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Distribution, connectivity, and conservation status of the Cascade red fox

The Cascade red fox (*Vulpes vulpes cascadenensis*) is one of 3 montane red fox subspecies, which have a unique evolutionary history having crossed the Bering Landbridge in North America 300,000 years ago during the Illinoian glaciation. They became isolated into sky-island populations and diverged from all other red foxes. We conducted noninvasive camera surveys and genetic sampling in southern Washington from 2008 to 2016. Our objectives were to (1) determine distribution in southern Washington and predict occurrence across their range, (2) assess genetic integrity and potential hybridization, and (3) determine how landscape features influence connectivity. We developed presence-absence and presence-only species distribution models that reflect the key habitat correlates of fox occurrence and predict occurrence across their range. We genotyped 51 individuals at 33 microsatellite markers and found that individuals in southern Washington comprise a single widespread population with a very low contemporary genetic effective population size. This metric ultimately determines the rate of diversity loss and, therefore, loss of evolutionary potential and the risks associated with inbreeding. Finally, we applied a landscape resistance approach to model the effects of landscape and climate variables on gene flow. A lack of knowledge of their basic ecology implies that we do not know how climate change in the mountains, which we are currently witnessing, will affect the fox. Moving forward, a clearer understanding of the relationship between fox habitat use and changing conditions in the mountains, related to climate warming, will improve our understanding of conservation in the montane biome.

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Revealing viewpoints on the science-practice interface in Ecology and Conservation

The science-practice interface in Ecology and Conservation is a contentious topic. While many have argued for the existence of a “science-practice gap” and called for “evidence-based conservation”, others questioned these concepts for assuming linearity in science communication, neglecting other knowledges and the intricate processes of decision-making. We used Q-methodology to systematically assess such diverse ways of thinking about the interface among scientists and practitioners. We focused on a tropical developing nation, as many current conservation issues occur in these countries. We asked ecologists hired at Brazilian universities and practitioners from the federal environmental agency to rank their agreement with 48 statements describing how the science-practice interface should be. PCA was used to identify groups of participants whose responses were similar, representing shared viewpoints. The predominant viewpoint was shared among scientists and practitioners who valued the integration of scientific and strategic knowledge to tackle environmental issues. The second was held mostly by practitioners assigning great importance to science in decision-making and calling for more relevant research. The last was shared by scientists less willing to collaborate, seeing practitioners as responsible for correctly interpreting science. All agreed scientists and practitioners are important actors, but differed on the specific roles assigned to them and the knowledge they hold. Except for the third viewpoint, there was high willingness for dialog, but several stressed the need for organizational structures stimulating interactions. By revealing patterns of shared thinking, we identified points of consensus and conflict to consider when linking science and practice in Ecology and Conservation.

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Choosing species for reforestation in highly diverse tropical forest communities

Choosing species for reforestation programs or community forestry in species-rich tropical rainforest ecosystems is a complex task. Reforestation objectives, social preferences, and ecological attributes must be balanced to achieve landscape restoration, timber production, or community forestry objectives. Here we develop a method to make better species choices for reforestation programs with native species when limited silvicultural information is available. We conducted community surveys to determine social preference of tree species and inferred their ecological suitability for open-field plantations from growth rates and frequency in forest plots at different successional stages. Several species, for which silvicultural data was available, were correctly classified as promising or unsuitable for open-field reforestation. Notably, we found a strong negative correlation between ecological suitability indicators and socioeconomic preference ranks. Only a single outlier species ranked very high in both categories. This result highlights the difficulty of finding suitable native species for community forestry and offers an explanation why reforestation efforts with native species often fail. We concluded that the



approach should be a useful first screening of species-rich forest communities for potential reforestation species. Our results also support the view that species-rich tropical rainforests are not an easily renewable natural resource in a sense that secondary forests will not provide an equivalent resource value to local communities.

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Genetic underpinnings of disease susceptibility in Yellowstone wolves

A classic paradigm in conservation genetics and species management posits that immunogenetic variation buffers against individual and population level disease risks. In its simplest form, this variation confers organisms and their populations with multiple immune responses, thereby limiting a pathogen's ability to evolve exploitation strategies of common weaknesses. As a result, numerous studies characterize variation in genes with known immune function, with few delving deeper into genomic analyses. Here, we seek to expand this paradigm and consider the role of genome-wide variation in governing individual disease state. Using sarcoptic mange in Yellowstone National Park (YNP) wolves as our study system, we survey immunogenetic variation and perform a genome-scale family-based association study to identify loci linked with disease susceptibility and severity. Critically, these analyses consider both traditional immune genes and loci typically excluded from more targeted immunogenetic approaches. Of equal importance, they are conducted in a natural population of reintroduced carnivores currently experiencing disease-mediated morbidity and mortality. Through their highly resolved pedigree and detailed longitudinal data, YNP wolves enable integration of environmental, demographic, and genomic parameters when evaluating risk factors of disease. The information gleaned from their study and integrative methods described herein may then inform management of similar reintroductions. We thus illustrate the importance of considering multiple facets of genomic variation in the complex ecology of wild vertebrates and disease, and hope others will adopt this approach for better monitoring, management, and evolutionary inference going forward.

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Conserving tortoises, conserving genomes

Understanding population structure and detecting the genetic distinctiveness of lineages is key to preserving genetic diversity in threatened species. In species radiations, such as that of Galápagos giant tortoises (*Chelonoidis* spp.), this can be a challenge given the relatedness of the species and their complex evolutionary histories. Genomic methods, which use thousands of genetic markers, can greatly increase the statistical power to detect population structure, even when only a few samples are available, as is often the case with threatened species. We use one such genomic method, ddRAD-seq, to discover thousands of genetic variants in three species of Galápagos giant tortoises and explore the statistical power of detecting population structure under a variety of sampling designs. We show that thousands of genetic markers can detect population structure when as few as two individuals per population are used, but only if the study design is carefully considered. By confirming the genomic distinctiveness of these three threatened Galápagos giant tortoise species, we add support to the current conservation plans for all the extant species, including breeding programs that prevent hybridization among the species. Beyond these implications for Galápagos giant tortoises, our study clearly demonstrates the power and limitations of genomic methods in conservation genetic studies. With conservation genomics still in its infancy, researchers must be careful to not allow the appeal of statistical power to take precedence over thoughtful study design.

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Site fidelity of arapaima in the Lower Amazon: management in a sea of depletion

Many floodplain fishes migrate laterally during high-water, moving into habitats adjacent to permanent water bodies. This is true for the arapaima (*Arapaima* sp.), a large and endangered fish of the Amazon. Protected areas and management units can be effective for arapaima conservation, but spatial scales of such areas need to match the scale of arapaima movements. This work studied the site fidelity of arapaima. In the low water season, 24 arapaima were marked with ultrasonic tags in two communities in the Lower Amazon, near Santarém, PA, Brazil. Arapaima were monitored over 12 months and throughout a complete flood cycle using an array of 19 fixed ultrasonic receivers across six lakes. We show that arapaima migrate laterally into and across the floodplain as waters rise. We also show that after one annual flood cycle, the majority of arapaima returned to their lake of origin. In fact, all arapaima returned to the same lake or to a lake no more than 0.5 km away. This indicates a high level of site fidelity for arapaima in this region. Our results also reveal that there was overlap in the home ranges of arapaima from different community zones. This shows that managing arapaima at small scales is possible but can



be compromised if management zones are too small and arapaima leave managed zones to immediately enter overfished areas. Spatial scale must be considered to ensure that conservation and management strategies are based on information relevant to the movements and habitat uses of the species.

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Shark finning: value chain analysis of shark products sourced from Bangladesh

Despite no export data of shark products into the international black market after 2010-11 in the national statistics of Bangladesh, shark fins, meat, skin, bones and teethes are being exported every year. Contrary to the popular belief, sharks are being targeted for more than 40 years in Bangladesh. The number is too high to sustain a population in the Bay of Bengal. In this current study more than 5 processing centers with the capacity of finning 10 tons of sharks a day and one liver oil processing centre have been identified. 50 traders, 10 target shark fishers, 125 by-catch fishers, more than 100 domestic consumers, 50 fish feed officials have been identified and interviewed. One agent who exports these products to Myanmar has been identified. Everyday landing of sharks in three landing centers from January, 2017 are being collected. DNA samples of 120 dried and fresh shark fin have been collected for identification and population analysis. Most strikingly 6 sawfish has been encountered within 6 months of time given the idea that we still might have a population inshore in Bangladesh. The ongoing study has unveiled more than 6 tons of sharks being landed a day in the pre-monsoon season in one landing centre. The data is going to be collected till June, 2017 and then will be analyzed to assess the threats of the shark population, species composition, motivation of the fishers and traders, value chain of the products and the loopholes of conservation strategies for sharks in Bangladesh.

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Quadcopter drone photography as a means of characterizing habitat for birds

Understanding habitat selection is a crucial step in conserving species threatened by loss of habitat. Many bird species select breeding and foraging patches from the air, and therefore efforts to better understand selection cues would be well-advised to do the same. The quality of widely available aerial photographs is improving, but coverage is incomplete, resolution is limited, and many aerial photos are taken during leaf-off, when breeding season vegetation characteristics may not be apparent. Unmanned Aerial Vehicles (UAV) or drones may be an effective solution. We took visible-light photos at heights of 25 m and 50 m above both used and unused nest boxes erected for use by American Kestrels (*Falco sparverius*) in Massachusetts, USA. We analyzed these photos through supervised classification to test whether different relevant vegetation categories (such as grass, woody plants, bare ground, and human structures) could reliably be identified by computer. We also attempted a number of different analysis pathways, including the use of Gaussian low-pass filters and different aggregation kernel sizes, to see which classification procedure yielded the best agreement with ground truth. We found that classification achieved Good ($\kappa > 0.6$) or Strong ($\kappa > 0.8$) agreement with ground truth at most sites, and that kernel size has a significant effect on classification accuracy. UAV photography is a promising new tool for analyzing habitat use and selection by birds and other taxa.

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Biotic predictors improve range estimates for migrating monarch butterflies in Mexico

Species distribution models (SDMs) are often used as conservation tools for migratory species. Despite the dependence of migratory species on biotic interactions along migration routes, most models do not account for these interactions. The monarch butterfly is a charismatic nectarivore that performs an impressive annual multi-generational migration from southern Canada to central Mexico. In contrast to the well-known breeding range in the north, the migration route in Mexico has many knowledge gaps. A better understanding of the effects of climate and butterfly-plant interactions on their distribution is especially urgent because of recent major population declines. We built Maxent SDMs for migrating monarchs in Mexico that include the effects of interactions with nectar plants and shelter trees, incorporating phenology. We acquired and vetted plant occurrence data from online databases, and collated monarch occurrence data from a new Mexican



monitoring effort and an American citizen-science database. We built SDMs for each plant species using climate and soil variables. We then generated monthly SDMs for monarchs using: i) climate variables and stacked models of each plant group, and ii) climate variables only. Per month, only nectar plants flowering in that month were included. Optimal climate-and-biotic models tended to predict occurrences more accurately than climate-only models, and often predicted lower suitability outside the known migration route. Improved predictions of monarch distribution that incorporate biotic interactions and phenology will be instrumental in helping Mexican conservation groups prioritize land for restoration and protection. This approach has expanded potential to improve conservation assessments for migratory species.

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Parks protect forest cover, especially where local human populations are high

Understanding the factors associated with forest loss is critical for conservation planning and monitoring of remnant forest cover within tropical nations. Since biodiversity hotspots hold the bulk of global biodiversity, yet are governed by national laws and policies, national evaluations of forest cover change—advocated by the UNFCCC—are most pertinent at the scale of individual hotspots. We examined demographic, administrative, and biophysical correlates of contemporary forest loss in the Western Ghats, India, following a period of rapid economic expansion post 2000 CE. Using recently improved open-source remotely-sensed data, we first estimated rates of forest loss from 2000-2012 for the entire hotspot. Next, we assessed the demographic, administrative, and biophysical factors correlated with forest loss, measured as the number of 30 x 30m pixels of forest lost within randomly selected 1 sq. km cells. Forest loss was significantly higher closer to roads or in areas with higher local human populations, but not if within protected areas. Wetter, evergreen forests were most prone to recent loss. Finally, to test scale-dependence of results, we analyzed factors driving forest loss for two landscape subsets within Western Ghats. Protected Areas were found to stem forest loss in the smaller-scale analysis as well, but not at high population pressure and with proximity to roads for one landscape. Our results clearly show that Protected Areas can help retain integrity of forest cover within biodiversity hotspots, especially in the face of high human population densities and road development, both of which are known drivers of increased forest loss.

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Tiger population recovery post ethno-political conflict in Manas National Park, India

Manas National Park (MNP), situated in the eastern-Himalayan-biodiversity hotspot is home to a wide array of flora and fauna. For nearly two decades (1990 - 2010) conservation efforts in MNP were compromised owing to ethno-political conflict. During this period, the population of Indian Rhinoceros (*Rhinoceros unicornis*) were poached out, necessitating a reintroduction program to repopulate the park. The conflict is also known to have severely impacted other wildlife species, including tigers (*Panthera tigris*). However, with no robust baseline estimates to compare against, a long-term tiger monitoring program was initiated by Aaranyak in partnership with several National and International NGO's. To assess the population status of tigers we carried out camera trap surveys across three years (2013- 2015) in two administrative ranges of the park spanning ~250 km². Estimates of density and population size were derived using a maximum likelihood based spatially-explicit closed capture-recapture framework where photo-captured individual tigers was identified by their stripe patterns. Our results highlight that despite being a small population, there is evidence of population growth at the site. The estimated density increased marginally from 1.04±0.2 to 1.49±0.27 tigers/100km² corresponding to an increase in population from 14 (95%CI: 10-19) to 20 (15-26) from 2013 to 2015. These results supported by evidence of breeding females, cubs and dispersal of cubs shows that the population is slowly recovering. This recovery assumes global significance as MNP is embedded within one of the largest Tiger Conservation Landscapes in the range of the species that spans north-eastern India, Bhutan and Myanmar.



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Genetic diversity estimates of small populations impacted by model choice

Estimates of species' genetic diversity are used to infer size, trajectory, and connectivity among populations, and ultimately to make conservation decisions. Coalescent theory, relating the genetic diversity of a sample to the population's demographic history backwards in time, has become invaluable for understanding population dynamics. However coalescent theory makes the assumption that samples are drawn from a large population. Since the effective population sizes of endangered species are often very small, it is important to understand the practical implications of this population size assumption for conservation-related studies. I used simulations to explore the differences in amounts of genetic diversity estimated by coalescent models and forward population models, which make no population size assumptions, at very small effective population sizes ($N_e = 10 - 1000$). I found that coalescent models significantly mischaracterize genetic diversity in populations with very small effective sizes, with a significant relationship to sample size. Coalescent models tend to underestimate genetic diversity when the sample size is much smaller than the effective population size, and overestimate when the sample size is larger than the effective population size. They also introduce more variance into estimates of genetic diversity than do forward simulations of the same populations. For conservation applications with very small effective population sizes, forward simulations that do not make population size assumptions are computationally tractable and should be considered for use over coalescent-based models. These findings underscore the importance of model choice for conservation applications.

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From egg to adult: factors influencing amphibian survival in small, isolated wetlands

Vernal pools are small, temporary wetlands that provide important nursery habitat for a number of threatened and endangered amphibians while generating habitat complexity at the landscape scale. These wetlands are easily destroyed and are disappearing due to inadequate protection. To maintain pool densities required to sustain vernal pool-dependent species, prioritizing the protection of high-quality pools is essential. Studies of pool-breeding amphibians often focus on egg mass counts to characterize vernal pool quality; however, few track amphibian survival. This can result in skewed conclusions about habitat quality if oviposition does not accurately predict juvenile production. I assessed the effects of pool heterogeneity on the larval survival of two pool-breeding amphibians, spotted salamanders (*Ambystoma maculatum*) and wood frogs (*Lithobates sylvaticus*) in central New York State, USA. A total of 74 pools from two sites were surveyed biweekly throughout the spring and summer to track pool volume and other abiotic factors. Survival was assessed with egg mass counts and a combination of visual encounter and stove pipe surveys to track larval occupancy. In total, spotted salamanders bred in 67 pools and wood frogs in 51; however, only 24 and 19 pools hosted salamander and frog larvae, respectively. Of 24 pools that dried during the sampling period, amphibian larvae were observed in just 7—all of which dried before larvae metamorphosed. Egg mass counts alone are inadequate indicators of habitat suitability, particularly in drought years; protecting pools with a range of hydroperiods is important to sustain populations through years when temporary pools become ecological traps.

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Green heuristics: race, ethnicity, and environmental consciousness revisited

While some scholars expect communities of color focused on materialist needs to pay less attention to environmental concerns, others argue that communities of color view the environment itself as a basic need, and thus favor more environmental intervention than their white counterparts. To speak to this conflict in the literature, this analysis asks the following questions: Do African-Americans and Latinos hold more favorable preferences toward environmental protection, preservation, and conservation than their white counterparts? If so, under what conditions do African-Americans and Latinos hold favorable environmental preferences? We theorize that environmental protection is in actuality a 'minority' specific issue as people of color are disproportionately affected by environmental hazards, and thus need a clean environment to improve the groups' social and economic mobility. We argue that linked fate helps explain these preferences. This analysis uses 2016 World Values Survey, and original data collected through the Washington Poll (2016). Results suggest that African-Americans and Latinos hold more favorable preferences toward various environmental issues than their white counterparts



do. This study adds to the existing literature by demonstrating that African-Americans and Latinos hold favorable views toward the environment because linked fate connects environmental issues directly to the community, and thus the groups' social mobility.

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Fencing Africa's protected areas: costs, benefits, and management issues

The use of fencing around Africa's protected areas (PAs) has generated considerable controversy in recent years. While fencing advocates have emphasized the benefits for carnivore conservation and the mitigation of human-wildlife conflicts, others have argued that fencing often has unforeseen consequences for people and wildlife. Through this study, we sought to help identify the circumstances under which fencing might be an effective and appropriate conservation tool. Specifically, we aimed to determine: when, where, and why fencing is used in Africa; how effective fencing is at achieving its objectives; what ecological, economic, and social issues are associated with the use of fencing; and what advantages and disadvantages result from fencing PAs. To answer these questions, we conducted a survey of officers, managers, and researchers at 63 fenced PAs (35 state-run, 27 privately run, and 1 community-run) across 10 countries in Africa. Our survey covered 8 substantive topics: (1) history of fencing at the respondent's PA; (2) structural features of the fence; (3) financial costs associated with the fence; (4) inspection, maintenance, and sources of damage to the fence; (5) effectiveness of the fence at containing wildlife and preventing unauthorized access to the PA; (6) impacts of the fence on wildlife migrations and dispersals; (7) vandalism, community views, and conflicts caused by the fence; and (8) overall pros and cons associated with the use of fencing. We gathered all data from July 2016 to March 2017 and are now analyzing our results, which we expect to complete by June.

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IUCN greatly underestimates threat levels of endemic birds in the Western Ghats

The validity of the threat status assigned to a species by the International Union for Conservation of Nature's (IUCN) Red List relies heavily on the accuracy of the geographic range size estimate for that species. Range maps used to assess threat status often contain large areas of unsuitable habitat, thereby overestimating range and underestimating threat. In this study, we assessed 18 endemic birds of the Western Ghats to test the accuracy of the geographic range sizes used by the IUCN for their threat assessment. Using independently reviewed data from the world's largest citizen science database (eBird) within a species distribution modeling framework, our results show that: (a) geographic ranges have been vastly overestimated by IUCN for 17 of the 18 endemic bird species; (b) range maps used by IUCN contain large areas of unsuitable habitat, and (c) ranges estimated in this study suggest provisional uplisting of IUCN threat status for at least 10 of the 18 species based on area metrics used by the IUCN for threat assessment. Since global range size is an important parameter for assigning IUCN threat status, citizen science datasets, high resolution and freely available geo-referenced ecological data, and the latest species distribution modeling techniques should be used to estimate and track changes in range extent whenever possible. The methods used here to significantly revise range estimates have important conservation management implications not only for endemic birds in the Western Ghats, but for vertebrate and invertebrate taxa worldwide.

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Large-scale illegal trade in India's tortoises & freshwater turtles

Wild tortoises and freshwater turtles (TFTs) are threatened globally as they are targeted for illegal international trade for meat, pet and traditional medicine markets in South and South East Asia. Several South Asian countries, including India, are believed to be contributing disproportionately large numbers of TFTs to this illegal, high volume trade, but there is little



understanding about the nature and dynamics of this trade in India. We conducted systematic online searches between 2011-15, and obtained data from 223 seizure reports of TFTs from India and international seizures of Indian species originating in India. We found high volume of trade with over 58,000 live TFTs seized during this period. At least 15 of India's 28 TFT species are illegally harvested, including 10 IUCN Threatened species. The top three species, both in terms of number of individuals seized and frequency of occurrence in seizures, were *Geochelone elegans*, *Geoclemys hamiltonii* and *Lissemys punctata*. Illegal commercial trade accounted for almost 90% of the seizures. Roadways, railways and airways were used to transport TFTs both within India, and to several known pet and meat hubs in Bangladesh, Thailand and four other East/Southeast Asian countries. The number of Indian species in commercial trade is now double as that reported in 1990s. Our results indicate urgent action is required for conservation of India's endangered TFTs, including awareness and capacity building among enforcement agencies for handling TFT seizures and strengthening international cooperation for law enforcement.

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Effects of forest fragmentation on the endangered lion-tailed macaque

The lion-tailed macaque (LTM) is one of the most endangered primates. It is estimated that only about 4000 individuals survive in the moist evergreen forests of Western Ghats mountain range in southern India. The major threat to its survival is habitat fragmentation. Previous studies in highly fragmented forests of Anamalai Hills indicated a reduction in the population growth rate and the survival of immature individuals. We hypothesized that a loss of genetic diversity caused by reduced gene flow between fragments may be responsible for these demographic changes. We also hypothesized that forest fragmentation and subsequent isolation increases physiological stress, frequency of agonistic behaviour and the prevalence of gastro-intestinal parasites in lion-tailed macaques. Genetic diversity was estimated by analyzing partial sequences of cytochrome b gene and control region of mitochondrial DNA obtained from fecal samples of wild macaques and from blood samples of captive individuals of known wild origin. The fecal samples also yielded fecal glucocorticoids and gastrointestinal parasites. Incidence and frequency of agonistic behaviour was estimated from 10-minute group scans. LTM in small and isolated forest patches show far less genetic diversity compared to those found in a more contiguous forest. Fecal glucocorticoid levels and time spent on agonistic behaviour seem to correlate with the proportion of adult males in an isolated group. Proximity to humans and livestock correlate with parasite species richness. Surprisingly, phylogenetic trees also reveal that LTM diverged into two distinct populations across the Palghat gap with the divergence dating to 2 million years before present!

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Slow loris trade in Vietnam: Exploring diverse knowledges and values

Wildlife trade can present a major threat to biodiversity. In Vietnam, slow lorises (genus *Nycticebus*) are subject to local, regional, and international demand for diverse uses including as medicine, meat, and for pets. Ethnographic approaches enable exploration of nuanced human-primate interactions in complex socio-cultural contexts. Here we combined ethnographic interviews of key informants involved in wildlife trade with information from questionnaires, focus groups, and a movie broadcast on Vietnamese television to explore diverse knowledges and values related to slow lorises and their use in trade in Vietnam. We infer distinct prices, uses, and networks for expanding regional and international markets as compared to local ones and highlight key findings related to gendered knowledge about slow lorises and more-than-human ontologies of slow lorises as active participants in human-loris interactions. We also discuss local memories of the slow loris' toxic bite as a diagnostic event that changes human behaviors. Our results confirm the dynamic complexity of trade in Vietnam, highlighting the importance of ethnographic methods to explore diverse knowledges and values for place-based conservation management of highly traded taxa.

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Marsh birds in urban lands: do streams facilitate population connectivity?

Habitat loss and fragmentation are the leading drivers of biodiversity loss worldwide. Although habitat loss has been thoroughly studied in island systems, the effects of habitat fragmentation on island species is less well understood, despite



the utility of islands as microcosms for landscape dynamics at larger scales. We examined the population structure and movement ecology of the Hawaiian gallinule ('Alae 'ula, *Gallinula galeata sandvicensis*), an endangered, endemic Hawaiian waterbird on the island of O`ahu. Over 75% of gallinule habitat on O`ahu has been lost, with remaining habitats surrounded by a diverse landscape matrix of urbanized and agricultural land, active military training areas, and roads. The connectivity of these relict populations is essential for the viability of the subspecies, but the effects of O`ahu's rapidly changing landscape on their population structure and movement habits is unknown. We tested the hypotheses that connectivity among gallinule populations was reduced by urban areas and roads and increased by bodies of freshwater including rivers, streams, ponds, and drainage ditches. We genotyped >150 gallinules at 13 habitats on Oahu and compared allelic frequencies to estimate effective dispersal rates between the island's remaining habitats, then used these data to compare a suite of hypotheses about landscape effects on dispersal. While roads and urban areas did not appear to affect effective dispersal rates, stream networks explained a large proportion of observed variation in population connectivity. We also found strong genetic structure between wetlands at small spatial scales, and evidence of shifting gene flow patterns across time.

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Unionid mussels: bioremediation potential in eutrophic freshwater ecosystems

Cultural eutrophication, the excessive primary productivity in response to anthropogenic nutrient loading, interferes with the natural processes of freshwater ecosystems. Adverse environmental and socio-economic impacts associated with the provision of imperilled ecosystem services include water scarcity, food deprivation and production of hazardous substances. Existing physical, chemical and biological remediation practices are partially successful, nonetheless they can be costly and require repetition. In the context of sustainability, it is crucial to develop self-sustaining practices to successfully alleviate the negative impacts of algal blooms in the long term. Here we examine the potential of using freshwater unionid mussels for the sustainable top-down control of phytoplankton in eutrophic freshwater ecosystems. Unionids have been selected due to their long lifespan, effective filtration of phytoplankton and the prospective combination with reintroduction programmes. *Anodonta cygnea* and *Unio pictorum* were used as model organisms of widespread native European unionids. Their clearance rate was assessed on Chlorophyta, Bacillariophyta and Cyanobacteria of various morphological features under laboratory conditions. Phytoplankton bio-volume was used as an indicator of biomass. Combinations of phytoplankton species were used to assess unionids' preferential feeding. Furthermore, the impacts of inter- and intra-specific competition on clearance rate were assessed by conducting experiments with combinations of mussels. The data obtained indicates the potential of unionids for use in developing bespoke bio-remediation models based on ecosystem parameters. The discussion focuses on the further work required for utilising unionid autecology in habitat management and biodiversity conservation programmes.



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Host-parasite response to landscape structure

Tropical deforestation is a global environmental change driver, with demonstrated impacts on biodiversity. However, how forest loss impacts key species interactions, including host-parasite interactions, remains poorly characterized. We evaluated the influence of habitat loss on infection patterns in a dung beetle-fecal helminth system, where indirect life cycle helminths use beetles as intermediate hosts, and transmission is completed after mammalian definitive hosts consume infected beetles. We selected twelve, 3km landscapes in the Atlantic Forest of São Paulo, Brazil, all constrained to similar soil type and elevation, but varying in forest cover from 10-60%. In each landscape, we sampled dung beetles with pitfall traps in eight forest fragments, and dissected infectious stage helminth larvae from 410 beetle individuals in three species (*Dichotomius assifer*, *D. mormon*, *D. quadrinodosus*) that occurred across most landscapes. We summarized landscape-level average infection intensity, prevalence, and aggregation for the most abundant parasite morphospecies encountered in each host species. We evaluated infection parameters as a function of landscape composition (forest cover) and configuration (number of fragments) for each host species independently, using both generalized linear models with appropriate errors (Poisson and Beta) and quadratic regressions, and performed variable and model selection with AICc. Preliminary analyses suggested that infection is strongly associated with the number of patches within a landscape, and correlates non-linearly with forest cover across all host species. We discuss the implication of these results for understanding the spatial patterns of infection in dynamic working landscapes.

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Amazon conservation through sustainable livelihoods: The case of *Astrocaryum chambira*

Increasing evidence supports that conservation in protected areas with indigenous communities requires effective policies that encourage local participation in management and promote people's livelihoods with ecologically and socially sustainable outcomes. Those challenges converge in the traditional use of *Astrocaryum chambira* fibers, a non-timber forest product processed for handcrafts in Amacayacu National Park (Colombian Amazon). In this scenario, our aims were to determine harvesting and processing using participatory observations and participatory mapping, assess the ecological impact of use determining the species population structure, and identify local and external actor's management and marketing strategies employing social network analysis and focus groups. Our results showed that harvesting and processing resemble other Amazon locations. Population structures in harvested areas display sustainable use. Social networks indicate that management practices are shared through reduced local ties of the same age or gender. Knowledge and marketing exchange with non-locals is rare and usually occurs through women leaders. Based on that social structure we performed focus groups based on age and gender. They indicate that men follow less strict traditional management practices than women or elders. Young men and women are receptive to nontraditional management strategies, and express greater economic dependence towards chambira fibers, but seasonally. These complementary management strategies and occasional marketing support a sustainable use. However, reduced social ties, scarce leadership, local population growth, and projected access roads threaten this scenario. We argue that decision making in populated protected areas need gender and age approaches, local leadership empowerment, and fostering a diverse set of livelihoods.

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Impact of novel light sources on arthropod communities

Urbanization is an emerging issue with the potential to transform the global landscape. An often ignored result of urbanization is the increase of excessive or obtrusive artificial light. This increase in artificial light, also known as light pollution, impacts organisms' environment and behavioral patterns. Previous research illustrates that light pollution alters community compositions, but there is a lack of literature quantifying the rate and extent of light pollution's impact on an ecosystem. To quantify the impacts of light pollution, this study investigates the effects of introducing novel light sources to an undisturbed forest. Before the introduction of light, pitfall traps were placed in transects and monitored to assess the invertebrate community in the area. These pitfall traps continued to be monitored after light was introduced at varying levels from 0-20 lux over a period of five days. At the end of the five days the light sources were shut off and pitfall traps continued to be monitored. Preliminary comparisons between the community, pre, during, and post light, show that artificial light may attract new species to an area and that the impact of light introduction may extend beyond when the light is on.



The results of this study may illustrate the potential community shifts light pollution produces and hint at how arthropod communities will change with increasing urbanization.

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Urban humpback whales: sighting patterns in the New York metropolitan area

The New York metropolitan area is located within a highly populated and urbanized coastal habitat. The ecosystem has been drastically altered by human activities, and some of the largest ships in the world navigate the network of channels leading to the Port of New York and New Jersey. Although the anthropogenic influence on the marine environment is significant, little is known of the cetaceans that occupy the surrounding waters. Humpback whale occurrence has historically been sporadic and infrequent, but in recent years, sightings have increased dramatically. Since 2011, there have been more than 350 sightings and a catalog of photographically identified whales contains more than 50 unique individuals. Whales have been documented feeding in and around major shipping channels, in close proximity to both commercial and recreational vessels. This overlap with human activities poses a risk to both humans and whales. If sightings continue to increase, then management plans may be necessary to mitigate these risks. Although the reasons for this recent phenomenon are not yet clear, sighting data can provide insight into how humpback whales are using this habitat. There is evidence of both seasonal and annual site fidelity, and at least one individual returned for three consecutive years. Sighting data will be presented in detail, including an analysis of occurrence patterns. Results of photographic matching efforts will also be discussed.

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Loss of songbirds in a small urban protected area: a sign of things to come?

As land use change continues to threaten biodiversity, land conservation may be the best approach to protect species. Over time, the establishment of protected areas for land conservation has shifted from large scale public projects to smaller private or local projects. Many modern conservation groups are only able to acquire small and non-connected areas of land, and thus, many small and isolated protected areas are established. Although several long term studies of protected areas exist, many are limited by their historic data, and few investigate small protected areas. Fortunately, unique long term bird banding data from a small protected forest in New Jersey, Hutcheson Memorial Forest, may provide insight into how other small protected areas will function in the future. This historical data includes multiple sampling events per year over multiple years allowing accurate community level assessments over time. Using the same assessment techniques, modern data was collected to compare to the existing historical data. Comparing these data sets show that in the sixty years that Hutcheson Memorial Forest has been established, six species have gone locally extinct, and many populations are performing worse than regional trends would predict. These unfortunate outcomes suggest that simply protecting an area may not provide benefits for the species that live there. When establishing new protected areas, conservationists should consider long term goals as well as best management practices to ensure their efforts to protect species of interest.

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Identifying potentially important humpback whale breeding areas in the Gulf of Guinea

Identification of breeding habitats is essential for conservation and management of endangered species; however, important breeding habitats of humpback whales (*Megaptera novaeangliae*) for large stretches off the west coast of Africa remain largely unresolved. To address this knowledge gap, species distribution models based on maximum entropy (Maxent) were conducted to identify potential areas of breeding habitat for humpback whale Breeding Stock B, which breeds in the Gulf of Guinea and surrounding waters, and to assess the extent to which those areas overlap with anthropogenic activities. Satellite telemetry data of humpback whales (N=13) collected in 2002 were analyzed using a behaviorally switching state-space model to categorize breeding and transiting behaviors. Breeding behavior points were used in conjunction with environmental parameters known to influence humpback whale habitat selection, including bathymetry, sea surface temperature, sea surface height, distance to shore, and distance to frontal activity, to model the probability distribution of suitable breeding habitat. A cumulative utilization and impact (CUI) analysis based on previously published methods was



then implemented to assess the degree of overlap between identified potential humpback whale breeding habitat and anthropogenic activities. Additionally, CUI analysis estimated the relative anthropogenic impact for each breeding area. Model outputs suggest potential humpback whale breeding habitat in the Gulf of Guinea and surrounding waters, compared with other data sources. Results will increase scientific understanding of humpback whale behavior and distribution, and guide future survey efforts. This study will also contribute additional information related to the expanded marine protected areas off Gabon and surrounding waters.

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Accounting the true value of marine resources towards inclusive conservation

Conservation will only be successful unless its narrative is changed. In many developing countries where stubborn poverty and myriad socio-economic problems have been wittingly used as an excuse to trade-off environment over development, conservation programs must be packaged not as luxury but a necessity. Hence, it is not only important that a community becomes richer or less poorer with the conservation intervention. Both the timing and equity considerations of the costs and benefits of conservation need to be clearly ascertained and carefully choreographed. But, how is this achieved in the case of corals conservation in a country like the Philippines where majority have been perennially poor amidst its perceived status as “the center of the center of marine biodiversity”? In this study, an ex-ante analysis of the impacts of a pioneering asexual coral transplantation technology has been conducted highlighting both the direct and indirect linkages between and among the biophysical and socio-economic impacts. Through a discrete choice experiment (DCE) approach, the socio-economic well-being of selected coastal communities in the Philippines attributed to the coral transplantation technology were assessed, along with the determination of the flow of the benefits through time. With corals transplantation conservation program that would need years before benefits are expected to be significantly felt, the use of participatory approaches with and by the coastal stakeholders themselves enhances ownership and empowerment. Legitimacy of programs is achieved with enhanced knowledge on how and when benefits flow across their social network as it significantly minimizes crowding-out.

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He Hua i ka Noi‘i Noelo The Application of Hawaiian Place Names in Scientific Inquiry

Hawaiian place names exemplify the interaction between kānaka (people) and ‘āina (land) and attach an identity to the surroundings based on key geographic, environmental, historical, and/or cultural features of the area. Historically and in the present day, place names prove useful because these names are rooted in environmental phenomena, ecological processes, cultural practices, and personal relationships with the area. Presently, the natural world around us has been drastically modified by human land use changes, cultural shifts, and climatic impact. The aim of this study is to research the ecological characteristics and cultural relationships, which define the identities of the various locations named by our kūpuna (ancestors). This study examines various sites in Hilo and North Kona, Hawai‘i. Through an integrated approach of researching oral histories, historical documents and community memories, and combining this cultural data with scientific data of how the area exists in the present day, we can maintain the integrity, cultural, and historical value of the ‘āina where we conduct our research. Our studies within these sites have demonstrated that the Hawaiian place names given to these locations accurately reflect the environmental conditions and characteristics of the locations as proven in scientific inquiries. We furthermore applied the Hawaiian naming methodology to sites in Papahānaumokuākea (the Northwestern Hawaiian Islands) whose names had been lost due to military occupation. In conclusion, the form of supplemental research methodology applied and documented in this study has demonstrated that Hawaiian place names are a definitive source of data for future environmental research.

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Factors predicting alien species richness in Argentina’s national parks system

Alien species introductions are a global phenomenon and protected areas are increasingly susceptible to them. Understanding the drivers of alien species richness is vital for prioritizing natural resource management, particularly in developing countries with limited resources. We analyzed the effects of coarse resolution environmental and anthropogenic factors on alien species richness (plants, mammals, and birds) in Argentina’s national parks system. We collected data on



year of park formation, park area, region, elevation range, number of rivers crossing area boundaries, roads entering area, mean annual rainfall, mean annual temperature, mean annual number of visitors, and Human Influence Index within and surrounding each park. We compiled 1688 alien records in 36 protected areas: 83% plants and 17% animals (9.5% mammals, 5.5% birds, 1.5% fishes, 0% amphibians, 0% reptiles). Alien plant richness was mostly influenced by environmental factors, while alien mammal and bird richness was driven mostly by anthropogenic factors, with models explaining 36-45% of data deviance. Most variables that positively influenced alien taxa related to increased variability in anthropogenic disturbance and environmental heterogeneity, suggesting greater niche space variability and increased opportunities for colonization as facilitators of alien establishment. Protected areas within or adjacent to areas with high human disturbance will face continuous pressure, therefore restricting settlement growth in and around these areas, as well as limiting visitors or their activities, may lessen the effects of human disturbance. Additional mitigation strategies such as creating buffer zones, increased monitoring, and law enforcement, may further improve alien species management within protected areas.

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Mapping mortality to mitigate conflict: spatial variations in risk for African lions

Carnivore population viability currently presents a global conservation challenge as human populations increase and suitable habitat for carnivores diminishes. Large carnivores such as African lions (*Panthera leo*) commonly attack livestock on lands adjacent to protected areas, resulting in human-wildlife conflict (HWC). These depredation events often lead to retaliatory killings of the offending lions. Conflict has been identified as a primary driver of wild lion population declines, estimated to have decreased by 43% in the last 20 years. Etosha National Park (ENP) in Namibia is an IUCN designated Lion Conservation Unit and has the largest surviving wild lion population in Namibia. Surveys show lion populations in ENP are currently stable and are therefore increasingly important to monitor and protect in the face of declines elsewhere. This project aims to improve conservation prospects for lions in ENP by examining GPS data of lion population movements indicating dispersal and habitat choice as they relate to the landscape features within and surrounding the park. This information will be used together with historical data on conflict-related killings to highlight areas of high risk for HWC incidents and subsequent lion mortalities. Identifying high risk areas will help to 1) identify high-priority areas for targeting lion conservation efforts and 2) design more effective conflict mitigation strategies based on landscape features and human land use practices particular to ENP and its surrounding areas.

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Illegal turtle trading at Bangladesh: extent, fluctuations and religious prospect

This study was conducted to evaluate the quantity and annual fluctuations of freshwater turtle trading on Tatibazar market Dhaka, Bangladesh during the months of October 2010 through September 2011. We counted only accounting for the five most commonly traded freshwater species: *Pangshura tecta*, *Morenia petersi*, *Lissemys punctata*, *Nilssonina hurum*, *Nilssonina gangetica*. We found that the most frequently offered turtle species of those five species we focussed on was *P. tecta* (mean 114.7 individuals/week), while the least offered species was *N. gangetica* (19.5 individuals/week). No clear differences in specialisation on certain species between traders have been observed. At two religious events of the Hindu community in October/November (Durga Puja, Kali Puja), offers went dramatically up; this festival period overlaps with egg-laying in all 5 species during which turtles are easy to catch and most vulnerable. Except for the two festival peaks and a little elevation during rainy season, offers stayed quite stable over the course of the year. Traders preferably offered turtles on the first Friday of the month than in the other weeks of the month (mean sum of offered turtles during first week of month=265.0; mean sum of offered turtles during average other week of month=243.1). This finding is though not significant (Wilcoxon signed rank test: $p=0.79$). Turtle trading has been passed on over generations and traders run their businesses through networking and cooperation. Social and scientific research will help to elucidate possible solutions such as turtle farming, an alternative to illegal trading that is also supported by consumers.



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Unraveling the independent drivers of biotic homogenization

Anthropogenic habitat loss influences the extinction and invasion processes in biotic homogenization (BH) that simplify regional biotas, but the factors driving these processes are not well understood. We investigated the drivers of invasion and extinction in dung beetles (a functionally-important, cosmopolitan taxa) across a gradient of native habitat loss in the Brazilian Atlantic Forest. We classified species as “losers” or “winners” in BH based on biogeographic affinity and habitat preference. We modeled four different diversity responses of winners and losers (abundance, and taxonomic, functional, and phylogenetic diversity) as a function of native habitat cover, total edge (measurement of landscape fragmentation), and longitude (measurement of proximity to the Cerrado, a potential source of disturbance-adapted taxa). We further quantified biodiversity response in sites buffered from and exposed to the Cerrado by a forested corridor. We found that all measures of “loser” diversity increased with higher forest cover and lower total edge, but were not related to longitude. Conversely, “winner” diversity increased closer to the open-habitat domain, had a sometimes-positive relationship with forest cover, and was unrelated to total edge. We found evidence of a forested mountain chain acting as a natural barrier to invasion, as “winner” biodiversity was higher on the side closer to the Cerrado, while “loser” biodiversity mostly did not differ between sides. Our study demonstrates that different factors drive the invasion and extinction processes behind BH, suggesting that they are separate processes. It also suggests that maintaining natural barriers may block the spread of invasive and generalist species.

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Rising tides and shrinking shores: evaluating how coastal management impacts wildlife

Understanding how wildlife respond to shoreline management will become more urgent to inform future conservation plans as climate-change induced sea-level rise worsens. At the Kennedy Space Center and Merritt Island Wildlife Refuge in central Florida, NASA constructed 1.4 km of coastal dunes to protect coastal resources from severe conditions: a 214m dune, completed in 2012, and a 1.2 km extension completed in 2014. To monitor how native wildlife used the constructed dunes, we set out a system of 9 drift fences modified to use pairs of game cameras to document small mammals and herpetofauna along the dune. Using data from 4,502 trap nights from June 2015 to June 2016, we identified 2,523 independent vertebrate triggers from 33 species along both the natural and constructed dunes. Our system detected 1 bird, 3 amphibian, 8 mammal, and 21 reptile species, including the federally protected Eastern Indigo Snake and Southeastern Beach Mouse, as well as the state protected Gopher Tortoise. All camera systems recorded similar numbers of species (14-20 per fence) with the highest number of species documented at the dune constructed in 2012. These results demonstrate that constructed dunes are used by a wide variety of rare and common species at our site, providing preliminary evidence that man-made dunes can be used as a potential management solution for both improving wildlife habitat and protecting coastal structures.

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From population to individuals: cross-level habitat selection in a dolphin population

Understanding and interpreting the interaction of individuals and populations with the environment and how this relationship outlines their spatial distribution is a key question to conservation ecology. Area use patterns observed for populations are ultimately an outcome from individual variability in habitat selection and their interaction with such environments. Are use and habitat selection by the population of Guiana dolphins, *Sotalia guianensis*, and its individual variability were accessed in the Cananeia estuary (25°03' S; 47°55' W), southeastern Brazil, during the summer and winter of 2015 and the summer of 2016. Environmental parameters were estimated aiming to explain population distribution and differences within individuals. For this purpose, resource selection probability functions (RSPF) were applied in generalized



additive models (GAM). Covariates tested included: distance to river mouths, distance to the estuary entrance, distance to urban areas, depth and tide. Geographic coordinates were used to model spatial autocorrelation. Eleven photo-identified individuals had their occupancy modelled and accessed in relation to their home range obtained from fixed kernel densities estimates. The population exhibited patchy group densities throughout the estuary in all seasons. Analysis revealed discrepancies in size and location of individual home ranges which lead to remarkable differences in the composition and estimates of parameters selected in the models for each individual. It is critical that conservation management tools take in account intrapopulation variability to the level of exposure to stressors and possible differences in the ecological role played by individuals.

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24 years later: plasticity of bird community adaptation to conservation challenges

The analysis of morphological variability allows us to explore phenotypic response in terms of plasticity to various challenges, which has been used to assess body condition, adaptation and health status of individuals. In the face of rapid environmental changes, we continue to explore ways to understand how species might respond. This research aims to compare, in a 24 year span, the morphology of birds of high mountain forest in National Natural Park Chingaza, Colombia. We compared four traits related to feeding, three to mobility, and weight; and compared them in different time periods using variance analysis, for thirteen species with sample sizes bigger than five individuals. There was no overall trend for all species, some on the feeding traits varied (decrease), while some of the mobility traits increased. When analyzed by ecological groups such as guild, insectivores differ in time in relation to feeding traits, but not mobility. While if analyzed by habitats dependence, those more closely related to forest differ, along with those that do not have a strong dependence of this ecosystem. During the time span of the analysis, the area has not been subject to habitat modifications, however based on climatic stations in the area, there has been a significant increase in the mean monthly temperature. Variations found in the morphological features, could represent plasticity to climatic variability, pondering the question as to what degree are these populations and communities able to rapidly respond to global changes.

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Satellite tracking reef manta rays (*Mobula alfredi*) to inform conservation management

The reef manta ray, *Mobula alfredi*, is a charismatic species that has captured the attention of people all over the world. This species of ray is popular among divers and tourists because of its large size and habit of appearing in groups. Recently, there has been an increased demand in Asian fish markets for manta ray gill plates, thin cartilage filaments used by the ray to feed, due to cultural beliefs that gill plates have medicinal properties. Manta rays only produce one or two pups at a time, have slow maturation times, and tend to aggregate in large groups. These factors make ray populations vulnerable to pressures from local fisheries. Gonubalabala is a remote island situated off of Milne Bay, Papua New Guinea, that is home to an understudied aggregation of manta rays. My research objective is to characterize the movement of manta rays around Milne Bay using satellite telemetry to inform conservation management. I hypothesize that there will be a clear spatial pattern of movement of this population of manta rays around Milne Bay. Additionally, I predict that areas which rays visit more frequently will be associated with cleaning stations or predictable plankton feeding sites. If there is a clear spatial pattern of movement, one or multiple community-based marine protected areas (MPAs) could be developed to specifically protect areas where mantas spend considerable amounts of time. Preliminary results show that there is a clear spatial pattern of movement and a previously unknown manta ray site has been discovered.

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Examining large carnivore occurrence and conflict in central India

Protected areas are increasingly becoming nested in a matrix of varying land-use, resulting in isolated forest patches. Consequently, conservation research is gradually shifting focus from insular habitats to larger landscapes, incorporating human-dominated areas. This allows for studying species adaptability, dispersal barriers, and human-wildlife interactions. Carnivores in India are a case in point. While leopards and sloth bears live in heterogeneous landscapes, tigers disperse



through a matrix of forests and human habitations. Our study was conducted across a 7000 km² Kanha-Pench forest landscape in central India. We aimed to examine (1) patterns and determinants of distribution for the three species, using single-species occupancy models, and (2) patterns of human-carnivore interactions, using multi-state occupancy models. Data was collected through indirect sign surveys and questionnaire surveys of local residents. We estimated habitat occupancy for tigers, leopards and bears at 56%, 75% and 80%, respectively. While livestock disturbance, human settlements, and habitat edges due to fragmentation had a negative effect for all species, forest cover, landscape configuration, prey and terrain heterogeneity positively influenced species occurrence. We also predicted probability of conflict with humans to be 50% for bears and over 80% for the felids. With large swathes of multi-use forests, open scrub, and grasslands at severe risk of conversion for agricultural and industrial purposes, our study highlights the need for understanding ecology of carnivores in human-dominated landscapes. This knowledge could contribute towards conservation planning, managing wildlife populations outside reserves in general, and integrating wildlife-permeable habitats with the extant protected area network.

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Trends in the export of mammals, birds and reptiles from Guyana (2006-2015)

Guyana is known for its rich biodiversity and is actively involved in cross-border and international wildlife trade. Guyana's international wildlife data are collected by The Wildlife Division in Guyana. However, there is limited or no awareness of what comprises Guyana's international wildlife trade and data generated has not been comprehensively studied and analyzed. This research investigated trends in Guyana's international wildlife export for mammals, birds and reptiles from 2006 to 2015 and identified the most targeted species in each group. Approximately 400,000 CITES and non-CITES individuals exported over the 10 years. The most exported group was reptiles followed by birds and then mammals. An average of 35 species of reptiles, 19 species of mammals and 24 species of birds were exported per year. The total amount of individuals exported did not surpass their allocated quota during the period. The most exported species for each group were the Orange winged parrot (*Amazona amazonica*), the Sakiwinki monkey (*Saimiri sciureus*) and Spectacled Caiman (*Caiman crocodilus*). While efforts are made to protect and conserve wildlife, unsustainable harvesting practices and habitat destruction are the major threats to wildlife.

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Fishing the critically endangered eel: management for sustainability in the UK

Recruitment of European, American and Japanese eels (family Anguillidae) has declined precipitously over the last thirty years. The IUCN Red List classes the European eel as "Critically Endangered" and the latter two as "Endangered". Meanwhile, these same species are highly sought after for human consumption, form a part of traditional cuisine in many countries and achieve high market prices for fishers and buyers. Fisheries for these species are found around the world, including Europe, Africa, Asia and North America. In response to top-down regulations, legal catches of these species have decreased, but evidence from trade statistics and seizures of contraband eels, suggest that illegal trade has grown. This study focused on the European eel fishery in the United Kingdom to identify management strategies that lead to better social and biodiversity outcomes by reducing the motivation to engage in illegal activities. As a member of the European Union, the UK has been subject to EU regulations on eel management, which are interpreted into national-level policies. In the past decade, these regulations have become increasingly stricter, with limits on allowed fishing methods, a cap on the number of licenses and a ban on exports outside the EU. In many places, the result has been a breakdown of localised co-management systems. I used interviews and participant observation with key stakeholders, along with quantitative data analysis to understand the changes in the fishery over time and identify instances of successful participatory management leading to socially and ecologically sustainable outcomes.

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Water parameters affecting Mississippi oyster reefs using NASA earth observations

Commercially-harvested oysters are a significant ecological and economic driver in multiple coastal regions throughout the world. In the last decade, the Mississippi Sound has seen a rapid decline in oyster reef production, especially in the years following large ecological disturbances such as Hurricane Katrina in 2005 and the flooding of the Mississippi River in 2011.

In partnership with the Mississippi Department of Marine Resources, the NASA DEVELOP team utilized remotely-sensed products in order to develop a climatology and time series of specific water quality parameters that can have an impact on oyster reef productivity. These parameters include salinity, sea surface temperature, chlorophyll-a, a DG (absorption due to gelbstoff and detrital material), total suspended matter, and turbidity. The project utilized data from several Earth observing satellites including Aqua MODIS, SMAP, Landsat 5 TM, Landsat 7 ETM+, Landsat 8 OLI and TIRS, MUR, plus the ESA product Sentinel-2 MSI and SMOS. The results from this project could potentially assist the MDMR by providing products for additional mapping and assessment of future oyster reef health and conservation in the Mississippi Sound. These products will also allow the project partners to improve future management practices for species recovery and the creation of additional oyster reefs.

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Dietary flexibility and health indicators in zebras facing nutrient declines

Falling nutrient content in vegetation across the world has been documented as climate change progresses. This is thought to be driven by increasing carbon dioxide concentrations in the atmosphere, allowing plants to take up more carbon for the same amount of water loss because of the increased concentration gradient from the outside to the inside of a leaf. This lowers the protein-carbohydrate ratio in plant tissues, a classic measure of nutritional value for herbivores. A component of my thesis investigates the effects of nutrient availability on zebra populations. Zebras are important savannah herbivores that improve pastures for other herbivores by removing old, tall grass, thus making way for fresh, nutritious grass. In addition, the Grevy's zebra is an endangered species that has been slow to recover from historical overhunting. It is therefore important for us to understand how falling nutrient availability may affect these herbivores that already eat low-quality food and may be vulnerable to further nutrient declines. I am using genetic techniques on dung samples to quantify the contribution of various grass species to zebra diets at different sites, including semi-arid and mesic sites that differ in nutrient availability, and I am tracking health indicators such as the body condition, parasite burden, and reproductive output of individuals. I will present data on zebra diet flexibility and patterns in zebra health indicators across sites, seasons, and years to draw inferences on how they may respond to future carbon dioxide increases.

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Delimiting Species of Madagascar's Cryptic Endemic Iguanas (Opluridae)

Taxonomy is a fundamental component of conservation, as assessments, regulations, and management efforts frequently operate on species units, and inaccurate taxonomies can mislead conservation work. Cryptic species (distinct species that are morphologically indistinguishable), in particular, present problems for effective conservation. When not accurately recognized, cryptic species are lumped into fewer nominal species, which can result in overestimates of population sizes and ranges, the misidentification of required habitats, and underestimates of conservation risk. Opluridae are a family of presumed cryptic iguanas endemic to the highly threatened arid and semi-arid habitats of Madagascar and the neighboring island of Grande Comoro. Currently, this family comprises two genera (*Oplurus* and *Chalarodon*) and eight species, seven of which are classified as 'Least Concern', with an eighth, recently described microendemic, awaiting conservation assessment. Seven of these species are defined based on morphological differences alone but recent molecular analyses have suggested the potential for cryptic species. Thus, comprehensive species delimitation analyses are warranted. We combine subgenomic, morphological, and spatial data across a broad sampling of Opluridae to define species boundaries. Preliminary results suggest that Opluridae may consist of nearly twice as many species as are currently recognized, which would have major implications for our understanding of species distributions, population sizes and health, and the condition of their habitats. Following a taxonomic revision, we will reassess the conservation statuses of all Opluridae species, and identify required habitats, in order to advise effective management of this unique iguana lineage.

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Trace elements as a method for sourcing migratory tree bats

Renewable-energy production from wind turbine facilities has recently expanded in the US. This has benefits in reducing production of greenhouse gasses but has negative impacts through increased mortality of tree-roosting bats due to turbine strikes. A key question that would guide management activities is whether bats that are killed are primarily from local populations or migrants. This requires developing methods for sourcing bats using biomarkers. Here we describe an



evaluation of the use of trace element analyses in bat fur to identify bats killed at wind facilities in the eastern and mid-western US as being migrants or from local populations. This is based on the idea that the concentration of trace elements in their fur is related to the amount of trace elements present in the soil, which is highly variable across large spatial scales. Using this information, we explore the feasibility of linking trace element profiles from individual bats with trace element reference maps to provide better estimates of the source regions of bats. We used ICP-OES to determine the concentration of multiple trace elements in fur, and compared this to publicly available soil trace element concentrations for the US and Canada. We then used a Bayesian probabilistic framework to produce likelihood-of-origin maps for each element for each individual bat, and combined elements using a Bayesian posterior probability framework. Overall, using trace elements may provide a novel way to source migratory bats.