly impact downstream. Further, planning efforts driven by federal and state policies that provide local government funding related to plan development have resulted in fractured planning environments where communities have land use, transportation, hazard mitigation, conservation plans, etc. Information from individual plans considered holistically might result in different outcomes. Finally planning processes and outcomes are rarely evaluated. These differences in ecosystem management and planning practices represent

substantial challenges. In the context of a coastal SC demonstration project, this presentation will discuss bridging strategies including: innovative outreach methods and technologies for engaging stakeholders; decision support incorporating local plan issues and actions in a spatially-explicit regional database; and using land use planning software as an integrating planning framework.

## 6. SOCIOECONOMIC TOOLS AND APPROACHES FOR LAND-SEA EBM AND CONSERVATION PLANNING

*\*Chuck Willer, Coast Range Association*

Ecosystem-based management (EBM) and integrated land-sea conservation planning require a deep understanding of a region's cultural, socioeconomic, economic and ecological conditions. This is particularly true when implementation issues are considered central to the planning and EBM frameworks. The land-sea interface presents a set of unique problems for implementation due to patterns of human coastal settlement and the perceived distinct nature of the terrestrial and marine environments by stakeholders, policy makers, and the public at large. As part of a multidisciplinary research program to guide integrated coastal planning, the presentation reports on the application of the Community Economic Profiling System and Community Socioeconomic Information System to Oregon's coastal region and reviews a newly completed Oregon coastal economic assessment that contextualizes traditional sectoral data in a broader ecological economic frame describing the role of land and sea ecosystem services to Oregon's coastal economy.

## 7. USE OF RESULTS CHAINS TO TEST ASSUMPTIONS ABOUT COASTAL CONSERVATION STRATEGIES

*\*Erica Fleishman, National Center for Ecological Analysis and Synthesis; \*Caroline Stem, Foundations of Success; \*Nick Salafsky, Foundations of Success*

Teams conducting conservation projects often have clear conservation goals and some ideas about strategies for achieving those goals. But teams rarely state explicitly how they think the strategies will help them reach their goals. A results chain is a tool that helps teams to visualize assumptions about how a particular action will lead to a desired outcome. We illustrate how results chains recently were used by local ecosystem-based management projects in coastal California, the Gulf of California, and the Western Pacific to clarify how the project teams believed that different interventions would reduce threats to their specific conservation targets. Specifically, results chains helped these teams to discuss and refine their theories of change, to identify ways to measure whether their actions are effective, and to develop a framework for sharing data and inferences with other groups (i.e., cross-site learning). We use these case studies to demonstrate how results chains can link project strategies, objectives, and goals, and provide a framework for identifying quantitative metrics to measure progress toward those objectives and goals. In these situations, use of results chains led to the identification of common challenges, research priorities, and inferences that would not have been apparent otherwise.

## 47. Inventory and Monitoring

### 1. A STRATIFIED DESIGN FOR MONITORING PRAIRIE-CHICKEN LEKS IN MINNESOTA WHILE ACCOUNTING FOR THE PROBABILITY OF DETECTION

*\*Michael A Larson, Minnesota Dept of Natural Resources*

Surveys for monitoring prairie grouse often document the number of males per lek during spring as an index of overall abundance. Spatial sampling designs and changes in the abundance of leks, however, often receive little attention. My objective was to design a survey to detect changes in the abundance of greater prairie-chicken (*Tympanuchus cupido pinnatus*) leks in Minnesota. I used occupancy modeling to estimate the probability of detecting a lek, the probability that a plot is occupied by a lek, and the effects of covariates on those probabilities. I used a dual frame sampling design with a list frame consisting of lek locations known to have been active during the previous year and an area frame consisting of ~260-ha plots covering the extent of prairie-chicken range in Minnesota. Less than 15% of plots are occupied by a lek, so to attain sufficient precision I recommend limiting surveys to mornings with little wind and stratifying plots in the area frame by the distance to the nearest known lek, proportion of area in grass, and road density. Stratified dual-frame sampling and occupancy modeling can provide information that is important for long-term monitoring and management of prairie grouse and other rare species.

### 2. ANDEAN BEAR SIGN - PROTOCOL DEVELOPMENT FOR AGING EXPLOITED GROUND BROMELIADS (*PUYA CLAVATICA*) IN THE ECUADORIAN PARAMO

*\*Kristina Timmerman, St John's University*

Andean bear (*Tremarctos ornatus*) populations are challenging to monitor because of their elusive behavior and their tendency to reside in remote areas with difficult access. Therefore, a common monitoring option is to use bear sign (e.g. scat, claw marks and evidence of feeding bouts) to document presence/absence and create measures of relative abundance over time. In addition to the aforementioned uses of bear sign, determination of sign age is another tool for population status assessment by providing measures of site visitation frequency and how recently an animal visited an area. Paisley (2001) reported aging data for scat; otherwise sign aging information for this species is not available in the published or academic literature. Andean bears remove the large, spiny leaves of the giant puya (a ground bromeliad) and in many cases, consume only the leaf base. The goal of this study was to develop a protocol for aging bear-exploited puya, a large ground bromeliad typical of high altitude grasslands in South America. The development of a standardized protocol for aging time since consumption is beneficial for those concerned with Andean bear population status. The protocol is easily learned and can be adapted to different regions.

### 3. ASSESSING ASSESSMENTS: UNDERSTANDING THE COSTS AND BENEFITS OF GLOBAL BIODIVERSITY ASSESSMENTS

*\*Sarah Wyatt, Conservation International*

The IUCN Red List of Threatened Species is the internationally accepted standard for evaluating species conservation status. Since 2001, the process of collecting, evaluating, and refining the information that is the basis of the IUCN Red List has increasingly been undertaken through expert-driven global assessments of entire taxonomic/ecological groups. These global biodiversity assessments, implemented via central coordination and regional workshops, represent a significant investment of financial resources, time, and effort. For example, the Global Amphibian Assessment, completed in 2004, assessed ~6,000 species in 3 years and cost ~\$2m. The current Global Marine Species Assessment will assess ~20,000

species and cost ~\$10m. To date, the costs and benefits of these ongoing assessments have not been systematically assessed relative to the claim that they maximize use of resources for growing the Red List. Understanding the costs requires accounting for workshop expenses, staff time, and expert volunteer effort. The assessment process is clearly beneficial for conservation planning and leveraging funding; the benefits for capacity building, developing biodiversity indicators, informing environmental impact assessments and stimulating research are evident, but more difficult to quantify. Global biodiversity assessments can be better designed by improving knowledge of their costs and benefits and the relationships between scientific process and conservation practice.

#### 4. MONITORING THE STATUS OF AN ISLAND-ENDEMIC SPECIES CALAYAN RAIL (GALLIRALUS CALAYANENSIS)

*\*Carl Oliveros, Isla Biodiversity Conservation;*  
*\*Cynthia Adeline Amoyo Layusa, Isla Biodiversity Conservation, Inc.;* *\*Michael Angelo Morales, Isla Biodiversity Conservation*

The Calayan Rail (*Gallirallus calayanensis*) is an island-endemic species classified as Vulnerable under the 2006 IUCN Red List of Threatened Species. Discovered in 2004, it is found in Calayan Island, Babuyan Group of Islands, northern Philippines. Results from island-wide surveys in April-May 2005 (3.42% of 323 stations has rails), January-February 2006 (20.6% of 471); and surveys from selected stations on October (26.96% of 115 stations in sitios Longog and Pilid) and December 2006 (12.36% of 89 stations), showed the rail to have a wide but patchy distribution with higher detection during the rainy season. Abundance rate was ranked low in the April-May, December 2005 surveys; moderate for the other dates. A total of 202, plus 13 off-census rails, were detected. Playback census was the survey technique employed. In February 2008, an island-wide survey will again be conducted to monitor the status and distribution of the Calayan rail. The same survey methods will be followed to allow for an unbiased comparison of results. Joining the team are trained local volunteers and possible sanctuary wardens with the aim to help build capability among the locals to monitor the status of this species. The result of the survey will also give an indication of the effectiveness of previous environmental awareness campaigns and where the teams should focus to strengthen its conservation efforts. Current threats to the species include slash-and-burn farming, illegal logging and hunting.

#### 5. ON THE USE OF PARATAXONOMY IN BIODIVERSITY MONITORING: A CASE STUDY ON COMMON WILD FLORA

*\*Jean-Claude ABADIE, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations;* *\*Camila Andrade, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations;* *\*Nathalie MACHON, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations;* *\*Emmanuelle PORCHER, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations*

Biodiversity monitoring programs are often impeded by a general decrease in the number of skilled naturalists. Here we studied how parataxonomy (the use of morphotypes, instead of

species), might be used by unskilled volunteers to survey plant communities. Our questions were: (1) Can morphotypes be used as a robust estimator of species richness (&#945;-diversity) and assemblage turnover (&#946;-diversity)? (2) What is the robustness of such methods? Double inventories were performed on 150 plots, one by a non-expert using morphotypes, the other by a taxonomist using species. To test the robustness of morphotype identification among participants, additional plots were surveyed by eight volunteers using the same protocol. We showed that (1) the number of morphotypes identified by unskilled volunteers in a plot was always strongly correlated with species richness. (2) Morphotypes were less sensitive than species to detect assemblage turnover. (3) Morphotype identification varied significantly within and between volunteers. Due to this lack of repeatability and reproducibility, parataxonomy cannot be considered a good surrogate for taxonomy. Nevertheless, assuming that morphotypes are identified with standardised methods, and that results are used only to evaluate gross species richness but not species turnover, parataxonomy might be a valuable tool for rapid biodiversity assessment of common wild flora.

#### 6. REVISED POPULATION ESTIMATES OF HAWAIIAN MOORHEN ON OAHU USING CALL-BROADCAST, WITH COMPARISON OF SURVEY METHODS.

*\*David DesRochers, Tufts University;* *\*Michael Reed, Tufts University*

The endemic and endangered Hawaiian Moorhen is currently found only on Kauai and Oahu. Population size estimates for this species are thought to be underestimates because of the moorhen's cryptic behavior. Standard survey methods include visual and aural detection, but recent research has shown that passive surveys of cryptic waterbirds underestimate population sizes. Alternatively, broadcasting vocalizations to elicit responses has increased detection dramatically. From 2005 - 2006, we used call-broadcast to survey for Hawaiian Moorhen at wetlands on Oahu. Additionally, we compared results from playback surveys with results from playback with other moorhen subspecies vocalizations and extended-time passive surveys. On average, call-broadcast increased detection by 30%. Two of the five call types we used were effective at eliciting responses. These two call types are thought to be associated with advertising territories and chick protection. Using mainland subspecies calls failed to increase detections compared with playback using Hawaiian Moorhen calls, and the number of moorhen detected after 60 minutes of passive observation did not differ from the number of birds detected during a brief playback survey. Incorporating call-broadcast into Hawaii's waterbird survey would increase detection of Hawaiian Moorhen, leading to more accurate estimates of the distribution and abundance of this secretive species.

#### 7. SPATIAL ANALYSIS OF SUB-SAHARAN CRANE RESEARCH

*\*Amy L Richert, James Madison University;*  
*\*Kerryn Morrison, Wetlands, Cranes, and Communities Project, Endangered Wildlife Trust, Johannesburg, South Africa;* *\*Helmut Kraenzle, James Madison University*

Sub-Saharan Africa supports 4 species of cranes, all of which are species of special conservation concern. Many research projects geared toward understanding natural populations of African cranes, their habitat requirements, and responses to environmental conditions have been conducted. However, assessments have not included spatial analyses at regional or international scales. Our project is designed to gain more

information about crane distribution patterns, movements, and potential threats. The objectives of our on-going work are to 1) establish a spatial database for use in GIS analyses, 2) create a visualization of crane populations through time at a sub-continental scale, 3) assess spatial gaps in Sub-Saharan Africa crane research, and 4) introduce undergraduate students to applied database management. We are working with multiple undergraduate students to obtain articles and other project summaries that exist within academic library resources and government and academic offices throughout Africa, the United States, and Western Europe. Students are placing summary information into a spatial database for use in analyses. Our presentation is a summary of the methods used to obtain spatial data including how attribute fields were developed. Also presented are the challenges and benefits associated with international communications within an undergraduate research setting and the results of the project to date.

## 8. USING DATA DEFICIENCY AS A GUIDE FOR SURVEY PRIORITIES: AMPHIBIANS AS A CASE STUDY

*\*Daniel Brito, Conservation International; \*Thomas Brooks, Conservation International; \*Will Turner, Conservation International*

Our knowledge of biodiversity is woefully inadequate. Only a fraction of the planet's species have been described by science (the "Linnean shortfall"). Even for described species, we often have only fragmentary information about their distributions (the "Wallacean" shortfall). These shortfalls in biodiversity knowledge place serious limitations on our ability to conserve biodiversity. As a result, several species are listed as data deficient (DD). Using data deficiency as a surrogate for lack of knowledge, we devise a strategic plan to prioritize survey areas. First a map of the potential distribution of all DD amphibians is overlaid, obtaining a DD surface. Directing surveys for peak areas in this surface would not only likely result in new site records of DD species (addressing the Wallacean shortfall), but also these areas of high peaks are likely candidate sites to hold new species to science (addressing the Linnean shortfall). A comparison between the locality data of new amphibian species (described in 2005), with the DD surface layer shows that most of these recently discovered species were described from sites located within the DD surface. This provides a new strategic way for planning surveys and obtaining high conservation benefits from them.

## 48. Land Use Planning for Conservation

### 1. LAND USE DYNAMICS AND IMPACTS ON CONSERVATION OF KENYAN COASTAL FORESTS IN MALINDI DISTRICT, COAST PROVINCE

*\*Mercy Mwanikah Ojoi, National Museums of Kenya*

The vast coastal forests of Kenya are experiencing rapid environmental degradation due to climate change and population growth. Dakatcha Woodlands and Marafa forests have been documented as Critical Ecosystem Biodiversity Hotspots [IUCN 1997]. These sites have no formal protection status and are highly threatened by anthropogenic factors. In this study, LANDSAT images over the past ten years and baseline data collected on the *Warburgia stuhlmannii*, a rare tree species, were used to understand land cover changes. Remotely sensed images were used to identify fragile ecosystems and monitor changes in land cover within and

around the sites. Data was obtained from LANDSAT time series maps. IDRISI was used to calculate percentage change in coverage. Ecological surveys and social studies were conducted to understand the conservation status of the *Warburgia stuhlmannii*, found in the Kenyan Coastal Forests and woodlands. Surveys were conducted to understand human threats impacting the survival of the species and its habitat. The study sheds light on land cover change and factors contributing to this loss. This is significant for the development of innovative solutions for long-term conservation of rapidly declining coastal biodiversity and development of a framework for decision makers who can promote conservation of such threatened natural habitats.

### 2. LANDSCAPE PLANNING FOR WILDLIFE AND HUMAN NEEDS: BUSHMEAT AND SURVIVAL IN THE SALONGA-LUKENIE-SANKURU LANDSCAPE, DRC

*\*Aurelie Camille Shapiro, World Wildlife Fund;*

*\*Lisa Steel, World Wildlife Fund*

The Salonga-Lukenie-Sankuru Landscape surrounds the largest tropical rainforest National Park in Africa, home to threatened mammals including forest elephants and endemic bonobos. The area also hosts a permanent, growing human population that depends on the forest for basic needs. The situation is at a critical point in which both animal and human populations need well-planned land management to ensure survival. The World Wildlife Fund has mapped potential species habitat from field data, as well as human impacts on the landscape with a focus on human access for bushmeat. Communities, their land needs and their access routes were mapped in order to estimate the human interaction with the forest. The overlap of suitable wildlife habitat in intact forest blocks and easy access are recommendations for anti-poaching patrols and managed hunting areas. Further analyses using MARXAN were performed to locate core protected areas, and buffer zones to support human extractive use for current and predicted population estimates to 2020. Finally, alternatives for hunting were mapped by locating potential agricultural zones in accessible, low habitat quality areas in order to reduce hunting pressure on local forests and provide an alternative, stable food source for local human populations. This targeted conservation planning will help local managers assign specific land uses throughout the landscape to provide for sustainable development amid persistent wildlife populations.

### 3. LARGE SCALE LANDSCAPE CONSERVATION AT THE SUBURBAN FRINGE

*\*Jonathan D Meade, Highlands Coalition*

A regional perspective is vitally important to understanding community-driven conservation efforts, particularly in suburbanized areas. In the 3.5 million acre Highlands of Pennsylvania, New Jersey, New York, and Connecticut, federal recognition has benefited local conservation by attracting partners and leveraging funding. The Highlands harbors over 250 species of special concern, 5 National Wild and Scenic Rivers, 4 National Heritage Areas, 1 National Park and 1 National Wildlife Refuge. While the region provides drinking water for over 15 million people, its natural resources are threatened by poorly planned development. Four comprehensive US Forest Service studies have prioritized areas for conservation, focusing on five resource categories: forests, water, agriculture, biodiversity, and recreation. In an increasingly complex socio-political environment, a coordinated response to these significant threats is required. The Highlands Coalition, an alliance of 180 organizations, has worked to protect priority resources for two decades in the shadow of one of the largest metropolitan regions on earth.

This partnership helps local organizations understand and connect to large scale conservation issues such as climate change, while fostering effective local efforts. This presentation shows how an adaptable, community-focused conservation approach can serve as an example for creating and sustaining interstate, multi-disciplinary, public-private relationships.

#### 4. ROLE OF FARM STRUCTURE ON DENSITY AND DIVERSITY OF BIRD COMMUNITIES ON FARMLANDS AROUND A TROPICAL RAINFOREST

*\*Nickson Erick Otieno, University of Nairobi, Kenya; \*Nathan Gichuki, University of Nairobi, Kenya; \*Samuel Kiboi, University of Nairobi, Kenya*

Steady growth in human population in the tropics in recent decades has led to increased demand for agricultural land to produce food, resulting in loss of natural habitat and biodiversity. Nevertheless, conservation and agriculture can be complimentary: biodiversity perform ecosystems services to farmlands, including pollination, seed-dispersal, nutrient cycling, and genetic exchange, while agricultural landscapes offer foraging and dispersal opportunities additional to the degraded habitats. Kakamega, Kenya's only tropical rainforest, has been severely fragmented from human encroachment. We studied 30 farms randomly selected along a forest proximity gradient, to assess influence of their structure on bird community structure, and support those from the degraded forest. We considered farms size, hedge characteristics, habitat heterogeneity, woody plants density, crop cover and plant diversity. Birds were surveyed five times using the Distance sampling procedure along line transects. From our results, birds were most dense on farms with tall indigenous woody vegetation while species richness and insectivore abundance were favoured by diverse plants and, thick hedges. Most birds encountered were insectivores (29.2%) and granivores (26.6%) but forest-associated birds and overall bird density declined away from forest edge. Farmlands around tropical forests are significant as dispersal and foraging areas for bird species threatened by forest destruction.

#### 5. SUCCESS OF A MUNICIPAL SYSTEMATIC BIODIVERSITY PLAN IN THE CAPE FLORISTIC REGION, SOUTH AFRICA

*\*Genevieve Quinault Kent Pence, private consultant; \*Kerry Sharon te Roller, CapeNature*

The Cape Action for People and the Environment Programme is a partnership programme that seeks to conserve and restore the biodiversity of the Cape Floristic Region (CFR) and adjacent marine environment, while delivering significant benefits to the people of the region. One of the objectives of the programme is to produce municipal fine-scale systematic biodiversity plans which can be used to direct land-use planning and decision-making by government bodies, influence agricultural practices, and guide the implementation of conservation action. In order to achieve this, the programme has invested substantially in ensuring that the data and methodology applied are appropriate for the desired products and intended purposes, and, secondly, that the recipients understand the implications of the plans and support their uptake and enforcement. This success story highlights innovative techniques adopted by the biodiversity planning project team, the resulting map and land use guideline products, and some of the early achievements in terms of the support and uptake of the Saldanha Bay Municipality Systematic Biodiversity Plan by its recipients.

#### 6. SYSTEMATIC PLANNING IN THE

#### PANTANAL BIOSPHERE RESERVE USING THE DECISION SUPPORT SOFTWARE-MARZONE

*\*Reinaldo Francisco Lourival, University of Queensland and Capes; \*Matt Watts, University of Queensland; \*Hugh P. Possingham, University of Queensland; \*Robert Pressey, James Cook University*

Heuristic algorithms are frequently chosen to efficiently achieve feature representation in systematic conservation planning. However, representation and complementarity in zonation schemes offers extra complexity to systematic planning, for two reasons: first, in zoning there is an assumption of partial contribution of each feature and zone towards the objectives. Second because each land parcel when allocated to a particular zone has its own cost structure affecting the way in which efficiency of reserve systems is measured. We aim to respond to two questions related to the Biosphere Reserve model. First, how can we optimize spatially-explicit compromises of representation under a multi-zone/objective context? And how site selection and planning unit allocation affect the constraints of the BR objectives? We used the MARZONE an adaptation of the set covering problem used in MARXAN software. MARZONE is able to handle the compromises between land suitability x availability under a multi-objective context. In order to respond to these questions we used the Pantanal Biosphere Reserve-PBR as our case study. Our results shows the design inadequacies of the PBR while propose a new configuration based on the sustainability for biodiversity and socio-cultural features, with the potential of measuring the tradeoffs between apparently conflicting objectives.

#### 7. TO FENCE OR NOT TO FENCE: USE OF WILDLIFE DATA TO INFLUENCE US GOVERNMENT FOREIGN ASSISTANCE DECISION-MAKING IN NORTHERN NAMIBIA

*\*Oliver E Pierson, USDA Forest Service International Programs; \*Michelle E Gadd, None*

In 2006, the Government of Namibia submitted a proposal to the Millennium Challenge Corporation (MCC), a US Government Corporation working to reduce global poverty through economic growth. One element of the \$300 million proposal is the eradication of foot and mouth disease in the Northern Communal Areas of Namibia in order for beef from that region to be eligible for export to international markets. The 'Disease Free Status Master Plan' depends upon eliminating the movement of all porcine and ruminant animals between Angola and Namibia west of the Caprivi Strip through the construction of a Veterinary Cordon Fence along the land border and the implementation of a monitoring program along the Kavango and Kunene Rivers. However, this region has seen increases in wildlife populations over the past ten years, and a veterinary cordon fence and a movement control program have the potential to lead to wildlife harm or death. Additionally, MCC's environmental guidelines state that its programs must not cause significant environmental hazards. This paper will present the decision making process used to review the best available wildlife data in this region, assess the potential impact of the disease free status plan on wildlife, identify mitigation measures (or fence modifications that would make the fence less detrimental), and arrive at a decision of whether or not to fund the fence. Lastly, we highlight how researchers can best present their data to influence policy decisions.

#### 8. VALUING THE ARC: MAPPING ECOSYSTEM SERVICES IN A TANZANIAN

## CENTER OF ENDEMISM

*\*Taylor Ricketts, World Wildlife Fund; \*Andrew Balmford, University of Cambridge; \*Neil Burgess, WWF; \*Guillermo Mendoza, Natural Capital Project; \*Pantaleo Munishi, Sokoine University of Agriculture; \*Shadrack Mwakalila, WWF - Tanzania; \*Erik Nelson, Natural Capital Project; \*Nasser Olwero, WWF - US; \*Mathieu Rouget, Zoology Department, University of Cambridge; \*Heather Tallis, Natural Capital Project; \*Sue White, Cranfield University*

Natural systems support human lives and livelihoods, and these ecosystem services can provide novel motivation and funding for conservation. Decision-makers, however, lack the information and tools needed to operationalize this intuitively appealing concept. Here, we use a new set of general models and available data to map five ecosystem services in the Eastern Arc Mountains of Tanzania, a global conservation priority. Our maps identify win-win areas, where concentrations of ecosystem services and biodiversity coincide, as well as areas of trade-off, where conservation will likely contribute fewer benefits to people. Simple but plausible scenarios of future land use change illustrate the likely consequences for biodiversity, ecosystem services, and their spatial concordance. These results illustrate the early findings of a 5-year collaboration among Tanzanian, UK, and US researchers, with continual input from leaders in the Tanzanian business, government, NGO, and donor communities. Using these general tools to map ecosystem services within conservation priorities will help clarify links between nature and human well-being, target payment schemes for ecosystem services, and align goals of conservation, economic development, and poverty alleviation.

## 49. Landcare & Conservation Biology: Improving the Value of Working Landscapes and Ecosystem Services

### 1. INTERNATIONAL LANDCARE: AN EMERGENT, SELF-HELP, COMMUNITY-BASED CONSERVATION ETHIC AND GLOBAL MOVEMENT

*\*David J Lowe, Landcare International; \*Dennis Garrity, World Agroforestry Centre*

An ecologically-challenged world needs resource stewardship tactics that truly engage community custodians and respond to their needs. Landcare, a conservation ethic and movement born in 1980s Australia, and now in 18 countries on five continents, drives community-level economic, social, and conservation action linked across whole landscapes. Landcare initiatives are as varied as local habitats and traditions, but universally foster a common culture of self-help and sustainability. Local crisis often spawns grassroots ingenuity, strengthens community bonds and skills, and generates modest seed funding. Branding leverages funding to grow and sustain projects with public-private partnership support—86% of all Australians recognize the Landcare logo. Watersheds are the typical unifying scale, linking initiatives across a region. Improved conservation practices are shared across broad Landcare networks and reinforced by public recognition. As a mark of extension success, Landcare-disseminated conservation techniques have been adopted by 75% of Australian farmers, well beyond the 40% that were actual Landcare members. We will outline Landcare success in Australia and its spread over the past

decade to South Africa, the Philippines, New Zealand, Germany, Iceland, and recently the U.S., Pacific Islands, East Africa, and elsewhere. The role of Landcare International and other facilitative networks also will be covered.

### 2. LINKING LANDCARE, ENERGY AND BIODIVERSITY: CURRENT EXAMPLES AND FUTURE POTENTIAL.

*\*Glen Stevens, Virginia Tech; \*Jefferson L. Waldon, Conservation Management Institute, Virginia Tech*

Landcare is an approach to natural resource management that focuses on organizing communities to develop integrated local networks and systems. These networks can provide for energy production on both public and private lands. We are involved with local Landcare groups that have identified strategies for meeting energy needs while at the same time addressing key environmental concerns and supporting local economies. We will discuss two specific examples of local energy projects that overlap with Landcare concerns. In Southwestern Virginia, Grayson LandCare is investigating the feasibility of stewardship contracting on Forest Service lands; this effort would involve using forest techniques that improve timber quality and forest value, while at the same time providing fuel for local public buildings. We are also working with the Piedmont Geriatric Hospital in Crewe, Virginia to identify strategies for firing boilers with locally produced, native warm-season grasses. Restoration of warm-season grasses in the region would provide a boon to farmers (increasing pasture yields, multi-market crops) and biodiversity (through restoration of a much-diminished habitat type and the native bird species that depend on this grassland habitat). Beyond these specific examples, we will address the key environmental, economic and social issues related to local energy networks.

### 3. SUSTAINABLE LANDCARE AND LOCAL FOOD SYSTEMS

*\*Carola Haas, Virginia Tech*

Landcare's attention to the "triple bottom line," economic, environmental, and community benefits, allows us to evaluate agricultural practices from a broader perspective. With "locavore" being the New Oxford American Dictionary's word of the year, the number of direct farm-to-consumer sales skyrocketing, and food safety alerts and recalls becoming more frequent, alternative food systems have increasing appeal. As conservation biologists, how can we evaluate the costs and benefits of alternative food systems, and what should and could we be doing to promote these? From consumers who ask questions about the practices used to produce their food, to farmers who count birds as an index to the quality of their management practices, to local governments who find ways to maintain a greenbelt around urbanizing areas to promote food security, many practices will have major consequences for agricultural landscapes. Diverse segments of a community can come together to support shared goals, and biodiversity conservation can be an indicator of success, as will be described in case studies.

### 4. LANDCARE AND CONSERVATION BIOLOGY: AN INTRODUCTION AND OVERVIEW

*\*David Porter Robertson, Virginia Tech*

Landcare is an international movement of citizens, landowners, and professional land managers, including conservation biologists, who are working together to take care of the land in a way that produces a broad range of improved economic, social, and environmental conditions (the triple bottom line).

As such, landcare contributes to the science and practice of conservation biology and links biodiversity goals to positive economic and community development objectives. The "landcare" movement began in 1986 in Australia where there are now approximately 5000 community landcare groups. Forty percent of farmers and land managers across Australia are members of these landcare groups. As many as 75% of Australian farmers are reported to utilize land stewardship techniques disseminated through the landcare network. In the past decade, the landcare movement has spread to a dozen countries, including New Zealand, the Philippines, South Africa, and the United States. Within the United States, community landcare groups are now thriving in the headwaters region of southwestern Virginia and western North Carolina. Landcare partners in the United States include the US Department of Agriculture and Environmental Protection Agency, the national associations of Conservation Districts, RC&D Councils, and Regional Councils in addition to local and regional partners such as land trusts and landowner groups.

## 5. LANDCARE & LANDOWNERS - THE CRITICAL LINK

*\*Christine Marie Gabbard, Virginia Tech*

Virginia's population has increased in recent years and this trend is not predicted to change. By 2030, the Commonwealth's population is expected to increase by nearly 24%. As population grows, the pressure to develop land will increase, resulting in loss of valuable habitats. Seventy-four percent of lands used by Virginia's species of greatest conservation need are in private ownership, and as a result are subject to development pressure. While conservation easements are tools to help protect land from development, they currently protect less than one percent of lands critical to Virginia's species of greatest conservation need. Effective land and resource management, on the other hand, not only protects critical habitat, but also improves air and water quality, reduces soil erosion, and increases carbon sequestration - all extremely valuable to Virginia's critical species and its citizens. Landcare is a landowner led community-based approach to sustainable land and resource management. Landcare recognizes landowners, and the powerful synergy created by organized landowners, are a critical link for sustainable management of valuable habitats. Landcare practitioners cultivate partnerships, create community networks, and procure funds to capitalize on opportunities and maximize profitability to support landowners, and to encourage implementation of sustainable land and resource management practices.

## 6. LANDCARE AND SCIENCE, WHO POSES THE RESEARCH QUESTIONS? THE INTRODUCTION OF LANDCARE IN SW VIRGINIA, USA

*\*Jerry Allen Moles, New River Land Trust*

The introduction of LandCare changes environmental, economic, social, and cultural relations. For those participating, new roles are assumed and existing relationship changed. For the scientists, the posing of research questions based upon "the state of knowledge" or the "cutting edge" and sponsors expectations -- whether government, corporate, or philanthropic -- is challenged by new players from the forests and fields, farmsteads, small towns, marketplaces, banks, farm equipment manufacturers, processing and distribution enterprises, etc., working together in the name of LandCare. The questions to be answered are based upon a consensus by people who feel they must cooperate in order to protect the productivity and sustainability of agriculture and forestry while maintaining quality environmental services. Rather than just being a provider of expert information and opinion based upon

empirical findings, the scientist enters into a new set of relationships as a partner vested in the outcomes of LandCare projects. To participate, the scientist becomes an active contributor to achieving community goals. Research is designed to "open doors" to community benefits. The goals are based upon decisions by the various players to take collective action to achieve these very same goals, "the triple bottom-line" of LandCare -- improved incomes, improved community services and amenities, and a healthy and vibrant environment.

## 50. Landscape Change on the Cumberland Plateau: Drivers, Consequences, and Policy Solutions for a Key Biodiversity Hotspot

### 1. THE CUMBERLAND PLATEAU LAND RUSH - HOW CAN WE BALANCE FOREST FRAGMENTATION WITH CONSERVATION?

*\*Daniel Carter, University of the South*

Within a five year time-frame, Marion County, Tennessee will experience over 40,000 (thousand) acres of traditional forestland converted to private, rural residential development. Since the county was formed in 1817, all seven cities within its boundaries, combined only account for 34,202 (thousand) acres. These former forested tracts are all located in remote areas of the Cumberland Plateau, with very few existing public services. Case-studies outline key factors allowing rapid forest fragmentation to occur in one county, including state and federally funded rural water line extensions, limited local land-use controls, and bluff-view real estate markets. Findings from the case studies suggest that each level of government plays a separate and often un-coordinated role in allowing for rapid fragmentation of large timber tracts, with little consideration for conservation or public recreation. Poor water planning has resulted in a situation where entire communities are out of water due to an unprecedented drought, while new water lines are being extended to large developments with no residents. Since many rural local governments are traditionally not in the land conservation business, policy solutions are identified that will enable local public involvement in the growth process, offering more opportunity for the conservation of local natural assets.

### 2. HABITAT CONSERVATION PLANNING AS ADAPTIVE GOVERNANCE IN THE NORTHERN CUMBERLANDS

*\*David Ostermeier, University of Tennessee, Knoxville; \*Emily Woodle, University of Tennessee, Knoxville*

Biodiversity and habitat conservation are often the domain of specialized governmental authorities who are often in conflict with other governmental institutions which promote the use of natural resources associated with endangered species and/or biodiversity hot spots. During the last decade, adaptive governance structures have been developing at local levels to address these place-based conflicts. Habitat conservation planning under the Endangered Species Act has become an example of these adaptive governance structures, and an HCP is being developed for the Northern Cumberland Region ([www.cumberlandhcp.org](http://www.cumberlandhcp.org)). The evolution of this HCP will be discussed, from grant funding and initial scooping to the development of current operational structures and processes. The trials and tribulations common to this HCP, and adaptive governance structures more generally, will be discussed and analyzed including: who is involved; how all the parties are integrated into an overall network; developing adaptive leadership; developing participant and network capacities; how

decisions are reached; and what is the nature of learning by partners, stakeholders and the public. Conclusions are discussed regarding HCPs as policy tools for addressing landscape change in the Northern Cumberlands.

### 3. BIRD DIVERSITY IN FORESTS, PLANTATIONS, AND EXURBAN AREAS ON THE CUMBERLAND PLATEAU: POLICY AND MONITORING IMPLICATIONS.

*\*David Haskell, University of the South*

Policies aimed at conserving forest biodiversity should be informed by data on the relative impacts of different types of forest loss on biodiversity. Forests on the Cumberland Plateau (Tennessee, USA) are being converted to monoculture pine plantations and to low density (exurban) residential areas. We compared avian diversity in forests, plantations and exurban areas on the Cumberland Plateau. By combining field surveys with digital habitat databases, then analyzing diversity at multiple scales, we found that plantations had lower diversity and fewer conservation priority species than did other habitats. Exurban areas had higher diversity than did native forests, but native forests outscored exurban areas for some measures of conservation priority. In addition, we examined the effectiveness of traditional road-side surveys of bird populations. We found that road-side surveys significantly distorted estimated population trends. It is therefore likely that the impacts of monoculture forestry have been underestimated in our region. We recommend revised methods for quantifying biodiversity and for accounting for forest loss in our region. In addition, forest conservation programs should downgrade incentives for plantations and should include settled areas within their purview.

### 4. THE ECOLOGICAL LEGACY OF INDUSTRIAL FORESTRY ON THE CUMBERLAND PLATEAU IN TENNESSEE

*\*Jonathan Evans, University of the South; \*Nicholas Hollingshead, University of the South*

The biologically diverse hardwood forests of the Cumberland Plateau are considered among the highest conservation-value forests remaining in North America. The large tracts of continuous forest that compose this region are mostly privately owned and have recently experienced rapid changes in land-use. We used remotely sensed data and on-the-ground assessment to measure changes in forest cover between 1981 to 2003 across a seven-county, 614,000-acre portion of the Cumberland Plateau in southern Tennessee. During this 22 year period, there was an accelerated rate of forest loss, with approximately 20% (95,000 acres) of the native forest being cleared or converted to other uses. Between 1981 and 2000, conversion to pine plantations accounted for the majority of all conversion activity. Between 2000 and 2003, while forest clearing continued to accelerate, the majority of cleared forest lands were left unmanaged. The ecological consequences of this forest conversion included: 1) the loss and fragmentation of upland forest habitat 2) isolation of publicly protected natural areas, 3) the loss of ephemeral pond habitat, 4) depletion of soil nutrient status, and 5) an amplification of the southern pine beetle epidemic. Our documentation of these ecological changes, along with increased public awareness, led to changes in forest policy and industrial forestry practices as well recent, state-level conservation initiatives for the Cumberland Plateau region.

### 5. ECONOMIC DRIVERS OF LANDSCAPE CHANGE: RESULTS OF A GIS SIMULATION

*\*Robert Gottfried, Dept. of Economics, Sewanee:*

*The University of the South; \*E. Douglass Williams, Dept. of Economics*

This paper develops a spatially-explicit, economic GIS model that simulates conversion of native hardwood forest to pine plantations or shrub/grassy cover, and to low density permanent and second homes in a seven county area on the southern Cumberland Plateau of Tennessee. Utilizing logit analysis to examine GIS data on forest cover change for the period 1997-2003, along with spatially explicit tax data, the paper estimates forest cover transition probabilities at the subparcel level and the probability that a home will be built at the parcel level. Smaller subparcels with environmental amenities appealing to homeowners that were part of parcels with homogeneous cover were less likely to be converted. Parcel characteristics, landowner type (timber company, other business, private individual, local/absentee) and nearby forest cover affected conversion to pine or grass/shrub. Parcel and landowner characteristics, and national economic conditions, affected the probability of home construction. The probabilities were fed into a GIS simulation model to simulate forest cover change and home construction twenty years into the future under differing economic scenarios. Home construction was very sensitive to national economic conditions whereas forest cover change was not. Scenarios that changed landowner types and that kept homes constant suggested that landowner type plays a large role in forest cover change and that home construction may help maintain native forest cover.

### 6. SIMULATING THE EFFECTS OF CONSERVATION EASEMENTS ON THE TENNESSEE SOUTHERN CUMBERLAND PLATEAU

*\*Brandon R Kaetzel, University of Tennessee*

This presentation will focus on the results from simulating the effects of purchasing conservation easements on the southern Cumberland Plateau of Tennessee. We will assess the relationship between measures of protection (e.g. acres in easements, percent of a target area protected) and various outcomes (e.g. acres of contiguous forest, connectivity of tracts of forest land, and edge effect). The results can be used to assess the necessity of protection through simulating the probability of development of a targeted area, with and without easements, as well as the economic tradeoffs between buying many small conservation easements or a few large ones.

### 7. POLICY PROPOSALS EMERGING FROM STAKEHOLDER DISCUSSIONS ON ENVISIONING THE FUTURE OF THE CUMBERLAND PLATEAU

*\*Charles Brockett, Sewanee: The University of the South; \*Katharine Wilkinson, Centre for the Environment, University of Oxford*

Featuring some of the highest conservation-value forests remaining in North America, Tennessee's Cumberland Plateau also is home to important human communities, often with deep roots and strong pride of place and tradition. The region currently faces widespread and intensive development pressures, particularly for retirement and second home construction on mountaintops and along ridgelines. In response, landowners (both corporate and individuals) are divesting and previously intact tracts of land are being subdivided. Given the significant interest in and unprecedented pressures on the Plateau, an interdisciplinary team from three regional universities facilitated a series of meetings in the Fall of 2005 bringing together stakeholders and decision-makers from local, county, regional, and state levels for dialogue on its challenges and future. The project's aim was to consider tools that are, or

could be, available for shaping the Plateau's future in accordance with residents' values and desires, and to encourage innovative action in response to communities' needs. The final conference had over 100 participants from seventeen different counties, along with regional and state officials. This paper by the project organizers reports on the results of these discussions, subsequent major conservation efforts in the region, and offers our own policy proposals following from them.

## 51. Landscape Ecology

### 1. A NON-LINEAR RESPONSE OF MARSH BIRD COMMUNITIES TO URBANIZATION IN MASSACHUSETTS LANDSCAPES

*\*Brian Glenn Tavernia, Tufts University; \*Michael Reed, Tufts University*

Effective conservation of marsh birds imperiled by habitat loss requires an accurate understanding of the relationships between habitat features at multiple spatial scales and species' distributions. Urbanization of adjacent landscapes has the potential to negatively impact marsh bird communities via several top-down and bottom-up mechanisms. Despite this, conflicting patterns have been reported in the literature; while some report the expected negative effect upon marsh adapted species richness, others report a positive effect. Conservation of state-listed marsh bird species in Massachusetts landscapes will require a clear understanding of the impact of urbanization on their distributions. To investigate this issue, we conducted marsh bird community surveys in 34 Massachusetts wetlands varying in the degree of surrounding urbanization. Degree of urbanization was defined by road density in the surrounding landscape; roads have the potential to impact wetland hydrology and water quality, resulting in reduced habitat quality for breeding marsh birds. Our results suggest that urbanization has a threshold effect upon marsh bird communities, such that long distance migrants and marsh specialists are less likely to occur in urban settings. Consequently, efforts to conserve marsh specialists may need to take a landscape approach, restricting the development of landscapes surrounding critical habitat for these species.

### 2. DOES LIVESTOCK GRAZING AFFECT THE SUITABILITY OF RED DEER (CERVUS ELEPHUS) DISTRIBUTION?

*\*Kamal Thapaliya, ITC, The Netherlands; \*Jan de Leeuw, International Institute for geo information science and earth observation (ITC); \*Hein van Gils, International Institute of geo information science and earth observation (ITC)*

The effect of livestock grazing on spatial distribution of wildlife was not addressed properly in previous research. The aim of this study is to explore and analyze the spatial distribution of red deer in relation to livestock grazing. 301 species' point records (15\*15 m) for cow, horse, deer, sheep/goat and gazelle based on dung (pellets) counts and 30 environmental predictors were prepared in GIS environment to map probability of spatial distribution of deer in Hustai National Park, Mongolia. Chi Square illustrates significant association of park management and distribution of the deer pellets ( $X^2 = 94$ ,  $df = 3$ ,  $P < 0.001$ ) as well as the distribution of marmots burrows ( $X^2 = 16.4$ ,  $df = 3$ ,  $P < 0.001$ ). Our study of livestock association with red deer demonstrated significant negative association ( $X^2 = 137$ ,  $df = 9$ ,  $P < 0.00$ ) for sheep/goat pellets and negative association ( $X^2 = 79$ ,  $df = 9$ ,  $P < 0.001$ ) for cow dung abundance. But positive association ( $X^2 = 18.3$ ,  $df = 9$ ,

$P < 0.03$ ) was observed with horse dung abundance. Logistic model ( $R^2 = .752$ ) shows highest probability of deer distribution with increasing elevation, higher slope, nearer to river and farther away from the roads. Elevation ( $R^2 = .654$ ) alone explain deer distribution similar to our final model. Further analysis of elevation related factors was carried and this confirm human disturbance and livestock grazing in the lower elevation is the causative factor governing occurrence of red deer in the higher elevation.

### 3. HABITAT USE OF ADAMAWA TURTLE DOVE (STREPTOPELIA HYPOPYRRHA): IMPLICATION OF PROTECTED AREAS IN DEGRADED LANDSCAPE

*\*Ademola Abiola Ajagbe, Ecologist*

The Adamawa Turtle Dove (*Streptopelia hypopyrrha*) is endemic to Northern regions of Nigeria and Cameroon. Their natural habitat is gradually eroded by increasing anthropogenic need for farmland, log and urban expansion. The activities of Adamawa Turtle Dove in the Amurum Forest Reserve, Jos, North Central Nigeria, and surrounding habitat that was degraded into farmlands were studied between February and April 2004. A total number of 185 individuals were recorded in Amurum and 228 in the surrounding farmlands. In the Amurum Forest, the peak of bird observation was before 07:00 hours, particularly in transects around the gallery forests. Birds perched and flying were higher in the Amurum Forest Reserve before 07:20 hours but no birds were seen foraging in the forest at that time. This suggests that these birds utilize farmlands during the day for foraging while they roost in the Amurum Forest Reserve. In the farmlands birds foraging, flying, perched and hopping were higher after 0720 hours. Most birds foraging were observed in the farmlands. Furthermore, there were unique assemblages of foraging Adamawa Turtle Doves in freshly burnt farmlands which implies the benefit of communal roosting in protected habitat. The forest reserve is also used for nesting which strongly indicate the value of the reserve to the Dove population in the degraded habitat. This study shows the significance gazetted protected areas for the conservation of birds in degraded landscape.

### 4. LEMURS AND LIVESTOCK: COMPARING LEMUR ABUNDANCE AND VEGETATION STRUCTURE BETWEEN TROPICAL DRY FOREST SITES

*\*Anne Clary Axel, Michigan State University;*

*\*Lyndsay Rankin, Michigan State University*

The conservation of biodiversity in tropical dry forests requires an understanding of the impacts of human land use on the landscape. Grazing is a leading impact on dry forests in southern Madagascar, yet little effort has been made to understand its effects on either forest vegetation or wildlife. We investigated the impact of grazing on the abundance of two endangered lemurs and on the vegetation structure of two forest types. We evaluated the effects of cattle grazing by comparing two ungrazed sites with two moderately and two heavily grazed sites in dry and riverine forests in, and around Beza Mahafaly Special Reserve. In a comparison of vegetation parameters, a significant effect for grazing ( $p < 0.05$ ) was found for forest vegetation variables such as seedling abundance, leaf litter thickness, and canopy openness. Surprisingly, there was no significant difference in abundance of either Lemur catta or Propithecus verreauxi between grazed and ungrazed sites. Despite the fact that grazing does have a strong impact on forest vegetation parameters, we suggest that maintenance of the two lemur species populations may not be incompatible with moderate grazing. Our data are consistent with other

research suggesting that *L. catta* in particular, is tolerant to disturbance. These results are especially timely given that the Malagasy National Park Service has recently enlarged the Beza Mahafaly Special Reserve and is now selecting areas which will remain open to grazing.

## 5. THE DYNAMICS OF ACACIA DREPANOLOBIUM UNDER HEAVY BROWSING IN AN ENCLOSED RESERVE IN KENYA

*\*Geoffrey Mwangi Wahungu, Moi University;*  
*\*LUCY KIRIGO MUREU, Moi >University, Kenya*

We monitored the growth and survival of marked adult and seedling whistling thorn *Acacia drepanolobium* at Sweet Waters Game Reserve in Kenya between 2003 and 2007. Sweet waters Game Reserve is a 90km<sup>2</sup> Conservation area that is completely fenced enclosing populations of three browsing mega herbivores; elephants, rhinos and giraffe. Over 2500 individually marked trees and seedlings of various age classes were marked and monitored twice a year between 2003 and 2007 for height increment, damage by any of the three herbivores, and mortality due to damage or drought. We compared tree growth, damage and seedling survival in *A. drepanolobium* between three treatments; the reserve, the ranch and a control area. Elephant related mortality in trees was 35% and increased predictably with increase in tree height. Giraffe browse significantly reduced flowering and fruiting in *A. drepanolobium* but did not directly influence height increment. However, giraffe browsing increased susceptibility to drought. Rhinos browse on seedlings and trees below 2m thereby affecting the rate of recruitment of seedlings into trees. Height class distribution of seedlings in the reserve is highly skewed with 20-40cm class the most represented. This 'storage' effect means that most seedlings remain below grass layer until they can get an opportunity to grow into trees in the absence of browsers.

## 6. THE INFLUENCE OF EXPANDING URBANIZATION ON STREAM BIOTA: RESULTS FROM THE MID-ATLANTIC AND SOUTHERN NEW ENGLAND USA

*\*Scott Goetz, Woods Hole Research Center; \*Greg Fiske, Woods Hole Research Center*

We examined the relationship between the built environment, landscape configuration, and water quality of streams across three physiographic provinces of the State of Maryland and in southern New England. We used image data products capable of discriminating fine-scale information of the land surface, including proportional impervious, tree, grass and crop cover, and then developed a range of statistical models that relate land cover information to stream biotic integrity within watersheds. The stream biota measurements included number of sensitive taxa (NEPT), biotic indices of biological integrity (BIBI), and the Hilsenhoff Biotic Index (HBI), each of which provides unique information. Impervious and tree cover were found to be the primary predictors of stream biota, although this varied with physiographic province and the response variable of interest. In Maryland, the best multivariate models predicted 65% of variability in BIBI and 62% of NEPT (N=59). In New England the best models predicted 76% of NEPT and 69% of HBI (N=83). We also tested the effectiveness of weighting land cover variables within a watershed based on distance from the stream channel and the presence of forest cover. These indices of landscape configuration were important in many, but not all cases, for improving the predictive quality of statistical models estimating stream biota metrics.

## 52. Landscape Ecology (2)

### 1. A COMPARISON OF METRICS PREDICTING LANDSCAPE CONNECTIVITY FOR A HIGHLY INTERACTIVE SPECIES ALONG AN URBAN GRADIENT

*\*Seth B. Magle, University of Wisconsin- Madison;*

*\*David M Theobald, Colorado State University;*

*\*Kevin R Crooks, Colorado State University*

Many wildlife species persist in fragmented habitat where movement between patches is essential for long term demographic and genetic stability. In the absence of direct observation of movement, connectivity or isolation metrics are a useful method of characterizing potential patch-level connectivity. However, multiple metrics exist at varying levels of complexity, and empirical data on wildlife distribution are rarely used to compare performance of metrics. We compare 12 connectivity metrics of varying degrees of complexity to determine which best predict the distribution of prairie dog colonies along an urban gradient of 384 isolated habitat patches in Denver, Colorado, USA. We found that a modified version of the incidence function model including area-weighting of patches and a cost parameterized surface had the best predictive power, where we assumed roads were fairly impermeable to movement, and low-lying drainages provide dispersal corridors. Thus, both patch area and the composition of the surrounding matrix affected the persistence of prairie dog colonies. Our results provide guidance for landscape habitat modeling in fragmented landscapes and can help identify target habitat for conservation and management of prairie dogs in urban habitat.

### 2. CARNIVORE CONNECTIVITY IN THE NORTHERN ROCKIES: USING SCAT-DETECTING DOGS AS A TOOL TO MODEL LINKAGE ZONE FUNCTIONALITY FOR A SUITE OF SPECIES

*\*Jon P Beckmann, Wildlife Conservation Society*

In the Greater Yellowstone Ecosystem (GYE), isolation is of particular concern for large carnivore species that currently occur inside the Yellowstone National Park core area. The Centennial Mountains along the Montana-Idaho border are a high priority concern for connecting the Yellowstone to Yukon system (Y2Y). Because the Centennials have been delineated not only as an area of possible linkage within Y2Y, but also identified as a possible peripheral sink area inside the GYE, it is critical to identify those human activities that potentially prohibit the Centennials from being used as a linkage zone by large carnivores. The aim of this project is to utilize a novel, non-invasive DNA sampling technique to examine connectivity for carnivores in the Centennials and surrounding valleys. I am using search dogs specifically trained to locate the scat of four target species (black bear, grizzly bear, cougar, and wolf) to sample the Centennials. I utilized a multiple logistic regression analysis with respect to habitat parameters, changes in land use patterns, and measures of human activity in combination with GIS to examine human impacts on each species' distribution and movements. I will discuss the resulting RSF models and surface probability of use maps that allowed me to highlight areas of highest priority for conservation action. Finally, I will discuss merits and limitations of using search dogs as a novel method for carnivore conservation at landscape scales.

### 3. DISPERSAL AND COLONISATION OF CYANO-LICHENS IN A HIGHLY FRAGMENTED

## LANDSCAPE.

*\*Ivar Gjerde, None; \*Magne Saetersdal, None;*

*\*Hans Blom, None*

Better knowledge on the dispersal ability of species is crucial for the development of conservation strategies in landscapes. We investigated the colonisation of former treeless heathland in southwest Norway by cyano-lichens. In a 16,000 ha study area 92 sites of potential cyano-lichen habitat was found. They were mainly small patches of aspen forest with age ranging from 20 to >100 years. Comprising only 0.4% of the area, we were able to record all specimens (thalli) of cyano-lichens present. Ten old potential source areas were found scattered within the study area, and the distance to younger habitat sites varied between 0.2 and 6 km. Despite the fragmented habitat configuration we recorded 32,000 thalli belonging to 23 different species. We found that species richness in sites increased with the age of the forest, whereas no effect on species richness of distance from potential source areas was detected. An investigation of genetic variation in one of the lichen species (*Lobaria pulmonaria*) supported these results (higher diversity of haplotypes in old sites, and no effect of distance). The results suggest that the dispersal ability of lichen diaspores is not limiting the distribution of species within the space and time scales investigated (0.2-6km, 20-100 years), whereas time for colonisation is more important. Thus presence of old habitat seems to be of more vital importance to this species group than the configuration of habitat within the landscape.

## 4. ENVIRONMENTAL CHANGE HASTENS THE DEMISE OF THE CRITICALLY ENDANGERED RIVERINE RABBIT (*BUNOLAGUS MONTICULARIS*)

*\*Greg Hughes, Cambridge Environmental Assessments; \*Wilfried Thuiller, Laboratoire d'Ecologie Alpine, UMR-CNRS 5553, Université J. Fourier, Grenoble, France; \*Guy Midgley, South African National Biodiversity Institute; \*Kai Collins, Mammal Research Institute, Dept. Zoology & Entomology, University of Pretoria, South Africa*

Declining population numbers coupled with the growing evidence of global change have focussed attention on the critically endangered riverine rabbit (*Bunolagus monticularis*) endemic to South Africa. The aim of this study is to develop a habitat model to aid in the identification of isolated populations, offer opportunities for re-introduction, and guide future conservation efforts by assessing the possible impacts of global change. We attempt a novel approach where plant species which afford the riverine rabbit cover from predation and its primary food sources are modelled for both current and future projections of potential habitat. Results suggest that unsurveyed suitable habitat might harbour previously overlooked isolated populations or offer new opportunities for re-introductions. Future climatic conditions under the most severe general circulation model for the region (HADCM3) suggest that, on average, in excess of 96% of the current habitat could become unsuitable, mitigated only slightly by a possible 7% increase in range. Consideration of existing land transformation increases this range reduction by a further 1%. Given that the bulk of future potential range lies well outside of the currently known and surveyed areas the current adaptation options of conservancy establishment and captive breeding need to be re-evaluated. Without positive human intervention the future of the critically endangered riverine rabbit under conditions of global change seems certain.

## 5. MODELING ALTERNATIVE COAL MINING

## AND TIMBER HARVEST SCENARIOS AND THE IMPACTS ON INTERIOR FOREST LOSS AND CERULEAN WARBLER HABITAT

*\*Lesley P Bulluck, Virginia Commonwealth University; \*Roger Tankersley, Tennessee Valley Authority; \*David Buehler, University of Tennessee*

We modeled scenarios of coal mining and timber harvesting in the Cumberland Mountains of Tennessee. Our objective was to calculate the amount of interior forest lost compared to total forest loss under realistic future scenarios and to assess the effects on cerulean warblers. We conducted sliding window analyses representing different edge effects (50, 100, 150, 250, and 300 m). The percentage of interior forest loss was 1.4-3.6 times greater than total mature forest loss. In one sub-region where the percentage of interior forest is currently high, 21-58% of interior forest was lost under expected levels of disturbance. Accounting for decreased cerulean warbler densities in edge habitats, twice as many breeding territories were lost compared with when edge and interior forests were assumed to have equal densities. Both mining and timber harvesting cause considerable declines in interior forest relative to total forest loss, but mining appears to have a larger per-hectare impact. For every hectare of forest removed from mining activities, there is a greater loss of interior forest than with the same area of forest lost from timber harvesting. This result is likely a reflection of the linear nature of contour mines and therefore the greater amount of edge created compared to timber harvests.

## 6. POPULATION RESPONSE OF STELLER SEA LIONS (*EUMETOPIAS JUBATUS*) TO SPATIAL AND TEMPORAL ENVIRONMENTAL HETEROGENEITY

*\*Michelle Elizabeth Lander, NOAA Fisheries/University of Washington; \*Thomas R. Loughlin, NOAA Fisheries; \*Miles L. Logsdon, University of Washington; \*Glenn R. VanBlaricom, US Geological Survey and University of Washington; \*Brian Fadely, NOAA Fisheries; \*Lowell W. Fritz, NOAA Fisheries*

The decline of the western stock of Steller sea lions (*SSLs*; *Eumetopias jubatus*) in Alaska has been attributed to changes in the distribution or abundance of their prey due to the cumulative effects of fisheries and environmental perturbations. Because previous studies indicated diet diversity was related to population decline within metapopulation regions of *SSLs*, the objective of this study was to examine habitat diversity within the context of recent population trajectories. Habitat use was assessed by deploying satellite tags on 45 *SSLs* from 2000-2004 within 4 regions of Alaska. The relationship between defined areas of use and the spatial heterogeneity and temporal variation in sea surface temperature (SST) and chlorophyll-a (*chl-a*) estimates from remotely sensed satellite platforms served as our data frame for investigating population trajectories and environmental processes, which may serve as proxies of prey location. Population trends and SST diversity were consistent with trends reported for diet studies, possibly indicating a link between environmental diversity, prey diversity, and distribution or abundance of sea lions. However, population change was more sensitive to the spatial pattern of *chl-a* diversity and there appeared to be an ecological threshold. Understanding how *SSLs* respond to measures of environmental heterogeneity will ultimately be useful for implementing ecosystem management approaches and developing additional conservation strategies.

## 7. UNDERSTANDING LANDSCAPE EFFECTS OF WILDLANDS ON FARMS: BIRD PESTS AND PEST-PREDATORS IN AN AGRICULTURE-RIPARIAN MOSAIC LANDSCAPE

*\*Suzanne Langridge, University of California Santa Cruz*

Agriculture can receive important ecosystem services from natural areas; such services could be incentives for restoring and conserving natural habitat. However, little is understood regarding the positive services or negative impacts that agricultural production receives from natural areas. Birds are mobile links between natural and agricultural areas and can have both positive indirect effects and direct negative effects on crops. In this presentation, I review how area of natural habitat can affect the distribution and behavior of birds, and therefore their role as natural enemies and pests in agriculture. In 2006 and 2007, I conducted bird surveys and foraging observations on 23 different 8 ha walnut farm plots. I analyzed how abundance, diversity, and foraging behavior of birds varied in terms of proportional area of riparian habitat around the farms. I found that pest bird flock presence and density decreased with increasing proportional area of riparian habitat. Densities of insectivorous riparian birds increased significantly with proportional area of riparian habitat. Successful foraging of insectivorous riparian birds also increased significantly with increasing proportional area of riparian habitat. Research on agricultural ecosystem services within a landscape context has focused on pollination services and arthropod natural enemies. My research demonstrates that landscape context can also affect density, diversity, and behavior of avian insectivores on farms.

## 53. Landscape Ecology (3)

### 1. A PREDICTIVE MODEL FOR WETLAND LOSS ON PRIVATE LANDS IN THE SOUTHEASTERN UNITED STATES: IMPLICATIONS FOR LAND-USE DECISION MAKING

*\*Kevin J. Gutzwiller, Baylor University; \*Curtis H. Flather, U.S. Forest Service*

Wetlands generally provide significant ecosystem services and function as important harbors of biodiversity. We used Multivariate Adaptive Regression Splines to develop a model to predict the risk of wetland loss as a function of wetland features and landscape context. Fates of wetlands from 1992 to 1997 were obtained from the National Resources Inventory for the U.S. Forest Service's Southern Region, and land-cover data were obtained from the Multi-resolution Land Characteristics Consortium. We randomly selected 70% of our 40,617 observations to build the model, and randomly divided the remaining 30% of the data into 5 test data sets. Based on the training data, our optimal model yielded prediction accuracies of 80.7% for wetland loss, 72.5% for wetland retention, and 76.6% overall. Land use surrounding the wetland, wetland ownership, and proximity to developed land (including roads) and other wetlands were important predictors of conversion. When applied to the 5 test data sets, the model's prediction accuracy averaged 79.3% for wetland loss, 71.4% for wetland retention, and 75.3% overall. Prediction accuracies for the test data sets were very similar to those for the training data, indicating the model has general predicative ability across the Southeast. Land-use planners and policy analysts can use the model to identify wetlands in danger of conversion, prioritize at-risk areas for protection, and identify factors that are likely to be responsible for wetland conversion.

### 2. COMMUNITY DIS-ASSEMBLY RULES AND THEIR CONSERVATION SIGNIFICANCE

*\*Trond H. Larsen, Smithsonian Institution*

Ecological assembly rules have long been studied to deepen our understanding of the origin and maintenance of biological communities. Unfortunately, in order to conserve biodiversity in response to rapid environmental change, it is now urgent to reverse our analysis. How are communities coming unraveled? Among other evidence, widespread nestedness of communities indicates these changes are predictable and non-random. I use a novel method, density functions, to explore the response of dung beetle communities to habitat fragmentation. By classifying species according to their population-level response along a gradient of disturbance intensity, I identify several rules governing community disassembly. Sensitive species, which tended to be rare and habitat specialists, declined rapidly to local extinction. Compensatory species peaked in abundance following the decline of sensitive species, presumably due to relaxed competition, but were weak dispersers and disappeared with more intense fragmentation. Persistent species, which tended to be small, common, and diet generalists, declined with fragmentation, but were able to persist at many sites. Supertramp species, which were poor competitors but strong dispersers, occurred at most sites and were most abundant without other species. Identifying community disassembly rules that apply to many different systems and taxa is important for predicting and mitigating the response of biodiversity to various kinds of environmental change.

### 3. GRAZING IMPACTS ON UPLAND GRASSLAND ARTHROPODS IN SCOTLAND WITH PARTICULAR REFERENCE TO MOTHS

*\*Nick Littlewood, Macaulay Institute; \*Pete Dennis, Macaulay Institute; \*John Skartveit, Scottish Agricultural College*

Acid grassland covers 9% of Scotland and hosts many plant and animal species of conservation interest as well as being important for livestock-rearing. Invertebrates are a key component of the biodiversity of such areas for their role in nutrient cycling and as food for upland birds. We investigated interactions between grazing livestock and arthropods in terms of abundance and, for Lepidoptera, species composition. A replicated randomized block experiment was set up with four different grazing treatments. Three years after establishment the biomass of foliar arthropods in the ungrazed treatment was approximately twice that in the commercial stocking treatment. The numbers of spiders, bugs, beetles, craneflies and caterpillars were related to sheep stocking density or an interaction of sheep with year since the start of the experiment. We further investigated nocturnal adult Lepidoptera assemblages by light trapping in year 5. Abundance and species richness were higher in less-grazed plots with, in particular, species feeding on graminoids and over-wintering as larvae being well-represented in the ungrazed treatment. However the commercial stocking treatment hosted a higher proportion of moth species that are in severe decline in the UK. This underlines the importance, for nature conservation, of grazing aimed at producing structural heterogeneity within the vegetation and, in particular, the risks associated with abandonment of grazing in the Scottish uplands.

### 4. LANDUSE CHANGES AND STREAM CONDITIONS IN THE GREEN RIVER WATERSHED OF KENTUCKY: OVERVIEW AND IMPACTS OF THE CONSERVATION RESERVE ENHANCEMENT PROGRAM

*\*Ouida Meier, Center for Biodiversity Studies, WKU; \*Albert Jon Meier, Biology, Western Kentucky University; \*Scott Grubbs, Biology, Western Kentucky University; \*Stephen Kenworthy, Geosciences, Western Kentucky University*

The Green River watershed in Kentucky is renowned for an aquatic faunal community among the richest in the U.S., with 151 fish species and 73 mussel species, including nine listed as endangered. The upper Green River watershed is the most diverse and least impacted sub-basin of this watershed. It has been targeted for a USDA Conservation Reserve Enhancement Program (CREP) to convert pasture and crop land to riparian buffers along the Green River and its tributaries. We initiated a sampling program to develop a comprehensive picture of pre-enhancement conditions in the region. Within our sampling program, measurements of water quality, riverbank erosion and habitat parameters were taken; historical invertebrate, fish and water quality data were analyzed as well. Using a GIS approach, we quantified landuse for the watershed at different scales. Some of the water quality parameters related most strongly to current land use patterns are total suspended solids, turbidity, and fecal coliform bacteria, related to both livestock (feeding operation) and human (septic system) input. The presence of exceptionally well-developed karst in parts of this watershed influences inputs of waste and runoff into the aquatic ecosystem and large-scale riverbank erosion patterns. Severe bank erosion was less frequent in the region dominated by karst drainage. Outside the karst drainage zone, severe bank erosion is more frequent on banks lacking a riparian buffer.

#### 5. NO IMPRINT OF LOCAL PROPAGULE SOURCES ON BRYOPHYTE RECOLONIZATION 50 YEARS AFTER CLEAR-CUTTING IN BOREAL FORESTS

*\*Kristoffer Hylander, Stockholm University*

Acknowledging that nature is dynamic implies that species regularly go extinct at various spatial scales. Knowledge of the process of recolonization, and at which temporal and spatial scale it operates on, is central to our understanding of species distributions, metapopulation dynamics, regional extinction risks and ecosystem resilience. In this study the recolonization pattern of boreal forest bryophytes was investigated in stands that had been clear-cut ~50 years ago. Species known to be sensitive to clear-cutting were inventoried in 23 mature forest stands and in adjacent young stands at 10, 20, 40 and 80 meters from the former forest-clear-cut edge. Quite surprisingly there was no tendency of a higher colonization rate close to the mature stands, although most species had started to recolonize the young stands in certain amounts. A possible explanation for the non-existing signs of positive influence of a local propagule source might be that the local propagule pressure is declining fast and is masked by a higher regional propagule rain already 10 m from the mature stand edge. For organisms with light propagules that are able to form a regional background propagule deposition level the role of mature forest stands in the recolonization process of the matrix might rather be to contribute to the background level of spores in the landscape than to affect the adjacent stands directly, which has important implications for where to locate sites for restoration and protection.

#### 6. OBJECT-BASED IMAGE ANALYSIS TO DETERMINE CONDITION OF ARID LANDSCAPES AT MULTIPLE SCALES FROM SATELLITE IMAGERY AND FIELD DATA

*\*Jason Karl, The Nature Conservancy; \*Brian*

*Maurer, Michigan State University*

Conserving arid habitats in many parts of the world requires effective management at scales commensurate with threats impacting them. Managers have embraced a landscape-scale management philosophy, but have not fully implemented it because of a lack of clarity of how to reconcile existing data and methods to landscape-scale management questions. We used a relatively new remote sensing method, object-based image analysis (OBIA), to describe ecologically-relevant scales from imagery and identify most reliable measures of rangeland condition at each scale. OBIA groups image pixels into polygons, or objects, based on measured between-pixel similarity. The objects, not pixels, are the basic unit for analyzing the image. We created hierarchies of image objects of different scales by varying the heterogeneity allowed within each object using IKONOS and Landsat imagery for two study areas in southern Idaho, USA. We compared mean within-object spectral variance to the variance of mean pixel values between objects and identified ranges where variability did not increase with scale. Comparison with field data confirmed that these ranges of scale invariability corresponded to differences in vegetation of the study areas, and allowed description of characteristics of each scale and measurement of which rangeland condition measures were most accurate at each scale. This approach helps managers identify scales relevant to answering questions of rangeland condition over large landscapes.

#### 7. PROTECTED AREAS HISTORY IN FRENCH WEST AFRICA

*\*KIEMA SEBASTIEN, Married, 1 Child*

Current estimates in conservation biology show a decline in plant and animal species diversity worldwide. The decrease of both wildlife and plants species habitats as a consequence of increasing human population pressures on land and the inability of some species to adapt to current rapid climatic changes are some of the main causes of this decline. Resorting to protected areas as an alternative to conserving endangered species becomes therefore a necessity. This study is a party of an interdisciplinary approach used to better understand the interactions between subsistence livestock breeding systems and plant diversity conservation within protected areas in the Sudanian-savannah of Burkina Faso (West Africa). From the literature review, it appeared that most of the protected areas were initially established for economical purposes. Protected areas history shows also that fauna was not early taken account in French Forestry policy because of diseases it could transmit to human. Only 16 woody plants have economic interest, excluding most of the others and all herbaceous species. This attitude explains the contrasted representations that surrounded populations have on protected areas and conservation measures.

#### 8. THE IMPACT OF FARMING ON VEGETATION COVER AND RODENT COMMUNITY STRUCTURE IN EXTREME-ARID SANDY DESERT

*\*Roy Talbi, The Inst. for Desert Research, Ben-Gurion Uni, Israel; \*Amos Bouskila, Department of Life Sciences, Ben-Gurion University of the Negev, 84105 Beer Sheva, Israel; \*Uri Shanas, Department of Biology, Faculty of Science and Science Education, University of Haifa-Oranim; \*Haim Tsoar, Department of Geography & Environmental Development, Ben-Gurion University of the Negev, 84105 Beer Sheva, Israel*

Along with habitat destruction and fragmentation, farming in arid environments creates terrestrial islands with abundant water and nutrients. Repercussions of desert farming expansion are not fully understood. We studied the edge effect of hyper-arid desert farming on vegetation cover and rodent community structure in the last sandy habitat in the southern 'Arava valley in Israel. To examine the effect of the annual 2 million-cube water that irrigate the nearby date plantation, we drilled 15 boreholes (<6.5m deep). We used aerial photos from the 50s on to map the vegetation cover by GIS methods, and sampled the rodent community by live-trapping and tracks identification on the sand. The inter-dune boreholes revealed for the first time a groundwater table in a depth of 1.5-6m. We found along the habitat-farm edges a significant increase of bush density during the past 20 years and an abundant population of the generalist rodent *Gerbillus nanus*, and absence of the native specialist *G. gerbillus*. The increased density of local vegetation (*Haloxylon persicum*) along the farm edges may be a result of the sub-surface flow of irrigation-water towards the dunes. We suggest that the dramatic vegetation change adversely affected the psammophilic gerbil, and positively served the generalist one. The *G. gerbillus* last stronghold in Israel is the southern 'Arava sand dunes. This gerbil will disappear, unless management action will be taken to reduce the vegetation cover.

## 54. Mammal Conservation

### 1. CONSERVATION AND ECOLOGICAL IMPLICATIONS OF HABITAT PREFERENCES BY CHILLA FOXES AND FREE-RANGING DOGS IN A HUMAN-DOMINATED LANDSCAPE IN SOUTHERN CHILE

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We investigated whether domestic dogs (*Canis familiaris*) influenced the use of space of chilla foxes (*Pseudalopex griseus*) in southern Chile, and tested the hypothesis that dogs interfere with chillas. We used scent stations, scats occurrence, telemetry and surveys to locals to assess which variables influenced habitat use by both species. We found that, when active, chillas used prairies more and native forest less than expected according to availability, whereas inactive chillas preferred native forest, the only habitat type that dogs did not use. Dogs concentrated their activity during the day, and their probability of occurrence increased at shorter distances from houses, whereas the inverse pattern was observed for chillas. The mean distance of chillas to human houses was positively correlated to dog densities within home ranges. We observed dogs persecuting and/or killing chillas, which was also corroborated by local people supporting the idea that dogs harass foxes. As dogs constrain the use of space and time by wild carnivores, and act as reservoirs for diseases of conservation concern, we strongly recommend removing feral dogs from areas of critical importance for biodiversity as well as to encourage responsible ownership of dogs among landowners.

### 2. CONSERVATION STATUS AND DETERMINANTS OF GOLDEN MONKEY (*CERCOPITHECUS MITIS KANDTI*) ABUNDANCE IN MGAHINGA GORILLA

## NATIONAL PARK, UGANDA

*\*Dennis Twinomugisha, Department of Zoology, Makerere University.; \*Colin Chapman, McGill University*

Understanding mechanisms permitting species to thrive in marginal habitats provides insights to formulate conservation plans. However, we are not yet acquainted with ecosystem dynamics in different types of protected area systems and it is difficult to predict what happens to species in parks over long periods. We sought to establish the population status and distribution of the golden monkey in Mgahinga National Park, Uganda, an afro-montane forest in the Albertine Rift. Census results from this study and past studies indicate a gradual decline of golden monkeys over 14 years. Phenological patterns and nutritional composition of food plants were examined as well as food distribution and habitat use. We argue that reliance on a very narrow dietary range may lead to nutritional stress, but it is possible that there are other contributing factors. We speculate that the observed decline may be related to inhabiting a stressful environment and therefore there may be low recruitment through births. We recommend restoration of a degraded part of the park to increase suitable habitat by 75%. Given the decline of an endangered subspecies in a protected area, this study underscores the value of long-term monitoring, which can detect conservation problems for timely action.

### 3. CULTURAL FESTIVALS: ITS IMPLICATIONS TO BAT CONSERVATION ON NEGROS ISLAND, PHILIPPINES

*\*Apolinario Bernardo Cariño, Wildlife Researcher; \*Tammy L. Mildenstein, Wildli; \*Samuel Cord Stier, Wildlife Researcher; \*Vincent Villarín Gunot, Assistant Researcher; \*Renee Mae Lorica, Wildlife Researcher; \*Jose A. Baldado, Public Servant*

Cultural festivals in the Philippines have been a tradition by many cities and provinces of the country annually. These festivals attract tourists both nationally and internationally. Aside from sharing traditional culture, history and myths where the festival is held, wildlife themes are now incorporated to showcase the diversity of flora and fauna in their area. Among these wildlife themed festivals are the "Langub" or Cave and the "KaSuLAD" Festivals of Mabinay and Pamplona, both are municipalities of the Province of Negros Oriental and the Mud Pack Festival of Mambukal, Murcia, Negros Occidental. These festivals depicted the life and ecology of bats and swifts living in caves and on trees and how they forage in the night and survived feeding in the forests and agricultural areas of the Island. This paper further discusses the impact of their presentations to the conservation of bats on the Island. Sustainability of this event is also documented among the participating local government units along with the interpretation of choreographers and artists for their presentation concepts. It is hoped that this cultural appreciation will help sustain the conservation and awareness of bats throughout the Island of Negros and the country as a whole.

### 4. EFFECTS OF IMMUNOCONTRACEPTION WITH PORCINE ZONA PELLUCIDA (PZP) ON THE BEHAVIOR OF WILD HORSES

*\*Cassandra Maria Nunez, Princeton University*

Porcine zona pellucidiae (PZP), an immunocontraceptive agent, was first administered to wild horses in 1988. Lower pregnancy rates resulted, with seemingly little to no effect on health or social behavior. Studies examining the behavioral effects of PZP on wild horses have focused on only a few populations, exclusively during the breeding season, and have not utilized

true controls. Management of wild horses on Shackleford Banks, NC has relied on this limited research. From December 2005 to February 2006, we studied twenty Shackleford mares to determine whether contraception affects social behavior during the non-breeding season. We examined two classes of females: contracepts, recipients of PZP (n=12); and controls, females that never received PZP (n=8). Contracepts consorted with more males, made more changes between harems, and spent more time in the center of their respective harems than did controls. These differences appear to diminish with time since inoculation. Distance to the harem male was marginally affected. Contraceptive status did not affect activity budget or physical condition. Our study shows that contraception with PZP significantly alters the social behavior of Shackleford Banks horses, refuting prior studies of other wild horse populations. This work demonstrates the risks of making managerial decisions in one population based upon limited data collected from another.

## 5. HABITAT HETEROGENEITY AND SPECIES RICHNESS: IS SPATIAL SCALE A FACTOR?

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*\*Michael L. Kennedy, The University of Memphis;*  
*\*Cornelio Sánchez-Hernández, Universidad Nacional Autónoma de México;* *\*María de Lourdes Romero-Almaraz, Universidad Nacional Autónoma de México;* *\*Gary D. Schnell, University of Oklahoma;* *\*Michael C. Wooten, Auburn University;*  
*\*Troy L. Best, Auburn University*

The prediction that habitat heterogeneity and species richness of small mammals are associated was tested at three spatial scales (point, local, and regional) in the tropical dry-forest region of Colima, Mexico. This location, within the Mesoamerican biodiversity hotspot, was sampled during winters of 2003-2008. Sampling was conducted (in total) on 30 trapping grids (each grid station with an arboreal and ground-level trap) using a 10m x 10m design at each level, which resulted in 200 traps per grid. Grids were trapped 7 nights during each sampling session. In total, there were 42,000 trap-nights (1 trap-night = 1 trap set for 1 night). Species richness at each spatial scale was examined in relation to 14 habitat variables, representing vertical and horizontal structure, taken at each trap site. Results confirmed a minimum of 22 species within the region studied. Data were examined using correlation and regression analyses. Habitat heterogeneity and species richness were associated with selected vertical and horizontal habitat features, but these varied with scale. Our results support previous investigations suggesting that scale is a factor in understanding habitat heterogeneity and species richness associations.

## 6. LIVESTOCK DEPREDATION BY LEOPARDS AND PREY ABUNDANCE IN SANAPUR COMMUNITY RESERVE, KARNATAKA

*\*Usham Somarendro Singh, Wildlife SOS;* *\*Rohit Singh, Wildlife SOS;* *\*Kartick Satyanarayan, Wildlife SOS;* *\*Geeta Seshamani, Wildlife SOS;* *\*Samad Kottur, Wildlife SOS*

Landscape modification by humans in the reserve forest and lack of ecological information on the leopard *Panthera pardus* in the non-protected area motivated the study. The study was initiated in 2007. 4 transects were monitored for abundance estimation of preys. Each transect was monitored 7 times and 119 km was covered. Overall prey density was  $12 \pm 2.7$  animals/km<sup>2</sup> and estimated density of langur (*Presbytis*

*entellus*) was  $9.3 \pm 3.8$  individuals/km<sup>2</sup>. 33 kills by leopards were examined during summer and monsoon. Leopards mainly depredated on goat *Capra hircus* (48.5 %) followed by dog *Canis familiaris* (24.2 %). Leopards killed more animals ( $\chi^2 = 13.1, p < 0.01$ ) near the cave. 64.5 % of the kills occurred outside the study area. Scat analysis (n = 11) showed that leopard was found to consume on 8 prey species. Primary preys were goat (45.8 %) and dog (16.7 %) while wild preys comprised of 16.7 %. We recommended for habitat conservation, prey base restoration and reintroduction of wild ungulates.

## 7. THE IMPACT OF COMMERCIAL HUNTING ON PRIMATE COMMUNITY STRUCTURE IN KORUP NATIONAL PARK, CAMEROON: IMPLICATIONS FOR MANAGEMENT PRIORITIES

*\*Joshua M. Linder, Duke University*

Commercial hunting is prevalent in the forest area between the Cross River in Nigeria and the Sanaga River in Cameroon and is the most immediate threat to many relatively large-bodied mammals, especially primates. I studied the impact of commercial hunting on primate community structure in Korup National Park (KNP), Cameroon, which is home to eight anthropoid primate species including the Endangered mainland drill and Preuss's red colobus, both of which are endemic to the Cross-Sanaga forest. To assess hunting impact I compared primate abundance between areas that differed in hunting intensity and examined changes through time in primate abundance by comparing my results to historical data sets. I also examined changes through time in primate relative abundance in hunter harvests by comparing results from my hunter harvest surveys to those conducted sixteen years earlier. Overall primate encounter rates did not significantly differ between survey sites, despite inter-site variation in hunting pressure. Differences among survey sites in primate species richness and relative abundance, were found, however, and were attributed primarily to variation in hunting pressure. Vulnerability to hunting varied among primate species and was associated with differences in intrinsic ecological and behavioral characteristics. Park management should focus conservation efforts in areas characterized by high primate species richness and abundance of the most vulnerable primate species.

## 8. TIMBER PLANTATIONS AS FAVOURITE HABITAT FOR GIANT ANTEATERS

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*\*Frauke Fischer, Department of Animal Ecology & Tropical Biology, University Würzburg, Germany;*  
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Timber plantations can have severe impacts on natural ecosystems. It therefore is of utter conservational importance to understand which aspects of plantation management increase the plantations' ecological value to native species. Although the giant anteater (*Myrmecophaga tridactyla*) is generally regarded as a savannah species, it is a common inhabitant of acacia plantations in North Brazil. As the giant anteater is listed as „Near Threatened“ and ranked high in a WCS priority setting exercise for conservation, this study aimed at determining its habitat preferences and ensuring giant anteater friendly management of the plantations. By means of extensive car-surveys and behavioural observations, we investigated densities and distribution patterns of anteaters in the study area. Densities were up to 20 times higher in the plantations than in

the savannah, but also within the plantations great density variations could be identified. Mean density was  $3.0 \pm 2.7$  individuals/km<sup>2</sup>; maximum density was 13.2 individuals/km<sup>2</sup> - more than 8 times higher than the highest value in scientific literature. Anteaters were likely distributed according to food supply but no correlation between productivity or management parameters of the plantations and the anteaters' distribution patterns could be found. Still it became clear that even artificially forested habitats can be valuable to giant anteaters, which needs to be considered when designing forestry and landscape management plans.

## 55. Mammal Conservation (2)

### 1. ACTIVITY BUDGET AND GROUP DYNAMICS OF GREVY'S ZEBRA (*EQUUS GREVYI*, OUSTALET 1882) ON SAMBURU COMMUNITY RANGELANDS, KENYA

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Grevy's zebra is endangered and less than 150 and 2000 individuals are remaining in Ethiopia and Kenya, respectively. Effective management of endangered species demands the understanding of its interaction with the environment, best expressed through activity patterns and sociality. To aid in making informed decisions towards the species recovery efforts, we undertook a study on diurnal activity budget and group sizes using focal animal sampling and direct count techniques. Grevy's zebras spend 54% and 46% of their time feeding in both wet and dry seasons, respectively. Hourly feeding time among the animal classes differed significantly over the seasons (wet season:  $F = 5.400$ ,  $p = 0.0002$ ; dry season:  $F = 5.508$ ,  $p = 0.0001$ ) but feeding intensified in early morning and late afternoon. Mean group size was significantly different over the two seasons ( $U' = 1279$ ,  $p = 0.04$ ), highest being  $5.03 \pm 2.41$  and  $13.66 \pm 5.35$  during the dry and wet seasons, respectively. Our study has indicated that limitation of food and water resources and pastoralists monopolization of these resource centers influenced the activity budget and group sizes. Therefore, rangeland improvements and community conservation education are required to enhance accessibility and availability of adequate food and water resources.

### 2. ASSESSING CONNECTIVITY OF WILDLIFE POPULATIONS IN TANZANIA: TOO LITTLE, TOO LATE, OR JUST IN TIME?

\*Clinton Wakefield Epps, *Oregon State University*; \*Benezeth Mutayoba, *Sokoine University of Agriculture*; \*Samuel K Wasser, *University of Washington*; \*Justin S. Brashares, *UC-Berkeley*

Conserving the connectivity of protected areas in complex landscapes has proved to be a significant challenge. In East Africa, Tanzania exhibits a remarkable array of parks, game reserves, and other protected areas but faces rapid habitat conversion around protected lands. Here, we review some primary concerns for corridor conservation in the context of central Tanzania, focusing on a 225 km-wide region lying between three protected areas. Using field transect surveys, population genetic data, and discussion with local people, we assessed the connectivity of wildlife populations across this region. We examined how species characteristics, habitat, and human activities affected the distribution of mammals >1 kg

over this area, including elephants, ungulates and carnivores. Large-bodied ungulates and the carnivores that specialize on them (lion and wild dog) appear to have experienced the greatest reduction in connectivity. Smaller-bodied ungulates appear to be more tolerant of human exploitation and disturbance. Rapidly increasing human populations, agricultural development near water sources, and the demand for bushmeat appear to be the primary threats to wildlife in the corridor region. Interest in corridor conservation within Tanzania is high and other research initiatives are providing a wealth of information on connectivity in the region. However, to succeed, conservation solutions will likely require locally-specific approaches with benefits clear to local people.

### 3. ASSESSMENT OF SEASONAL REPRODUCTIVE TRAITS IN A WILD MONGOLIAN FELID, THE PALLAS' CAT (*OTOCOLOBUS MANUL*)

\*Bariushaa Oyuntuya, *National University of Mongolia*; \*William Swanson, *Cincinnati Zoo & Botanical Garden*; \*Bariushaa Munkhtsog, *Mongolian Academy of Sciences*; \*Steve Ross, *Bristol University*; \*Meredith Brown, *Michigan State University*; \*Amanda Fine, *Wildlife Conservation Society*; \*Ravchig Samiya, *National University of Mongolia*

Little is known about the ecology of the Pallas' cat (*Otocolobus manul*), a small-sized felid native to Mongolia. For an ongoing radiotelemetry study, free-ranging males ( $n=5-6$ /season) were re-captured in the pre-breeding (October), breeding (February) and post-breeding (June) seasons and anesthetized for morphological measurements (body weight, testicular volume). Semen was collected by electroejaculation and evaluated for sperm presence, concentration, motility and morphology. Body weight peaked in the pre-breeding season whereas testicular volume was greatest during the breeding season. All ejaculates ( $n=6$ ) collected during the breeding season contained concentrated spermatozoa (mean  $\pm$  SEM,  $29.7 \pm 8.0$  million sperm/ejaculate) with excellent progressive motility (range, 70-90%) and normal morphology (range, 29-62%). In contrast, only 3 of 11 ejaculates collected in the pre- or post-breeding season contained spermatozoa, with greatly reduced sperm numbers ( $1.0 \pm 0.7$  million sperm/ejaculate), confirming the pronounced reproductive seasonality previously observed in Pallas' cats in captivity. These findings represent the first seasonal characterization of seminal traits in any free-ranging felid and provide valuable information about the reproductive status of wild Pallas' cats in Mongolia. This study also has shown that semen collection and analysis can be incorporated into field research protocols for more comprehensive ecological assessment of wildlife species.

### 4. CONSERVATION OF NEOTROPICAL CARNIVORES UNDER DIFFERENT PRIORITIZATION SCENARIOS: MAPPING SPECIES TRAITS TO MINIMIZE CONSERVATION CONFLICTS

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Carnivores are severely endangered, being strongly affected by conflicts with human population worldwide. Nevertheless, few

studies have attempted to define broad-scale conservation priorities for this group. Prioritization exercises for species conservation emphasize areas with high endemism or severe habitat loss. More scientifically-derived sets can be produced by including attributes such as species ecological and evolutionary traits in prioritization analyses. We used biogeographical data of species distribution to define priority sets of ecoregions for Neotropical carnivore conservation. We mapped species traits (evolutionary history, body size, rarity and extinction risk) and used these as constraints in area-selecting analyses. We proposed three distinct prioritization scenarios: one of urgent intervention, one of species persistence, and another of lower human impact. We found that only 8% of Neotropical ecoregions are needed to represent all 64 carnivore species at least once. In the lower human-impact set, 12 ecoregions were needed to represent all species. These coincide only partially with those attained by other prioritization scenarios. In the urgent intervention and in the species persistence scenario, 14 and 12 ecoregions were represented, respectively, and the congruence between either one or the lower human-impact set was fairly low. These results provide a coarse-scale initial framework for focusing conservation efforts within the Neotropical region.

## 5. ECOLOGY AND CONSERVATION OF CROSS RIVER GORILLA IN BOSHI MOUNTAIN PORTION OF THE CROSS RIVER NATIONAL PARK, NIGERIA

*\*Ernest Ike Nwufoh, Threatened Resources Conservation Centre (TRCC)*

- Boshi extension portion lies in the northern end of the Okwangwo Division of the Cross River National Park (CRNP), Nigeria. The area is known for harboring one of the isolated populations of Cross River gorillas *Gorilla gorilla diehli* in Nigeria. The area was formerly known as Boshi Extension Forest Reserve originally established as a gorilla sanctuary in 1958. It was incorporated into the Cross River National park to provide protection to the gorillas. Some years after the surveys by Ebin in 1983, and the creation of the Cross River National Park under the Decree 36 of 1991, the status of these gorillas was gradually being reassessed. Intensive hunting pressure has made the sub population in this area highly mobile and local trends in range utilization are difficult to elucidate. Studies by Oates and Nwufoh in 1990 and 1999 respectively estimated a gorilla size of 20-30 weaned individuals. The most recent sighting of gorillas in the area recorded 4 young ones in a group of ten individuals. This study looked at the ecology and the situation of habitat degradation occasioned by fire outbreak as well as the hunting status in comparison with the Park's administration and operations.

## 6. ENERGETIC MODELS OF SPECIES ABUNDANCE FOR CONSERVATION

*\*Hamish Alexander Colin Wilman, University of California, San Diego; \*Walter Jetz, UCSD*

We use information about the energetic needs of species as well as the abiotic conditions under which they persist to predict their local abundances. We utilize a comprehensive, geo-referenced dataset of mammalian population densities compiled from the literature and combine species-level biotic and local abiotic conditions. We develop the use of a trophic-level-specific measure of individual energy needs for predicting mammalian abundances. We further explore the additional effect of factors influencing energy availability (i.e. productivity, temperature, precipitation, etc.) on abundance. Traditional approaches have focused on body size as a predictor of mammalian abundance. However, in these cases

body size is merely a proxy for energy use and there is considerable variation in the body size- abundance relationship. We see significantly less variation between our measure of energy needs and abundance, proving its utility as a standalone predictor of mammalian abundance. Including other ecological and environmental attributes of the location explains important additional variation, and elucidates the relative importance of biotic and abiotic controls of abundance. Predicting local abundance using simple models of energetic needs and readily-available information on environmental determinants has profound utility for the conservation of species in the face rapid global change.

## 7. GENETIC EXAMINATION OF RECENT DEMOGRAPHIC HISTORY IN AFRICAN ELEPHANT POPULATIONS: POACHING OR CLIMATE?

*\*Jason Munshi-South, Baruch College, City University of New York; \*George Wittemyer, University of California, Berkeley; \*Elizabeth Archie, University of Montana*

African elephants have experienced severe population declines due to land conversion and poaching that should result in genetic signatures in elephant populations throughout Africa. Alternatively, climatic drying and retraction of savannah and forest habitats through the mid-Pleistocene and Holocene may have impacted elephants more dramatically than recent events. We examined these hypotheses using Bayesian coalescent analyses of microsatellite genotypes (8-20 loci) from elephants from northern (Samburu, 400 individuals) and southern Kenya (Amboseli, 545 individuals), and Gabon (Gamba Complex, 162 individuals). We predicted that the Kenyan populations would show a genetic signature from recent poaching. In contrast, we predicted that the Gabon elephants would produce no signature because this population has not been heavily poached, and equatorial rainforests should remain relatively stable during dry periods in East Africa. However, we found evidence of a major demographic contraction (7 to 15-fold) in all three populations that consistently dates to 2,500 years ago, corresponding with a period of desert expansion and multi-century droughts in sub-Saharan Africa. These results indicate that savannah and rainforest herbivores were more heavily affected by past climate change than previously appreciated. Conservation geneticists need to carefully consider the implications of prehistoric climate events for genetic management of endangered species.

## 8. USING GIS AND ROADKILL DATA TO IDENTIFY HABITAT CHARACTERISTICS ASSOCIATED WITH NORTH AMERICAN BADGER MOVEMENT PATTERNS AND EVALUATE CORRIDOR MODELS

*\*Tanya Diamond, San Jose State University; \*Shannon Bros, San Jose State University*

Small populations of North American badgers, *Taxidea taxus*, live in fragmented habitats within the San Francisco Bay Area and Monterey Bay Counties in Northern California. Due to increasing fragmentation of badger habitats it is important to identify potential corridors that badgers may utilize to facilitate movement between the habitat patches. Using GIS, a habitat suitability model for badgers was created using soil, vegetation, slope, urban areas, and road layers. We have found that the choices made in ranking and weighing habitat characteristics need to be quantified when developing a habitat suitability model. We often assume that species will choose to travel through habitat characteristics that are typically found in their

home ranges, which may not always be the case. Road kill data and Logistic Regression was used to identify habitat characteristics selected by badgers while traveling outside of their home range. A Least-Cost Corridor analysis was performed on the cost surface layers to identify potential corridors within the region. Badger road kill data was then compared with the delineated corridors to test the model and identify the primary areas currently utilized by badgers for implementing future corridor plans. Road kill data was also used to evaluate alternative models by comparing the distance from road kill locations to the location of a road predicted by various other models.

## 56. Marine Conservation

### 1. A SENSITIVITY ANALYSIS OF RESOLUTION FOR A HABITAT MODEL FOR NORTH ATLANTIC RIGHT WHALES

*\*Ellen Hines, Florida Fish & Wildlife Research Institute; \*Cherie Keller, University of Florida*

When modeling habitat for species with sparse numbers and widely distributed, resolution is especially important. We performed a sensitivity analysis to evaluate resolution choice for a habitat model for the North Atlantic right whale (*Eubaleana glacialis*) in their only known calving grounds off the southeastern United States, as part of a risk analysis of whale-ship collisions. Previous analyses used 4x4km resolution. We investigated using 2x2km resolution to reflect the scale of variables in a more refined model. We compared distributions of mean aerial survey effort, sea surface temperature (SST), bathymetry, and species per unit effort. The shape of variable distributions and characterization of relationships among variables were similar for both cell sizes. Mean and Standard deviations for SST and bathymetry were similar at both cell sizes, indicating that variables were relatively homogeneous in a 4x4km cell. The number of cells with whale sightings is similar, whereas the number of cells with no sightings is greatly increased at 2x2km. Because data aggregated at 4x4km does not fit either a Poisson or a negative binomial distribution, either resolution would be better represented in a logistic model. Results indicate that while whale sightings are adequately represented at 4x4km resolution, the spatial accuracy of associated vessel distribution data supports the use of finer resolution for the overall model of risk for whale and ship co-occurrence.

### 2. COASTAL AND MARINE CONSERVATION PRIORITIES IN BRAZIL

*\*Ana Paula Leite Prates, Ministry of Environment, Brasil; \*Luis Henrique de Lima, Secretariat of Aquaculture and Fishery; \*Anthony Chatwin, National Fish and Wildlife Foundation*

Extending almost 9000 kilometers, the Brazilian waters support a great variety of ecosystems, including mangroves, coral reefs, dunes, sandy beaches, rocky shores, marshes, lagoons and estuaries that are home to myriad species of fauna and flora, many of which are endemic and some of which are threatened with extinction. The Brazilian government developed a National Plan of Protected Areas that includes special consideration of the coastal and marine environments and well defined strategies for the establishment of a representative and effectively managed system of marine areas. In partnership with The Nature Conservancy (TNC), the government launched a project to identify priority areas for conservation, including candidates for the creation of new protected areas. Through a series of regional workshops, using methods for Systematic

Conservation Planning over 300 Brazilian coastal and marine experts provided input for a planning process that was completed in 2006. The process identified 506 priority areas in the coastal zone and an additional 102 priority areas in the marine environment. When implemented, the national system of coastal and marine protected areas, comprised of the proposed new areas along with the already existing ones, will provide much-needed protection of the coastal and marine environments of Brazil.

### 3. FROM FISHMEAL TO FISH MEALS - AFFECTING THE LARGEST SINGLE SPECIES FISHERY IN THE WORLD

*\*Patricia Majluf, Centro para la Sostenibilidad Ambiental - U.P. Cayetano Heredia*

Almost 40% of the world's marine landings are reduced to fishmeal and oil, which are traded globally as inputs for intensive animal production systems. Conveniently described as "forage" fish, the world's pelagic fish stocks are increasingly used by the reduction industries with dire consequences for marine ecosystems, which depend on them to transfer energy from plankton to the top predators, and affecting food security in the countries where most of these fish are caught. Forage fish include sardines, anchovies, mackerels and herrings, which are very prized and important components of the diet of people around the globe. Even so, a common justification for using them for reduction to fishmeal is that they are not palatable to people. We report here the results of a first initiative to increase consumption of Anchovetas in Lima, Peru. The 1st and 2nd Anchoveta Week (Dec of 2006 and 2007) involved 30 of Lima's top restaurants, introducing thousands of Peruvians to Anchovetas gourmet style. Of the close to 1200 surveyed, most (> 90%) liked them and would eat them again. Increased national awareness of the nutritional values of this fish has resulted in greater availability in local markets and greater consumption. Catching Anchovetas mainly to feed humans, would not only increase the fisheries' contribution to national welfare, but create a more lucrative export market, allowing Peru to gradually switch away from the unsustainable fishing policies it currently has.

### 4. HOW ARE OUR MPAS DOING?: ASSESSING GLOBAL PATTERNS IN MARINE PROTECTED AREA MANAGEMENT EFFECTIVENESS

*\*Jed Holtzman, Yale School of Forestry and Environmental Studies; \*Helen E Fox, WWF-US; \*Gonzalo Cid, National Oceanic and Atmospheric Administration; \*Michael Mascia, World Wildlife Fund; \*Catherine McNally, University of Rhode Island; \*John Parks, National Oceanic and Atmospheric Administration; \*Robert Pomeroy, University of Connecticut*

Without effective management, marine protected areas (MPAs) are unlikely to achieve the high expectations conservationists have for them. Numerous MPA assessment initiatives have recently been developed at various spatial and temporal scales, including the WWF/IUCN guidebook *How is Your MPA Doing?* (HIYMPAD). Almost without exception, these management effectiveness assessments have been useful to sites to clarify and evaluate their objectives, yet efforts to examine broader regional or global patterns of results from the many site-level effectiveness evaluations are only beginning. Here, trend analyses were conducted on HIYMPAD indicator data collected by 24 MPAs worldwide. Taken as a whole, the group of MPAs involved in the management effectiveness

evaluations appeared to fare somewhat positively, though measures of socioeconomic and education outcomes performed below the norm. Biophysical assessments were greatly emphasized over collection of socioeconomic and governance data. While national governance, social and economic wellbeing, and MPA size impacted MPA performance, they each did so quite modestly. We suggest that, to better understand variation in MPA performance, a committed investment is needed by the conservation community to standardize and build local capacity in MPA monitoring and evaluation.

## 5. LAST STAND OF THE EASTERN PACIFIC LEATHERBACK TURTLE: CREATION AND CONSOLIDATION OF PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA

*\*James Robert Spotila, Drexel University; \*Frank Vincent Paladino, Indiana Purdue University Fort Wayne; \*Rotney Piedra, MINAE; \*Clara Padilla, The Leatherback Trust; \*Maria del Pilar Santidrian Tomillo, Drexel University; \*Bryan Wallace, Conservation international*

The leatherback turtle, *Dermochelys coriacea*, declined over 90% in the Pacific Ocean from 1980 to 1995. The last major nesting colony in the Eastern Pacific was in Guanacaste Province Costa Rica. We began to study the population there in 1989. In 1990 a new Park was established at Playa Grande by Presidential Decree. Due to opposition from developers the Park was threatened with dissolution in 1993-1994. An international campaign saved the Park and in 1995 the Park was enlarged and made permanent by Law. Since that time we worked to consolidate the Park through scientific studies, local and national education and environmental action and international campaigns and fund raising. Creation of a new non-profit, The Leatherback Trust, facilitated fund raising. Visits to the beach attracted donors. A major fund raising effort led to a "war chest" to defend the Park, support land acquisition and continue the effort to consolidate the Park. Despite lethargy in the bureaucracy and leadership of the government of Costa Rica and a misinformation campaign, slander, personal attacks, and death threats against us by developers, the campaign has succeeded in saving the Park and making it a central focus of conservation efforts in Costa Rica.

## 6. SOFTWARE TOOLS FOR COASTAL-MARINE ECOSYSTEM-BASED MANAGEMENT

*\*Sarah Carr, NatureServe; \*Patrick Crist, NatureServe*

Innovative software tools for planning for and implementing coastal-marine ecosystem-based management (EBM) are emerging from regional resource planning and management projects from around the world. For example, software tools can now help predict ecosystem response to human and natural disturbances, select optimal areas for conservation or restoration, visualize the impact of development and resource-use scenarios on an ecosystem, collect local knowledge about a resource, and facilitate stakeholder voting on management alternatives. Using these tools can improve environmental decision making by helping resource managers incorporate science into decisions, address multiple objectives, and build consensus for management actions among stakeholders. The EBM Tools Network ([www.ebmtools.org](http://www.ebmtools.org)) is an international alliance of government, non-profit, academic, and private tool developers, users, and training providers to promote awareness, development, and effective use of software tools and methods for EBM. This presentation will provide information on the range of technology tools available for planning for and

implementing EBM in coastal-marine environments and their watersheds and the benefits and limitations of using technology tools. We will also describe an on-line resource for comprehensive information on EBM tools ([www.ebmtools.org](http://www.ebmtools.org)) and provide information on relevant training opportunities.

## 7. STATUS AND CONSERVATION OF MARINE TURTLES ON SANDY AND ROCKY BEACHES OF PAKISTAN

*\*Muhammad Zaheer Khan, University of Karachi*

The coastal areas of Pakistan are unique due to their ecology and biodiversity. Five species of marine turtles have been recorded from Pakistan. These are green turtle, olive ridley turtle, hawksbill turtle, loggerhead turtle and leatherback turtle. Out of these, only first two species are known to nest on the coastal areas of Sindh and Balochistan. Some of the coasts of areas of Pakistan are surveyed as globally important nesting habitats for two species of marine turtle, green turtle and olive ridley. Nesting of green turtle (*Chelonia mydas*) and olive ridley turtle (*Lepidochelys olivacea*) takes place at many places on the Hawkesbay and Sandspit along Karachi Coast, and Ormara and Jiwani along Balochistan coast. A detailed survey of the nesting by green turtles on all the existing and potential turtle nesting sites was conducted. In Sindh Kapasee Point in Cape Monze area, sandy beaches in Khai and Patiani Creeks, and in Balochistan Wadh Bandar, Ras Malaan, Sapat area and Kund Malir in Hingol National Park, Kapasee area in Gwadar, Shadi Kaur area near Pasni, Pushkan Raank area, Ganz area and Astola Island have been identified as new turtle nesting sites.

## 8. THE CONSERVATION STATUS OF CETACEANS IN GHANAIAN COASTAL WATERS

*\*OFORI-DANSON KWABENA PATRICK, UNIVERSITY OF GHANA, LEGON, GHANA*

In many West African countries, pressures from rapid population growth and declining fish catches have made dolphins immediate food need. Between 1998 and 2000, surveys of artisanal ports were undertaken to identify dolphin species and other small cetaceans landed by local fishers in coastal Ghana. A total of 14 out of the 18 reported species in the West African subregion were encountered, dominated by the Clymene dolphin *Stenella clymene* (35%), followed by the pantropical dolphin *Stenella attenuate* (17%), the common bottlenose dolphin *Tursiops truncatus* (16%) and Risso's dolphin *Grampus griseus* (7%). However, incidental catches are turning into targeted fishing and there is growing desire to use dolphins as baits for catching sharks for the shark-fin trade as scarce foreign exchange earner. Any estimate of annual catches in Ghana is premature, but will not be less than high hundreds. As a result, the diversity and abundance of dolphins are under threat. There is urgent need for enforcement of Wildlife Conservation Legislature and adoption of new measures to address the protection of small cetaceans, including increased community-based education and continued monitoring nationwide. Knowledge of spatial and temporal distribution of the cetaceans could provide the base for local dolphin-watching ventures.

## 57. Marine Conservation (2)

### 1. A GLOBAL MAP OF HUMAN IMPACT ON MARINE ECOSYSTEMS

*\*Benjamin S Halpern, National Center for Ecological Analysis and Synthesis; \*Shaun*

Walbridge, National Center for Ecological Analysis and Synthesis; \*Kimberly A Selkoe, Hawai'i Institute of Marine Biology; \*Carrie V Kappel, National Center for Ecological Analysis and Synthesis; \*Fiorenza Micheli, Stanford University; \*Caterina D'Agrosa, Arizona State University; \*John F Bruno, University of North Carolina at Chapel Hill; \*Kenneth S Casey, NOAA National Oceanographic Data Center; \*Colin Ebert, National Center for Ecological Analysis and Synthesis; \*Helen E Fox, WWF-US; \*Rod Fujita, Environmental Defense; \*Dennis Heinemann, Ocean Conservancy; \*Hunter S. Lenihan, Bren School of Environmental Science and Management; \*Elizabeth M.P. Madin, University of California, Santa Barbara; \*Matthew T Perry, National Center for Ecological Analysis and Synthesis; \*Elizabeth R Selig, University of North Carolina at Chapel Hill; \*Mark Spalding, The Nature Conservancy; \*Robert Steneck, University of Maine; \*Reg Watson, University of British Columbia

The management and conservation of the world's oceans require synthesis of spatial data on the distribution and intensity of human activities and the overlap of their impacts on marine ecosystems. We developed a standardized, quantitative method, based on extensive expert judgment, to estimate ecosystem-specific differences in impact of 17 anthropogenic drivers of ecological change. The results provided impact weights used to combine multiple drivers into a single comparable estimate of cumulative human impact (within the last decade) on 20 marine ecosystem types. Our analysis indicates strong spatial heterogeneity of both drivers and impacts, with no area in the ocean unaffected by human influence and a large fraction (41%) strongly affected by multiple drivers. Most of the highest predicted cumulative impact is on continental shelves and slopes, which are subject to both land and ocean-based anthropogenic drivers. However, large areas with relatively little human impact remain, particularly near the poles. The analytical process and resulting maps provide flexible tools for marine spatial planning and ecosystem-based management by assessing if or how human activities can be spatially managed to reduce their negative impacts on ecosystems. These maps can also inform regional and global efforts to allocate conservation resources by identifying regions where better management of human activities could achieve higher reduction of impact scores.

## 2. CONSERVATION OF MARINE MAMMALS IN THE MYEIK ARCHIPELAGO OF MYANMAR

\*Ellen Hines, Florida Fish & Wildlife Research Institute; \*Mya Than Tun, Myanmar Department of Fisheries; \*Leslee Parr, San Jose State University

We conducted surveys in the Myeik Archipelago to determine dugong and cetacean distribution using interviews and boat-based seagrass surveys. Our goals were to assess the distribution and population patterns of marine mammals and their habitat, determine issues that potentially threaten them and provide recommendations on management and conservation. We conducted interviews with Burmese and Karen settlers and Moken sea gypsies. Burmese and Karen settlers migrated here to escape from poverty and oppression. Moken are nomads who live in and travel on small boats during the dry season, and build temporary structures in the rainy season. Respondents only see the occasional dugong, the last in early 2006. There is no directed hunting, but if a dugong is seen

or stranded, it is killed and eaten. All respondents regularly see dolphins and sea turtles. Fifty percent of respondents mentioned that dolphins are commonly caught in gillnets and crab nets. Villagers catch dolphins to eat and to sell their meat. Based on our interviews and opportunistic sightings, further research should be conducted on dugong and cetacean distribution, the incidental catch of dolphins in gillnet fisheries and the use of dolphin body parts as medicine in the Archipelago. We recommend educational programs on the importance of conserving and managing coastal systems, marine mammals and fisheries.

## 3. FISHERIES DISCARDS AS FOOD FOR SEABIRDS: FAST FOOD, JUNK FOOD, OR HEALTH FOOD?

\*Lisa Wickliffe, Dept. Forestry and Natural Resources, Clemson University; \*Patrick Jodice, USGS South Carolina Cooperative Fish & Wildlife Research Unit

Population dynamics of seabirds have been linked to availability of bycatch discarded from commercial fishery operations. In South Carolina, USA, populations of brown pelicans and royal terns have declined since the late 1980s, populations of sandwich terns and laughing gulls have increased, but the mechanisms underlying these shifts are unclear. South Carolina also supports a shrimp fleet that operates in inshore waters where these species forage. We examined the distribution and abundance of seabirds at shrimp trawlers in relation to colony locations. We also determined the fate of fish discarded as bycatch and the energy density of the discarded fish. Trawlers were attended regularly by all species of locally breeding seabirds out to ca. 30 km from colonies. Laughing gulls were the most frequently observed seabird at trawlers followed by brown pelicans, royal terns, and sandwich terns. Seabirds selected smaller discard items compared to larger items, and selected benthic fish that typically would not be available as prey. Laughing gulls may be affected most strongly by the availability of additional food via discarded bycatch but terns and pelicans forage at trawlers frequently enough that changes in the size or trawling patterns of the shrimp fleet could affect their foraging ecology.

## 4. FISHERIES REGULATION IN NEW ENGLAND BEFORE 1900

\*Karen Elise Alexander, University of New Hampshire

New England fisheries have long characterized the culture and prosperity of a region rich in history. However, declining fish stocks have threatened the sustainability of fisheries both historically as well as today. The first documented landings shortages were in the 1650s for cod and the 1670s for mackerel. Gear restrictions, fishing moratoria and the mandatory opening of milldams during anadromous fish spawning seasons, were enacted by town governments and the Massachusetts General Court, the provincial legislature by the 1680s. Then and subsequently, regulation followed perceived decline in fisheries production. Two hundred years later, fishing regulations adopted by town and state legislators in Maine in 1859, and the Maine Fish Commission founded in 1861 became catalysts for policy advising on a federal level. This paper provides an overview of the relationship between government and fisheries from 1630 to 1900. It shows that regulation has been the norm, not the exception, in New England and that, before the 20th-century, regulation usually came at the request of fishers who were the first to perceive problems. Today, this rich history of regulation has been ignored in management decisions. Investigating why policy

responses have substantially failed for more than 150 years is crucial to developing a social and ecological framework for laws that will promote sustainable fisheries.

## 5. MESOAMERICAN MARINE PROTECTED AREA EFFECTS ON RESOURCE USER LIVELIHOODS

*\*Mark Eric Zegler, University of California Santa Barbara*

This paper analyzes the changes in the livelihoods of local coastal resource users that occurred due to the designation of marine protected areas in Belize and Mexico within the Mesoamerican Barrier Reef Systems (MBRS). These marine protected areas are situated in coastal waters of the Bacalar Chico Marine Reserve and the Parque Nacional Arrecifes de Xcalak in Belize and Mexico respectively and were both established to promote biodiversity conservation and economic development. Fieldwork in 2004-2005 documented the changes that occurred to local livelihoods in the conservation, fishery, and tourism sectors. The modifications to coastal governance regimes changed local livelihoods in each case study area. In both cases, some locals benefited as conservation and tourist use expanded, while others lost jobs in the fishery sector. The results of this research indicate that marine protected areas affect livelihoods and shift use from commercial fishing to conservation and tourist use of the reef. Geographic information system analyses of informant map biographies indicate that the spatial patterns of livelihood activities changed within the boundaries of each respective marine protected area. Evidence suggests protected area networks can be effective in promoting societal goals for conservation and development if geographic, institutional, and social factors are included in the design process.

## 6. THE ROLE OF SOCIOECONOMIC DATA IN DESIGNING AND EVALUATING MPA NETWORKS—CALIFORNIA'S MARINE LIFE PROTECTION ACT NORTH CENTRAL COAST PROCESS

*\*Astrid Scholz, Ecotrust; \*Sarah A. Kruse, Ecotrust; \*Charles Steinback, Ecotrust; \*Mike Mertens, Ecotrust*

While there is growing recognition that successfully addressing socioeconomic concerns during marine protected area (MPA) design processes is critical to their implementation and success, the practicalities and data requirements are often daunting. In order to better inform the California Marine Life Protection Act's stakeholder driven MPA design process and conduct analyses of the relative effects of the MPA proposals on commercial and recreational fisheries, we use data layers characterizing the spatial extent and relative stated importance of fishing grounds for eight commercial and four recreational fisheries. This information was collected from 275 fishermen using a participatory GIS application, Open OceanMap. Using this data, we evaluate the potential impacts on commercial and recreational fishing grounds and conduct a socioeconomic impact analysis on commercial fisheries in order to assess the relative effects of the various MPA proposals. We discuss how the results of these analyses were used in the evaluation of multiple rounds of MPA proposals and, more specifically, how various MPAs may have different effects on different fisheries. We also briefly highlight what the evaluation process could have looked like in the absence of local knowledge interviews and the related analyses. Finally, we report on methodological innovations and project lessons and reflect on future modifications to the development and use of socioeconomic data in similar processes.

## 58. More People Working for More Fish - - A National White Water to Blue Water Plan to Conserve Fish Habitat

### 1. HISTORY OF THE NATIONAL FISH HABITAT ACTION PLAN

*\*Gary T Myers, Tennessee Wildlife Resources*

#### *Agency*

The Sport Fishing and Boating Partnership Council (SFBPC), an advisor to the Secretary of the Interior and the Director of the U. S. Fish and Wildlife Service, issued a special report in January, 2002. One recommendation was that "The FWS and its Fisheries Program should serve as a catalyst among states, tribes and other stakeholders to lead development of a "National Aquatic Habitat Plan". Fisheries personnel within the U. S. Fish and Wildlife Service and their leadership were supportive. SFBPC began stakeholder meetings to determine the level of support for a plan when the Association of Fish and Wildlife Agencies decided to lead its development. Stakeholder meetings continued with strong support for a plan. Volunteers were enlisted to serve on a core workgroup and a plan was developed. A National Fish Habitat Board (NFHB) was established to oversee implementation. The Board established a Science and Data Committee that is overseeing completion of a National Fish Habitat Assessment scheduled for completion in 2010. The Board has approved partnerships to become involved in implementation, established interim plan goals, approved draft legislation, adopted an aggressive budget, approved a communications plan, and is hopeful that enabling legislation will pass congress and that a dependable funding mechanism will be established.

### 2. A NATIONAL PLAN FOR FISH HABITAT CONSERVATION - THE NATIONAL FISH HABITAT ACTION PLAN

*\*Susan-Marie Stedman, NOAA, National Marine Fisheries Service*

The National Fish Habitat Action Plan (Action Plan) is a national investment strategy to maximize the impact of conservation dollars on the ground. Under the Action Plan, federal, state, and privately-raised funds will be the foundation for building regional partnerships that address the Nation's biggest fish habitat problems. Modeled after the North American Waterfowl Management Plan, this is the most comprehensive effort ever attempted to treat the causes of fish habitat decline, not just the symptoms. The goals of the Action Plan include establishing at least 12 regional partnerships - know as "Fish Habitat Partnerships" - who will be responsible for the assessment of regional habitat conditions, the prioritization of conservation needs, and the leveraging of resources to implement local projects to protect, restore, or enhance fish habitat. Through these Fish Habitat Partnerships, the Action Plan will achieve two other goals: protecting healthy and intact habitat and improving the condition of damaged priority habitats. Finally, the Action Plan requires a science-based approach to habitat conservation that will be facilitated by a national assessment of the condition of fish habitats, to be updated every 5 years. Federal, state, NGO, and private partners have been implementing the Action Plan since it was signed in April of 2006, and have achieved a number of milestones in that time. Much remains to be done, however, and in many ways the work has just begun.

### 3. THE SCIENCE FOUNDATION FOR THE NATIONAL FISH HABITAT ACTION PLAN: THE

## NATIONAL FISH HABITAT ASSESSMENT

*\*Gary E. Whelan, Michigan Department of Natural Resources*

For the National Fish Habitat Action Plan to be successful, it is critical to periodically assess the status of the Nation's fish habitat and to have a method to determine the effectiveness of funded projects. The National Fish Habitat Board will use a system that classifies all of the Nation's waters from the mountains to the continental shelf. The inland classification system will use a system similar to that used in the The Nature Conservancy/Aquatic GAP system and will have units ranging from very large landscape groups to individual reaches. The coastal classification system will use a system similar to NOAA/NatureServe CMECS system. One unique feature of this assessment will be the linkage between the classified units and condition scores of the tributary inland systems to the coastal systems. All classified units will be scored in the quality of the following processes: Hydrology; Water Quality; Connectivity; Channel and Bottom Form; Material Recruitment; and Energy Flow. Scores for each classified unit will be averaged across processes and compared against the theoretical maximum and currently existing best systems within each group (Horizontal Scoring). Larger watershed and landscape units will have scores averaged over their composite units to provide system scores (Vertical Scoring). As funded projects change processes, the assessment will allow the tracking of system changes and will show the improvements/changes in the Nation's fish habitats.

## 4. THE ROLE OF FISH HABITAT PARTNERSHIPS IN IMPLEMENTING THE NATIONAL FISH HABITAT ACTION PLAN

*\*THOMAS R BUSIAHN, U.S. FISH AND WILDLIFE SERVICE*

The National Fish Habitat Action Plan is an investment strategy to protect, restore, and enhance the condition of aquatic habitats across the U.S. Regional-scale "Fish Habitat Partnerships" modeled after bird conservation "Joint Ventures" are the primary work units of the Action Plan. The key role of Partnerships is to identify strategic priorities for conservation action in the form of geographic focus areas or key stressors or impairments. Partnerships should have governance structures that involve a range of public and private partners, and that encourage participation by non-traditional partners such as corporations, landowners, and local governments. Partnerships should have capabilities to scientifically assess habitat conditions for setting strategic goals and measuring progress. The National Fish Habitat Board is responsible for developing policies and guidance for recognizing Fish Habitat Partnerships. To date, the Board has formally recognized five Partnerships, and has received letters of intent from thirteen others. The pattern of development indicates that Partnerships may cover the entire U.S. within a few years. Unresolved issues include the optimum spatial scale of Partnerships, how overlapping Partnerships will coordinate, and long-term financial support for Partnership operations. Ultimate success will depend on enlisting non-traditional partners, especially those whose actions affect fish habitat, to address the root causes of habitat degradation.

## 5. DEVELOPMENT OF AN AQUATIC HABITAT CONSERVATION PLAN FOR THE SOUTHEASTERN UNITED STATES

*\*Scott Robinson, Southeast Aquatic Resources Partnership; \*Marilyn Barrett O'Leary, Southeast Aquatic Resources Partnership*

The Southeast Aquatic Resources Partnership (SARP) is a

unique regional partnership of state and federal natural resource agencies, conservation organizations, and private industry dedicated to the conservation of aquatic resources in the southeastern United States. Early in the development of this partnership, the members recognized that aquatic habitat issues and concerns were a common thread among all partners. SARP conducted watershed assessments of four watersheds (Altamaha River, GA; Duck River, TN; Pascagoula River, MS; Roanoke River, NC) across the region to investigate habitat threats and opportunities. Similarities among the nature of aquatic habitat threats and challenges were noted, and reinforced further by an examination of the State Wildlife Action Plans of the member states of SARP. SARP subsequently developed the Southeast Aquatic Habitat Plan, which contains on-the-ground approaches to restoration and protection in the objectives and targets, and regional coordination in the integrated conservation strategies. Detailed assessments of habitats, using methodology prescribed by the National Fish Habitat Science and Data Report, are now being conducted in river basins across the Southeast to develop prescriptive measures that will allow SARP partners to protect and conserve critical habitats across the region.

## 6. PRIORITIZING FISH HABITAT PROTECTION, RESTORATION AND ENHANCEMENT WORK FOR THE EASTERN BROOK TROUT JOINT VENTURE

*\*Mark Hudy, US Forest Service; \*Teresa Theiling, US Forest Service; \*Eric Smith, Virginia Tech Department of Statistics*

Abstract. --- Our objective was to develop a science based prioritization model to allocate limited funds to subwatersheds identified in the Eastern Brook Trout Joint Venture (EBTJV) that are in need of protection, restoration or enhancement. The EBTJV's first priority is to protect and build core areas around "Intact" subwatersheds. Subwatersheds with high probabilities of being "Intact" surrounded by subwatersheds with high probabilities of being "Intact" are thought to have a greater chance of long-term successful conservation work. A model developed for the EBTJV to predict brook trout status also provided the individual subwatersheds (n = 5,001) probability of being "Intact". We explored various combinations of an individual and neighboring subwatersheds probabilities of being Intact to develop a single score for each subwatershed. By developing a single prioritization score for each subwatershed, the EBTJV can strategically allocate funds for several objectives. For example, because not all regional or state strategic plans can contribute equally to protecting "Intact" subwatersheds, the score can also be used to allocate funds to restoring "Extirpated" subwatersheds or enhancing "Reduced" subwatersheds. Prioritizing conservation efforts will assist the EBTJV in meeting their long-term goals.

## 7. TWENTY YEARS OF THE NORTH AMERICAN WATERFOWL MANAGEMENT PLAN AND WHAT IT CAN MEAN FOR THE FUTURE OF THE NATIONAL FISH HABITAT ACTION PLAN

*\*John E. Frampton, South Carolina Department of Natural Resources*

The North American Waterfowl Management Plan (Plan) signed by Canada and the United States in 1986 established a continental strategy for cooperation and for conservation of waterfowl. The Plan with three subsequent updates is the most ambitious and successful wildlife conservation initiative ever implemented. It is dependent on partnerships, referred to as Joint Ventures, that involve federal, state, tribal and local

governments as well as NGOs and private entities. Separate Joint Ventures were established for habitat areas and for specific waterfowl species. To date, partners have invested over \$4.5 billion to help protect and enhance over 15.7 million acres of habitat for waterfowl and other wetland-dependent species. The Plan's locally driven Joint Venture concept is a perfect model for use in moving forward the National Fish Habitat Action Plan (NFHAP). A NFHAP modeled after the Plan with fishery joint ventures would allow for the management, recovery and enhancement of shared fishery resources based on a biologically driven plan, forged by strong alliances and refined through time by an evaluation process. To provide financial support for the Plan, Congress passed the North American Wetlands Conservation Act in 1989. This Act provided a secure funding source for wetland habitat conservation projects. Similar federal legislation to support the NFHAP should be encouraged.

## 8. EVERYTHING YOU WANTED TO KNOW ABOUT THE NATIONAL FISH HABITAT ACTION PLAN—SUMMARY AND Q&A SESSION

*\*Kay McGraw, NOAA Restoration Center*

The National Fish Habitat Action Plan (NFHAP) is an unprecedented national effort to conserve and restore fish and shellfish habitat throughout the United States, including those in coastal and estuarine areas. It involves a vast array of people from private organizations as well as local, state, and federal agencies and tribes who are dedicated to protecting and enhancing aquatic habitats. Preceding speakers in the session will provide details on the history, structure, and goals of NFHAP, details about habitat assessment, partnerships, and accomplishments. This question and answer period will include a very brief summary of the major points covered in previous presentations, as well as some questions to initiate discussion and prompt audience participation. It will also provide an opportunity for information exchange as scientists working on NFHAP begin the daunting task of gathering appropriate data for habitat assessments and Fish Habitat Partnerships seek participants to help develop strategic plans and implement projects.

## 59. Outreach, Education, and Policy

### 1. A GRADUATE COURSE IN APPLIED ADAPTIVE MANAGEMENT AT THE UNIVERSITY OF MARYLAND

*\*Vinaya Swaminathan, Foundations of Success;*

*\*Marcia Brown, Foundations of Success; \*Nick Salafsky, Foundations of Success*

Sound training in adaptive management - designing, managing, monitoring, and learning from conservation efforts - is essential for any conservation practitioner. Research by University of Maryland students found that many conservation organizations seek adaptive management skills in prospective employees. This research also found, however, that only 6 out of 26 surveyed conservation graduate programs at U.S. universities offer courses that cover the adaptive management cycle as defined by the Conservation Measures Partnership's Open Standards for the Practice of Conservation. To address this gap, Foundations of Success worked with the University's Sustainable Development and Conservation Biology Program to develop and offer a Masters-level course in adaptive management that combined hands-on group work on real conservation projects with traditional classroom lectures. This course ran in Spring 2007 and, based on formal evaluations

from students, faculty, and participating practitioners, was extremely successful and valuable. This model has proven an effective means for introducing the applied skills and tools of adaptive management in an academic setting and could potentially be replicated in other graduate conservation programs around the world.

## 2. ANALYSIS OF U.S. POLICY OPTIONS TO ADDRESS ILLEGAL LOGGING

*\*Pervaze Sheikh, Congressional Research Service*

Illegal logging is a pervasive problem throughout the world that costs governments an estimated \$15 billion annually in lost royalties. The United States is the world's largest wood products consumer and one of the top importers of tropical hardwoods. Some are concerned that U.S. demand for tropical timber might be a driver of illegal logging. The United States has no specific domestic laws that address all aspects of illegal logging. Three policy options from a U.S. Congressional perspective that aim to reduce illegal logging were analyzed in this study. Options include amending the Lacey Act to include foreign plant species, establishing requirements in free trade agreements for the conservation of forest reserves and enforcement of environmental laws, and targeting funds to address gaps in timber management in foreign countries from federal conservation programs. For region-specific and short-term solutions to illegal logging, improving the enforcement and monitoring capacity of foreign countries through grants under international conservation programs might be most efficient. Further, amending the Lacey Act might have widespread effects on reducing illegal logging, but only among U.S. importers and exporters that ship timber to the United States. Although each policy option is centered on the U.S. timber trade, addressing illegal logging through U.S. federal laws and policies might provide other timber importing countries with ideas to follow suit.

## 3. ARE CHANGING COMMUNITIES PRODUCING POSITIVE PREDATOR PERCEPTIONS? A CASE STUDY FROM RURAL KENYA

*\*Kerrie Anne Therese Loyd, University of Georgia*

Large carnivores can not be contained within protected reserves and understanding human-wildlife conflict on communal and private lands is critical to future conservation efforts. This case study focuses on four variables of a larger data set about human-predator interactions in rural Kenya. Interviews examined pastoral livestock farmers' perceptions of large predators, behaviors towards predators, suggested solutions to predator conflict and potential value of having large predators on community lands. The study was conducted on the West Gate Conservancy (formed on the Ngutuk Group Ranch in 2004) and the Ngaroni Group Ranch in the Samburu district of Kenya. Results reveal implications regarding the attitudinal value of living on a conservancy adjacent to a wildlife reserve. Interviewed residents of the Conservancy were more positive in their perceptions of large predators and realized potential economic value (e.g. ecotourism) of living with carnivores. Though both communal lands are expected to host high numbers of predators, residents of the Group Ranch, located farther from any nature reserves and isolated from ecotourism, held more negative perceptions of predators. Implications suggest that some human-wildlife conflict can be alleviated as additional communal conservancies and nature reserves are established and awareness of ecotourism is strengthened.

## 4. AWARENESS, BELIEFS AND CULTURE - THE ABC OF CHALLENGES TO SPOT-BILLED

## PELICAN CONSERVATION MANAGEMENT IN SRI LANKA.

*\*Kanchana Dilrukshi Weerakoon Ranasinghe, Eco Friendly Volunteers (ECO-V)*

A scientific study conducted by ECO-V, a Sri Lankan conservation organisation found that globally threatened Spot-billed Pelican (*Pelecanus philippensis*) populations struggle for survival due to a lack of awareness, community beliefs, and invasive plant species associated with remaining breeding, feeding and roosting habitats. Fresh water man-made tanks, feeding habitats for many native and migratory water birds, are getting covered by Eichhornia (Water Hyacinth) but people are totally unaware of the damage. Fishing is the main income for people but lack of awareness prevent them protecting water source. Hunting pelicans and other water birds, cutting down native trees which are roosting and breeding habitats of species, water pollution by chemicals and non- biodegradable polythene are some other threats to the existing pelican populations. Training youth as "friends of pelicans" was a successful strategy in pelican conservation. Naturally the Buddhist culture has potential to be supportive and respect nature but lack of awareness handicapped taking actions. ECO-V, has conducted 6 youth camps, 5 exhibitions, 10 work shops and more than 100 lectures to create awareness. Establishing 2 native plant nurseries (1000 plants) and conducting 2 manual cleaning campaigns for invasive plant species were some of the actions taken for restoring the habitats. Within 3 years of project period, 80% of the community know about pelicans and importance of protecting their habitats.

## 5. COLLABORATIVE CONSERVATION: SOLIGA CULTURAL ECOLOGY AND BIODIVERSITY CONSERVATION IN BILIGIRI RANGASWAMY TEMPLE WILDLIFE SANCTUARY, INDIA.

*\*NITIN DEVDAS RAI, Ashoka Trust for Research in Ecology and the Environment; \*Chikkananjegowda Madegowda, Ashoka Trust for Research in Ecology and the Environment; \*Siddappa Setty, Ashoka Trust for Research in Ecology and the Environment*

India's biodiversity conservation policy continues to marginalize traditional communities. Contemporary ecological research and conservation efforts do not acknowledge the history of forest use or traditional knowledge of indigenous communities, resulting in erroneous inferences about forest dynamics and adverse conservation outcomes. Using ethnographic information on Soliga cultural ecology, vegetation analysis, and socio-economic baselines we demonstrate that inclusive conservation strategies can be evolved. Soligas have farmed and configured the forests of the Biligiri Rangaswamy Hills for centuries. Soliga understanding of forest ecological processes has enabled them to explain current forest dynamics and predict the unintended ecological consequences of state-driven fire suppression regimes. We found experimental corroboration for the Soliga claim that traditional fire regimes reduce plant hemi-parasite densities. Fire reduces hemi-parasite load on *Phyllanthus emblica* trees thereby increasing *P. emblica* survival. Soligas historically farmed and manipulated the forest in regulated spatial configurations based on clan boundaries. Current levels of biodiversity are a result of Soliga forest management within these boundaries. Indigenous knowledge of forests should be incorporated into current forest governance systems that not only privileges traditional cultural ecologies but also ensures democratic and socially just conservation strategies.

## 6. ECOSYSTEM RESTORATION: EVALUATING LOCAL KNOWLEDGE AND MANAGEMENT SYSTEMS OF FISHERMEN IN FOSU LAGOON, GHANA

*\*Sarah N/A Darkwa, SUNY-College of Environmental Science & Forestry; \*Richard Smardon, SUNY-ESF*

The recent addition of Fosu Lagoon to the list of water bodies with "dead zones" has raised a lot of concern for the people who depend on it for their livelihood. The existing resource practices may not be very effective in conserving the lagoon. To assist the fishermen, there is the need to understand their local knowledge and management systems. This paper examines the practices of the Fosu Lagoon fishery management system in Ghana. A survey of 120 fishermen is used to address questions of local knowledge, resource management and adaptive management. Findings show that existing management practices may provide useful information about the fishermen's concerns such as the emergence and persistence of alien and invasive species. Increasing population and subsequent increasing demand for fish, along with a lack of strong local institutions are key factors impacting the lagoon. About 87% of the fishermen identified the following measures as important ways to restore and conserve the lagoon: replanting mangroves, desilting the lagoon, and avoiding dumping waste into the lagoon. Although existing local management practices have not fully protected the lagoon thus far, these practices can serve as a baseline upon which educational programs can be drawn and implemented.

## 7. FORMALIZING FOREST ACCESS AND IMPLEMENTING SUSTAINABLE BRAZIL NUT MANAGEMENT IN MADRE DE DIOS, PERU

*\*Cesar Moran-Cahusac, Asociación para la Conservación de la Cuenca Amazónica; \*Luz Marina Velarde, Asociación para la Conservación de la Cuenca Amazónica; \*Megan Elizabeth MacDowell, Amazon Conservation Association*

In 1999, the Amazon Conservation Association (ACA) established its Sustainable Brazil Nut Management program in the southwestern Amazon region of Madre de Dios, Peru. Since then, the project has protected over 600,000 hectares of humid tropical forest through community-based conservation. ACA has provided technical support to more than 420 families, which were earning a living as Brazil nut harvesters. The program has offered a number of services, including 1) helping to establish 476 extractive reserves, known as Brazil nut concessions, 2) mapping each concession with GIS, 3) redesigning Brazil nut trails to improve efficiency and minimize environmental impact, 4) helping to obtain voluntary Forest Stewardship Council and organic certifications for 48 concessions, and 5) helping to develop more than 370 sustainable forest management plans, approved by the Peruvian forestry department. As a result, the program has clarified land tenure and resolved conflicting land uses in the region. These concessions now act as a buffer to deforestation driven by the paving of a new international highway. In addition, the program has collected age, size, productivity, health, and location information for over 120,000 individual trees, one of the largest tree distribution databases in existence. ACA is now working on value added production chains to increase the percentage of revenue that remains with the Brazil nut harvesters.

## 8. GREEN INFRASTRUCTURE AND PUBLIC HEALTH: AN EVALUATION OF THE FLORIDA

## COMMUNITIES TRUST OPEN SPACE ACQUISITION PROGRAM

*\*Christopher Coutts, Florida State University*

Although the social good of public health is a major benefit and potentially powerful justification for land conservation, it has seldom been explicitly touted in local and regional land conservation efforts. Land conservation is fundamental to public health not only because it supports the most basic of human needs for air, water, and food, but it also supports other needs now nascent in the literature including environmental supports for social capital, physical activity, and mental health. The applications of 617 communities applying for state funding from the Florida Communities Trust (FCT) land conservation program between 2001 and 2006 were evaluated to determine disparities between funded and unfunded communities in their responses to application questions with public health significance. The analysis revealed common characteristics among communities receiving support for open space acquisition and disparities between funded and unfunded communities in their support for community health and well-being. The results indicated that funded communities were more likely than unfunded communities to include almost all of the application criteria determined to support public health. Among the most notable differences is that funded communities are much more likely to propose trails and greenways projects. The FCT is supporting public health and this latent benefit can and should be used as another important justification for land conservation.

## 9. HOW DOES CONSERVATION AFFECT LOCAL LIVELIHOODS? AN EMPIRICAL ASSESSMENT OF THE SOCIOECONOMIC EFFECTS OF COSTA RICA'S NATIONAL PARK SYSTEM

*\*Kwaw Senyi Andam, International Food Policy Research Institute; \*Paul Ferraro, Department of Economics, Andrew Young School of Policy Studies, Georgia State University; \*Margaret Buck Holland, Gaylord Nelson Institute for Environmental Studies, University of Wisconsin-Madison*

Protected areas are one of the mainstays of conservation policy. However, the impact of protected areas on the livelihoods of local communities is hotly contested. Although there is widespread concern about potential harmful consequences of establishing protected areas, empirical estimates are lacking. We use matching methods applied to Costa Rican census tract data collected over the last three decades to estimate the changes in local socioeconomic outcomes that would have occurred in the absence of protected areas. We find no evidence that protected areas, on average, had harmful impacts on the livelihoods of local communities. In contrast, we find that protection had small positive effects on some socioeconomic outcomes. Traditional methods used in the conservation science literature to estimate impacts of protected areas would have led to the opposite, erroneous conclusion because those methods do not fully control for confounders that mask protection's impact. More specifically, protected areas tend to be targeted to areas with low potential for economic growth.

## 10. LEADERSHIP: A NEW FRONTIER IN CONSERVATION SCIENCE

*\*Jim C. Manolis, Minnesota Dept. of Natural Resources; \*Kai M. A. Chan, University of British Columbia; \*Myra E. Finkelstein, University of California Santa Cruz; \*Scott Stephens, Ducks*

*Unlimited; \*Cara R. Nelson, University of Montana; \*Jacqueline B. Grant, Michigan Technological University; \*Mike Dombeck, David H. Smith Conservation Fellowship Program*

Leadership is a critical tool for expanding the influence of conservation science, but recent advances in leadership concepts and practice remain underutilized by conservation scientists. Furthermore, an explicit conceptual foundation and definition of conservation-science leadership are not available in the literature. To begin to address this problem, we define conservation-science leadership, identify a core set of principles that are specifically applicable to conservation biology, and develop recommendations for expanding leadership capacity among conservation scientists and practitioners. We define conservation-science leadership as the act of advancing the integration of conservation science into policy, management, or society at large. As such, leadership is not defined by status or position; it is an activity that can be exercised broadly throughout the conservation field. We identify 7 key leadership principles: 1) recognize the social dimension of the problem; 2) combine strengths of multiple leaders; 3) cycle frequently through action and reflection; 4) balance action with strategic patience, 5) get and maintain attention, 6) extend your reach, and 7) cultivate diversity. We recommend that conservation scientists and practitioners commit to developing themselves as leaders and that SCB, conservation organizations, and academia should increase support for leadership through research, teaching, and professional development.

## 11. ONTARIO'S ENDANGERED SPECIES ACT: STRONGEST IN NORTH AMERICA?

*\*Stacey Lee O'Malley, University of Toronto, Department of Ecology and Evolutionary Biology; \*Mart R Gross, University of Toronto*

Ontario's newly revised Endangered Species Act (OESA, 1971, 2007) is touted as the strongest legislation of its kind in North America. We contrast OESA to Canada's federal Species at Risk Act (SARA, 2003) and the US Endangered Species Act (ESA, 1973, 1978). All three Acts struggle with the definitions of "habitat" and "species." ESA retains the strongest protection for habitat because it does not differentiate between private and public landholdings. SARA has the weakest protection as it explicitly applies only to federal lands, while OESA applies only to provincial lands within the Ontario jurisdiction. SARA has the strongest recognition of units of biodiversity below the species level since it allows independent scientists to determine these units (e.g., Designatable Units, DU). The ESA has more complex and seemingly less effective DPSs (Distinct Population Segments) and ESUs (Evolutionarily Significant Units). By contrast, OESA has the power of dealing with populations as it covers a geographically restricted area, but has yet to scientifically identify populations within its jurisdiction. The OESA was the first legislation for biodiversity protection in North America. With its new revisions it could be the most powerful, but like all acts, there is room for further improvement.

## 12. PUBLIC PARTICIPATION IN ENERGY POLICY: A CASE STUDY OF THE SAN JUAN CITIZENS ALLIANCE

*\*Andrea Marie Feldpausch, Texas A&M University*  
The United States is reaching a point of energy uncertainty, with increasing pressures to seek independence from foreign fuel and become more environmentally conscious in energy production and use. Though technology is the harkened savior, it has yet to fully mature, putting further strain on energy

producing regions within the United States. Among these regions is the San Juan Basin in northwestern New Mexico and southwestern Colorado, known for its oil and natural gas production. This area is also described by some of its residents as an environmental sacrifice zone, suffering serious impacts from industry. In this paper, I examined how the San Juan Citizens Alliance (SJCA), a regional environmental NGO, provides voice for citizens of the basin using Susan Senecah's Trinity of Voice. Using text from organization newsletters, I found that SJCA incorporates a plethora of public participation actions, ranging from mass letter writing and attending public meetings to litigation and lobbying Congress, to provide access, standing, and influence to their constituency. Though the organization is not always successful in their ventures, SJCA's high membership numbers, diverse representation of stakeholders, and persistence in action afford the Alliance the voice required to impact energy and environmental policies in their region.

### 13. THE U.S. FARM BILL AND SCB: RECOMMENDATIONS, LESSONS LEARNED, FUTURE OPPORTUNITIES

*\*Andrew R Holdsworth, Minnesota Dept. of Natural Resources; \*Robert Dana, Minnesota Department of Natural Resources; \*Melissa A. Driscoll, Minnesota Department of Natural Resources; \*Jim C. Manolis, Minnesota Dept. of Natural Resources; \*Derric Neville Pennington, University of Minnesota; \*Kelly Pennington, University of Minnesota; \*Joe Walton, S&S Tree and Horticultural Services*

Agricultural practices have a major effect on biodiversity conservation, ranging from the 'dead zone' in the Gulf of Mexico to conversion of remaining native habitats and the degradation of freshwater habitats. Yet conservation biologists are just beginning to grapple with the challenges and opportunities of conservation in agricultural landscapes. The Minnesota Chapter of SCB initiated a year long effort to inform its members about the biodiversity consequences of the Farm Bill and influence the conservation capacity of the pending 2007 Farm Bill by offering conservation biology-informed recommendations and meetings with congressional members. MN Chapter recommendations for the Farm Bill were approved by the SCB Policy Committee and adopted by the North American Section of SCB. They address protecting native grassland habitat, expanding biodiversity benefits of land retirement programs, reducing the impacts of invasive species, improving technical assistance, targeting conservation programs to priority areas, providing incentives for ecologically appropriate biofuel production, and funding research and performance measures. Although SCB is a new player in the Farm Bill, many conservation organizations welcomed its involvement. The Farm Bill represents one of many key areas for conservation biologists and SCB to enhance biodiversity conservation in agricultural landscapes.

### 14. WHAT DOES HIGH HUMAN POPULATION GROWTH ALONG PARK BORDERS TELL US ABOUT COSTS, BENEFITS AND CHALLENGES OF PARK-BASED CONSERVATION IN THE 21ST CENTURY?

*\*Justin S. Brashares, UC-Berkeley; \*George Wittemyer, University of California, Berkeley; \*Paul Elsen, UC-Berkeley; \*William T. Bean, UC-Berkeley; \*A. Coleman O. Burton, UC-Berkeley*  
Nature parks have been criticized for decades as creations of

and for an elite few. This is particularly true in developing regions where parks are often viewed as holdovers of colonial imperialism in which costs of establishing parks, but few benefits, are borne by disenfranchised rural communities. However, park creation may benefit rural inhabitants by providing access to road networks, employment, foreign aid, increasingly scarce provisioning services such as firewood and bushmeat, and areas of safety during strife. If parks are attractants perceived locally to provide opportunities otherwise scarce we expected immigration to drive high rates of population growth along park borders. In contrast, the opposite may occur if parks deprive local people of natural resources or burden communities with conflict with park animals or staff. We found that from 1960-2000, average human population growth on the borders of 306 rural parks in 45 countries in Africa and Latin America was nearly double average rural growth. Higher population growth on park edges was evident across ecoregions, countries and continents and suggested parks were magnets for human settlement. This finding shed new light on the relationship between parks and local inhabitants, but raised new questions about the economic, social or other mechanisms that drive settlement near parks. Here we discuss those mechanisms and consider the implications of our results for protected area management.

## 60. Parks, People, and Posterity: Reconsidering the Ethical Dimensions of International Conservation

### 1. THE ETHICS OF CONSERVATION BEYOND PARKS, WITH A CASE STUDY FROM PERU

*\*Sahotra Sarkar, University of Texas at Austin*

The role of national parks in biodiversity conservation has increasingly come to be questions, particularly in densely-populated regions of the South. Critics have argued that the national park model is derived from a wilderness myth which has little relevance to areas outside the regions of the North in which it originated. This paper explores what other models may potentially be used to plan for biodiversity conservation and how they would receive their ethical justification. In particular options for embedding biodiversity concerns in the resource management practices of forest communities, especially in the neotropics, are explored. A case study from the Peruvian Amazon shows how these management practices consist of community control of watersheds and forests based on longstanding traditions of inter-group and intra-group rights and duties. Unlike the national park model, human exclusion plays no role in this form of natural resource management. Moreover, since management is directed to large classes of taxa, most biodiversity surrogates prioritized by conservation biologists fall under the aegis of these practices. The potential for extending the targeted taxon sets to include other biodiversity components is explored. Finally, the fieldwork shows that the normative framework used by groups includes concern for natural values beyond instrumental uses of species as resources but makes no reference into nebulous concepts of intrinsic value.

### 2. PARKS, PEOPLE & POSTERITY: A NORMATIVE ANALYSIS OF INTERNATIONAL CONSERVATION

*\*Thad Miller, Arizona State University; \*Ben Minteer, Arizona State University*

Conservation biology is somewhat unique among the natural sciences in that it was established in response to a crisis, the rapid loss of biodiversity, with a clear mission - to stem the tide

of this loss (Terborgh 2000). Moreover, this mandate has often carried for many a strong ethical commitment; the embrace of the intrinsic value of wild species and ecosystems (Soulé 1985). The foundational value and ethical dimensions of international conservation are often left unexamined, yet they are clearly at play in the current debates over the efficacy of protected areas (Redford, Brandon & Sanderson 1998), integrated conservation and development projects (McShane & Wells 2004), and sustainable development in international conservation (Roe & Elliot 2004). In this paper, we will set the stage for an analysis of how environmental, social, and disciplinary values have produced a new - but familiar -- rift in the international conservation community, one in which conservation biologists promoting protected areas ("nature protectionists") have become pitted against more development-oriented conservationists ("social conservationists") intent on reforming the dominant protected areas model. We believe that explicit attention to and critical scrutiny of the ethical dimensions of the debate, in tandem with a clearer expression of conservation methods and objectives, will reveal significant points of convergence on common conservation actions and policy goals.

### 3. HARD CHOICES: UNDERSTANDING THE TRADE-OFFS BETWEEN BIODIVERSITY CONSERVATION AND HUMAN WELL-BEING

*\*Thomas O. McShane, Global Institute of Sustainability, Arizona State University; \*Alexander Nyangero Songorwa, Sokoine University of Agriculture; \*Ann P. Kinzig, Arizona State University; \*Bruno Monteferri, SPDA; \*HOANG VAN THANG, Center for Natural Resources and Environmental Studies, Vietnam National University; \*Juan Luis Dammert Bello, Sociedad Peruana de Derecho Ambiental; \*Manuel Pulgar Vidal, Sociedad Peruana de Derecho Ambiental; \*Peter Brosius, Center for Integrative Conservation Research, University of Georgia; \*Peter Coppolillo, Wildlife Conservation Society; \*Sheila O'Connor, Global Institute of Sustainability, Arizona State University; \*TRAN CHI TRUNG, Center for Natural Resources and Environmental Studies (CRES), Vietnam National University*

Win-win scenarios, where both biological diversity is conserved, and human well-being is improved, in specific places over time have been difficult to achieve and thus rarely realized. Compromise, contestation and conflict are more often the norm. The Advancing Conservation in a Social Context (ACSC) research initiative is investigating the complex trade-offs that exist between human well-being and biodiversity conservation goals, and between conservation and other economic, political and social agendas at local, national and international scales. Resolving the trade-offs between biodiversity conservation and human well-being is difficult because the relationship between people and nature is so strongly influenced by where they are raised, how they are educated, their life experiences and survival conditions, and options they have faced. These different beliefs exert a strong influence on behavior. Assumptions based on inadequate evidence often obscure legitimate differences in preferences and limit the effectiveness of policy and programmatic interventions. The challenge for conservationists is to explicitly acknowledge the need to share risks and costs. Often hard choices need to be made and these must be openly and honestly negotiated. Not to do so leads to unrealized expectations and

ultimately unresolved conflict.

### 4. ETHICAL OBLIGATIONS AND REAL WORLD CONSERVATION

*\*John Gwilym Robinson, Wildlife Conservation Society*

Parks and managed areas are increasingly having to be responsive to a multitude of ethical obligations: the conservation of biodiversity, the reduction of poverty, the imperative of social justice and cultural integrity, the improvement in livelihoods. Interventions by different institutions and groups, be they local communities, government agencies, private corporations or non-governmental organizations, must consider these different obligations. They must respond to biological exigencies such as irreplaceability and species vulnerability, and social imperatives such as the legitimacy of people's claims to land and resources, and their social and economic vulnerability. Some interventions will benefit biological, social and economic interests - others will require trade-offs. Interventions must therefore recognize the different obligations and interests, define priorities, and allow negotiation and consultative decision making.

### 5. FAIR TRADE-OFFS: SOME PUZZLES

*\*Bryan Norton, Georgia Institute of Technology; \*Paul Hirsch, Georgia Institute of Technology*

In understanding conflicts over conservation planning and practice, it is common to speak of trade-offs between conservation and development goals. How should we conceive and make such trade-offs? A "minimalist" interpretation of trade-offs is proposed: since one cannot do everything, any decision to do one thing rather than another "costs" the values that would be served by the unchosen options. The minimalist interpretation uses no particular conceptual or disciplinary models to analyze trade-offs. One could set, as a minimal condition on good trade-off decisions, a procedural rule that each affected party should have a voice at "the table". This rule, however, leads to a puzzle. Since different participants in a situation have different values, they tend to formulate the problem from different perspectives, and these perspectives lead to differing problem formulations which, in turn, suggest that different individuals and groups will be affected and therefore deserve a seat at the table. It will be argued that these difficulties can only be addressed by recognizing the crucial role of values in deciding "scale" and "boundary" issues. Examples and new research will be offered to explain how values, problem formulation, and issues of fairness play out in trade-off decisions.

### 6. USING DEVELOPMENT MEANS TO A CONSERVATION END? - OR - USE DEVELOPING A MEAN END TO CONSERVATION?

*\*Nick Salafsky, Foundations of Success*

The ongoing debate over the ethicality and effectiveness of integrating conservation and development is so thorny because it conflates two fundamentally irreconcilable and opposing truths. On one hand, true conservation requires eliminating or at least minimizing human use of natural systems. On the other, conservation is almost exclusively a human endeavor that ultimately requires getting resource users to support conservation aims. So what's a conservation practitioner to do? The need to address this problem has become particularly acute and relevant in the context of recent efforts to develop a common language and software tools for designing, managing, monitoring, and learning from conservation efforts. If you are writing a vague text description of your ecotourism or

education strategy, you can fudge and claim that this work will simultaneously achieve both conservation and development ends. But if you diagram a results chain (theory of change) showing how your proposed strategy will achieve both ends, you soon realize you have to make choices and tradeoffs -- that it is impossible to reach these mutually exclusive goals. The solution thus lies in sorting out ends from means. Conservation organizations need to focus solely on clear biodiversity ends, but make judicious use of development means that address human stakeholder needs and concerns. If we continue to conflate these two conflicting ends, resource over-use will inevitably lead to a mean end to conservation.

## 61. Population Dynamics

### 1. HEARD BUT NOT SEEN: USING SIGNATURE VOCALIZATIONS AS INDICATORS OF POPULATION HEALTH

*\*Mya Elizabeth Thompson, Cornell University; \*Katharine Payne, Cornell University; \*Andrea Turkalo, Wildlife Conservation Society; \*Kathryn Cortopassi, Cornell University*

In densely-forested environments where visual communication is often ineffective, many animals rely on acoustic displays to share information. For such species, acoustic monitoring has the potential to deliver information about population health that would otherwise be unavailable. In this study we determined that age-sex class signatures are embedded in the vocalizations of African forest elephants by measuring a sample of 465 low-frequency calls from the a forest clearing in the Dzanga National Park, C.A.R. where study subjects have been individually identified and their behavior is readily observed. Using a non-parametric classification tree technique, we grouped vocalizations into age and sex class categories based on 35 acoustic predictor variables. Vocalizations were successfully classified by age class with 75% accuracy overall, with some classes reaching 88% accuracy, and by sex class with 68% accuracy. Because tree-based models are useful in predicting age and sex class, they can be applied in the classification of vocalizations from acoustic sensors in forested habitats where elephants cannot be observed visually. Such information can play an important role in the management of these populations: currently over half of the forest elephant range remains unmonitored and low-frequency elephant calls allow surveys to cover large areas. These classification methods will likely prove useful for other vocal taxa of conservation concern.

### 2. HUNTING PATTERNS, POPULATION DENSITY, GROUP SIZE, AND CONSERVATION OF THE WHITE-LIPPED PECCARY (TAYASSU PECARI) IN THE CALAKMUL REGION OF MEXICO

*\*Rafael Reyna, University of Florida; \*EDUARDO NARANJO, ECOSUR-Mexico; \*Colin Chapman, McGill University; \*George Tanner, University of Florida*

The white-lipped peccary (WLP) is a social ungulate that forms the largest groups documented for any tropical forest ungulate species. In the last 20 years WLP have become increasingly rare in México and Central America, and the more frequent reporting of smaller groups is speculated to be related to increased hunting pressure. Here we present information relevant to the conservation of this species in terms of their group sizes and structure, breeding season, population density,

and hunting patterns in the Calakmul region of southern Mexico. Group sizes, age structure, and breeding season were recorded in one large non-hunted site (Calakmul Biosphere Reserve, CBR) and four adjacent hunted sites. Population density was estimated in CBR, and hunting patterns were recorded from three adjacent villages. Groups of WLP were on average larger in the reserve (median=25, SE=1.84, n=9), than in the hunted areas (median=16, SE=1.84, n=15), but groups were generally smaller than those reported in other forests. Smaller group sizes in hunted areas signal a conservation concern for this species in the Calakmul region. Population density estimate (0.43 / km<sup>2</sup>), is smaller than some estimates being used for legal hunting purposes, and hunting occurs mainly in the dry season, when the breeding season is at the peak and groups are visiting water bodies where they are more easily hunted.

### 3. LEAVING THE NEST: A CRITICAL PERIOD IN THE LIVES OF TROPICAL COUNTRYSIDE BIRDS

*\*Cagan H Sekercioglu, Stanford University*

We need demographic data from all life cycle stages to understand and predict population dynamics of tropical bird species, many of which are threatened with extinction. The period between leaving the nest and juvenile dispersal is little studied, but is critical in shaping bird populations. Between 1999-2007, we conducted mark-recapture, radio tracking, and nest monitoring to study the population dynamics of three diverse tropical forest bird species. We compared their population trends, breeding success, adult and juvenile survivorship in various types of Costa Rican forested and deforested habitats. Mark-recapture estimates of adult survivorship did not explain population trends. For two species, nest productivity did not differ, but for the most forest-dependent species productivity in forest remnants was a third of that in deforested countryside, suggesting an ecological trap. However, in deforested habitats, daily post-fledging mortality was nine times higher for *Turdus assimilis* and for all species combined. Overall mortality rate of 156 radio tracked adults was 3.2% and 0.08%/day/bird, but for 18 tracked fledglings, 50% and 5.5%/day/bird. 86% of fledglings in coffee plantations versus 27% of fledglings in forest fragments were predated. These results emphasize the conservation importance of combining various methods to study tropical birds' post-fledging period, which has substantial effects on population dynamics, but is an understudied stage of avian life history.

### 4. POPULATION DYNAMICS AND CONSERVATION OF ARAPAIMA IN FLOODPLAINS OF THE CENTRAL AMAZON

*\*Leandro Castello, Mamiraua Institute for Sustainable Development, Tefe, Brazil; \*Donald Stewart, College of Environmental Science and Forestry; \*Caroline Arantes, Mamiraua Institute for Sustainable Development, Tefe, Brazil*

The pirarucu (*Arapaima* sp.) is an economically important but heavily over-exploited fish species of floodplains of the Amazon, but we know nothing about their population dynamics. To foster sustainable pirarucu fisheries, we developed an age-structured population model that is largely empirical and based on a population that has increased 10-fold in abundance in 8 yr. The model simulated well observed numbers of pirarucu, with low mean absolute percentage errors for juveniles (8%), adults (18%), and catch (23%). We found the following: (1) Annual recruitment is directly and positively related to spawner abundance ( $R^2 = 0.66$ ), but not to inter-annual variation in water levels ( $p$ -value > 0.05). (2) Pirarucu

populations can sustain annual catches of up to 30% of adults if individuals that are sexually immature or reproducing are protected. (3) Fishing-selectivity of pirarucu caused by use of harpoons and gillnets can lower dramatically yield potentials through removal of the faster-growing individuals of the population. (4) Conversely, changing the fishing-selection from Juvenile to Adult fish seemed to reduce mean age-at-first-reproduction from 5 to 3 years, but not length-at-first-reproduction, which remained the same. Hence, the pirarucu seemed to grow faster and mature earlier despite dramatic increases in population density, and this combined with the possibility of harvest of Adults bodes well for the recovery of depleted populations.

## 5. RESOURCE OR SINK HABITAT? USING BEHAVIOR TO LINK RESTORATION TO BUTTERFLY POPULATION VIABILITY

\*Cheryl B Schultz, Washington State University Vancouver; \*Leslie Rossmell, Washington State University Vancouver; \*Elizabeth E. Crone, University of Montana

Numerous land management agencies are currently investing substantial effort in restoring habitat for endangered butterflies. However such efforts are rarely evaluated with respect to either the behavior or the population dynamics of at-risk butterfly species. Fender's blue (*Icaricia icarioides fenderi*), an endangered butterfly in Oregon's Willamette Valley, USA, uses Kincaid's lupine (*Lupinus sulphureus kincaidii*), a threatened plant species, as its sole hostplant at many sites. Recent efforts have emphasized habitat expansion with focus on nectar-source enhancement when hostplant seed is scarce. The Nature Conservancy restored 1.6 ha of upland prairie habitat adjacent to intact habitat in 2003. In 2005 and 2006, we observed Fender's blue behavior across restored and intact habitats. We find that butterflies actively use newly restored areas for nectar resources. However, once butterflies move beyond the edge region, the likelihood that they return to intact habitat substantially declines. We investigate the effects of behavioral responses to nectar buffers using an empirically based biased correlated random walk model. This behavioral approach links on-the-ground restoration action to population dynamics, a linkage rarely made in scientific literature and one with potential to greatly aid restoration strategies for endangered invertebrates.

## 6. SOCIAL AND BIOLOGICAL CARRYING CAPACITIES

\*Mart R Gross, University of Toronto; \*Eric Davies, University of Toronto

Conservation biology is still searching for its principles. One of its important borrowed principles is the "biological carrying capacity (e.g., K)" at which maximum population size is sustainable. We now present a conservation biology specific principle which we call the "social carrying capacity (S)". Modeling K and S shows that endangerment can occur when either  $S < K$  (culling) or when  $S > K$  (harvesting, aesthetics). When  $S > K$ , humans then promote population numbers above their biological sustainability. For example, winter feeding at the National Elk Reserve near Jackson, Wyoming can lead to biodiversity loss in Yellowstone Park through summer overgrazing by elevated elk numbers. Similarly, humans construct landscapes with selected native species or exotics based on  $S > K$ . We must then supplement K (e.g., watering, disease control). Rarely is  $S = K$ . We show that an understanding of the world's carrying capacities as both biological and social provides remarkable insight into which species will be at risk, which species will be exotics, and how

much we are willing to invest in the conservation of biodiversity. Conservation biology in the future should use social carrying capacity as a guiding principle together with biological carrying capacity.

## 7. UNDERSTANDING THE LINKAGES BETWEEN HIV/AIDS AND NATURAL RESOURCES MANAGEMENT IN UGANDA

\*Jackson Bwagiro Tumwine, Makerere University

In Uganda, millions of people depend heavily on genetic species and eco-system diversity to support their livelihoods. This bio-diversity contributes both directly and indirectly to human health and nutrition. The direct contribution of biodiversity is invaluable source for medicinal remedies and applications where the indirect contribution is through eco-system services for example filter against toxic substances from the air and sequestering of carbon. With the scourge of HIV and AIDS, there is a threat to sustainable use of these natural resources. One of these is biodiversity conservation and natural resources management. However, it has been found out that information available on the linkages of HIV and AIDS with the environment is very anecdotal. The goal of this paper is to: to establish the linkages between HIV/AIDS and the environment in Uganda and suggest action plans that could be explored by conservation and resource management organizations in the fight against AIDS epidemic in Uganda.

## 8. VARIATION IN THE RELATIONSHIP BETWEEN OFFSPRING SIZE AND SURVIVAL PROVIDES INSIGHT INTO CAUSES OF MORTALITY IN HAWAIIAN MONK SEALS

\*Jason D. Baker, US National Marine Fisheries Service

The reasons why wildlife populations decline in abundance are often unknown; thus, research focuses on attributing relative support to various explanatory hypotheses. Here it is hypothesized that variation in the relationship between offspring size and survival in a population should provide insight into causes of mortality; for example, size-dependent and size-independent mortality will affect the shape of the size-survival curve differentially. This hypothesis is examined using weaning girth measurements and subsequent survival outcomes for Hawaiian monk seal pups, a species which is currently declining in abundance as a result of low juvenile survival. The overall relationship (all years combined) between monk seal girth and survival traces a sigmoid curve, with no asymptote attained within the size range of pups measured. Comparing size-survival curves during years with high, medium, and low first-year survival suggests that an intensification of size-dependent mortality, probably related to food limitation, is commonly associated with poor cohort survival. A notable exception at one colony indicates that size-independent mortality, probably a result of a known high incidence of shark predation, is associated with high juvenile mortality. Analyzing variability in the relationship between body size and survival can be a powerful tool for evaluating sources of mortality and, ultimately, aid in diagnosing population declines.

## 62. Population Dynamics (2)

### 1. EGG POACHING: A MAJOR FACTOR IN THE POPULATION DECLINE OF LEATHERBACK TURTLES, DERMOCHELYS CORIACEA, AT PARQUE NACIONAL MARINO LAS BAULAS, COSTA RICA

*\*Maria del Pilar Santidrian Tomillo, Drexel University; \*Vincent Sellito Saba, Virginia Institute of Marine Science; \*Rotney Piedra, MINAE; \*Frank Vincent Paladino, Indiana Purdue University Fort Wayne; \*James Robert Spotila, Drexel University*

The population of leatherback turtles (*Dermochelys coriacea*) that nest at Parque Nacional Marino Las Baulas (PNMB) was the subject of an organized system of poaching that removed approximately 90% of all the eggs laid for about 20 years. Poaching and high mortality rates of adults in the Ocean are believed to have caused a rapid and precipitous decline in the number of nesting turtles that might lead to the extinction of this population. We simulated the effect of poaching and fisheries on the numbers of nesting leatherback turtles at PNMB. We created a Leslie matrix based on the life table of a natural population of Eastern Pacific leatherback turtles. We simulated (1) the impact of continuous poaching at 90% level on the population, (2) the impact of reducing poaching to lower intensities and (3) the effect of eradicating poaching at different stages after it was introduced. Finally, we simulated the effect of increasing mortality levels of adults to recreate the effects of fisheries on the adult population. Our analysis showed that poaching could be the most important single cause for the fast decline of the population of leatherback turtles that nest at PNMB. Thus, beach protection is critical for the survival of this population. Likewise, protection in the ocean is also crucial to prevent eastern Pacific leatherbacks from extirpation due to fishery activities.

## 2. FRIEND OR FOE: BEHAVIORAL INTERACTIONS BETWEEN AN INTRODUCED AND NATIVE SALAMANDER SPECIES.

*\*Heather R. Cunningham, Department of Biological Sciences The University of Alabama; \*Leslie J. Rissler, Department of Biological Sciences, University of Alabama*

Invasive species are frequently cited as being a leading cause of biodiversity loss. An often overlooked attribute in invasive research is behavior; studies generally focus on ecological, life-history, or genetic characteristics. However, studies have found that changes in levels of aggression and territoriality may strongly impact the fate of the introduced and native species. Unfortunately, the role of territorial behavior in invaded vertebrate systems is poorly understood. At Mountain Lake Biological Station (MLBS) in Virginia, *Plethodon montanus* (Northern Grey-Cheeked Salamander) was the introduced between 1935 and 1945. This species is ecologically similar to the native *Plethodon glutinosus* (Northern Slimy Salamander). As both species are known to exhibit aggressive territorial behavior the objective of this study was to determine if the non-native *P. montanus* influenced the territorial behavior of the native *P. glutinosus*. We found that individuals of *P. glutinosus* from MLBS were more aggressive towards individuals of *P. montanus* from MLBS versus populations where the introduced salamanders originated. This discrimination was not observed in individuals of *P. glutinosus* from undisturbed populations. Studies that examine behavioral interactions between invasive and native species can provide unique insights into factors affecting invasion dynamics.

## 3. MODELING THE ROLE OF BEHAVIOR IN WILDLIFE RESPONSES TO LANDSCAPE CHANGE

*\*Joshua Lawler, University of Washington; \*Nathan H. Schumaker, US Environmental Protection Agency*  
Land-use change alters landscapes at different rates and to

different degrees. Wildlife responses to shifting habitat conditions vary from species to species depending on the rate of landscape change, species' life history traits, and aspects of behavior such as dispersal patterns and nest-site fidelity. Here, we explored how these factors together determine the extent to which Willow Flycatchers can track changes in a managed landscape in western Oregon. Using a spatially explicit population model, we simulated flycatcher populations in the Umpqua watershed of the Coast Range in Oregon over a 100-year period. Landscape change reflected current and likely future forest management activities across a variety of land-ownerships. We parameterized the model with known attributes of Willow Flycatcher behavior and life history traits. Despite overall increases in habitat quality, Willow Flycatcher populations were unable to track the rapidly shifting mosaic of suitable and unsuitable habitats, and thus declined steadily. We used the results to explore how rates of landscape change, dispersal ability, nest-site fidelity, and survival rates impact flycatcher persistence. Although all four factors influenced the population's response to landscape change, nest-site fidelity had a particularly strong effect on the population's response to the shifting habitat mosaic. Our results emphasize the importance of species' behavior in determining wildlife responses to landscape change.

## 4. POPULATION VIABILITY OF AUSTRALIAN GREY NURSE SHARKS WITH FISHING MITIGATION AND CLIMATE CHANGE

*\*Corey James Alexander Bradshaw, University of Adelaide; \*Victor M Peddemors, Macquarie University; \*Rory B McAuley, Western Australia Department of Fisheries; \*Robert G Harcourt, Macquarie University*

Increasing biodiversity loss requires realistic approaches to avoid species extinction through intervention. The worldwide decline in sharks is particularly disconcerting because we still understand little of their basic demography and how they will fare with changing climates. We developed stochastic population viability models for the Critically Endangered grey nurse shark to predict medium- (3 gen) and long-term (40 gen) extinction risk. Models used measured and inferred demographic rates, estimates of shark meshing and fishing mortality, and predictions of climate-induced range shift. Under current reported rates of recreational, commercial and mesh fishing mortality, the estimated population has a > 40 % chance of becoming quasi-extinct (< 50 females) within 3 generations (50 years). If fishing mortality rates are under-reported, extinction risk rises to nearly 100 %. For the population to persist over 3 generations, at least 3-4 times the estimated population size is required. Reduction in fishing-related mortality through the use of non-offset circle hooks, a shift from meshing nets to drumlines for beach protection, and an increase in the enforcement and extent of sanctuary zones all reduced extinction risk markedly. Range expansion southwards is likely to reduce extinction risk by facilitating population exchange. Our results demonstrate the necessity of including all major sources of uncertainty (including climate change) into PVAs.

## 5. QUANTIFYING THE EFFECTS OF SENESCENCE AND PREY LIMITATION ON KILLER WHALE REPRODUCTION

*\*Eric Ward, NOAA*

Two populations of fish-eating killer whales inhabiting the inland waters of British Columbia (Canada) and Washington State (USA) have been listed recently under both the U.S.

Endangered Species Act and the Canadian Species At Risk Act due to concerns over small population sizes and recent declines. Using Bayesian model averaging, we assessed the impact of a wide range of factors on killer whale fecundity - variables included in our model included anthropogenic impacts (vessel traffic, contaminants), demographic effects (Allee dynamics), and fluctuating prey abundance. Prey was included to specifically addressing whether killer whale production is limited by prey availability (Chinook salmon). Our results indicate that killer whale fecundity is highly impacted by abundance of Chinook salmon - between years of low salmon abundance and high salmon abundance, the probability of a female calving was determined to increase by 50%. Potential future growth of this population is potentially limited by historical live capture harvests (aquaria), declining Chinook, and a skew in the population's sex ratio at birth in recent years.

## 6. THE EFFECTS OF DISTURBANCE TO FOREST COVER ON AMPHIBIAN POPULATIONS AT A REGIONAL SCALE

*\*Elizabeth B. Harper, SUNY College of Environmental Sciences and Forestry; \*James P Gibbs, State University of New York College of Environmental Science and Forestry; \*Raymond D. Semlitsch, University of Missouri - Columbia; \*Malcolm Hunter, University of Maine*

Pool-breeding amphibians in temperate forests require high-quality aquatic and terrestrial habitat for reproduction, foraging and overwintering. Human land-use practices that degrade any of these habitat components can decrease local population viability and reduce connectivity among local populations thereby affecting regional population stability. The collaborative Land-use Effects on Amphibian Populations project (LEAP) has experimentally manipulated forest habitat to determine the effects of disturbance caused by forestry practices on amphibian populations in Maine, Missouri and South Carolina. Using data from over thirty LEAP experiments carried out over the past five years we have developed multisite demographic models of amphibian responses to a range of disturbance scenarios. These models include species with a range of life history strategies and incorporate studies of amphibian behavior and physiology. Our primary goal was to identify thresholds of scale and intensity of forest disturbance beyond which regional persistence is unlikely, and to use these results to inform policy makers about ways to balance forestry activities with amphibian population persistence. Our model predictions emphasize that adequate connectivity among local populations is dependent on characteristics of both aquatic habitat (the total number, density and hydroperiods of local breeding sites) and terrestrial habitat (area, frequency and intensity of disturbance).

## 7. THE GHOST OF CLIMATE PAST: LONG-MEMORY PROCESSES AND POPULATION EXTINCTION

*\*Karim Al-Khafaji, Stanford University; \*Shripad Tuljapurkar, Stanford University*

Population declines and extinctions worldwide are so dramatic that biodiversity loss has been considered an aspect of global change in its own right, on par with warming and other aspects of climate change. Existing population models of extinction risk assume that temporal fluctuations in population growth rates are uncorrelated or only weakly correlated. However, it is widely recognized that populations are driven by climatic variables like temperature and floods that have persistent autocorrelations, i.e. are long-memory processes. It is unclear

how long-memory in the driving processes affects population dynamics and extinction risk as our intuition is largely based on assumptions of temporal independence (so-called white noise models). Increasing attention has been paid to the noise frequency spectra of environmental processes, and particularly spectral reddening, but there has been little explicit work on long-memory per se. Using simulation and analytical approaches we demonstrate that long memory, characterized by the Hurst exponent, can dramatically impact expectations of population extinction in both density independent and density dependent models. This is particularly significant as GCM's of global climate are relatively poor at reproducing long-memory properties in climatic variables despite being quite successful at recreating their historical distributions. This implies that assessment of extinction risks based on modeled future climate may be misleading.

## 8. USING GENERALIZATIONS DEVELOPED FROM EXISTING DEMOGRAPHIC DATA TO GUIDE MANAGEMENT FOR DATA-POOR SPECIES

*\*Cynthia Hartway, University of Montana; \*L. Scott Mills, University of Montana; \*Matthew Kauffman, University of Wyoming*

Lack of data presents a significant barrier to designing effective management plans for sensitive species. Management interventions are costly and time consuming, yet managers must often make decisions without good evidence that their efforts will increase population performance. Can the demographic responses of past efforts and perturbations guide the management of data-poor species? We addressed this question by conducting meta-analyses on data culled from 147 studies to determine the ability of six common management practices to increase survival and reproduction across multiple taxa. Results indicate that broad generalizations can be made about the effectiveness of some management actions. For example, studies of bird reproductive success indicates that, on average, predator removal programs increase nest success by 41%, whereas habitat alteration through controlled burning increases nest success by 20%, and cessation of grazing generally has no effect. Furthermore, in some cases, variability in the demographic effect of management can be explained by ecological factors: nest success of tree-nesting birds experience a significantly greater boost following predator removals than do ground-nesting species. These meta-analyses results can be combined with demographic models to prioritize on-the-ground actions that most efficiently increase population growth and persistence for species of concern.

## 63. Poster Session

### 1. PHYLOGEOGRAPHIC ANALYSIS REVEALS MULTIPLE UNDESCRIBED SPECIES OF AMPHIPODS IN CHIHUAHUAN DESERT SPRINGS

*\*Richard Seidel, Department of Zoology, Miami University; \*Brian K. Lang, New Mexico Department of Game and Fish; \*David J. Berg, Department of Zoology, Miami University*

Biodiversity conservation and the identification of conservation units among invertebrates are complicated by low levels of morphological difference, particularly among aquatic taxa. Thus, biodiversity has been underestimated in communities of aquatic invertebrates, as revealed by high genetic divergence between cryptic species. We sequenced portions of the

mitochondrial cytochrome c oxidase I (COI) gene and 16S rRNA gene from amphipods in the Gammarus pecos species complex, endemic to springs in the Chihuahuan Desert of southeastern New Mexico and western Texas. Our analyses uncovered the presence of eight separate species in this complex, in which only three nominal species are described. The distribution of these species in highly correlated with geography, with many of the detected species present only in one spring or one spatially-restricted cluster of springs. We show that patterns detected in the G. pecos species complex also correlate with endemic gambusia fish, cyprinid pupfishes, and trionid snails. Our results suggest that future biodiversity investigations in desert spring habitats are likely to identify endemic species within other groups of aquatic invertebrates. Because of their limited distributions, such species will be of great conservation concern.

## 2. RELATING LOCAL ABUNDANCE TO GEOGRAPHIC RANGE: MACROECOLOGY IN THE TROPICAL DRY FORESTS OF MEXICO

*\*John N Williams, University of California Davis*

Data from tropical systems increasingly suggest that the majority of tree species, which occur locally at low densities, may have broader geographic ranges than previously thought. If true, this pattern would contradict a central tenet of macroecology: Brown's hypothesis that local species abundance and elevation breadth are positively correlated with range size. This study examines the relationship between range size and local abundance for the community of tree species at two sites in the seasonally dry tropical forests of Pacific Coast, Mexico. Species composition data were collected along a 500m elevation gradient from the coast to the foothills of the Sierra Madre mountain range to generate local abundance profiles for each species. These profiles were then compared to available species range data to test whether range breadth is a good predictor of local abundance. Additionally, I test whether the distribution of range sizes for each site supports the mid-domain effect or suggests a pattern that is not expected by chance, such as a high proportion of species occurring at low densities and characterized by broad geographic ranges. An abundance-range breadth pattern for these uncommon to rare species, if present, may help conservation planners determine where to direct protection efforts in ways that will capture the highest levels of diversity and endemism.

## 3. TOWARD AN UNDERSTANDING OF CLEMATIS FREMONTII S. WATSON (RANUNCULACEAE) IN THE SOUTHEASTERN UNITED STATES

*\*Meredith Callahan Montgomery, University of Tennessee at Chattanooga; \*Joey Shaw, University of Tennessee at Chattanooga*

Cedar glades are unique habitats ranging from the Midwest through the Ozarks and into the southeastern United States. They are areas of Ordovician, Silurian, or Mississippian dolomite or limestone bedrock with characteristically shallow and rocky soils that create harsh environmental conditions for plant survival. Consequently, cedar glades are marked by high numbers of endemic plant species. One such species is *Clematis fremontii* S. Watson, which is normally restricted to the Midwest. However, two disjunct populations of *C. fremontii* inhabit cedar glades located in Rome, GA and Chattanooga, TN. The existence of these populations outside of the Midwest is an anomaly. We are using floristic studies, GIS mapping, field surveys, and tools from molecular genetics to determine whether these two southeastern populations are recent introductions or disjunct relict populations. This diverse

combination of methods will provide unique insight into the population dynamics, biogeography, and gene flow of this rare plant species.

## 4. A METHOD TO OBTAIN A BIOTIC INTEGRITY INDEX USING DIFFERENT SENSITIVITY LEVELS OF BIRD TO FOREST FRAGMENTATION IN SOUTHERN BRAZIL

*\*Luiz Dos Anjos, Universidade Estadual de Londrina; \*Gabriel Beleia McCrate, Glen Helen OEC; \*Joao Vitor Campos e Silva, Universidade Estadual de Londrina; \*Gabriela Menezes Bochio, Universidade Estadual de Londrina; \*Fernando Palomino, Universidade Estadual de Londrina*

A Biotic Integrity Index is presented using levels of sensitivity of birds to forest fragmentation as field information. The levels of sensitivity to forest fragmentation of birds were previously published based in field data gotten in the Londrina city region, southern Brazil. Three levels of sensitivity were considered: high, medium, and low. In the present study, 30 bird species were selected, 10 in each level, and the presence/absence of them were verified in forest fragments in the Londrina region. Based on occurrence data of those selected species, was gotten the Biotic Integrity Index in each fragment multiplying the recorded species number with high sensitivity by three, the recorded species number with medium sensitivity by two, and the recorded species number with low sensitivity by one, and dividing the sum of these three values by 60. The values of the Biotic Integrity Index were in concordance with size and isolation of the forest fragments: smaller and isolated fragments had lower values while the larger and no isolated had the higher values. The largest forest fragment in the region, which is a Reserve, presented the highest value of the Biotic Integrity Index. This study suggests that this Index, when analyzed comparatively between fragments, may be useful in conservation decisions in fragmented landscapes. KEY WORDS. Biotic Integrity Index, Atlantic forest, forest fragmented landscapes, conservation.

## 5. A FLORA OF THE NORTH CHICKAMAUGA CREEK GORGE STATE NATURAL AREA

*\*Stacy Huskins, University of Tennessee at Chattanooga*

The North Chickamauga Creek Gorge State Natural Area (NCCG) consists of 7,073 acres and is located in Hamilton and Sequatchie counties in eastern Tennessee. The NCCG is on the eastern edge of the Cumberland Plateau and is bordered by the Ridge and Valley physiographic province. Broadly defined habitat types support a diverse assemblage of plants on the NCCG's upper plateau surface, gorge slopes, stream banks, and ruderal areas. Fifty collecting trips were made during the 2006 and 2007 growing seasons and 526 species of vascular plants in 108 families were documented. Seven species with either a state or federal listing were documented: *Spiraea virginiana*, *Nestronia umbellula*, *Sabatia capitata*, *Diervilla sessilifolia* var. *rivularis*, *Panax quinquefolius*, *Viola tripartita* and *Glyceria acutifolia*., and several populations of *Scutellaria montana*. Over fifty species of non-native species have also been documented, including *Microstegium vimineum*, *Lespedeza bicolor*, and *Albizia julibrissin*.

## 6. IDENTIFYING TEMPORAL CORRIDORS FOR CONSERVATION PLANNING IN THE CONTEXT OF CLIMATE CHANGE.

*\*Nancy-Anne Rose, University of Northern BC;*

*\*Phil Burton, Canadian Forest Service*

A changing climate means that protected areas may no longer be able to sustain the biological features they are expected to protect through time. To address this issue, we identified and mapped several temporal corridors using bioclimatic envelope models based on the current range of selected targets, an interpolation tool that facilitates mapping of current and future climates, and GIS software. A temporal corridor represents a portion of a particular target e.g., an ecological zone, the range of a focal species that could persist over time, which if set aside for conservation may succeed in providing long-term protection from climate-driven changes. A series of GIS layers representing a target's bioclimatic envelope for four timeslices were intersected with the resulting overlap representing a target's temporal corridor. For example, the areal extent of the Interior Douglas-Fir zone increases with 0.03% of its envelope remaining in BC's Central Interior. Ideal bioclimatic conditions for the lichen *Nephroma occultum* are predicted to increase by 17% and the temporal corridor suitable for its persistence approximates its current distribution. Temporal corridors represent potential sites that could be set aside for conservation with the expectation that bioclimatic conditions will remain suitable for a particular target. As such, the concept and application of temporal corridors could be an important component of future protected area planning and biodiversity conservation.

## 7. THE FROGS OF OCEANIC ISLANDS AND IMPLICATIONS FOR FOREST CONSERVATION IN SOLOMON ISLANDS

*\*Patrick Pikacha, Conservation International*

The Solomon archipelago has a very high level of frog diversity than previously known. There are 27 known species, and many more specimens still to be identified. Because of extreme elevational gradients on these oceanic islands (for instance on Kolombangara within a few kilometers, the elevation goes from sea - level to more than a 1600m), there different habitats occupied by various species within close proximity to each other. It also appears that levels of endemism especially of montane species may be far greater than expected. Our results also show that some species occupy very specific habitats, and require particular forest types including undisturbed lowland forests, or cooler montane forests for instance. Unfortunately much of the lowland rainforests of these islands have been destroyed by unsustainable industrial logging. Except for some ridge forests, and the montane forests there has been much pressure put on important habitats. We recommend that aggressive surveying and systematic work be done on the frogs of these oceanic islands. Also that conservation and protection of tropical rainforests now requires urgent attention.

## 8. PRESENT AND PREDICTED DISTRIBUTION AREA OF HERMANN TORTOISE (*TESTUDO HERMANNI*) FROM ROMANIA: IMPLICATIONS FOR CONSERVATION

*\*Laurentiu Rozyłowicz, University of Bucharest, Centre for Environmental Research and Impact Studies; \*Maria Patroescu, University of Bucharest*

The Hermann's Tortoise (*Testudo hermanni boettgeri* Mojsisovics, 1889) population is declining due to the habitats degradation, killings caused by the local people, cropping for pet animals. To better understand the future status of Hermann's Tortoise in the context of climate change, we examined how climate and habitat affect the present and future distribution of this ectothermic specie. Hermann's Tortoise

occupies a narrow area in SW Romania, in surfaces with average annual temperatures of 10,5°C and grassland and shrub submediterranean habitats. The current area was estimated with the bioclimatic envelope using 256 presence localities and Worldclim 1.4 climatic database (1950-2000). The future bioclimatic envelope for the present area was estimated using Intergovernmental Panel on Climate Change (IPCC) data. The specie's bioclimatic envelope was correlated with land use prognosis, therefore although the species will have in the future 100 years favorable climatic conditions on a larger area, habitats fragmentation will determine the reduction of the current area by almost 75%.

## 9. NURTURING BIOPHILIA AND COMMUNICATING CONSERVATION ETHOS

*\*Pramod Padmanabhan Nair, Salim Ali Centre for Ornithology & Natural History, Coimbatore, India*

The paper narrates a story of conservation education from India aimed to nurture biophilia through the programmes that explore, learn and care the nature. In this world of IT revolution, the factors like skill to recognize, sensitivity to feel, intellect to analyze, intelligence to choose, will power to decide and courage to act are more important than passing the information. The process designed for students had many steps as 1) Introduction to biodiversity of neighborhood through nature walks 2) Skill development to identify and study the life of surrounding organisms 3) Student research projects on local conservation issues 4) Involvement in field research with scientists as citizen scientists. 5) Involvement in the conservation action activities with NGOs as providers of first hand information and action force. 6) Involvement in analysis and interpretation of results. 7) Presenting the results, discussing and debating in a common platform. Though nothing new in the activities sequenced above, the motivating presence of selected strategies to nurture the passionate and emotional relationship with living nature made all the difference in conservation education of hundreds of young students. Though the emotional dilution of scientific rigor is not acceptable at any cost, a light passion underpinning with strong curiosity driven learning-teaching movement could make all the difference in the life of these students. Experience and the data proves.

## 10. A CONTESTED ICON OF 'HANDS-ON' RESEARCH: IMAGES FROM THE HISTORY OF WILDLIFE TELEMTRY

*\*Etienne S. Benson, MIT*

Since its invention around 1960, wildlife telemetry has become increasingly important for keeping track of wild animals in the field. It has also served as a lightning rod for public opposition to 'hands-on' research and management. Here I present historical images of wildlife telemetry drawn from research in archives and specialized publications and discuss their role in shaping public opinion about the practices of conservation biologists. I focus on images from well-known controversies over the radio-tagging of grizzlies in Yellowstone in the 1960s and California condors in the early 1980s, as well as lesser-known conflicts regarding the radio-tagging of tigers in Nepal and bowhead whales in the Arctic in the 1970s. These images reflect broad shifts in public attitudes regarding intensive monitoring of wildlife populations. Such attitudes, I argue, have gone through three broad phases: first, a celebratory phase in the 1960s, when biologists claimed the technique would help to depoliticize conservation; second, a conflictual phase beginning in the 1970s, when environmental and animal-rights activists challenged biologists' authority; and finally, a conciliatory phase since the late 1980s, when the technique has been seen as useful for both political activism and scientific

research.

#### 11. UNWRAPPING THE FLAGSHIP CONCEPT: A CASE STUDY ON TROPICAL ISLANDS

*\*Diogo Gaspar Verissimo, Durrell Institute of Conservation and Ecology; \*Iain Fraser, Durrell Institute of Conservation and Ecology; \*Jim Groombridge, Lecturer; \*Douglas MacMillan, Durrell Institute of Conservation and Ecology*

The flagship species concept is an important conservation marketing tool often used to raise funds and awareness. Its use in conservation campaigns has been widely discussed but flagships are also used by the tourism industry to attract foreign visitors interested in wildlife and natural areas. These tourism ventures can play a major role in funding conservation activities, so there is a need to understand the factors that determine what makes an effective flagship in this context. This is especially important for tropical islands which depend on tourism but contain many endemic and threatened species that lack the characteristics of traditional flagships. We describe an innovative study that investigated which bird species characteristics were most important to foreign tourists in Seychelles. We used choice experiments to estimate visitor willingness to pay for conservation and found that conservation attributes had most influence on respondents' choices. Endemism was one of the most important attributes which is encouraging for the marketing of biodiversity in tropical islands, as these are rich in endemic species. In addition, we found that attributes conventionally perceived as key characteristics of flagships, such as large body size or visibility, were not as important as might have been assumed. This suggests that the flagship concept is more flexible than first thought and could be extended, to a wider range of species and locations.

#### 12. NATURE, CULTURE AND LOCAL HISTORY: THE ENVIRONMENTAL EDUCATION PROGRAM OF THE MANED-WOLF CONSERVATION PROJECT IN THE SERRA DA CANASTRA, BRAZIL

*\*Marcelo Ximenes Aguiar Bizerril, Universidade de Brasília; \*Carla Cruz Soares, Instituto Pró-carnívoros; \*Jean Pierre Santos, Instituto Pró-carnívoros; \*Fabiana Lopes Rocha, Instituto Pró-carnívoros; \*Flávio Henrique Guimarães Rodrigues, Universidade Federal de Minas Gerais; \*Rogério Cunha de Paula, CENAP - Instituto Chico Mendes*

This work reports the first year of the environmental education program in the surrounding communities of the Serra da Canastra National Park, one of the main sanctuaries for the maned-wolf conservation in Brazil. Our objective was to begin a process of engaging the community in the discussion about local environmental questions. We carried out two main actions: the organization of a book about the region, and the implementation of an itinerant movie theater, locally known as "Cine Lobo". During 5 months, a group of 30 members of the community - such as teachers, students, farmers, tourism entrepreneurs, public employees - worked in the writing of a book about cultural, historical, environmental and economic aspects of the Serra da Canastra region. The "Cine Lobo" consisted in the exhibition of three 15 minutes films about our project, local environment and strategies to minimize conflicts between farmers and the maned wolves. These short movies were presented at schools, farms and small villages and were followed by commercial circuit movies of the community's

interest, and later by a discussion of the themes involved. Authors' participation and opinions about the book demonstrated that its writing is a powerful tool for community engagement. Likewise, the community participation and the crescent demand for exhibitions of the "Cine Lobo" indicates that the usage of cinematographic language is effective in stimulating the community interest in conservation themes.

#### 13. TO HOWL OR NOT TO HOWL... THAT IS THE QUESTION: DEVELOPING EFFECTIVE OUTREACH MATERIAL CONTENT TO INFLUENCE ATTITUDES TOWARDS PREDATORS

*\*Megan M Draheim, George Mason University; \*Larry L Rockwood, George Mason University; \*Chris Parsons, George Mason University; \*Gregory Guagnano, George Mason University*

Wildlife professionals often have only a few moments to grab the attention of their target audiences in outreach campaigns. Many contacts are made only with brief glances at posters, flyers, or brochures. Although the best way to effect change in attitudes towards wildlife species is through in-depth educational programs, this is not viable in many circumstances. Therefore, wildlife professionals should understand how best to make use of limited time and space. A survey was conducted that supplied "sound-bite" length pieces of information about coyotes in various categories (coyote behavior and ecology, human-coyote interactions, and images of coyotes) and looked at the effect this information had on attitudes. Amongst other findings, statements about coyote behavior, especially those that emphasized the social aspects of their lives, proved to be most effective in increasing positive attitudes, causing significant changes in five out of six measurements ( $p < 0.01$ ). Statements about attempts to eradicate coyotes were viewed negatively, and a traditional image associated with coyotes (a coyote howling) was viewed negatively, whereas images of coyote social interactions were viewed positively. Although coyotes are not a species of conservation concern, they can be used as a proxy for other predatory species that are endangered or threatened. This information will be useful to wildlife managers, environmental educators and others interested in designing outreach materials.

#### 14. DEVELOPMENT AS A THREAT TO BIODIVERSITY: WHAT ROLE DO CONSERVATION ORGANIZATIONS PLAY?

*\*Renee Mae Lorica, Wildlife Researcher; \*Apolinario Bernardo Cariño, Wildlife Researcher; \*Tammy L. Mildenstein, Wildli*

Boracay Island in Malay, Aklan is a prime tourist destination in the Philippines. During the last few years, it has been subjected to unregulated development, resulting to water source and quality crisis, and waste management problems. These developments were also detrimental to the existence of the flying foxes roosting in the area. The construction of road systems along their roost will eventually extirpate the bats in their natural habitat. Thus, concerned individuals, conservation organizations and groups initiated a campaign towards the conservation of the bats' roosting sites and their habitat on the Island. This paper discusses the processes on how the initiatives were done to counter the ongoing development in the area. Apart from the proposed management plan formulated by the group, a bat learning center will be established to provide awareness on the importance of bats both for the local and international audience.

## 15. A SURVEY OF DUIKERS(CEPHALOPHUS) IN BIA CONSERVATION AREA (BCA) IN GHANA.

*\*Darlington Saykay Tuagben, African Section*

Duiker is a type of antelope that belongs to the order Cetartiodactyla, family Bovidae, subfamily Cephalophinae, and genus Cephalophus. Duikers live exclusively in forests and scrublands of Africa. In the BCA which is one of the protected areas in Ghana, duikers are vulnerable to poaching which may drive them to extinction if appropriate management is not put in place. This research was conducted to ascertain the species, distribution and abundance of duikers in the BCA and also to advise the authority on the best management strategy for the area. This will enable the authority to put in place appropriate measures to ensure that poaching is curbed and this once abundant species is conserved. To achieve the objectives, a two day reconnaissance survey was conducted which enabled the stratification of the study area into high and low density areas based on the preliminary average encounter rate of 6.00 animal signs per km during the reconnaissance survey. An Optimum Sample Size (OSS) of 50km was calculated using the Line Transect method of one km each. From the data collected, it was observed that five species of duiker are distributed in the study area with the Maxwell's duiker being the most abundant of all. A UNEP/WCMC survey in 1993 reported only 3 species of duikers. The results of this research will enable management to put in place best management practices in the BCA by providing alternative livelihoods for stakeholders to reduce poaching.

## 16. PARK-COMMUNITY RELATIONS MATTER: COMPARATIVE ANALYSIS OF TWO ADJACENT PROTECTED AREAS IN THE ECUADORIAN AMAZON

*\*Diana Carolina Alvira, School of Natural Resources and Environment, University of Florida;*  
*\*Karen A. Kainer, School of Forest Resources and Conservation and the Center for Latin American Studies (Tropical Conservation and Development Program), University of Florida*

Between Ecuador's Cayambe-Coca Ecological Reserve (RECA) and Sumaco-Napo Galeras National Park (PNS) are forest patches, riparian forests and living fences interspersed among pastures for dairy production and some crops. Comparative differences in park support and management approaches were related to different outcomes in farm forests and conservation-related activities. The lower RECA region, funded mainly by the Ecuadorian Environmental Ministry, has had multiple boundary conflicts. Park managers are well-trained technically, but do not have the necessary equipment nor training to manage external park relations. They have developed few activities with neighboring communities and local government. In contrast, PNS is part of the Sumaco biosphere reserve with clearly defined use zones. Park managers are well-equipped and well-trained, and have established community outreach programs (i.e., mushroom production, bamboo handicrafts, school project) such that even park boundaries are maintained by a local youth group. The reserve is managed by a broad coalition (i.e., Environmental Ministry, local governments, international and local NGOs, research and education institutions, private industry) with diverse funding. Correlating, forest persistence and quality was better on farms at the PNS influence zone versus RECA-related farms. This comparative case suggests that protected area integrity is enhanced when emphasizing livelihood goals and community relations.

## 17. IMPLICATIONS OF POLICY AND PRACTICE ON CONSERVATION IN A HUMAN DOMINATED LANDSCAPE IN THE WESTERN GHATS, INDIA.

*\*Archana Bali, University of Alaska Fairbanks;*  
*\*Kartik Shanker, Centre for Ecological Sciences, Indian Institute of Science, Bangalore, India.*

Conservation in human dominated landscapes is often facilitated through either the top-down State conservation policies or bottom-up community participation. We conducted a study in coffee plantations in the Western Ghats, India to evaluate (i) the effectiveness of existing conservation policies, namely the Wildlife Protection Act and Preservation of Trees Act and (ii) local practices and conservation awareness. Data was collected from local planters and labourers through interviews, group discussions and non-participatory observations. Most respondents revealed that hunting of wild animals is a traditional practice in the region and is still widespread; and felling, logging and shade lopping of native trees occurred in the estates. The laws to protect wildlife and native trees were not effective due to lacunae in implementation and a lack of awareness regarding the two legislations. The State authorities cited lack of resources, especially for landscapes outside protected areas, as a reason for this. More non-native timber species are planted due to constraints in felling native trees. Thus, a law intended to protect native species has actually led to its decline. We conclude that the existence of conservation laws is relatively meaningless, especially in human dominated landscapes, unless there is commitment towards enforcement. Alternately, since most respondents agreed to comply with laws if direct incentives were provided, bottom-up approaches may be a better strategy.

## 18. CONSERVING RATTAN AND WRIGHTIA TINCTORIA:BY UTILISING THE INVASIVE WEED LANTANA CAMARA AS A SUBSTITUTE

*\*Ramesh Kannan, Mr.;* *\*Gladwin Joseph, Dr.;*  
*\*Uma Shaanker.R, Dr.*

In the Western Ghats of India, south and north of Palghat in Kerala, and in northern and southern Karnataka, are found a wide variety of rattan. There are a total of 21 species of which about 14 are economically useful and harvested extensively for making furniture and other products. However, over the past two decades the harvest of rattan has declined drastically, primarily due to resource scarcity. Wrightia tinctoria is another threatened plant species, known for its pungent fresh leaves and seeds, both of which are known to have medicinal value. Its close-grained wood looks like ivory and is used for carving and wood-turning toys. Domestic and booming export market for these toys has led to resource depletion of W. tinctoria. Loss of rattan and W. tinctoria resources due to indiscriminate harvesting is also likely to sound the death knell for many rural artisan communities whose entire livelihood depends on the availability of these raw materials. Against this backdrop, it has become essential to identify alternatives to ease the pressure on and conserve rattans and W. tinctoria. Soligas the tribal artisans of South India are ingeniously utilising the invasive weed Lantana camara, as a substitute for rattan and W. tinctoria, and converting it into value added products such as furniture, toys and articles of household utility. Currently, nearly 50 replicas of cane furniture and 25 designs of toys produced by these artisans from lantana, are in great demand in the market.

## 19. COMMUNITY-BASED TOURISM: A PATHWAY TO SUSTAINABILITY IN NIGERIA'S

## PROTECTED AREAS

*\*Bola Olusola Adeleke, Redeemer's University,  
Department of Transport and Tourism Studies*

The recent diversification of domestic tourism needs in Nigeria, seen particularly in increasing demand for ecotourism shows that there is much potential for further development of nature tourism much of which takes place in protected areas. However numerous challenges exist. Three National Parks with highest tourist inflow were selected from the three major ecological zones of the country. Structured questionnaires were administered to 80 tourists selected by random sampling and to 13 leaders of Community-Based Organisations (CBOs) selected by purposive sampling technique from each park. Results identified four success factors common to the three parks as organised institutional arrangements, self regulation related to conservation, high environmental awareness and the existence of partnerships. Results also demonstrated how community based tourism can be facilitated by building upon these success factors and how this would address the existing challenges to tourism and conservation in protected areas. It can therefore be concluded that adequate management of these success factors would significantly contribute to the sustainability of protected areas. Park managements are therefore advised to take advantage of this in solving most of the challenges facing protected areas in the area of conservation and tourism.

## 20. HOW DOES THE METACOMMUNITY CONCEPT APPLY TO SYSTEMS WITH LINEAR DISPERSAL NETWORKS? A TEST WITH STREAM SYSTEMS

*\*Bryan L. Brown, Clemson University; \*Chris Swan,  
University of Maryland, Baltimore Co.*

The metacommunity concept incorporates space and dispersal into community ecology and is potentially a powerful framework for both basic and applied ecology. However, metacommunity theory does not explicitly consider linear, or simple-branching dispersal networks which are common in both natural and anthropogenically-modified systems. Stream systems are obvious representatives. We data from the Maryland Biological Stream Survey to address two questions related to stream metacommunities: 1) Do the constraints of linear-type dispersal networks affect metacommunity composition? and 2) Are network effects similar among different stream fauna (macroinvertebrates vs. fish)? Our analysis of the MBSS data revealed that 1) The linear-type dispersal network of streams constrains community composition through dispersal limitation. However, effects were most prominent in high-order (3rd) streams. In headwater streams, our analysis indicated environmental filtering was the chief determinant of community structure. 2) Surprisingly, effects were similar for both fish and macroinvertebrates, though the signal was stronger for fish, most likely because many macroinvertebrate taxa have the capacity for dispersal outside of stream networks. The metacommunity concept is a potentially powerful framework but our results clearly demonstrate the need to consider the specific configuration of a metacommunity in order to fully apply metacommunity theory to linearized systems.

## 21. THE EFFECTIVENESS OF THE PARTICIPATORY FOREST MANAGEMENT AND COMMUNITY BASED ORGANIZATIONS IN CONSERVATION OF THE INDIGENOUS FORESTS IN CENTRAL KENYA

*\*David kimani kuria, Kijabe Environment*

## Volunteers

In the recent past, the concept of community conservation has been gaining popularity in Africa. In Kenya for instant concept been embraced as Participatory Forest Management (PFM) within the forest sector and is allowing for co-management of natural resources with local communities. This approach just like many other conservation approaches has some strengths and limitations that could hasten or slow the attainment of conservation objectives of the resource at hand. This paper looks at how PFM is being implemented at Kereita Forest on the southern part of the much famed Aberdares forest. It specifically looks at the involvement and contribution of multi-stakeholders particularly the local communities, the achievements made so far and the challenges encountered. The paper further looks at the importance and contribution of the local community groups in the achievement of conservation objectives at this important biodiversity site. It concludes by highlighting the factors that are favoring PFM and tries to area for improvement.

## 22. MOHÉLI MARINE PARK, COMOROS SUCCESSES AND CHALLENGES OF THE CO-MANAGEMENT APPROACH

*\*Melissa Hauzer, C3-Comores; \*Chris Poonian,  
Community Centred Conservation (C3); \*Cheikh  
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Mohéli Marine Park was initially regarded as a model for comanagement of marine resources, but is now operating at a vastly reduced capacity following an end to external funding sources. An assessment of current perceptions of local stakeholders was recognized as an essential first step to rebuild the Park's capacity and effectiveness. This study aimed to ascertain stakeholders' current perceptions of the Park, using focus group interviews to evaluate six key parameters. It was apparent that local communities were aware of the importance of PMM, but felt that it had failed to include their needs or consider their input in its management. Concern was expressed for the lack of sustainability or alternative livelihoods; inequitable distribution of benefits; exclusion of women; continuing environmental threats and a concurrent lack of enforcement of regulations. The key recommendations to arise from this work were: 1 ensure sustainability through effective financial planning and promotion of low-cost, appropriate management techniques; 2 mobilize local communities to create a truly comanaged PMM; 3 ensure tangible benefits to local communities through realistic alternative livelihood options, particularly for fishers; 4 ensure equitable sharing of benefits and awareness of PMM, 5 involve women in the management of PMM as the primary local educators and motivators for future generations; 6 inform law enforcement officials to ensure respect and enforcement of PMM regulations.

## 23. PROTECTING 70.000 HECTARES IN COMMUNITARIAN LANDS THROUGH INCENTIVES IN ECUADORIAN DRY FOREST

*\*Jaime Ernesto Camacho, Fundacion Natura/The  
Nature Conservancy; \*Augusto Pinzon, Fundacion  
Natura*

Dry forest are top conservation priority for Ecuador due to its biological diversity, their endemism and ecological services. To conserve up to 70.000 hectares of dry and garua forest in communitarian land we develop an incentives scheme to integrate communities in conservation. A local NGO and the communities with the participation of the national authorities sign a conservation agreement. The communities agree to establish an area as permanent forest in which clearings are

forbidden and other uses are regulated. They also establish communitarian rules to manage natural resources (wood, non timber products). In exchange, the NGO pays the community an incentive which is used by the communities to contract local parkguards and make control of the resource use in their territories. If there are surplus, they use them to cover some communitarian needs. So far, the incentives have been working: logging is regulated and reduced and communities are more aware of forest importance and are willing to continue conservation of their resources. There's a need to increase incentives and to improve communities capacities to control and manage natural resource. It's also important to involve other stakeholders like local governments in the process.

#### 24. CONSERVATION OF A FRUGIVORE IN A TROPICAL RAINFOREST ECOSYSTEM AND ITS HABITAT

*\*Sindhu Kaimal, Arkansas State University; \*Bindu Kaimal, Arkansas State University; \*Mathangi Gopalan, Arkansas State University; \*Richard Grippio, Arkansas State University*

The Great Indian Hornbill (*Buceros bicornis*), a large frugivorous rainforest bird is among the endangered faunal groups in the Vazhachal Reserve forests, South India. We used Participatory Rural Appraisal (PRA) to explore and evaluate the relationships between natives of the region and the hornbill population decline which was then incorporated into a Risk Assessment Model. The anthropogenic stressors affecting hornbill populations were identified as logging of primary forests and hunting. Stella 8.1 Modeling used to quantitatively predict effects of these stressors on the hornbill populations suggests that the populations could drastically decline within ten years. The Vazhachal region is one of the strongholds for the Great Indian hornbill and other sympatric species that co-exist there. Paradoxically, the region also suffers threats of a hydro-electric project and habitat modifications due to plantations. However, we conclude that none of the probable causes discussed in this study can fully explain the decline in the Great Indian Hornbill at Vazhachal Reserve Forests, confirming the need for comprehensive demographic monitoring throughout its range to target effective conservation action. We also recommend that a study of the minimum viable population would further provide a focus for the interpretation of ecological and genetic factors that influence the persistence of a threatened population.

#### 25. ARE SHADOW COFFEE PLANTATIONS CRITICAL FOR MAMMAL CONSERVATION ?

*\*SONIA ANTONIETA GALLINA DE GONZALEZ, INSTITUTO DE ECOLOGIA, A.C.; \*ALBERTO GONZALEZ-ROMERO, INSTITUTO DE ECOLOGIA, A.C.*

Shadow coffee agrosystems is the main economic activity in the central portion of the State of Veracruz, Mexico. Veracruz is the second most important region for coffee production in the country. (42.25% during 2000-2001). Coffee plantations replaced the cloud forest that occupied 28% of the state. During 2002-2006 we sampled 8 different coffee plantations, four times each, with a total of 400 night/traps and 240 night/camera traps. We registered mammals using Tomahawk traps, Stealth-cam camera traps, tracks, local people information. Twenty four species (3 marsupials, 2 edentata, 1 lagomorph, 6 rodents and 12 carnivores), 75% of the 32 mammals previously reported for the cloud forest. The alpha diversity varied from 8 to 21 species. The common species were: common opossum (*Didelphis marsupialis*), nine banded armadillo (*Dasypos novemcinctus*), eastern cottontail (*Sylvilagus floridanus*) and

gray fox (*Urocyon cinereoargenteus*). The rare species were: northern tamandua (*Tamandua mexicana*), greater grison (*Galictis vittata*) and the jaguarondi (*Puma yagouaroundi*). The ecological diversity varied from 1.37 to 1.89, and the guilds varied from 5 to 11. Coffee plantations are agrosystems in risk because their transformation to sugar cane crops and urban expansion, so this is a critical fact for mammal conservation in the region. Key words: coffee plantations, mammal conservation, Veracruz, Mexico.

#### 26. PEOPLE FOCUSED CONSERVATION OF HIMALAYAN CLIFF BEE APIS LABORIOSA IN THE HIMALAYAS

*\*Farooq Ahmad, International Centre for Integrated Mountain Development, Kathmandu, Nepal; \*Surendra Raj Joshi, ICIMOD; \*Min Bahadur Gurung, ICIMOD*

The Himalayan cliff bee, *Apis laboriosa*, thrives in the Himalayas and provides a vital and efficient link between people's livelihoods through honey hunting, essential gene flow services through pollination, and active participation in the complex of biodiversity. To conserve and maintain the vibrancy of bee populations The International centre for integrated mountain development commissioned a community-based conservation and development programme for bees in their nesting habitats. The Program is multi-faceted and includes institutional and individual capacity building, strengthening the age-old honey hunting tradition through bee watch tourism, gender mainstreaming etc. with the help of communities to stabilize bee populations. A baseline of cliff sites and nest numbers was prepared and regularly updated from year 2000 to date, to see the impacts of project -induced change and practices on the dynamics of bee populations. The paper helps us understand the importance of the human dimension in reversing declining populations of this important pollinator. The process has helped conserve bee diversity besides opening pathways to improved livelihoods for surrounding communities.

#### 27. BIODIVERSITY CONSERVATION AND COLLABORATIVE MANAGEMENT IN JAMAICA'S BLUE AND JOHN CROW MOUNTAINS NATIONAL PARK

*\*Jesse Worker, School of Natural Resources and Environment--University of Michigan; \*Danielle Gartner, School of Natural Resources--University of Michigan; \*Jesse Lewis, School of Natural Resources--University of Michigan; \*Elizabeth Nellums, School of Natural Resources--University of Michigan; \*Anna Ruzaj, School of Natural Resources--University of Michigan*

This interdisciplinary project examines community participation in conservation management, looking at the impact of land use practices on biodiversity in Jamaica's Blue and John Crow Mountains National Park. One of the threats to the park is the spread of invasive species, which is facilitated in part by land clearance for agriculture. To assess the connection between collaborative management and attitudes and behaviors that affect land use decisions, we conducted surveys and interviews in local communities, with government agencies, and with non-government organizations. We also gathered data on birds, insects, and invasive plant species found in areas of varying disturbance, to quantify the impact of disturbance relative to levels of community participation. Our results indicate that moderately disturbed forests in the buffer

agricultural matrix contain levels of species diversity comparable to natural forests, and that expressed attitudes across the communities are generally favorable towards conservation. However, land-use behaviors are constrained by poverty and lack of available land, and community participation has largely been limited to consultative roles. To protect biodiversity we suggest that park management focus greater attention on the agroecological matrix as a reserve for biodiversity, through prioritizing certain areas for conservation, and strengthening local institutions across a broader cross-section of each community.

## 28. NON-INVASIVE GENETIC SAMPLING OF A SMALL POPULATION OF ASIAN ELEPHANTS IN A FRAGMENTED LANDSCAPE IN NEPAL

*\*Narendra Man Babu Pradhan, Department of National Park and Wildlife Conservatio, Nepal*

The elephant population of Bardia National Park, Nepal was functionally extinct in the early 1990s, but was rescued by a considerable number of immigrants from India within a short period of time. We carried out non-invasive genetic sampling in order to assess population size, herd structure and kinship. A capture-mark-recapture estimate suggested that there were approximately 50 individuals in the 280 km<sup>2</sup> study area of the park. Notably, our sample represented more males than females, 18 versus 13. However, the sex ratio was male-biased only among sub-adult individuals where we found 10 males compared to only 2 females. This observation strongly suggests the presence of sub-adult male immigrants in the population, which was also supported by negative relatedness values between the adult females and many of the sub-adult males. Our data indicated somewhat reduced genetic diversity, which probably can be explained by a founder effect in 1994 and the presence of many related individuals among the founders. However, since immigration of sub-adult males seems to be quite common, there are good prospects for enhancement of genetic diversity. Further immigration is promoted by the corridors connecting Bardia National Park to other wildlife reserves and national parks in Nepal and across the Indian border. Indeed, for long-term conservation of the Asian elephant in Nepal, it is imperative to conserve these natural corridors of suitable elephant habitat.

## 29. THE EFFECTS OF HABITAT FRAGMENTATION AND LANDSCAPE FEATURES ON NEW ENGLAND COTTONTAIL (SYLVILAGUS TRANSITIONALIS) POPULATION GENETIC STRUCTURE

*\*Lindsey Erin Fenderson, University of New Hampshire; \*Adrienne Kovach, University of New Hampshire; \*John Litvaitis, University of New Hampshire; \*Marian Litvaitis, University of New Hampshire*

The New England cottontail (*Sylvilagus transitionalis*, NEC) has experienced severe population decline and range contraction in recent decades due to habitat loss resulting from land use change. It is has long been a species of regional conservation concern and is currently awaiting federal listing under the Endangered Species Act. Persistence of NEC populations will be critically dependent upon connectivity among remaining, suitable habitat patches. To this end, we initiated a study to investigate the genetic structure of remnant populations of NEC and used recently developed landscape genetic methods to evaluate population connectivity. Microsatellite genotyping was completed on 195 individuals sampled across the entire range of the NEC via live-trapping or

noninvasive collection of fecal pellets. Population genetic analyses were performed using both traditional, population-based approaches (F-statistics) and individual-based approaches that were conducted without defining subpopulation boundaries a priori. There was significant population differentiation overall, suggesting limited gene flow among geographically separated populations. Heterozygote deficits were found at multiple loci for the subpopulations, suggesting that loss of genetic diversity may be a concern. Landscape genetic methods were also used to identify dispersal corridors and to establish where habitat restoration and NEC reintroductions would be ideal for improving gene flow and assisting species recovery.

## 30. GENETIC EVIDENCE OF HYBRIDIZATION BETWEEN THE RARE BULRUSH SCIRPUS LONGII AND ITS COMMON RELATIVE SCIRPUS CYPERINUS

*\*Ron MacKay, Department of Biology, Mount Saint Vincent University; \*Sarah Reid, Department of Biology, Dalhousie University; \*Robert William, Department of Biology, Mount Saint Vincent University; \*Nicholas M. Hill, unknown*

We investigated the vulnerability of *Scirpus longii* (Long's bulrush, Cyperaceae) populations in southwestern Nova Scotia to loss by genetic invasion. This member of the Atlantic Coastal Plain Flora is found nowhere else in Canada and is of special concern (Species at Risk Act, 2006) and globally imperilled (Nature Conservancy, 2006). We suspect that populations may be vulnerable to genetic invasion, as *S. longii* flowers only when disturbed (as by fire, herbivory, or human traffic) and annually-flowering *Scirpus* species are usually nearby. Thirty-five RAPD (Random Amplified Polymorphic DNA) marker loci were identified in 101 *Scirpus* individuals obtained from the wetlands of the lower Medway River. These show that three sites are low-diversity populations of *S. longii*, six sites are *Scirpus cyperinus* or closely related to *S. cyperinus*, and one site is a mixture of *S. longii* and the products of hybridization between the two species. A rich variety of ratios of *S. longii* specific to *S. cyperinus*-specific markers are found among the individuals of the latter site, suggesting introgression. We conclude that gene flow between *S. longii* and *S. cyperinus* has occurred, hybrid plants are capable of sexual reproduction, and Long's bulrush in Nova Scotia is vulnerable to genetic invasion.

## 31. CONSERVATION GENETICS OF THREE COASTAL BEETLES IN A BIODIVERSITY HOTSPOT

*\*Stylianos Chatzimanolis, University of Tennessee at Chattanooga; \*Michael S Caterino, Santa Barbara Museum of Natural History*

This paper examines the population genetics of three coastal beetles in the highly impacted dune systems of central and south California. We address the following questions a) what is the population structure of these beetles, b) what are the historical and recent connection of the coastal habitats in California, and c) what can we predict about the restorability of coastal communities based on our data. To answer these questions we analyze mitochondrial COI sequences of a darkling beetle (*Coelus ciliatus*), a histerid beetle (*Hypocaccus lucidulus*) and a water scavenger beetle (*Cercyon fimbriatus*) using Bayesian phylogenetic analysis as well as several population genetic approaches, including coalescent population expansion, AMOVA, isolation by distance and Fst. The results indicated that the phylogeographic signal among these three

species was not concordant and indicated population expansion and ample gene flow for *Cercyon* but not for the other two species. Most of these results can be explained based on the differences in the biology of these beetles and we conclude that flight ability and microhabitat of these species has a major influence in their ability to disperse among dune patches. Loss of coastal habitats will produce an irreversible loss of genetic diversity for two of the three species examined.

### 32. PLANT CONSERVATION BIOTECHNOLOGY - PROGRESS FOR ROMANIAN FLORA

*\*Anca Paunescu, Institute of Biology*

The loss of plant genetic resources has made necessary the development of new ex situ conservation methods. Advances in biotechnology provide new techniques for plant germplasm conservation and evaluation. Biotechnological tools such as in vitro culture, cryopreservation and molecular biology offer a valuable alternative to plant diversity studies, genetic resource management and conservation. This review summarizes the advances in plant conservation biotechnology with special emphasis on conservation efforts of Romanian flora. Strategies and the plant species used for establishment and maintenance of germplasm collections are reviewed.

### 33. GENETIC DIFFERENTIATION OF MARBLED SALAMANDERS WITHIN AN ISOLATED WOODLOT

*\*Joe Bartoszek, Wright State University*

The fragmentation of habitat reduces gene flow between isolated populations. Isolated populations risk extinction through reduced genetic diversity, increased inbreeding and genetic drift, and decreased reproduction and survival, referred to as the extinction vortex. Ambystomatid salamanders are known to have natal fidelity to their breeding pool. Using microsatellites, I compared gene flow between two populations of marbled salamanders (*Ambystoma opacum*) on either side of a railroad track (West and East) and two breeding populations in different years on one side of the railroad tracks (West 2005 and West 2006) within an isolated woodlot. Observed heterozygosities were significantly lower ( $P < 0.05$ ) than expected heterozygosities. Testing allelic distribution, the combined P value scores for West and East populations were significant ( $P < 0.05$ ) but the combined P value scores for the West 2005 and West 2006 populations were not significant ( $P = 0.85$ ) indicating the allelic distribution is different between the West and East populations, but not between the two years in the West population. The amount of difference seen between the West and East sides of the railroad track, relative to the difference between the two years on the West side indicates either a strong fidelity to the natal pool in these populations and/or the railroad track acting as a barrier to the two populations.

### 34. POPULATION ESTIMATION OF BENGAL TIGER PANTHERA TIGRIS TIGRIS BY NONINVASIVE GENETIC SAMPLING

*\*Jyotsna Bhagavatula, Centre for Cellular and  
Molecular Biology*

The Bengal tiger *Panthera tigris tigris* is an endangered species. Population estimates of endangered animals are a pre-requisite for conservation planning and for evaluating the conservation practices already in place. However, due to the tiger's cryptic behaviour indirect methods based on signs and natural markings have been used for estimating populations in the wild. The main objective of our study was to develop a non-invasive sampling based genetic method, with tiger faecal

samples as a source of DNA, for population estimation of tigers in the wild. We developed and validated mitochondrial cytochrome b based PCR primers for reliably identifying tiger faecal samples from those of sympatric carnivores. Microsatellite markers were developed with a Probability of Identity of  $< 0.01$  for distinguishing individual tigers. Abundance and density estimates of tigers were obtained by a closed population mark-recapture analysis of genotypes of DNA isolated from faecal samples collected from Tadoba-Andhari Tiger Reserve, a protected area in south-central India. The results of our study show that noninvasive genetic sampling can be used for population estimation of tigers in protected areas in India.

### 35. GLOBAL FACTORS DRIVING EMERGING INFECTIOUS DISEASES: IMPACT ON WILDLIFE POPULATIONS

*\*Alonso Aguirre, Wildlife Trust*

The extinction of species across the globe is accelerating, directly or indirectly due to human activities. Biological impoverishment, habitat fragmentation, climate change, increasing toxification, and the rapid global movement of people and other living organisms have worked synergistically to diminish ecosystem function. This has resulted in unprecedented levels of disease emergence which poses a threat to the survival and health of biodiversity. What is often overlooked in discussion of the health consequences to humans is that critically endangered wildlife species are at grave risk of extinction by disease outbreaks. Furthermore, the continuous degradation of ecosystems is leading to increased stress, immunosuppression and greater susceptibility to disease. Disease can be catastrophic to a diminished, stressed population becoming in some instances the leading factor of local, regional and global extinctions. The strategies of the new field of conservation medicine include long-term monitoring, health assessment, and interventions to protect species at risk. We particularly must minimize the threat of any potentially catastrophic disease outbreaks resulting from anthropogenic changes to the environment. Current and future diagnostic molecular techniques offer new opportunities to identify tools for the management and possible treatment of diseases in imperiled species.

### 36. ISOLATION OF AEROMONAS CAVIAE ON THE SKIN OF FREE-RANGING AMPHIBIANS IN THE NORTHERN ANDES OF PERU

*\*Mirella Villena, Laboratory of Bacteriology,  
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Bacterial infections are one of the first causes of morbidity and mortality in captive and wild amphibians. These bacteria are a part of the normal flora of these species, and only cause disease when there is a breakdown in the natural defense mechanisms. Among bacterial diseases, the most overdiagnosed and misdiagnosed disease is red leg syndrome. The most frequently implicated etiological agent is *Aeromonas hydrophila*, however, many other gram-negative bacteria can be involved, like *Acinetobacter*, *Proteus*, etc. Therefore it is necessary to know to what extent these bacterial agents are in susceptible species like the amphibians. The aim of this study is determining the presence of *Aeromonas* spp. in free-ranging

amphibians in the northern Andes of Peru. Skin swabs from amphibians of the mountain forest at the Área de Conservación Privada Huiquilla, Amazonas-Peru (06°23'22"S, 77°29'54"W, 2800 m.a.s.l.), were taken. The samples were collected from amphibian of the genus *Pristimantis* and *Gastrotheca*. The microbiological analysis was carried on in the Laboratory of Microbiology, F.V.M., San Marcos University, Lima-Peru. Established protocols for *Aeromonas* isolation were used. We found *Aeromonas caviae* in the 16.7% of the samples. The results of this preliminary work suggest the potential endangered of infection in these species with *Aeromonas*. For holding the environmental equilibrium and the amphibian's health, it's essential to propose conservation alternatives in the area.

### 37. GLOBAL WARMING & BIODIVERSITY: EVALUATING AN INCONVENIENT TRUTH

*\*Jessica M Nolan, University of Arkansas; \*Jeremy Youmans, University of Arkansas*

Global climate change is a major threat to biodiversity worldwide. One way to motivate changes in behavior is via mass media outlets such as documentary films. Since May 24, 2006, millions of people have seen Al Gore's movie "An Inconvenient Truth" (AIT). Several countries have even proposed to show the film in school classrooms as part of their science curriculum. The purpose of the present set of studies was to evaluate the extent to which AIT accomplishes its apparent goals of convincing, educating, and motivating viewers to reduce greenhouse gas emissions. Two studies were conducted, one with a sample of community moviegoers, and one with a sample of students. Participants were randomly assigned to complete a survey either before or after watching AIT. The survey was designed to measure attitudes, beliefs, and behavioral intentions related to global warming. The results of both studies showed that watching "An Inconvenient Truth" does increase concern and motivation to reduce greenhouse gases. However, the results of Study 2 suggest that the willingness to take action does not necessarily translate into action one month later. Recommendations are made for how the movie should be used to create behavioral change.

### 38. HOW SHOULD WE RANK SPECIES AS CONSERVATION PRIORITIES?

*\*Emily Margaret Meuser, Simon Fraser University; \*Howard W. Harshaw, University of British Columbia; \*Arne Mooers, Simon Fraser University*

Current species conservation prioritizing considers only threat of extinction, but other species attributes may also be important in determining species' rankings as conservation priorities. We calculated evolutionary distinctiveness (ED) values for Canadian mammals, and compared ranking by this metric to current threat ranking. Also, we conducted a survey of British Columbians, and asked them to rank four species attributes: distinctiveness, economic importance, decline and global responsibility, in terms of conservation importance. In conjunction, we scored respondents' beliefs about the nature of human-environment interactions using the New Ecological Paradigm (NEP) scale. We then mapped these NEP responses onto respondents' rankings of species attributes. Rankings of conservation priority change markedly when species attributes other than threat of extinction are taken into account.

### 39. AN ANALYSIS OF THREE PROGRAMS INVOLVED IN CAROLINA BAY WETLAND CONSERVATION

*\*Joseph Robert Burger, Department of Biology, The University of Louisiana at Monroe; \*Jeffrey J.*

*Pompe, Department of Economics, Francis Marion University; \*Travis W. Knowles, Department of Biology, Francis Marion University*

Substantial evidence supports the inextricable link between biodiversity and ecosystem function, yet environmental policies continue to focus on either preserving ecosystem services or protecting biodiversity. We analyze three programs that either restore or preserve Carolina bay wetlands. These ecosystems are biologically rich, featuring many rare, threatened and endangered species, and provide breeding sites for many animals including amphibians. Carolina bays also provide valuable wetland ecosystem services. Unfortunately, greater than 90% of the original Carolina bays have been severely altered. Recent efforts have attempted to identify remaining intact Carolina bays for preservation, and restoring degraded ones. We summarize the efforts of the South Carolina Heritage Trust Program in identifying, acquiring, and preserving intact Carolina bays. We also investigate the effectiveness of the Wetlands Reserve Program (WRP) and Wetland Mitigation Banking (WMB) in restoring these ecosystems on private land. We document differences in the incentive mechanisms between these two programs. We identify the ecological and economic objectives of the WRP and WMB, and summarize their prospects for restoring biodiversity and ecosystem services provided by Carolina bays. We conclude that restoration and preservation policies should be designed to maintain biodiversity, which will enhance wetland ecosystem services.

### 40. DOMINANT WOODY VEGETATION NEAR HUMAN DISTURBED LANDSCAPES ON MT. MAKILING, LUZON ISLAND, PHILIPPINES

*\*Inocencio Escoton Buot Jr., Institute of Biological Sciences, University of the Philippines Los Banos*

Forty plots were set up near disturbed landscapes on Mt. Makiling, Philippines to know the woody species composition. A total of 89 species in 72 genera and 42 families were recorded. The agricultural farm and the residential had the lowest number of woody species (17-19). The forest edge had 25 species. The buffer zone and undisturbed forest had the highest number (45). Cluster analysis showed two distinct groups, the vulnerable and the more stable landscapes. At a lower dissimilarity level, the five land uses are distinct. Basal area values indicate *Brassaia actinophylla*, *Cocos nucifera*, *Ficus* spp., *Gmelina arborea*, *Spathodea campanulata* and *Sweitenia macrophylla*, as dominant in vulnerable landscapes. *Alangium longiflorum*, *Chisocheton cumingianus*, *Litsea garciae*, *Luderkia bernardoi* and *Pisonia umbellifera* dominate the more stable landscapes while *Arenga pinnata*, *Celtis luzonica* and *Diplodiscus paniculatus* are the most dominant in both the vulnerable and the more stable landscapes.

### 41. MYCORRHIZAL BIODIVERSITY IN NORTHERN MOUNTAINOUS REGIONS OF PAKISTAN-YESTERDAY, TODAY AND TOMORROW

*\*Ghazala - Nasim, University of the Punjab*  
Mycorrhizal fungi are an important component of the rhizosphere of a vast majority of plants. The fungi form mutually beneficial relationship with the roots of these plants. These associations are often obligatory but can be facultative. Four different stands in the Northern areas of Pakistan were sampled and analysed using simple ecological methods. The stands sampled were situated in Nalter and Astore, Gilgit. The stands included undisturbed natural vegetation stands and disturbed stands. The disturbed stands were characterized by excessive cutting and felling of trees and overgrazing leading to entirely changed picture of the plant communities and

associated mycoflora. For mycological studies the roots of plants of the above mentioned stands along with the rhizosphere soil were sampled and processed. It was recorded that the types of ectomycorrhizal fungi varied as the forest stands matured. The fungi almost trend to disappear when the forest trees are cut. The number of root tips with ectomycorrhizae decreased when the stands were disturbed. So was the case with vesicular arbuscular mycorrhiza forming endogonaceous spores number. The weight of water stable aggregates also reduced in the soils of disturbed stands. These disastrous situations then end up with removal of rest of the forest vegetation and excessive erosion or removal of top fertile soil. This can be avoided with proper management of these fungi.

#### 42. TECHNIQUES FOR RECLAIMING MINED LANDS WITH NATIVE PLANTS

*\*Maria Melnychuk, The Nature Conservancy*

Annually, in the United States alone, hundreds of thousands of hectares of land are disturbed by extracting minerals. Although nonnative plants are commonly used for reclaiming mined lands, using native plant species would be more beneficial to the environment. In this experiment I examined the role of mycorrhizae, seeding rate, and fertilizer in promoting growth of native plants at a reclaimed mine site in central Arkansas. Permanent field plots were established to examine effects of treatments on native plant cover, nonnative plant cover, and bare ground. By the final year of data collection, 18 native species had been newly established at the experimental site. Compared to plots without mycorrhizae, plots with mycorrhizae had significantly higher native plant cover in the first sampling year only. The addition of native seed was important—plots without added seed had significantly lower native plant cover in the second and third sampling years. Overall, mean native plant cover increased significantly over the three years of the study, with a 500% increase from year one to year three. This experiment demonstrates that native plants can be established on areas previously reclaimed with aggressive, nonnative species.

#### 43. GRASSLAND RECONSTRUCTION AND MANAGEMENT TO INCREASE LANDSCAPE BIODIVERSITY

*\*Szabolcs Lengyel, University of Debrecen, Hungary; \*Eszter Déri, University of Debrecen, Hungary; \*Balázs Deák, Hortobágy National Park Directorate, Hungary; \*Roland Horváth, University of Debrecen, Hungary; \*Tibor Magura, Hortobágy National Park Directorate, Hungary; \*Béla Tóthmérész, University of Debrecen, Hungary*

Current models of future changes in land use in Europe predict that large portions of agricultural land will be abandoned due to global change and crop yield development. Here we study the effect of grassland restoration on former arable lands on landscape-level biodiversity. Our model system is the 5000-ha Egyek-Pusztakócs marsh and grassland complex in Hortobágy National Park (E-Hungary), where c. 500 ha arable land has been converted to grasslands in 2005-2007. In a repeated measures design, we study the changes occurring in plants/vegetation, major invertebrate taxa and birds. In year 1, the species richness of weeds and generalist animals increased greatly. Two different seed mixtures resulted in different plant assemblages but similar animal assemblages, and both differed in composition by whether restoration started from alpha or wheat fields. As early as year 2, the cover of native plants exceeded that of weeds, and the richness of animal species characteristic to the target loess steppes and alkali grasslands

approached those of generalists. Our results suggest that the reconstruction of grasslands on former arable lands, followed by controlled semi-natural succession can indeed lead to increases in landscape-scale diversity of habitats and species and can be a viable option for conservation action.

#### 44. ECOLOGICAL CHARACTERIZATION OF SWAMPY FOREST OF ZINVIÉ FOR SUSTAINABLE CONSERVATION OF BIODIVERSITY (BENIN-WEST-AFRICA)

*\*KOUDERIN Kotcholé Martial, CREDI-Ngo*

Ecological characterization of the swampy forest of Zinvié in Benin was achieved following its floristic and fauna survey. Vegetation data were collected according to the method of Braun Blanquet. An ethnobotanical and ethnozoological survey helped to assess, relations and interactions between populations and existing biological resources. The analysis of water physico-chemical parameters revealed temperatures varying between 24\* and 25\*C. This low value because of the cover of vegetation that throw back the most part of the sun energy. The matrix (208 species X 29 releves) submitted to the factorial analysis of correspondence helped to distinguish 3 plants communities. The value of Sorensen index (Is = 86.67%) between the community 2 and 3 is indicative of a similarity for these two communities. The Shannon diversity index calculated for the tree population of the community 1 gave an average value (HS = 3,6 bits) that expresses medium conditions for the species. The ethnobotanical and ethnozoological survey revealed a various range varied of non timber forest products and animal resources exploited by the riparian populations. The presence of *Tragelaphus speckii* and otter registered on the red list of the IUCN are to be valued for a sustainable conservation of biodiversity in that area.

#### 45. FIRST-YEAR GROWTH AND SURVIVAL OF RIPARIAN TREE-PLANTING TRIALS TO RESTORE AVIAN HABITAT IN THE COLORADO RIVER DELTA.

*\*Stephen Handler, University of Montana/ Sonoran Institute*

Despite its reduced condition, the Colorado River Delta remains a vital conservation area for avian species. To restore riparian forest habitat in the Delta, we tested the effects of various treatments on the first-year growth and survival of irrigated mesquite seedlings and rooted cuttings of cottonwood and willow. Mean first-year growth of seedlings planted from 2.8-L pots was comparable between fall-planted honey mesquite (*Prosopis glandulosa*) and spring-planted honey mesquite (182 cm to 171 cm). Fall-planted screwbean mesquite (*P. pubescens*) grew less than spring-planted screwbean mesquite (114 cm to 172 cm), likely due to a widespread lepidopteron larval infection. Individuals planted in the spring from 2.8-L pots and 12-cm plugs had similar first-year growth for both species (171 cm to 167 cm for honey mesquite, 172 cm to 179 cm for screwbean mesquite). Rooted cuttings of cottonwood (*Populus fremontii*) grew taller on average than cuttings of willow (*Salix goodingii*) in the first growing season (126 cm to 100 cm), and both species had greater growth when planted from 2.8-L pots than 12-cm plugs (144 cm to 114 cm for cottonwood, 116 cm to 92 cm for willow). Survival was high throughout this first season for all species and treatments. These results expand upon conclusions of similar restoration projects undertaken in the United States, and demonstrate that areas within the Colorado River riparian corridor in Mexico are suitable for habitat improvement.

#### 46. MEASURING WILDLIFE ACTIVITY ON

## OPEN AND REMOVED FOREST ROADS IN IDAHO USING REMOTE CAMERAS

*\*T. Adam Switalski, Wildlands CPR*

Thousands of miles of forest roads are being removed across the U.S. northern Rockies to help restore threatened wildlife, yet little is known about the effectiveness of this restoration practice. Forest roads allow access deep into forestlands increasing poaching, fragmentation, and negative edge effects. The Clearwater National Forest (ID) has removed more than 600 miles of forest roads in an effort to restore fish and wildlife habitat. Using remote cameras, we captured more than 500 photos of animals on open and removed roads over the course of two summers. Raw data suggests that black bear (*Ursus americanus*) and moose (*Alces alces*) selected for removed roads over open roads. They also appeared to be spatial and temporal partitioning by bear and moose in response to hunting pressure. While occasionally detected on open roads during the field season, they were never found on open roads during the hunting seasons. Additionally, bears and moose were rarely detected on open roads during daytime hours. Similarly, we never detected coyote (*Canis latrans*), mountain lion (*Felis concolor*), and bobcats (*Lynx rufus*) on open roads during the daytime. Traveling on open roads only in the cover of darkness and staying on removed roads during the hunting seasons may decrease wildlife vulnerability to human exploitation. Our study supports growing evidence that restoration through road removal is beneficial to wildlife.

## 47. LIFE-HISTORY TRAITS, PHENOTYPIC PLASTICITY AND THE SUCCESS OF PLANT REINTRODUCTION: A NEW APPROACH

*\*Florence NOEL, University of Bern; \*Daniel MOSER, University of Bern; \*Markus Fischer, University of Bern*

Species decline, and ultimately extinction, are natural phenomena (Levin, 2000), but they have sped up dramatically during the last centuries due to human activities. In Switzerland, 23% of the plant species are threatened with extinction (Moser et al. 2002). Therefore, major objectives of conservation biologists and evolutionary ecologists are to determine the causes and consequences of rarity (Gaston and Kunin, 1997) and to maintain and protect rare species. For this purpose, reintroduction programs could be efficient management options. However, in the past such programs showed a highly variable success and it is still unclear how the outcome of reintroduction can be predicted. Therefore, we are studying the relationship of the population growth of 28 reintroduced populations (initiated 10 years ago) of 24 rare aquatic species in Switzerland with environmental variables and with species characteristics including phenotypic plasticity and life-history traits. Our results will help setting priorities and establishing better protocols for reintroduction and will add to the knowledge on causes of rarity.

## 48. STUDY OF LOCAL MANAGEMENT OF CONTINENTAL FISHERIES RESOURCES IN THE SOUTHERN BENIN

*\*ZOSSOU Enangnon Eversun, FSA*

The southern Benin is rich in freshwater (lakes, lagoons, rivers) which are very important for the local communities because of interests they derive from fishing. But the vitality and even the survival of this vital sector of economy is threatened by the drastic reduction of fisheries resources. It's a continuous collapse of these resources and a dwindling of fishermen incomes. That situation leads to a problem of access to common resources which are scarce in a context of competition between communities with divergent rules and interests. This

situation leads to a question: how the local communities who live mainly on those resources have reacted in their management? This research project aims to study the various safeguards both traditional and modern which are established for resources conservation and the behaviour of the local population with these measures. More specifically, it will involve (i) identify and analyse within the local community socio-economic factors that lead to the degradation of fisheries resources, (ii) identify and analyse the various strategies and conservation measures both traditional and modern implemented for the sustainable management of fisheries resources, and (iii) analyse the behaviours of local communities with various conservation measures.

## 49. SPECIFIC-SPECIES TABOOS AND BIODIVERSITY CONSERVATION IN NORTHERN MADAGASCAR

*\*Kate Mannle, Oxford University; \*Elise Tora, University of Antsirana; \*Hoby Tahosy Radaniarison, University of Antsirana*

Recent literature suggests that existing informal institutions such as resource and habitat taboos should be taken into account by conservationists. A survey of villages in the Bobaomy and Montagne des Français areas of Northern Madagascar (n=220) showed that residents have many species-specific fady or taboos which include a number of IUCN Redlisted species. Respondents reported that the origin of these species-specific fady is primarily based on the fear of supernatural retribution from tsiny, an animal spirit that can cause harm or death to the transgressor. In addition, results indicate that people who hold strong beliefs in tsiny are less likely to hunt than individuals who do not believe strongly in tsiny. The nature of species-specific fady in this region however is somewhat flexible and individualistic indicating that while fady should not be relied on solely for biodiversity conservation, beliefs such as specific-species fady are often compatible with the wider aims of the global conservation movement and could have an important role in communicating and engaging with local stakeholders. A closer examination of specific-species fady and exploration of their origins may help Western conservationists working in the area to better understand local peoples perceptions and interactions with their environment.

## 50. UPHILL BATTLE: ELEVATION IMPEDES INVASION AND MINIMIZES IMPACTS OF PROSOPIS JULIFLORA IN A PROTECTED AREA

*\*Lesley Geills Campbell, Rice University; \*Thomas A. Waite, Ohio State University; \*Sarah J. Corey, Ohio State University; \*Anil K Chhangani, The School of Desert Sciences; \*Paul F Robbins, University of Arizona*

The invasion of exotic plants into protected areas is a major concern, particularly where invasion could spread well into the core and cause pervasive ecological degradation. More optimistically, even an invasive species might extend only marginally beyond the boundary and do so with benign impacts. We explore the spatial extent and ecological impacts of an invasion by *Prosopis juliflora* into the Kumbhalgarh Wildlife Sanctuary (KWS) in Rajasthan, India. We detected *P. juliflora* in 37% of plots scattered throughout KWS, suggesting unchecked invasion. However, *P. juliflora* was mostly restricted to low-elevation sites near the border, where its presence was associated with reduced woody plant species richness, but this seemingly perverse effect dissipated rapidly with increasing elevation. At all but the lowest elevations, the presence of this species had no apparent effect on species

richness, and it remains unclear whether the effect was causal. Thus, *P. juliflora* and its apparent ecological impacts were largely restricted to a band of low-elevation habitat along the border. Within this band, human activities were associated with enhanced, not suppressed, species richness. Our findings add to the growing appreciation for the complexity of coupled human-nature systems and prompt reflection on the wisdom of control programs for invasive species in protected areas flanked by resource-dependent humans.

#### 51. DEFORESTATION, SOIL LOSS AND DISASTER RISK IN THE EL AMPARO MICRO-WATERSHED IN NUEVA SEGOVIA, NICARAGUA AS IMPACTED BY TRADITIONAL LAND MANAGEMENT

*\*Travis Keith Douce, Technische Universität München*

Land management practices contribute to environmental degradation and affect the frequency and intensity of natural disasters. GIS was integrated with the Universal Soil Loss Equation as a first-order method to identify how traditional land management practices and the southern pine beetle (SPB) (*Dendroctonus frontalis* Zimm) impact deforestation, soil loss, and disaster risk in a 187.6 ha micro-watershed located in a rural, poor and mountainous community in Nueva Segovia, Nicaragua. Because little geophysical data existed, soil types, land-uses and vegetation characteristics were recorded and mapped using a GPS unit. Other pertinent data sets were taken from data archives. A GIS simulation was created to determine a 15 year projection of the micro-watershed based on current land-use trends and projected southern pine beetle attack. Data from the current study and other national studies were inserted into a disaster risk model to determine future disaster trends for the community. Few soil conservation measures were utilized, and spatial analysis indicated that annual agriculture on steep slopes contributed significantly to soil loss. Agroforestry is replacing forests, and areas of new agroforestry contribute substantially to soil loss when located on steep and very steep slopes. Forests are highly resistant to soil loss, and 18% of pine forests are currently at risk to SPB attack. It is likely that environmental degradation and disaster risk increases in the future.

#### 52. HUMAN PRESSURES ON AMPHIBIAN BIODIVERSITY ARE CONCENTRATED IN REGIONS CRITICAL TO CONSERVATION

*\*Nirmal Kumar Bhagabati, Sustainable Development and Conservation Biology Program, University of Maryland, College Park; \*Will Turner, Conservation International; \*Thomas Brooks, Conservation International; \*Larry Gorenflo, Dept. of Landscape Architecture, Pennsylvania State University*

We investigated how global-scale spatial patterns of past and emerging human pressures (population, habitat conversion and land agricultural suitability) overlap with the distribution of amphibian biodiversity, and how this knowledge can help guide future conservation action. We overlaid an equal-area hexagon grid over the earth's land surface and evaluated irreplaceability (via C-Plan) of grid cells for amphibians in the context of human dimensions measures. 66% of highly irreplaceable (conservation-critical) sites are densely populated, compared to only 35% of the remaining sites. 85% of the most irreplaceable sites are not optimal for agriculture, and 90% have experienced low habitat conversion. Thus, the main emerging threat to these regions may be population pressure rather than commercial

agriculture. We cannot limit conservation to sparsely populated areas, since most of the irreplaceable sites are also densely populated. Emerging human impacts on amphibian biodiversity are notably concentrated in north-western South America, coastal North America, Central Africa, Madagascar, northern Australia and Borneo, making these (among others) priority regions for amphibian conservation.

#### 53. LOVING OUR PARKS TO DEATH: SUSTAINABLE DEVELOPMENT LESSONS FROM YELLOWSTONE

*\*Michael Martin Gunter, Jr., Rollins College*

This paper explores the political history of Yellowstone National Park, arguing Americans would better understand and adopt the much maligned concept of sustainable development by learning a handful of key lessons from the Yellowstone story. Most Americans do not even know what the term sustainable development really means, let alone embrace it openly. But national parks are a different story. According to noted environmental scholar and Pulitzer prize-winning author E.O. Wilson, more Americans actually visit national parks each year than attend all our major professional sporting events - combined. Tapping into this phenomenon, this paper critiques the dual mission of our national parks, highlighting how tensions between providing both recreation and preservation mimic sustainable development tensions between economic development and environmental protection. This work explores the question of how to limit visitation in national parks like Yellowstone and the role of the automobile in our parks before transitioning into discussion of our oil dependent economy and how that restricts sustainable development in United States. Emphasis is on energy conservation and consumption habits as well as transportation alternatives like rail.

#### 54. BUFFERING RISK: ASSESSING ANNUAL CATCH LIMIT SETTING UNDER THE MAGNUSON-STEVENSON FISHERY CONSERVATION AND MANAGEMENT REAUTHORIZATION ACT OF 2006

*\*Kathryn Alese Semmens, University of Delaware*

How much of a buffer is needed between a catch limit and target to ensure no overfishing? This question is key to setting Annual Catch Limits (ACLs) under the recently updated Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSRA). The MSRA's new provisions dictate that Regional Fishery Management Councils establish ACLs and accountability measures at levels that prevent overfishing in each fishery management plan. However, the relationship between ACLs, optimum yield, and overfishing limits has yet to be clearly delineated. Due to uncertainty in many aspects of stock assessments, including natural and fishing mortality rates, it is necessary to develop buffers that account for uncertainty and risk to prevent overfishing. For instance, in data poor fisheries the amount of buffer between the limit and target catch level should be increased to reduce the risk of overfishing. To simulate the potential application of an ACL policy, age structured bioeconomic models were constructed for the Gulf of Mexico Red Grouper and Red Snapper. The probability that management measures would not exceed critical levels was determined after accounting for uncertainty with a Monte Carlo simulation. Based on the potential use of ACLs in these specific fisheries, guidance applicable to all fishery regions regarding risk assessment and ACL setting is given.

#### 55. PRELIMINARY INVESTIGATION INTO THE INDIGENOUS KNOWLEDGE AND

## CONSERVATION STATUS OF IRVINGIA WOMBOLU IN MIDWESTERN NIGERIA

*\*Foluso May Ogbe, University of Benin;*

*\*OYOMOARE LOLADE ERUOGUN, UNIVERSITY OF BENIN; \*Betty Ofure Idialu, University of Benin*

*Irvingia wombolu* (bush mango; Irvingiaceae) is a perennial, medium sized, ever-green tropical African tree. It naturally occurs in dry-land forest but thrives in wet conditions. Its kernels are highly valued by local people, containing oil, protein, essential amino acids and vitamins. They are extensively utilized as a soup thickener in most West African countries. Seeds are harvested mainly from natural forests by children and women with planted trees accounting for less than 10% of total annual harvest. The kernels are widely traded domestically and internationally with potential for further market expansion. It however, faces the risk of genetic erosion through loss of natural habitat and intense pressure on seeds, the most successful means of propagation. As a basis for proposing a conservation plan and sustainable harvesting of *I. wombolu* seeds, we carried out a preliminary investigation into its indigenous knowledge, management and conservation status in Midwestern Nigeria using Egor Local Government Area as a case study. We performed field observations in selected markets and farms within five random locations and interviewed respondents and key informants, employing methods as free-listing and ranking. This pilot study documented the local uses, economic potential and threats to the conservation of *I. wombolu* in Midwestern Nigeria.

## 56. THE EFFECTS OF ROADS AND VEHICLES ON VERTEBRATES IN NATURAL LANDSCAPES, HUNGARY

*\*Janos Farkas, assistant professor*

The effects of roads have been turned out more and more obvious. In Europe, annually, more than 10 billion vertebrates are hit by vehicles. The roads imply especially serious danger for those animals, which live in small, isolated populations. Since these populations are more sensitive for disturbance, that can easily lead to their extinction. The hungarian roadnetwork is quite dense comparing to other countries worldwide, therefore its impact on the adjacent flora and fauna is larger than the average. During our research we compared areas, where there is a conflict between the roads or their traffic and the wildlife, especially mammals to those, where rate of the conflict was tried to be reduced with the aid of technical structures. The goal of our research was to estimate the scale of usage of the existing corridors by the studied species and to reveal those sites, where the construction of new corridors is required. Our results show, that the individuals of the studies species used the different types of corridors in most cases. However, the factors affecting the use of wildlife passages are different for the different vertebrates.

## 57. LANDSCAPE-SCALE INFLUENCE ON LARGE WOOD DEBRIS INPUT AND STREAM HABITATS IN THE CORUMBATAÍ RIVER BASIN, SOUTHEAST BRAZIL

*\*Silvio Frosini de Barros Ferraz, UNESP; \*Felipe Rossetti Paula, ESALQ; \*Pedro Gerhard, EMBRAPA*

Riparian zones are sources of important structural components for the lotic environment, including large woody debris (LDW). They act altering the morphology of the channel, increasing your complexity offering refuge for the aquatic organisms. Landscape fragmentation affects the dynamics of the ecosystems, besides riparian environments, bringing consequences for the lotic environments. We studied the

influence of the catchment's landscape in the supply of LDW and channel structure. Nine catchments of Corumbataí river basin in southeast of Brazil were selected and landscape variables included forest proportion (catchment and riparian zone), riparian forest biomass, forest fragments (number, size, edge, and channel distance), soils and channel order. Field measurements included LDW biomass, pools (number, proportion formed by the woody debris, spacing among them, width, depth, area, type), flood plain width, predominant substratum and steepness of the reach. Statistical analyses were accomplished seeking to identify correlation among variables and its influence on LDW input and channel structure. Stream habitat was found highly influenced by landscape since LDW is directly correlated to forest proportion and pools area is inversely correlated to forest edge. The absence of vegetation in the riparian environment is reducing LDW input and simplifying channel structure, reducing habitat of many aquatic species.

## 58. UNDERSTANDING LANDSCAPE-LEVEL INDICATORS OF LIFE HISTORY EXPRESSION IN PARTIALLY MIGRATORY ONCORHYNCHUS MYKISS

*\*Justin Mills, Department of Fisheries and Wildlife, Oregon State University; \*Jason Dunham, Forest and Rangeland Ecosystem Science Center, U.S. Geological Survey; \*Gordon H. Reeves, PNW Research Station, USDA Forest Service; \*Christian E. Zimmerman, Alaska Science Center, US Geological Survey*

Factors influencing expression of migratory behavior in partially migratory species include both environmental and genetic influences. Understanding these influences is important for maintaining species viability. In the Pacific Northwest, USA, many populations of anadromous (marine migrant) *Oncorhynchus mykiss*, or "steelhead," are protected under the Endangered Species Act (ESA), though protected individuals frequently co-occur with non-anadromous conspecifics, or "rainbow trout", that are not protected. There is little apparent reproductive isolation or genetic differentiation between the forms and in many cases they may interact and give rise to each other. In this study, we sought to understand patterns of anadromy in relation to mapped landscape characteristics across the John Day River basin, Oregon, USA. We used elemental ratios (Sr/Ca) in otoliths to identify juveniles (ages 0+, 1+) with anadromous mothers, indicating the presence of female steelhead, and compared their distribution to mapped landscape characteristics. We were able to assign maternal parentage to juveniles and quantified spatial diversity and distribution of anadromy. These indicators of variability in life history expression provide important clues about where and what to manage to influence expression of anadromy and recovery of threatened steelhead.

## 59. NUTRIENT CONCENTRATIONS OF RIVERS AND STREAMS IN FLORIDA AS A FUNCTION OF THE PROPORTION OF CONSERVATION LANDS IN THOSE WATERSHEDS

*\*Michael McManus, The Nature Conservancy; \*James Silvanima, Florida Department of Environmental Protection; \*Gail Sloane, Florida Department of Environmental Protection*

We are investigating the relationship between water quality of surface waters, particularly nutrient concentrations, in watersheds and the proportion of conservation lands in those

watersheds. We use annual medians of nutrient concentrations calculated from monthly samples taken at 66 fixed monitoring stations on large rivers and small streams in Florida from 2001 to 2006. The working hypothesis is that watersheds that have a high proportion of lands in conservation will have lower median nutrient concentrations because these conservation lands will act as "buffers" compared to watersheds that have a small proportion of conservation lands. Other independent variables to be included in our model comparisons are whether monitoring stations are in karst regions or not and whether the waterbody has the legislative designation of an "Outstanding Florida Waters" or not. Using dynamic visualization, we observed that ammonia and organic nitrogen concentrations at a monitoring station in a conservation area were at times greater than concentrations from stations in watersheds with little or no conservation areas. A static designation of lands as conservation areas may not capture the actual dynamics of land practices and how those practices affect nutrient concentrations of nearby surface waters.

#### 60. THE IMPACTS OF LOCAL AND LANDSCAPE DRIVERS ON POLLINATOR AND NATURAL ENEMY BIODIVERSITY AND DELIVERY OF RELATED ECOSYSTEM SERVICES TO CROPS IN KENYA.

*\*Mark Otieno, Centre for Agro-Environmental Research, the University of Reading*

Local communities of insects are influenced by both the local management used on the farm and also the context of the farm in the wider landscape. However, the relative contributions of these two drivers of community structure are generally not known. The present study investigates the impacts of both drivers in tandem, on biodiversity of pollinators and natural enemies and delivery of related ecosystem services to an economically important crop, pigeon pea. The study was conducted in a series of nine paired farms along a gradient of landscape context in Kibwezi, Kenya. Results indicate reduced pollinator abundance on farms where pesticides were applied. Pollinator visitation also significantly increased with fertilizer usage which may be due to an increase in flower attractiveness with greater crop growth with additional nutrient availability. Pollinator visits to flowers was significantly higher on farms closer to semi-natural habitats than ones more distant. This could be due to surrounding vegetation providing pollinators with nesting sites or alternative forage resources. Proximity of farms to semi-natural habitats and pesticide usage appear to be important drivers of pollinator abundance and diversity. More intense and focused studies on the responses of natural enemies are required before firm conclusions can be drawn.

#### 61. ROADS TAKE THEIR TOLL: THE IMPACT OF TRANSPORTATION NETWORKS ON MAMMALS IN NORTHERN NEW YORK STATE

*\*Margot Brooks, St. Lawrence University; \*Erika Barthelmess, St. Lawrence University*

Roadways in the United States stretch more than 13 million km. Road construction has destroyed more than 5 million hectares of wildlife habitat. Road construction and vehicular traffic impact wildlife indirectly by altering the chemical and physical environment in which animals live and directly through automobile collisions with wildlife. In this study we set out to assess the impact of vehicle collisions on mammal populations. We conducted road surveys to measure the level of vehicle-induced mortality and to determine whether there were non-randomly distributed areas with high road kill frequencies (mortality "hotspots"). Further, we experimentally tested whether the presence of road-killed animals on the road

attracts scavengers and thus results in higher road mortality rates. The minimum average vehicle-induced mortality rate was 10 mammals per week (actual value likely at least 3 times higher). About 50% of road kills were Rodents, 30% Carnivores, 13% Lagomorphs, 5% Artiodactyls and 2% other mammals. The presence of dead animals on roadways did not increase the mortality rate of scavengers. Unlike the case for some amphibians and reptiles, we detected no obvious hotspots of road mortality. Factors determining the locations and rates of road mortality are likely species specific, making generally applicable mitigation strategies difficult.

#### 62. HABITAT SELECTION BY BROWN BEARS IN DEOSAI NATIONAL PARK, PAKISTAN, AND IMPLICATIONS FOR PARK MANAGEMENT

*\*Muhammad Ali Nawaz, Norwegian University of Life Sciences; \*Jon E. Swenson, Norwegian University of Life Sciences*

We investigated habitat selection of brown bears and the impact of human disturbance factors in Deosai National Park, Pakistan. An Ecological Niche Factor Analysis indicated that bears avoided higher elevations and steeper slopes, and showed a higher preference for more productive parts of the park (marshy, grassy, and stony vegetation types). Only 65% area of the park was vegetatively productive, with a standing crop of about 900 kg dry matter/km<sup>2</sup>. The marshy vegetation was the most preferred habitat, probably due to its highest forage production and highest density of golden marmots. Brown bears tolerated human structures like roads and camps, but strongly avoided grazing areas with high livestock density. Until recently, the park seems to have sustained resource use by communities without significantly affecting the brown bear population or other park resources. However a large influx of livestock by nomad grazers in the last two years has become a major challenge, which needs urgent attention to continue the present brown bear population recover and to secure its habitat. We recommend monitoring of the livestock and a detailed inventory of the rangeland to understand grazing dynamics in the park and to maintain sustainable stocking rates.

#### 63. PREDICTING SUCCESSFUL STOPOVER: INDIVIDUAL BASED MODELS OF RED-EYED VIREOS (VIREO OLIVACEUS) IN A HETEROGENEOUS LANDSCAPE

*\*Emily B Cohen, The University of Southern Mississippi; \*Frank R Moore, The University of Southern Mississippi*

Migration may be the period when most songbird mortality occurs and most of the migration period is spent at stopover sites, making understanding the impact of environmental changes such as habitat loss or fragmentation along the migratory routes essential for conservation. We conducted a translocation experiment to test if migrants select habitat types, the energetic consequences of time spent in a habitat of a given quality and how energetic condition affects selection. During spring migration of 2007 fifteen red-eyed vireos were tracked in an unfamiliar landscape. All of the birds released in the low (pine) and intermediate (mixed pine and hardwood) quality habitat types left them and moved into higher quality habitat types. The birds released in the highest quality habitat (hardwood) all remained in that habitat type except one which moved into the intermediate quality. Birds released in pine displaced longer linear distances on the day of release ( $F_{2,14}=10.514, p=0.002$ , pine =  $863.5 \pm 288.7$  m,  $n=6$ ) than birds released in either mixed (=  $235.6 \pm 87.9$  m,  $n=5$ ,  $p=0.004$ ) or hardwood (=  $292.0 \pm 317.8$  m,  $n=4$ ,  $p=0.011$ ). We did not find any evidence for movement being related to the

energetic condition of the bird. The results of this experiment will be used to create a behavioral-based model of how habitat quality and landscape context affect the probability that a migrant refueling enroute will survive to continue migration.

#### 64. HUMPBACK WHALE (MEGAPTERA NOVAEANGLIAE) DATA FROM THE MARINE MAMMAL SANCTUARY OF SAMANA BAY, DOMINICAN REPUBLIC

\*Liliana Betancourt, Programa EcoMar, Inc.;  
\*Alejandro Herrera-Moreno, Programa EcoMar, Inc.

Data on distribution, habitat use, social groups and photo-identification of humpback whales were obtained from commercial whale-watching vessels during January to March in the years 2004 to 2006, in the Marine Mammal Sanctuary of Samaná Bay. During the three years of study there were 1,333 sightings totaling 3,044 whales sighted, during 667 trips. The data reveal distinct variation patterns in the bi-weekly spatial distribution during the three months of season. At the end of January and during March the sightings are dispersed and are located toward the mouth of the bay and the oceanic region, while in February they are concentrated more inside the bay. The comparison of almost two decades of data shows that humpback whales have continued visiting the Samaná Bay year after year. The areas and timing of aggregation have also remained the same. This highlights the bay's importance as a reproductive area in the Caribbean and Atlantic region. The dominant social groups were couples, mothers with calves, solitary whales and competitive groups. For mothers with calves, sightings were most frequently observed at inner and shallower positions, while other humpback whale groups were distributed throughout all depth ranges. These results demonstrate the importance of the opportunistic whale watching commercial platforms to obtain valuable permanent, descriptive and predictive information about the spatial-temporal distribution of humpback whales.

#### 65. HYBRIDIZATION AND ITS EVOLUTIONARY IMPLICATIONS FOR CONSERVATION

\*Pasan Harendra Samarasin-Dissanayake, University of Toronto; \*Mart Gross, University of Toronto

Conservation typically treats hybrid organisms as "biological mistakes", "unnatural", or "threats to parental species". Thus, no biodiversity policy in North America provides guidelines for dealing with hybrids. Yet, rates of hybridization have recently increased, coinciding with global environmental change, and hybrids in the past have become new plant and animal species. Here, we present evidence to suggest that hybrids should be included in biodiversity protection policies for at least three reasons. First, contrary to common belief, threats by hybrids to parental species is relatively minimal. Most known hybrids do not reduce adaptations in their parental species. Second, hybridization may be adaptive at an individual level in the face of short-term environmental change. Females can increase their fitness in some situations by mating with heterospecific males rather than producing pure offspring. Third, the Wrightian adaptive landscape is changing; some valleys are now peaks and vice versa. Hybridization is therefore an important evolutionary process which can result in new genotypic combinations that may better match the new landscape. In summary, hybrids may neither be mistakes, unnatural or threats, and instead may be biodiversity which has higher fitness and better adaptations than either parental species. For these reasons, hybrids should be recognized as potentially

valuable members of biological diversity and treated appropriately by conservation.

#### 66. DENSITY AND NATURAL HISTORY OF CHESTNUT BELLIED HUMMINGBIRD (AMAZILIA CASTANEIVENTRIS) IN COLOMBIA

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Density and natural history of Chestnut Bellied Hummingbird (*Amazilia castaneiventris*) in the Eastern Cordillera of Colombia. - Patterns of spatial distribution and population density of species depend on their intrinsic properties, interactions with other species, and availability and distribution of resources. Patterns of space use and population densities of hummingbirds, particularly montane species, are poorly documented. The *A. castaneiventris* is considered rare throughout is classified as Critically Endangered. Between July to November 2007 we conducted monthly surveys along three transects, and made ad libitum observations to estimate population densities and obtain information on spatial distribution, breeding period and diet of the Hummingbird. This study was carried out in a 100-ha forest in (Soata), Colombia. We estimated a total density of 2.1 ind/km<sup>2</sup>. We did not observe fluctuations in abundance or evidence of altitudinal migration. The available information suggests that the *A. castaneiventris* has low population densities and that its habitat is dramatically reduced. These characteristics make this species extinction prone. It remains to be tested if this species is rare at larger scales and throughout its distribution range.

#### 67. ESTIMATION OF PERSIAN LEOPARD (PANTHERA PARDUS SAXICOLOR) DENSITY USING CAMERA TRAPPING TECHNIQUE IN SARIGOL NATIONAL PARK, IRAN

\*Mohammad Sadegh Farhadinia, Iranian Cheetah Society (ICS); \*AliReza Mahdavi, Iranian Cheetah Society (ICS)

Abstract. Camera trapping in combination with closed population robust mark-recapture statistics has recently been introduced as an unbiased and practical method for estimating density of elusive large cats. Here we present the results of the first attempt to apply these methodologies to estimate density of endangered Persian leopard (*Panthera pardus saxicolor*) in Iran. In a high density area in Sarigol National Park in northeastern Iran, we tested this method by trapping very intensively within a 60 km<sup>2</sup> area to determine the true number of animals in that area during 2 winters. Results suggest a relatively high density of leopards, yielded an estimate of 5 independent animals, which translates to a density of 0.08 independent individual for every 1 km<sup>2</sup> (SE 0.02). Nevertheless, it is hypothesized that concentration of leopards from a wide range of mountainous areas inside the small national park during winters in search for ungulates migrated to lower elevations as well as to find mate in rutting season account mainly for high estimated density of the animal in Sarigol.

#### 68. HUMAN DIVERSITY IN THE NATURE

## CONSERVANCY AND ITS IMPLICATIONS FOR CONSERVATION: A FIRST LOOK

*\*Yumiko Lea Chattulani, Duke University Student*

Population demographics in the United States are rapidly changing and increasing workplace diversity will become crucial for the survival of many environmental organizations. Although The Nature Conservancy (TNC) is a global organization and employs many people in different countries, they are also interested in increasing ethnic diversity in their offices in the United States. The purpose of this study was to look at ethnic diversity in TNC offices in the United States, examine diversity challenges and successes at other environmental organizations, and provide suggestions for increasing the ethnic diversity within TNC. I did a literature review and interviewed TNC employees, employees at other environmental organizations, TNC high school and college interns, and environmental students. TNC employees recognized the lack of diversity as a challenge, but the overall relationship between minority and non-minority employees appeared to be positive. TNC interns stated that their internships would be successful in inspiring and engaging students of color in TNC activities. Many recommendations for increasing diversity at TNC were provided. These included participating in more community outreach activities, partnering with more diverse organizations, and helping people to realize the wide variety of careers available at TNC. The data will be used to inform TNC's fledgling diversity initiative in the United States.

## 69. CAST THE DEVIL OUT? - DEVIL FACIAL TUMOUR DISEASE AND THE PHILOSOPHICAL QUESTIONS SURROUNDING EFFORTS TO SAVE THE TASMANIAN DEVIL

*\*Denise (DJ) J Sproat, University of Central Lancashire*

Introduction: Tasmanian Devils suffer from a lethal and infectious cancer - Devil Facial Tumour Disease (DFTD) - currently no cure, treatment, pre-clinical diagnostics or prevention. Thus, our most ethical and humane action may now be to not interfere in extinction, perhaps even assist via euthanasia. Discussion: Devils have low genetic diversity, reduced variability in Major Histocompatibility Complex genes, lack of resistance to neoplastic infection, and may be a genetically doomed species. Due to expected effects of DFTD and management actions, a perceived obligation to save devils to prevent ecosystem impacts, or avoid introduced species incursion, is negated. DFTD does not have obvious human causes; it can be argued humans have no duty to save the species. Plus, actions to delay extinction may be considered immoral since may prolong and increase overall suffering. Evolution requires loss of unfit members even if humans prefer to keep them. If the devil is saved, the inherent genetic issues persist. The species is highly vulnerable to future environmental change including another transmittable cancer. Conclusion: Little value-based questioning has taken place. Focus has been disease management/extinction prevention. Since likely cannot save the devil as a species, we should now question and focus on what is best for the individuals - exercise compassion and humane action, consider their suffering and do what we can to end it. Distasteful as it is.

## 70. BUILDING SOCIAL CAPITAL TO RESTORE AND MONITOR LONGLEAF PINE BIODIVERSITY AT THE NORTHERN EXTENT OF THE BIG THICKET REGION OF SOUTHEAST TEXAS, USA

*\*William Forbes, Stephen F. Austin State University*

Fire suppression has pushed many North American forest landscapes towards a threshold of restorability, largely due to potential costs of burning or mechanical brush removal. Limits to monitoring biodiversity also relate to costs. Citizen involvement can partially offset such costs and provide social and political capital to spur action. The Natural Areas Preservation Association's 100-acre Catahoula Preserve, an in-holding surrounded by the fire-suppressed Upland Island Wilderness on three sides, may serve as a pilot site for citizen involvement in restoration and monitoring of longleaf pine forest at the northern extent of East Texas' Big Thicket region. Considerable official discussion has already occurred up to decades earlier regarding potential restoration of the surrounding encroached stands. This poster summarizes a survey and plan to renew interest in restoring and maintaining this forest. Reasons for delay include government planning costs, other agency priorities, wilderness "management" taboos, and relative lack of citizen concern. Potential for local social capital exists within school environmental education programs, Native Plant Society of Texas chapters, participatory ecotourism, and the All Taxa Biotic Inventory (ATBI) in the Big Thicket National Preserve, which includes an education component. Participatory GIS can help generate citizen interest.

## 71. GOVERNING BIODIVERSITY: PROCEDURAL AND DISTRIBUTIONAL JUSTICE IN SOCIAL DILEMMAS

*\*Cornelia Ohl, Department of Economics, UFZ - Helmholtz Centre for Environmental Research; \*Wolfgang Lexer, Department of Landuse & Genetically modified organisms, Umweltbundesamt GmbH; \*Therese Stickler, Department of Landuse & Genetically modified organisms, Umweltbundesamt GmbH; \*Geta Risnoveanu, Department of Systems Ecology and Sustainability, University of Bucharest; \*Nicoleta Geamana, Department of Systems Ecology and Sustainability, University of Bucharest; \*Martin Beckenkamp, Max-Planck-Institute for the Research on Collective Goods; \*Stefano Fiorini, Macaulay Land Use Research Institute; \*Anke Fischer, Macaulay Land Use Research Institute; \*Myriam DUMORTIER, Research Institute for Nature and Forest; \*Jim CASAER, Research Institute for Nature and Forest*

Conservation of biological diversity, a paradigm institutionalised through international agreements such as the Convention on Biological Diversity, or the Habitats Directive in Europe, has important implications for the management of all natural resources, as it requires a re-arrangement of management practices in a multi-faceted fashion. Despite the fact that protected areas may contribute to global well-being, they might thus impose disproportionately high costs at the local level. Due to the divergence of cost and benefits it is widely recognized that effective and fair management for biodiversity conservation requires inclusive cooperative approaches among different groups of people. To shed light on the role it plays for effective management we introduce the problem of biodiversity conservation as a complex social dilemma. We then explore the importance of procedural and distributional fairness for solving problems of social dilemma and apply our framework to two case studies: the first one considers biodiversity protection in the Alpine region Verwall, Austria, highlighting the importance of procedural fairness; the second case study considers the Small Island of Braila,

Romania, highlighting the relevance of distributional fairness. We conclude that consideration of both, distributional and procedural fairness is important for solving complex social dilemmas.

## 72. "SUSTAINABLE BUT JUST ON THE EDGE:" THE SUSTAINABILITY OF THE COMMERCIAL WHALE-WATCHING INDUSTRY IN THE LOWER BAY OF FUNDY, NEW BRUNSWICK, CANADA

*\*Eli Gyamaah Bamfo, Ryerson University; \*Michal Bardecki, Ryerson University*

Given the non-consumptive nature of wildlife viewing, whale watching is often regarded as a means of conserving natural cetacean populations, while providing local economic opportunities for coastal communities. The principal contention of this study is that a sustainable whale-watching system is governed by a multiplicity of ecological, economic and social factors which can be characterized as agents of strength (which reinforce sustainability) or agents of vulnerability (which inhibit sustainability or indicate a non-sustainable system). A framework is presented to ascertain the agents of strength and vulnerability within the commercial whale-watching industry in the lower Bay of Fundy, New Brunswick, Canada. The framework is used to assess the management, environmental and economic sustainability dimensions of the region's whale-watching industry. The study is based on personal interviews with tour operators and self-administered questionnaires from whale-watching customers. Several factors were found to be positively reinforcing the industry (e.g. the consistency of whale encounters, the diversity of tours offered by the operators, and the high level of customer satisfaction). Conversely, a number of variables were identified as potential areas of vulnerability, including: the present downturn in tourist visitation to the region, on-ground competition between the operators, and the need for a consolidated marketing program.

## 73. INVASIVE SPECIES THREATEN SUBSISTENCE IN A DRYLAND ENVIRONMENT

*\*Tammy Y Watkins, University of Georgia*

In northern Kenya, as in much of the world, pastoralists are seen as backward and have been marginalized by development and governments to increasingly dry and arid environments. Yet these same environments, the arid and semi-arid lands, are increasingly threatened by development. In Kenya, and other countries of East Africa, *Prosopis juliflora* is becoming more prevalent in landscapes. Originally introduced by development agencies for firewood, timber or even shade and windbreaks in the harsh environment, it is now a prevalent bush species in understories of riverine gallery forests and in bushlands throughout much of Kenya. This tropical species has adapted to the arid lands by becoming incredibly invasive. In Turkana District, Kenya, where the primary mode of subsistence is pastoralism, local perceptions of this threat are far different than the government's, judging by education and information provided to the populace. This paper examines these differences and makes suggestions for culturally acceptable means of controlling the spread of the species while also utilizing it in various ways.

## 74. REFUGIAL FOREST OF THE WESTERN LESSER CAUCASUS

*\*Levan Mumladze, CLP*

WESTERN LESSER CAUCASUS HAS  
EXTRAORDINARILY HIGH PROPORTION OF RELIC  
SPECIES. FORESTS HERE SURVIVED PLIOCENE AND

ICE AGE. MANY SPECIES DESCEND FROM TAXA  
EXTINCT ELSEWHERE. THE FORESTS ARE UNDER  
HEAVY PRESSURE. LOGGING IS NOT WELL  
REGULATED YET, MOREOVER, LITTLE ATTENTION IS  
PAID TO THE OLD-GROWN FORESTS IMPORTANT FOR  
BIODIVERSITY MAINTENANCE. THE PROJECT AIMS  
WERE: 1. TO MAP MOST IMPORTANT PLOTS, USING  
GIS ANALYSIS OF RELIC SPECIES HABITATS 2. TO  
ATTRACT PUBLIC AND GOVERNMENTAL ATTENTION  
TO THE REFUGIAL PLOTS. WE COLLECTED SEVERAL  
DISTRIBUTION POINTS OF A FEW RELIC AND  
ENDEMIC SPECIES AND THEN CREATED PATTERNS  
OF THEIR DISTRIBUTION AREAS. BASED ON THE  
PREDICTED RANGES OF SELECTED ENDEMIC  
SPECIES, THE PREDICTED AREAS OF THE HIGHEST  
CONCENTRATION OF ENDEMIC SPECIES COMPLEXES  
WERE OUTLINED. THE MULTIVARIATE ANALYSIS  
SHOWS IMPORTANCE OF INDIVIDUAL  
ENVIRONMENTAL CHARACTERISTICS FOR  
MAINTAINING THE RELIC SPECIES COMPLEX. THIS  
RESULTS ARE CONSIDERED BY THE LOCAL  
COMMUNITY AND GOVERNMENTAL INSTITUTIONS.

## 75. STAKEHOLDER VALUE ANALYSIS FOR RESTORING ECOSYSTEM SERVICES IN THE SKAGIT BASIN

*\*Daniel D. Lee, The Nature Conservancy*

The Skagit River is the largest contributor of fresh water to the Puget Sound and contains a myriad of socio-economic interests such as tourism, fishing and farming. To enhance The Nature Conservancy's conservation planning efforts and community outreach in the watershed, a stakeholder value analysis regarding ecosystem services was performed to identify commonalities and areas of potential conflict between stakeholder groups. Seven ecosystem services and 39 stakeholder interests groups were categorized by scale: local, regional, global. This analysis used stakeholder mandates or mission statements, which were available for all organizations involved, to identify and rank interests ecosystem services. Ecosystem services directly mentioned in the statements ranked highest and were assigned a value of two; when ecosystem services were alluded to, the interest ranked lower and received a value of one. Results show flood protection, wildlife refugia and water purification as the services with the greatest total interest level. Insights gained from this study help The Nature Conservancy engage local communities in the conservation of the ecosystems that provide critical ecosystem services by identifying those ecosystem services that most explicitly linked to stakeholder values. They foster community ownership of conservation efforts and help to bring scientific findings into community management decisions.

## 76. ARTHROPOD DIVERSITY ON ERIOGONUM FASCICULATUM REMAINS STABLE ACROSS WEED CONTROL REGIMES IN GRASS-INVADDED CALIFORNIA COASTAL SAGE SCRUB

*\*Jutta C Burger, Irvine Ranch Conservancy;*

*\*Michael A Patten, University of Oklahoma;*

*\*Richard A Redak, University of California*

California coastal sage scrub (CSS) habitats can become invaded by non-native grasses after disturbance, such as wildfire. There is concern that invaded habitats become less favorable to wildlife, support lower biological diversity, and ultimately undergo type conversion to non-native grassland. We sampled arthropods from the shrub *Eriogonum fasciculatum* in grass-invaded post-fire successional CSS

habitat for three years in 1 ha replicate invasive grass treatment plots to compare treatment effects on diversity. Plots experienced either: 1) short-term grazing by sheep, 2) application of grass-specific herbicide, 3) application of herbicide with thatch removal, or 4) no treatment. Arthropods were sampled directly from eight shrubs within each plot using a modified vacuum blower. Shrub dimensions and vegetation surrounding each shrub were also recorded. Abundance and richness did not differ across treatments, though they did across years. A subset of the arthropod groups were, however, significantly affected by the vegetation immediately surrounding sampled shrubs. We conclude that arthropod diversity was resistant across different invasive grass control measures at a local scale, but also that grass control measures only marginally altered non-native grass cover. The association of surrounding vegetation with arthropod assemblages suggests a link between habitat quality and diversity that should be pursued further.

#### 77. WATER RELATIONS OF A WELWITSCHIA MIRABILIS COMMUNITY THREATENED BY MINING IN THE NAMIB-NAUKLUFT NATIONAL PARK, NAMIBIA

*\*Keir Soderberg, University of Virginia; \*Stephen Macko, University of Virginia; \*Joh Henschel, Gobabeb Training and Research Centre*

The southernmost *Welwitschia mirabilis* community in Namibia is presently under threat from a proposed copper mine in the Namib-Naukluft National Park. The new mine would require significant dewatering of the aquifer beneath the *W. mirabilis* community, which could disrupt the water balance of these plants. This study investigates the dependence of *W. mirabilis* on groundwater using stable isotopes of O and H in the plant water, groundwater and soil water along with C and N isotopes in the plants and soil, as well as a small scale survey of the groundwater levels. While some contend that *W. mirabilis* utilizes fog as its primary water source, a previous 14-year study of this community indicated that leaf growth was correlated with rainfall rather than fog. In the present study, water levels measured in nine exploration boreholes in and around the plant community indicate that the plants only occur where water is less than 37 m below the ground surface. In addition, initial  $\delta^{15}N$  results suggest that the plants are less water stressed than would be expected for the amount of rainfall in the area. Root cuttings of two *W. mirabilis* individuals were collected along with fog water and adjacent groundwater and soils. The O and H isotope compositions of the extracted plant and soil water allow for the source waters to be suggested through correlations with the isotope compositions of the adjacent groundwater and fog water.

#### 78. ICE STORM IMPACTS ON THE CANOPY STRUCTURE OF A NORTHERN HARDWOOD FOREST

*\*Brian Weeks, Center for Biodiversity and Conservation, the American Museum of Natural History; \*Steven Hamburg, Brown University; \*Matthew Vadeboncoeur, University of New Hampshire*

In 2005, we quantified changes in foliage-height profiles in the canopy of a northern hardwood forest at the 3,160 ha Hubbard Brook Experimental Forest, New Hampshire, after a severe ice storm in 1998. We predicted that the ice storm would allow increased American beech (*Fagus grandifolia*) recruitment and recovery, in part due to the prevalence of beech bark disease, which increased beech root sprouting prior to the storm. Data

were collected in 15x15 m plots established in 1998 to assess storm damage, with 22 in damaged areas and 10 in undamaged control areas. Foliage-height profiles were created using a point-quadrat approach to sample leaf heights, and a pole-mounted leaf area index (LAI) sensor to measure LAI at 1 m intervals up to 10 m. We confirmed findings from 2000 that the total LAI in damaged areas had returned to estimated pre-storm levels, but found roughly 15% more of total LAI between 6-10 m in damaged canopies. By correlating leaf height and tree DBH, we determined that trees with DBH of 10-16 cm contributed the increased leaf area. Using vegetation inventory data from 1997 and 2002, we found a significantly greater increase in the density of beech with DBH of 10-16 cm in damaged areas. Foliage-height profiles can impact rates of transpiration and photosynthesis, canopy nutrient content, and bird community composition. Increased beech density is likely to decrease forest biomass, foliar concentrations of base cations and N, and the economic value of the forest.

#### 79. RE-COLONIZATION OF DEPLETED AREAS BY THE ENDANGERED NASHVILLE CRAYFISH

*\*Jim Carpenter, Lipscomb University*

The Nashville crayfish (*Orconectes shoupi*) is restricted to 1 small watershed in Tennessee. Recovery from local extinction events depends upon the species' ability to re-colonize. Also, the method of protecting segments of the population in areas to be disturbed has been removal and upstream transport before disturbance. But time required for the depleted area to be re-colonized was unknown. I monitored re-colonization of sites where crayfish had been removed. A 50m site was chosen in each of 3 streams, with differing characteristics in amount of stream flow, substrate, and past history of capture rates and species mix. Sweeps of each site were conducted until an estimated 80% of the site crayfish population were removed. Crayfish were transported 1-2 km upstream. Sites were surveyed at regular intervals until capture rates indicated that crayfish densities were at pre-removal levels. Population density and species relative abundance varied greatly between the 3 sites. All sites showed rapid re-colonization, with capture rates increasing significantly in the first few days after depletion. Depletion did not appear to affect relative densities of species. Results indicate that in order to remove a significant proportion of the population prior to disturbance, a series of sweeps need to be made. Further, rapid re-colonization may result in population levels at pre-removal levels during disturbance activities that last more than a few days, unless follow-up removals are done.

#### 80. WHEN AND WHERE FIRES BURN IN THE AMAZON

*\*Marion Adeney, Duke University; \*Norman L Christensen, Duke University; \*Stuart Pimm, Duke University*

Fires threaten tropical forests worldwide. In the Amazon, they damage more forest area than is cleared each year. Fires reduce biodiversity, release carbon, reduce rainfall, and make forests prone to future burning. What parts of the Amazon burn, when do they burn, and what strategies prevent fires? Previous work noticed that fires are close to roads and are more frequent in El Niño years. We quantify these general relationships across the entire Brazilian Amazon, and for a decade with two El Niño related droughts. Fire incidence declines exponentially with increasing distance from roads. Fewer fires occur within protected areas than outside and the difference is greatest near roads. Thus, reserves are especially effective at preventing fires where they are most likely to burn, but they do not provide absolute protection. Even within reserves, at a given distance

from roads, there are more fires in regions with high human impact than with low impact. During drought years, there are more fires in high impact forests, even inside reserves. The effect of El Niño on fires is greatest outside of reserves and near roads. Finally, we ask if indigenous reserves, limited use reserves, and fully protected reserves differ in their effectiveness. There is no clear answer.

#### 81. FOREST RESPONSE TO AN EMERGING FOREST DISEASE: SUDDEN OAK DEATH IN COASTAL CALIFORNIA

*\*Letty B. Brown, UC Berkeley*

Over the past century, plant diseases have had major impacts on forested ecosystems worldwide. An important emerging forest disease is Sudden Oak Death, the causal agent of which, *Phytophthora ramorum*, was first identified in 2000. In 2002, we began an investigation into the impacts of the disease on mixed evergreen forest communities dominated by coast live oak (*Quercus agrifolia*) and bay laurel (*Umbellularia californica*). It has been hypothesized that coast live oak/bay laurel forests are naturally succeeding towards bay laurel-dominated forests (McBride 1974). Bay laurel is a foliar host of *P. ramorum* which kills coast live oaks, thereby raising the forest spore load. We measured understory herbaceous plant and shrub parameters and woody plant seedling and sapling densities, over a gradient of disease severity to assess whether SOD is facilitating this succession. Woody seedlings are present at densities of 0.37 to 2.08 seedlings/m<sup>2</sup>, and sapling densities varied from 1.20 to 46.86 saplings per .08 ha plot. Initial results suggest that SOD is facilitating succession towards bay-laurel dominated forests, and correlations exist between forest infection gradients and other understory parameters. Through direct lethality to infected trees, this novel plant-pathogen combination has the potential to indirectly affect the composition and diversity of non-target understory species.

#### 82. ABUNDANCE BY LINE TRANSECT OF MAMMAL AND BIRD IN VARZEA FOREST: BENI, BOLIVIA

*\*Nestor Hugo Aranibar Rojas, Asociacion Armonia*

Much of the wildlife in Bolivia is locally threatened, mainly because of human activities. In order to establish effective wildlife conservation strategies we must first know the distribution, abundance and habitat requirements of the fauna. In support of the San Marcos indigenous community's wish to implement actions for the conservation of the biodiversity of their communal lands, we carried out evaluations of mammal and bird populations in várzea forest. Line-transect censuses were made in 2005 and 2006. A total of 31 mammal species and 220 bird species were recorded; however, due to limitations of the sampling method, density and/or abundance could be estimated for only 41% of mammal species and 2.2% of bird species. Comparison of the San Marcos varzea forest with others forest sites in the region, which were evaluated with the same methodology, shows similarity in diversity and composition of the mammal and bird populations, even though the other sites are not similar in habitat structure. In general, the application of the line-transect method is effective for monitoring certain forest mammal and bird species in the region as well as the ecology of seasonally inundated forests

#### 83. PINUS NIGRA SUBSP. BANATICA FORESTS SITE CONSERVATION IN ROMANIA WITHIN THE EUROPEAN DEVELOPMENT OF THE NATURA 2000 NETWORK

*\*Maria Patroescu, University of Bucharest;*

*\*Laurentiu Rozyłowicz, University of Bucharest, Centre for Environmental Research and Impact Studies; \*Mariana Dobre, University of Bucharest; \*Mihai Razvan Nita, University of Bucharest*

The black pine has in Europe local and regional taxonomical variations, having a strong disjunctive area in Portugal, Spain, southern France and Italy, Balkan Peninsula and Mediterranean islands. In Romania the black pine has been identified in fragmented areas, as an endemic subspecies *Pinus nigra* subsp. *banatica*. The geographical isolation, dating from the last glacial, was favoured by the calcareous substratum and the Mediterranean influenced climate. The *Pinus nigra* subsp. *banatica* Romanian site is included in the Domogled-Cerna Valley National Park, protected area established in 2000 according to the NATURA 2000. *Pinus nigra* subsp. *banatica*, considered priority element in the "Habitats Directive", appears at altitudes of 500-1000 m, in compact forests with reduced regenerative layer, or isolated on calcareous cliffs, with herbaceous layer that contains world and European endangered taxons. The tourism and forestry-pastoral attractiveness of the site requires monitoring these activities and the natural and anthropic risks in order to harmonise the conservation of the *Pinus nigra* subsp. *banatica* forest with the landscape and vulnerable, endangered or critical endangered species etc. Including the *Pinus nigra* subsp. *banatica* site in the NATURA 2000 network asserts integrating territorial arrangement politics with those of preserving natural capital and a sustainable environmental management.

#### 84. LAND-USE/COVER CHANGES (1988 - 2002) AROUND A FOREST RESERVE OF PRIMATE CONSERVATION IMPORTANCE: IMPLICATIONS FOR SUSTAINABILITY OF FOREST/WOODLANDS

*\*Edward Nector Mwavu, Makerere University, Kampala, Uganda*

Land-use/cover changes around Budongo Forest Reserve (BFR) were analysed from LandSat images (1988 and 2002) and associated field-based studies, to understand their implications for sustainability of forests/woodlands in the area. Major land-use/cover classes discriminated were forest/woodland, sugarcane plantations, and grassland/shifting cultivation. Land-use/cover changes resulted from agricultural expansion (main land-use practice), increasing human population, conflicts of interest and political interference in management, and unclear land tenure. Sugarcane plantation area increased over 17-fold, from 690 ha in 1988 to 12729 ha in 2002, with a loss of 4680 ha (8.2%) of forest/woodland. Sugarcane plantations run along the forest edge, with no buffer zone, resulting in direct conflicts between farmers and forest wild animals. Forest/woodland on private/communal lands is continuously lost and encroachment into BFR occurs. Unsustainable agricultural expansion and local people's perception of BFR as an obstacle to agriculture, threatens the conservation of forest wild plants and endangered chimpanzees. Legal protection of forests/woodlands on private land is difficult, either because of conflicts of interest, political interferences or lack of human and financial capacity. Therefore, their sustainable management for development and conservation will require strong institutions that seek a balance between resource exploitation and conservation.

#### 85. EVALUATION OF BUTTERFLIES AS ECOLOGICAL INDICATORS IN WESTERN GHATS, INDIA.

*\*Anoop Das Karumampoyil Sakthidas, Mr*

Butterflies are known to be one of the most appropriate taxonomic groups for environmental evaluation. The study attempted to identify butterfly assemblages that could be used as indicator species for six tropical forest habitat types in the Western Ghats, India. Butterfly assemblages were characterized using transects (Pollard walk). I used the indicator species concept, a method which assesses, for each taxon, whether it is a significant indicator of a particular habitat, based on the criteria of specificity and its frequency within that habitat. I used factorial analysis and community indices to identify the butterfly assemblages and Indicator Value measure was used to identify symmetric indicator species for each of the forest habitat type that characterized each of the forest habitat types. Indicator species identified for disturbed evergreen forests, evergreen forests and evergreen-grassland ecotone. This study has shown that butterfly assemblages are habitat specific and some species are faithful indicators of tropical forest types and indicates the high conservation value of the area. These findings highlight the importance of a bioindicator-based approach to ecological monitoring, rather than the use of a diversity index approach in which species identity plays no part.

#### 86. THE EFFECTS OF ACORN PRODUCTION OF CUP-RINGED OAKS ON ABUNDANCE OF LARGE MAMMALS IN YUSHAN NATIONAL PARK, TAIWAN

*\*Kuan-Fu Lin, National Pingtung University Institute of Wildlife Conservation; \*Mei-Hsiu Hwang, National Pingtung University Institute of Wildlife Conservation*

Acorns present a high-nutrition food for large-sized wildlife, including bears throughout their geographical ranges. The objective designed to monitor the phenology and acorn production of the ring-cupped oak (*Cyclobalanopsis glauca*) forest in Yushan National Park, Taiwan to understand the effects of acorn production on temporal and spatial dynamics of potential acorn predators, including ungulates and endangered black bears (*U. t. formosanus*). The acorns of ring-cupped oaks started to fall off and consumed by wildlife since Oct. until Feb. Among the fallen acorns collected by 200 seed traps, 70% were during Nov. and Dec. and high percentage of them (85%) were consumed by wildlife. We found that the more the trees produced acorns, the more bears used ( $r = 0.311$ ,  $P < 0.001$ ,  $n = 498$ ). Camera trapping (2006-2007 Oct.) identified 13 species of larger mammals out of 2,448 effective animal photos, with an Occurrence Index of 31.6 (OI, photos taken in 1,000 hours). The sign survey and camera trapping both showed a seasonal variation in the relative abundance of large mammals. Most of the bear photos (87%,  $n = 15$ , OI = 0.19) were taken in Nov. and Dec., coinciding with the availability peak of acorns on trees. The same situation also happened to bear's potential prey, i.e., ungulates, such as muntjacs (*Muntiacus reevesi*), Sambar deer (*Cervus unicolor*), and wild boars (*Sus scrofa*). The relative abundance of large mammals in the acorn season was more than twice in the non-acorn season.

#### 87. COMPARING THE EFFECTS OF RECENT AND HISTORICAL FRAGMENTATION IN STREAM FISHES: A LANDSCAPE GENETICS APPROACH TO THE TENNESSEE RIVER ICHTHYOFAUNA

*\*Anna George, Tennessee Aquarium; \*David A. Neely, California Academy of Sciences*

In the United States, 5500 large dams, and over 96,000 small impoundments now sever formerly free-flowing rivers. This

habitat alteration clearly disrupts connectivity of riverine ecosystems and is a major barrier to gene flow. Previous studies have demonstrated that impoundments directly impact population structure of individual species, but there have not yet been large-scale assessments of changes in genetic diversity. Within the southeastern United States, the Tennessee River drainage has an unusually diverse and imperiled fish fauna. Ongoing taxonomic studies of fishes are still recovering undescribed species, suggesting that high levels of endemism in the aquatic fauna may be partly due to historical fragmentation and allopatric speciation within the drainage. Large-scale construction of dams over the past century has caused an additional loss of connectivity between almost all populations. Our objective is to use genetic data from fishes in the Tennessee River drainage to examine the effects of fragmentation on genetic structure. Populations with higher genetic diversity were consistently found in rivers without large impoundments. Our results also indicate that the biogeographic history of the Tennessee drainage has played as important a role as contemporary fragmentation in shaping the recovered genetic patterns.

#### 88. NITRATE CONTAMINATION IN URBAN AND RURAL SPRINGSHEDS OF THE UPPER FLORIDAN AQUIFER, SOUTHWEST GEORGIA

*\*Stephanie Eugina Allums, Joseph W. Jones Ecological Research Center; \*Stephen P Opsahl, Joseph W. Jones Ecological Research Center*

Widespread nitrate contamination of groundwater is an emerging global problem with consequences for both human and ecosystem health. Groundwater in the Upper Floridan aquifer is susceptible to nitrate contamination, the extent of which may vary depending on land use within recharge areas. Springs along the lower Flint River (Georgia, USA) discharge large quantities of water from the Upper Floridan aquifer directly into the river. We examined groundwater chemistry over a five year period in four large springs (Radium, Riverview, Bovine, and Hog Pen Springs) which discharge into the lower Flint River between Albany and Bainbridge, Georgia. The Radium Spring recharge area includes substantial urbanized land cover; whereas, the other three springs are recharged in locations dominated by agriculture. Significantly lower nitrate in Radium Spring was attributed to differences in land use. Long-term trends for all springs demonstrated a statistically significant increase in groundwater nitrate. Elevated nitrate in aquatic ecosystems may degrade suitable habitat for fishes and aquatic invertebrates. This factor is especially important for the declining Gulf-strain striped bass which utilize these springs as thermal refugia. This study demonstrates the importance of long-term data for evaluating the effects of anthropogenic activities on regional groundwater quality.

#### 89. MONITORING INORGANIC POLLUTION IN FRESH WATER ECO-SYSTEM USING WATER BIRD AS BIO-INDICATOR

*\*Ravi Shanker Kanoje, Freelance Environmental Researcher & Consultant*

Assessment of environment impact of Malanjkhand Copper Mines on fresh water ecosystem has not been initiated. Copper ores are excavated in the open cast mines. Sulphide ores are concentrated in ore refining plant by oil floating process. The residue with water and sand are drained in to the Tailing Dam by high current of water through pipelines. Tailing Dam is supposed to be polluted with copper salt. Water birds at the Tailing Dam and Karamsara Tank in mines area were recorded. Samples of water were collected from the Tailing Dam and

Karamsara Tank. Emission spectroscopy was used for detection and estimation of copper content. Abundance of water birds and concentration of copper were compared. In the Karamsara Tank there were 158 water birds of 9 species whereas in the Tailing Dam 90 water birds of 5 species were found. Abundance of water birds in the Karamsara Tank is higher than the Tailing Dam. The concentration of copper in Karamsara Tank was found to be 0.02 mg. / liter whereas in the Tailing Dam it is as high as 1.09 mg. / liter. The congregation of 70 Spot-billed Ducks in the Tailing Dam indicates its affinity to wards highly polluted water with copper salt. Similarly the presence of 10 numbers of Black-winged Stilt in the Tailing Dam also shows its tolerance capacity towards copper content in water. This is a good example of use of avifauna as a bio-indicator. Sampling of water and observation of water fowls may be done at least six times in a year.

## 90. POPULATION STATUS OF EASTERN HELLBENDERS IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK AND CHEROKEE NATIONAL FOREST, USA

*\*Michael John Freake, Lee University; \*Sarah Neslund, Lee University; \*Jennifer Norton, Lee University*

Eastern hellbenders *Cryptobranchus alleganiensis* (Cryptobranchidae, Caudata) have suffered population declines over most of their range. Anecdotal reports and limited field surveys have indicated that populations have likewise declined in the southern Appalachians, and little is known about the viability of remaining populations. Our project aims to identify the current distribution and population viability of hellbenders in the relatively pristine watersheds of the Great Smoky Mountains National (GSMNP) and Cherokee NF. Out of 10 rivers with historical records of hellbenders, we have identified just three rivers in which hellbenders are still present and in which all size classes are represented, including gilled larvae (indicating current reproduction and recruitment). The hydrology and productivity differs between the rivers, and this appears to be reflected in population density (estimated by capture rate) and body length/cube root mass (body condition index). We also found three additional rivers with hellbenders, however population densities appear relatively low, and as yet there is no evidence of current reproduction. Our data confirm that hellbenders have declined within the GSMNP and Cherokee NF, however healthy populations still exist. These populations will be increasingly critical as development pressures and shifts in land use continue to increase in the southern Appalachians, resulting in potential degradation of upland watersheds.

## 91. BIOTIC INTEGRITY OF CERRADO STREAMS FROM RIO CUIABÁ BASIN, MATO GROSSO, BRAZIL

*\*Nadja Gomes Machado, CEPROTEC - Centro Estadual de Educação Profissional e Tecnológica de Mato Grosso; \*Jerry Magno Ferreira Penha, Núcleo de Estudos Ecológicos do Pantanal (NEPA), Instituto de Biociências, Universidade Federal de Mato Grosso; \*Eduardo Martins Venticinque, Wildlife Conservation Society*

In the last 30 years, Cerrado comes suffering severe anthropic impacts because of its conversion in simplified systems which provokes alterations in species composition of streams. Being thus, our objectives had been: (i) to evaluate the integrity biotic of streams of first and second order in the Basin of the River Cuiabá and (II) analyzing if the Index of Biotic Integrity (IBI)

follows changes in: environmental quality measured by Index of Environmental Quality, presence of environmental barriers, types of land use and variations in the mesohabitat structure. We showed 26 streams and its basin. In each stream, we closed a stretch of 50 meters with blockade nets and used electrofishing. We used Spearman Correlation and Multiple Regression Analysis. We collected 697 individuals distributed in 6 orders, 15 families and 49 species. The IBI followed changes of IQA with all streams ( $r^2 = 0.4$ ) and increased more in streams without barriers ( $r^2 = 0.58$ ). Types of land uses had not affected the biotic integrity ( $N=26$ ;  $dF=4$ ;  $H= 4,860$ ;  $P=0.302$ ), but barriers had affected it ( $N=26$ ;  $dF=4$ ;  $H= 11,027$ ;  $P=0.026$ ). The IBI was not sensible to the variations in the mesohabitat structure ( $F_{2,23} = 0.373$ ;  $R^2 = 0.031$ ;  $Axe1 p = 0.620$ ;  $Axe2 p = 0.490$ ). The IBI revealed as a reasonable instrument to evaluate the environmental changes, but we cannot ignore that some metrics combined get same result what complicate its analysis and interpretation.

## 92. CHANGING AGE STRUCTURES IN POPULATIONS OF ZEBRA MUSSELS IN THE ST. CROIX NATIONAL SCENIC RIVERWAY

*\*Byron Karns, National Park Service*

The affects of zebra mussels in freshwater systems in North America have been well documented—particularly on native mussels (the St. Croix has 40 species). In 1992, the first zebra mussels were discovered in the Mississippi above the confluence with the St. Croix River, but reproduction was not pinpointed in the St. Croix until 2000. The NPS has gathered information about the population age structure of St. Croix zebra mussels to determine recruitment, growth rates, and mortality. Anecdotal accounts of periodic, but substantial zebra mussel die-offs in large river systems have been recently noted suggesting an early season recruitment followed by a late season population crash. These observations have been casual and not systematically well documented. In order to predict impacts to river biota, an organized assessment of seasonal population dynamics of zebra mussels in a large river system is necessary. The St. Croix River is a 6th order system with various zebra mussel infestations within the downstream most 22 miles, however in 2007, densities of this invasive animal reached over 12000m<sup>2</sup> within the last 6 miles. If conditions in certain rivers allow for veliger settlement and establishment, but mussels cannot mature, implications for management are numerous.

## 93. ECOLOGY AND CONSERVATION OF THE BLACKSIDE DACE, PHOXINUS CUMBERLANDENSIS, A THREATENED STREAM FISH IN KENTUCKY AND TENNESSEE, USA

*\*Tyler R. Black, Tennessee Technological University; \*Jason E. Detar, Pennsylvania Fish and Boat Commission; \*Brena K. Jones, North Carolina Wildlife Resources Commission; \*Hayden Thomas Mattingly, Tennessee Technological University*

The blackside dace, *Phoxinus cumberlandensis*, is a federally protected minnow endemic to small streams in the upper Cumberland River drainage of Kentucky and Tennessee, USA. The species is a key inhabitant of a watershed that has experienced water quality problems for many years. We recently studied blackside dace distribution, abundance, movement patterns, reproductive behavior, and habitat affinities to assist ongoing conservation and recovery efforts. Dace densities were estimated by mark-recapture experiments and averaged 12-17 individuals per 100 m<sup>2</sup>. Unfortunately, many sites harbored dace populations existing at low densities.

Most dace were highly residential and did not move >200 m over a year's time. However, a sizeable minority (20-40%) was mobile and moved up to 4 km, including one dace that migrated into a neighboring stream. We observed 25 spawning events, all associated with creek chub, *Semotilus atromaculatus*, nests containing clean substrate. Finally, we constructed logistic regression models to predict dace presence as a function of reach-scale habitat variables. The best-performing models predicted dace persistence in stream reaches with June-August water temperatures <20 °C and conductivities <240 µS. Through this research program we have described certain ecological conditions needed to promote conservation of a unique species in a global hotspot of biological diversity.

#### 94. EFFECTS OF DAMS ON RIVERS AS ALTITUDINAL BIOLOGICAL CORRIDORS

*\*Osvaldo Jordan, Alianza para la Conservacion y el Desarrollo (ACD); \*Ariel Vargas, Centro de Estudios de Recursos Bioticos (CEREB)*

Although protection for free movement of genetic materials along altitudinal gradients is an important conservation goal, biological corridors are usually conceived as belts of forested land, overlooking the fact that every free flowing stream on Earth fulfills altitudinal corridor functions. Effectiveness of riverine corridor function is affected by multiple anthropogenic impacts, but probably the most disruptive is fragmentation by dams. Fragmentation is disastrous for diadromous species, particularly on islands, peninsulas and other regions where the distance between mountaintops and sea level is short. On the Mesoamerican Isthmus, where 381 large dams are presently proposed, diadromous species dominate the lotic fauna apart from insects. As a case study of probable effects of dams on diadromy, we cite two hydro dams proposed for the Teribe-Changuinola watershed, just downstream of the La Amistad International Park World Heritage Site, shared by Panama and Costa Rica. Of a total 24 fish species documented from this watershed; 8 are diadromous, including both the largest and most abundant species. Fragmentation of these rivers by dams would result in multispecies extirpations in the entire Panamanian area of the Park, encompassing over 600 miles of perennial streams in an area of 800 square miles reaching to the continental divide.

#### 95. IMPACTS OF LAND USE AND REGIONAL STREAMFLOW CHANGE ON STREAMS IN THE LOWER FLINT RIVER BASIN, GEORGIA: IMPLICATIONS FOR MUSSEL CONSERVATION STRATEGIES

*\*Tara K. Muenz, J.W.Jones Ecological Research Center; \*Stephen W Golladay, J.W. Jones Ecological Research Center; \*David W. Hicks, J.W.Jones Ecological Research Center; \*Rebecca C. Thomas, J.W.Jones Ecological Research Center*

Protection of rare and sensitive freshwater mussels requires the development of timely conservation strategies supported by knowledge of riparian and instream habitat conditions that impact their survival and recovery. Many streams of the Lower Flint River Basin (LFRB) remain as viable habitat for freshwater species and harbor some of the most diverse mussel assemblages in the Southeast. However, land use changes, hydrologic alterations, and declines in native fish species have adversely affected mussel diversity and abundance throughout the region. Adequate streamflow is one habitat characteristic necessary to maintain mussel habitat. Within the past few decades this region has experienced dramatic changes in land

use and in stream flows with the advent of agricultural irrigation in the 1970s. Extensive mussel declines have also occurred in some tributary streams as a result of recent droughts. We address these threats and concerns by examining land use and stream-flow changes, habitat condition, and species responses to drought in two watersheds within the LFRB. Priority areas for conservation within the Basin include several tributaries, many of which harbor federally endangered and threatened mussel species.

#### 96. ALTERNATIVE ENGINEERING SOLUTIONS TO PROTECT A SPECIALISED UNDERGROUND-LIVING RODENT

*\*Attila Németh, Department of Systematic Zoology and Ecology of Eötvös Loránd University; \*András Máté, Kiskunság National Park Directorate; \*Sándor Zsebok, Department of Systematic Zoology and Ecology of Eötvös Loránd University; \*Dávid Czabán, Department of Systematic Zoology and Ecology of Eötvös Loránd University; \*Anita Rózsás, Department of Systematic Zoology and Ecology of Eötvös Loránd University; \*Janos Farkas, assistant professor; \*Gábor Csorba, Hungarian Natural History Museum, Department of Zoology*

The exclusively underground living Lesser blind mole rat (*Spalax leucodon*) is a critically endangered and strictly protected species in Hungary. By detecting its unique seismic communication a new locality of this specialised rodent has been proven recently. The area, part of a grassland ecosystem typical for the Pannon Ecoregion, is under threat by highway construction. There are 3 basic engineering solutions to build a motorway: 1) traditional raised soil embankment 2) elevated motorway (supported by pylons) 3) tunnelling underground. The traditional way is by far the cheapest but would have a catastrophic, irreversible effect on such an ecosystem. The pylons allow the recolonisation of the flora and fauna but primeval grasslands are extremely sensitive communities and sign of even smaller scale disturbances can be detected for a hundred years; moreover, there is no experience for the translocation of mole rats threatened directly by construction and translocation can not be done without knowing the exact distribution of the different karyological forms. Tunnelling is extremely expensive but if done by drilling the surface will not be affected. As mole rat populations are known to persist in military zones, as well, the vibration and noise probably present tolerable disturbances for the individuals. Considering the conservation biological aspect as a priority, underground tunnelling is the best solution for protecting this special ecosystem.

#### 97. PRE-ENFORCEMENT POPULATION ASSESSMENT, MOVEMENT, AND GENETIC CONNECTIVITY OF QUEEN CONCH (*STROMBUS GIGAS*) POPULATIONS IN BELIZE

*\*John Anthony Cigliano, Cedar Crest College; \*Melinda Sandridge, Cedar Crest College; \*Danielle Skinner, Cedar Crest College; \*Rachel Vereneck, Cedar Crest College; \*Bryan Bugler, ReefCI; \*April Ridlon, ReefCI; \*Richard Kliman, Cedar Crest College*

We assessed the pre-enforcement status of queen conch populations in the Sapodilla Cayes Marine Reserve (SCMR) in southern Belize in spring and summer 2006 and 2007, collecting data on density and age structure of aggregations

inside and outside the reserve in shallow-water (<3m; N=10) and deep-water (>15 m; N=2). We also tagged conch to study dispersal/migration patterns. Aggregation densities were among the highest reported. Shallow-water aggregations consisted mainly of juveniles and were found in seagrass meadows. Deep-water aggregations were found in sand and sand/seagrass habitats and contained only adults. Spawning was observed in these aggregations and, thus, may act as spawning refugia. Preliminary analysis of tagging data suggests that juveniles migrate seasonally between shallow (spring-summer) and deep (fall-winter) sites while adult conch from deep-water aggregations are sedentary. To assess genetic population structure and connectivity among populations, DNA was sampled from three locations in Belize (SCMR, Port Honduras Marine Reserve, Turneffe Atoll) and one location in the Turks and Caicos Islands. Estimates of polymorphism at the mitochondrial CO1 locus are high and average pairwise divergence among pairs of the Belize populations and the TCI population ranged from 0.00456 to 0.00592. Fst values among pairs of Belize populations were low. Thus, currently, with limited data, our sampling has not found spatial or temporal population structure within Belize.

#### 98. MARINE PROTECTED AREAS IN SOUTH AMERICA: A SPATIAL ANALYSIS OF ECOREGION COVERAGE

*\*Andres Gomez, Columbia University*

Current awareness of the threats faced by the world's oceans has increased support for the establishment of marine protected areas (MPAs) globally. Recently, the Latin American Parks Congress lamented the lack of protection of the region's marine ecosystems and called for an increase in MPA number and area with the goal of meeting internationally agreed conservation targets. Efficient expansion of the current MPA network requires knowledge about current coverage in order to guide the placement of future reserves. Here I analyze the coverage of MPAs in South America (SA) at the ecoregion level by country. In addition, by aggregating these spatial data, I calculate the current distance to target (i.e. the area needed to meet agreed conservation goals) in each country and ecoregion. These results show that most marine ecoregions in SA are significantly below even conservative conservation targets and point to those marine ecological units currently most underrepresented (including ecoregions currently not represented in any MPA) in every country in the continent. Expansion of the regional MPA network will require consideration of conditions at smaller spatial scales, but this analysis provides a first indication of critical needs in MPA placement in South America.

#### 99. PUTTING LIFE INTO ECOSYSTEM-BASED MANAGEMENT THEORY: A PLANNING APPLICATION USING INFORMATION ON MARINE BIODIVERSITY AND FISHERIES

*\*Zach Ferdana, The Nature Conservancy; \*Michael Beck, The Nature Conservancy*

Ecosystem-Based Management (E-BM) considers the cumulative impacts of different sectors and is intended to reverse the order of management priorities to start with the ecosystem rather than the species. Although genuine in its approach, transitioning this concept into information and ultimately decision-making is complicated and the path to its realization is unclear. Here we provide a practical example of how to take spatial information on biodiversity and fishery production, two decision support tools, and an overarching planning framework in order to put life into E-BM theory. This talk provides an overview of a planning framework that

incorporates fisheries modeling and biodiversity conservation decision support tools. Conservation planning and fisheries modeling can be incorporated into an integrated approach illustrated here by utilizing information on ecosystems, habitats, and species in a portion of the Northern California Current. Within this framework we demonstrate the use of two commonly used decision support tools for biodiversity conservation and fisheries objectives, Marxan and Ecopath with Ecosim, respectively. This is one example where both tools are used to provide initial planning solutions that fulfill multiple objectives. One practical and powerful way to realize E-BM is to make information and analyses transparent to decision makers and advance integrated tool development.

#### 100. STABLE ISOTOPE ANALYSIS OF CALIFORNIA SEA LION DIET TO RECONSTRUCT HISTORICAL RESPONSES TO ENVIRONMENTAL CHANGE

*\*Sabrina Nicole Foster, University of Virginia;*

*\*Stephen Macko, University of Virginia*

Climate change poses the critical question of how species will alter distribution patterns in response to environmental stresses; a clear answer will be required to improve long-term planning for the protection of threatened and endangered species. Stable isotope analyses, long an indicator of diet, may provide the required information. Analyses of teeth from the California Sea Lion (*Zalophus californianus*), a top marine predator, are used to investigate alterations in foraging patterns and food web structure that occur in response to short-term environmental changes, such as El Niño-driven shifts in productivity. The  $\delta^{13}C$  and  $\delta^{34}S$  signatures of tooth samples are analyzed to evaluate the potential for nutritional stress undergone by the species during periods influenced by a shift in the primary production at the base of the food web, or resulting from foraging greater distances from shore, as well as at deeper depths. Similarly, the  $\delta^{15}N$  results are investigated to assess the differences in relative vulnerability between sexes, taking into consideration the fact that females are essentially confined to nursery sites during pupping season. Modeling the changes in distribution and foraging patterns of *Z. californianus* suggests several avenues which should be considered in long-term conservation planning for threatened top marine predator species, including identification and conservation of potential future nursery sites.

#### 101. LARGE-SCALE DEPLETION OF BLACK ABALONE IN CALIFORNIA AND MEXICO: PATTERNS OF DECLINE AND PROSPECTS FOR UNAIDED RECOVERY IN A WARMING OCEAN

*\*Glenn R. VanBlaricom, US Geological Survey and University of Washington; \*Melissa J. Neuman, US National Marine Fisheries Service, Southwest Regional Office*

The black abalone (*Haliotis cracherodii*) has experienced declines of 90% or more in density through about 80% of its geographic range, which extends along the west coast of North America from Pt. Arena, California, to Isla de Cedros, Baja California Sur. The black abalone is a prosobranch gastropod mollusk occurring in rocky intertidal and shallow subtidal habitats on exposed shorelines. Declines are most severe south of 35° 40' N. The primary cause is a lethal disease, withering syndrome (WS), first observed off southern California in 1985. WS is caused by a Rickettsia-like prokaryote that invades and disables the digestive system. Mortality rates are enhanced by above-normal sea surface temperatures. Disease-induced mortalities have reduced abalone densities below minima necessary for successful reproduction and recruitment.

Withering syndrome is spreading northward and may soon encompass the entire geographic range of black abalone. Other factors contributing to declines include poaching, commercial and recreational harvest, and natural predators. A Status Review Team (SRT), convened by the US National Marine Fisheries Service, has developed a simple population model suggesting a 96% probability that black abalone will suffer functional extinction within 30 years. The black abalone is designated "critically endangered" on the IUCN Red List. Recently the SRT recommended that black abalone be listed as "endangered" pursuant to the US Endangered Species Act.

## 102. BIRD ASSEMBLAGE COMPOSITION IN A ROCKY BEACH IN ARGENTINA

*\*Leandro Luis Tamini, Museo Argentino de Ciencias Naturales; \*Ruben Dellacasa, Argentina*

Studies of birds biodiversity in beaches, and impact of tourism on, is necessary to implement given the increased tourist activity in coastal regions. The aim of this work was to generate baseline information to the conservation the bird assemblage of a rocky beach in the north of Argentina. This community included migratory species of Sandpipers and Plovers and the vulnerable Olrog's Gull *Larus atlanticus*. From April 2006 to March 2007 we conducted a research along 6 km of north coast of Argentina (38°33'S 58°37'W) carry out 2 counts of birds per month. We made 11,084 observations of twenty three species of birds: Gulls (3 species, 52.2 % of observations), Ducks (3, 14.9 %), Sandpipers (4, 14.5 %), Oystercatchers (1, 5 %), Terns (4, 3.6 %), Sheathbills (1, 3.6 %), Plovers (3, 3 %), Cormorants (1, 3 %) and others like Petrels, Swans and Penguins. Between 9.16 species (SD = 1.47) in autumn and 11.2 species (SD = 0.84) in spring were recognized per season. Additionally, in this coast, bird watching tourism might be a way to educate local people about the value of biodiversity and create local and national incentives for successful protection and preservation of natural areas.

## 103. PASTURE MANAGEMENT ON FLORIDA RANGLAND AFFECTS THE CONSERVATION VALUE OF WETLAND PLANT ASSEMBLAGES

*\*Elizabeth Boughton, University of Central Florida; \*Pedro Quintana-Ascencio, University of Central Florida; \*Patrick Bohlen, Archbold Biological Station; \*John Fauth, University of Central Florida; \*David Jenkins, University of Central Florida*

Agricultural landscapes serve as buffers that protect natural areas and provide habitat for many species. However, pasture management greatly influences ranchland conservation value. On Florida ranches, wetlands comprise ~13% of the landscape and two types of pasture management are used: "improved" pasture (IP; exotic forage grasses/fertilizer) and semi-native pasture (SNP; a mixture of exotic and native grasses/no fertilizer). We surveyed plant assemblages of twenty wetlands in each pasture type and found that it affects the composition and diversity of wetland plant communities. Wetlands within SNP had higher native plant richness ( $p=0.001$ ) and contained fewer exotic plants than IP wetlands ( $p<0.001$ ). Within SNP wetlands, exotic richness decreased as native richness increased ( $r^2=0.51$ ,  $p<0.001$ ); this relationship was not found in IP wetlands ( $r^2=0.036$ ,  $p=0.423$ ). Increases in exotic species were related to increased soil N ( $p=0.05$ ) and P ( $p=0.03$ ). Higher nutrient levels in some SNP wetlands may be caused by fertilizer runoff and changes in organic matter due to grazing and fire regime. Current work is manipulating grazing and fire in wetlands in each pasture type to determine how nutrient levels and native and exotic species richness respond.

Understanding how pasture management affects wetlands embedded within Florida rangelands is critical for balancing agricultural and conservation interests, and has implications for semi-tropical regions worldwide.

## 104. OPPORTUNITIES AND THREATS TO BIODIVERSITY CONSERVATION IN THE NORTHERN PORTION OF THE BRAZILIAN CERRADO

*\*Mariana Napolitano Ferreira, Instituto de Biociencias, Universidade de Sao Paulo; \*Cristiano Campos Nogueira, Conservation International - Cerrado Program; \*Ricardo Machado, Conservation International - Cerrado and Pantanal program; \*Mario Barroso, Conservation International - Cerrado and Pantanal program; \*Rafael Fonseca, Conservation International - Cerrado and Pantanal program*

The Cerrado is the second largest Neotropical ecoregion and also the world's richest and most threatened tropical savanna. Jalapão-western Bahia (JWB) biodiversity corridor, in the northern region of the Cerrado, holds the largest tracts of natural remnants and the largest protected areas (PAs) in central Brazil which altogether protect almost 1,600 square kilometers, making this region extremely important to the conservation of Cerrado biodiversity. Even so, the natural ecosystems of JWB corridor face increasing threats. Most PAs were recently established and show inadequate levels of implementation. This study aimed to evaluate the conservation status of JWB corridor. We analyzed several assessment factors, based on data collected during field trips and interviews with local managers, complemented with secondary information. Results indicate that anthropogenic fires, illegal hunting and cattle ranching are the main threats inside the PAs, while cash-crop agriculture has been responsible for severe land transformation in their immediate surroundings in the recent years. PAs still lack basic infrastructure, information, human resources and planning mechanisms to mitigate impacts and promote effective biodiversity conservation. Integrated planning and implementation of PAs, land use control and best practices in agricultural zones outside the reserves are essential strategies to reduce impacts to this biologically unique and highly threatened portion of the Brazilian Cerrado.

## 105. SEARCHING FOR WIN-WIN SOLUTIONS FOR AVIFAUNA AND FARMERS IN THE CACAO AGROECOSYSTEMS OF SOUTHERN CAMEROON

*\*Casey J. Sanders, Technische Universität München; \*Thomas V. Dietsch, UCLA Center for Tropical Research; \*Denis J. Sonwa, International Institute of Tropical Agriculture*

Traditional cacao agroforests are one of the most biodiverse agricultural systems in sub-Saharan Africa. Unfortunately, farmers have begun managing the shade canopy for fewer commercial tree species, putting the conservation potential of these systems at risk. Identifying a suite of trees that supply farmers with valuable products and ecosystem services, particularly pest control by natural enemies, will aid the design of best management practices that preserve biodiversity and provide income to farmers. This study observed avian foraging behavior to determine tree species preferences and resource use by birds in the shade and cacao layers of 12 farms in three villages of southern Cameroon. The avifauna used the plant category Other Trees (comprised of 56 infrequently used tree

species) in one-third to one-half of the observations per village. Proportions of insect, fruit and nectar consumed by each bird species in the cacao layer were measured to determine relative potential to control insects. Low sample sizes in the cacao required birds to be grouped into foraging guilds for analysis. Arthropods comprised over 60% of prey for the sallyier-foilage gleaner, nectivore and arboreal foliage gleaner guilds, suggesting that birds contribute a valuable ecosystem service to farmers. However, the high proportion of tree species used by birds suggests that maintaining a high diversity of shade trees is a critical challenge for conservation in cacao landscapes of sub-Saharan Africa.

#### 106. URBAN RIPARIAN CORRIDORS: HOW DOES WIDTH INFLUENCE BIODIVERSITY?

*\*Christopher David Ives, Macquarie University;*  
*\*Mark Patrick Taylor, Macquarie University;*  
*\*David Nipperess, Macquarie University; \*Peter Davies, Ku-ring-gai Council*

This study investigated biodiversity patterns within urban riparian bushland corridors in Sydney, Australia, in order to assess the influence of variation in riparian corridor width. Terrestrial macroinvertebrates and plants were sampled at 18 sites of varying corridor width within the Ku-ring-gai Local Government Area. Comparison of narrow corridors with large remnants enabled ecological changes resulting from urban encroachment to be identified. Data on ant morphospecies revealed minimal variation in richness between sites of differing corridor width, but significant changes in faunal composition, particularly for corridors less than 20 m in width. Narrower corridors exhibited reduced rates of species turnover, particularly at the urban-bushland interface, thus supporting the concept of biotic homogenisation resulting from urban edge effects. Analysis of floristic biodiversity is currently being used to supplement the ant morphospecies data. Abiotic factors (e.g. soil properties) and landscape influences (e.g. adjacent and upstream landuse) will also be assessed. Differences in the responses of invertebrates and plants to variation in corridor width and other environmental factors is of significant importance to environmental planning. Formulating optimum riparian corridor widths for biodiversity conservation in urban landscapes will likely require compromise between the habitat requirements of various taxa and consideration of a site's unique environmental characteristics.

#### 107. EFFECTS OF THE VEGETATIVE AND BUILT LANDSCAPE ON BREEDING RIPARIAN BIRD COMMUNITIES: LAND COVER, SCALE AND WOODY VEGETATION EFFECTS

*\*Derric Neville Pennington, University of Minnesota;* *\*Mary L Cadenasso, University of California, Davis;* *\*Robert B Blair, University of Minnesota*

With over half of humanity now residing in cities and growing, urban environments present a unique challenge for conserving our planet's biodiversity. Riparian systems are of particular interest because of the ecological services they provide to both people and an array of other animals and plants. We chose to study urbanization effects on riparian systems along an urban gradient within metropolitan Cincinnati, Ohio, U.S.A. Based on our research, we report on how breeding avian diversity and composition responds 1) locally to woody vegetation structure and composition, and 2) across the landscape to the vegetative and built aspects of the urban environment, at four different scales (50, 100, 250, and 500 m). We employ the HERCULES land cover dataset to focus on elements of the biophysical structure of the urban environment - buildings, building type

and vegetation - separately. In order to ascertain potential mechanisms, we explore how life-history characteristics permit some species to utilize and even thrive in urban areas while others cease to exist based on the following functional groups: migration, feeding, brooding strategy, and endemism. We provide management recommendations for land managers, landscape architects, urban planners, and citizens that can enhance native species diversity around urban streams.

#### 108. FREQUENT TRANSMISSION OF IMMUNODEFICIENCY VIRUSES AMONG BOBCATS AND PUMAS IN AN URBAN FRAGMENTED LANDSCAPE

*\*Sam Franklin, Colorado State University; \*Jennifer Troyer, National Cancer Institute; \*Julie Terwee, Colorado State University; \*Lisa Lyren, USGS; \*Walter Boyce, University of California Davis; \*Seth Riley, National Park Service; \*Melody Roelke, National Cancer Institute; \*Kevin Robert Crooks, Colorado State University; \*Sue Vandewoude, Colorado State University*

With the exception of human immunodeficiency virus (HIV), which emerged in humans after cross-species transmission of simian immunodeficiency virus (SIV) from nonhuman primates, immunodeficiency viruses of the family Lentiviridae typically represent species-specific viruses that rarely cross species lines to infect new hosts. Among Felidae, numerous immunodeficiency-like lentiviruses have been documented, but only a handful of cross-species transmissions have been recorded, with none perpetuating in the recipient species. This investigation of feline immunodeficiency virus (FIV) infection in bobcat and puma in urban southern California provides evidence that cross-species infection has occurred frequently among these animals. Data suggest that transmission may have occurred from bobcats to pumas, perhaps due to puma predation on bobcats, a situation similar to that which fostered transmission of HIV to humans. The relationship between the geographic location of an individual and its FIV isolate was highly correlated, underlining the possible utility of FIV sequences for tracking animal movement and contact in fragmented areas. The reasons why FIV transmission between the two species appears localized to two small geographic areas within their extensive overlapping range remain elusive, but potentially suggest increased contact rates, and hence disease transmission, in urbanizing landscapes.

#### 109. BIKE PATHS AND NEW PONDS: AMPHIBIAN RESTORATION IN THE PACIFIC NORTHWEST

*\*Katie Holzer, Lewis and Clark College*

The current extinction crisis is affecting amphibians particularly strongly. Recognition of their global decline has led to restoration efforts around the world, but many of these projects lack ecological information that would improve their success. This study addresses two questions that will add to the base of knowledge for amphibian restoration efforts: 1. Do paved bicycle paths affect amphibian movement? 2. What amphibian species colonize new ponds relative to established ponds in the same area? To test if bike paths act as barriers I marked and recaptured amphibians in a wildlife refuge containing bike paths. I tracked their movements and used a model to determine if bike paths inhibit movement. To determine how many and which species of amphibians bred at new restoration ponds versus established ponds I conducted frog calling and egg mass surveys. Bike paths seem to be partial barriers to amphibian movement. The Pacific treefrog,

*Pseudacris regilla*, was found calling and their egg masses were found at all established ponds and some new ponds. This may be due to differences in the areas surrounding the ponds. Long-toed salamander, *Ambystoma macrodactylum*, eggs were found in a subset of ponds. The invasive American bullfrog, *Lithobates catesbeianus*, was found calling in an established, permanent pond but not at any of the newly constructed, seasonal ponds. This is likely because *L. catesbeianus* generally breeds later in the year when these ponds are dry.

#### 110. STUDYING OF GLOBALLY RARE SPECIES OF BIRDS IN THE SOUTH-WESTERN SIBERIA

*\*Andrew Valerievich Bazdyrev, Team member of a project supported by BP conservation programme (CLP); \*Evgeniy Murzakanov, Project leader supported by CLP (BPCP)*

The present work was carried out in 2006-2007 on the territory of Barabinskaya lowland and in the northern part of Kulundinskaya steppe in the southeastern part of Western Siberia. Aim of the work: to study two global rare species of birds such as the white-headed duck (EN) and the sociable lapwing (CR). Tasks: to study a geographical distribution and estimate the quantity, select the Important Birds Areas (IBA), estimate the level of awareness of local population about conservation of birds, establish contacts with local organizations and create recommendations for them. Methods: number monitoring, car rout records of birds, description of the biotopes characteristics, GIS-mapping with use of cosmic photographs, selection of IBA, interviewing local populations. Results: low awareness level of a local population, but we registered a significant decrease (by 4-30 times) of the number of the white-headed duck in the region. Though the total number of the white-headed duck was underestimated in Russia, and we can say that the studied region is an important area for conservation of the white-headed duck population. 65 pairs of birds nest were registered. Also a GIS-map of the white headed-duck distribution in the region was created, 8 new IBA were revealed.

#### 111. THE WATERBIRD-FISHERIES INTERACTIONS OF THE SAKUMO II LAGOON, GHANA

*\*ANGELA MANEKUOR AHULU, UNIVERSITY OF GHANA*

Abstract Sakumo II lagoon one of the Ramsar sites in Ghana inhabits about 40 different species of waterbirds. It serves as the major source of income for about 20-150 fishermen daily. Interactions between piscivorous birds and fish are of great significance to both bird and fishery management. Fish consumption around large waterbird populations suggests removal of about 20-30 % of the local fish production. The annual take by seabirds and fisheries worldwide is of the same order of magnitude, in the range 50-100 million tonnes a year. The estimated annual global food consumption of all seabird species is 96.4 million tonnes. The study aimed to describe and quantify the level of interactions between waterbirds and fish production, of the Sakumo II over a year. A simplified conceptual model in the form of a Forrester diagram was developed to explain resource partitioning and competition between birds and man in the lagoon. A total of 44,644 individuals of waterbirds were counted during the study period, 66% of these were piscivorous birds. An estimated average of 3,730,133.16 kg of prey items were consumed by piscivorous birds during the study period. This constituted 3.20 % of the total fish production of the lagoon. Statistical analysis showed that feeding rates and success of piscivorous birds is dependent on the production of fish in the lagoon. Recommendations

included the need for a holistic management of both bird and fish resources of the lagoon.

#### 112. POTENTIAL HABITAT IMPORTANCE OF VERNAL POOLS FOR WHITE-TAILED DEER ODOCOILEUS VIRGINIANUS AND MOOSE ALCES ALCES IN A NEW HAMPSHIRE WILDERNESS AREA

*\*Timothy Dexter, Antioch University New England;*

*\*Robert Fritz Baldwin, Clemson University*

A well documented biodiversity function of woodland vernal pools is breeding habitat for numerous amphibian species. However, little information is available on importance of vernal pool habitats for mammals. During spring 2007, we identified 24 "biologically significant" vernal pools in Pisgah Wilderness State Park in Chesterfield, NH (USA). Each pool was paired with a randomly placed dry control plot of the same size and shape, in the same forest type, and 8805;100m from any wetland. During mid-August (pools at their driest), mammal scat was systematically counted within vernal pools, controls, and a 30m buffer surrounding both. Vegetation type and abundance was also characterized at vernal pools and control plots. We found more deer scat at controls than at vernal pools ( $\chi^2=23.26, P < 0.0001$ ), more deer scat at vernal pool 30m buffers than at control 30m buffers ( $\chi^2=5.27, P = 0.022$ ), no difference between moose scat at controls than at vernal pools ( $\chi^2=1.84, P = 0.18$ ), and more moose scat at vernal pool 30m buffers than at control 30m buffers ( $\chi^2=20.95, P < 0.0001$ ). Additionally, more deer and moose scat was found in the 30m buffers of vernal pools with higher vegetation abundance than at vernal pools with lower vegetation abundance ( $\chi^2=27.18, P < 0.0001$ ). Our results suggest that in undeveloped forested landscapes, vernal pool edges, especially those with more vegetation, may be of habitat importance to deer and moose.

#### 113. DISTRIBUTION OF EXOTIC PLANTS ALONG A STEEP ALTITUDINAL GRADIENT FACILITATED BY ANTHROPOGENIC ACTIVITIES

*\*Jesse Kalwij, Stellenbosch University; \*Mark Robertson, Pretoria University; \*Berndt Janse van Rensburg, University of Pretoria*

Question: What determines the distribution of exotic plants along a steep altitudinal gradient? Location: Sani Pass road, Grassland biome, South Africa Results: Community structure, richness and abundance of exotics were negatively correlated with altitude. Greatest invasion by exotics was recorded for adjacent land in the 1500 m level. Of the 44 observed exotics, 27 were found at higher altitudes than expected and upper altitudinal limits were spatially clustered around potential propagule sources. Conclusions: Spatial clustering of upper altitudinal limits around human inhabited areas suggests that exotics originate from there, while the exceeding of expected altitudinal limits suggests that distribution ranges of exotics are presently underestimated. Since exotics are generally characterized by a high propagule pressure and persisting seedbanks, future tarring of the Sani Pass road is likely to cause an increase of exotic species richness and abundance: initially due to construction related soil disturbance and subsequently due to increased traffic, water run-off, and fire frequency. Adequate measures should be adopted to prevent this.

#### 114. DEMOGRAPHY AND SPATIAL OCCUPATION OF AN INTRODUCED POPULATION OF SIBERIAN CHIPMUNKS

## (TAMIAS SIBIRICUS) IN A FRENCH SUBURBAN FOREST

*\*Julie MARMET, Museum National d'Histoire Naturelle, Département Ecologie et Gestion de la Biodiversité*

The Siberian chipmunk, a new pet sold in Europe, was introduced in French suburban woody areas during the late seventies. In order to understand the establishment process of this terrestrial chipmunk, we studied demography and spatial occupation parameters of a population first observed in 2000. A 4-years survey (2004-2007) was carried out using Capture-Mark-Recapture methods on a trapping area of 14 ha. During this period, we accomplished 6,421 trapping events (captures and recaptures). Over the years, the size of the population increased and the age and sex structure of the population varied. Chipmunks used small home range with high rate of overlap between sexes and presented strong multiyear site fidelity. These results show that chipmunks were able to establish a stable social organization in a new environment, as well as to attain a high reproduction success. This suggests a successful establishment of this introduced population.

## 115. COMPARATIVE POPULATION GENETIC ANALYSIS OF CON-SPECIFIC, CO-OCCURRING INVASIVE AND NON-INVASIVE SPECIES OF LANTANA IN BR HILLS, WESTERN GHATS, INDIA

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Invasive species are becoming a pervasive threat to world's biodiversity. In recent years, several attempts have been made to characterize the underlying factor responsible for invasiveness of a species. Among the various qualities, genetic make-up appears to be an important factor responsible for invasiveness of a species. However, there are very few studies that have validated this. In this study an attempt was made to assess the population genetic diversity of an invasive species, *Lantana camara* Linn. (native to Jamaica) and compared with its co-occurring, non-invasive *Lantana indica* Roxb. (Verbinaceae). The study was carried out in Biligiri Rangaswamy Temple (B.R.T) Wildlife Sanctuary, Western Ghats, India. The random quadrat data suggested that invasive *L. camara* ( $24.6 \pm 10.73$ ) possess significantly higher densities than non-invasive *L. indica* ( $10.3 \pm 5.77$ ). However, the population genetic data obtained from ten RAPD primers indicated that both invasive and non-invasive species did not differ significantly, though there was variation. Further, the results were confirmed by repeating the experiment in another locality within the BRT sanctuary. Our results leads a conclusion that invasiveness of a species is independent of its genetic diversity, perhaps the life-history traits may be more important than merely the genetic composition.

## 116. DECOUPLING OF LAKE FOOD WEBS BY THE INVASIVE RUSTY CRAYFISH (ORCONECTES RUSTICUS)

*\*Tim Kreps, Bridgewater College; \*David M Lodge, University of Notre Dame*

Linkages between ecosystems and habitats can strongly affect ecosystem function through exchange of energy and materials. In lake food webs, large piscivorous fish integrate littoral and

pelagic energy sources through the consumption of a variety of smaller fish and macroinvertebrate prey. We tested the hypothesis that the introduction of the invasive rusty crayfish (*Orconectes rusticus*) decouples benthic and pelagic food webs by reducing the abundance of small fish and non-crayfish benthic macroinvertebrates. We examined differences in patterns of energy flow in lakes invaded by *O. rusticus* and in uninvaded lakes using stable isotope ratios of carbon ( $\delta^{13}C$ ) and nitrogen ( $\delta^{15}N$ ). The trophic position of juvenile crayfish was lower in invaded relative to uninvaded lakes likely indicating decreased reliance on macroinvertebrates prey and greater dependence on lower quality detritus and algae. Diets of piscivorous fish relied more strongly on littoral energy sources and walleye, an obligate piscivore, had a lower trophic position in invaded than uninvaded lakes. These results suggest a reduction in benthic macroinvertebrate and small fish abundance and the decoupling of the littoral and benthic food webs. This decoupling of habitats is likely to lead to an overall reduction in energy flow to the top of the lake food web.

## 117. CONSERVATION AND CLIMATE - USING TECHNOLOGY TO INFORM DECISION MAKING

*\*Chris Zganjar, The Nature Conservancy; \*Evan Girvetz, University of Washington; \*George Raber, University of Southern Mississippi; \*Dominique Bachelet, The Nature Conservancy; \*Josh Lawler, University of Washington*

Significant challenges arise when conservation managers must develop site-based strategies to address a global phenomenon such as climate change. The resolution of future climate projections is often too coarse and too uncertain to be useful to local practitioners. The Nature Conservancy (TNC) is developing a comprehensive database and toolbox to provide climate change information and various climate change scenarios to assist conservation practitioners and decision-makers in anticipating and adapting to the ecological impacts of climate change. By integrating database management and analytical tools with a refined web-based interface, this system will simplify the acquisition, synthesis and analysis of relevant climate information, while providing maps, graphs, and tables that can be directly used for conservation planning and decision making. Moreover, this system serves as a framework for storing and organizing climate change information, which allows for additional datasets and analysis techniques to be added modularly as they become available. This tool represents a component of how TNC's Climate Change Team is working in collaboration with academia, government agencies, and other NGOs to quantify the uncertainty and distribute climate change information in ways that facilitate conservation action globally.

## 118. MODELING LANDSCAPE CONNECTIVITY IN THE SOUTHERN APPALACHIANS UNDER CLIMATE CHANGE SCENARIOS

*\*Hugh Irwin, Southern Appalachian Forest Coalition*

Landscape connectivity between conservation lands or reserves is a core concept of conservation biology. Maintaining and restoring the conservation integrity of conservation lands is only part of the mission of effective conservation. Landscape corridors are also needed to serve as connections between conservation lands to allow genetic interchange and to permit animal and plant movements. Climate change will make landscape connectivity even more important as species are forced to adapt to changing climate conditions. As climate change is incorporated into conservation planning, it is

important to anticipate how well existing reserve systems are capable of accommodating species adaptation and movements. Conservation planning efforts are in need of tools that can evaluate the potential for establishing corridors between reserves based on projected changes in geographic distribution under climate change scenarios. GIS models of geographic distribution changes for selected focal species will be used to evaluate existing reserves and corridors in the southern Appalachians. This evaluation will be used to identify corridor needs for the focal species under climate change scenarios. Species will also be identified that will likely have difficulty adapting to climate change on their own.

#### 119. ENDANGERED TREES DECLINE AND CLIMATE CHANGE DISTURBANCE: THE CASE OF DRACAENA OMBET IN ELBA MOUNTAIN PARK, EGYPT.

*\*Mohammed Mansour, nature conservation sector egypt; \*Usama Mohammed, nature conservation sector - egypt*

Dracaena ombet is global endangered plant, its subpopulations on Gabel Elba Mountain (GE) in Egypt are particularly threatened. D. ombet grows on highest slopes in Elba Mountain in Egypt and also in Sudan, Djibouti, Ethiopia and Somalia. It is in rapid decline due to overgrazing and droughts. Goal of our research was to prepare a baseline assessment for D. ombet conservation status with participation of local community as part of our research which supported by conservation leadership program. We conducted eco-geographical survey, to identify its distribution and current status in GE. Ten sites surveyed and analyzed, we tracked and tagged the D. ombet trees and its geographical location detected using GPS, tree density, DBH and the impact degree was estimated. During 2007, 398 trees have been recorded. Survey results indicated that species facing accelerated decline in extent and quality of its woodland due to climatic changes and drought effect, which 55% of its populations was vanished, many of which appear unhealthy and there was no signs for new generation. The populations located within extent of occurrence equal 23.8 sq km, about 15.87% of the whole GE massive, Area of Occupancy for D. ombet using a Grid technique at 0.25 sq km grid scale equal 2.25 sq km, about 1.5% of GE massive. D. ombet's suitable habitats facing high degree of fragmentation due to drought and acacia woodland clearance. Based on results we recommended preparation a conservation action plan for D. ombet in Egypt.

#### 120. META-ANALYSIS OF RARE NEOTROPICAL XYLARIACEOUS FUNGI TO DETECT CLOUD FOREST SPECIALISTS ENDANGERED BY CLIMATE CHANGE

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We compared records of 121 neotropical Xylaria taxa from Belize, Ecuador, the Guianas, Mexico, Puerto Rico and Venezuela in order to determine if there were tropical montane or cloud forest specialists that might be endangered by climate change. All of the global climate change models indicate increased drought in the Caribbean. Lifting of the cloud base has also been indicated in Central America and the Andes. Determining habitat specialization is difficult for rare species as detection is an issue, so we focused on widespread species

recorded in two or more countries. Three widespread but rare neotropical montane specialists were strongly indicated. An additional seven widely distributed Xylaria taxa occurred primarily in montane forests and might also be affected by climate change. Another 28 species reported from only one country probably includes additional montane specialists, indicating that these species may be adversely impacted by climate change, but their risk is difficult to evaluate. Follicolous and fruit inhabiting species were overrepresented among montane species as compared to their representation among all taxa. Xylaria species on fruit and leaves are frequently host-specific while those on wood are not. Host-specialization may be an additional risk factor among Xylaria species restricted to cloud forests.

#### 121. PUTTING CLIMATE CHANGE THEORY INTO PRACTICE FOR WILD LAND CONSERVATION

*\*Molly Smith Cross, Wildlife Conservation Society; \*Gary Tabor, Yellowstone to Yukon Conservation Initiative*

A major challenge facing biodiversity conservation is how to develop strategies that enable species and ecosystems to cope with the inevitable impacts of climate change. While a growing body of research has identified a number of adaptation options for addressing climate change, these recommendations are often too general to translate into actual management and conservation actions on the ground. The ability to implement these general recommendations is also hampered by insufficient communication between climate change scientists and conservation practitioners. Our project addresses these issues by bringing together scientists and conservation practitioners to test several general recommendations and apply them to site-based conservation decision-making at a particular location - the Greater Yellowstone Ecosystem (GYE). We developed a framework that uses multi-stakeholder workshops to: 1) identify GYE species most threatened by climate change; 2) assess the impacts of climate change on a subset of those species; and 3) translate the generic adaptation recommendations into a portfolio of specific adaptation scenarios. We found that this "bottom-up" approach is necessary for integrating climate change models into on the ground conservation decision making, and is an improvement over "top-down" approaches that generate generic recommendations that are difficult to implement.

#### 122. CONSERVATION OF THE ENDEMIC BIRDS IN CONIFEROUS FORESTS ASIDE THE QINGHAI-TIBET PLATEAU IN CHINA

*\*Yun Fang, Institute of zoology*

Fang Yun1, Sun Y.-H.1, Tang Songhua1, W. Scherzinger2, S. Klaus3 The woodland aside the Qinghai-Tibet Plateau are proofed as a very important hotspot of biodiversity. Several endemic bird species or subspecies are distributed in the coniferous forest of the high mountains, such as Chinese grouse (*Bonasa sewerzowi*), Sichuan jay (*Perisoreus internigrans*), Snowy-cheeked Laughingthrush (*Garrulax sukatschewi*), Sichuan wood owl (*Strix davidi*) and Tengmalm's owl (*Aegolius funereus beickianus*). Due to intensive logging, grazing and other human activities in former times, the remaining patches of old growth forest became isolated and fragmented. We studied the basic ecology and habitat requirements of these endemic birds in western China, and started a conservation project in cooperation with European researchers. In addition we used satellite image analysis to study the extent of distribution and fragmentation of the woodland. Our results showed that the endemic birds in our

study area in "Lian Hua Shan Nature Reserve"/Province of Gansu, are quite endangered by the high degree of fragmentation. In consequence we provide conservation suggestions for the protection of the locally endemic bird fauna. Due to high altitude (2,300-3,500m) and a relatively dry continental climate, the restoration of habitats is difficult, and will last for several decades.

### 123. RED-RUFFED LEMURS, VARECIA RUBRA, DISPERSE AN EXOTIC SPECIES IN A REGENERATING FOREST: IS THIS DETRIMENTAL OR BENEFICIAL TO CONSERVATION?

*\*Barbara Martinez, University of Minnesota*

Frugivorous lemurs can act as agents of forest regeneration through seed dispersal as evidenced by the endangered red-ruffed lemur, *Varecia rubra*. I studied this species in a regenerating forest corridor surrounded by agriculture within Masoala National Park, Madagascar. The corridor has patches of former agricultural land where park employees have been replanting tree saplings since 1997 under the assumption that fruit-bearing trees will lure lemurs into the regenerating patches to disperse more seeds. Ten years later, these patches have an interrupted canopy and are still dominated by invasive shrubs. I collected data on the feeding and ranging behavior of *V. rubra* and their seed dispersal via feces. Results show that lemurs dispersed seeds throughout the corridor in both the regenerating patches and the forested patches. However, lemurs were not feeding on the planted food trees in the regenerating patches. They fed on and dispersed an exotic shrub, *Clidemia hirta*. One reason is that few planted seedlings were bearing fruit after 10 years; none were bearing fruit during the study period. The implications of these findings suggest that *V. rubra* are important seed dispersers, but the long-term effects on the composition of the regenerating parcels might not reflect the park managers' goals. Park managers can possibly capitalize on this behavior to aid in the dispersal of interior forest seeds through feeding stations in the patches of *C. hirta*.

### 124. IMPACT OF HUNTING AND BUSHMEAT TRADE ON WILDLIFE BIODIVERSITY LOSS IN CAMEROON: A CASE STUDY OF BANYANG-MBO WILDLIFE SANCTUARY

*\*Ajonina Abugiche Samuel, Brandenburg University of Technology Cottbus, Germany*

The Banyang-Mbo Wildlife Sanctuary is a multi-use lowland tropical rainforest in southwestern Cameroon designated by Cameroon government to protect 11 species including the most endangered primates in Central and West Africa *Mandrillus leucophaeus* and *Pan troglodytes*. Local communities maintain user-rights of forest and natural resources as long as conservation goals are not compromised. Over 55 villages within sanctuary area exert hunting pressure on wildlife for dietary requirements and income source. A seven month study was conducted to assess current impact of hunting pressure on wildlife biodiversity loss with hope to recommend managed sustainable hunting system to Forestry and Wildlife ministry. Carcasses of animals from daily hunt of 84 hunters were weighed, sexed and aged. Socio-economic data on weapon type, use, price of each animal killed and destination was recorded in the 14 study villages. Hunters were interviewed in an attempt to understand hunters' perception of hunted game and their capacity to implement a managed hunting system. 33 species were harvested, 3,176 individual animals with total biomass of 22,400.43kg killed. Placing into taxonomic groups, duikers 34% and rodents 22% were most affected. Hunting might be unsustainable as indicated by a decline in yield over

time. *Mandrillus leucophaeus* and *Pan troglodytes* face risk of local extinction. I recommend alternative income sources like cottage industries.

### 125. PAYMENTS FOR ECOSYSTEM SERVICE MARKET IMPACTS ON BIODIVERSITY CONSERVATION

*\*Jane Carter Ingram, Wildlife Conservation Society;*

*\*David Wilkie, Wildlife Conservation Society*

Payments for ecosystem services (PES) are rapidly evolving as a mechanism to both conserve natural resources and support livelihoods. However, several recent studies have shown that biodiversity and ecosystem service priority areas do not always overlap, thus, bringing into question the effectiveness of PES markets for biodiversity conservation. This paper will review several types of PES markets across multiple case studies and, from these, elucidate key factors and challenges associated with different PES markets' effectiveness for conserving biodiversity. The discussion will address what the implications of these factors might be for decision making and priority setting in biodiversity conservation and ecosystem service market development. The talk will conclude with a conceptual framework on how ecosystem markets might be developed to engage with and enhance biodiversity conservation efforts in developing countries.

### 126. DEVELOPING A PROACTIVE VETERINARY DRUG MONITORING NETWORK TO CONSERVE AFRICA'S ENDANGERED VULTURES USING A FORENSIC AND CAPACITY-BUILDING APPROACH

*\*Ngaio Richards, Department of Forensic Science, Anglia Ruskin University; \*Steve Lancaster, Foundation for Analytical Science & Technology in Africa, BP; \*Anthony Gachanja, Jomo Kenyatta University of Agriculture & Technology, FASTA*

Poisoning by the carbamate insecticide carbofuran is strongly suspected as the primary culprit for Africa's ailing vulture population. Meanwhile, the nonsteroidal anti-inflammatory drug diclofenac, implicated in the near extinction of Gyps vultures on the Indian subcontinent, has been licensed for veterinary use in some parts of Africa. There is still debate as to whether or not presence of diclofenac and use of other NSAIDs might be of concern. But the state of Africa's vulture population is tenuous, and even a few contaminated carcasses could have severe repercussions. Thus it is imperative to have tools in place should the need for monitoring ever arise. A forensic method is being developed to detect diclofenac and other NSAIDs in the hair of livestock animals and feathers of vultures via GCMS. These matrices are able to withstand harsh environmental conditions and have been used to detect a variety of environmental compounds. Other matrices such as bone and vitreous humour are under consideration as well. This method will be disseminated to the Jomo Kenyatta University of Agriculture & Technology in Nairobi so that it can be used to analyse vulture samples under the auspices of their centre for analytical excellence. Forensic principles, adaptations of the detection method, opportunities for laboratory outreach and capacity-building and development of a monitoring network will be discussed as well as how to balance a pressing conservation issue with an impending one.

### 127. SUSTAINABLE FORESTRY: SYNTHESIS OF TNC PROJECTS

*\*Karlynn Louise Christine McIlwain, The Nature*

*Conservancy; \*Tosha Comendant, The Nature Conservancy; \*Jeanette Howard, The Nature Conservancy*

The Nature Conservancy has become involved in an increasing number of large-scale transactions and projects seeking to advance responsible forest management practices and public policies that aim to protect, restore and manage the world's forests. Within this overarching forest conservation goal, sustainable forestry is being employed both domestically and internationally as a distinctive and creative tool for forestland conservation. This project examines The Nature Conservancy's use of working forests as a conservation tool by analyzing the goals, ownership, partnership, management, and monitoring techniques being employed to evaluate the compatibility between timber harvest and biodiversity protection. We conducted 30 interviews with forest practitioners who are influencing the management of over 20 million acres of working forests. The majority of projects were established to abate the threat of development, restore degraded habitats, and maintain human livelihood. Selective harvesting was the most frequently used method (77% of projects). The Nature Conservancy primarily responsible for monitoring, serving as advisors to partners and landowners, and land stewardship. Connections between working forests and biodiversity protection are not well established. There is a clear need for additional data and analysis to add to the critical knowledge gap between sustainable forestry and biodiversity protection.

#### 128. GIANT PANDAS: USE OF NEAR INFRARED REFLECTANCE SPECTROSCOPY (NIRS) TO MONITOR AN ENDANGERED SPECIES

*\*Erin Wiedower, Texas A&M University; \*Rachel Hansen, Memphis Zoo; \*Andy Kouba, Memphis Zoo; \*Lisa Stevens, Smithsonian's National Zoo; \*Kathy Hawk, San Diego Zoo; \*Rebecca Snyder, Zoo Atlanta; \*Doug Tolleson, Arizona Agricultural Experiment Station*

Giant pandas (*Ailuropoda melanoleuca*) are a highly recognized endangered species throughout the world. Obtaining population estimates in the wild is difficult and costly. Various factors have also made reproduction among captive populations a challenge. Near infrared reflectance spectroscopy (NIRS) may be a solution to both hurdles. NIRS has been demonstrated to differentiate between gender (Godfrey et al 2001), age class (Osborn et al 2002), and reproductive status (Tolleson et al 2001b,c) of both domestic and wildlife species. The objective of this study was to determine if NIRS could be similarly applied to giant pandas. Fecal samples were collected from pandas at the Memphis Zoo, Smithsonian's National Zoo, Zoo Atlanta, and San Diego Zoo from 2003 to December 2007. All samples were dried in a forced-air oven at 60°C, ground to pass through a 1mm screen, and dried again at 60°C prior to scanning. Predictions between a total of 300 male and female fecal sample spectra were 87% correct for females and 95% correct for males. One hundred fecal spectra used to predict between adults and juveniles was 100% correct for both age classes. Discriminant equations created between pregnant and non pregnant females resulted in an RSQ of 0.707 and SECV of 0.299. It has been determined that NIRS can be a valuable tool for differentiating between the gender, age class, and, potentially, reproductive status of giant pandas.

#### 129. STRENGTHENING THE ENFORCEMENT OF ILLEGAL LOGGING THROUGH NEAR REAL-TIME MONITORING AND RAPID RESPONSE

*\*John Musinsky, Conservation International; \*Kelly Maynard, Conservation International; \*Justin Epting, Conservation International; \*Iwan Wijayanto, Conservation International - Indonesia; \*E. Ermayanti, Conservation International - Indonesia*

Illegal logging represents a threat not only to biodiversity but to the economic health of countries where it occurs. The intensity and impact of illegal logging varies widely, but it frequently results in significant forest degradation, exacerbates poaching and wildlife trafficking, threatens the livelihoods of forest-dependent peoples, and may be closely associated with organized crime rings that contribute to official corruption. At its most extreme, illegal logging results in large scale forest destruction and the release of significant amounts of carbon into the atmosphere. This presentation describes how Conservation International, in conjunction with the American Forests and Paper Association and the U.S. Department of State, is attempting to strengthen enforcement and provide a deterrent to illegal logging in Indonesia by quickly and accurately detecting illegal logging activity using an array of state-of-the-art and low-tech satellite remote sensing techniques; promoting rapid response by streamlining near real-time access to suspected illegal forest activity alerts; and strengthening the capacity of national and provincial park management agencies and civil society to follow-up on surveillance with effective enforcement. Partners in this effort include Indonesia's Ministry of Forestry, local conservation response units, Fauna and Flora International, and the AKAR network, an alliance of local NGOs.

#### 130. DESIGNING AN EFFECTIVE FECAL HORMONE EXTRACTION METHOD FOR FIELD WORK

*\*Rachel Moreland Santymire, Lincoln Park Zoo; \*Diana Armstrong, Lincoln Park Zoo*

Hormonal analysis provides information about wildlife population dynamics, but can be difficult to do in the field. Our goal is to develop a quick and effective field method for fecal hormone extraction. Objectives are to compare: 1) three methods of fecal hormone extraction [laboratory (LAB), homogenize (HO) and handshake (HS)] and 2) two storage methods [Solid Phase Extraction (SPE) vs. plastic tubes (PT)]. Samples (n=23) from captive African wild dogs (*Lycan pictus*) are thoroughly mixed, 3 aliquots of each are weighed (~0.5g) and 5 mls of 90% ethanol are added. For LAB, samples are agitated on a mixer (setting 60; 30 min), centrifuged (1500 rpm; 20 min) and poured into clean, glass tubes. For HO and HS, aliquots are either HO (1 min) or HS (1 min) and poured through filter paper into clean, glass tubes. Samples are split and either analyzed for corticosterone (C) using an EIA or stored in SPE (following manufacturer's instructions) or PT [evaporated with air and heat (60°C)]. After storing at RT for 30 d, samples are reconstituted in buffer and analyzed for C. Mean recovery of HO and HS compared to LAB was 99.0% and 76.5%, respectively. After 30 d, 19.6% and 17.5% of C is recovered from SPE for HO and HS, respectively; and 90.4% and 112.1% from PT for HO and HS, respectively. Results demonstrate that HO is more comparable (P= 0.003) to LAB than HS and PT storage is more efficient than SPE (P < 0.001) making HO-PT the most effective field method.

#### 131. ARE RARE PLANT SPECIES "FALLING THROUGH THE CRACKS" OF CONSERVATION STRATEGIES BASED ON COMMUNITY?

*\*Michael Powell, University of the Sunshine Coast, Australia; \*Arnon Accad, Queensland Herbarium; \*Mike Austin, CSIRO; \*Sama Low Choy, Queensland University of Technology; \*Kristen Williams, CSIRO; \*Alison Shapcott, University of the Sunshine Coast*

Land Managers are increasingly implementing vegetation conservation at the biological community level. This approach may be inadequate for conservation of rare species where community association is weak or where the distribution of species is patchy or restricted relative to the extent of the community or communities it occupies. Moreover ecological theory predicts that species act individualistically, and global warming may change the strength of any community association. We identified vegetation community associations for three rare and threatened mid-stratum trees endemic to subtropical rainforests in southeast Queensland, Australia: *Macadamia integrifolia*, *M. ternifolia* and *Triunia robusta*, and developed statistical models with spatial predictions of potential habitat for them. All three species were found to occupy relatively small subsections of the geographic distribution of a range of vegetation communities, several of which are low conservation status. A small area of common predicted potential habitat was identified within an area now largely cleared. The remnant vegetation community dominant within this area has low conservation status due to presence of a large area of the same community several hundred kilometres to the south, outside the range of the three species. This study highlights the potential deficiencies of community-based approaches for conservation of rare species, and presents a complementary approach subject to availability of sufficient data.

### 132. DESIGNING A COLLABORATIVE INFRASTRUCTURE FOR KNOWLEDGE-BASED POPULATION MODELING OF MULTIPLE SPECIES OVER LARGE AREAS

*\*Edward J. Laurent, North Carolina State University*

Anthropogenic changes to climate and landscape patterns are known to affect species' distributions, densities and population viability. Hence, there is a need to understand these relationships and predict their consequences given various change scenarios. The application of data-driven predictive modeling approaches are limited, however, by the scope and complexity of resources necessary to sample and monitor species over large areas. Knowledge-driven modeling, whereby model structure and parameter values are based on a thorough review of existing knowledge, offers a prudent alternative strategy. These models can be tested with data when available, and extended to predict changes under various scenarios. Knowledge-based modeling may be optimized through collaboration via the Internet. We present framework that includes three primary environments: 1) Knowledge (collaboration and dissemination), 2) Information (data), and 3) Modeling (analysis). The Knowledge Environment provides access to resources (e.g., existing knowledge, collaborators, validation data, tools) via Internet services. The Information Environment provides standard yet flexible structures for partners to store knowledge of species' habitat associations, densities, and vital population rates. The Modeling Environment enables partners to design, share, and modify tools needed for hierarchically structured, spatially and temporally explicit models of species' distributions, densities and productivity.

### 133. SOUTHERN APPALACHIAN

### INFORMATION NODE - A GATEWAY TO REGIONAL BIODIVERSITY INFORMATION

*\*Shelaine C. Hetrick, NBII-SAIN*

As a collaborative effort among diverse stakeholders, the Southern Appalachian Information Node (SAIN) is a unique source for integrated science created and coordinated within this region. A geographically themed node of the USGS National Biological Information Infrastructure, SAIN assimilates biological information from multiple agencies and regional resources to improve collaboration towards better resource management, and information access. Given the overlapping goals of SAIN and SCB toward education, access to and distribution of biological knowledge, SAIN continues to seek partnerships among conservation professionals. SAIN works to highlight research of regional significance and increase awareness about the region's unique ecosystems, both terrestrial and freshwater. By making such research widely available within the NBII, policy makers, students, researchers, and resource managers gain access to information needed to make informed assessments. SAIN provides visibility and accessibility to diverse research interests and unifies the growing body of scientific knowledge via metadata standards and monitoring protocols that make scientific knowledge more accessible through data interoperability. Current SAIN interests include developing partnerships to highlighting endemic biota of conservation concern to the southeastern region such as amphibians, reptiles, mountainous ecosystems, freshwater invertebrates, and organisms affected by global climate change.

### 134. BUILDING CAPACITY FOR ANDEAN CAT MONITORING IN ARGENTINA'S ANDEAN STEPPE, A PROMISING NEW SITE FOR LONG TIME CONSERVATION.

*\*Rocio Palacios, Andean Cat Alliance (ACA);*

*\*Cañadell Sebastian, Andean Cat Alliance (ACA)*

The Andean cat (*Leopardus jacobita*, AC) is one of the least known cats worldwide whose distribution recently increased into the Southern Andean steppe. This immense, sparsely populated region contains many protected areas providing some of the best long-term conservation prospects for the AC. The aim of this project is to increase knowledge of the AC distribution and status in the southernmost portion of its range while training protected area personnel in carnivore ecology, monitoring and conservation planning. This objective is accomplished by using a theoretical-practical course, which is given in protected areas. The course has already been given to more than 100 people (park rangers, students and technical personnel) in the first sites. We expect to create links between the more enthusiastic attendants, creating a self sufficient monitors network. Also a field handbook designed by this project is being freely distributed and school and specific monitors' workshops are planned. During field activities (practical part of the course) carnivore's signs are collected, and genetic analysis of scats confirmed the presence of AC. The AC has never been studied for this eco-region where prey communities are expected to be different than those from northern areas. The first information about the status and biology of the AC in this region will be obtained while leaving a legacy of trained persons to carry out monitoring and conservation planning for the AC for years to come.

### 135. REFINING MAMMALIAN RANGE MAPS FOR MACROECOLOGY AND CONSERVATION

*\*Ginevra Lillian Ryman, UCSD; \*Walter Jetz, UCSD*

Species' extent of occurrence range maps (EOO maps) are currently the basis for many studies in macroecology and

conservation biology. However, the methods used in generating these maps have inherent problems with range overestimation. Overestimation of bird species range sizes increases with decreasing range size, and habitat breadth: the species of the highest concern to conservation biologists often have the highest range overestimation. Such overestimations may lead to a falsely optimistic picture of starting conditions in the face of impending climate and land-use change. Improvement of EOO maps is therefore highly needed. In this study we have used simple, qualitative habitat models for mammals to increase range map quality. Literature information on habitat preferences was linked to the 22 habitat categories for which a global land-cover map at 1km<sup>2</sup> resolution was available. Subsequently this land-cover map was used to clip off from species' EOO all habitats that are clearly unsuitable. Out of the 2,649 maps of terrestrial mammals available, clipping resulted in a mean reduction of 34.8% of range area compared to the original unclipped EOO maps. Validation of range refinement using known species presence points confirmed minimal levels of false absences incurred by the procedure. The resulting maps will prove to be a valuable data set for conservation biologists and macroecologists, and allow for more accurate conservation assessments of threatened species.

### 136. INFERENCE MONITORING OF GLOBAL CHANGE IMPACT ON BIODIVERSITY

*\*Florencia Sangermano, Clark University*

One of the fundamental aspects of assessing the impact of climate change on biodiversity is the monitoring of biodiversity and ecosystems. With rapid global changes, there is a need of a rapid assessment of biodiversity status for conservation and management purposes. Current approaches on monitoring biodiversity rely mainly on long term observations of predetermined sites and re-sampling of previously surveyed regions, with the disadvantage that they require large amounts of time, money and personnel to be executed. The use of remotely sensed data has high potential for the inference of ecological status, because with satellite images it is possible to monitor large areas in short periods of time. Despite this known advantage and the large amount of remotely sensed data publicly available, just a few datasets (mostly related to land cover and elevation) have been used for this purpose. In this work I present preliminary results of a method for inferential monitoring of the impact of global change on biodiversity. Applied to a subset of South American mammals, the method combines changes in climate extracted from remotely sensed data, with environmental niche information from species distribution modeling techniques, to generate maps of biodiversity stress. The results of the stress maps produced with this method are in agreement with peer-reviewed results based on field measurements showing the power of the technique for inferential biodiversity monitoring.

### 137. SPATIAL USE AND HABITAT SELECTION OF WHITE-TAILED SEA EAGLES (HALIAEETUS ALBICILLA) IN NORTHERN GERMANY

*\*Friederike Scholz, Institute for Zoo and Wildlife research; \*Oliver Krone, Institute for Zoo and Wildlife Research*

Information on spatial use and special habitat requirements of a threatened species are of particular interest for conservation and management issues. Since July 2006 various aspects regarding these topics have been studied extensively in adult white-tailed sea eagles (*Haliaeetus albicilla*) by means of GPS telemetry within the framework of our project. Currently, locations of seven sea eagles wearing backpack transmitters are existent.

All locations are imported into a Geographic Information System (GIS) using vegetation maps and digital orthophotos as basic layers for habitat analysis. The six animals investigated yet used home ranges of 10,7 to 114,3 km<sup>2</sup> (100% Minimum Convex Polygons) and 1,3 to 7,5 km<sup>2</sup>, respectively (95% Fixed Kernel estimates). Habitat composition within home ranges was different from the composition of the study area, with a smaller proportion of agricultural areas and settlements within home ranges. Concerning GPS locations, distinct preference of riparian vegetation and avoidance of agricultural areas and settlements was found using log-likelihood chi-squared statistics. The sea eagles were detected considerably closer to habitat edges than would have been expected from a random distribution, suggesting the importance of edge structures as perches. By the protection of habitat structures identified as crucial for sea eagles by these and prospective results, the ongoing recovery of the German sea eagle population can be directly supported.

### 138. IMPLICATIONS OF GPS COLLAR ERROR ON WILDLIFE HABITAT USE STUDIES: THE ASIATIC BLACK BEAR OF SICHUAN CHINA

*\*Jewel Andrew Trent, Virginia Tech; \*Mike Vaughan, Virginia Tech; \*William J. McShea, Smithsonian Institution*

Abstract: While GPS collars are fast becoming the tool of choice for habitat use studies of large and far ranging animals, little attention has been given to the effects of GIS error on results. Studies employing radio tracking data mapped on GIS habitat layers are especially susceptible to erroneous results due to the use of multiple layers of remotely collected data. To determine the habitat use, landscape scale movement, and spatial patterns, an adult female Asiatic black bear (*Ursus thibetanus*) was fitted with a GPS collar in Tangjiahe Nature Reserve, Sichuan, China. GPS radio tracking data were analyzed to determine both GPS point location error and GIS habitat boundary error. The impacts of such error on habitat use were then determined by placing buffers around each point and around every habitat edge. Preliminary data analysis demonstrates that within any given point buffer area the presence of one distinct habitat type was low at 22% (N=50), whereas the added habitat buffers resulted in a distinct habitat type at 56% (N=50) of the points. To develop an accurate model of habitat use, the proportion of habitats within each buffer zone were utilized to represent habitat use for that specific point. This resulted in an increase in the total number of habitat types used and a redefined matrix of proportional habitat use. These results reveal how GPS and GIS errors can impact habitat use determination and the importance of compensating for such errors.

### 139. PRIORITY SETTING FOR THE CONSERVATION OF BIRDS IN COLOMBIA, AN APPROACH TO THE CHALLENGE OF PRESERVING THE REMAINING FORESTS IN THE TROPICS

*\*Clara Isabel Bohorquez, American Museum of Natural History - Center for Biodiversity and Conservation*

Identifying conservation priorities is particularly essential in the tropics where most of the biodiversity of the planet is found and where habitat transformation and deforestation is an increasing threat. The lack of complete biological inventories and collecting biases makes ecological modeling useful for predicting the distribution of species and selecting areas that are most suitable for protection, using point occurrence data and environmental feature maps. Spatial distributional models

can be used to predict current distribution of species in untransformed landscapes and to select those areas most suitable for conservation by combining the predicted current distributions with socio-economic variables. To illustrate this modeling approach, I provide conservation opportunity maps for a set of bird species from the Colombian Andes. This overall methodology shows enormous potential for selecting priority areas for conservation particularly in the tropics, where frameworks for defining regional conservation priorities are usually lacking and where conservation effective actions are an urgent necessity.

#### 140. USE OF THE CRITTRZ SIMULATION SYSTEM TO MODEL GENETIC AND DISEASE PROCESSES IN POPULATIONS WITH DYNAMIC SPATIAL AND SOCIAL STRUCTURES

*\*Thomas Joseph Olivier, Green Creek Paradigms, LLC*

This report describes abilities of the CRITTRZ simulation system to model gene frequency dynamics and infectious disease transmission in mammalian populations subdivided by complex, spatial and social structures. CRITTRZ is an open-source population simulation library written in the Python computer language. It provides modules for simulation of a host of population processes, including age and sex structured survival and reproduction, migration between subpopulations, group fissions and fusions, diploid gene inheritance and infectious disease transmission. It can manipulate Idrisi GIS raster data directly or indirectly via calls to Idrisi software functions. Raster data layers are used to represent landscape states ( such as resource distributions ) and population states ( such as group home ranges and local population densities ). CRITTRZ simulations of gene and infectious disease transmission in Old World monkey populations are presented. Simulated monkey populations are distributed over heterogeneous landscapes, subdivided into groups that fission and fuse, occupy changing home ranges and exchange migrants. Analyses of disease spread patterns and gene distributions in populations with different structural and process assumptions are presented. These applications demonstrate the ability of CRITTRZ to model localized, complex population processes often of interest to conservation biologists.

#### 141. DO TARGETED CONSERVATION PRACTICES ENHANCE GRASSLAND BIRD CONSERVATION? EVALUATING THE SUCCESS OF USDA HABITAT BUFFERS FOR UPLAND BIRDS

*\*Sam Riffell, Mississippi State University; \*L. Wes Burger, Mississippi State University; \*Rick Hamrick, Mississippi State University; \*Kristine Evans, Mississippi State University; \*Mark Smith, Auburn University*

The Conservation Reserve Program provides financial incentives to voluntarily retire cropland into conservation practices. In 2004, a targeted, native grass conservation practice - CP33 Habitat Buffers for Upland Birds - was created to help meet specific habitat goals of the Northern Bobwhite Conservation Initiative for northern bobwhite and other grassland birds. To monitor bird response in Mississippi, we randomly selected 40 CP33-buffered fields and paired them with unbuffered control fields with similar cropping system and adjacent habitats within the same landscape. We surveyed singing males at field margins during summer 2006 and 2007.

We used Poisson regression to test for effects of CP33 buffers, but first controlled for effects of weather and surrounding land use. Dickcissel, Northern Bobwhite, Mourning Dove, Northern Mockingbird, Red-bellied Woodpecker, and Red-winged Blackbird were significantly more abundant ( $P < 0.10$ ) on CP33 bordered fields during at least one year. In agricultural landscapes, CP33 field buffers may increase available habitat non-target species in addition to target species. When programmatic incentives are targeted to specific habitat objectives, the Conservation Reserve Program has great potential to help ameliorate current population declines for grassland- and edge-associated species. Continued monitoring of existing practices is necessary to better target CRP subsidies and increase the program's habitat benefits.

#### 142. A DEVELOPER-INITIATED CONSERVATION PLAN FOR POOL-BREEDING AMPHIBIANS: MIXED QUALITATIVE AND QUANTITATIVE RESEARCH

*\*Nate K Colbert, Antioch University New England; \*Robert Fritz Baldwin, Clemson University*

In North America, increasing conversion of rural land to residential subdivisions plays a major role in habitat destruction and fragmentation of wetland landscapes. Some developers incorporate habitat into "conservation subdivisions" because clients prefer an environment rich in biodiversity. In the State of Maine (USA), a new law to protect vernal pool wildlife encourages developers to design their projects around amphibian conservation needs. This study documents the efforts of one developer to incorporate two vernal pools, wetland buffers, and migration connectivity into his site plan. To estimate population viability, we surveyed breeding populations of amphibians and characterized and mapped major terrestrial and neighboring wetland habitats using field plots, air photos, and a GIS. Egg mass counts for spotted salamanders (69 at pool A, 113 at pool B) exceeded thresholds for "biological significance" under the law; wood frogs were present (29 at pool A, 33 at pool B). Based on our biological inventory and mapping, the developer incorporated the pools, buffers, and migratory corridor into his deed as a conservation easement. Interviews we conducted with neighboring landowners revealed a willingness to extend these protections at larger scales. Interviews with the developer revealed a profit motivation. While isolated, this project serves as a case study for developers and/or regulators wanting to design conservation plans for amphibians, based on local conditions.

#### 143. ASSESSING THE POTENTIAL FOR LARGE-SCALE HABITAT CONVERSION IN THE NORTHERN APPALACHIAN/ACADIAN ECOREGION

*\*Robert Fritz Baldwin, Clemson University; \*Stephen Christopher Trombulak, Middlebury College; \*Elizabeth Baldwin, Clemson University; \*Gillian Woolmer, Wildlife Conservation Society Canada*

North American landscapes that have long been lightly settled by people are experiencing widespread conversion to vacation residences and infrastructure. As developers seek amenity-rich lands, conservation planners require an array of spatial methods to anticipate risk. To forecast conversion in the Northern Appalachian/Acadian ecoregion (330 000 km<sup>2</sup>), we developed a screening process to distinguish at-risk portions of the landscape based on urban area proximity, size of amenity, gaps in protection, and likelihood that land owners will develop (the ecoregion is dominated by large-scale parcels traditionally

managed for forestry and increasingly for real estate [e.g., as REIT's]). Screening was designed to be easily modified by planners. In a GIS, we added developable zones to the 10 783 lakes and ponds in the ecoregion and assessed risk to these lands based on protection and private ownership category at two distances from 15 major urban areas. Thirty-eight of 387 landowners were most likely to develop their lands, and 11 of these accounted for 97.5% of the total high risk area (625-1118 km<sup>2</sup>). Nearly all high-risk land (94.6%) lay outside of currently settled areas; most (69.1%) was under the purview of a single agency, the Land Use Regulatory Commission of Maine, suggesting a policy solution. Large-scale, highly dispersed conversion of lightly settled, privately owned forests represents risk to the natural amenities themselves (i.e., lakes) and to landscape integrity.

#### 144. SNAPSHOT OF BIODIVERSITY ON COFFEE PLANTATIONS IN THE EL TRIUNFO BIOSPHERE RESERVE: MAKING A BASELINE FOR FUTURE MONITORING OF EASEMENT EFFECTIVENESS

*\*Juan Pablo Galvan, University of Maryland, College Park*

We conducted snapshot surveys of birds, mammals, reptiles, and amphibians and collected survey data on threats to biodiversity on conservation easements on four shade-coffee plantations in the buffer zone of the El Triunfo Biosphere Reserve in Chiapas, Mexico. The data collected in July 2007 showed that bird diversity across plantations was fairly similar, ranging from 82-94 species, and that other species of high conservation priority, such as Jaguar and Baird's Tapir, occur on easements. While there is high biodiversity present in forest patches on plantations and owners are committed to green-coffee certification and conservation easements, threats such as poaching, fire, and negative attitudes towards certain wildlife species exist. Survey data were used to produce baseline data reports that will be used by Pronatura Sur, a regional conservation organization, to monitor threats and conservation targets on the plantation easements as part of the organization's Voluntary Lands Conservation Program (VLCP). This program has worked with landowners since 2000 to preserve biodiversity on private lands within the reserve and ensure the biological connectivity of core zones through conservation easements. By utilizing conservation easements on private lands the VLCP can help ensure that El Triunfo, which includes the largest and most well preserved patches of cloud forest in Mexico, remains one of the most pristine and diverse natural areas in the country.

#### 145. SOUTHERN CALIFORNIA: ECOLOGICAL RESILIENCE & LANDSCAPE-SCALE RESTORATION

*\*David Olson, Irvine Ranch Conservancy; \*Megan Lulow, Irvine Ranch Conservancy; \*Jutta C Burger, Irvine Ranch Conservancy; \*Jared Considine, Irvine Ranch Conservancy; \*Michael O'Connell, Irvine Ranch Conservancy*

Over a century of intensive grazing, waves of invasive weeds, and urbanization have all increased fire frequency and contributed to progressive type conversion of Southern California's native ecosystems to alien-dominated landscapes. Given this situation, rapid restoration of ecological resilience is necessary to stabilize and reverse downward trajectories of many species, habitats, and processes. Merely protecting the land is no longer enough to preserve it. We propose that by taking the following seven key management actions, ecological

resilience of native habitats can be restored to southern California wildlands. In order of priority based on their estimated ecological importance and need for management attention, they are to: (1) dramatically reduce fire frequency, size and intensity; (2) strategically and rapidly restore native vegetative structure to non-native habitats; (3) reduce mortality of larger carnivores through safe internal (priority) and external (secondary priority) corridors and reduction in rodenticide use; (4) protect and restore 'climate change corridors' of healthy native habitat across priority environmental gradients; (5) strategically control invasive species; (6) ensure drought refugia for wildlife; and (7) manage human access. As management objectives are achieved on each of these activities, their relative priority for action and investment may shift over time.

#### 146. DOES REMOTELY SENSED LAND-COVER CHANGE SIGNAL LATENT IMPACTS ON TREE SPECIES DIVERSITY WITHIN A PROTECTED AREA?

*\*Sarah J. Corey, Ohio State University; \*Thomas A. Waite, Ohio State University; \*Lesley Geillis Campbell, Rice University; \*Anil K Chhangani, The School of Desert Sciences; \*Jennifer Rice, University of Arizona; \*Paul F Robbins, University of Arizona*

Land-cover change detected within protected areas should be cause for concern. Such change could be the signature of chronic illicit activities including fuelwood collection and livestock grazing, which could leave a legacy of ecological degradation. Using remotely sensed data, we recently documented extensive land-cover change in the Kumbhalgarh Wildlife Sanctuary in Rajasthan, India. Vegetation density changed in a quarter of pixels during the first 13 years (1986-1999) following the sanctuary's establishment, with many patches showing a decrease and others showing an increase. Here, we use on-the-ground data subsequently collected in 132 random plots to explore whether the remotely sensed changes indicated impending changes in diversity of woody plants. We show that species richness, species sharing, species assemblages, and incidence of invasive and useful species were statistically similar among plots in which vegetation density had decreased, increased, or remained similar. Not only did we fail to provide evidence for wholesale shifts in diversity following land-cover change, but we also report that intensity of disturbance associated with human activities was similar across plot types. Our findings prompt further reflection on the efficacy and outcome of restrictions on resource use within protected areas flanked by large populations of resource-dependent humans.

#### 147. EVALUATION OF A NATURAL DISTURBANCE MODEL APPROACH TO FOREST MANAGEMENT: A STUDY OF THE CAVITY-USING COMMUNITY.

*\*Hilary Cooke, University of Alberta; \*Susan Hannon, University of Alberta*

Based on the premise that wildlife in boreal ecosystems are adapted to fire, the Natural Disturbance Model (NDM) prescribes forest harvesting that approximates the spatial extent and residual unburned structure associated with fire disturbances. We evaluated the efficacy of this approach for conserving the cavity-using community in two pairs of large (>1500 ha) unharvested and NDM-harvested mature mixedwood forests in Alberta and Saskatchewan, Canada. In unharvested landscapes Northern Flickers (*Colaptes auratus*), Hairy Woodpeckers (*Picoides villosus*), and Pileated

Woodpeckers (*Dryocopus pileatus*) were keystone cavity excavators and Yellow-bellied Sapsuckers (*Sphyrapicus varius*) were dominant excavators. The excavating guild in the harvested landscapes was similar in composition to the unharvested landscapes but had fewer Sapsuckers and more Flickers. In the harvested landscapes Flickers and Pileated Woodpeckers persisted as keystones while Sapsuckers remained dominant excavators. Flickers used open areas with small residual patches whereas Sapsuckers used large patches. We conclude that 1) despite changes in the abundances of mature boreal excavators the functional role of keystone and dominant excavators is preserved in an NDM-harvested landscape, and 2) keystone and dominant excavators selected for a range of residual patch sizes provided they included large-diameter, diseased trees.

#### 148. THE BALANCE BETWEEN BIODIVERSITY CONSERVATION, ECONOMIC BENEFIT FLOW TO COMMUNITIES - TEMBE ELEPHANT PARK, PART OF THE FUTU - TEMBE TRANFRONTIER AREA

*\*Wayne Matthews, KZN Wildlife*

Wedge up against Mozambique is KwaZulu-Natal's Tembe Elephant Park, which the Tembe people gave up for conservation 20 years ago, to protect the people from elephants and produce benefits to the communities. Can protected area management and planning be based on ecological economics, while still conserving the biodiversity associated with a hotspot, an example from Maputaland, South Africa? Tembe as part of the Maputaland Centre of Plant Endemism [MC] is acknowledged as one of the important centres of plant diversity/endemism in Africa. The principal hypothesis is that the MC is characterised by plant communities that match particular set of environmental variables, and the biodiversity reflecting the geomorphological history of the region. Vegetation studies highlighted two plant communities endemic to the MC, namely Sand Forest and Woody Grassland. The dynamics of the vegetation types and role of elephant and other ungulates is presented. To achieve an overall balance between the components it is critical to develop a unified, clear vision so as to achieve a park's mandate. In TEP the Integrated Management Plan (IMP) is vehicle that is used to develop a unified, clear vision. The IMP forms the framework within which the reserve will be managed, aligned and developed in an endeavour to achieve the biodiversity conservation, ecotourism and partnership objectives as envisaged by the various stakeholders during a consultative planning process.

#### 149. COMPOSITION, STRUCTURE, AND DENDROECOLOGY OF A MIXED PINE-HARDWOOD FOREST, SOUTHERN CUMBERLAND PLATEAU, ALABAMA: IMPLICATIONS FOR ECOSYSTEM MANAGEMENT

*\*Arvind Aniel Rombawa Bhuta, Department of Geography, Virginia Tech; \*Justin L. Hart, Department of Geography, University of North Alabama; \*Rebecca L. Murray, Conservation Management Institute; \*Laura E. Hendrick, Conservation Management Institute*

The Cumberland Plateau is known for high gamma diversity. However, quantitative information documenting this diversity and its drivers are limited forcing land managers to make decisions based on limited knowledge. Redstone Army Arsenal (RAA) is located on the southern Cumberland Plateau in Alabama. RAA is actively engaged in multi-land use forest

ecosystem management for their forestland. Land uses include: U.S. military mission support; recreational opportunities; enhancing biodiversity and wildlife productivity; and maintaining ecosystem health. To aid in the development of a resource management plan promoting biodiversity and ecosystem health, while contributing to an understanding of gamma diversity, we quantified species composition and stand structural characteristics at RAA. Dendroecological techniques were used to evaluate stand age, document historical forest disturbance, and the relationship between climate and annual tree growth. Forests were delineated into 481 stands > 2 ha via 684 inventory points and 593 stands < 2 ha via GIS. Of the total 5907 ha surveyed, 1586 ha were pine dominated, 2671 ha were hardwood, and 2015 ha were mixed pine-hardwood. This study provides land managers at RAA with quantitative information on their forestlands and adds to the knowledge base for ongoing conservation efforts in the greater Cumberland Plateau region.

#### 150. MONITORING CARBOFURAN RESIDUES IN THE ENVIRONMENT AND ASSESSING THE RISKS TO VULTURES IN KENYA

*\*Peter Otieno, Maseno University; \*Joseph Lalah, Maseno University; \*Munir Virani, The Peregrine Fund, National Museums of Kenya*

All vulture species in Kenya face imminent extinction as a result of an increase in the number of environmental poisoning incidents. There is concern that exposure to carbofuran, a cholinesterase inhibitor, is the major cause of reported vulture mortalities. Furadan is stocked in most agro-chemical outlets within areas surveyed and marketed widely in Kenya. Local people in areas around wildlife conservancies in Laikipia and Isiolo districts, two affected areas, have also admitted to using carbofuran to poison mammalian predators such as lions in response to loss of pastoral livestock. A survey will be carried out in these districts, especially in the areas around the conservancies, to ascertain level of carbofuran usage in the region and investigate alleged misuse. Environmental and suspicious carcass tissue samples will be analysed for residues of carbofuran and metabolites via HPLC. From these results, potential routes of exposure to vultures will be identified and an ecological risk assessment drawn up. The results of the study will be used as a basis to advise government, farming groups, wildlife conservationists, and environmentalists on the need to restrict or ban the use of carbofuran in Kenya. This discourse is essential given the continued, elevated incidences of wildlife mortality and the potential repercussions to people. The presentation will cover our findings and discuss some of the challenges, such as carrying out the work in the midst of political upheaval.

#### 151. OBJECTIVE CRITERIA FOR SELECTING COVERED SPECIES AND ACTIVITIES IN MULTISPECIES HABITAT CONSERVATION PLANS ON THE CUMBERLAND PLATEAU, TENNESSEE

*\*Trisha Johnson, Tennessee Technological University; \*Mark Thurman, Tennessee Wildlife Resources Agency; \*Kirk Miles, Tennessee Wildlife Resources Agency; \*Alex Wyss, The Nature Conservancy; \*Haydn T Mattingly, Tennessee Technological University*

A Habitat Conservation Plan (HCP) is required to apply for an Incidental Take Permit under Section 10 of the U.S. Endangered Species Act. Permit applicants may elect to cover multiple listed/nonlisted species and any number of landuse

activities that could cause incidental take of the covered species. A recent critique of multispecies HCPs revealed substantial variability among HCPs regarding (1) confirmation of species' presence in the project area and (2) the degree to which species-specific conservation measures are included in the plan. Here we present an objective approach for permit applicants to select appropriate species and activities for coverage in multispecies HCPs, and illustrate the approach using our current efforts to support development of two HCPs on Tennessee's Cumberland Plateau. First, we created general flow charts, one for species selection and one for activities selection, containing criteria that should be widely applicable to most multispecies HCPs. Then we modified the charts using the State Wildlife Action Plan (SWAP) model for Tennessee. In short, our approach involves a progressive, systematic culling of putative species and activities until the resulting short lists contain only those meeting the criteria in our flow charts. Species and activities eventually recommended for coverage should therefore have both a strong scientific and legal basis for inclusion.

#### 152. THE CHICAGO WILDERNESS GREEN INFRASTRUCTURE VISION: IMAGINING A FUTURE FOR NATURE AND PEOPLE IN A METROPOLITAN LANDSCAPE

*\*Christopher Richard Mulvaney, Chicago Wilderness; \*Laurel Ross, The Field Museum; \*Jonathan Markel, The Field Museum; \*Dennis Dreher, Cowhey Gudmundson Leder, Ltd.*

Human development often occurs with little or no consideration of the surrounding natural landscape. Ironically, this can be an important component for human welfare, especially given both increasing threats from major environmental challenges such as global climate change and the recognized health benefits acquired from direct access to green space. In this poster, we present a model vision for the Chicago region that was developed by Chicago Wilderness (CW), a consortium of over 220 public and private organizations dedicated to preserving biodiversity in the greater Chicago metropolitan region. The Green Infrastructure Vision (GIV) is a map-based interpretation of goals outlined in the 1996 CW Biodiversity Recovery Plan that identifies 1.8 million acres of "Resource Protection Areas" surrounding the 360,000 acres of protected land within the Chicago landscape. The 140 Resource Protection Areas mapped by the GIV serve as opportunities to focus land acquisition, expand restoration on private land, and promote greenway connections, conservation easements, conservation design practices, agricultural preservation, protection of sensitive groundwater recharge areas, implementation of wastewater reclamation alternatives, and protection of stream and wetland buffers. Chicago Wilderness member organizations are presently working to integrate the GIV into regional and local planning efforts and to achieve on-the-ground implementation of its many biodiversity recommendations.

#### 153. CLASSIFICATION OF PROTECTED AREAS SYSTEM IN THAILAND FOR CONSERVATION PRIORITY

*\*Yongyut Trisurat, Kasetsart University; \*Anak Pattanavibool, Wildlife Conservation Society, Thailand Program*

Protected areas in Thailand were first established 45 years ago. Currently there are more than 200 protected area units covering approximately 19% of the country's land area. The government of Thailand intends to increase protected area systems to 30% of the country in 2016. The objective of this paper is to address

the effectiveness of protected area systems for biodiversity conservation. This research classified 187 terrestrial national parks and wildlife sanctuaries into five classes from very high to least resource potential for biodiversity conservation. The Linear Combination Method of multiple criteria of 10 biophysical factors and human threats, as well as international recognition was employed to assess protected areas. Each factor was ranked and weighted by national experts based on the characteristics of each protected area. The results reveal that 15 protected areas were classified as very high resource potential. High, moderate, low and least resource potential classes encompassed 42, 67, 52 and 11 units, respectively. The Department of National Park Wildlife and Plant Conservation is now proposing this finding to the Ministry of Natural Resources and Environment in order to revise the existing protected area categories and management structure.

#### 154. LANDSCAPE CONSERVATION PLANNING BALANCING WILDLIFE AND HUMAN NEEDS IN A DATA POOR CONTEXT

*\*David Gerard Williams, African Wildlife Foundation; \*Julie Luetzelschwab, USDA Forest Service; \*Jef Dupain, African Wildlife Foundation; \*John Sidle, USDA Forest Service; \*Janet Nackoney, University of Maryland Dept. of Geography*

In many high biodiversity areas, conservation planners are challenged by vast data gaps. Set in the Democratic Republic of Congo, the 74,000 Km<sup>2</sup> Maringa-Lopori-Wamba landscape supports diverse and rare fauna including the endangered bonobo. The landscape is one of the Congo Basin's least developed and remote regions. Its inhabitants are some of the poorest in Africa; most depend on natural resources to meet basic needs. Land use planning is needed to address a growing human population and the potential of a revived logging sector which jeopardize both biodiversity and livelihoods. The African Wildlife Foundation worked with partners including the USDA Forest Service to apply a landscape zoning approach that segregates key conservation areas from incompatible land uses balancing the needs of people and conservation targets. Facing a dearth of explicit or surrogate spatial data for conservation targets, the team used MARXAN to first target "human reserves"-land best suited to human habitation-before applying conservation constraints such as existing protected areas, connectivity, and key habitat areas in subsequent scenarios. The systematic approach added confidence to decision-making fostering an efficient configuration of envisioned protected areas, community-based natural resource management areas, and sustainable agriculture and fisheries management interventions. While a valuable planning tool, it requires validation and community participation to be implemented.

#### 155. ESTABLISHING PROTECTED AREAS DURING TROUBLED TIMES: BAND-I-AMIR NATIONAL PARK, AFGHANISTAN

*\*Mohammad Ayub Alavi, Wildlife Conservation Society (WCS)*

Afghanistan encompasses a surprisingly diverse assemblage of wildlife and plant species resulting from its location at the intersection of three Biotic Realms and its varied topography. However, the country's biodiversity has been significantly eroded by millennia of intensive land use and recent decades of conflict. Conservation efforts in Afghanistan have been hampered by security concerns, the economic insecurity of local people and structural discrepancies between western concepts of environmental preservation and traditional approaches to land tenure and decision-making. Here, we focus

on the evolution of Band-i-Amir National Park, which was first slated as a protected area prior to the outbreak of hostilities in 1979. Band-i-Amir is composed of six, high-altitude, travertine-dammed lakes of exceptional beauty. However, these unique geologic formations and associated native flora and fauna are threatened by profoundly unsustainable practices of resource use. Here we examine early successes and challenges in establishing a protected area in a post-conflict region characterized by biodiversity loss, population increase, poverty and traditional practices. Although Band-i-Amir National Park is still in its development phase, initial results affirm that established principles of protected area development can be successful in troubled regions.

#### 156. MODELING RED SQUIRREL POPULATION VIABILITY UNDER A RANGE OF LANDSCAPE SCENARIOS IN FRAGMENTED WOODLAND ECOSYSTEM ON THE SOLWAY PLAIN, CUMBRIA, UK

\**Claire D Stevenson, University of Cumbria;*  
\**Darren G Moseley, Forest Research;* \**Andrew D Ramsey, University of Cumbria;* \**Owen T Nevin, University of Cumbria*

To assess the viability of the red squirrel *Sciurus vulgaris* in fragmented woodlands on the Solway Plain we used a combination of Vortex population viability analysis and BEETLE (Biological and Environmental Evaluation Tools for Landscape Ecology). Habitat fragmentation and the expansion of the North American grey squirrel *S. carolinensis* have had a detrimental effect upon red squirrel populations in the UK; assessing the viability of the remaining populations can guide in conservation management decisions. The initial field work showed red squirrels to use 5 of the 23 woodland fragments on the Solway Plain at a density of 0.65 squirrels ha<sup>-1</sup>, with a minimum dynamic area of 66 ha of red squirrel woodland habitat being identified using Vortex. Red squirrels may use more than one woodland fragment in its home range as long as fragments are connected functionally with the land cover between fragments producing a low cost for the squirrel. The functional connectivity of these woodland fragments was modeled within BEETLE to create habitat networks. Vortex was then used to identify which habitat networks would hold a viable population. Two areas were identified which could, if the correct landscape management is prescribed, potentially hold viable populations of red squirrels on the Solway Plain. This combination of behavioral, demographic and landscape modeling allows scenario building and has application across a wide range of conservation area design problems.

#### 157. BIODIVERSITY OF AKSU-DZHABAGLY STRICT NATURE RESERVE, THE OLDEST IN CENTRAL ASIA

\**Irina Jashenko, Tethys Scientific Society;* \**Roman Jashenko, Institute of Zoology*

Eighty year old nature reserve Aksu-Dzhabagly is located in the Kazakhstan part of the West Tien Shan. Our analysis of regional biodiversity and own data on invertebrate fauna as well as published information on flora and vertebrate species show that Aksu-Dzhabagly plays an important role in regional biodiversity conservation. Aksu-Dzhabagly has a high level of representation of the whole West Tien Shan biodiversity. It has almost all regional landscape types, 14 of 16 vegetation types, 72.5% of vertebrate species, more than 50% of invertebrate species, 51.3% of vascular plant, and about 80% of fungi species. There are 10% of endemic plant species from 30% endemic genera and about 50% endemic invertebrate species. Flora consists of 1737 species (including 1312 vascular plants,

64 lichens, 63 alga, 64 bryophytes, 235 fungi); 72 species are the ancestors of agricultural plants. Known invertebrate species consists of 53 mollusks, more than 2500 insects (77 orthopterans, 388 hemipterans, about 1000 beetles, 175 hymenopterans, 463 lepidopterans), etc. Vertebrate species include 7 fishes, 3 amphibians and 11 reptiles (regionally 70%), 267 birds (130 nesting, 137 wintering or migrating), 52 mammals (regionally 79.6%). The major threats are fires and illegal tourism in border areas as well as poorly-qualified personnel.

#### 158. HISTORICAL AND ACTUAL DISTRIBUTION PATTERNS OF THE GIANT OTTER (*PTERONURA BRASILIENSIS*) IN BOLIVIA

\**Veronica Denisse Zambrana Rojas, Asociación Faunagua*

The giant otter (*Pteronura brasiliensis*) is one of the most endangered mammals in South America (IUCN). For Bolivia, little is known about this species and basic information on habitat requirements is lacking. In order to assess and explain the actual distribution patterns of *Pteronura*, a Bolivian giant otter research team (LONDRA WATCH) started the collection of reliable data on the species, overcoming financial, logistic and time limitations. The first results show a significant recovery of the giant otter in clear water floodplains (occurrence in 90% of total quadrants), compared with white water floodplains (occurrence in 10% of total quadrants). So far, it is not known which habitat factors affect the distribution patterns of giant otters. Actual distribution seems to be influenced both by historical hunting patterns and by present human presence. Moreover, our results show that clear water systems provide very suitable habitat for the species and can play an important role in the recovering of the giant otter on a national scale. On the other hand, it is thought that the lower productivity of these systems may set a limit to local giant otter density. Key words: Bolivia, Amazon floodplains, distribution patterns, *Pteronura*. Zambrana, Verónica. Asociación Faunagua, Sacaba-Cochabamba, Bolivia. E-mail: [veronicazambrana@gmail.com](mailto:veronicazambrana@gmail.com)

#### 159. RECOVERY DYNAMICS AND VIABILITY OF THE WHITE-TAILED EAGLE (*HALIAEETUS ALBICILLA*) IN GERMANY

\**Justine Sulawa, Leibniz Institute for Zoo and Wildlife Research;* \**Alexandre Robert, UMR 5173 MNHN-CNRS-UPMC;* \**Ulrich Köppen, Hiddensee bird ringing centre;* \**Oliver Krone, Institute for Zoo and Wildlife Research*

Understanding the effect of protection measures on the recovery of endangered populations is crucial for assessing the efficiency of management plans. Following the ban of DDT, PCB and other detrimental chemicals in the 1970s, the European white-tailed eagle populations exhibited rapid recovery dynamics. Using nest monitoring data, CMR data and population dynamics models, we examine both short and long term viabilities of the German population of the species. In a first step, the analysis of dead recovery data of 1273 individuals ringed as nestlings between 1991 and 2006 allowed estimating survival rates. Results indicated that the annual survival rate was higher for immature birds ( $s_{1-5} = 0.92$ ) than for adults ( $s_{>6} = 0.88$ ), a pattern presumably explained by territorial fights, which are frequent among adult breeders. This result was confirmed by the analysis of reproduction data uncovering a negative density dependent relationship on the proportion of breeding pairs having a territory. In a second step, a two-sex age structured model was used to examine the joint effect of

population regulation (number of suitable territories), environmental and demographic stochasticities. All results indicated that only pessimistic scenarios with strong inter-annual variation in demographic parameters and very small carrying capacity could lead to substantial extinction probabilities within 100 years. The efficiency of management measures is discussed in the light of these results.

#### 160. HABITAT ANALYSIS OF BLACK-TAILED PRAIRIE DOGS TO SUPPORT THE REINTRODUCTION OF BLACK-FOOTED FERRETS IN CANADA

*\*Tara Stephens, University of Calgary; \*Darren Bender, University of Calgary; \*David Gummer, Parks Canada*

The black-footed ferret, a specialist predator of prairie dogs, was extirpated from Canada prior to 1974. Currently, a national recovery team is working to re-introduce ferrets in black-tailed prairie dog colonies in Grasslands National Park in southwestern Saskatchewan, Canada. Establishment of a viable population of ferrets will largely depend on the size and distribution of the prairie dog metapopulation. Our research objectives are to identify the characteristics and spatial configuration of prairie dog habitat and estimate the relative viability of the prairie dog metapopulation and its capacity to support ferrets. We used a resource selection function (RSF) to investigate prairie dog habitat associations and generate an inventory of potential prairie dog habitat. We found that prairie dog occurrence is predictable from surficial geology, soil texture, elevation, slope and aspect. We identified 3240 ha of habitat with high probability ( $P > 0.85$ ) of predicted use by prairie dogs - 3 times more than believed necessary to establish new prairie dog colonies to support ferrets. The predictive surface generated from the RSF will be used in a viability analysis to assess the sensitivity of the prairie dog metapopulation to environmental, ferret reintroduction and prairie dog management scenarios. Our results will provide preliminary estimates of theoretical carrying capacity for ferrets in Canada and direction for habitat and population management for both species.

#### 161. DYNAMICS OF POPULATION DECLINES IN BLACK ABALONE WITHIN THE CALIFORNIA CHANNEL ISLANDS: IMPLICATIONS FOR THE PERSISTENCE OF REMAINING POPULATIONS

*\*Tal Ben-Horin, University of California Santa Barbara*

Among the projected outcomes of human-induced climate change is the extinction of many species, however predicting the specific effects of climate change is often confounded by associated and interacting processes. The black abalone, *Haliotis cracherodii*, along with all species of California abalone, has experienced significant declines in abundance over portions of its range over the past few decades. A combination of stressors has contributed to these declines including overexploitation, habitat modification, and withering syndrome (WS), a chronic wasting disease first observed along the northern Channel Islands, California following the 1982-1983 El Niño. This disease, caused by a rickettsia-like prokaryote, has been found in wild populations of most abalone species south of Santa Mateo County and is augmented by food supply and thermal stress associated with anomalous sea surface temperature. The northward spread of WS has been well documented and under even modest scenarios of climate change it must be anticipated that this disease will impact individuals across this species' entire range. The dynamics of

declining populations were investigated at 10 permanent intertidal study sites in Channel Islands National Park to test hypotheses of deteriorating population dynamics as extinction nears. Simulations of processes driving population declines highlight the causal mechanisms of local extinctions and provide an outlook for the fate of remaining populations.

#### 162. DEVELOPMENT OF A CAPTIVE REARING PROGRAM FOR THE LARVAE OF THE ENDANGERED HINE'S EMERALD DRAGONFLY (*SOMATOCHLORA HINEANA*)

*\*Colleen Doyle Satyshur, University of South Dakota; \*Daniel Soluk, University of South Dakota*

Continuing threats from habitat destruction and climate change prompted development of captive rearing protocols for the federally endangered Hine's emerald dragonfly (*Somatochlora hineana*). Larvae take 3-5 years to emerge and require a habitat that features clean, spring and seep fed streamlets that dry for part of the year. During droughts and winter larvae survive by using the burrows of the predatory devil crayfish (*Cambarus diogenes*). Captive rearing began in 2003. Normally, larvae were housed individually in controlled environments where temperature and feeding regimes mimicked those in the habitat. During summer months, some larvae were placed in their original habitat in cages that allowed natural food sources, temperatures and light regimes while protecting larvae from predators. Large larvae were allowed to emerge in field enclosures. Survivorship ranged from 75% to 87% in 2005-6. To determine appropriate feeding and growth rates, captives were compared to wild-caught larvae. Head width, total length and weights were measured to reveal instar sizes and durations. The successful emergence rate was greater than 90% in 2005-6. Emergence of wild-caught and captive larvae overlapped in time. This work allowed the standardization of successful rearing methods for mid to late instar larvae. Captive rearing will allow testing of restored habitat, augmentation of populations and potentially re-introductions.

#### 163. EFFECTS OF CAPTIVITY ON PELAGE COLOR IN THE OLDFIELD MOUSE

*\*M. Elsbeth (Misty) McPhee, Cornell University*

Previous research shows that, for predator avoidance, natural selection favors a coat color in wild oldfield mice (*Peromyscus polionotus*) that matches the mouse's sandy substrate. In captive-bred populations of oldfield mice, significant changes in predator response behaviors and cranial morphology have been documented as a function of relaxed selection in the captive environment. This study tested whether or not coat color in the same populations of *P. polionotus* differed as a function of relaxed selection in captivity. If so, variance in coat color would increase with increased generations in captivity. Reflectance of pelages of mice from four populations (wild-caught, F2, F14, and F35). These data were reduced with a Principal Components Analysis and the two factors responsible for the majority of the variance were compared across populations with the Fligner-Killeen Test for Homogeneity of Variances and an ANOVA. Unlike cranial morphology and predator response behaviors, pelage color was not altered by generations in captivity. Neither variance nor mean reflectance differed across the four populations. These data suggest that coat color is not a costly trait to maintain in a predator-free environment. In addition, these results show that not all traits are vulnerable to altered selective forces in the captive environment. Thus when comparing captive-bred animals to their wild counterparts, multiple traits should be measured and mechanisms of change considered.

164. ESTABLISHING NEW POPULATIONS OF THE FEDERALLY ENDANGERED FORB, ASTRAGALUS BIBULLATUS, IN LIMESTONE CEDAR GLADES

\**Matthew Albrecht, Missouri Botanical Garden;*

\**Kimberlie McCue, Vanderbilt University*

Populations of the endangered cedar glade forb, *Astragalus bibullatus* (Pyne's Ground-plum), were introduced into two novel primary cedar glade sites as a safety net against extinction in the wild, where only 5 populations remain. Seed sourced from wild populations were used to develop seed germination and seedling establishment protocols at the Missouri Botanical Garden. Of the 272 seeds sown in greenhouse conditions, 56% germinated and 39% survived to the seedling stage. In the spring and fall of 2001, seedling cohorts were outplanted from six maternal lines into five different cedar glade plots within one primary glade site. Seedlings were monitored for survivorship, growth, and reproduction for five consecutive years. Overall, 11% of transplants survived, but there were differences in demographic performance among the five glade sites. Also, seed sourced from one maternal line consistently outperformed others across all transplant sites, demonstrating the importance of maternal effects in establishing novel plant populations. A small portion (16%) of transplants set seed over the entire monitoring period, and one new seedling recruit was observed at the transplant site in 2005. This study supports *ex situ* conservation protocols that emphasize the collection of propagules by maternal line, demonstrates that multi-agency collaboration is necessary when establishing new populations of endangered plants, and provides life-history information for future recovery planning.

165. AIRBORNE MULTI-SPECTRAL IMAGING AS AN ASSESSMENT AND MANAGEMENT TOOL FOR PRESCRIBED FIRES

\**Robert Kremens, Rochester Institute of Technology;*

\**Matthew B. Dickinson, USDA Forest Service;*

\**Anthony Bova, USDA Forst Service; \*Loredana Suci, Ohio Univeristy; \*Valerie Young, Ohio University*

Assessing the ecological effects from wildland fires is difficult and time consuming. Even such simple metrics as 'total acres burned' or 'percentage burned area' is often impossible to obtain accurately on a landscape scale. Remote sensing, particularly using multi-spectral airborne imagery, can accurately measure a number of prescribed fire metrics simultaneously at high temporal and spatial resolution. Of particular importance are total heat release and peak power output (related to fire effects and fuel consumption); fire motion and residence time (related to fire behavior); and vegetation health and fire extent (related to fire effects). Some of these effects can be measured using single 'snapshot' images after the fire (vegetation health and fire extent) while other effects can be measured by taking a series of images of the active fire over the burn period of the event. We will show results on fire extent, fire behavior, fire motion, vegetation health and other metrics derived from a series of coordinated airborne/ground experiments during the spring of 2004, 2007 and 2008. These experiments were conducted in National Forests, State Forests and private land trusts in Ohio, Kentucky, Florida and Georgia.

166. ASSESSING THE UTILITY OF REMOTE SENSING VARIABLES IN MODELING DISTRIBUTIONS OF THREATENED AND ENDEMIC BIRDS OF COLOMBIA

\**Leone Marion Brown, Stony Brook University;*

\**Jorge Velasquez-Tibata, Stony Brook University;*

\**Catherine H. Graham, Stony Brook University*

Remote sensing has not been broadly used in distribution modeling, especially for conservation applications. This is somewhat surprising because remote sensing data provide real time estimates of land cover that are essential for accurate prediction of species current (actual) distributions. We evaluate the usefulness of remote sensing data, as compared to more traditional climate data (e.g., extrapolated climate surfaces from WorldClim) for modeling the distributions of 214 bird species of conservation concern in Colombia. We use ten bioclimatic variables obtained from WorldClim and derived from annual and monthly temperatures and precipitation, and nine remote sensing variables derived from MODIS, SRTM and QuikSCAT satellite imagery. We find that elevation and measures of canopy complexity contribute to the models more than twice as often as any of the bioclimatic or other remote sensing variables. Leaf area index, percent canopy cover and slope contribute to the models as often or more often than seven out of the ten total bioclimatic variables. These results clearly demonstrate the utility of remote sensing variables in modeling species distributions to obtain accurate predictions necessary for effective conservation planning. We hope these results encourage further exploration and utilization of remote sensing data that are both widely available and improving greatly in spatial and temporal resolution.

167. COMMUNITIES, CARNIVORES, AND LOW-RISK LIVESTOCK CORRIDORS: TOWARDS MAINTAINING SOCIAL-ECOLOGICAL RESILIENCE IN COMMUNAL NAMIBIA

\**Jeff Robert Muntifer, Round River Conservation Studies; \*Richard Wyler Tingey, Round River Conservation Studies; \*Philip E Stander, Predator Conservation Trust*

The social-ecological system of traditional pastoral livelihoods and free-ranging predators in communal areas of Namibia's Kunene region has persisted for centuries leading to widespread, yet low volume predator persecution. However, the recent boom in nature-based tourism and devolved governance and economical ownership over resources has led to a change in the system; incentives for wildlife conservation through increased revenue has led to a parallel increases in livestock and predators leading to unprecedented conflict. Engaging with one local community, Torra Conservancy, we estimated a resource selection function (RSF) for livestock suitability from local knowledge interviews linked to a geographical information system (GIS). This was then overlaid with a spatial and temporally-explicit lion RSF model to map relative probability classes of interactions. This GIS-based approach served as an effective engagement tool, permitted identification of probable high-risk zones, while also provided an assessment of potential opportunities to better inform land use planning through mapping low-risk livestock movement corridors. This is particularly important in a landscape such as the Kunene, where the arid nature and unpredictable seasonal rains require livestock herders to be highly mobile. The integration of maps, science-based models and traditional knowledge is crucial for implementing successful management measures to maintain a social-ecological system's resilience.

168. SEARCHING FOR HOTSPOTS WITHIN A HOTSPOT - USING GLOBAL PRIORITIZATION SCHEMES AT A REGIONAL LEVEL. AN EXAMPLE FROM THE NORTHERN WESTERN

## GHATS.

*\*Sameer Prafulla Punde, Applied Environmental Research Foundation (AERF); \*Archana Jagdish Godbole, Applied Environmental Research Association; \*Jayant Sarnaik, Applied Environmental Research Foundation (AERF)*

Identifying priorities is an integral part of conservation planning. Current approaches in priority setting range from species based approaches to landscape level planning. This research focuses on two global prioritization schemes- the Important Plant Area (IPA) program and the High Conservation Value Forests (HCVF) network and their use in identifying priority areas for forest conservation at a regional level. Conservation planning at a finer spatial scale is more relevant to agencies and managers who operate at the level of the management unit. The study demonstrates spatial prioritization whilst dealing with gaps in data, uncertain threat status of species and ill-defined habitat types. In such a scenario, data collection relied on rapid site assessments and extensively tapping local knowledge. A rule-based analysis in GIS was used and an innovative rating system for assessing habitat quality was incorporated into the analysis. This pilot project has resulted in maps depicting 17 priority areas within 2 districts of the northern Western Ghats. This study not only paves a way for a more comprehensive study and development of a systematic conservation plan for the Western Ghats hotspot but also demonstrates the applicability of two widely accepted prioritization schemes at a finer spatial scale.

## 169. DISTRIBUTION AND SPECIES RICHNESS PATTERNS OF BIRD COMMUNITIES IN HIGH ELEVATION FORESTS

*\*Heather Lessig, Virginia Tech; \*William J. McShea, Smithsonian Institution; \*Jeffrey R. Walters, Virginia Tech*

The Southern Appalachians support a unique forest ecosystem at high elevations in which the breeding distribution of several bird species of conservation concern extends to unusually southern latitudes. Dual threats of rising global temperatures and potential wind energy development impact these high elevation forests across multiple scales. Understanding which bird species are sensitive to elevational gradients and how species richness patterns change over this gradient is critical for conservation planning and management and also contributes to a better understanding of regional patterns of biodiversity. We conducted bird surveys and corresponding site and landscape level habitat surveys at 36 high elevation sites on public forests in Virginia over three summers. We monitored 95 species at 1,095 points, including 11 species of conservation concern. We examined effects of elevation in combination with other environmental covariates on species richness patterns at multiple scales. In addition, for a subset of nine particular elevation-sensitive species, we investigated the relative importance of habitat characteristics at the local versus the landscape scale. Results highlight the scale dependency when determining species distribution and regional patterns of species richness and the need to consider multiple habitat factors in conservation planning and management.

## 170. SCALE AND TIME EFFECTS ON THE HABITAT REQUIREMENTS OF AN ENDANGERED SPECIES, THE RED-BILLED CHOUGH

*\*Jerome Wassef, DEE, University of Lausanne; \*Gwenaelle Le Lay, DEE, University of Lausanne;*

*\*Alexandre Hirzel, DEE, University of Lausanne;*

*\*Pierre-Alain Oggier, Nature Center; \*Raphaël Arlettaz, Zoological Institute, University of Bern*

Endangered species are central issues in biological conservation. To define efficient management strategies, it is crucial to properly identify their environmental requirements. Habitat suitability models can support this work. The red-billed chough (*Pyrrhocorax pyrrhocorax*) is an endangered bird in Switzerland, living in western alpine regions. The study area supports this bird's last Swiss population, comprising about 50 breeding pairs. Our goal was to identify the main environmental elements driving habitat choices of this species and, in particular, whether they vary seasonally according to the species ecology and behaviour. We considered several environmental parameters: landcover, topography, climate and snow cover. We carried out ecological niche factor analyses (ENFA) at three spatial scales, 3, 10 and 30 kilometres, for the nesting period and three foraging periods (spring, fall dispersal and winter). The results showed that feeding places such as mountain pastures and dry meadows are the most important parameters. Temperature also matters, birds looking for warmer places of the alpine areas. We observed an effect of scale. For instance, tall intensive vegetation areas act at the broad scale whereas mountain pastures and rocks at the local scale. About snow cover, snow frequency is clearly the best explaining predictor. For conservation, we suggest that the management of dry meadows is of prime importance to maintain suitable environments for this species.

## 171. DOES DENSITY-DEPENDENT HABITAT USE LIMIT THE UTILITY OF RESOURCE SELECTION FUNCTIONS? AN EXAMPLE WITH THE RED WOLF

*\*Todd D Steury, Washington University; \*Karen Beck, North Carolina State University; \*Art Beyer, Fish and Wildlife Service; \*Dennis L Murray, Trent University*

Resource selection functions (RSFs) have become an important tool for quantifying habitat occupation by animals. However, both habitat use and selection should be a function of the density of the observed population. To our knowledge, no study has generated RSF coefficients across population densities in order to examine the relationship between habitat selection/use and density. Instead, researchers typically assume that populations are at equilibrium, even though many populations typically undergo notable changes in density over time. We calculated RSFs for red wolf habitat use each year from 1991 through 2004, a period of marked red wolf population expansion, and correlated coefficients from RSFs with red wolf density. We found that relationships between most RSF coefficients and number of red wolf packs in the recovery area were asymptotic, indicating that habitat selection changed little with variability in population density at relatively high density. However, the relationship between the constant term in RSF models and number of wolf packs was logarithmic, signifying a linear increase in overall habitat use relative to population density. The implications of our results are that RSF models describing relative probability of habitat use should be approximately accurate over a range of high population densities. However, RSF models that attempt to define the absolute probability of habitat use may only apply to population densities observed during the study period.

## 172. AN UMBRELLA SPECIES FOR ATLANTIC ESTUARIES? STATE AND FEDERAL POLICY GAPS FOR THE DIAMONDBACK TERRAPIN

### (MALACLEMYS TERRAPIN)

*\*Amanda Dianne Hackney, Clemson University;*

*\*Robert Fritz Baldwin, Clemson University*

Reptiles are experiencing global declines and pond turtles (Emydidae) are particularly vulnerable to human infrastructure. The diamondback terrapin uses multiple habitats in the estuarine environments of the Gulf Coast and Atlantic states (US). Interacting effects of coastal development, overharvesting, abandoned crabbing gear, road mortality, and nest predation are causing population declines. To assess gaps in policy protections, we surveyed laws of the 16 states in the species' range, and federal laws applying to harvest and estuarine environments used by the species. Only Rhode Island provides endangered species protection and only Massachusetts lists terrapin as threatened. States offer protection through regulated harvests (historically, terrapin were heavily harvested; [CT, NJ, NY, DE, FL, LA]), or legislation that protects the species from any take (MD, VA, NC, SC, GA, AL, MS, TX). Two states (NY, NJ) require terrapin-specific Bycatch Reducing Devices in all crab pots, DE and MD require them only in recreational pots. At least 7 federal laws directly or indirectly regulate take, wetland, and/or coastal activities (Lacey Act, CWA, FWCA, NAWCA, WPPFA, CBRA, NEPA). As with all species with broad geographical ranges, multiple jurisdictions and overlapping environmental laws make coordinated policy prescriptions challenging. However, if listed under the US Endangered Species Act the terrapin would serve as an umbrella species for coastal habitats.

### 173. DNA STRAND BREAKAGE IN PAEDOMORPHIC AMBYSTOMA TALPOIDEUM EXPOSED TO NAVIGATE®

*\*Anna M McKee, University of Georgia; \*Ken Jones, University of Georgia; \*John C Maerz, University of Georgia; \*Travis Glenn, University of Georgia*

2, 4-dichlorophenoxy acetic acid (2, 4-D) is one of the few herbicides registered in the U.S. for application to aquatic environments and is the most common aquatic herbicide used to control invasive freshwater plants. Few studies have been conducted on the genetic effects of exposure to aquatic 2,4-D on non-target species despite evidence that the aquatic form of 2,4-D may be more genotoxic than the closely related carcinogenic turf form. This study investigated the effects of exposure to aquatic 2,4-D on DNA strand breakage in paedomorphic *Ambystoma talpoideum*. Salamanders in outdoor mesocosms were exposed to Navigate® at the manufacturer's recommended dosage (24.41 g/m<sup>2</sup>). Blood and liver cells were collected from exposed and unexposed *A. talpoideum* one day prior to exposure and 1, 14, and 42 days post-exposure. Cells were stained with in situ DNA nick-end labeling (TUNEL) and propidium iodide (PI) and analyzed using flow cytometry. Estimates of DNA strand breakage relative to total DNA content per sample were not statistically different between treatments. Future work will determine the sensitivity of this method for quantifying DNA strand breakage in blood and liver cells of *A. talpoideum*, and thus how much 2, 4-D may be impacting salamanders through genotoxicity.

### 174. INFLUENCES OF LAND USE, HABITAT SCALE, AND WEATHER ON BIRD CALLING ACTIVITY

*\*Matthew G Skaggs, Dept. of Biology, Western Kentucky University; \*Jonathan L Bowers, Dept. of Biology, Western Kentucky University; \*Albert Jon Meier, Biology, Western Kentucky University;*

*\*Cabrina Lee Hamilton, Biology Western Kentucky University; \*Thomas Aaron Hulsey, Western Kentucky University Department of Biology; \*Ouida Meier, Center for Biodiversity Studies, WKU*

This study is gaining insight on the influences of land use parameters, habitat scale, and weather on birds in Kentucky's upper Green River watershed. Large scale riparian habitat restoration is being funded by the USDA Conservation Reserve Enhancement Program in the Green River basin. Ten sampling sites were established along the Green River. Sensors measuring temperature and humidity are placed at each site. Since identification of birds by sound is far more comprehensive than by sight, we surveyed birds by monitoring their calls. Birds were recorded using 20 SongCatcher recording units during spring and summer. Three minute sound measurements were taken at one hour intervals for periods lasting between nine to 14 days. Sounds are currently being analyzed by ear and by using XBAT and Raven acoustic analysis software from the Cornell Laboratory of Ornithology as well as a privately developed software, SongScope. Presence/absence matrices of community composition are gathered for each site using correlation features which give percentage accuracy of observed data versus an archived database of known bird songs. Regressions were used to relate land use at various scales with bird calling activity.

### 175. AVIAN COMMUNITY COMPOSITION WITHIN PASTURES AND TALL GRASS PLANTINGS IN THE UPPER GREEN RIVER WATERSHED, KENTUCKY

*\*Thomas Aaron Hulsey, Western Kentucky University Department of Biology; \*Cabrina Lee Hamilton, Biology Western Kentucky University; \*Wayne M. Mason, Biology Western Kentucky University; \*Albert Jon Meier, Biology, Western Kentucky University*

According to the National Audubon Society, grassland bird species have declined since 1967. We are working to detect the influences of pastures and Conservation Reserve Enhancement Program (CREP) tall grass plantings on grassland and neotropical songbirds in Kentucky's Upper Green River watershed. We conducted summer surveys on nine CREP sites and ten pasture sites. Surveys were conducted along transects about 50-m wide with the length of transects varying among sites. Bird species were tallied if they were observed perched in the field, if a nest with eggs/ young was found in the field, or if the species was observed feeding directly over the field. Birds at the field boundaries were not included in the analysis. Unpaired T-tests were used to analyze the data. Results showed that ten of 35 species found in the 19 sites were found significantly more often in CREP sites than in pasture sites. Several of these species are of particular concern, including the northern bobwhite. Three species were found significantly more often in pasture sites than in CREP sites. Additionally, CREP sites contained higher mean species richness than pastures.

### 176. ASSESSMENT AND CONSERVATION OF THREATENED BIRD SPECIES AT LAOJUNSHAN, SICHUAN, CHINA

*\*Jie Wang, Institute of Zoology, Chinese Academy of Sciences; \*Peng Luo, Institute of Zoology, Chinese Academy of Sciences*

Laojunshan Nature Reserve is located at Yibin city, Sichuan province, south China. It belongs to eastern part of Liangshan

mountains and is among the twenty-five hotspots of global biodiversity conservation. The local virgin alpine subtropical deciduous forests are abundant, which are actually rare at the same latitudes and harbor a tremendous diversity of plant and animal species. It is listed as a Global 200 ecoregion (WWF), an Important Bird Area (No. CN205), and an Endemic Bird Area (No. D14) (Stattersfield, et al. 1998). However, as a nature reserve newly built in 1999, it is only county-level and has no financial support from the central government. Especially, it is quite lack of scientific research. We conducted our project from April to June 2007, funded by Conservation Leadership Programme. Two fieldwork strategies were used: "En bloc-Assessment" to produce an avifauna census and ecological assessments; "Special Survey" to assess the conservation status of some threatened endemic bird species. During our investigation, sixty-eight bird species, belonging to eight orders and nineteen families were recorded. We conducted various community activities in local villages and schools and trained the rangers of the reserve with scientific research.

#### 177. TWENTY-YEAR TRENDS IN AVIAN DIVERSITY IN THE HUDSON RIVER VALLEY, NEW YORK

*\*Melissa Catherine Peterson, University of Albany*  
As anthropogenic disturbance continue to threaten local habitats and communities, it is necessary to understand the role of ecological indicators on a regional landscape. I examined the long-term, landscape level change on the richness, abundance and composition of avian species in the Hudson River Valley, New York. I analyzed trends in a 20-year dataset of bird observation in relation to changes in land use cover mapped from satellite imagery. The objective of this research was to determine the effects (positive or negative) of land conversion on trends in breeding bird populations in a heavily developed corridor in Eastern, New York. By grouping all identified breeding species into assemblages it allowed for a comparative study of bird community dynamics on a regional scale. Overall, 172 species were confirmed breeding in the study area, with 9.8% added between the two atlas periods. However at the local level, species richness declined by 7 % between the survey periods and the average species frequency declined by 17%. Over half of all species declined in frequency, including eleven species not previously detected. Mean turnover per sampling block was approximately 4 % per year on average, indicating that only 20 % of species found in a given block were detected in both surveys. Grassland, forest specialist and shrubland birds experienced the greatest decline in frequency and range, while generalist species experienced the greatest growth.

#### 178. GREY BREASTED PARAKEET CONSERVATION PROJECT

*\*Ciro Albano, Aquasis; \*Weber Girão, Aquasis; \*Thieres Pinto, Aquasis; \*Alberto Campos, aquasis; \*Igor Joventino, Aquasis*

The Grey-breasted Parakeet (*Pyrrhura griseipectus*) is a Critically Endangered bird endemic to NE Brazil. It's taxonomic and conservation status has been only recently better understood, so far preventing the species from figuring in internationally endangered lists. Baturité Mountain Range - a moist forest enclave in the state of Ceará surrounded by semi-arid vegetation is the most important remaining habitat of the species. Although the main forested areas are designated as a State Protected Area, the management is oriented for sustainable use and stricter measures are needed to ensure the conservation of this ecosystem. The main objective of this project was to conduct a series of actions for the conservation

of the species to avoid its extinction. In this sense, we conducted a 12 months fieldwork along the Baturité range; the activities included: characterization of the habitats; recording of habits and behavior; identification of plant species included in its diet; nest location and monitoring; and awareness campaign. All data are organized in a GIS, indicating critical areas for habitat protection. Until now, those data's are helping to promote the creation of 11 private protected areas. A second step started in 2008, concentrating the efforts in awareness campaign and installation of nesting boxes in areas previous selected, aiming to improve the breeding population inside protected areas; since one of the main causes of the population decline is the illegal trapping.

#### 179. DECLINING AVIFAUNAL DIVERSITY OF SAMBHARLAKE IS AN IMPORTANT BIO-INDICATOR OF THE ILL-HEALTH OF THE LAKE

*\*Seema Kulshreshtha, Govt. Shakambhar PG College, Sambharlake (Jaipur) Rajasthan, INDIA; \*Brij Kishore Sharma, Department of Zoology, RL Saharia Govt. PG College, Kaladera (Jaipur), Rajasthan, India*

During past 25 years Sambharlake has faced serious ecological threats in terms of water level and as a result severe decline in the population of aquatic avifauna. This study deals with seasonal variation of avifauna during 2002-07. Method of Sibley and Munro was used for bird counting. The lake attracted only a few hundreds of aquatic avians. Birds like Great Cormorant, Great White Pelican, Painted stork, Black Stork and Sarus Crane are rare sights now. Flamingos *Phoenicopterus ruber* and *Phoenicopterus minor* are visiting the lake but their number has declined from 20000s to a few hundreds. Smaller aquatic fauna too has reduced from 72 as in late 1990s to 40-42. Resident species observed are Little Grebe, Pond Heron, Black-winged Stilt, Eurasian Thick-knee, Red wattle Lapwing and Kentish Plover. Migratory species like Northern Shoveller, Cerlew Sandpiper, Ruffs, Pied Avocet, Common Teal, Gadwall and Northern Pintail were observed. Poor rainfall, high temperature, formation of about 235 anicuts and illegal salt extraction are major reasons for low water levels and complete drying of lake bed in summers. Urgent conservation strategies are needed to save this Ramsar site of an international relevance.

#### 180. EFFECTS OF EXOTIC INVASIVE VEGETATION ON BREEDING BIRDS ALONG THE NORTH CHICKAMAUGA CREEK

*\*Shannon Elaine Hatmaker, University of Tennessee at Chattanooga*

Included in Tennessee's rich faunal diversity are 170 species of breeding birds. An important avian conservation effort today involves protecting riparian areas from habitat loss as they often serve as ecological corridors for bird movement and support a large number of species. However, the North Chickamauga Creek riparian forest located in Hamilton County, Tennessee is being fragmented by urbanization. These urban landscapes allow for the invasion of exotic vegetation and the replacement of native species. This project examines the avian community response to exotic invasive shrubs in southeastern riparian forests. Many invasive plant species are present along the North Chickamauga Creek where native vegetation is primarily oak-pine forest. I am examining the effects of exotic invasive vegetation on breeding bird diversity and density, and associated changes in biotic interactions. This is a critical concern for conservation efforts and this research may be utilized to address complex issues of biodiversity and

exotic plant management.

### 181. POPULATION ESTIMATES OF ELEPHANTS IN GHANA REVEAL UNEXPECTEDLY HIGH NUMBERS

*\*Bright Kumordzi, UNEP-WCMC*

Information on elephant ranges and numbers is vital for their effective conservation and management. This counts especially in West Africa where elephant populations are small and scattered. Digya national park in Ghana harbours some of the least studied elephant populations in Africa. We conducted a dung count survey of the Digya elephant population to determine the densities and distribution of elephants in the park using a systematic segmented track line design. . 1. To determine the mean dung-pile survival time, 2. To estimate elephant density and numbers 3. to determine distribution of elephants in the Digya national park We estimated mean density of dung-piles was 323 km<sup>2</sup> and mean dung survival time was estimated to be 44 days (SD = 2 days). We estimated 341±53 (95% confidence interval) elephants with density of 0.41elephants /km<sup>2</sup>. Elephants were found in the south western portion of the park .We provide information to augment the Regional Elephant Database and should facilitate strategic planning and management.

### 182. CONSERVING CULTURALLY SIGNIFICANT FISHERIES IN EASTERN BAND OF CHEROKEE INDIAN TRIBAL WATERS

*\*Mike LaVoie, Eastern Band of Cherokee Indians*

Freshwater fishes have been intricately connected to traditional Cherokee Indian life and culture for centuries. The Eastern Band of Cherokee Indians (EBCI) has recently moved toward establishing a multi-faceted fisheries management program that strives to preserve aquatic ecosystem integrity and enhance culturally significant fish populations. In order to further these objectives conservation measures have been implemented for native sucker, redhorse, and southern Appalachian brook trout populations. The EBCI is currently working to re-introduce the imperiled sicklefin redhorse (*Moxostoma* sp.), a formerly abundant and large bodied food fish, to the upper Oconaluftee River. Propagation and re-introduction efforts began in 2007 and will continue in 2008 with subsequent monitoring activities. Biological studies of other sucker and redhorse (*Catostomidae*) populations will also be initiated in the spring of 2008 to gather baseline population data and enhance management capabilities. A fish weir will be utilized to sample catostomid populations and gather life history, distribution, and movement data. Southern Appalachian brook trout management plans are also being designed and implemented in Cherokee tribal waters involving distribution surveys, genetic inventories, population monitoring, and habitat restoration. These efforts are moving the EBCI toward the ability to self sustainably manage and conserve important cultural fisheries resources.

### 183. DOWN THE RIVER AND BACK UP AGAIN: TOWARD CONSERVATION OF PACIFIC LAMPREY IN THE COLUMBIA BASIN, USA

*\*Christopher Charles Caudill, University of Idaho;*  
*\*Christopher Peery, University of Idaho; \*Charles T. Boggs, University of Idaho; \*Matthew L. Keefer, University of Idaho; \*Mary L. Moser, NOAA-Fisheries*

Management of migratory species is particularly challenging because organisms frequently transit areas with differing ecological characteristics, regulatory frameworks, and human

value systems. Pacific lamprey (*Lampetra tridentata*) is one such species currently in decline in the interior Columbia River basin of the U.S. Pacific Northwest. Lamprey use rivers and streams for spawning and early rearing, while most growth occurs in the ocean. Lamprey must pass a highly modified river corridor in the Columbia River system between these habitats including up to 9 mainstem hydroelectric projects with fish passage facilities designed primarily for salmonids. We have undertaken a series of studies to improve understanding of population status and adult migration behavior at dams and in spawning tributaries. Major results include: (1) counts of lamprey at dams are biased because most movement occurs at night when no counting occurs; (2) adult migration success past dams is frequently low and is related at least in part to conditions encountered in fishways; and (3) lack of natal stream fidelity in combination with current migration obstacles may be disproportionately impacting interior populations. Successful conservation of this ecologically and culturally important fish will require addressing the large current data gaps and developing a conceptual model for an ecosystem or community approach to management in a system managed primarily for a single taxon (salmonid fishes).

### 184. LIFE HISTORY CHARACTERISTICS OF GROTTO SCULPIN (*COTTUS CAROLINAE*) IN CAVE AND SURFACE STREAMS OF PERRY COUNTY, MISSOURI

*\*Clint R Johnson, University of Central Arkansas;*

*\*Julie Lynne Day, University of Central Arkansas;*

*\*Ginny Adams, University of Central Arkansas*

Grotto sculpin are a unique population of banded sculpin (*Cottus caroliniae*), endemic to Perry County, Missouri. Grotto sculpin are found in only six cave streams and surface resurgence sites, and are believed to transition between cave and surface streams throughout their lifetime. Troglomorphic species are considered one of the most threatened groups of organisms world wide due to their limited range, specific habitat requirements, and limited biological information available. Basic ecological characteristics, like growth and life history, are crucial to understanding and conserving this unique fish. Grotto sculpin were sampled in two caves and their corresponding resurgence sites every four to eight weeks beginning in August 2005. Fish were measured for several parameters and implanted with an elastomer tag for mark-recapture analysis. Large numbers of young-of-year fish were observed on surface sites from spring through fall (May-October) before disappearing, presumably into the nearby caves. Length-frequency histograms of total length were compared from each sample site using FiSat software. Growth constants were found to be up to twice as high in surface streams as cave streams. We believe grotto sculpin are using these resurgence sites as nursery areas to allow young fish to grow quickly before entering into the caves, minimizing chances for cannibalism by larger sculpin after migration underground.

### 185. REDUCING PELAGIC STINGRAY (*PTEROPLATYTRYGON VIOLACEA*) BY-CATCH IN CENTRAL MEDITERRANEAN LONGLINE FISHERIES

*\*Susanna Piovano, Department of Animal Biology, Torino University, Via Accademia Albertina 17, 10123 Torino, Italy; \*Simona Clò, CTS, Via Albalonga 3, 00183 Roma, Italy; \*Giovanni Basciano, AGCI-AGRITAL, Via Bargoni 78, 00153 Roma, Italy; \*Cristina Giacomini, Department of*

*Animal Biology, Torino University, Via Accademia  
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The incidental catch of unwanted species during fishing operations, known as by-catch, has proved to be a serious problem for the conservation of marine biodiversity and it is now a big issue in the fisheries management. The pelagic stingray *Pteroplatytrygon violacea*, a Near Threatened species in the Mediterranean Sea, is affected by a high by-catch rate in pelagic longline fishery targeting swordfish. This stingray is usually discarded by fishermen due to the lack of commercial value, and the specimens are released in so poor health conditions that their fate is settled. In this study we tested circle hooks to evaluate their effectiveness in decreasing the stingray by-catch rate. One of the major association of fishing cooperatives, the AGCI-AGRITAL, was involved in the project. In 2005-2007 we run 67 experimental longline fishing sets in the Strait of Sicily (central Mediterranean Sea). Circle and J hooks were put alternately along the longline. Data were collected by on-board observers. A total of 147 pelagic stingrays were incidentally caught, 78.2% hooked by J hooks and 21.8% by circle hooks. Our results show that J hooks hooked more pelagic stingrays than C hooks (Wilcoxon Signed Ranks test:  $Z=-4.708$ ,  $p<0.001$ ). Our findings show that the use of circle hooks can effectively reduce the negative impact of longline fishing operations on pelagic stingrays, with a mean capture rate significantly lower than J hooks.

**186. CURRENT CONSERVATION OF  
PORPHYROPORA SPECIES (COCCOIDEA,  
MARGARODIDAE) IN CENTRAL ASIA,  
TREASURES FROM ANCIENT TIME**

*\*Roman Jashenko, Institute of Zoology; \*Irina  
Jashenko, Tethys Scientific Society*

According to ancient documents including the Bible as well as Armenian and Egyptian writings, Porphyrophora species have been the source of the red dye (carmine) since ancient times.; two species (*P.polonica* and *P.hamelii*) greatly influenced the culture and history of Middle East and Europe. Historical and etymological analyzes allows us to suggest that ancient carmine industry originated in Central Asia. The world fauna of these insects consists of 52 species inhabiting mostly Palaearctic area (46 species). More than half of known Porphyrophora species are distributed in Central Asia but are not represented well by existing protected areas, only 2 species were found within strict nature reserves (IUCN category 1A) and national parks as well as 4 species in special reserves (IUCN category 3). Five species inhabit 7 protected territories planned in Kazakhstan. Populations of carmine insects often occupy very small areas of a few tens of square meters in steppe and semi-desert biotopes. Because of this, their conservation requires complete protection of these areas. Even short-term inundation, fire, ploughing up of land, and chemical treatments can destroy a population. Because of continued loss of populations four Porphyrophora species were included into government Red Data Books of Central Asian states. In this case we suggest expanding some existing national protected areas to include Porphyrophora and creating new protected areas solely for the protection of these species.

**187. PERSIAN LEOPARD STATUS AND  
CONSERVATION PLAN IN IRAN'S CAUCASUS  
ECO-REGION**

*\*Ali Aghili, Leopard Conservation Society (Charity  
Organization)*

Iran is an unknown country for most of the conservation communities, and except one species related and two ecosystems related international conservation projects (all

governmental), there is no other international conservation cooperation and partnerships. One of the first of its kind regional cooperation through civil society participation is happening within the Caucasus biodiversity hotspot conservation project, which is a CEPF (Critical Ecosystems Partnership Fund) project which is running through WWF offices in the region. One of the main concerns the Caucasus project is finding solutions for conserving the endangered mammal species of the region, which the flag specie of them is Persian (Caucasian) Leopard, and for reaching this goal, two Iranian non-governmental organizations and charities, Center for Sustainable Development and Leopard Conservation Society are working as WWF Caucasus partners to implement the Project overall goals in Iran. So as a poster I am willing to show the Leopard Status in Iran and the actions which are taking to help its survival, which are implementing the Caucasian Leopard Conservation Plan in Iran, as bringing the Government and Local Societies closer for conservation of the protected areas and the corridors which are vital for Leopard survival in Iran's Caucasus Eco-region.

**188. CONSERVATION OF THE CAATINGA  
HOWLER MONKEY**

*\*Thieres Pinto, Aquasis; \*Igor Joventino, Aquasis;  
\*Alberto Campos, aquasis; \*Ciro Albano, Aquasis;  
\*Weber Girão, Aquasis*

The Caatinga Howler Monkey (*Alouatta ululata*) is a poor known primate species, restricted to a small range in NE Brazil. Since it was recently raised to species status, it's still considered a subspecies in the IUCN Red List, who already classified it as Critically Endangered. Its range still being determined, and is known from a few sites in Maranhão and Ceará States, and some unpublished areas in Piauí State. This semi-arid region is dominated by the Caatinga Biome. Poaching and habitat loss are the main threats to most howler monkey species. The species range is situated in one of poorest areas in Brazil. There is virtually no information about the interactions between the species and the local people. So far, the only known efforts for the conservation of the species were conducted by the Center for the Protection of Brazilian Primates (CPB). They have been basically surveying the species present range and some genetic characteristics. The Aquasis' team has conducted preliminary surveys to identify potential study sites to gather data about the species conservation issues. The Aquasis' long term goal is to promote the species recovery all over its range through habitat conservation and community involvement. As part of this conservation process, it's important to fill some information gaps in order to evaluate the species conservation status and to produce an action plan by identifying the conservation priorities for the species and to propose actions to address them.

**189. LOCATING POTENTIAL DELMARVA FOX  
SQUIRREL HABITAT USING AERIAL LIDAR**

*\*Aaron Hogue, Salisbury University; \*Zoe Hanley,  
Salisbury University; \*Michael Scott, Salisbury  
University*

The Delmarva Fox Squirrel (DFS, *Sciurus niger cinereus*) is federally endangered due to its extirpation from 90% of its historic range on the Delmarva peninsula. Recovery efforts have focused on reintroducing DFS to sites within their former range. Previous studies found DFS require tall, closed-canopy forests. This study evaluates the utility of Light Detection and Ranging (LiDAR) data for locating viable DFS habitat. The US Fish and Wildlife Service used aerial LiDAR data to construct a map of canopy height and cover for all forests in Dorchester County, Maryland. Field verification of the LiDAR results was

carried out in two forests within this county. Sampling plots were selected by overlaying a grid of 18m x 18m cells on the LiDAR map and randomly selecting fifty cells (plots) from areas containing an average canopy height over 20m and cover over 80%. Plots were located using a Trimble GPS unit. Canopy height was measured as the average height of five randomly chosen trees. Canopy cover was measured along transects with an ocular tube. As predicted, the LiDAR and field data were significantly positively correlated for both canopy cover (0.388,  $p=0.005$ ) and height (0.533,  $p=0.000$ ). A paired t-test revealed no significant mean difference between the LiDAR and field data for cover ( $p=0.752$ ) or height ( $p=0.151$ ). These results indicate that LiDAR data accurately estimate canopy height and cover in tall, closed forests, and may be useful for locating suitable DFS habitat.

## 190. CRITICAL STATUS OF AMBURANA CEARENSIS IN ARGENTINA

*\*Pamela Fierro, CEBIO NGO; \*DIEGO REGONDI, CEBIO NGO; \*Roque Yapura, CEBIO NGO; \*Luis Rivera, CEBIO NGO; \*Natalia Politi, CEBIO NGO*

In Argentina *Amburana cearensis* is distributed only in the piedmont forest of Salta and Jujuy provinces. Each province has a different management strategy; Salta allows logging of the species, while in Jujuy it is banned. Land transformation, cattle raising, and unsustainable logging of this species has decreased and fragmented *A. cearensis* populations, it is considered endangered by IUCN. Our objective was to determine the population status of the species in Argentina to be able to delineate management guidelines. We conducted surveys in 17 sites (10 in Salta; 7 in Jujuy) along the distributional range of the species in Argentina. In each site 20-100 m long of variable width transects were allocated. We encountered a total of 199 individuals >10 cm DBH (in Salta 61; in Jujuy 138). In Salta 80% of the individuals were encountered in one site, with a DBH of 14+4 cm. While in Jujuy the individuals were distributed more evenly among all the sites surveyed, with a DBH of 25+16 cm. The low number of individuals encountered in this study suggests that the species status is critical and urgent conservation measures should be taken. Specifically, Salta province should halt logging the species until sustainable management recommendations can be delineated.

## 64. Protected Area Planning and Design

### 1. A GLOBAL ANALYSIS OF TORTOISE AND FRESHWATER TURTLE DISTRIBUTIONS WITH IDENTIFICATION OF REGIONAL PRIORITY CONSERVATION AREAS

*\*Kurt Andrew Buhlmann, Savannah River Ecology Lab; \*Thomas Akre, Longwood University; \*John B. Iverson, Earlham College; \*Deno Karapatakis, Savannah Rvier National Laboratory; \*Russell Mittermeier, Conservation International; \*Arthur Georges, University of Canberra; \*Anders Rhodin, Chelonian Research Foundation; \*Peter Paul vanDijk, Conservation International; \*J. Whitfield Gibbons, Savannah River Ecology Lab*

We compiled museum and literature occurrence records for all of the world's tortoises and freshwater turtle species. Verified locality points were correlated with GIS-defined hydrologic unit compartments (HUCs). We constructed "projected" distribution maps for each species by selecting additional HUCs that connected known point localities in the same

watershed or physiographic region, and similar habitats and elevations as the verified HUCs. A total of 305 species were recognized for this analysis and assigned to one of seven geographic regions of the world. In only two areas of the world did as many as 18 species co-occur in individual HUCs. Patterns of global species richness were determined and compared to existing large-scale conservation strategies. Of the 34 recognized Biodiversity Hotspots, 30 contain turtles and 221 species occur within them; 75 species are considered endemic. All five major Wilderness Areas contain turtles (86 species), and 17 are endemic therein. Smaller wilderness areas collectively contain 94 species, with 1 endemic. However, 116 turtle species have either more than 50% of their projected ranges outside of these three conservation strategies collectively or do not occur in them at all. For these remaining species we identify priority Ecoregions that should receive conservation consideration in order to assure that all 305 species fall under a large-scale conservation umbrella.

### 2. ARE PROTECTED AREAS PROTECTED?

*\*Lucas Neal Joppa, Duke University; \*Scott Loarie, Duke University; \*Stuart Pimm, Duke University*

Protected areas are the principle defence against species extinctions. We consider four regions of tropical moist forests—the Amazon, Congo, South American Atlantic Coast, and West Africa. Within these regions, do protected areas retain more non-fragmented, natural vegetation than adjacent unprotected lands? (And, if some regions do and some do not, what might lead to the differences?) Also, are protected areas large enough for the species we wish to protect? Protected areas do retain non-fragmented natural forest cover, but there are many caveats and important geographical differences. Many areas are protected de facto - protected because they are remote or otherwise inaccessible. These include many protected areas in the Amazon and Congo, where human impacts do not challenge them, and they retain forest cover as well as the areas that surround them. Ensuring that these two regions remain remote is the best management strategy. In contrast, protected areas in the Atlantic Coast forest and West Africa show sharp boundaries in forest cover. These may be protected de jure — that is, effective laws protect them — but they are usually too small to retain viable populations of all their species. In these regions, opportunities to connect forest fragments should take priority.

### 3. CLIMATE CHANGE, BIODIVERSITY CONSERVATION AND THE ROLE OF PROTECTED AREAS: AN AUSTRALIAN PERSPECTIVE

*\*James Watson, Centre for Ecology, University of Queensland*

The reality of human-forced rapid climate change presents an unprecedented challenge to the conservation of biodiversity in Australia. In this paper I review the current major threats to Australian native species. These threatening processes are currently affecting the population viability of many species and degrading key ecological processes that underpin the long term integrity of the landscape's ecology. I argue that a conservation plan that relies on accumulating small amounts of protected lands across the continent, using a set of arbitrary conservation 'targets', will not be effective in mitigating the impacts of human-forced climate change on Australia's biodiversity. I propose that the foundation of a climate adaptation conservation strategy is to develop a whole-of-continent conservation plan that recognizes the importance of protecting and restoring those natural processes that have made species resilient in the past. The following are key elements of an effective conservation plan: identifying and protecting

important climate refugia (both ecological and evolutionary); conserving the large-scale migration corridors that operate at continent scales; maintaining viable populations of all extant species to maximize intra-species genetic diversity and thus options for local adaptation; reducing all current threatening processes at the landscape scale across the continent; and protecting and restoring key large scale ecological processes.

#### 4. COMPARING AND INTEGRATING SCIENCE AND COMMUNITY-BASED CONSERVATION APPROACHES: PRIORITIZING AREAS FOR MARINE PROTECTION

*\*Natalie Ban, University of British Columbia;*

*\*Amanda CJ Vincent, University of British Columbia*

Ecological and socio-economic-political criteria are intertwined in conservation planning, making it difficult to directly compare the results of prioritization using systematic ecological planning versus community-selection. We compared and integrated systematic science-based and community-based prioritization of areas for marine protection. We used the decision support tool Marxan with abiotic and biotic data to develop the science-based prioritization. We developed partnerships with two indigenous groups in British Columbia, Canada, and used semi-structured interviews and community meetings to assess community priorities for marine conservation. These two resulting maps showed many similarities in the inshore areas, and participants at feedback sessions rated the science-based maps as fairly good at highlighting areas important for conservation. Participants scored the integration scenarios either equivalent to or better than the science-based maps. The map of an example of a protected area network resulting from the integration scenario was preferred by participants over the community-selected areas only. Our findings lend credibility to both science-based and community-based approaches for prioritizing marine areas because they verified each other. Integrating a science-based approach and community-preferences appears to be the favored solution, as it was preferred by participants and achieved all the conservation objectives.

#### 5. DO CONSERVATION CORRIDORS INCREASE BIODIVERSITY SPILLOVER INTO THE MATRIX?

*\*Lars Brudvig, Washington University in St. Louis;*

*\*Ellen I. Damschen, Washington University in St.*

*Louis; \*Nick M Haddad, North Carolina State*

*University; \*Douglas J. Levey, University of Florida;*

*\*Joshua J. Tewksbury, University of Washington*

Reserve design theory concentrates on protecting and augmenting species diversity in core habitats. Conservation efforts could be accelerated if higher diversity caused by reserve design strategies like corridors created spillover from core areas into the surrounding matrix. However, despite countless efforts to connect isolated habitats, there is little knowledge about how corridors alter spillover effects. We used experimental landscapes at the Savannah River Site (SC) to test whether positive effects of corridors on plant biodiversity in ~1 ha open habitats spill over into matrix pine forest. Relative to isolated habitats, plant species richness around habitats connected by corridors was higher for 20 - 30 m into the matrix. Importantly, the magnitude of this spillover effect was large relative to the area of core habitat, increasing the area with elevated richness from 10,000 m<sup>2</sup> (core habitat) to 19,600 or 26,000 m<sup>2</sup> (relative to isolated habitat with high or low edge-to-area ratio, respectively). Both wind and animal dispersed

plant species contributed to this pattern, but in different ways. Corridors and habitat edge-to-area ratio increased richness of wind dispersed species, whereas corridors alone increased richness of animal dispersed plant species in the matrix. These results underscore the importance of considering connectivity during reserve design and suggest that the benefit of corridors for biodiversity is dramatically larger than previously suspected.

#### 6. INDICATOR TAXA REVISITED: USEFUL FOR CONSERVATION PLANNING?

*\*Frank Wugt Larsen, University of Copenhagen;*

*\*Jesper Bladt, University of Aarhus; \*Carsten Rahbek, University of Copenhagen*

Indicators for biodiversity are needed to facilitate the identification of complementary reserve networks for biodiversity conservation. One widely adopted approach is to use indicator taxa (e.g., birds or butterflies), despite the ongoing debate regarding their usefulness as indicators. Until now, no study has systematically assessed to what extent the differences in effectiveness between indicator taxa are simply caused by differences in number of species in the taxa rather than taxonomic differences per se, nor if indicator taxa outperform a random set of a comparable number of species. Here, we examine three distributional species datasets for sub-Saharan Africa (4,039 spp.), Denmark (847 spp.), and Uganda (2,822 spp.) to test these aspects of the effectiveness of indicator taxa. First, we found that species-rich indicator taxa tend to perform better than species-poor indicator taxa (although there are some exceptions). Second, when controlling for the effect of number of species, we found relatively smaller differences in effectiveness between taxa. Third, we found that random sets of a comparable number of species are more effective than most indicator taxa. Finally, our findings suggest that it is difficult to predict what taxa would perform relatively well as indicators. Overall, these findings suggest that conservation planners should simply focus on increasing the number of species as basis for priority setting, rather than on finding the 'perfect' indicator taxa.

#### 7. PROMOTING AQUATIC TOURISM POTENTIALS OF NIGERIAN PROTECTED AREAS: A CASE STUDY OF OLD OYO NATIONAL PARK

*\*Samson Oluwagbemiga Ojo, Dr.*

The study aimed at determining composition, abundance and distribution of some aquatic resources for sustainable ecotourism development. The study was based on typical wet and dry seasons and river stratification. Fish sampling of Ogun River in the park done with monofilament gillnets of 38mm to 127mm and graded hooks. Physico-chemical properties of the river also determined. 12 fish families and 30 species were identified and 5 were classified as ornamental or fishes of ecotourism importance. Optimal fish catches was achieved with mesh size between 51mm and 76mm. Highest species diversity found in upstream and decreased downward. Sex ratio showed 6.48 female: 3.52male. Effect of seasons and mesh sizes were significant for total catches, however significant difference observed in number and weight of fishes among mesh sizes ( $P < 0.05$ ). Significant correlation ( $P < 0.05$ ) observed between length and weight of fishes during the dry and wet seasons with  $r$  values of 0.774 and 0.894 and mean condition factor ranged from  $0.55 \pm 0.11$  to  $2.34 \pm 0.29$ . Gear selectivity determined by selection factor value (SFV). Mean physico-chemical values are within tropical ranges. Socio-economic status of fisher folks was also determined. Ogun River has high ecotourism potentials based on fishes identified.

## 8. THE INFLUENCE OF DATA SOURCE IN IDENTIFYING AREAS OF CONSERVATION PRIORITY

*\*Jared Underwood, Arizona State University; \*Caterina D'Agrosa, Arizona State University; \*Leah R. Gerber, Arizona State University*

Identifying areas of conservation priority often requires the use of imperfect available data. Two common methods to identify areas of conservation priority include the use of: 1) data on species richness, and 2) systematic reserve design to create a complementary set of reserves. Both methods require species distribution data (either predicted distribution or occurrence records) during the planning process. While studies have assessed the impact of data quantity and quality on the reserve design process, few studies have assessed the sensitivity of results to the type of data used in analyses. Here we simulate the establishment of regional reserves based on predicted distribution data and occurrence records. We assess sensitivity of the conservation planning process to type of data by comparing sets of richness and complementary reserves for both occurrence and predicted distribution data. We found that the location and extent of reserve network was highly dependent on the type of data assumed in analyses. Spatial overlap between reserve networks never exceeded 28%. We propose a novel method to incorporate different types of data so that errors associated with each are mitigated, while reserve area requirements are still minimized. The results of this study highlight the importance of considering type of data in the conservation planning process.

## 65. Protected Area Planning and Design (2)

### 1. ECOSYSTEM SERVICES IN THE CENTRAL INTERIOR OF BC: A SPATIALLY EXPLICIT STUDY OF THEIR VALUE IN CONSERVATION PLANNING

*\*Lara Hope Hoshizaki, University of British Columbia; \*Kai M. A. Chan, University of British Columbia; \*Brian Klinkenberg, University of British Columbia, Department of Geography*

In the past, the socioeconomic needs of human communities and goals of biodiversity conservation have been considered largely incongruent. However, by prioritizing the supply of ecosystem services within the goals of conservation planning we may increase opportunities for the protection of biodiversity. In conjunction with the Nature Conservancy of Canada, we examined the potential impact of conservation on the supply of four ecosystem services in the Central Interior of British Columbia (carbon storage, timber production, freshwater provision and flood mitigation). We calculated ecosystem service values from biophysical datasets using a GIS. These values represent the difference in the provision of services based on whether the land is conserved or subject to alternate uses. Using the site selection software Marxan, areas with high values of ecosystem services were identified. These hot spots were then compared to land units which have been prioritized for biodiversity protection. Services such as carbon storage have been found to complement biodiversity conservation goals, whereas timber production is contradictory. These results directly connect human benefits to conservation and reveal new possibilities for future planning efforts.

### 2. FROM CONSERVATION PLANNING TO ACTION: WHAT'S INVOLVED IN

## IMPLEMENTATION?

*\*Madeleine Bottrill, The Ecology Centre, University of Queensland; \*Bob Pressey, James Cook University*

Frameworks for systematic conservation planning have tended to emphasize methods for representing biodiversity and promoting its persistence but have given limited attention to the requirements of implementation. Even the strongest science has therefore often failed to deliver the actions necessary for biodiversity conservation on the ground and in the water. We are faced with a gap between the assessment part of planning and the crucial implementation part. This gap must be filled if systematic conservation planning is to minimize the loss of biodiversity. How can we and better integrate implementation into the planning process? As part of an IUCN joint-Commission initiative, we are developing a framework, consisting of broad stages and detailed steps, for the whole process of conservation planning. By combining best-practice from the conservation literature and approaches used by organizations and agencies worldwide, we use this framework to list the tasks and decisions required for implementation. An implementation strategy is complex. It involves engaging stakeholders, assessing the socio-economic context for planning, collecting and analyzing spatial socio-economic data, and turning notional plans into conservation actions. The framework aims to make sense of this complexity and provide the most comprehensive overview to date of implementation and its relationship to other aspects of planning.

### 3. HOW MUCH TIME AND MONEY TO SPEND ON ECOLOGICAL DATA FOR CONSERVATION PLANNING?

*\*Hedley Grantham, University of Queensland; \*Kerrie Wilson, The Nature Conservancy; \*Bob Pressey, James Cook University; \*Atte Moilanen, University of Helsinki; \*Tony Rebelo, SANBI; \*Hugh Possingham, University of Queensland*

There has been minimal evaluation of how investment in different biodiversity data improves decisions about the location of new conservation areas. Our objective was to investigate the return on investment in different biodiversity data and determine the value in waiting for better data before selecting new conservation areas given the opportunity costs associated with habitat loss. To determine the return on investment in different levels of survey data, we used the Protea Atlas where we randomly sub-sampled plots to simulate different levels of initial investment before selecting new conservation areas. We then applied landscape scenario models for 10 years where new conservation areas were implemented each year and habitat destroyed each year. We also explored if it is worth waiting for better data if restricted each year by the number of plots that can be surveyed. For this, each landscape scenario was run for 20 years with a block of reservation for 10 years somewhere within this time depending on how many years of initial surveying. We found that return on investment quickly diminishes after a small initial investment in data. We also demonstrate that waiting for better data may not necessarily be the best strategy.

### 4. IDENTIFICATION OF NATIONAL PRIORITY AREAS FOR PROTECTED AREA EXPANSION IN SOUTH AFRICA

*\*Zuziwe Rostina Jonas, Ms; \*Stephen Holness, Dr; \*Jeanne Nel, Ms*

Protected areas are the cornerstones of national and international conservation strategies. The establishment and

management of a representative and effectively managed system of protected areas is a key strategic approach in the conservation of South Africa's biodiversity. Using systematic biodiversity planning tools, the National Protected Area Expansion Strategy identifies priority areas where protected area expansion would contribute to meet national biodiversity targets. The National Spatial Biodiversity Assessment 2004 demonstrated that the current National Protected Area System does not adequately conserve a representative sample of the country's biodiversity or maintain key ecological processes across the landscape and seascape. The study aimed at identifying national priority areas for protected area (PA) expansion including both stewardship and creation of large formal protected areas. In the current National Protected Area System, the majority of biomes and marine bioregions are not adequately protected. As a result only four of 11 biomes have more than their protected area target represented in the National Protected Area System. The identified priority areas for expansion have a total area of 122 782 km<sup>2</sup>. This represents 9.7% of the total surface area of South Africa, Lesotho, and Swaziland. The spatial assessment identified 42 priority areas with a total area of 16 925 700 ha, of which 12 278 200 ha are priority areas for PA expansion.

#### 5. KEY BIODIVERSITY AREAS, IMPORTANT BIRD AREAS, AND ALLIANCE FOR ZERO EXTINCTION SITES AS A BASIS FOR NATIONAL GAP ANALYSIS

*\*Matthew N Foster, Conservation International;*

*\*Michael J Parr, American Bird Conservancy*

189 countries that are Parties to the Convention on Biological Diversity, established the Program of Work on Protected Areas, which sets a 2010 deadline to complete national gap analyses of protected areas. The identification and prioritization of Key Biodiversity Areas (KBAs), Important Bird Areas (IBAs), and Alliance for Zero Extinction (AZE) sites can help fulfill the CBD mandate for gap analysis. These are sites of global significance for biodiversity conservation, identified using globally standard criteria and thresholds, based on the occurrence of species requiring safeguard at the site scale; they thus provide an effective, justifiable, and transparent set of conservation targets from which a gap analysis can be conducted. Overall, 24 (13%) of the 189 CBD countries have these baseline KBA data for multiple taxa readily at hand and can use them as a tool to quickly fulfill the gap analysis requirement. An additional 47 countries (25%) are in the process of identifying KBAs. Additionally, IBA identification has been completed for 143 of the countries (76%). Finally, the AZE analysis was conducted globally, and 80 CBD countries (42%) contain these 'tip-of-the-iceberg' KBAs. For countries (and, in the marine realm, EEZs) that do not yet have such data available, we explore options for quickly assembling the data on the highest priority subset of KBAs in order to use those data in national protected areas gap analyses.

#### 6. MARXAN AND ZONATION: TOOL SELECTION AND IMPACT ON CONSERVATION AREA DESIGN

*\*Dan Bruce Segan, University Of Queensland;*

*\*Doug Ward, University of Queensland; \*Bob*

*Pressey, James Cook University; \*Hugh Possingham, university of queensland*

Systematic conservation planning often relies on software tools. However, we rarely consider how choice of tool affects selection of areas and conservation outcomes, or which tools are most suitable for which problems. We compare two widely used conservation planning tools: Marxan and Zonation.

Marxan utilizes the minimum-set framework in which the objective is to achieve a target level of each conservation feature, while minimizing cost. Zonation utilizes the maximal coverage framework in which the objective is to maximize the amount of conservation benefit, given a fixed budget. The study compares the two output types (proposed solution sets vs. individually ranked units) using cost, representation, and spatial configuration as evaluation criteria. The analysis considers how each tool responds to changes in problem complexity (number of planning units and features considered), data type (modeled species, point occurrence, vegetative cover), and aggregation method (avoidance of fragmented solutions). Zonation solutions contained higher average levels of species representation across solutions. As problem complexity increased, target driven solutions were more efficient in Marxan. Conclusions include recommendations for tool selection based on problem formulation, and methods for using both tools in conjunction to increase representation and efficiency of solutions. We illustrate our analysis with examples from a case study in New South Wales, Australia.

#### 7. PROTECTED AREA ESTABLISHMENT AND THE ENDOGENOUS EFFECT OF RESIDENTIAL DEVELOPMENT

*\*Daniel Boyd Kramer, Michigan State University;*

*\*Patrick Doran, The Nature Conservancy - Michigan*

The objective of this study was to determine whether the establishment of protected areas induces more land conversion to residential development on surrounding land parcels than might otherwise be expected. We identified a sample of land parcels from Michigan's exurban fringe, areas beyond the outer-belt of metropolitan areas but within their commuter sheds. We then develop several models to explain whether a particular land parcel transitioned from an undeveloped to a developed state over a particular time step based on its distance to an existing protected area while controlling for other protected area, land parcel, local, and regional attributes. Initial results provide some evidence that protected areas induce residential development. The results suggest the need for a reassessment of the most effective scale and configuration of future protected areas, a better understanding of biological, social, and ecological dependencies before protected area establishment, and more urgent consideration of buffer zones and wildlife corridors.

#### 8. SIMULATING THE EFFECTS OF USING DIFFERENT TYPES OF SPECIES DISTRIBUTION DATA IN RESERVE SELECTION: A CASE STUDY USING THE IBERIAN HERPETOFAUNA

*\*Silvia Carvalho, Faculdade de Ciências da*

*Universidade de Lisboa; \*José Carlos Brito, Centro*

*de Investigação em Biodiversidade e Recursos*

*Genéticos da Universidade do Porto (CIBIO/UP);*

*\*Bob Pressey, James Cook University; \*Eduardo*

*Crespo, CBA, Centro de Biologia Ambiental da*

*Universidade de Lisboa; \*Hugh Possingham,*

*university of queensland*

In a perfect world systematic conservation planning requires detailed information on the distribution of biodiversity within the planning region. However, this information is invariably incomplete for most species. Two main types of distribution data are frequently used: observed and predicted distribution data. The fundamental question planners face is - which is better under what circumstances? We used simulation procedures to analyse the effects of using different types of

distribution data in reserve selection performances in terms of species representation, costs and cost-efficiency. To compare different approaches we first assumed the data we had was exactly correct. We used occurrence data from 25 amphibians and 41 reptiles of the Iberian Peninsula. We then sampled fractions of this data and either used it as it was, or modelled predicted distributions using Maxent. This enabled us to build three other types of data sets: "predicted", "transformed predicted" and "mixed". We performed reserve selection on the different data sets using Marxan. Our results suggest that reserve selection is sensitive to the type of species distribution data and that the most cost-efficient decision depends on the completeness of species distribution data and on the species conservation targets. While there is no one best approach for every scenario, "transformed predicted" data sets generated an acceptable compromise between species representation and cost in most scenarios.

## 66. Protected Area and Land Use Planning

### 1. CONSERVATION PLANNING WITH DYNAMIC THREATS: THE ROLE OF SPATIAL DESIGN AND PRIORITY SETTING FOR SPECIES PERSISTENCE

*\*Piero Visconti, University of Queensland; \*Bob Pressey, James Cook University; \*Daniel Segan, University of Queensland; \*Brendan A Wintle, University of Melbourne*

Conservation actions typically have to be scheduled because of limited resources and ongoing biodiversity loss. Planners therefore need to predict the dynamics of threats and their effects on species to schedule conservation actions that minimize the loss of biodiversity during the protracted process of implementation. The interdependence of habitat patches for the persistence of populations suggests that conservation priorities should be based on threats to both focal patches and their neighbours, the loss of which would compromise the achievement of conservation objectives in focal patches. To test this need, we designed alternative area selection strategies that considered threats to only focal patches or to both focal and neighbouring patches. We modelled species distributions after each annual increment of habitat loss. We used two different models: "pattern" with local covariates only; and "process" with local and connectivity covariates. We selected areas with a recent variant of MARXAN that allows for multiple conservation actions and costs. Strategy performance was measured as the total suitability score of the model projection after 20 years of incremental conservation action and habitat loss. The strategy that combined threats to focal and neighbouring patches with the process model outperformed the others. This demonstrates the importance of considering spatial and temporal patterns in threat when planning for the conservation of species in complex landscapes

### 2. LINES ON A MAP: CHALLENGES IN DELINEATING CONSERVATION AREAS AND GUIDELINES FOR MOVING FORWARD

*\*Naamal Kaushalya De Silva, Conservation International; \*Ruth Grace Ambal, Conservation International Philippines; \*Melizar V. Duya, Conservation International Philippines; \*Roger James, Melanesia Center for Biodiversity Conservation - Conservation International; \*Penny F. Langhammer, PhD Student; \*Randal Storey, GIS*

*Specialist; \*Kristen Williams, CSIRO; \*Dezhi Wang, CI-Shanshui Center for Nature and Society; \*Hao Wang, Peking University / CI-Shanshui Center for Nature and Society*

Safeguarding sites, through formal protected areas and other means, is critical to achieving numerous conservation goals. However, drawing boundaries for such sites is difficult. For instance, Key Biodiversity Areas (KBAs, sites of global significance for biodiversity conservation) have been identified in many countries, including China, the Philippines, and Papua New Guinea. In these and other regions, deciding where delineation should lie along a continuum from the ecological needs of target species to the sociopolitical reality on the ground depends on the local context. Approaches must be flexible to accommodate these ecological and practical realities. In China, government ownership of land means that management units are of primary importance; here, KBAs follow existing protected area boundaries or local political boundaries. By contrast, in Papua New Guinea, where most land is communally owned, habitat is relatively intact, and management units are ill-defined, KBA boundaries are generally determined by species habitat requirements and natural geographic units such as watershed sub-catchments. The Philippines is a middle ground, where KBA delineation can integrate ecological and sociopolitical data to suggest how to expand existing protected areas. We draw from experiences in these three nations to highlight the importance of local context, but also to generate some general guidelines for delineation that can be applied globally.

### 3. MAPPING ECOSYSTEM SERVICES FOR PLANNING AND MANAGEMENT: A BIOGEOGRAPHICAL APPROACH

*\*Benis nchine Egoh, Stellenbosch University; \*Belinda Reyers, NRE, CSIR*

In this study we map the production of five ecosystem services in South Africa: ground and surface water, soil formation and retention, and carbon storage. Using concepts borrowed from biogeography and the mapping of species distributions we map both the ranges and hotspots of ecosystem services, and assess the relationship and spatial congruence between services. This study illustrates that 1) most of South Africa's land surface is important to supply at least one service, 2) there are low levels of congruence between the service ranges and even lower levels between the hotspots for different ecosystem services, and 3) primary production appears to show potential as a surrogate for ecosystem service distribution. We discuss the implications of a heterogeneous landscape for the provision of ecosystem services and their management and highlight the potential resource intensiveness of conserving such services in a country such as South Africa. We conclude with calls for a systematic approach to ecosystem service planning which moves beyond biophysical assessments and highlights the opportunities presented by available data and principles of biogeography for conservation planning

### 4. OPTIMIZING SAN FRANCISCO BAY SALT POND RESTORATION FOR AVIAN COMMUNITIES USING AN INTEGER PROGRAMMING APPROACH

*\*Diana Stralberg, PRBO Conservation Science; \*Steven Phillips, AT&T Labs; \*David L. Applegate, AT&T Labs; \*Nils Warnock, PRBO Conservation Science; \*Mark Herzog, PRBO Conservation Science*

The 2003 public acquisition of 5,471 ha of salt ponds provides an unprecedented opportunity to restore large areas of tidal

marsh in San Francisco Bay. It also introduces management trade-offs, since the existing ponds support large numbers of waterbirds that could experience declines with the loss of this managed habitat. Thus our objective was to identify configurations that simultaneously maximize populations of marsh- and pond-associated species. For each salt pond, we modeled the basic choices: should it be restored to a tidal marsh, or kept as a managed pond, with what salinity and depth? We used habitat-based models that predict avian responses to these decisions and to future tidal marsh conditions and landscape context. The models were used in integer programs that find optimal solutions and support non-linear density models and objective functions. We found that a too-simple objective, such as maximizing a weighted sum of all species' populations, leads to simplistic optimal designs (all managed pond or all tidal marsh) that are driven by one or two species. Optimizing the sum of log populations prioritizes rare species, giving heterogeneous solutions that benefit more species. Setting a minimum population size for species of greatest conservation concern gives further improvements, as does including landscape variables.

## 5. SUSTAINING BIOLOGICAL AND CULTURAL DIVERSITY: A REVIEW OF OPPORTUNITIES AND CHALLENGES

*\*Eleanor J Sterling, CBC, AMNH; \*Alaka Wali, Field Museum; \*Georgina Davie Cullman, Columbia University; \*Paul Bick, University of Illinois at Chicago*

Do initiatives for biodiversity conservation and cultural survival have fundamentally conflicting or complementary aims? This presentation reviews efforts to sustain biological and cultural diversity, highlighting trade-offs when integrating both objectives. Many traditional approaches led to the perception that conservation is fundamentally anti-people, but this is changing. Conservation strategies have innovated and diversified, incorporating local stakeholder concerns, with varying levels of success. Similarly, cultural survival initiatives have embraced conservation ethics to varying degrees. Activists for biodiversity conservation and sustainable livelihoods for people in fragile ecosystems are often working to mitigate the same threats (e.g., globalization). Indeed, we believe that cultural and biological systems must be understood as coupled and mutually influential. Sometimes this interaction generates a resilient outcome, positive for both biological and cultural diversity; other times, the outcome is impoverished and unstable. No matter the outcome at a given moment, however, dynamism is a certainty over time. How can efforts to conserve biodiversity and sustain cultures coalesce more effectively, and overcome the tensions of the past? We provide recommendations for policy makers and practitioners, based on outcomes from the 2008 Symposium at the American Museum of Natural History, "Sustaining Cultural and Biological Diversity in a Rapidly Changing World."

## 6. WHAT FACTORS DRIVE CONSERVATION POLICIES IN DENSELY HUMAN POPULATED SAVANNAS?

*\*Delali Benjamin Dovie, University of Ghana*

The South African Department for Water Affairs and Forestry lists over forty tree species as nationally protected based mostly on the extent of use, keystone and cultural roles. However, assessments, carried out in nature reserves, urban markets and through secondary sources often omitted the diverse magnitude of the coupled human-biodiversity issues. A combination of ethnobotanical and plant diversity studies across South African communal tenure areas, representing biodiversity and anthropogenic disturbance interface showed that local people

recognized 6.3% of woody plant species that needed state protection. Although some locally available species were found in the national lists of protected woody plant species, they were locally abundant because they were favoured by the high human disturbance in those environments. The study further suggests that several other species requiring protection status are being omitted by traditional science as scientists often alienate local people in such assessments especially in Africa. Species such as *Trichocladus ellipticus*, *Cyathea capensis* and *Raphia australis* have been suggested as possibly vulnerable based on traditional criteria. Hence, there is the need to add value to protected lists criteria based on knowledge systems within a coupled human-environment framework.

## 7. TOWARDS A BIOLOGICALLY INFORMED CLASSIFICATION OF FRESHWATER SYSTEMS FOR CONSERVATION PLANNING IN THE AUSTRALIAN WET TROPICS

*\*Stephanie Renee Januchowski, ARC Centre of Excellence for Coral Reef Studies at James Cook University; \*Bob Pressey, James Cook University; \*Richard Pearson, School of Marine and Tropical Biology*

The unique perennial streams and dynamic wetlands of the Wet Tropics bioregion support a high diversity of freshwater species, yet most protective management in the bioregion has focused on terrestrial species and habitats. Further, extensive forest clearing and drainage works for expanding agriculture on tablelands and lowland floodplains has caused extensive loss and degradation of stream, wetland, and riparian habitats, with few data on the extent and severity of these changes. To address current gaps in knowledge of freshwater systems and limitations in their conservation status, we are currently designing a field sampling program that will provide a basis for biologically informed classifications of freshwater habitats for conservation management. The sampling program will involve a cost-efficient field survey method for selected taxa. Classifications will be developed with the involvement of stakeholders to ensure knowledge is available to and used by local and regional management authorities. With these stakeholders, we will collaboratively identify priorities for protection and restoration of freshwater habitats in the bioregion. We also aim to apply field-derived data to evaluate uncertainties in our classification through field checking of selected sites. This will allow us to explicitly account for uncertainty when selecting areas for conservation management.

## 8. TOWARDS INTERACTIVE RETURN-ON-INVESTMENT CALCULATIONS FOR CONSERVATION PLANNING

*\*Doug Ward, University of Queensland; \*Bob Pressey, James Cook University; \*Daniel Segan, University of Queensland; \*Hugh Possingham, university of queensland*

Finding ways of making the most of the 'conservation dollar' has long been important in conservation planning. Representation units (e.g. vegetation types, marine habitats) are commonly used as biodiversity surrogates in conservation planning; but which of these units and how much area of each gives the best return on investment? Species-area relationships (SAR) provide useful continuous benefit functions for representation units and can be used to calculate return on investment (ROI) in terms of species protected per dollar invested. To apply SARs in conservation planning at the resolution of local or regional representation units, some practical scientific challenges needed to be addressed. We

compared two landscape-scale methods for estimating SAR parameters, derived them for different taxonomic groups, and measured uncertainty in estimating SAR parameters. We then adjusted ROI by accounting for compositional overlaps between representation units and the effects of species spatial autocorrelation. The study resulted in a prototype decision-support system for applying SAR-based ROI calculations for representation units. This is the foundation for a more sophisticated interactive planning tool, applicable at resolutions suitable for local and regional scale conservation planning. Future work will include disturbance effects for SARs in human modified landscapes, benefit functions for species persistence, other biodiversity processes, and ecosystem services.

## 67. Recovery of Endangered Species

### 1. ADAPTING MANAGEMENT FOR RECOVERY OF SPECIES AT RISK IN NATIONAL PARKS: THE CASE OF THE PIPING PLOVER (*CHARADRIUS MELODUS MELODUS*) IN ATLANTIC CANADA

*\*Livia Goodbrand, Dalhousie University; \*Deborah Austin, Parks Canada Agency*

Recovery of species at risk in a dynamic environment requires management that can be adapted to local conditions. Despite extensive federal protection, piping plovers in Eastern Canada have been critically endangered since 1985, and present survival is still management-dependent. Indeed, conservation strategies have been in place for 20 years, and yet regional productivity continues to fall short of the recovery goal of 1.65 young/pr. The purpose of this study was to determine and compare success of piping plover management strategies in 3 National Parks (Kejimikujik [KJ], Kouchibouguac [KB] & Prince Edward Island [PE]). Erecting nest enclosures resulted in greater fledging success overall (GLM,  $p < 0.001$ ), likely due to a reduction in overall predation ( $p < 0.001$ ). However, this varied by location with enclosures having no effect on fledging in KJ ( $p = 0.71$ ), and resulting in an increase in the rate of nest abandonment in PE ( $p < 0.001$ ). Interestingly, the plovers at KJ have the lowest rate of increase, remain unaffected by natural events (flooding, burial,  $p = 0.98$ ), exhibit similar responses to predation as PE and KB, and yet are entirely unresponsive to management activities. Further, levels of visitor use appear to increase disturbance to the birds as measured by re-nesting ( $p = 0.05$ ). Results from this study provide necessary quantification of the effectiveness of specific recovery actions and the importance of adapting management strategies to site-specific differences.

### 2. ARE RE-INTRODUCTIONS AN EFFECTIVE METHOD FOR MITIGATING DECLINES IN VASCULAR PLANT SPECIES?

*\*Sarah Dalrymple, University of Aberdeen; \*Gavin Stewart, Centre for Evidence-Based Conservation*

Re-introductions are increasingly utilised to conserve threatened plant species. Through a systematic review of peer-reviewed literature, conservation reports, web-based sources and practitioner interviews, we have compiled a list of approximately 600 species re-introductions worldwide. As far as we know, this is the most comprehensive dataset on the technique. Analysis of the studies has shown a great deal of variation in the quality of information recorded. Indeed, the majority of studies are not suitable for quantitative analysis. Many examples of failed re-introductions are only briefly mentioned so little can be learned from past mistakes. The

authors are also aware that there may be a publication bias towards successful projects meaning that failures are under-reported in the scientific literature. Reasons for failure of re-introductions can often be attributed to the continued presence of the original cause of the decline of natural populations (such as grazing) or too few propagules used in the re-introduction. Successful re-introductions often incorporate ex-situ cultivation and post-translocation management. However, it is difficult to draw reliable conclusions due to the lack of long-term monitoring that has been reported. Despite over 40 years of using re-introductions, there are still many uncertainties associated with the technique and monitoring of existing re-introduction attempts will be the best way of increasing the success of such projects in the future.

### 3. GENETICS AND POPULATION STRUCTURE OF AN ENGLISH YEW GENE CONSERVATION FOREST AT FOOTHILLS OF THE EASTERN ALPINE MOUNTAINS

*\*Raphael Thomas Klumpp, Asst. Prof.; \*Amallesh Dhar, PhD student; \*Bernhard Aigner, Student; \*Herwig Ruprecht, Research Asst.; \*Harald Vacik, Ao. Uni. Professor*

Population of slow growing long lived plants like English yew (*Taxus baccata* L.) typically received little attention in the past. Due to less interest, this species is now recognised as a rare and endangered species and declining sharply from most of its ranges. The aim of the present work was to describe the population structure in respect of different tree parameters (height, DBH, Vitality, etc) and genetic structure based on isozyme analysis. Genotyping of individual trees has been carried out by analysis of bud materials with starch gel electrophoresis. The average height and DBH of the yew population is 7.47 m and 17.0 cm respectively. The health condition is relatively good where 63 % of yew represent the very vital to vital condition. The natural regeneration is potentially high 5209 seedlings/ ha. For isozyme analysis 9 isozyme gene loci were investigated. English yew showed ordinary level of genetic variation with a mean number of alleles per locus (A/L) of 2.78, and 78 % of loci were polymorphic. The average expected heterozygosity was ( $H_e$ ) 0.334 and the mean observed heterozygosity ( $H_o$ ) 0.241. Considering the genetic diversity and stand structure the population represent a valuable gene pool for future conservation of *Taxus baccata* in Austria.

### 4. GYPS JOURNEY FROM MOUNTAINS TO THE SEA.

*\*kartik b. shastri, bird conservation society gujarat-vulture cell.*

vultures (gyps) species visited from Himalayan mountain to Ahmadabad, Gujarat (23°06'N, 72°36'E) at different locations since 1999 during winter season. search was carried out once a fortnight and once a gyps and birds of prey was located it was observed every week. during this research gyps himalyaensis, gyps fulvus, gyps indicus, neophron percnopterus. and locally migrant gyps bengalensis and other birds of prey. what they eat, injury during travels, mortality in birds of various age classes, including the adults and observation of sick vultures are discussed, study on carcass dump-yard at dabhala also discussed. journey from mountains to land and sea is discussed they come from 7000 to 9000 feet. why they come particular dates on every year.

### 5. LONG-TERM SURVIVAL OF TRANSLOCATED GOPHER TORTOISES: A

## COMPARISON OF NEWLY RELEASED ANIMALS AND PREVIOUSLY ESTABLISHED RESIDENTS

*\*Tracey Dianne Tuberville, University of Georgia / Savannah River Ecology Lab; \*Terry M. Norton, St. Catherines Island Foundation; \*Brian D. Todd, University of Georgia / Savannah River Ecology Lab; \*Jeffrey S. Spratt, The Nature Conservancy*

Most turtle species require high adult survivorship to maintain stable populations. Translocations are often implemented to manage turtle populations but may cause demographic perturbations via increased mortality or dispersal of released animals. The gopher tortoise is one of the most frequently translocated turtle species. Short-term monitoring indicates that dispersal by released tortoises is common, but few long-term data are available to determine if losses are sustained for multiple years. We investigated long-term apparent survival of gopher tortoises translocated to St. Catherines Island, Georgia, based on 12 years of mark-recapture data. We compared apparent survival of newly released tortoises and previously established residents and determined if apparent survival varied as a result of sex or initial size at release. Apparent survival did not vary between adult males and females (0.98 per six-month interval), but was lower in immatures (0.83 per six-month interval) and varied as a function of initial size at release. We documented a temporary reduction in apparent survival of newly released tortoises but high survival of translocated tortoises once they become established as residents. Comparable data from naturally-occurring populations are currently lacking. Long-term studies of both translocated and naturally-occurring populations are needed to more effectively manage remaining tortoise populations.

## 6. PATCH CONNECTIVITY AND GENETIC DIVERSITY CONSERVATION

*\*Maile Catherine Neel, University of Maryland*

To evaluate sufficiency of US federal critical habitat designations and a proposed conservation plan in promoting long-term persistence of the endangered plant *Astragalus albens*, I examined patterns of genetic diversity and landscape connectivity. *A. albens* harbors substantial genetic variation and shows no evidence of historic bottlenecks, suggesting little risk of extinction due to genetic homogeneity. The 91 existing *A. albens* patches were connected at a distance of 2100 m; 94% of patches were <1000 m from the nearest patch. Maintaining large population sizes and connectivity among populations throughout the species' ecological and geographic ranges will most likely conserve existing diversity. Both reserve networks partially accomplish these goals by including >89% of the extent of the species, including the largest populations, and capturing all detected alleles. However, both networks exclude occurrences from one portion of the species' range, possibly speeding loss of local adaptations. In addition, network connectivity is reduced with 65 critical habitat patches being connected at a distance of 6200 m and 61 proposed reserve patches being connected at 9500 m. Although total network connectivity would be reduced, connectivity at scales most relevant to gene flow remains mostly in tact, providing a potentially promising outlook for species persistence.

## 7. PROTECTED AREAS HAVE NOT HALTED THE DECLINE OF THE THREATENED FLORIDA SCRUB-JAY (APHELOCOMA COERULESCENS)

*\*Raoul Boughton, Archbold Biological Station; \*Reed Bowman, Archbold Biological Station*

Intensive pressure by urban expansion and a decline in fire frequency in the last fifty years has seen a drastic reduction in the number of Florida Scrub-Jays. Several estimates of the population have been made during this period with the last and most extensive conducted during 1992 and 1993. The 92-93 study roughly estimated the total Florida Scrub-Jay population to be between 3,500-5,000 groups or 10,000-15,000 individuals. We compared 62 protected federal or state sites that were surveyed during 1992-1993 and 2003-2006. In both census periods numbers were recorded as groups, with average group size estimated at three individuals. The 92-93 surveys counted 598 groups within the 62 sites while the 03-06 surveys recorded only 395 groups, a 32% decline. Of the 62 sites, 47 declined in number of groups with 16 of these becoming extirpated. The remaining 15 sites stayed the same or increased slightly. Sites with small numbers of groups in 1992-1993 were highly vulnerable to local extinction. Here we investigate how protected sites size of scrub habitat, isolation and management practices influence the persistence of Florida Scrub-Jay populations. Unprotected lands have had greater extirpation rates and fragmentation than protected lands and unrealistically at best would have declines similar to these protected areas, suggesting the total Florida Scrub-Jay population to be at most about 2000-3300 groups.

## 8. USING INCENTIVES TO RECOVER THE THREATENED UTAH PRAIRIE DOG

*\*Ted Toombs, Environmental Defense*

The threatened Utah prairie dog was one of the first species to be put on the endangered species list in 1973. Today it is not much closer to recovery, but a new incentive-based private lands conservation approach is proving to be valuable part an overall strategy. A primary challenge of prairie dog conservation is that most of the population inhabits private lands where their burrowing behavior causes damage to urban and agriculture property. Thus, a key to the species recovery is finding ways to enlist the help of private landowners in restoring habitat. Since 2001, Environmental Defense has worked with private landowners and agency partners to develop a private lands recovery program that includes financial incentives through Farm Bill programs, and safe harbor agreements as key elements. These tools have proven successful in encouraging landowners participate. More recently a market-based recovery credits system for the species is being developed to further increase landowner participation and create a market for species recovery. The presentation will outline the incentive-based conservation approach used for the prairie dog as an example of an approach that might be broadly applicable to other endangered species in the US that are dependent upon private lands.

## 68. Risk Assessment and Uncertainty

### 1. A QUANTITATIVE COMPARISON OF THE VIABILITY MODELS DEVELOPED FOR ESA-LISTED SALMONIDS OF THE U.S. PACIFIC COAST

*\*Shallin Busch, Northwest Fisheries Science Center; \*Paul McElhany, Northwest Fisheries Science Center; \*Mary Ruckelshaus, National Marine Fisheries Service*

Viability models for Pacific Coast salmonids listed under the Endangered Species Act were created by eight technical recovery teams, with each team responsible for the assessment of listed salmonids in a large geographical area (e.g. Puget Sound). These viability models vary due to factors such as

regional biology, data availability, and the choices made by their developers. Due to this variation, developing a comprehensive understanding of the status of listed salmonids is problematic. We have compared the teams' viability models by running data from 35 listed salmonids populations through all available models. Estimates of current abundance and productivity vary with the structure of the model and the types of parameters built into the model. Forecasts of extinction risk vary for additional reasons such as the assignment of quasi-extinction thresholds. When each model was run using the parameter sets defined by its creators, viability estimates for most populations varied widely. Standardizing all possible parameters (e.g. quasi-extinction threshold) tightened the range of extinction estimates and better revealed how model structure influenced extinction risk estimates. Documenting that variation in extinction risk estimates exists and identifying the reasons for this variation will help managers better understand the differences and similarities among these models and will clarify the status of listed salmonids.

## 2. CAPTURING THE COMPLEXITIES OF ENVIRONMENTAL CHANGE & INFECTIOUS DISEASE: A COMPREHENSIVE LITERATURE REVIEW OF EMERGING INFECTIOUS DISEASES

*\*Karen Levy, Stanford University*

To move beyond describing overall correlations between environmental change and emerging or re-emerging infectious diseases, there is a need to move towards describing mechanistic relationships between the organisms involved, transmission routes, and disease outcomes. We outline a framework for conceptualizing the impact of distal environmental change on infectious disease burden, and apply this framework with a review of the literature. Our approach emphasizes connections between proximal environmental characteristics (related to water, climate, air, animals, plants, genetics, human practices, and the human environment) to disease transmission cycle components (organisms, contact rates, and transmission probabilities). Diseases reviewed were chosen to be representative of the different transmission groups outlined in the framework. Articles found through PubMed searches were assigned to combinations of the proximal environmental characteristics and transmission components listed above. We evaluated the weight of evidence for this matrix of environment-transmission connections to identify strengths and gaps in the literature for each disease, as well as across disease types. The literature review enables a structured evaluation of the existing empirical evidence for the representative diseases chosen. This approach guides future research towards capturing the inherently complex and interdisciplinary relationships between environment and disease.

## 3. COMPARISON OF GENETIC DIVERSITY IN MOUSE POPULATIONS HISTORICALLY EXPOSED TO POLYCYCLIC AROMATIC HYDROCARBONS

*\*Jessica Kristin Leet, University of Tennessee at Chattanooga; \*Margaret Kovach, UTC; \*Joey Shaw, University of Tennessee at Chattanooga; \*Sean M Richards, University of Tennessee at Chattanooga*

The difference between a biological indicator of exposure and an indicator of effect is often debated in ecological toxicology. We maintain that contaminant exposure correlated with an increase or decrease in genetic diversity is the most conclusive measure of a population-level effect. To test this theory, we measured the genetic diversity of white-footed mice

(*Peromyscus leucopus*) populations living on hazardous waste sites versus those on reference sites. The parameter of genetic diversity was microsatellite heterozygosity. Polycyclic aromatic hydrocarbons and other contaminants from coal tar have been found on the hazardous waste sites, and are known to be bioavailable to small mammals. Samples came from mice of four contaminated sites in South Chattanooga, TN (20 samples from each site) and three uncontaminated reference sites (approximately 30 samples from each site). Preliminary data for three microsatellite markers show that the contaminated populations are more homozygous than the reference populations. The data also show statistically significant ( $p < 0.05$ ) gene differentiation between the South Chattanooga populations compared to the reference populations. Our data indicate that pollutant exposure on contaminated sites in South Chattanooga influenced the genetic diversity of mammalian populations as compared to reference populations. Thus, we maintain that the mice on the contaminated sites have been truly affected by, not simply exposed to contaminants.

## 4. LARGE-SCALE CONSERVATION PLANNING WITH INCOMPLETE INFORMATION: LAND COSTS ARE KEY

*\*Jai Ranganathan, National Center for Ecological Analysis and Synthesis; \*William Murdoch, University of California, Santa Barbara; \*Stephen Polasky, University of Minnesota*

A perennial concern in conservation planning is the need to make immediate decisions using incomplete information. We explored ways of reaching reasonable decisions in such situations by using a return-on-investment (ROI) approach to setting priorities in the case of temperate grasslands in Argentina. Temperate grassland is among the world's most globally imperiled Major Habitats. Argentina contains some of the best remaining temperate grasslands, but there is virtually no published fine-grained information on species distributions, biodiversity, or land costs. We did have spatial data providing ranges of land costs on a gross spatial scale, locations and shapes of remaining grassland and two weakly correlated measures of the threat to those grasslands (human footprint index and agricultural pressure). We developed a "greedy" algorithm that allocates funds sequentially among grassland areas to build up a conservation portfolio that ultimately covered about 15% of the original habitat. The ROI approach reduced total funds required by > 80% compared to an approach that ignored costs. The final distribution of protected areas was well distributed across grassland types, and was remarkably insensitive to the threat layer used. Land costs had the largest effect on the areas selected for conservation. Thus, while more biological information might well influence our emphasis on areas selected, the analyses suggest that finer-scale data on costs should be a priority.

## 5. PREDICTING GENE FLOW FROM TRANSGENIC FISH TO WILD POPULATIONS: LESSONS LEARNED FROM CONFINED RISK ASSESSMENT TESTS

*\*Kelly Pennington, University of Minnesota; \*Anne R Kapuscinski, University of Minnesota*

Transgenic fish being developed for aquaculture are likely to escape and interbreed with wild relatives in the nearby environment. Predicting the likelihood and consequences of transgene flow from genetically modified fish to a wild population of conspecifics would help to assess the environmental risks of farming transgenic fish. Our study is the first multigenerational study of gene flow from a transgenic

animal (growth-enhanced medaka, *Oryzias latipes*). We tested the reliability of the "net fitness" model for predicting gene flow. We conducted confined experiments first in semi-natural mesocosms, and then in microcosms with simulated environmental variation (food availability and predation). We collected fitness component data (fecundity, fertility, age at sexual maturity, mating advantage, juvenile viability and adult viability) on transgenic and non-transgenic fish. To test model predictions of gene flow and its consequences, populations of non-transgenic medaka were "invaded" by transgenic medaka. The results of the first invasion experiments ranged from disappearance to doubling of the transgene frequency. Preliminary results from the second experiments suggest that environmental variation may have a greater effect on the fitness of transgenic fish. Decisions regarding whether to permit farming of transgenic fish should be informed by confined gene flow tests that include many generations and variation in environmental factors important for the animal's life history.

## 6. SUITABLE PROXIES FOR ASSESSING EQUIVALENT EXTINCTION RISKS FOR DIFFERENT TAXA

*\*Tracey Regan, NOAA Fisheries/NRC; \*Barbara L. Taylor, NOAA Fisheries/Southwest Fisheries Science Center*

One of the central goals as conservation biologists is to identify those species at a high risk of extinction in order to direct attention and resources into protecting them. Probabilistic estimates of extinction risk are often difficult to attain due to constraints on data availability. Instead proxies such as number of mature individuals, range size and trends are used in place of an estimate of extinction risk. However the accuracy of different proxies and whether they result in equivalent extinction risks for different taxa has not been well tested. We develop population viability analysis models for different life histories types and then test a number of commonly used proxies for extinction risk to determine how well each proxy performs given a particular level of risk. Of the proxies tested, annual growth rate performed the best across the different life histories. However to ensure equivalent extinction risks, the magnitude of the rate differed across life history types. These results suggest that a one size fits all approach to assessing extinction risk using proxy criteria does not necessarily ensure equivalent extinction risks across different taxa and the development of life history specific proxy criteria for assessing extinction risk are needed.

## 7. USING SIGHTING RECORDS TO DECLARE ERADICATION OF AN INVASIVE SPECIES

*\*Tracy Margaret Rout, University of Melbourne; \*Michael A. McCarthy, University of Melbourne*

A major challenge for invasive species managers is deciding when an eradication program can be deemed successful. Declaring eradication and ceasing to monitor when the invasive species is still present can lead to a re-emergence, with resulting ecological and economic impacts. However, continuing to monitor when the species has been eradicated is a waste of resources. Regan et al. (2006) were the first to pose this problem in an economic way, and minimise the net expected cost of the decision. They find the optimal time to declare eradication, based on the number of consecutive surveys in which the species is not found (absent surveys). Their formulation requires estimates of detectability and persistence—parameters that are often difficult to estimate. We eliminate the need to estimate these parameters by instead using the more readily available presence-absence sighting record to calculate the probability the invasive species is still

present. We derive a rule of thumb and an approximation, which both give results that are close to the exact optimal solution. Our approximation is a simple calculation, making it an accessible tool that could be applied by managers of invasive species eradication programs. Regan, T. J., M. A. McCarthy, P. W. J. Baxter, F. D. Panetta, and H. P. Possingham. 2006. Optimal eradication: when to stop looking for an invasive plant. *Ecology Letters* 9:759-766.

## 69. Scientists and Managers: Bridging the Gap

### 1. A NEW SYSTEM FOR LINKING CONSERVATION SCIENCE AND CONSERVATION PRACTICE VIA THE INTERNET

*\*James R. Stritholt, Conservation Biology Institute; \*Jeff Christensen, Maya Design, Inc.; \*Josh Knauer, Maya Design, Inc.; \*Mike Higgins, Maya Design, Inc.; \*Brendan Ward, Conservation Biology Institute; \*Tosha Comendant, The Nature Conservancy*

In order to practice conservation effectively, it is essential for conservationists, policymakers, activists and scientists to have access to a wide variety of data about complex ecological, political and economic systems. While a number of data integration projects have attempted to build conservation science database super-systems, most have failed to overcome the key challenges: compelling people to share, easy and flexible access to data and information, and guidance for using scientific data, analytical methods and results. We developed an innovative information system that addresses these core challenges. This new Internet-based service allows users to search conservation data geographically and by topic. Users are able to: (1) integrate and view multiple conservation datasets, (2) create their own visualizations, (3) view data interchangeably as maps, tables, or graphs, (4) combine or fuse datasets, (5) save and share their visualizations with others, (6) download raw datasets for more advanced uses, and (7) upload their own data to the system. Users are also able to evaluate, comment and rank the data they find, making good data more valuable and easier to find by others. The system is being designed to foster collaboration, significantly speed up the transfer of conservation science to conservation practitioners, and ultimately lead to better science-driven conservation decisions.

### 2. BIODIVERSITY DATABASES: A NEGLECTED FRIEND

*\*Rebecca Ng, World Wildlife Fund*

Field data is expensive, painstaking, and laborious to compile. Yet, existing biodiversity databases are inconsistent, incomplete, poorly organized, or all of the above. In no other industry is the currency, which to conservation, field data arguably is, treated so casually. Using a recently-developed global map of freshwater ecoregions as the basis for this review, we detail how biodiversity databases gain from well-formulated standardization, and how much work is left to be done. Over 100 publicly-available database sources were examined using criteria including: database structure, data type, geographical coverage and biological classification. Data standards are highlighted for both collection methods and organization, and analyzed comparatively between database types. The freshwater fish database behind Freshwater Ecoregions of the World is used to illustrate the power of

standardized-form biodiversity data. Database investment is critical to stretch ever-shorter conservation funds, and to inform conservation at global, continental and ecoregional scales.

### 3. DATA MANAGEMENT - A CRITICAL LINK BETWEEN SCIENTISTS AND MANAGERS

*\*John Douglas Peine, U.S. Geological Survey; \*Tom Burley, Institute for a Secure and Sustainable Environment; \*Brandon League, Institute for a Secure and Sustainable Environment; \*Shelaine Hetrick, Biodiversity Informatics Group Lead*

One of the most fundamentally important yet invariably overlooked aspects of effective collaboration between scientists and resource managers is effective data management. Frequently unanswered questions include where is it, how well is it documented, and how does it contribute to a cumulative body of knowledge? The USGS National Biological Information Infrastructure is focused on answering these questions. The relevancy of data management is illustrated via a case study. The grassy balds of the Roan Mountain Massif is a national hotspot for species diversity and richness at risk. Federal and state agencies and three NGOs collaborate on adaptive management and the area has been a focus of scientific study for over 50 years but the data from research and management practices has not been systematically documented so there is no foundation to track ecosystem health nor interdisciplinary science. Six legacy databases were documented to illustrate the extent of the problem. In every case, documentation was lacking on all aspects of data management. This concern is a systemic problem that needs to be solved as the stressors on ecosystems escalate exponentially. A data management toolkit has been developed to provide guidelines to facilitate documentation with a minimal amount of complexity and cost.

### 4. FURTHERING IMPLEMENTATION OF SYSTEMATIC CONSERVATION PLANS IN THE EASTERN CAPE, SOUTH AFRICA: SOCIAL MARKETING, BEHAVIOUR CHANGE AND LAND USE PLANNING

*\*Angelika Wilhelm-Rechmann, Nelson Mandela Metropolitan University; \*Richard Cowling, Nelson Mandela Metropolitan University; \*Craig R Lefebvre, Population Sciences International*

To further the implementation of Systematic Conservation Plans in the Eastern Cape, South Africa, a social marketing approach is used to forge a partnership with local land use planners and to convince them to meaningfully integrate the biodiversity maps in their work processes. Social Marketing is the strategic application of highly successful marketing technologies to further societal good instead of commercial gain. Firstly the reasons for non-adoption and the perceived and possible benefits of using the maps have been investigated in a formative research process. Based on these insights, a strategic promotional program is being developed using a variety of insights gained in conservation psychology. The aim is to make existing perceived benefits of Systematic Conservation Planning-Products more salient and to introduce new benefits. Concurrently, the primary problems with and barriers to using the biodiversity maps are being addressed. This ongoing behavior change project presents an instance of applying conservation psychology to enhance conservation implementation where the legal and cultural contexts have proven insufficient to address biodiversity loss.

### 5. GENETIC RISK AND ENDANGERED

### SPECIES: STRENGTHENING LINKS BETWEEN SCIENCE AND RECOVERY

*\*Lesley Geills Campbell, Rice University; \*Sara Zeigler, University of Maryland; \*Maile Catherine Neel, University of Maryland*

Conservation and management for species listed under the U.S. Endangered Species Act should be informed by the best available science. Prioritizing research needs is challenging, and the disciplinary expertise of people setting priorities often strongly influences the process, making priorities less than objective. Ideally research reflects risks to species and provides insight into ways to reduce such risk. We assessed how well the application of genetic data to federally listed plant taxa (N=640) meets this ideal by reviewing the published literature and 261 approved recovery plans. We asked whether taxa most at risk of extinction due to genetic factors associated with small population size or reductions in population size, number of populations, and range receive more attention from conservation researchers and policy-makers. In agreement with objective research priorities, recovery plans recommended genetic research for taxa with lower abundances ( $P<0.001$ ), and declining population sizes ( $P=0.03$ ), population numbers ( $P<0.001$ ), and ranges ( $P<0.001$ ). In contrast, published research focused on listed taxa with larger population sizes ( $P<0.001$ ) and did not prioritize taxa with declining number of populations ( $P=0.31$ ) or range size ( $P=0.41$ ). Therefore, research priorities of agency personnel writing recovery plans more objectively reflected the relative extinction risk of taxa with small and declining populations than did the publication record of conservation biologists.

### 6. INTEGRATING ADVANCED MITIGATION PLANNING INTO A REGIONAL CONSERVATION NETWORK

*\*Patrick R. Huber, University of California Davis; \*Evan Girvetz, University of Washington; \*James Thorne, Information Center for the Environment; \*Allan Hollander, Information Center for the Environment; \*James Quinn, University of California Davis; \*Michael McCoy, Information Center for the Environment*

Utilizing compensatory mitigation requirements can be a useful component of regional conservation planning strategies, however mitigation planning and implementation has usually occurred in a piecemeal and nonsystematic manner independent of regional conservation goals. Using two case studies involving multiple road projects located in dissimilar watersheds, we show how early and regional mitigation planning can be a constructive part of a regional conservation plan and develop a set of principles that can be used to guide mitigation efforts. Using the MARXAN reserve selection algorithm we identified specific ownership parcels that would satisfy mitigation needs for impacts due to these road projects. Then we identified more general regional conservation needs using the MARXAN reserve selection algorithm together with focal species-based connectivity analysis. The parcels identified for satisfying the mitigation needs were found to coincide strongly with parcels identified for the regional conservation needs. We further identified locations for potential implementation of onsite mitigation plans where programmed road projects intersect areas displaying high connectivity. This approach shows environmental mitigation based on systematic conservation planning methods (e.g. MARXAN) can contribute to regional conservation efforts. We conclude that regional mitigation efforts can and should be integrated with other regional conservation activities.

## 7. MAINTAINING STRONG PARTNERSHIPS FOR PUBLIC RESOURCE CONSERVATION: THE COOPERATIVE ECOSYSTEM STUDIES UNITS NETWORK

*\*Thomas E. Fish, Cooperative Ecosystem Studies Units Network*

Entering its tenth year this year, the Cooperative Ecosystem Studies Units (CESU) Network is a national network comprising thirteen U.S. federal environmental and natural resource management agencies and over 240 universities, NGOs, state agencies, and other nonfederal partners. The network includes 17 CESUs representing distinct biogeographic regions across the U.S. states and territories. Each CESU develops its own independent strategic plan outlining regional research and management priorities, as well as partner expertise to facilitate connections between agency field staff and managers and partner institution scientists. Each year, the CESU Network supports hundreds of diverse collaborative projects to address management technical assistance needs, knowledge development and research, and education and capacity building in support of natural and cultural heritage resource conservation. This presentation will provide an overview of the CESU Network, its history, and future directions, including increasing emphasis on landscape and regional scale multi-institutional projects to address issues that transcend political and ecosystem boundaries--such as climate change, invasive species, air quality, and water resource management.

## 8. MANAGING FOR PUBLIC ACCESS AND LISTED SPECIES IN THE COASTAL ZONE: THE CASE OF NONBREEDING PIPING PLOVERS (CHARADRIUS MELODUS)

*\*Olivia LeDee, University of Minnesota, Twin Cities; \*Kristen Nelson, University of Minnesota; \*Francesca Cuthbert, University of Minnesota*

More than one third of U.S. federally listed species inhabit the coastal zone. This region, under increasing pressure from development activities, is also home to more than half of the U.S. population. The product is the contemporary tension between public access and ecosystem conservation. To understand how this conflict influences coastal management, we conducted a web survey of managers of 43 federal Critical Habitat units designated for protection of a threatened species, the Piping Plover (*Charadrius melodus*). We found that public access and ecosystem conservation are currently the primary goals of managers, 97 and 93% respectively, and to address both goals, numerous survey units incurred mission changes from sole-purpose initiatives (i.e. public access, ecosystem conservation) to a multiple-use mission (i.e. resource-based recreation). More than 1 million recreationists frequent some survey locations and studies indicate that unregulated public access negatively impacts nonbreeding plovers. Although managers cite activities that will be beneficial to management of the nonbreeding Piping Plover (e.g enforcement of leash laws), most survey locations (78%) have yet to address the conflict of interest between public access and ecosystem conservation. Low-cost, low-tech strategies that meet both goals exist and the tension will be exacerbated if neglected (i.e. inaction).

## 70. Social Science

### 1. LESS IS MORE: RARITY TRUMPS

## QUALITY IN LUXURY MARKETS

*\*Agnès Gault, Université Paris Sud (Orsay); \*Franck Courchamp, Université Paris Sud (Orsay)*

The international market of luxury goods has almost doubled since 1990, and is now worth more than 150 billion US \$ a year. This market, fuelled by a great deal of legally and illegally exploited wildlife species, results in an enormous commercial pressure that could have very serious implications for the species involved. Indeed, it occurs that the human predisposition to place exaggerated value on rarity often surpasses the obstacle of the escalating costs of exploiting a declining species. This attitude can eventually lead the species into an extinction vortex (through an Anthropogenic Allee Effect). We studied the exemplary case of caviar trade which has led to such an overexploitation that all 27 sturgeons species are listed under CITES since 1997. Despite their well-publicized imperilled status, extreme commercial pressure on 15 species still persists. We tried to identify the mechanism responsible for this counterintuitive caviar overexploitation. We conducted tasting sessions among a public of caviar consumers, proposing 624 volunteers two samples of caviar each, that were labelled as coming from a 'rare' and a 'common' species of sturgeon. In fact, both samples came from the same tin. We demonstrated an irrational preference for the "rare" product, a behaviour which we suspect to drive the entire luxury market and which undoubtedly presents a dramatic risk for biodiversity.

### 2. MANAGEMENT OF A 'COMMUNITY FOREST': POWER INTERACTIONS AROUND A FOREST MANAGEMENT PLAN (BOUGNOUNOU - BURKINA FASO)

*\*Sita ZOUGOURI, Cultural Anthropology Department in Uppsala University*

My focus in this study is to understand local actors' interactions around a forest management plan created by the state. The forest management plan is saturated with the social, political, and religious dynamics of Bognounou village. How has this management plan been transformed into a local institution supervised and controlled by local powers, precisely a village chief and "fetish"? The term 'local actors' denotes a plurality of individuals who can be divided into two categories: a) "people of village" whose rights of access and usage over natural resources is limited, and b) "owners of the village" one lineage, representing and embodying the local political and religious power in the chief and the "fetish.". The power interactions have an undeniable impact on people's conservation behaviors of the forest. For example, in the district there are many cases of disrespecting the management rules where people continue to cultivate land in other parts of the forest. But in Bognounou case, as a technical manager stated, there are no cases of disrespecting management rules. The material for this study, which constitutes part of my PhD thesis, elicits the following theoretical and empirical questions: how do local and traditional powers controlling members' lives and practices appropriate a state-sponsored forest management project as a local institution? In other words, how are local powers involved in modern conservation practices?

### 3. RUBBER-BASED SETTLEMENT PROGRAM AS A MEANS OF REDUCING LAND DEGRADATION AND IMPROVING PEOPLE'S LIVELIHOOD: BANGLADESHI CASE STUDIES

*\*Tapan Kumar Nath, The University of Tokyo; \*Inoue Makoto, The University of Tokyo*

As an alternative strategy to improve rural livelihoods and

reduce the land degradation, a rubber-based settlement program, called Upland Settlement Program (USP), had been implemented in the Chittagong Hill Tracts (CHT) of Bangladesh. It settled 3000 landless tribal families (planters) in 59 villages, raised 2126 ha homestead agroforestry and 4860 ha of rubber plantations between 1985 - 2007. Based on empirical studies in 10 USP villages, this paper reports how the program enhanced rural livelihood and prevented land degradation. Due to joining the program, livelihood of planters had improved to some extent through building of several livelihood capitals including human, physical, natural, financial and social capital. Many planters had given up shifting cultivation which has been considered as a major cause of land degradation. The settlement program had cleared secondary forests and could not regain its original biodiversity through rubber plantations and homestead agroforestry. We explored some factors including mishandling of project budget, improper establishment and maintenance of rubber plantations (e.g. planting seedlings closely without weeding), lack of effective collaboration between planters and project authority, and ineffective leadership that caused poor outcomes of the program. Suggestions including effective participation of planters are made to sustain the program activities for the benefit of the planters and environment.

#### 4. THE CODEPENDENCY OF HUMANS AND REEFS

*\*Jeanine Anne Clark Bremer, Aurora University/Northern Illinois University*

The United States hosts the world's third largest barrier reef. As such, how Americans have interacted with the reef over time has changed from one of outright exploitation to a more preservationist mode. This paper presents a condensed history of how the US values the Florida reef by examining legislation, or the lack thereof. Three distinguishable periods demonstrate our relationship with the reef. First, a highly exploitative phase during the early republic to the mid-1900s is evident, which is inclusive of extracting resources and promoting the field of wrecking. Second, a period in which recognition is given to the treasure that the resource is, culminating in the creation of the state park. Third, a period in which legislative action is taken to protect the resource as evidenced by the National Marine Sanctuary Act and its subsequent renewals and amendments. An examination of these stages allows for a better understanding of the perceptions of people over time, with regards to the reef, and the goals of our nation regarding natural resources as a whole. This allows for critical analysis of actions previously taken and permits us to make educated decisions about the future. With the small island of Bonaire succeeding in making their entire fringe reef a sanctuary and the accelerating rate of bleaching (reported to depths of 90 feet at Sabas), it is time that we analyze how we have and how we should work to protect the world's third largest barrier reef.

#### 5. THE CONNECTION OF REMOTE COMMUNITIES: CONSERVATION IMPLICATIONS

*\*Daniel Boyd Kramer, Michigan State University;*

*\*Gerald Urquhart, Michigan State University*

The forces of globalization are increasingly penetrating the remote communities of the world and are likely to affect local biodiversity in complex and profound ways. Remote communities are those that lie at the periphery of existing global networks of commerce, migration, and technology. The objective of this study was to review the evidence for the conservation consequences of global connection for remote communities. We undertook a comprehensive review of existing work using eight organizing hypotheses. We also

present a case study of several communities along the Misquito Coast of Nicaragua which are undergoing rapid change due to various infrastructure initiatives. Results indicate that while we have some understanding of the major drivers and outcomes of global connection, little is known about the pathways and processes of change. The results suggest the need for a greater understanding of how local context mitigates the effects on biodiversity in remote communities due to connection to global networks of commerce, migration, and technology.

#### 6. UNDERLYING DISCOURSES IN BIODIVERSITY CONSERVATION: A Q-METHODOLOGY STUDY.

*\*Leon-C. Malan, Colby-Sawyer College*

Most disagreement and conflict are based on differences in the underlying values and assumptions of parties to the conflict. The more we know and understand those underlying values, the more constructive the dialog, and the more likely acceptable policy decisions. This study uncovered some of the major discourses and paradigms in biodiversity conservation by means a Q-method study. Some of the key contributors to the biodiversity conservation literature were surveyed as part of the data collection to uncover underlying assumptions about biodiversity conservation in protected areas. Three distinct paradigms emerged from the data. This paper will report the results and conclusions of a discourse analysis and will explain the implications of these underlying values for biodiversity conservation. The paper will conclude by demonstrating the value of this particular methodology (Q - method) for resolving complex environmental problems.

#### 7. UNDERSTANDING SOCIAL CONTEXT: MEASURING SOCIAL WELL-BEING AT THE ECOREGIONAL SCALE

*\*Sheri Stephanson, World Wildlife Fund; \*C. Anne Claus, World Wildlife Fund; \*Michael Mascia, World Wildlife Fund*

To effectively plan for large-scale conservation, conservation organizations must understand social conditions at the ecoregional scale. To describe the context for our work and understand the challenges and opportunities we face, we are measuring health, education, political empowerment, economic well-being, and culture in six landscapes: Coastal East Africa, Borneo, Namibia, Coral Triangle, Bering Sea, and the Terai Arc. Initial results suggest that relying on commonly used indicators - such as the Millennium Development Indicators - enables efficient data collection. However, data on other indicators of relevance to conservation, such as cultural practices or access to environmental education, do not always exist evenly across a large scale. Social data also typically correspond to political and/or administrative boundaries, which do not seamlessly match ecoregional boundaries. This creates methodological challenges to fit social data to the appropriate ecological scale, while maintaining data integrity. These results highlight the complexity and value of creating integrated conservation planning frameworks that effectively capture variable social conditions.

### 71. Social Science (2)

#### 1. CONSTRAINED BY CONSERVATION, LIBERATED BY CAPITALISM? CONSERVATION-INDUCED LIVELIHOOD CHANGE IN NORTHERN THAILAND

*\*Robin Roth, York University*

The inhabited forests of Northern Thailand are experiencing considerable conflict due to the establishment of protected areas designed to conserve highland forest by constraining livelihood activities. In response, government and non-government officials are promoting intensive market-based agriculture and rural farmers are seeking out market opportunities to help them cope with lost resources. The result of this convergence is increasing market-oriented governance in landscapes where people's livelihoods and biodiversity are both at risk. Drawing on data gathered in two communities using focus groups, key informant interviews and a household survey, this paper seeks to understand the social implications of increased market activity in buffer and enclave communities. It finds that households have differential capacity to take advantage of emerging market opportunities, based on past market experience, comfort with risk, social networks and geographic location of their land. It further finds that successful farmers wish to expand their agricultural lands re-igniting conflict with park authorities. The paper argues that the reliance on market mechanisms to alleviate conservation conflict is ill-founded. It recommends that closer attention to individual and community mechanisms through which market integration occurs as well as the type of markets farmers are being integrated into is needed to inform more effective strategies for meeting conservation and livelihood goals.

## 2. HUMANS AND COYOTES IN SUBURBIA: CAN FAMILIARITY LEAD TO SUSTAINABLE COEXISTENCE?

*\*Heather Wieczorek Hudenko, Cornell University;*

*\*Daniel J Decker, Cornell University; \*William F Siemer, Cornell University*

Despite urbanization of natural areas, many carnivore species persist in suburban landscapes. The close proximity of humans and carnivores in these areas increases opportunity for interactions. This is especially true for widely-distributed species such as the coyote. Managing human-coyote interactions to reduce negative impacts is of growing interest among wildlife managers and communities. Evidence suggests that sustainability of human-coyote coexistence varies from region to region, but little scientific information about human-coyote interactions is available. We hypothesized that individuals who have more experience with coyotes engage in behaviors that minimize human-coyote conflict. We conducted telephone surveys in two areas of New York State to examine the relation between duration of coyote presence and resident tenure on measures such as awareness, experience, risk perception, and concern. Analyses indicate that people living in areas with a longer history of coyote presence, or who had longer tenure in an area with coyotes, tend to express less concern about these predators. These respondents also tend to believe coyotes are a nuisance rather than a threat. The results imply that people may adjust to living with coyotes and may minimize problems by learning to achieve a balance between tolerance and intervention. Understanding the relationship between people and this mesopredator may have broader implications for human-carnivore coexistence in suburban landscapes.

## 3. PUBLIC UNDERSTANDING OF COASTAL WETLAND LOSS AND RESTORATION IN THE US GULF OF MEXICO

*\*Craig A. Miller, Warnell School of Forestry and Natural Resources, University of Georgia; \*Meya V. Holloway, Louisiana State University*

Abstract We conducted a self-administered mail survey of 4,111 residents of the Mississippi River Valley during spring

2006. Questionnaire items addressed awareness of problems associated with coastal erosion, general attitudes toward ecosystem restoration and coastal wetlands, and support for coastal wetland restoration. We received 1,441 (35.1%) total responses. Although a majority (71%) of respondents perceived coastal wetland loss to be a very important issue and a majority (68%) also viewed restoration coastal wetlands as very important, few (7%) were aware of the national education campaign designed to increase public awareness. As expected awareness of coastal erosion and restoration activities was higher among Louisiana residents, however awareness of educational programs was also low (17%). Support for greater returns of oil and gas royalties existed across residents from each of the 4 regions, with a significant majority (66% overall) favoring funding equal to other states. Public support was strong for lands created through restoration projects undertaken with public funds to become public lands. Results of this study indicate a public receptive towards receiving information regarding coastal wetland loss and supportive of restoration efforts, however such information is perceived to be lacking given the low awareness and understanding exhibited by respondents to this survey.

## 4. SOCIAL PSYCHOLOGY FOR CONSERVING ELEPHANTS: USING HUMAN DIMENSIONS RESEARCH TO MITIGATE HUMAN-ELEPHANT CONFLICT

*\*Christine Browne-Nunez, University of Florida*

Changing land use and increasing human and elephant populations have led to increased conflict around Amboseli National Park, Kenya. The surrounding private group ranches are critical seasonal dispersal areas. Several organizations have implemented human-elephant conflict interventions aimed at improving attitudes toward elephants. My research objectives were to: (1) test attitude theory and survey methods in a rural African setting and (2) provide human dimensions data needed to monitor and adapt conservation strategies. I examine the influence of interventions and other variables, such as value orientations, perceived risk and demographics on attitudes and behaviors. A stratified random sample of 568 pastoralists and cultivators was surveyed using a pretested, standardized questionnaire. A majority of respondents had positive attitudes toward elephants, with tourism revenue most often cited as the reason for tolerance. Those disliking elephants were concerned about problems caused by elephants such as harm to people and property. Respondents with knowledge of interventions were more likely to be tolerant. This paper illustrates the importance of identifying attitudes and behaviors of local people toward wildlife, and understanding the factors that explain them. It demonstrates how theoretical models and methods from the social sciences can be used to advance attitudinal research in the field of wildlife conservation and improve data that is informing management decisions.

## 5. TESTING BHUTAN'S ATTEMPT TO BALANCE CONSERVATION AND DEVELOPMENT: THE LITTLE COUNTRY THAT COULD?

*\*Jeremy Brooks, University of California, Davis;*

*\*Monique Borgerhoff Mulder, University of California, Davis*

Development can reduce environmental degradation by providing access to technology and economic incentives to sustainably manage resources. Adherents to this approach cite the Kuznets Curve, which suggests that while degradation initially increases, continued development reduces impacts on the environment. Development may, however, negatively

impact traditional resource exploitation patterns, alter environmental values, and weaken the relationship between those values and conservation behaviors. With this study I explore the interaction between economic and socio-cultural factors and the importance of each in stimulating conservation behavior in Bhutan. I investigated the impacts of development and environmental values on conservation behaviors (recycling, tree planting, and minimizing agricultural inputs and fuelwood use) using structured surveys in 240 households in eight villages. Using logistic and OLS regressions, I found that greater market integration is associated with recycling but also with increased use of pesticide, herbicide and fertilizer. Additionally, Buddhist-based values were positively associated with tree planting but did not predict any other conservation behaviors. Depending on the behavior studied, modernization can have positive or deleterious impacts on the environment. While Buddhism currently appears to play a minor role, religious understanding is growing as development progresses in Bhutan and may eventually be important for conservation efforts.

## 6. UNDERSTANDING PARTICIPATION IN INCENTIVE PROGRAMS THAT PROTECT ENDANGERED SPECIES ON PRIVATE LANDS

*\*Michael G. Sorice, Texas A&M University; \*J. Richard Conner, Texas A&M University*

Incentive programs are important tools to enhance endangered species protection efforts on private lands. The success of these programs is contingent on landowner participation; however, little social science work has been done to understand factors influencing cooperation. This study examines landowner willingness to enroll in cost-share incentive programs targeted toward endangered species protection. Using data collected from interviews and surveys of farmers and ranchers in six counties in central Texas, landowner profiles were created and path models examined behavioral intentions to enroll. Landowners in this sample identified themselves as wildlife stewards but without much knowledge about endangered species. They generally were unsure about enrolling in programs that require setting aside endangered species habitat. Landowners relying on the land for income were the least likely to indicate an intention to enroll. Additionally, increasing rootedness (i.e., longer land tenure and family history in community) was negatively related to intention to enroll. Finally, there was a positive relationship between landowners who operate their land for recreational purposes and intention to enroll. When considered in the context of land demographics and species habitat requirements, an understanding of the landowners and their willingness to participate in incentive programs can help agencies and NGOs increase the efficacy of endangered species protection on private lands.

## 7. WHERE DOES CONSERVATION GET STUCK?: INCLUDING EXPERT OPINION IN LARGE-SCALE CONSERVATION PLANNING

*\*Elizabeth Baldwin, Clemson University; \*KAREN BEAZLEY, DALHOUSIE UNIVERSITY; \*CONRAD REINING, WILDLANDS PROJECT*

Expert opinion is frequently included in conservation planning, and is often presented as a "black box" without a clear methodological framework. This research was conducted to: 1) solicit expert opinion to refine a science based large-scale conservation plan for the 80 million-acre Northern Appalachian Ecoregion, and 2) investigate the use of expert opinion as a conservation planning tool in a systematic transparent manner. Qualitative methodology was employed to analyze the text from four meetings with 28 conservation planning experts in

the region during spring of 2007. Themes emerged that transcend the particular case and relate to overall issues of expert opinion inclusion in conservation planning. We found that expert recommendations related strongly to the missions and goals of the organizations they came from. At a given meeting experts tended to converge on a set of recommendations, suggesting that a "consensus atmosphere" may lead a group of experts to the same conclusion. We recommend that expert opinion, if integrated into conservation planning research, be documented and interpreted according to qualitative research methods, so that other practitioners and researchers may understand how particular planning decisions were made in order to improve the replicability of conservation planning studies.

## 72. Spatial Ecology and Conservation

### 1. A NULL MODEL FOR INVASIVE SPECIES AND BIOTIC HOMOGENIZATION: DISENTANGLING HOMOGENIZATION, PSEUDOHOMOGENIZATION, AND CRYPTIC HOMOGENIZATION.

*\*Kevin G. Smith, Tyson Research Center, Washington U. in St. Louis; \*Jon Chase, Washington University in St. Louis*

One potential consequence of the widespread introduction of nonindigenous species is the loss of regional biotic distinctiveness, leading to taxonomic homogenization of biotas among localities. Similarity indices such as Jaccard's Index are often used to assess changes in compositional similarity resulting from species introductions and these indices are useful metrics of taxonomic homogenization in invaded regions. However, changes in species richness alone can result in significant changes in similarity for probabilistic reasons, leading to potential misinterpretations of the role of introduced species in biotic homogenization. A null model approach can be used to account for this probabilistic effect of species richness on similarity measures, allowing a more accurate assessment of the effects of nonindigenous species on biotic similarity and biodiversity. Our null model results show that similarity indices can suggest biotic homogenization when in fact none has occurred ("pseudohomogenization"), or they can suggest an absence of homogenization when it actually has occurred ("cryptic homogenization"). Null expectations can also be generated to predict situations where misinterpretations are most likely. We suggest that the more widespread application of a null model approach to studies of biotic homogenization will improve our understanding of how species introductions affect compositional similarity and regional diversity.

### 2. A SWARM-BASED APPROACH TO INTEGRATING MULTIPLE TIME AND SPATIAL SCALES; SHRIMP, HUMANS, AND HYDROLOGY IN LUQUILLO FOREST, PUERTO RICO

*\*Jorge A Ramirez, Civil Engineering Department, Colorado State University; \*Paul Box, CSIRO Center for Arid Zone Research, Australia; \*Todd A Crowl, Watershed Sciences, Utah State University; \*John Loomis, Colorado State University*

Any model starts with a definition of boundaries and scales at which things matter for the system in question. When modeling shrimp migrating through a series of freshwater pools, one considers the world from the shrimp's point of view, with the

river connecting pools during highly variable flows as an external factor to which shrimp respond. The shrimps' responses are measured in meters and hours. Humans recreating in the same rivers use the pools, but base their behavior on larger factors in the landscape, like overall attractiveness of the area and presence of other people, acting over a day or a weekend. The river discharge responds to variations in rainfall, runoff, topography, and landcover in the watershed. While each system is one aspect of a larger whole, integrating them in a true interacting, multi-scale framework is complex. Swarms are extensions of agent-based models, where collections of agents carry their own schedules of actions; this allows for models to be encapsulated in other models, and collections of models at different resolutions to be resolved to a common definition of time (concurrency). In this paper we present a platform for integrating these multi-scale systems, by representing the landscape and all actors within as swarms, using data and sample output from the Luquillo rainforest, Puerto Rico.

### 3. CONSERVATION STRATEGY FOR REPTILES ALONG THE TEESTA VALLEY, SIKKIM

*\*Basundhara Chettri, Salim Ali Centre for Ornithology and Natural History; \*Subramanian Bhupathy, Salim Ali centre for Ornithology and Natural History; \*Bhoj Kumar Acharya, Salim Ali Centre for Ornithology and Natural History*

Understanding the distribution of species along the altitudinal axis helps in examining the ecological and biogeographical patterns, which is important for the conservation of biodiversity. Paucity of information on reptiles and increasing anthropogenic activities along the Teesta valley calls immediate conservation attention. Due to wide variation in altitude (300-4800m) and climate (tropical-arctic), Teesta valley in Sikkim offers ideal ecosystem for evaluating the distribution of species. Present study was conducted during 2003-2006 along the Teesta valley using Time constrained visual encounter surveys. The altitude range was divided into seven zones at 500m interval. Totally, 42 species were observed after 2494 man-hours search. These species includes five rediscovery after 60 years. Maximum of 21 species in 500-1000m and minimum of three species in 2500-3000m were observed. Maximum number of exclusive (restricted to single zone) and all rediscovered species was found below 1000m. Most reptiles of the Teesta valley are specialized to specific altitude zones as 60% species was restricted within 1000m range. Range profile revealed that most of the species observed in lower altitude were not found in higher altitudes. Based on total species, rediscovered, exclusive and restricted species, we recommend the extension of protected areas to the lower altitudes (<1000m) which is rapidly depleting due to the unsustainable developmental activities.

### 4. HABITAT CONTRIBUTION TO BIODIVERSITY CONSERVATION IN THREE COFFEE PRODUCING LANDSCAPES IN COLOMBIA.

*\*Lina María Sánchez Clavijo, Centro Nacional de Investigaciones de Café - CENICAFE; \*Jorge Eduardo Botero, Centro Nacional de Investigaciones de Café - CENICAFE; \*Sandra Milena Durán, University of Manitoba; \*Juan Gonzalo Vélez, Servicios Ambientales Geográficos; \*Rocío García, Universidad del Quindío*

We evaluated habitat contributions to biodiversity conservation in three agricultural landscapes in the Colombian Andes, using plants, birds and ants. Shade coffee plantations dominated all landscapes, but other land-uses were included in a gradient from natural vegetation remnants to open productive systems. We sampled vegetation in plots, birds in point counts and ground ants using traps. Regional diversity was high for all groups. Communities were dominated by generalist species adapted to intervention but also featured some rare, forest-dwellers. Remnants had the highest plant diversity but not the highest bird or ant diversity, although they had the highest vulnerable-species richness. Shade coffee made the largest contribution to bird diversity and a high one to ant diversity, depending on shade characteristics and landscape context, with a species composition intermediate between remnants and open treed land-uses. Variation in community composition between habitats was high for plants, as a direct result of human intervention; intermediate for birds, which seemed to respond to vegetation structure; and low for ants, with many species using most habitats. The most urgent measures to conserve the remaining fraction of the original biota are protection and enrichment of natural habitats, incentives that allow shade coffee to continue as the major productive system, biodiversity-friendly management strategies, and increases in tree cover and connectivity.

### 5. JAGUAR DISPERSAL CORRIDORS: MAKING THE MAPS A REALITY

*\*Katherine Zeller, WCS/Panthera; \*John Polisar, Wildlife Conservation Society; \*Roberto Salom, Wildlife Conservation Society*

Many corridor initiatives begin with analyzing an area for connectivity using remotely-sensed GIS layers. This is a sensible first step in any corridor initiative, however, turning the results of the analysis into a tangible corridor on the ground is often a leap that is difficult to accomplish. This is due to many factors including a lack of literature on how to ground truth corridors, how to use the information gathered while ground truthing, and how to proceed with implementing a necessarily multifaceted conservation plan from there. The Wildlife Conservation Society recently began a project entitled Path of the Jaguar, a corridor connecting populations throughout the jaguar's range. The corridors were identified through a GIS-based connectivity model using expert opinion. We then developed a ground truthing methodology to 1) field verify the GIS output and determine the biologically best corridor between populations, 2) determine if jaguars are using the corridor, and 3) to collect data on the corridor that cannot be discerned from GIS layers but is necessary for both identifying a viable corridor and for future conservation planning. The approach involves working at many levels from the individual land owner to the federal government. In Costa Rica, our methods proved to be successful for accomplishing our goals and making the jaguar corridor a reality. We hope our methods will serve as a much-needed template for other corridor initiatives.

### 6. MOVEMENT OF AFRICAN BUFFALO IN A TRANSFRONTIER CONSERVATION AREA

*\*Robin Naidoo, WWF; \*Pierre du Preez, Ministry of Environment and Tourism; \*Mark Jago, Ministry of Environment and Tourism; \*Greg Stuart-Hill, WWF LIFE Plus Project; \*Jo Tagg, Ministry of Environment and Tourism; \*L. Chris Weaver, WWF LIFE Plus Project; \*Scott Loarie, Carnegie Institution of Washington*

Understanding animal movement patterns can help in the

design of conservation management strategies, especially for area-sensitive species that roam across large regions having natural and anthropogenic boundaries. We attached satellite collars to ten female African buffalo (*Syncerus caffer*) in a transfrontier conservation area centred on the Caprivi Strip of Namibia. Our goals were to quantify buffalo movement patterns across landscapes that vary seasonally in the spatial distribution of important resources, and to assess the effects of putative natural and anthropogenic barriers on movement. We found that individuals in landscapes consisting of river floodplains and woodlands had most (> 80 %) fixes on the floodplains during the dry season, but moved deep into woodland habitats (up to 40 km from the river) during the wet season. Individuals in areas with a mosaic of grasslands and woodlands showed nomadic behaviour within home ranges (284 - 475 km<sup>2</sup>) across both wet and dry seasons. In no instance did any collared individuals cross the two major rivers in our study areas, but buffalo did cross national boundaries (from Namibia into Angola and back), administrative boundaries (from parks to communal lands and vice versa), and human infrastructure (a paved two-lane highway). Understanding such movements, and how anthropogenic boundaries are superimposed on heterogeneous "natural" landscapes, is key to managing for connectivity in large conservation areas.

## 7. NICHE-BASED DISTRIBUTION MODELS TO THE RESCUE OF RARE SPECIES

\**Gwenaelle Le Lay, DEE, University of Lausanne;*

\**Antoine Guisan, DEE, University of Lausanne*

Preservation of rare species is a central issue in conservation, but their ecology and geographical distribution are often insufficiently known and taken into account by managers. In this study, we aimed at using the potential of habitat suitability models to: 1) improve ecological knowledge of rare species, 2) enhance capacity of detecting new populations in the field and 3) define more objectively the species threat status, both in the present and in the future after climate change. We developed a global framework based on public databases of species occurrence and environmental data to produce habitat suitability maps. We tested this approach on endangered plant species in Switzerland. Their potential range was based on the modeled environmental suitability. We further used this information to complement the usual threat criteria, such as proposed by the World Conservation Union (IUCN). As demonstrated by field testing, for three endangered species, the models proved efficient tools for discovering new populations of the species. When projected into a changed future, models suggest possible modification of species' threat status, some species becoming more threatened than currently. Such model-based approach has the potential to better support management decisions, based on objective information on species' habitat distribution. Moreover, it inserts conservation strategies in the future environmental constraints.

## 8. UNCOVERING GENETIC DIVERSITY WITHIN THE THREE-LINED SALAMANDER: PHYLOGENETICS AND ECOLOGICAL NICHE MODELING

\**Brian L. Daughtry, The University of Alabama;*

\**Nathan Putman, The University of North Carolina at Chapel Hill;* \**Leslie J. Rissler, Department of Biological Sciences, University of Alabama*

Understanding the relationship between genetic diversity and ecological niche divergence among closely related species is integral in understanding speciation, biodiversity, and necessary conservation management practices. We used two

sister species, *Eurycea longicauda* and *E. guttolineata* (Caudata: Plethodontidae), to evaluate this relationship and discern cryptic diversity in the southeastern United States. The ND4 mitochondrial DNA region from individuals across the ranges of both species was sequenced and analyzed. Ecological niche models were developed through MAXENT and were based on pertinent climatic variables. Genetic analysis coupled with niche modeling commonly aid in identifying unique lineages and morphologically cryptic species. Our results support the recent elevation of *E. guttolineata* to species status and warrant further phylogenetic study of both populations. We also encourage continuing utilization of these methods to uncover cryptic biological diversity, especially in amphibians which commonly exhibit little morphological differentiation between species and face growing conservation concerns.

## 73. Spatial Ecology and Conservation (2)

### 1. COUPLING HABITAT, POPULATION, AND LANDSCAPE-CHANGE MODELS FOR FISHERS (MARTES PENNANTI) IN THE SIERRA NEVADA, CALIFORNIA

\**Wayne D. Spencer, Conservation Biology Institute;*

\**Heather Rustigian, Conservation Biology Institute;*

\**James R. Strittholt, Conservation Biology Institute;*

\**Robert Scheller, Conservation Biology Institute;*

\**Alexandra Syphard, Conservation Biology Institute*

An isolated fisher (*Martes pennanti*) population in the southern Sierra Nevada, California, is threatened by wildfires and by management intended to reduce fire risks. To predict changes in habitat and population viability under various management and fire scenarios, we coupled a fisher habitat model with a spatially explicit population model (PATCH) and a landscape change model (LANDIS-II). We predicted habitat value at the home-range scale using Generalized Additive Models and systematic fisher detection-non detection data. We selected a preferred model using information theory and the need for predictor variables responsive to forest disturbances simulated in LANDIS-II. We used PATCH to estimate equilibrium fisher population sizes and to identify potential source, sink, and expansion areas. The habitat model provides a tight fit to fisher data except in one subregion (Kern Plateau) that may be ecologically unique. We estimate the fisher population at 160-360 individuals (excluding juveniles) with about 57-147 adult females. Northward expansion into unoccupied but suitable habitat north of Yosemite National Park has the greatest potential to increase population size, but translocation may be necessary due to dispersal impediments. Predicted source, sink, bottleneck, and expansion areas are informing forest management decisions. We are now using the models to assess how management can most benefit fishers given the probabilistic interplay between fuels management and fires.

### 2. DEFORESTATION AND POLLINATOR FLORAL FIDELITY

\**Berry J Brosi, Stanford University;* \**Martin Arford, Saginaw Valley State University*

A key challenge for conservation biology is understanding how ecological interactions—not just "head counts" of species—are being altered by ongoing global environmental changes. Though an increasing number of reports are showing relative resilience of bee diversity and abundance to land use change, it remains unclear if pollinator foraging behavior may be affected by landscape context, with potentially significant repercussions for plant reproductive success. In particular, a pollinator's floral fidelity—or number of plant species visited in a single foraging

trip—is a major determinant of interspecific pollen transfer and successful pollination. We studied the composition of pollen loads carried by two species of social stingless bees (Apidae: Meliponini) collected across gradients of both distance to forest and forest fragment size in a heavily deforested landscape in southern Costa Rica. While we continue to gather and analyze data, preliminary results indicate that in sites with a greater proportion of surrounding native habitat and in sites with greater bee diversity, the pollen loads of individual bees reflect greater floral fidelity. These results are important for understanding the effects of land use change on ecological interactions and present an argument for conserving even small areas of native habitat in largely deforested areas.

### 3. ECOSYSTEM-BASED MANAGEMENT CAN PREVENT SCALE MISMATCH: THE DUGONG CASE STUDY

*\*Helene Denise Marsh, James Cook University;*

*\*Alana Marie Grech, James Cook University*

To be effective, conservation management of wide-ranging marine mammals such as dugongs must be implemented at spatial scales appropriate to their biology, geopolitical arrangements and relevant local communities. We used spatial risk assessment to evaluate whether there is a mismatch between the scale at which dugong populations function and the geopolitical and local scales at which risks to dugongs are managed in the 348,000 km<sup>2</sup> Great Barrier Reef World Heritage Area, an example of ecosystem-based management. We used mt DNA to propose three biologically-appropriate spatial scales for dugong management in the region, allowing for uncertainty in the data. We classified each area in a 2x2 km<sup>2</sup> grid of the region as of high medium and low conservation value to dugongs based on a spatially-explicit population model derived from 20-years of systematic aerial surveys. Each grid cell was also scored on the basis of whether gill-netting or Indigenous hunting is permitted to occur or is conducted there. The percentage of dugong habitats of high and medium conservation value that were highly protected from these two major sources of anthropogenic mortality was similar at the three spatial scales. We also identified specific locations relevant to each spatial scale where further management intervention would reduce anthropogenic mortality.

### 4. EXPAND OR MULTIPLY? THE RELATIVE VALUES OF METAPOPOPULATION PATCH NETWORK SIZE AND INDIVIDUAL PATCH AREA

*\*Samuel Coulson Nicol, University of Queensland;*

*\*Hugh Possingham, university of queensland*

Should managers of metapopulations spend their money increasing the size of existing patches, or is it better to restore habitat to create a totally new patch? Although this is a classic question in metapopulation ecology, it has never been examined in a decision-theoretic context. Stochastic dynamic programming (SDP) was used in conjunction with a spatially implicit stochastic patch occupancy model to obtain an optimal state-based solution to this problem. An exact simplification of the SDP will be presented, giving a simple algebraic rule of thumb that can be used by managers. The model is used to prioritise management options for a case study of the endangered Mount Lofty Ranges Southern Emu Wren (*Stipiturus malachurus intermedius*) of South Australia (Westphal, Pickett, Getz & Possingham, 2003. *Ecol. App.* pp 543-555). We discovered that the best action for managing the Emu Wren population is to increase the size of all existing patches to a minimum threshold size before considering increasing the number of patches. Subject to the assumptions of

the model, decision theory suggests that managers should generally increase existing patch areas as far as possible before choosing to restore new patches.

### 5. HABITAT SPECIFICITY OF AMAZONIAN TREE SPECIES

*\*Hannah I. Stevens, The New York Botanical Garden*

Knowing the habitat requirements of a plant species is fundamental to understanding its response to environmental change. Using location data from herbarium collections and a series of spatial analyses, this study addresses the questions of how tree species in the Amazon Basin are distributed, and to what degree they are restricted to particular habitat types. A total of 315 tree species from a sample of more than 21,000 specimen records were analyzed. Using GIS, a new matrix of habitat types was delineated using precipitation, evapotranspiration and soil type data, and the number of habitats that each species occurred in was recorded. Results indicate that at least ten percent of the species analyzed are restricted in their distribution, i.e. occur in less than 18 habitat types. Extrapolating this finding to the estimated 45,000 plant species found in the Amazon Basin, at least 4,500 local taxa are potentially threatened by factors such as climate change and habitat loss. The methods developed in this study provide a novel approach for identifying species which may not have otherwise been recognized as potentially threatened.

### 6. USING DEATH ASSEMBLAGES IN EXTANT STANDS OF AN OBLIGATE POST-FIRE SEEDING SHRUB *CEANOTHUS VERRUCOSUS*, TO INFORM FIRE MANAGEMENT

*\*Dawn Lawson, San Diego State Univ./Univ California Davis; \*Helen M. Regan, University of California, Riverside; \*Paul H. Zedler, University of Wisconsin, Madison; \*Janet Franklin, San Diego State University*

The coastal chaparral and sage scrub of southern California are considered endangered ecosystems due, in part, to urban expansion and associated fire suppression. *Ceanothus verrucosus*, a species restricted to these systems, is considered vulnerable because its life history requires fire for population re-establishment. There is concern that prescribed burning may be necessary to ensure its persistence. We used stochastic population viability analysis (PVA) to evaluate this concern. Model-based risk assessments can be problematic in poorly studied species because of the data demands of the models and, indeed, no long term data sets were available for this species. The data necessary to parameterize the model were obtained by 1) using the death assemblages of *C. verrucosus* in extant stands to estimate mortality rates through ring counts, and 2) estimating other vital rates (post-fire germination rates, seedling mortality, seed longevity) from data on functionally similar species. We use this information to estimate the risk of decline. Our models showed that even in the case of an 85 year fire free interval *C. verrucosus* is more threatened by short than by extended fire intervals. We present the results of our PVA and its application to Navy and National Park Service fire management planning.

### 7. LARGE-SCALE MULTISPECIES CONSERVATION PLANNING USING SPATIALLY-EXPLICIT MODELS IN FLORIDA

*\*Karen V Root, Bowling Green State University*

Florida has a heavily-impacted, heterogeneous landscape, which presents challenges for conservation. My approach to

these challenges combined spatially-explicit metapopulation models for 60 vertebrate species to form a set of Multispecies Conservation Value (MCV) maps. These maps combined the habitat suitability, for each species at each location, with the contribution of that location to each species' viability, weighted by each species' risk of significant decline. Alternate maps targeted a variety of goals, e.g., specific taxa or ecosystems. I also examined the contribution of priority areas to existing managed areas in terms of connectivity, heterogeneity, size and shape. Substantial differences in the priorities emerged depending on the goals. Priority areas for birds captured more than 80% of natural ecosystems, whereas priority areas for the herps captured less than 35% of any particular ecosystem. This suggests that caution is warranted when planning is based on specific groups. Areas identified as most valuable were often adjacent to or connecting existing managed areas. In contrast to methods focused on biodiversity hotspots, this risk-based method highlighted areas that would contribute the most to the long-term viability of the most vulnerable species. It is flexible, can incorporate dynamic elements, and could be readily applied to other regions.

## 74. Student Competition A

### 1. CAN SPECIES REINTRODUCTIONS AID ECOSYSTEM RESTORATION? A CASE STUDY FROM ARID AUSTRALIA

*\*Alexandra Iona James, University of New South Wales; \*David J Eldridge, Department of Environment and Climate Change, NSW. University of New South Wales; \*Brydie M Hill, Arid Recovery*

Whilst the primary goal of reintroductions has been the establishment of wild populations, there is increasing recognition of the potential for reintroductions to restore ecosystem function. The substantial range declines of the greater bilby (*Macrotis lagotis*) and the burrowing bettong (*Bettongia lesueur*) are thought to have had dramatic effects on ecosystem processes in the Australian arid zone because of their impacts on surface soils. We studied the effects of their reintroduction on litter and seed capture and soil nutrient levels, in comparison to two prevalent fossorial animals; the exotic European rabbit (*Oryctolagus cuniculus*) and the native sand goanna (*Varanus gouldii*). Bilbies and bettongs dug deeper and wider pits and excavated significantly more soil than rabbits or goannas. Litter and viable seed was restricted almost exclusively to the pits and soil in the pits had significantly higher levels of labile carbon and mineralisable nitrogen than surface soils. Compared with surface soils, bilby, bettong and goanna pits contained relatively more labile carbon than rabbit pits. The significantly greater soil excavation by bilbies and bettongs and the higher concentration of carbon in their pits, demonstrate that these reintroduced fossorial mammals play important roles in the creation of fertile patches. This study demonstrates that through habitat modification, reintroduced species can affect ecosystem function by enhancing resource retention at a local scale.

### 2. CONSERVATION PRIORITIES BASED ON ALTITUDINAL DISTRIBUTIONS OF SPECIES IN SIKKIM, EASTERN HIMALAYA

*\*Bhoj Kumar Acharya, Salim Ali Centre for Ornithology and Natural History; \*Lalitha Vijayan, Salim Ali Centre for Ornithology and Natural History; \*Basundhara Chettri, Salim Ali Centre for Ornithology and Natural History*

Biologically diverse areas need immediate conservation attention due to the fast rate of degradation of natural forests. Sikkim, part of the Eastern Himalaya biodiversity hotspot, witness tremendous loss of biodiversity. Accurate information on distribution patterns of species is important to identify hotspots for planning reserves and prioritizing areas for conservation. We used the altitudinal distribution pattern of three taxa (birds, butterflies and woody plants) to identify high diversity areas in Sikkim and examined the adequacy of existing protected areas for conservation. Sikkim is the catchment area of river Teesta and the entire gradient of altitude, climate and vegetation of Sikkim is reflected along the Teesta valley. The study was conducted along the Teesta valley covering 300 to 4800m elevation using circular plot method for birds and butterflies, and quadrat for plants. Species richness was analyzed at 500m interval. Maximum number of species was found at 1500-2000m for birds, and 500-1000m for butterflies and plants. The combined richness showed peak between 500-1500m. Even though, Sikkim has 3050 km<sup>2</sup> protected area coverage their distribution does not match with the biologically diverse areas. All the existing protected areas lie above 1500m. The unparallel distribution of species and protected areas suggests the extension of protected areas to lower altitude and recommends full protection through community participation.

### 3. DESCRIBING HISTORICAL PATTERNS OF MARINE LIFE POPULATION DYNAMICS USING A LIFE HISTORY APPROACH: A 120 YEAR HISTORY OF THE CALIFORNIA SPINY LOBSTER

*\*Deborah Ann McArdle, University of California Santa Barbara; \*Brian Kinlan, Marine Science Institute, University of California, Santa Barbara*

This study uses a novel approach, coupling methods from ecology and history to examine the long-term population dynamics of the California spiny lobster. We fit a time series of catch and effort, spanning 120 years, to a Bayesian model to estimate historic biomass and exploitation rates and to determine whether and the extent to which life history traits, size structure and growth rate, have responded to changing exploitation over the last century. The lobster has a long-lived, highly iteroparous, high fecundity life history that is well suited to withstand environmental fluctuations. However, over a century of fishing has severely reduced its biomass and average lifespan, potentially diminishing the population's resilience. The present population biomass and size structure may be insufficient for lobster to fulfill its ecological role, possibly lowering the resilience of the ecosystem and ultimately the fishery. Furthermore, the lobster population is following a trajectory that may lead to earlier age at maturation, meaning reverting back to a prior state could take a long time. Thus, restoring older age classes, and in so doing increasing the likelihood that conservation efforts are successful, may require in some areas the entire size structure of the population be allowed to return to historical levels.

### 4. DO-IT-YOURSELF CONSERVATION: HOW HOME LANDSCAPING CHOICES AFFECT BIODIVERSITY

*\*Kristina N. Smyth, Saint Louis University*  
Conservation efforts often overlook urban and suburban private properties, yet they have high potential as a major land type for conservation. In order to make worthwhile recommendations to homeowners, we need detailed information about the nature of ecological relationships in this relatively novel habitat. In this study, twenty-three private residences along an urban-suburban

gradient in St. Louis, MO, USA were surveyed to determine whether there is a positive relationship between vegetation complexity and insect diversity in residential front yards. Sites were chosen by door-to-door solicitation resulting in a 96% participation rate. A correlation between vegetative diversity and arthropod diversity, similar to that seen in previous non-residential ecological research, was upheld in these residential habitats: front yards with greater proportion and diversity of vegetation showed a greater number and diversity of insects, both in general and within a more specific representative group (Diptera). This information, corroborated by the recent upsurge of public conservation awareness, reinforces recommendations to homeowners that their landscaping choices can make a difference in biodiversity conservation. By gathering basic data and including homeowner input in the research process, this research is an example of a straightforward start towards inclusion of urban and suburban residences in conservation efforts.

## 5. ESTIMATING SEASONAL ABUNDANCE OF MIGRATORY WILDEBEEST IN NORTHERN TANZANIA USING A COMPUTER-ASSISTED INDIVIDUAL IDENTIFICATION METHOD

*\*Thomas A Morrison, Dartmouth College*

Accurate estimates of basic population parameters have grown increasingly valuable to the conservation and management of wild animal populations. Here, I present a method for estimating abundance of a migratory wildebeest population using photographic and computer-assisted identification of lateral stripe patterns. Because misidentification of photographs leads to errors in capture history data, I use a new closed population mark-recapture modeling approach that uses estimators based on quadratic distance functions. These estimators are augmented by independent estimates of misidentification error taken from individuals with unique horn patterns. Results from simulations demonstrate that this approach performs well in terms of reducing bias and improving precision when compared to models that do not account for misidentification. I use this method to estimate the abundance of a wildebeest population in Northern Tanzania that has declined 8-fold since 1988. Given certain conditions, this identification systems and mark-recapture modeling approach should be useful for estimating demographic parameters in other wildebeest populations, or in populations of other species with non-evolving individually identifiable natural markings.

## 6. EVERGLADES WATER LEVELS INFLUENCE SOURCE-SINK DYNAMICS OF ENDANGERED WOOD STORKS IN SOUTH FLORIDA, USA

*\*Rena Borkhataria, University of Florida; \*Peter Frederick, University of Florida*

We used satellite telemetry to quantify the use of Everglades wetlands by endangered juvenile wood storks and their survival rates in years in which water levels at the time of fledging were approximately average, low, or high. We then used a stage-based demographic model to examine the contribution of south Florida colonies to the population as a whole. We found that in average or low water level years, fledgling wood storks frequently used Everglades wetlands prior to dying or dispersing northward. In contrast, fledglings made little use of Everglades wetlands in years with deeper water. Instead, during wetter years birds were found in the agricultural areas to the north. Mortality was much higher for birds dispersing during the 2 wetter years than during the normal or dry year. Our demographic models indicate that the frequency of wet years

can determine whether South Florida colonies act as a source or a sink for the Southeastern US population as a whole. Our results strongly reinforce the need to provide water conditions that encourage earlier nesting, so that fledging reliably occurs earlier in the dry season. Without this, nesting in South Florida may have a negative impact on the population as whole.

## 7. BEING A CONSERVATION BIOLOGIST IN THE POLICY ARENA

*\*Anne R Kapuscinski, University of Minnesota*

Conservation biologists engage in many ways with policies directly affecting biodiversity conservation, such as the US Endangered Species Act and protected areas policies. It is increasingly important, however, for conservation biologists to participate pro-actively in other policy arenas, such as technology policy and economic policy, which can generate new threats to or new opportunities for biodiversity conservation. My experiences with technology and environmental policy suggest that, even when in the minority, conservation biologists can make crucial contributions to the formation and implementation of policy. In this talk, I will distill the lessons learned from my years of service in the policy arena into four principles: (1) be centered, by having clarity in your own mind about your core values, assumptions and goals; (2) be well-informed about the policy context, including but not limited to the relevant science; (3) be your whole complicated self—both scientist and advocate—and honestly indicate when your input presents science and when it is your professional judgment; and (4) be humble, as this is the way to genuine listening, learning, deliberation and dispute resolution. If you lead by example following these principles, be ready for big challenges and big impacts (often the least-noticed).

## 75. Student Competition B

### 1. INTEGRATED ECOLOGICAL AND SOCIAL ASSESSMENTS FOR CONSERVATION PLANNING AND RESERVE DESIGN

*\*Brent J Sewall, University of California, Davis;*

*\*Amy L Freestone, Smithsonian Environmental Research Center; \*Mohamed F.E. Moutui, Action Comores Anjouan; \*Ishaka Said, Action Comores Anjouan; \*Nassuri Toilibou, Action Comores Anjouan; \*Saindou M Toumani, Action Comores Anjouan; \*Daoud Attoumane, Action Comores Anjouan; \*Cheikh M Ibouira, Action Comores Anjouan*

Conservation biologists have made impressive strides in reserve design and biodiversity prioritization, identifying key areas to target for conservation on the basis of population and community ecology. Conservation practitioners, however, are faced with a far more complex challenge: balancing these conservation goals with concerns about feasibility and the perspectives and interests of local human populations. To translate conservation biology research into effective planning and implementation, we must explicitly gather and synthesize all information relevant to conservation decisions. Here we present a broad-based ecological and social conservation assessment and planning effort in Union of the Comoros, a small African island nation. We combined ecological assessments of endangered species and highly diverse rainforests with attitudinal surveys of local village residents and consultation with a range of conservation actors. This enabled an integrated assessment of the conservation value, threat, and feasibility of seven potential forest reserve sites, and

led to a detailed conservation plan highlighting key objectives, priority actions, and prerequisites for successful conservation in each region. This approach to conservation planning will enable conservationists to move beyond one-size-fits-all recommendations or relationships of antagonism or neglect of local communities to opportunities for important conservation advances with broad and sustainable local support.

## 2. MEASURING GAPS IN OCEAN LAW FOR ECOSYSTEM-BASED MANAGEMENT

*\*Julia A Ekstrom, University of California, Santa Barbara*

Government and academia have clearly established the need for an integrated ecosystem-based approach to marine management to alleviate problems of fragmented sector-based management. However, in order to operationalize ecosystem-based management (EBM), decision-makers need to better understand the morass of law governing the ocean in order to prioritize and target place-specific problems in EBM planning. This paper demonstrates a technique that identifies and measures legal gaps in ocean management by combining ecosystem ecology with the information retrieval and social network analysis. Using ecosystem models, the links in the ecosystem that are absent from the regulatory body of laws are gaps. I demonstrate the legal gap analysis technique using a generic estuarine ecosystem. A comparison in the modeling of a sector-based system (Shipping and Transportation) and an ecosystem model revealed a strong significant correlation between the sector model and its associated laws. Conversely, the ecosystem model output revealed few correlations, a reflection of the existing fragmentation. Results of the combined tests initially proved to have promise for identifying legal gaps. The presented methodology, with its capacity to identify and measure legal gaps in specific locations, provides decision-makers with a tool to tackle the major obstacle of fragmentation through EBM.

## 3. RAPID ASSESSMENT OF RISKS TO A MOBILE MARINE MAMMAL IN AN ECOSYSTEM-SCALE MPA NETWORK

*\*Alana Marie Grech, James Cook University;*

*\*Helene Marsh, James Cook University*

Ecosystem-scale networks of marine protected areas (MPAs) are important conservation tools, but their effectiveness is difficult to quantify in a timeframe appropriate to species conservation because of data deficiencies. The dugong (Dugong dugon) is a mobile marine mammal that occurs in the Great Barrier Reef World Heritage Area, a region protected by an ecosystem-scale network of MPAs. We developed a rapid approach to assess the risk to dugongs in the region and evaluate options to ameliorate that risk. We used expert opinion and a Delphi technique to identify and rank 5 human factors with the potential to adversely impact dugongs and their seagrass habitats: netting, indigenous hunting, trawling, vessel traffic, and poor quality terrestrial runoff. We then quantified and compared the distribution of these factors with a spatially explicit model of dugong distribution. We estimated that approximately 96% of high, 93% of medium and 72% of low conservation value habitats for dugongs are at low risk from human factors. Using a sensitivity analysis, we found that to ameliorate the current risk to dugongs would require a reduction of commercial netting or indigenous hunting in remote areas, and a reduction of vessel traffic and poor quality terrestrial runoff or commercial netting in urban areas. Our approach enabled us to compare and rank risks in order to identify the most severe risks first, and to locate specific sites that require further management attention.

## 4. SELECTIVITY OF ANCIENT AND MODERN AVIAN EXTINCTIONS ON PACIFIC ISLANDS

*\*Alison G. Boyer, University of New Mexico*

Can prehistoric avian extinctions on Pacific islands be used to model extinction risk in modern birds? To answer this question, I gathered ecological data on all known indigenous, non-migratory, land and freshwater birds of tropical Pacific archipelagos. Using remains from numerous subfossil assemblages on Pacific islands, I compiled a species list for each island and estimated body mass and dietary constraints for extinct species. Extinct species were divided into "prehistoric" and "historic" extinction categories based on the timing of their latest occurrence. I compared the selectivity of prehistoric extinction events to historical extinctions and modern endangered species using regression trees. Results show a strong correspondence between ancient and modern extinction risk, using IUCN category as a proxy for extinction risk in the modern avifauna. The overarching pattern underscores the importance of body size and endemism on extinction risk in living species.

## 5. SHOULD WE PROTECT THE STRONG OR THE WEAK? AN ANALYSIS OF RISK AND RESILIENCE IN MARINE PROTECTED AREAS

*\*Edward Tasman Game, University of Queensland;*

*\*Eve McDonald-Madden, University of Queensland;*

*\*Hugh Possingham, university of queensland*

Catastrophic disturbances such as cyclones or mass coral bleaching poses a major threat to coral reefs worldwide. Marine reserves have often been touted as way of ensuring recovery from uncontrollable disturbance at a faster rate than unprotected habitats; but should we protect those areas at greatest risk, or those at least risk? We formally define this problem and explore the conditions under which each of these strategies is optimal. If our conservation objective is to maximize the chance of having at least one healthy site then the best strategy is always to protect the lowest risk site. On the other hand, if we wish to maximise the expected number of healthy sites, the optimal strategy is more complex; if protected sites are likely to spend a significant amount of time in a degraded state, then it is best to protect low risk sites. Alternatively, if most areas are generally healthy then we should, counter intuitively, protect sites at higher risk. We illustrate these strategies with an example of cyclone disturbance to coral reefs. The optimal conservation strategy with regard to the risk of uncontrollable disturbances can differ dramatically depending on your objective and the level of success expected within reserves. A proper treatment or risk is fundamental to all conservation actions and can indicate surprising routes to conservation success.

## 6. THE EFFECT OF URBANIZATION ON AN ENDEMIC COASTAL BUTTERFLY

*\*Allison K Leidner, North Carolina State University;*

*\*Nick M Haddad, North Carolina State University*

Habitat loss and fragmentation are major drivers of biodiversity loss. These threats are particularly severe for species in coastal habitats undergoing rapid urbanization. One such species is a newly identified butterfly, *Atrytonopsis new species 1*, which is endemic to sand dunes along a 30-mile stretch of barrier islands in North Carolina. Many of the remaining butterfly populations are in isolated patches of sand dune surrounded by an urban matrix. Consequently, the movement of individuals between populations may be severely restricted, limiting the long-term viability of the species. In some cases, populations are connected by small strips of sand dune or are separated only by sparse development. We investigated how the landscape

between butterfly populations affects their dispersal and population structure. Because local butterfly population sizes are often quite large, but are separated by many miles, we used population genetic techniques to infer the rate of movement between populations. Our results suggest that development in the intervening landscape does limit the movement of *Atrytonopsis*, but that the intensity of development does not necessarily have a strong effect on population structure. These results, combined with previous research on movement and behavioral data, will inform conservation strategies for *Atrytonopsis*.

## 7. BALANCING THE CONSERVATION OF THREATENED SPECIES AND INDIGENOUS CULTURES: THE CHALLENGE FOR DUGONGS

*\*Helene Denise Marsh, James Cook University*

Balancing the conservation of iconic threatened species with different cultural values to Indigenous peoples and the wider community is challenging because of competing international and national obligations to conserve species and cultures that are both under threat. The IUCN lists the dugong as vulnerable. Internationally, Australia is expected to play the pivotal role in dugong conservation as the only developed country with a significant dugong population. Dugongs are of the highest cultural value to the coastal Indigenous peoples of remote regions of northern Australia, who regard hunting as one of their most important expressions of Indigenous identity. Considerable progress has been made in the western science required to inform the conservation of dugongs and their habitats including improved understanding of their distribution and abundance, life history, genetics and spatial ecology. This knowledge has informed significant management interventions. Nonetheless, Indigenous hunting is essentially unregulated, despite many years of intermittent government interventions and a national policy aimed at promoting management partnerships between Traditional Owners and governments. Progress will require long-term political commitment to building effective programs of community-based management coordinated across appropriate ecological scales. Such programs could provide employment opportunities that would help address the social problems in these remote communities.

## 76. Sustainable Agriculture

### 1. AVIAN COMMUNITIES AND VEGETATION STRUCTURE IN CACAO AND BANANA AGROFORESTRY SYSTEMS OF TALAMANCA, COSTA RICA

*\*Chad Benjamin Wilsey, University of Washington, College of Forest Resources; \*Stanley Temple, University of Wisconsin-Madison*

Identifying the structural elements of agroforests correlated to animal diversity will inform conservation efforts on private lands located in habitat buffers and corridors. We examined the relationships between vegetation structure and avian communities in four shaded agroforestry systems in Talamanca, Costa Rica: abandoned cacao, cacao, cacao with banana, and banana. During two field seasons, we identified 2,791 trees from approximately 59 species and 2,605 birds from 106 species. Canopy, understory, and groundcover vegetation as well as avian community composition differed between systems while avian species diversity was similar. Agroforestry systems lacking banana had significantly more forest birds and fewer agricultural generalists than systems with banana. Understory- and ground-foraging birds were also more abundant in agroforests without bananas. Small (<15cm

diameter) tree diversity and groundcover explained a substantial portion of the variation in avian community composition in one season ( $r^2=0.48$ ). Vegetation measures (e.g. groundcover, canopy height, and small tree diversity) also explained portions of the variation in the abundances of forest birds and understory- and ground-foraging birds. Results indicate that cacao agroforests should be positioned near remnant forest to maximize their conservation value for forest birds, while banana and cacao with banana agroforests should be located adjacent to disturbed areas.

## 2. BIODIVERSITY AT RISK FROM EXTINCTION DUE TO INVASIVE WEEDS: A CASE STUDY FROM NORTHWEST PAKISTAN

*\*Ikramullah Khan, NWFP Agricultural University Peshawar - The University of Queensland Australia*

Due to the diverse geographic condition, Pakistan is rich in both agricultural and wild biodiversity including a wide variety of crops and medicinal plants. These indigenous plants are used by local people for different ethnobotanical purposes including medicine, nutrition, and shelter. Besides the effects of many factors, invasive species are playing a devastating role. Between March 2003 and September 2004, we surveyed 200 farmers from 20 villages in the D. I. Khan District of North West Frontier Province (NWFP), asking about invasive weeds and their effect on the local biodiversity. Ten species of weed were reported as invasive and having devastating effect on the local biodiversity. These were *Avena fatua*, *Carthamus oxyacantha*, *Prosopis juliflora*, *Eucalyptis camaldulensis*, *Phragmites australis*, *Xanthium strumarium*, *Galium aparine*, *Asphodelus tenuifolius*, *Imperata cylindrica* and *Trianthema portulacastrum*. Of these *Prosopis juliflora* and *Eucalyptis camaldulensis*, strongly allelopathic were purposely introduced. The remaining species were either introduced accidentally or were present in the local flora, but became invasive due to changes in the ecosystem. Due to the aggressive behaviour of these species our local biodiversity is on the risk of extinction of endemic species. To conserve the native biodiversity we should control the existing species and prevent the introduction of invasive species in future.

## 3. COUNTRYSIDE BIOGEOGRAPHY: ARE AGRICULTURAL AREAS USEFUL FOR THE CONSERVATION OF FOREST-DEPENDENT BIRDS AT KEREITA, CENTRAL KENYA?

*\*Mwangi Githiru, National Museums of Kenya; \*David Kimani Kuria, KENVO*

How biodiversity responds to different land-use intensities determines the shape that conservation policies take. Using point counts, we surveyed the avifauna in three land-use systems in a human-dominated landscape in central Kenya: Agricultural zone, Disturbed and Undisturbed Forest. Overall, 2563 individuals comprising 94 species were recorded during the study. Mean number of species per ha were significantly lower in the agricultural area than both forested habitats, but mean bird densities were not significantly different amongst them. Bird species diversity as well as evenness indices were significantly higher in the forested habitats than in the agricultural area. The undisturbed forest had significantly higher proportion of forest-dependent species (FF and F) than the other two. Presently, only a small proportion of the forest-dependent bird fauna remain in the agricultural landscape. However, amount of trees and potatoes in the agricultural area had a significant positive effect on avian diversity and abundance of forest-dependent species there. Whilst potatoes were likely to be a proxy for another factor (such as high altitude or proximity to forest), these findings demonstrate that

increasing wooded habitats leads to more forest species in agricultural areas. Whereas forest-dependent species may not maintain sustainable populations there, this provides strong evidence that well-managed agricultural areas could play an important role in their conservation.

#### 4. CROP STRAW BURNING PRACTICE-A THREAT TO ARBUSCULAR MYCORRHIZAL BIODIVERSITY

\*Ghazala - Nasim, University of the Punjab;

\*Rukhsana - Bajwa, Mycology and plant pathology, University of the Punjab

The burning of crop straw or vegetable remains is a traditional agricultural practice in many countries of the world including Pakistan. Present study reveals that the crop straw /vegetable remain burning practices in urban Pakistan is a growing threat to the biodiversity of arbuscular mycorrhizal (AM) fungal communities in the region. The study reports that some of the species of AM fungi use these plant portions as their ecological niches and categorically sporulate in decaying sheathing leaf bases/non root portions like scale-leaves of cereal crops and vegetables respectively. This includes species of Glomus, Sclerocystis and Acaulospora. Setting the left over plant materials into fire has lead to complete burning of the biomass into ashes and sterilization of upper 10-15cm of surface soil. This practice if continues may totally eliminate the threatened species like Glomus monosporum, Acaulospora bireticulata and Sclerocystis pakistanica. Keywords: Arbuscular mycorrhizal fungal biodiversity, Ecological nich, non-root plant portions.

#### 5. FUNCTIONAL TRAITS OF PLANT COMMUNITIES IN FIELD BOUNDARIES: INFLUENCE OF FARMING PRACTICES AND LANDSCAPE CONTEXT

\*Carole CHATEIL, Museum National d'Histoire Naturelle, UMR 7179, Mécanismes adaptatifs: des organismes aux communautés; \*Sophie Gachet, Museum National d'Histoire Naturelle; \*Emmanuelle PORCHER, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations; \*Jean-Claude ABADIE, Muséum National d'Histoire Naturelle, UMR5173 Conservation des espèces, restauration et suivi des populations

Many conservation measures focus on species protection, but they should also aim to preserve the ecological integrity of communities, including the diversity of ecological functions of ecosystems. In farmland, numerous management measures are implemented to protect biodiversity, which is subject to intense and repeated anthropogenic disturbances, and to maintain the many ecosystem services it provides, through a sustainable management of both cultivated fields and non-productive farmland (e.g. hedges, field boundaries). However, their actual efficacy in maintaining the functional diversity of communities has rarely been tested and is likely to depend strongly on the landscape context. To assess the combined impact of (1) agri-environment measures (including organic farming) and (2) landscape on the functional diversity of plant communities, we studied biological traits of 196 common plant species observed in the boundaries of 62 fields sampled in 2006 around Paris, France. We show that the flora of conventional fields is depleted in entomophilous species compared to organic fields, and that the presence of natural habitats in the vicinity of fields is determinant for the functional diversity of the community. We discuss the implications of these results for the

conservation of agroecosystem services.

#### 6. INCREASE OF SOIL FAUNA DIVERSITY BY THE USE OF FRESH ORGANIC MATTER AT PALENQUE CHIAPAS, MEXICO. A CASE OF SUSTAINABLE MAIZE PRODUCTION.

\*ESPERANZA HUERTA -LWANGA, EL COLEGIO DE LA FRONTERA SUR; \*Efrain MONTEJO-MENESES, El Colegio de la Frontera Sur

Earthworms, as ecosystem engineers (sensu Jones et al. 1994), can be a useful alternative in soil restoration efforts (Butt et al. 1995 and Butt et al. 1997). They have shown a plant grain yield effect proportional to their biomass with values of above 30 gm<sup>2</sup> (Lavelle et al. 1998, Brown et al. 1999), so they may constitute a potential resource of great interest to agriculture durability (Lavelle et al. 1999). At Palenque Chiapas, Mexico, we installed an experience with the use of leaves and stems of *Mucuna pruriens* var. *utilis* (a leguminous well used at tropics) and maize in order to increase fresh organic matter at the soil. Six treatments with four replicas were developed in a 12 year cultured area surrounded by primary vegetation (Tropical rain forest). The experience lasted 10 months, where we measured soil fauna diversity and abundance by TSBF method (Anderson and Ingram 1993), each three months. Soil properties (organic matter, total nitrogen, pH) were also measured. Also we planted maize. At the end we found an increase of organic matter and soil diversity. At the plots where the highest presence of earthworms were found (64 gm<sup>2</sup>) we observed the highest maize crop biomass 24% superior of control plots. Plots with leaves and stems of *Mucuna pruriens* var *utilis* and maize were the plots with the highest earthworm diversity (5 species).

#### 7. PERENNIAL OPTIONS FOR BIOENERGY FEEDSTOCKS

\*Virginia Dale, Oak Ridge National Laboratory

The proposed vast increase in bioenergy usage and production will have interdependent environmental and socioeconomic impacts; yet the complexity and scale dependency of land-use decisions and their impacts are not understood, defined, or described with adequate clarity to enable policy makers to develop strategies to ensure a sustainable bioenergy future with acceptable environmental and socioeconomic consequences. Our conceptual model of bioenergy feedstocks provides a way to improve understanding and management of social and environmental factors affecting and affected by bioenergy use. The components considered include current environmental and socioeconomic conditions and feedbacks as well as the bioenergy features [type of fuel, plants species, management practices, and type and location of production facilities]. A systems approach increases understanding of feedbacks, effects of changes to any of the interactions, and how perturbations influence a new level or type of stability. By focusing on examples using perennial plants, we document biofuel feedstocks options that have reduced environmental impacts as compared to annual crops. This perspective also helps identify key pressure points for which policy actions might be most effective for those stakeholder groups that have common ground. The model also defines scale-dependent metrics that indicate when changes in the system can be observed and measured at different geographic scales.

#### 77. Taxa Conservation

##### 1. CONSERVATION INITIATIVES TOWARDS SAVING THE CRITICALLY ENDANGERED CEBU CINNAMON TREE

*\*Orlyn Barte Orlanes, Cebu Biodiversity Conservation Foundation; \*Lisa Marie Jamadron Paguntalan, Cebu Biodiversity Conservation Foundation; \*Philip Godfrey Cosep Jakosalem, Cebu Biodiversity Conservation Foundation, Inc.*

The Island of Cebu in Central Philippines, is home to one of the world's threatened plant, the Cebu Cinnamon tree *Cinnamomum cebuense* Kostermans. Very little was known about the Cebu Cinnamon tree since the time it was first described in 1986 (Kostermans, 1986). A survey on the population and distribution of the Cebu Cinnamon tree was conducted from 2003 to 2006 using purposive search and total population counts in the six largest forests in Cebu. At least two additional sub-populations were found. The study also identified 25+ mature trees from only four mature individuals known in 2003 and to more than 800 individuals from only 49 in 2003. Effective community-based conservation and management actions were implemented on areas where the Cebu Cinnamon trees were found in partnership with organized communities. Regular monitoring of the phenology of the Cebu Cinnamon trees was also done. Community nurseries were established and Cebu Cinnamon was included as one of the priority species in habitat restoration activities. The project also successfully lobbied for the support of local governments in ensuring the protection of Cebu Cinnamon and the remaining forests.

## 2. DEVELOPING A CONSERVATION MANAGEMENT STRATEGY FOR THE GOLDEN-WINGED WARBLER IN THE CUMBERLAND MOUNTAINS

*\*Kelly Caruso, University of Tennessee; \*David Buehler, University of Tennessee*

Many of the wildlife species that inhabit early-successional habitats have experienced steep declines in recent decades in the Southern Appalachians. Research data indicates that wildlife species associated with these forests are in decline, partly because much of this land has been converted to non-forest uses. The golden-winged warbler (*Vermivora chrysoptera*) is one such declining species at risk, and has been declining at such a significant rate, that extirpation from the eastern portion of their range is a distinct possibility without concerted management action (Buehler et al. in press). The general objectives of our study are to restore early-successional habitat using prescribed burning as a management tool, and monitor the response of golden-winged populations over the next four years. We will analyze nest success, adult within-season survival, density, and early-successional avian community influence on golden-winged density. Experimental habitat management in the southern Appalachians has proven to be successful at increasing golden-winged populations (N. Klaus, GA DNR, pers. comm.; Bulluck, Caruso, and Buehler, Univ. TN, unpubl. data). We tripled the number of individuals on one site within two years following the burn management. We will continue to monitor the effectiveness of the management regime for this species, in order to determine an ideal conservation strategy

## 3. ECOLOGICAL EFFECTS OF MAJOR INJURIES IN DIAMONDBACK TERRAPINS: IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

*\*Kristen Kimberly Cecala, Warnell School of Forestry and Natural Resources; \*J. Whitfield Gibbons, Savannah River Ecology Lab; \*Michael E.*

*Dorcas, Davidson College*

Many turtle species frequently suffer major injuries due to attempted predation or anthropogenic factors. Diamondback terrapins (*Malaclemys terrapin*) are one species known to be affected by anthropogenic activity, but we know little about the causes of injuries. In declining diamondback terrapin populations, learning more about causes and results of injuries can be helpful in developing sound management plans. We examined patterns of limb loss and major shell injuries in a population of terrapins studied for 24 years at Kiawah Island, South Carolina to infer the cause of injuries and possible predators on terrapins. The rate of shell injuries has increased temporally, possibly as a result of increased watercraft activity. Because no differences in rates of limb loss were found between males and females, we conclude that limb loss likely results from aquatic encounters (i.e., limb loss does not appear to be the result of terrestrial predation during nesting). We also found that males experience reduced body condition when injured, and that terrapins with a major injury have lower survivorship than uninjured terrapins. We conclude that, in addition to protecting nesting habitats, measures to protect terrapins from watercraft activity may increase the survivorship of adult terrapins.

## 4. MICROHABITAT SELECTION OF TWO SYMPATRIC SPECIES, FLORIDA BOG FROGS AND BRONZE FROGS

*\*Thomas A Gorman, Virginia Tech; \*Carola Haas, Virginia Tech*

Quantifying habitat selection of related, sympatric species may help elucidate the extent of resource partitioning and competition. Specifically, analyses of microhabitat selection assist researchers in identifying the specific vegetation structures or physical conditions that may be important to persistence of populations or species. Florida bog frogs (*Rana okaloosae*) are endemic to northwestern Florida and are sympatric with the more widely distributed bronze frogs (*Rana clamitans*). Our objective was to determine whether these closely related, sympatric frogs selected different microhabitat characteristics at male calling sites, which in turn may influence successful reproduction (e.g., egg survival and hatching rate) and/or survival. From 2006-2007, we quantified microhabitat characteristics of male calling sites used by both species of frogs in a unique steephead habitat on Eglin Air Force Base, Florida. Model selection indicated that calling sites for bog frogs were best described by habitat features consistent with potential oviposition sites (i.e., depth, emergent, velocity water temperature, pH, and a water temperature-pH interaction), whereas bronze frogs selected sites based on features consistent with increasing male calling success (i.e., emergent and submergent vegetation, depth, velocity, depth-velocity interaction, and distance to cover). At this scale, these ranids select microhabitat differently, suggesting there is resource partitioning.

## 5. RANAVIRUS PREVALENCE IN AMERICAN BULLFROGS INHABITING PONDS WITH CATTLE ACCESS

*\*Matthew Gray, University of Tennessee; \*Debra Miller, University of Georgia; \*Charles Baldwin, University of Georgia*

Ranaviruses have been associated with most of the reported larval anuran die-offs in the United States. It is hypothesized that anthropogenically induced stress may increase pathogen prevalence in amphibian populations by compromising immunity. Cattle use of wetlands may stress resident tadpole populations by reducing water quality. We isolated a

Ranavirus, Frog virus 3 (FV3), from green frog (*Rana clamitans*) and American bullfrog (*R. catesbeiana*) tadpoles collected at 5 cattle-access and 3 non-access ponds on the Cumberland Plateau, Tennessee, U.S.A. We found FV3 in both tadpole species and cattle land-use types; however, green frog tadpoles residing in ponds with cattle access were 3.9X more likely to be infected with FV3 compared to those in non-access ponds. No difference in FV3 prevalence was detected between cattle land uses for American bullfrog tadpoles. A seasonal trend in FV3 prevalence also existed, with prevalence greater in autumn and winter than in summer for both species. We also found that FV3 prevalence decreased significantly as Gosner stage increased in American bullfrog tadpoles. Our results suggest that cattle use of wetlands may increase prevalence of FV3 in ranid tadpoles, although this effect may depend on species, season and tadpole developmental stage.

## 6. THE EFFECT OF CHANGES IN LEGAL PROTECTION STATUS ON FOREST COVER WITHIN THE MONARCH BUTTERFLY BIOSPHERE RESERVE IN MEXICO

*\*M. Isabel Ramirez, Universidad Nacional Autonoma de Mexico; \*Lincoln P. Brower, Sweet Briar College; \*Linda S. Fink, Sweet Briar College; \*Daniel Slayback, SSAI / NASA Goddard Space Flight Center; \*Raul Zubieta, Universidad Nacional Autonoma de Mexico*

The Monarch Butterfly Biosphere Reserve, in which more than a billion monarch butterflies spend the winter, was given legal protection through presidential decrees in 1986 and 2000. The 1986 decree designated 4,491 ha surrounding the known overwintering sites as a core zone in which all logging was prohibited, and an additional 11,619 ha as a buffer zone, in which limited logging was permitted. Subsequently, discovery of overwintering sites outside of the original core zone, plus evidence of rapid regional deforestation, led to a revision of the core and buffer zones in late 2000. This new decree designated 13,552 ha as core zone and 42,707 ha as buffer zone. We used Landsat and Aster imagery to compare rates of forest change from 1986 through 2000 and from 2000 through 2006, in areas that gained protection (from unprotected to buffer zone, and buffer to core) and areas that had unchanged protection status. We found that dense forests continued to have high rates of disturbance (0.6 - 1.9%) inside the new reserve limits, especially in areas given increased protection. It is important to underline that the lowest disturbance rate (0.6%) was found in the area that was core zone for the entire period, 1986-2006, and that the overall disturbance rate has been decreasing.

## 7. THE INFLUENCE OF BEAVER ON BROOK TROUT INVASION AND NATIVE WESTSLOPE CUTTHROAT TROUT DISPLACEMENT IN HEADWATER STREAMS OF SOUTHWESTERN MONTANA

*\*Magnus McCaffery, The University of Montana*

The spread and success of nonnative species may be enhanced by native species in unusual ways. Throughout the western US, spread of exotic brook trout (*Salvelinus fontinalis*) has been implicated in the decline of native cutthroat trout (*Oncorhynchus clarkii*). Landscape factors that influence the extent and impact of this invasion remain poorly understood. Beaver (*Castor canadensis*) alter stream habitat characteristics considerably, but it is unknown how this affects brook trout invasion success, or the consequences for native trout. I used temperature loggers and mark-recapture in headwater streams to establish how beaver affect (i) stream temperatures, (ii)

brook and cutthroat trout distributions, and (iii) their demographic rates. Beaver presence was found to elevate stream temperatures, sustain brook trout invasion at higher elevations, increase the degree of sympatry between trout species, and confer a positive effect on brook trout survival. Juvenile cutthroat survival was unaffected by beaver, although higher survival was evident in later life stages. While brook trout invasion is likely exacerbated by beaver, certain cutthroat life stages benefit from their presence, thus potentially facilitating coexistence of these species. With beaver presence and fish invasions ubiquitous across the North American landscape, this research elucidates the importance of beaver to both native species conservation and invasive species management.

## 8. USING LANDSAT THEMATIC MAPPER IMAGERY TO IDENTIFY LEOPARD FROG DROUGHT REFUGIA

*\*David Mushet, U.S. Geological Survey, Northern Prairie Wildlife Research Center and North Dakota State University, Environmental and Conservation Science Program; \*Ned Euliss, U.S. Geological Survey, Northern Prairie Wildlife Research Center; \*Craig Stockwell, North Dakota State University*

Northern leopard frogs (*Rana pipiens*) over-winter at the mud/water interface in wetlands or other bodies of water that do not freeze solidly. When wetlands freeze completely to the bottom, leopard frogs are eliminated and must recolonize from surrounding, deeper wetlands where over-wintering was successful. During periods of extreme drought (e.g., 1988-1992), wetlands with adequate water depth for over-wintering leopard frogs are few and often widely dispersed. At the Cottonwood Lake Study Area in Stutsman County, North Dakota, leopard frogs were eliminated from all wetlands during the 1988-1992 drought and did not recolonize the site until 1996. We used Landsat Thematic Mapper imagery and various image analysis techniques (e.g., principle components analysis, color mapping, density slicing) to identify likely drought refugia for northern leopard frogs. We found only 19 water bodies in Stutsman County that had sufficient water depth during drought to serve as refuges. We used average leopard frog dispersal distances from the literature (i.e., 1000 m) to develop hypotheses as to how and from where recolonization of the Cottonwood Lake site occurred.

## 78. Taxa Conservation (2)

### 1. A SPATIALLY-EXPLICIT APPROACH TO MIGRATORY BIRD CONSERVATION IN CALIFORNIA

*\*Dick Cameron, The Nature Conservancy; \*Diana Stralberg, PRBO Conservation Science; \*Mark Reynolds, The Nature Conservancy; \*Kirk Klausmeyer, The Nature Conservancy; \*Sylvia Busby, The Nature Conservancy*

Conservation of migratory shorebirds and waterfowl presents unique challenges due to the distances traveled during migration, the diversity of threats encountered, and the current reliance on agricultural landscapes for wintering and migratory passage. To advance migratory bird conservation efforts in California, we developed a spatially-explicit approach to model conservation and landscape change scenarios by integrating habitat data and statewide bird surveys with expert-based habitat associations. Using this approach, we analyzed the distribution, relative density and level of conservation

management afforded these focal species at scales relevant for conservation implementation. For many species, agricultural land provides surrogate habitat, yet has very low levels of long-term conservation management, ranging from 2% to 6%. Levels of conservation management for natural habitats are higher (44% for freshwater wetlands), but from a population perspective, only 17% of the total shorebird population has adequate long-term protection. We used Marxan to identify portfolios of shorebird and waterfowl conservation areas totaling 3.7 million hectares to provide a blueprint for migratory bird habitat conservation for the California portion of the Pacific Flyway.

## 2. BEHAVIORAL CHANGES OF OVERWINTERING MONARCH BUTTERFLIES IN RESPONSE TO FOREST CHANGES IN THE MONARCH BUTTERFLY BIOSPHERE RESERVE FROM 1977 TO 2008

*\*Lincoln P. Brower, Sweet Briar College*

The locations of the overwintering sites of monarch butterflies in Mexico have been mapped, with increasing accuracy and thoroughness, since 1977. Butterflies return to the same massifs year after year, often to the same watersheds, and frequently to the same stands of trees. Our historic colony database, however, also includes sites that formerly supported colonies but are no longer used. We have overlaid the locations of wintering sites on a time series of aerial photographs and satellite images from 1971 to 2006, and can correlate changes in site use with forest disturbance by fire, small-scale logging, and large-scale clearcutting. In addition to completely abandoning sites, butterflies are establishing colonies in newly-disturbed forests that no longer provide suitable abiotic conditions. Even in forests with lower levels of disturbance, butterflies are showing subtle behavior differences compared to the 1970's and 1980's. Colonies shift locations more frequently and earlier in the season, move to lower elevations, and break up and depart on earlier dates at the end of the winter. These behavior patterns are not detected by the current methods used to monitor the status of the monarch butterflies. The implications of these changes for the viability of the monarch migration are not yet clear, and are of concern.

## 3. FOREST EDGE EFFECTS ON THE PHYSIOGNOMY OF MICROHABITATS IN BWINDI IMPENETRABLE NATIONAL PARK (BINP) AND ON THE BEHAVIORAL ECOLOGY OF L'HOEST'S MONKEYS

*\*Tharcisse Ukizintambara, Center for Tropical Ecology and Conservation, Antioch University New England; \*Beth A. Kaplin, Center for Tropical Ecology Conservation, Antioch University New England*

In this study, we investigated whether and how the diversity and abundance of important food tree species and terrestrial herbaceous vegetation (THV), and the amount of ground and canopy vegetation cover differ between edge and interior forest microhabitats of BINP. We surveyed the distribution and abundance of tree and terrestrial herb species, and recorded percent ground cover and canopy cover from random plots. We found that l'hoest's monkeys fed on more than 80% of plant species present in the study area. The food trees were more diverse and abundant on the edge than in the interior ( $t = 3.744$ ,  $df = 64$ ,  $p < 0.001$ ). THV was more diverse on the edge than in the interior ( $t = 6.24$ ,  $df = 121$ ,  $p < 0.001$ ). The canopy was more covered on the edge than in the interior ( $t = 5.284$ ,  $df = 71$ ,  $p < 0.001$ ), whereas the ground vegetation was more dense in the

interior than in the edge microhabitats. This study has lifted up our conservation concerns regarding species living on forest edges. While finding diverse but scattered food sources including occasional crop raiding, they are exposed to considerable risks of predation and persecution than the interior groups which engage more in social activities because of ranging in dense and clumped THV on which l'hoest's monkeys feed most and in which they hide from predator attacks such as eagle, jackal and golden cat, away from any major human disturbances.

## 4. INTEGRATING GEOGRAPHY AND MICROCLIMATOLOGY TO EVALUATE THE PHYSIOLOGICAL SUITABILITY OF SITES SELECTED BY OVERWINTERING MONARCH BUTTERFLIES IN MEXICO

*\*Daniel Slayback, SSAI / NASA Goddard Space Flight Center; \*Linda S. Fink, Sweet Briar College; \*Lincoln P. Brower, Sweet Briar College; \*M. Isabel Ramirez, Universidad Nacional Autonoma de Mexico*

Monarch butterflies are extreme specialists in their selection of wintering sites in Mexico. Each year an estimated one billion butterflies aggregate in 5 to 15 forest sites with a combined area of less than 25 hectares, dispersed over a total area of 110 by 120 km. The long-term conservation of these butterflies requires that we understand the forest characteristics associated with their aggregations. In the winters of 2004-2007 we set out arrays of temperature and humidity dataloggers in current and former butterfly colony sites, and in forest areas never used by butterflies. We have used these data within a GIS to model potential physiological constraints on colony location, including freeze risk, flight opportunity, and lipid depletion rates, for both known colony sites and areas known not to be used by overwintering monarchs. The physiological constraints we found to be identified with colony sites were then modeled over the entire overwintering area, to determine if additional areas exist that provide similar conditions. We have found that some physiological constraints do correlate with colony locations, and that additional areas that provide similar conditions do exist. Thus we conclude that physiological constraints explain part, but not all, of the monarchs' choice of colony sites.

## 5. USING DATA FROM MUSEUM SPECIMENS TO BUILD A PRELIMINARY CONSERVATION ASSESSMENT OF SPECIES

*\*Gary A Krupnick, Smithsonian Institution; \*W. John Kress, Smithsonian Institution; \*Warren L Wagner, Smithsonian Institution*

The Global Strategy for Plant Conservation calls for a preliminary assessment of the conservation status of all known plant species by the year 2010. To date insufficient progress has been made on meeting this target. New efforts to develop a preliminary list beyond using the full IUCN criteria in plant assessments are needed. Here we present an algorithm that provides a preliminary assessment of the conservation status of plant species using data from herbarium specimens. We use Hawaiian specimen data from the United States National Herbarium to determine the parameters of the algorithm and then use specimen data from the Arecaceae, Gesneriaceae and Heliconiaceae for trials of the algorithm. The algorithm was calibrated to insure 95% accuracy in placing the Hawaiian plant species into previously and independently determined threatened categories. About 28% of the Hawaiian taxa, 35% of the species of Heliconiaceae, 32% of the species of Gesneriaceae, and 27% of the species of Arecaceae were identified as Not Threatened and will not need any further

evaluation. Species identified as Potentially Extinct and Potentially Threatened using the algorithm can be further assessed by additional herbarium material and/or conservation specialists for final evaluation using other assessment strategies (e.g., regional and national lists, taxonomic expert assessment, etc.).

## 6. VARIATION IN LIPID RESERVES AS AN INDICATOR OF THE CONDITION OF MIGRATING AND OVERWINTERING MONARCH BUTTERFLIES

*\*Linda S. Fink, Sweet Briar College; \*Lincoln P. Brower, Sweet Briar College; \*M. Isabel Ramirez, Universidad Nacional Autonoma de Mexico*

Monarch butterflies nectar on wildflowers during their southward fall migration and convert the sugar to lipids. The butterflies rely on these lipids for energy during the winter, and to fuel a proportion of their northward migration in the spring. We measured the lipid content of butterflies sampled from two wintering sites in Mexico in early December, January, and mid-March in 2004-05, 2005-06 and 2006-07, and we made comparisons with historical lipid samples analyzed by our lab group periodically since the 1970's. We have detected a downward trend from 1977 to 2006 in the early winter lipid levels. These values reflect conditions during the fall migration, and suggest that migrating butterflies are encountering less nectar or expending more energy. Butterflies with lower lipid reserves have a higher probability of starvation during the winter, but starvation risk is also related to the butterflies' rate of energy expenditure. We are testing the hypothesis that variation in lipid consumption between December and March is correlated with variation in the microclimate characteristics of the sites. If our analysis supports this hypothesis, then the energy budget of the monarch butterfly may be negatively affected by changes in microclimate resulting from loss of forest cover or from climate change.

## 7. WHAT IS THE TAXONOMIC STATUS OF THE FEDERALLY LISTED ENDANGERED SPECIES *AGALINIS ACUTA* (OROBANCHACEAE)?

*\*James Pettengill, University of Maryland College Park; \*Maile Catherine Neel, University of Maryland*

Upon being listed as a federally endangered species in 1988, *Agalinis acuta* was assumed to represent a distinct species. However, a phylogeny of the genus including single accessions of *Agalinis tenella* and *A. acuta* suggested the two species may not be independently evolving lineages. To better understand the evolutionary relationships of these species, we created a more comprehensive phylogeny from 7 chloroplast DNA loci and the nuclear ITS locus (total aligned length = 11,820 nucleotides) assayed from multiple individuals of these two species and 27 other congeneric species. The resulting phylogeny indicated that there was no statistical support for *A. tenella* and *A. acuta* being reciprocally monophyletic and that *Agalinis decemloba* was also indistinguishable. To further evaluate the relationships among *A. tenella*, *A. acuta*, and *A. decemloba*, we sampled 64 morphological characters from multiple individuals from multiple populations of each species. These data suggest high correct classification rates at both the population and species levels. Given the fact that reciprocal monophyly is not always to be expected between recently diverged species due to incomplete lineage sorting and the results of the morphological data, we advocate that *A. acuta* continued to be protected under the Endangered Species Act until more rapidly evolving loci can be assayed.

## 79. Taxon-based Conservation

### 1. AUTOMATED REMOTE TELEMETRY: DEVELOPING A MANAGEMENT PLAN FOR THE SAN NICOLAS ISLAND FOX

*\*Francesca J. Ferrara, Institute for Wildlife Studies; \*Brian Hudgens, Institute for Wildlife Studies; \*Dave Garcelon, Institute for Wildlife Studies*

San Nicolas island fox densities are unusually high, making the population very susceptible to the spread of a novel virulent disease. Utilizing recent technological advances, we developed an automated remote system to effectively and efficiently monitor foxes to obtain baseline mortality estimates and to detect potential threats in time to prevent population declines to critical levels. Since July 2006, 122 foxes were fitted with radio collars transmitting unique ID signals to remote receiving stations throughout the island. This automated system allows a single biologist to monitor daily survival of a larger number of foxes compared to traditional telemetry. Young foxes had <5% annual mortality, typically associated with vehicular trauma or entrapment. Older adults had >50% annual mortality with multiple factors contributing to death. We suggest monitoring 100 adult foxes with a 90-10 split between younger and older adults. With this effort, we would expect one mortality per month in each age class, and suggest that observations of 2 or more mortalities within a 30-day period trigger management actions ranging from rush necropsy to immediate trapping and quarantine of a healthy fox population. The remote telemetry system has exhibited great potential as a useful conservation tool for many species as we develop and refine disease models and management triggers for the San Nicolas island fox.

### 2. CROP SIZE AND ITS RELATIONSHIP TO SOIL NUTRIENTS IN FOUR CANOPY PALMS AT LA SELVA BIOLOGICAL STATION, COSTA RICA

*\*Nora Bynum, AMNH; \*Monica Stich, Nicholas School of the Environment and Earth Sciences, Duke University*

We examined variation in crop size in four canopy palms (*Welfia regia*, *Euterpe percolorata*, *Iriatea deltoidea*, and *Socratea exorrhiza*) in six half-hectare plots that span the soil nutrient fertility gradient at La Selva Biological Station in Costa Rica from February 2006- November 2007. Crop size was estimated by monthly visual inspection, using a standardized protocol to follow individual fruiting branches from first appearance to senescence. We monitored a total of 329 stems in the six plots, and observed complete reproductive cycles in a total of 229 fruiting branches. Average crop size was significantly higher in *Euterpe* (>3000 fruits) than in the other species. Using published fertility data (nutrient availability to 1 m soil depth) for the six plots, we constructed a linear model which revealed that phosphorous was negatively correlated with crop size in *Euterpe*, and positively correlated with crop size in *Welfia* and *Socratea*. Crop size in *Euterpe* appeared to be more strongly influenced by the concentration of nitrogen. Previous work has demonstrated the contribution of edaphic variation to the distribution and density of several canopy palm species at La Selva. Edaphic conditions also appear to play a role in determining fruit crop size in canopy palms, which are important food resources for many rainforest organisms. Supported by NSF BE/CBC 0421178.

### 3. FREE-RANGING CATS AND THEIR

## IMPACT ON WILDLIFE FAUNA- A PROBLEM OUT OF CONTROL

*\*Dagny Natalia Krauze, Warsaw University of Life Sciences; \*Jacek Goszczynski, Warsaw University of Life Sciences; \*Jakub Gryz, Warsaw University of Life Sciences*

The work aimed at determining the range of greatest impact of cats by identifying patterns of their activity and area searching and their predation upon wildlife fauna. At first, 6 villages in central Poland were surveyed. It showed that on average one animal was kept in the household, few cats were provided with proper food (around 40% was given milk only), all of them roamed freely, reproduced without control and hunted regularly. The density, estimated from transect counts (XI 2002-X 2005) along standard routes, was dependent on temperature, precipitation and time of the day. In spring and summer, cats presented a two-peaked activity pattern, while in cold seasons it was more stable throughout the day. The animals were much less active in cold and rainy weather. Cat predation was studied for four years (2004-2007) with three methods (prey collection, scat and stomach content analysis). Prey composition depended on the method applied. Prey collection underestimated share of invertebrates, insectivores (unpalatable prey) were found less often in scats and stomachs. Moreover, predation rate revealed by prey collection was much lower (2,1 items/cat/month) than by scat or stomach content analysis (42 and 51 items/cat/month, respectively). To conclude, cats may exert strong pressure (biggest in summer) on wildlife species as they are numerous and their outdoor presence is not restricted.

## 4. INCIDENTAL TAKE OF ENDANGERED PALLID STURGEON IN A COMMERCIAL CAVIAR FISHERY

*\*Phillip Bettoli, U.S. Geological Survey; \*Michelle Casto-Yerty, Tennessee Technological University; \*George Scholten, Tennessee Wildlife Resources Agency*

We quantified the bycatch of endangered pallid sturgeon (*Scaphirhynchus albus*) in Tennessee's shovelnose sturgeon (*S. platyrhynchus*) caviar fishery by accompanying commercial fishers and monitoring their catch in April-May 2007. Fishers removed 327 live sturgeon from their gear in our presence, of which 93 were harvested; we also obtained the carcasses of 20 sturgeon that a fisher harvested out of our sight. Two of the 113 harvested sturgeon were confirmed pallid sturgeon based on microsatellite DNA analyses. Additionally, fishers gave us five, live pallid sturgeon that they removed from their gear. If the incidental take of pallid sturgeon (1.8% of all sturgeon harvested) was similar in the previous two commercial seasons, at least 169 adult pallid sturgeon were harvested by commercial fishers in the Tennessee waters of the Mississippi River in 2005 and 2006. While retrieving a gill net set the day before, a fisher we were accompanying retrieved a gillnet lost two days earlier. That ghost net caught 53 sturgeon; most of those fish were dead, including one confirmed pallid sturgeon.

## 5. MONITORING FOR PEST MANAGEMENT: WHERE AND HOW MUCH?

*\*Cindy Hauser, University of Melbourne*

This project demonstrates how monitoring effort should be allocated over a heterogeneous landscape to detect new incursions of a pest or disease. A simple generalized model of pest detection and management is used to determine the allocation that minimizes expected monitoring and management costs. The model includes: - the probability of

pest presence at each homogeneous site in the landscape; - the relationship between expenditure on monitoring and the probability of detecting the pest if it is present; - the cost of controlling the pest if it is successfully detected; - the costs incurred if the pest is not detected in the present, resulting in spread, damage and increased control costs when the pest is eventually detected. Our results confirm the intuitive approach of avoiding areas where the pest is unlikely to be present or the monitoring method is unlikely to successfully detect the pest. However, the functional form of how much monitoring effort to allocate elsewhere is less intuitive: optimal monitoring effort has a logarithmic relationship with the probability of pest presence. This approach to allocation of monitoring resources is demonstrated using data and models of orange hawkweed (*Hieracium aurantiacum*) in alpine Victoria, Australia. However the method is sufficiently flexible for use in a range of terrestrial and marine environments, where natural features and/or economically valuable species are threatened by pest species.

## 6. PARROTS TAKE IT WITH A GRAIN OF SALT: 18 SOIL LICKS IN SOUTHEAST PERU ARE HIGH IN AVAILABLE SODIUM

*\*Luke Losada Powell, University of Maine; \*George Van Nostrand Powell, World Wildlife Fund; \*Thomas Underhill Powell, EcoTest Laboratories, Inc.; \*Donald Brightsmith, Texas A&M University, Schubot Exotic Bird Center*

Although geophagy (soil eating) is widespread in parrots of the Peruvian Amazon, it remains unclear why parrots consume soil. To test hypotheses on the soil characteristics that parrots select for, we collected soil samples at 18 parrot geophagy sites and 18 control sites across the Department of Madre de Dios in southeastern Peru. We analyzed soils for percent clay and for concentrations of 21 metals, using an extraction procedure for "available" metals to simulate the parrot digestive system. Only sodium and magnesium were significantly higher in consumed soils vs. unconsumed controls. Sodium concentration in soil consumed by parrots averaged 1137 (+/- 382) parts per million (ppm), eight times higher than control soils and 27 times higher than was found in macaw foods. Although magnesium concentration in consumed soils averaged 527 (+/- 248) ppm, twice that of controls, this was six times less than in macaw foods. We conclude that magnesium and clay percentage are not likely targets of geophagous parrots and that sodium needs may drive parrot geophagy in southeastern Peru. We stress the need to evaluate the importance of this under-protected resource to the maintenance of parrot populations in this remarkably species rich region.

## 7. REPRODUCTIVE SUCCESS OF AMERICAN OYSTERCATCHERS IN SOUTH CAROLINA, USA: EVIDENCE OF AN ECOLOGICAL TRAP?

*\*Janet M Thibault, Clemson University; \*Felicia Sanders, South Carolina Department of Natural Resources; \*Patrick Jodice, USGS South Carolina Cooperative Fish & Wildlife Research Unit*

Ecological traps are habitats of low quality that are insufficient for reproduction but nonetheless attract individuals over habitats of higher quality. We examined reproductive success and causes of nest failure in American Oystercatchers (*Haematopus palliatus*). This species is experiencing a decline throughout its range and appears to experience frequent nest failures. In South Carolina, most oystercatchers nest on narrow, elevated mounds of oyster shells deposited naturally along the edges of bays by storms. These shell rakes also may form

artificially, however, by boat wakes along heavily trafficked waterways. We compared reproductive success of oystercatchers nesting on naturally formed shell mounds in Bulls Bay, Cape Romain National Wildlife Refuge, with those nesting along shell rakes formed by boat wakes along the Atlantic Intracoastal Waterway (AICW) adjacent to the Refuge. Productivity was higher, nest survival was higher, more chicks reached fledging age, and parents that fledged chicks spent more time feeding at their nesting territory in Bulls Bay compared to the AICW. Predation, human disturbance, boat over-wash, and poor food availability all appear to contribute to poor reproductive success along the AICW. Continued nesting along the AICW by oystercatchers with repeated failures would suggest that there is a mismatch between environmental cues used to select nesting habitat and the actual quality of the habitat with respect to fitness.

## 8. WHY DOES THE AMERICAN BISON NEED TO BE RESTORED?

\**Kent H Redford, Wildlife Conservation Society;*  
\**Keith Aune, Wildlife Conservation Society;* \**Eva Fearn, Wildlife Conservation Society*

Two hundred years ago, there were approximately 60 million bison in herds that ranged from Mexico's Chihuahua desert to Alaska's Yukon Flats. As North America's largest land mammal, their grazing patterns, movements, and behavior influenced the composition of grassland ecosystems. But by 1900, this iconic keystone species was nearly extinct. Thanks to early reintroduction efforts, 450,000 bison exist today. However, over 95% are in managed private production herds, and the bison's ecological functions have not been restored. The future of the species faces erosive threats. Compounding issues include uncoordinated genetic management, disease, and multiple regulatory frameworks. Restoring the bison's ecological function will help restore prairie and shrub steppe ecosystems and reconnect human cultures with a rich part of North American natural history. Restoration will require multiple, free-ranging herds interacting with a diversity of native species, and ensuring the genetic health of the species by allowing herds to be above a minimum viable population size and subject to natural selection. Restoration of grand herds will also inspire and sustain American cultures. Ensuring the ecological future of bison requires the long-term, large-scale coordination of scientists, agencies, NGOs, Native Americans, and producers from Mexico, the US, and Canada. A broad-based coalition is working to lay the ground work to achieve ecological restoration of bison over the next century.

## 9. WHY NOT KILL A TIGER?

\**Alison Wadmore, Imperial College, London, UK;*  
\**E.J. Milner-Gulland, Imperial College London*  
A huge amount of time and money has been spent on wild tiger conservation, yet numbers continue to decline. Debates on the best courses of action are held at a global, national and local level, but are these discussions well informed? Upon what evidence base are decision-makers debating options, and how solid or complete is that evidence base? It is generally accepted that there are three main threats to wild tigers, namely habitat loss, prey depletion and commercialised poaching; in order to enable a systematic management assessment to allocate funds for the greatest return on investment, each of these threats would need to be quantified at least to a reasonable level of confidence. However partly due to its illegal nature, there is a big gap in the scientific analysis of poaching that could lead to inappropriate strategic choices being made. Using India as a case study, this research builds an evidence base for tiger poaching, to sit alongside ecological evidence when informing decision-makers. Analysing poaching incidents and any

resulting legal action, it quickly becomes clear that there are huge incentives and minimal deterrents to killing and selling a wild tiger. Only closer inspection of this new knowledge base can identify causes and successful interventions, and ignoring or excluding it may even make any ecological progress a wasted effort.

## 80. The Politicization of Endangered Species Science

### 1. CONSERVATION SCIENCE AND CONSERVATION POLITICS: HISTORICAL PERSPECTIVES ON THE CURRENT CHALLENGE TO SCIENTIFIC INTEGRITY

\**Curt Meine, International Crane Foundation*

The current challenges to scientific integrity have precedents throughout conservation history. They reflect an inherent tension between conservation science and conservation policy. That tension has sometimes been problematic and controversial. At other times, however, it has informed their partnership in ways that has served the public interest while advancing their respective goals, methods, and effectiveness. Against this backdrop, how do we understand the recent wave of politicization? How can history help to defend the integrity and independence of science in the public arena? By examining the evolution of the science/policy relationship, we can assess the degree to which the current challenges represent a continuation of past trends, or an aberrant departure from the norm.

### 2. POLITICAL INTERFERENCE IN THE PROTECTION OF COHO SALMON IN THE KLAMATH RIVER BASIN

\**Mike Kelly, none available*

As a technical lead biologist for National Marine Fisheries Service, NOAA fisheries anticipated Endangered Species Act Section 7 consultation on the operation of the Bureau of Reclamation's Klamath Project, I was responsible for the completion of a biological opinion on the Southern Oregon Northern California Coast coho salmon analyzing the effects of proposed stream flows. Unfortunately the biological opinion and RPA were not developed according to the legal requirements of the ESA and its implementing regulations. NOAA Fisheries biologists were denied the opportunity to conduct the obviously necessary analyses, and by dictating how the NOAA Fisheries team should interpret information contained in a National Research Council interim Klamath report. Political pressure prevented NOAA Fisheries from applying the "best available science" and from properly analyzing the Bureau of Reclamation's proposed "reasonable and prudent alternative" which turned out to be neither.

### 3. THE POLITICIZATION OF ENDANGERED SPECIES SCIENCE

\**Francesca T Grifo, Union of Concerned Scientists*

One of the great strengths of the Endangered Species Act is its foundation in sound scientific principles and its reliance on the best available science. Unfortunately, time and time again, when scientific knowledge has seemed to be in conflict with its political goals, the current administration has manipulated the process through which science enters into its decisions. At many federal agencies and departments, including the Department of Interior, there are multiple patterns of abuse of science, deep systemic changes in the rules governing the workings of agencies such as the Fish and Wildlife Service, intimidation and coercion of scientists. The

end result has been political interference with both listing decisions, critical habitat designations. Reversing this downward spiral will take the persistent and energetic engagement of the scientific community as this administration draws to a close and we transition to the next. Protections for whistleblowers, greater transparency in decision making, and reforms to the regulatory process are all critical to ensure ongoing robust scientific input into endangered species decisions.

## 81. The Road to Recovery: Science to Secure Freshwater Mollusk Biodiversity

### 1. THE ROLE OF FRESHWATER MUSSELS IN FOOD WEBS AND THEIR NUTRITIONAL REQUIREMENTS IN ECOSYSTEMS

*\*Susan Jerrine Nichols, U.S. Geological Survey;*

*\*Teresa J. Newton, US Geological Survey*

As large, long-lived filter feeders, unionid mussels are capable of altering nutrient cycling in riverine food webs. Unionids create a nutrient shunt, removing suspended particles and associated nutrients to the substrate where they are available to other biota. Nutrients can also be sequestered into unionid biomass and removed from the food web. The effect of this nutrient shunt on riverine food webs depends, in part, on unionid density and biomass. The precipitous decline in unionid populations over the last 150 years, represents a significant reduction in benthic filter-feeding biomass which may lead to alterations in ecosystem function. Thus, certain watersheds may see an increase in nutrient loading and accelerated nutrient transport downstream because the filter-feeding biota are not as effective. Even areas with moderate unionid densities may not have the same influence on nutrient cycling as they did historically as the species assemblages necessary for maximizing facilitation of resources may not be present. Recovery of native unionid communities may help re-establish their roles in riverine food webs (e.g., nutrient cycling) to the benefit of watershed restoration efforts.

### 2. HYDROPHYSICAL FACTORS AFFECTING NATIVE MUSSEL DISTRIBUTIONS IN LARGE RIVERS

*\*Steven Zigler, U.S. Geological Survey; \*Teresa J.*

*Newton, US Geological Survey*

Mussels are influenced by complex interactions of biotic and abiotic factors acting at various spatial scales. In flowing systems, geomorphology and hydrology drive hydrophysical features that strongly influence mussel communities due to direct (e.g., displacement, dispersal) and indirect effects (e.g., host fish distribution, food) on mussel life histories and population processes. Our work to develop statistical and spatial models for large rivers suggests that certain complex hydraulic variables (e.g., shear stress, Froude number) greatly improve our ability to predict mussel distributions, but that interactions with physical features such as slope are important. Thresholds at both high and low values of hydraulic variables constrain mussel distributions, and result in models predicting low populations in poorly connected backwater areas and the navigation channel, whereas main channel border areas with high geomorphic complexity (e.g., river bends, islands) and small side channels were more favorable to mussels. Discharge-specific models indicate that droughts and floods may have substantial effects on mussel distributions. Thus, hydrophysical conditions and their spatial and temporal variability must be considered for successful conservation and restoration efforts for mussels. Additional research to evaluate

patterns of diversity, and distribution of key assemblages and rare species at scales relevant to potential management actions in large rivers are needed.

### 3. MINIMIZING GENETIC RISKS ASSOCIATED WITH HATCHERY PROPAGATION AND AUGMENTATION OF FRESHWATER MUSSEL SPECIES

*\*Gregory R Moyer, USFWS*

The predominant motivation for most restoration projects is ecological. That is, the goal is to bring a species back to something closer to its historical abundance and as a result, restore the ecological functions and services it provided and possibly even a limited, sustainable fishery. From this perspective, goals can be described largely in terms of population sizes. Abundance, however, is not necessarily an indicator of population viability; therefore the primary goal of any restoration plan should be to maintain or restore the evolutionary processes that allow long-term species persistence. This requires minimizing genetic risks associated with hatchery propagation and knowledge about levels and types of genetic diversity necessary to maintain the ability to adapt over time. I present an overview of genetic problems and pitfalls associated with hatchery-based enhancement including genetic risks associated hatchery propagation and augmentation.

### 4. VISION FOR A WATERSHED APPROACH TO REBUILDING NATIVE BIVALVE RESOURCES FROM THE HEADWATERS TO COAST FOR BOTH BIODIVERSITY AND POPULATION BIOMASS

*\*Danielle Kreeger, Partnership for the Delaware Estuary*

The decline of native freshwater mussels is worrisome because of lost biodiversity, ecosystem services and because it signifies a drop in environmental integrity. Marine bivalves are also in trouble with steep declines in populations causing substantial loss of ecosystem services. As we move toward ecosystem-based approaches to conserving, managing, and restoring aquatic resources, bivalve shellfish arguably represent the best "common denominator" group for integrating these efforts because they live throughout tidal and non-tidal waters, occupy diverse niches, and can be abundant enough to serve as ecosystem engineers driving key functions. As a case study for a watershed approach to studying bivalves, key bivalves living throughout the Delaware Estuary were compared in their population-level water processing. Summer physiological data were integrated with abundance estimates. Although oysters appear to have slightly greater clearance rates, their total water processing (~10 billion L/h) was comparable to a species of freshwater mussel (~10 billion L/h), but both were dwarfed by an estuarine mussel (~60 billion L/h). This first attempt at a watershed comparison indicates that all native bivalves furnish ecosystem services regardless of being tidal or non-tidal, commercial or noncommercial. Expanding the conservation and restoration dialogue to include the full diversity of native bivalves will provide new opportunities to promote the integrated health of large watersheds.

### 5. RECOVERY UNDER THE ENDANGERED SPECIES ACT: THE ROLES OF SCIENCE AND POLICY

*\*James Michael Scott, University of Idaho; \*Maile Catherine Neel, University of Maryland; \*Aaron Haines, University of Idaho; \*Dale Goble, University*

## of Idaho

The purpose of the ESA is to conserve listed species and the ecosystems on which they depend. Limited guidance has been provided on what recovery means. The USFWS defines recovery operationally through two types of documents: recovery plans and downlisting and delisting rules published in the Federal Register. We quantified the operational definitions of recovery as it is specified in the recovery plans and Federal Register documents. For 1,084 species with approved recovery plans we recorded whether the USFWS deemed each species to have potential to be downlisted or delisted and the number of individuals and number of populations required for downlisting or delisting. We compared these numbers to the numbers historically, at listing, and at the time the plan was written. We will discuss the role science and society has in determining recovery goals for endangered species.

## 6. PROGRESS IN FRESHWATER MUSSEL CULTIVATION AND RECOVERY AT VIRGINIA'S AQUATIC WILDLIFE CONSERVATION CENTER

*\*Nathan Lee Eckert, Virginia Department of Game & Inland Fisheries*

The Virginia Department of Game and Inland Fisheries established the Aquatic Wildlife Conservation Center (AWCC) in 1998 to recover the high number of endangered freshwater mussels in the Upper Tennessee River System of Virginia. The facility is located along the South Fork Holston River (SFHR) near Marion, Virginia. The AWCC draws water from the SFHR that passes through a 5-acre pond to increase temperature and algal productivity. Adult mussels are held in circular fiberglass tanks that can provide optimal habitat conditions for each species. Thirty-seven species of freshwater mussels have been held at AWCC with 27 spawning in captivity. Twenty-one species have been propagated producing over 1,690,000 juveniles. A portion of juveniles are held for grow-out in a flow through system supplied with filtered river water, eight species have been raised to over one year of age in this system, two species have become sexually mature. To date, over 518,000 mussels have been released ranging in age from 1 day to 9 years. In addition to mussels, the state endangered spiny riversnail, *Io fluviialis*, is raised at AWCC with over 10,750 released ranging from 3 months to two year old. These animals are released into 6 designated mussel restoration reaches in the Powell, Clinch, and North Fork Holston rivers of the upper Tennessee River System of Virginia.

## 7. APPLYING CONSERVATION GENETICS TO THE RECOVERY OF FRESHWATER MOLLUSKS

*\*Timothy L King, US Geological Survey Leetown Science Center*

Delineation of the appropriate unit of management is especially critical when the composition of a population is manipulated, whether by reintroduction from external stocks or by reestablishment of gene flow and migration patterns by the exchange of individuals from different populations. The intended use of cultured unionids as a conservation tool underscores the need to recognize the genetic composition of natural and managed populations. If a goal of unionid conservation efforts is to permit the continued evolution of a species, then it is important to establish the genetic and taxonomic relationships among managed individuals or populations. We have undertaken studies to recognize the hierarchical structure of genetic variation in at-risk species. We will highlight the management implications resulting from studies designed to assess the population structure within

watersheds, determine the phylogeographic structure among watersheds representing the species' range, and position the observed genetic variation in the appropriate taxonomic context. Although unionid populations that constitute an important component in the evolutionary legacy of the species can only be protected under the U.S. Endangered Species Act if the entire species or subspecies is listed, recognition and protection of significant intraspecific differentiation should be an integral component of legislatively mandated recovery plans.

## 8. RECOVERY UNDER THE ENDANGERED SPECIES ACT

*\*Mary Parkin and Deborah Crouse, US Fish and Wildlife Service*

Deborah Crouse. Recovery of imperiled amphibians in the United States is governed by the Endangered Species Act of 1973. While certain provisions of the ESA are procedural, the ESA does provide a science-based framework for the development and implementation of an effective recovery program for listed species. For example, the process of listing or delisting a species requires an evaluation of threats to the species organized under five categories. The ESA also requires recovery plans to include measurable, objective criteria to determine whether or species has recovered. The Service is now requiring recovery plans to include criteria for determining that the threats that led to a species' being listed have been sufficiently reduced to ensure that recovery is maintained. This presentation will outline recovery requirements under the ESA, how these apply to listed amphibians, and how they might benefit recovery of amphibians. Examples from the recovery programs for several currently listed amphibian species will be discussed. 4401 N. Fairfax Dr., Rm 420, Arlington, VA 22203, USA. (Debby\_Crouse@fws.gov.)

## 9. THE METRICS OF RECOVERY: LINKING DECISION-MAKING AND MONITORING FOR THREATENED AND ENDANGERED SPECIES

*\*Michael C. Runge, U.S. Geological Survey*

Managers of threatened and endangered species need to be able to track progress toward recovery to evaluate the efficacy of past decisions, to guide current and future decisions, and to know when a change in listing status is warranted. The metrics that are used to track progress toward recovery need to be both meaningful and measurable: meaningful in being directly linked to the ultimate management objectives; measurable in being tied to practical and affordable monitoring protocols. The most meaningful metric is the cumulative distribution function of the time to (quasi)extinction, because this is tied directly to the risk (extinction) that the U.S. Endangered Species Act is trying to manage. But the risk of extinction is not, itself, measurable, except through a population viability analysis. Still, a quantitative recovery criterion stated in terms of the risk of extinction provides an overarching recovery metric that integrates the separate elements of a threats analysis (especially the "five factors" specified in the ESA), puts all recovery actions on a common scale (thus allowing examination of trade-offs among them), and permits derivation of stepped-down proxy metrics that can be measured with practical protocols. Such an approach avoids some of the problems with many current recovery criteria, which can be arbitrary, incoherent, and unnecessarily rigid. The solution is to link recovery monitoring directly to the decision context in which it will be used.

## 10. CONTEXT-DEPENDENT EFFECTS OF FRESHWATER MUSSEL COMMUNITIES ON

## STREAM ECOSYSTEM FUNCTION.

*\*Caryn C. Vaughn, University of Oklahoma*

Freshwater mussels naturally occur as dense, speciose communities that perform important functions by linking benthic and pelagic compartments in rivers. The amount of material mussels filter from and contribute back to the water column and sediments depends on mussel biomass and flow regime (water volume and residence time). In addition, mussel species have different physiological optima that govern their performance, including filtration and excretion rates. Thus, within the biomass-flow regime constraint, species composition and environmental gradients interact to determine the magnitude of processes provided by mussels. Further complicating this scenario, mussel species interact both negatively (competition) and positively (facilitation), these interactions impact mussel condition and thus performance, and are also dependent on species composition and environmental context. Mussels are declining globally, reducing the biomass available to process stream water, most rivers have been manipulated so that flow and thermal regimes are altered, and mussel species dominance patterns are changing in response to both local land use and regional climate change. All of these factors lower the tipping point beyond which processes performed by mussels in rivers may rapidly decline. Restoring natural ecosystem function in rivers historically inhabited by mussels will require restoring entire mussel communities.

## 11. EXAMPLES OF GENETIC VARIATION IN IMPERILED FRESHWATER MUSSELS AT DIFFERENT SPATIAL SCALES AND THE IMPLICATIONS FOR SPECIES CONSERVATION.

*\*Kevin J Roe, Iowa State University*

Conservation planning for the recovery of freshwater mussel species is complicated by several factors including the fact that mussels have complex life histories, which require parasitizing a vertebrate host in order to complete development. It is assumed that host fish vagility directly affects the connectivity of mussel populations and through this the degree of gene flow between populations. Knowledge of genetic connectivity (or isolation) of populations is critical for the wise management of this imperiled group. Although, detailed and accurate knowledge of host usage is lacking for most species of freshwater mussels, the development of species-specific microsatellite markers allows the assessment of gene flow at various spatial scales. A comparison of the genetic variation in two mussel species: the widely distributed sheepsnose (*Plethobasus cyphus*) and the highly endemic Louisiana pearlshell (*Margaritifera hembeli*) will be presented. Both species are of conservation concern, and are respectively considered Candidate and Threatened species by the USFWS. The comparison will test the prediction that *M. hembeli* will exhibit high levels of genetic similarity and *P. cyphus* will exhibit low levels of genetic similarity between populations (isolation by distance). The degree of genetic similarity observed between populations can be then be used to inform the search for fish hosts.

## 12. RE-EVALUATING THE ROLE OF DAMS IN SOUTHEASTERN FRESHWATER MOLLUSK CONSERVATION STRATEGIES

*\*Michael M. Gangloff, Appalachian State University*

Impoundments are widely recognized as having dramatic impacts on freshwater mollusk and fish assemblages. Impacts of larger dams are dramatic and well-documented, but smaller structures remain poorly understood. Assessing the impacts of low-head dams (i.e., those <5 m height) on habitats and biota is

critical to imperiled mollusk management because 1) low-heads greatly outnumber larger dams and occur in a greater range of stream sizes and types, and 2) there is increasing conservation interest in removing small dams as part of stream restoration. Recent emphasis has been placed on potential fragmentation of mollusk populations by mill and other low-head dams. However, emerging counter evidence suggests that these structures may enhance mollusk habitat in downstream reaches. Comparisons with historical surveys suggest that if small dams are neglected partial collapses can lead to dramatic habitat degradation and loss of sensitive mollusk populations. Federal and state agencies need to be more concerned with the condition and future of breached low-head dams while recognizing that some intact structures may benefit mollusks thereby offsetting negative impacts to other aquatic fauna. Removal of unstable small dams together with habitat preservation, flow management, and propagation currently form the cornerstones of southeastern mollusk conservation and recovery programs.

## 13. FRESHWATER MUSSELS: CHALLENGING CONSERVATION EFFORTS IN A RACE AGAINST TIME

*\*George Watters, Ohio State University*

Freshwater mussels are the most imperiled animals in North America and their protection is a high conservation priority. They are unique in having a parasitic larval stage that requires a fish host on which to complete their metamorphosis. Mussels have evolved numerous novel methods of luring the proper hosts to them to be infested. These include portions of the female mussel's anatomy and packages of larvae that mimic fish food items, including larval fish and insects. However, the necessity of a host complicates the recovery of these endangered animals. Many of these freshwater mussels are so imperiled that their recovery can only be attained by captive breeding programs. To this end state and federal agencies have created conservation facilities devoted to mussels. These facilities identify the proper hosts for mussel species and attempt to propagate them. Propagation methods include releasing artificially infested fish, release of newly metamorphosed juveniles, release of juveniles grown out in the laboratory or in cages, in vitro metamorphosis, and cryopreservation of gametes and glochidia.

## 14. GLOBAL DIVERSITY AND CONSERVATION OF FRESHWATER MOLLUSKS: CAUSES, CONSEQUENCES AND CHALLENGES FOR THE FUTURE

*\*Arthur E Bogan, North Carolina State Museum of Natural Sciences; \*Ellen E. Strong, Department of Invertebrate Zoology, Smithsonian Institution, National museum of Natural History*

Freshwater mollusks occur worldwide on six of the seven continents and are represented by ~4000 species of gastropods in 33 families and by ~1030 species of bivalves in 19 families. Assembly of the world's freshwater mollusk fauna has occurred through repeated invasions of continental waters by numerous independent lineages - nearly 40 among gastropods alone. Global hotspots of gastropod diversity include the Mekong and Mobile River basins, ancient lakes like Baikal, Ohrid and Tanganyika, and springs and groundwater systems of the southwestern United States, Europe and Australia. Bivalve diversity is highest in the rivers of the southeastern United States and the Mekong River basin of Southeast Asia. Together with terrestrial gastropods, these animals are arguably the most endangered group of animals with the highest number of extinct species: gastropods with 58 extinct species and bivalves

with about 35 extinct species. Major causes of decline and extinction can be attributed to habitat modification and destruction combined with low vagility and long generation times which inhibit their ability to adapt quickly to rapid environmental change. Conservation of our molluscan resources will require marshalling diverse efforts and resources including basic research and inventories, enhanced communication and outreach, and active intervention.

## 15. WATER QUALITY EVALUATION TOOLS FOR DESIGNING AND IMPLEMENTING FRESHWATER MUSSEL RECOVERY ACTIONS

*\*Tom Augspurger, U.S. Fish and Wildlife Service;*  
*\*Christopher G Ingersoll, US Geological Survey;*  
*\*Richard Joseph Neves, Virginia Tech*

The exposure of freshwater mussels to pollutants in surface and sediment pore water is among the suspected factors limiting recovery and merits attention. The National Strategy for the Conservation of Native Freshwater Mussels recognizes pollution as a priority, so aquatic toxicology and risk assessment methods are being applied to address toxic effects of pollutants on mussels. While there are important influencing factors, chemical risks generally can be characterized with two measurable endpoints: exposure (pollutant concentration and variability over time) and toxicity (concentration associated with adverse effect). The most applicable exposure data are site-specific water quality measurements, but reference watershed data are also useful. Most pollutant toxicity assessments for mussels are based on single chemical testing, but we currently understand toxicity for few chemicals, species, or mussel life stages. Toxicity extrapolation methods, such as interspecies correlation models and species sensitivity distributions, can be used to estimate toxicity for untested species. These tools can help to prioritize pollutants for recovery projects. Effluent testing, in-stream caging studies, and field surveys for mussels provide complementary site-specific data to address combined chemical and non-chemical stressors in streams. Available data indicate that ammonia, metals, chlorine, sediment, and dissolved oxygen merit special attention in mussel restoration projects.

## 16. A SPATIAL AND TEMPORAL SCALE MONITORING APPROACH TO RECOVER AND SUSTAIN FRESHWATER MOLLUSKS WITH EMPHASIS ON COMMUNITIES, POPULATIONS, AND INDIVIDUALS

*\*Alan D. Christian, Arkansas State University;*  
*\*John L. Harris, Arkansas Highway and Transportation Dept.*

To meet the goals to recover and sustain freshwater mollusks, we are developing approaches to monitor a variety of spatial-temporal scales. We address approaches used for relocations and anthropogenic disturbances across these scales to monitor conditions and changes at the watershed, reach, micro and macro habitat, assemblage, and individual levels. We use cumulative watershed effects models to estimate sediment loads under current land use conditions and compare them to a "natural" condition. We are modeling hydraulic conditions in streams and relating conditions to known mussel distributions to identify preferred hydraulic conditions and investigating associated geomorphological relationships. Habitat characterization and assessment protocols identified macrohabitats that may influence the distribution of freshwater mollusks, their thresholds of habitat degradation, and relationships between mollusks and cohabitants. Fish and macroinvertebrates have been used to assess habitat and water quality for mollusks and provide information on potential host

fish. Standardized protocols have been developed to assess populations at temporal scales appropriate to the program goals. Propagated individuals and relocated individuals have been monitored for movement and reproductive status. We have used fitness measures to monitor status and changes in individual concentrations. Finally, these efforts have been accomplished in collaboration with multiple stakeholders.

## 82. Urban Area Conservation

### 1. CHANGES IN NATURAL SELECTION DRIVEN BY ANTHROPOGENIC HABITAT ALTERATION

*\*Erin Marnocha, University of California Los Angeles;*  
*\*Ryan Calsbeek, Dartmouth College;*  
*\*Thomas B. Smith, University of California Los Angeles*

Human activities are dramatically altering ecosystems across the planet, however the long-term evolutionary consequences of these changes remain poorly understood. Recent work suggests that the homogenizing effects of anthropogenic habitat alteration may inhibit the process of diversification and negatively impact biodiversity. Here we use mark-recapture data on brown anoles (*Anolis sagrei*) to demonstrate that anthropogenic habitat alteration may, in some cases, promote diversification by creating divergent, highly localized selection regimes. We show that human-driven habitat changes impact both the strength and form of natural selection acting on hindlimb length, a heritable, fitness-related trait in anoles. We also demonstrate fine-scale genetic differentiation between populations inhabiting natural and disturbed habitats. Results highlight an important way that human activities may disrupt natural evolutionary processes.

### 2. IMPACTS OF CLIMATE CHANGE AND URBAN DEVELOPMENT ON THE SPOTTED MARSH FROG (*LIMNODYNASTES TASMANIENSIS*) IN THE MERRI CREEK CORRIDOR

*\*Joab Norbert Wilson, PhD student;*  
*\*Sarah Bekessy, RMIT University*

Climate change, habitat destruction and alteration are among the most serious threats to frog species world wide. Altered hydrology due to climate change and habitat degradation as a result of urbanisation can both adversely affect frog population sizes. This study examines both of these impacts using a predictive spatial habitat suitability model for the spotted marsh frog (*Limnodynastes tasmaniensis*) in the Merri Creek Corridor, Melbourne, Australia. This species was chosen as it is known to be sensitive to the both the effects of climate change and urban development. Bayesian logistic regression modelling was used to estimate current and future habitat suitability of pond sites in the region, and a range of scenarios were explored through the use of simple hydrological and urbanisation models. The relative impacts of urbanisation and climate change were compared. It was found that increasing aridity will have negative implications for the species, however in the short-term, urban development poses a greater threat to populations. The study provides recommendations for including such predictive models in urban planning and restoration activities to prepare for future conservational challenges.

### 3. INFLUENCES OF URBANIZATION ON THE COMPOSITION AND STRUCTURE OF

## RIPARIAN FOREST COMMUNITIES IN CINCINNATI, OHIO, U.S.A.

*\*James Hansel, Miami University; \*Derric Neville Pennington, University of Minnesota; \*David Gorchov, Miami University*

Riparian forests provide vital ecosystem services for humans and a diversity of other organisms; however, these areas are increasingly vulnerable to degradation associated with urbanization and land use change. This study examined how urbanization affects temperate woody riparian plant communities in an urban metropolitan area. Our objective was to characterize woody riparian plant communities and identify how land-cover influences diversity, composition and structure. Land-use variables, including percent impervious cover, percent grass cover, building density, building area, and distance to nearest road and railroad, were quantified by a Geographic Information System and IKONOS satellite imagery and were used as measures of urbanization. Understory diversity, structure, and composition displayed a greater response to urbanization than did canopy measures. We found that exotic canopy species were positively correlated with urbanization while native canopy and understory plants were negatively correlated to urbanization. Certain native and exotic woody species appear to be good indicators associated with varying levels of urbanization. The exotic understory species, *Lonicera maaekii* (Rupr.) Herder, was the most abundant and ubiquitous woody species throughout the study area. Our findings are important because compositional and structural changes in riparian plant communities by exotic species invasions could diminish the ecological functioning of these systems.

## 4. INTEGRATED APPROACH IN CONSERVING URBAN CONSERVATION AREA CASE STUDY: MUARA ANGKE WILDLIFE SANCTUARY

*\*edy sutrisno, Bogor agricultural university*

Muara Angke Wildlife Sanctuary is one of the remaining natural forest habitat in Jakarta. It covers a 25 ha marshes area mixed with mangrove species. As a conservation area in the urban, it needs special approach in the management which meets the urban people characteristic. Encouraging people of Jakarta city to involve in supporting the conservation of Muara Angke Wildlife Sanctuary is a critical. A multistakeholder management, environmental education and public awareness, optimizing the role of media, establish a voluntary based activities are several approach in order to develop conservation constituents. This paper explains challenges and constraints in implementation of public awareness and conservation education efforts to obtain support for conservation in the urban area.

## 5. NORTH AMERICA'S NEWEST URBAN WILDERNESS PARK

*\*Michelle Thomas, University of Toronto; \*Eric Davies, University of Toronto; \*Ralph Tonninger, Toronto and Region Conservation Authority; \*Mart Gross, University of Toronto*

Toronto's Tommy Thompson Park is emerging as a new urban wilderness park. It has the potential to significantly increase natural biodiversity within the city landscape. The park is an artificial peninsula that extends five kilometres into Lake Ontario, directly in front of Toronto, Canada's largest city with a population of over 2.5 million. Construction began in 1959 as a breakwater, and then a dump site for clean fill from construction waste (e.g., concrete, rubble). While not initially

planned as an urban wilderness, it has been naturally colonized by over 400 plant species, and hundreds of animals. It has also become an internationally recognized water-bird nesting site (ICBP). Two of these species are of particular interest: Canada's largest colony of black-crowned night herons and the Great Lakes' largest colony of double-crested cormorants. Plans for Tommy Thompson Park include the preservation of significant wildlife species and protecting environmentally significant areas. However, these objectives are problematic in practice. Issues of concern include conflicting usage of the park by various species, in particular the rising population of cormorants and its potential relationship with trees and other nesting species, and personal values of people, who value some species over others. While the park is a hotspot for urban biodiversity, it also highlights the difference between biological and social carrying capacity.

## 6. POSITIVE AND NEGATIVE EFFECTS OF URBAN AREAS ON CONSERVATION AREAS

*\*Robert Ian McDonald, Harvard University*

With rapid global urbanization, particularly in Asia and southern Africa, the proximity between cities and protected areas will increase. We conducted a literature review of documented effects of cities on protected areas to quantify what the future may bring. The spatial scale of impact depends on the type of effect, varying from local to global, with the most severe effects occurring when cities and parks are closer than 50 km. We also examined the Conservation Projects database of The Nature Conservancy to determine if threats reported by conservation practitioners varied by the amount of surrounding urbanization. Conservation projects in urban areas had a different distribution of threats than rural projects, including more frequent problems with invasive species. Overall, given that the median distance from a park to a city is already less than 50 km in many regions, we conclude that thousands of protected areas are already impacted by cities.

## 7. RESTORING COMPLEX HABITATS AND LOCAL BIOTIC CONNECTIONS: FROM MILITARY BASE TO PUBLIC PARK

*\*Steven Handel, Green Shield Ecology; \*Milan Mitrovich, Green Shield Ecology; \*Ken Smith, Ken Smith Landscape Architect*

A former 700 hectare Marine Corps Air Station in Orange County, California has been made available to become a high biodiversity public facility, the Orange County Great Park. The park must have many functions including cultural, athletic, educational, social, and natural habitat spaces. A modern botanical garden will be included that teaches the ecological history and function of the site. Much of the landscape will be restored into a complex Mediterranean biome, including sage scrub, oak woodlands, riverine communities, and grasslands and meadows. One large natural stream buried for 60 years will be restored. These new habitats also will connect remnant nature reserves in coastal hills and inland mountains, to allow movement of animals and seeds through the region. An extensive education program will make this new park a vehicle for understanding sustainable living in this arid region. The design is by collaboration among ecologists, landscape architects, civil and structural engineers, and architects, all who are charged with making an ecologically sustainable landscape embedded in a large metropolitan area near Los Angeles, California.

## 8. WILDLIFE ABUNDANCE PATTERNS ALONG GRADIENTS OF URBANIZATION IN THE NORTH CAROLINA SANDHILLS

*\*Ronald W Sutherland, Nicholas School of the Environment, Duke University*

Rapid urbanization threatens the survival of native wildlife species worldwide. If we are to fully grasp the implications of the ongoing growth of urban areas on biodiversity, we need to be able to quantify the response patterns of a wide range of different species to the intensification of urban land use. In this study, I set up two road-based transects across full gradients of urbanization and habitat loss in the diverse longleaf pine forests of the Sandhills region of North Carolina, USA. The transects (75 and 81 km long) were driven repeatedly at night in the field seasons of 2006-2007, and all vertebrate animals (live or dead) encountered were tallied. A total of 3931 animals were recorded after driving a total of 16,037 km. Ground-nesting birds (nightjars and quail) were also surveyed using night and daytime point counts distributed along one of the road routes. My results reveal that total snake, amphibian, and bird abundances are positively associated with high forest and wetland cover and negatively associated with increasing levels of traffic and urban land use. Conversely, mesopredator mammals responded slightly positively to increasing urbanization, and negatively to intact forest cover. Both ground-nesting birds and snakes showed negative correlations with mesopredator abundance. These results confirm the hypothesis that many native vertebrates in the southern USA will continue to rapidly retreat from the onslaught of urban development.

## 83. Wildlife Conservation in China

### 1. ACCURATE DNA-BASED INDIVIDUAL IDENTIFICATION OF RED PANDA (*AILURUS FULGENS*) USING FAECAL SAMPLES

*\*Xiangjiang Zhan, Institute of Zoology, Chinese Academy of Sciences; \*Yu Guo, Institute of Zoology; \*Hua Wu, Institute of Zoology, CAS; \*Fuwen Wei, Institute of Zoology, CAS*

Although the red panda (*Ailurus fulgens*) is an endangered species facing a serious risk of local extinction in the wild, the accurate demography and genetic variation of the panda remain little informative. Microsatellite analysis using fecal DNA has proven effective on counting individuals and estimating population size of elusive animals. In our study, 9 microsatellite markers were consistently successful for amplification of red panda faeces. None of the locus is departed from Hardy-Weinberg expectations. By genotyping 67 red panda faeces systematically collected from Liangshan Mountains, 29 individuals were identified. Overall the population was in equilibrium, not significantly different from zero and genetic diversity wasn't low. GIMLET showed that eight loci would be enough in individual identification. Genotyping fecal DNA microsatellite provides a sensible way to accurately identify the red panda.

### 2. THE RELATEDNESS AMONG INDIVIDUALS OF GIANT PANDA IN MATING LOCATION

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Information on the dispersal patterns and mating systems is quite important for conservation programs, particularly for small populations or in declining or threatened species.

However, little knowledge is known about the dispersal patterns and mating systems of giant panda. Here, we intended to study dispersal pattern and mating system of wild giant panda by analysing the relatedness among individuals in mating location. 143 feces samples were analyzed by using 19 microsatellite loci, and 26 individuals (4 females and 22 males) were identified. The mean relatedness among individuals, among females, among males, and between females and males in mating location is 0.103, 0.035, 0.108 and 0.076, respectively, all of which are less than 0.125. Moreover, the rate of mean relatedness below 0.125 among females, among males, and between females and males in mating location is 83%, 79% and 78%, respectively. These results indicated that the average relatedness among individuals in mating location is very low, and that there is no relatedness among most individuals in mating location. Moreover, the low relatedness among individuals in mating location also indicated that both male and female were in dispersal, which could be a result of inbreeding avoidance to obtain larger fitness benefit.

### 3. THE ROLE OF LONG-TERM STUDIES ON CONSERVATION OF RARE PHEASANTS

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As most pheasants live in the forest, the distribution and abundance of pheasants may reflect the quality of forest ecosystem. China is one of the countries which rich in pheasants. Among the 50 species of pheasants found in the world, 27 species occur in China, and 11 are global threatened species. Pheasant is one important group of birds which has high priority in wildlife conservation in China. Since 1980s, Long-term studies have been carried out on the biology and ecology of the rare pheasants in China, the outputs of these studies have made great contributions to the conservation of the threatened species and their habitats. In this paper, some examples are given to illustrate the role of long-term studies on conservation of China's rare pheasants, and the developments of scientific research on these birds in the future are discussed.

### 4. POTENTIAL CHEMOSIGNALS IN THE ANOGENITAL GLAND SECRETION OF GIANT PANDAS, *AILUROPODA MELANOLEUCA*, ASSOCIATED WITH SEX AND INDIVIDUAL IDENTITY

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With a combination of dichloromethane extraction and analysis by gas chromatography-mass spectrometry (GC-MS), we found 39 compounds in the anogenital gland secretion (AGS) of captive adult giant pandas, *Ailuropoda melanoleuca*, during the non-mating season. In addition to indole, squalene, and some of the straight-chain fatty acids that had been characterized previously from the AGS of giant pandas, we identified several

new compounds such as decenal, two isomers of decadienal, phenylacetic acid, 5-methylhydantoin, hydroquinone, phenylpropanoic acid and erucic acid. Quantitative comparison of the relative abundances of the 20 main GC peaks revealed that 5-methylhydantoin, indole, and erucic acid are putative female pheromones, whereas squalene and hydroquinone are putative male pheromones. In addition to the presence of a few individual-specific compounds, the relative abundances of most of the 21 constituents varied more between individuals than within individuals. The chemical composition of different AGS samples from the same pandas consistently displayed a minimum cluster distance, much smaller than that between samples from different individuals in a hierarchical linkage cluster dendrogram. Our results indicate that the AGS might contain an "odor fingerprint," and synthetic chemosignals might be useful in modulating the behavior and physiology of giant pandas. This result will be helpful for the conservation and management of both the captive and wild pandas.

## 5. PROBLEMS, PRACTICES AND PERSPECTIVE OF CETACEAN CONSERVATION IN THE YANGTZE

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There are two species of fresh water cetaceans surviving in the Yangtze River system in China, which are the baiji (*Lipotes vexillifer*) and the Yangtze finless porpoise (*Neophocaena phocaenoides asiaeorientalis*). The threats faced by the cetaceans include over- and illegal fishing, vessel traffic, water project development, and water pollution. In order to prevent the extinction of baiji and a sharp decline in the abundance of the porpoise, in situ conservation and ex situ conservation strategies were proposed and have been implemented since the middle 1980s. In the past 20 years, six nature reserves and two semi-natural reserves have been set up along the river. But, the administrative measures taken in the natural reserves have not yet kept the populations of both species from sharply declining. On the other hand, under careful management, the porpoises in the semi-natural reserves have been reproducing naturally and successfully. Additionally, a small breeding group of porpoises is being established in captivity. Under the existing severely degraded conditions of the Yangtze system, even the in situ conservation efforts in the natural reserves, and in the entire Yangtze River system, including the lakes, should not be ignored or abandoned at any time, the ex situ conservation should be emphasized, and the need to establish more new semi-natural reserves should be placed on the agenda of local and central governments in the near future.

## 6. MICROSATELLITE VARIATION AND GENETIC STRUCTURE OF FINLESS PORPOISES IN CHINESE WATERS

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To assist in conservation and management of the finless porpoise (*Neophocaena phocaenoides*) in Chinese waters, ten microsatellite loci were used to screen 117 finless porpoises from the Chinese water. It was supported to subdivide the finless porpoises in Chinese waters into three populations, which is consistent with previous morphological as well as mitochondrial analyses. Contrary to the low genetic diversity revealed by mtDNA control region sequences, relatively high levels of microsatellite genetic variation were found in these populations ( $HE=0.732-0.795$ ). Genetic differentiation was

significant among populations with FST values ranging from low (0.070) to moderately large (0.137) values. The relationship between genetic and geographical distance was tested by means of a series of Mantel tests. Although low level of genetic differentiation between the Yangtze river and the Yellow Sea cannot completely ruled out the probability of gene flow between both populations, immigration rates estimated by a Bayesian method suggest that migration is not likely to occur among populations, which is also supported by assignment tests. The mode-shift test did not detect any distortion of allele frequencies, and tests of heterozygosity excess were not significant in any populations. The recent incorporation of rare alleles from immigrants is likely more plausible than population expansion to explain the heterozygosity deficiency observed in the South China Sea population.

## 7. GENETIC SIGNATURE OF ANTHROPOGENIC POPULATION DECLINE AND FRAGMENTATION IN THE HIGHEST PRIMATE SPECIES, RHINOPITHECUS BIETI, ON TIBETAN PLATEAU

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Tibetan Plateau is regarded as one of the six hottest hotpots globally because of the high biodiversity and specificity of endemic species on high elevation. The topographic variation of the Qinghai-Tibet Plateau and the climate changes in the Pleistocene are widely regarded as two of the most important factors influencing the population dynamics of local species and their genetic diversity pattern. But little is known about impact of the human activity on the species there. Here we reported the first large-scale population genetics analysis of the highest primate, Yunnan Snub-nosed monkey (*Rhinopithecus bieti*). Even this monkey lives on the high elevation with 3000-4700m, it is found that it is suffering from human activity and habitat fragmentation, which caused the population decline and the gene pool were split into five population (A-E) with significant difference. Southern Population D and E with lower elevation and more human pressure, show genetics signature of recent population decline, suggesting the collapse of *R. bieti* was from low to high elevation. This result demonstrate the human impact of the high elevation biota and the mechanism: road and residential area split the habitat and cause population fragmentation, land use of lower elevation result in population decline. It also suggest that the human exploitation is becoming the third and more powerful factor in shaping the population dynamics and genetics diversity pattern and of wildlife on Tibetan Plateau.