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Landscape prediction of bobcat spatial distribution in Wisconsin.

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In 2006, a record 356 bobcats (*Lynx rufus*) were harvested from the northern third of Wisconsin, exceeding any previous success rate. There has been mounting interest in expanding the bobcat harvest zone and a concomitant interest in increasing quota levels. Current harvest boundaries are relatively arbitrary, are not defined by ecological boundaries, and do not adequately reflect the bobcat's statewide distribution. The unknown distribution of bobcats in Wisconsin continues to hamper sound management decisions. Research objectives were to: 1) model bobcat habitat use, 2) apply the model statewide to predict bobcat distribution throughout Wisconsin, and 3) evaluate the predictive success of the model. We developed a predictive logistic regression model with adaptive kernel core areas

estimated from over 1,000 locations from 10 radio collared female bobcats collected between 1991 - 1999 from three study sites in northern Wisconsin. The model was applied statewide using recent land-cover information to identify three levels of suitable bobcat habitat at the scale of 4.5 km², the mean size of a female bobcat core area. The predictive accuracy of the model was evaluated with an independent data set obtained by a detector dog trained to locate bobcat scat and with non-invasive hair snares. Hair snares were erected and scats were detected along transects established statewide in the three levels of suitable habitat. Identification of individuals from hair and scat were made using DNA analysis and estimates of minimum bobcat densities were used to validate the predictive accuracy of the model. Several transects corresponded with established winter track routes to facilitate an analysis of the relationship between track count indices and noninvasive sampling.

Assessing movement patterns and habitat use of suburban bobcats using GPS/VHF collars.

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Kiawah Island, a 3,494 ha coastal barrier island, is located approximately 32 kilometers southwest of Charleston, South Carolina. Kiawah is a residential and resort community with 1,200 permanent residents and thousands of visitors each year. Currently, there are 3,250 developed lots on the island with an additional 2,300 lots planned for development. Despite development pressures, Kiawah remains home to a healthy and stable bobcat (*Lynx rufus*) population of approximately 30 individuals. In January 2007, we initiated a study to assess fine-scale habitat use and detailed movement patterns of Kiawah Island bobcats. Five adult bobcats (3 males, 2 females) were fitted with GPS collars during March-April 2007. Four collars were programmed to acquire positions every 10 minutes and drop off after 34 days. These collars averaged 2,420 locations and a 50% fix rate. The 5th collar was programmed to acquire a position every 30 minutes, dropped off after 71 days, obtained 2,853 locations, and had an 84% fix rate. All collars performed adequately in the field and testing showed >90% of points, with PDOP values under 9.9, were accurate to + 20 meters. Data showed that bobcats consistently spent daylight hours in patches of thick shrubs, typically in high marsh or secondary sand dune areas, and traveled extensively throughout more developed areas during nighttime hours, likely in search of food. Traveling bobcats consistently avoided golf courses and salt marsh and extensively used marsh edges and vegetated buffer strips along roads and golf courses. This initial GPS study, though brief in duration, provided an extensive amount of detailed data on bobcat habits and movement patterns. It also identified specific patches of cover, some in very close proximity to development, used by bobcats as daytime refugia. This information is currently being used by the Kiawah Island Conservancy to prioritize land preservation efforts.

Bobcat (*Lynx rufus*) dispersal in Iowa.

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Abstract: Recolonization of bobcat (*Lynx rufus*) populations in the Midwest has presented challenges for managers with little knowledge of the species population dynamics in a highly fragmented agricultural landscape. Dispersal and philopatry are a critical component of population dynamics of a recolonizing

population, which is likely influenced by landscape features for bobcats. In Iowa, we examined movements of 119 radio-monitored bobcats, recording 20 juvenile (< 1 yr.) dispersal events with 7 juveniles displaying philopatric behavior. The majority of juvenile males dispersed (80%), while 42% of females did not. We recorded the earliest juvenile dispersal initiation on January 12, but initiation varied greatly (= June 3). Females dispersed 40 days earlier than males their first year. We identified up to 4 separate dispersal bouts of juvenile radio-marked individuals over 3 yrs, averaging 101 days between dispersal bouts. Straight-line dispersal distances ranged from 5.5 - 189.5 km (= 76.1 km), with a maximum dispersal distance of 425.6 km. On average, males dispersed 43 km farther than females. Based on average home range sizes, females and males dispersed 5.0 and 7.6 times their home range diameter, respectively. Individuals dispersed the farthest during their first dispersal bout (= 69.7 km) with distances during sequential dispersal bouts similar (= 25.0 km). Habitat composition and fragmentation was similar for core areas selected after each dispersal bout, but on a landscape level, bobcats selected forested areas consistently. We recorded only one individual dispersing north of Iowa's bobcat population center (southern Iowa), which followed a wooded river corridor surrounded by intensive row-cropping. Wooded riparian corridors appear critical in facilitating bobcat dispersal to other suitable forested habitat in the intensively row-cropped areas of the Midwest. Managers will need to maintain this connectivity among suitable patches to promote the further recolonization of bobcats in the Midwest.

Retrospective changes in habitat supply for Canada lynx and snowshoe hares resulting from timber harvesting: Implications for lynx recovery?

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Canada lynx (*Lynx canadensis*) are a specialist predator and often exhibit habitat selection for regenerating conifer forests where snowshoe hares (*Lepus americanus*) are abundant. The quantity and spatial distribution of high quality hare habitats are profoundly influenced by forest disturbance and succession, thus we assessed the spatiotemporal variability in lynx and hare habitat to evaluate retrospective trends in habitat supply for the U.S. threatened lynx within an extensively managed landscape. Our goal was to understand how timber harvesting influences spatiotemporal patterns of habitat, snowshoe hare densities, and lynx occurrence across 1.5 million hectares of commercial forestland in Maine, which represents the core habitat for the largest population of lynx in the coterminous U.S.A. We developed and tested a spatial habitat model that predicts lynx occurrence based on forest characteristics and landscape configuration using a Landsat satellite-based land cover time series (1970-2007). We integrated land cover data, results from empirical studies, and predictive modeling to document changes in landscape pattern, to predict changes in hare densities, and to quantify trends in lynx occurrence. Forest harvesting occurred across >50% of our study area 1970-2007. Pre-emptive and salvage clearcutting in the 1970s and 1980s in response to a widespread insect outbreak greatly influenced broad-scale forest age structure and increased landscape-scale hare densities and lynx occurrence during the 1990s and 2000s. Predicted hare densities at the lynx home-range scale increased from a mean of 0.29 hares/ha in 1988 to 0.60 hares/ha in 2004, and the area with ≥50% probability of lynx occurrence increased from 117,022 ha to 407,511 ha (+250%). Shifts in forest policy after 1988 have, however, significantly reduced the annual extent of clearcut harvesting, which may cause future declines in landscape densities of hares. Correspondingly, the lynx population is expected to decline, which may influence the future success of U.S. recovery efforts.

Survival of lynx reintroduced to Colorado.

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ABSTRACT: Any viable population of Canada lynx (*Lynx canadensis*) was extirpated from Colorado as early as the 1970's. A reintroduction program was initiated in 1997 and a total of 218 lynx, captured from wild populations in Canada and in Alaska, were released in the state from 1999-2006. Accurate estimates of demographic parameters for this reintroduced population are essential to assess the success of the reintroduction program and to develop future management recommendations. In particular, the Canada lynx is a relatively long-lived species and thus, adult survival is likely to play a key role in the dynamics of the population. All released lynx were equipped with VHF and/or satellite collars allowing biweekly locations to be obtained. While such telemetry data is often analyzed using known-fate or nest-survival models, these approaches could not be applied to our data due to movement outside of the study area, irregular ("ragged") and missing location data, and issues associated with collar failure and replacement. We describe how the more general multi-state mark-recapture models can be applied to the Colorado lynx post-release monitoring data to address these problems. We used this approach to estimate monthly and annual survival rates of adult released lynx, as well as to explore factors affecting survival such as sex, time spent in captivity, movement, and origin of lynx. We make recommendations concerning the future directions of the lynx reintroduction program in Colorado to ensure the highest survival of released animals, as well as for other reintroduction programs. Our analysis methods should have broad applicability to other telemetry projects that cannot meet the strict assumption of known fate, especially when detection probability does not equal 1, and where field methods result in irregular sampling intervals.

Survival and cause-specific mortality in sub-adult and adult Florida panthers.

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Estimating survival rates and cause-specific mortality rates of endangered or threatened species are important steps in identifying threats to those species and understanding and predicting their population dynamics. We estimated survival and cause-specific mortality rates for the critically endangered Florida panther (*Puma concolor coryi*) from radio-telemetry data collected during 1981-2006 for animals independent from their dams. Survival rates were estimated using the Cox proportional hazard method, while the nonparametric cumulative incidence function estimator was used to estimate cause-specific mortality rates. We used necropsy data to assign deaths to five mortality categories: collision with vehicle, intraspecific aggression, disease, other, and unknown. We compared survival and cause-specific mortality estimates by sex and age-category (sub-adult and adult), with year as a random effect. Overall annual survival was 82% (95% CI: 78%-85%). The principal cause of mortality was intraspecific aggression, at 8% (95% CI: 6%-10%). Females exhibited higher survival rates than males, which had higher mortality due to intraspecific aggression and collisions with vehicles than females. Sub-adult females had higher survival than adult females. Adult males had higher survival than sub-adult males, which had higher mortality due to intraspecific aggression. The year of the study had no significant effect on survival rates. Sex and age categories are important risk factors for Florida panthers and should be incorporated into any population modeling effort. The high rate of intraspecific aggression documented in this population is typical for the species, although limited area for sub-adult male dispersal could play an increasing role in keeping this rate high.

Assessing public support for Florida panther recovery.

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The small population of Florida panthers is increasingly threatened by habitat loss and degradation resulting from continued human expansion into core panther habitat in Southwest Florida. To better understand public support and opposition to panther recovery efforts, a telephone survey was conducted during March 2007 on a stratified random sample of 802 Florida residents. Strata were defined based on (1) location in core panther habitat (Southwest Florida) or a potential translocation site (South Central Florida) and (2) rural or urban setting. Two hundred residents were surveyed within each strata to enable comparisons of behavioral intentions, management preferences, attitudes, subjective norms, risk perception, knowledge levels and demographics. The weighted mean score on the behavioral intention scale was 3.33 on a 5-point scale, indicating a moderate intention to act in support of recovery. Fifty-two percent of respondents were willing both to write a letter to a political official and to pay a small additional tax in support of recovery. Seventy-five percent would not vote for a political official who favored development over panther recovery. Respondents expressed support for panther management practices targeting recovery (3.43) and positive attitudes toward panthers and panther protection (3.89). The perceived risk from panthers was low (2.30). Regression analysis of all response variables showed that behavioral intentions were directly predicted by management preferences, attitudes and subjective norm, and indirectly affected by risk perception, knowledge, and demographic characteristics. Respondents opposing recovery tended to agree that panther protection leads to land use restrictions, to believe that panthers compete with hunters for game species, and to oppose translocation of panthers into their home county. Statistically significant differences were found among strata. Results will be helpful in developing public outreach materials and targeting specific audiences.

Trials and tribulations associated with the deployment of GPS radiocollars on Florida panthers: A characterization of fix success and overall collar performance.

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As the size and cost of GPS radiocollars have decreased, the use of these products on wildlife has increased. Manufacturers of GPS radiocollars promise extensive datasets that have the potential to answer research questions historically difficult to assess with ground or aerial VHF radiotelemetry. The Florida Fish and Wildlife Conservation Commission (FWC) has collected aerial VHF locational data on the Florida panther (*Puma concolor coryi*) on a three-day per week regimen since 1981. In order to more comprehensively assess panther habitat selection and activity patterns throughout the diel period, we have concentrated on deploying 4 brands of GPS radiocollars since 2005 (n = 27). Weights of collars ranged from 330 to 780 grams and fix schedules varied from every 7 hours to hourly fixes. Total number of locations acquired by individual collars ranged between 137 and 10,734. Average fix success rate for recovered collars was 68.7% (n = 19, range: 35.1% - 87.0%) and deployment times ranged from 52 to 611 days. Failure of 13 units (deployment time range: 115-433 days) involved GPS receiver and VHF beacon malfunctions, premature breakaway, and 6 failed units have yet to be recovered. Durability issues (broken antennas, casing damage) were notable in some models. Only 3 of 8 breakaway mechanisms released on schedule. Each collar brand has associated strengths and weaknesses that have guided subsequent deployment of this technology on panthers. Short fix intervals (< 2 hours) have revealed fine-scale movement patterns associated with road crossings, use of unimproved highway

underpasses, and kill sites that would have been difficult to document with VHF monitoring. Additionally, advances in approximately real-time data transmission technology in some new models of GPS collars may eventually assist in reducing financial burdens and risks associated with aerial data collection while providing timely locations of study animals.

Counting pumas by categorizing physical evidence.

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The occurrence of Puma concolor can be confirmed by detecting physical evidence (i.e. tracks, urine markers). However, determining the number of pumas responsible for creating this sign is problematic. We addressed this difficulty by categorizing physical evidence (sign) and applied this method during the Puma concolor coryi (Florida panther) project. Three rules were used to distinguish individuals. (1) Gender was determined by track size or stride length; (2) Time (freshness) was determined by known events within the past 24 hours such as wind or rain; (3) Distance between individual track sets was used as an exclusionary tool to avoid overcounting. We evaluated accuracy by capture and by comparison to 3 other indices. This method could be adapted to census other large felines.

Zoonotic disease awareness and protection: insights from a wildlife biologist's death .

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Biologists often investigate wildlife mortality events or disease outbreaks to understand the cause of death in individual animals and the effects on populations. This valuable information can inform management decisions. Prior to these investigations, consultation and planning on both animal and human health issues are necessary to help ensure that collection of data on wildlife and zoonotic diseases is maximized and risks to biologists are minimized or appropriately mitigated. A case study of a plague-associated death of a wildlife biologist at Grand Canyon National Park, Arizona, in November 2007 provides insights into the utility and need for this approach. The experienced biologist necropsied a collared mountain lion (*Felis concolor*) that he believed died of trauma from intra-specific aggression. The biologist was found deceased at his residence one week later, and his death was confirmed as pneumonic plague. Subsequent testing on archived tissue samples from the mountain lion isolated *Yersinia pestis* of the identical sub-type, thus confirming the biologist's source of infection. The biologist's work-related death highlighted a National Park Service (NPS) need to examine and improve existing guidance on safe handling of wildlife—a need that likely exists in many other federal, state, and university programs. A multi-disciplinary NPS team including wildlife health, risk management, and public health representatives collaborated to develop a comprehensive guidance document that uses job hazard analyses as a foundation to identify and mitigate risks. These risks include not only zoonotic diseases, such as plague, but physical hazards, injury from animals, and environmental conditions. Collection of wildlife data is an important tool in wildlife management and proper sampling and/or disposal of animal carcasses can help protect human, as well as animal health; however, consultation and collaborative development of safe work practices are critical to helping ensure biologists' safety in performing this essential work.

Community protected areas and the conservation of jaguar and their prey in the Chinantla Region of the Sierra Norte, Oaxaca, Mexico.

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This study explored the phenomenon of community-owned protected areas and evaluated their contribution to the conservation of jaguar (*Panthera onca*) and their prey. The region studied is known as the Chinantla, an ethnic region populated by Chinantec indigenous peoples in the Sierra Norte of Oaxaca (SNO), southern Mexico. The SNO has been identified as one of nineteen priority sites for jaguar conservation in Mexico. The four Chinantec communities in the study area have declared 205 km² of their land as community protected areas where hunting has been banned. Since 2003, the National Commission of Natural Protected Areas (CONANP) in Mexico has recognized 34 community protected areas. With an estimated 56-62% of its forests under community ownership and 11.5% of its land already designated in its reserve network, there are few significant public lands remaining in Mexico that could be designated as federal protected areas. Thus, Mexico presents a national laboratory for studying jaguar conservation on lands beyond public protected area boundaries. Ecological research was done using camera traps, which registered two jaguars in a 144 km² study area. A total of nine jaguar photographs were taken after 1,151 trap nights yielding a 'photographic-capture' rate of 7.82 jaguar captures/1,000 trap nights. Socioeconomic and cultural data on human-jaguar interactions, prey abundance, and livestock depredation were collected through semi-structured and structured surveys. This was apparently the first study on local people's perceptions towards jaguars in Mexico and also the first to systematically assess the status of the species in both southern Mexico and in community protected areas.

Changing constituencies and conservation on Costa Rica's Osa Peninsula

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Corcovado National Park's 1975 creation initiated organized conservation on Costa Rica's Osa Peninsula. Scientific mobilization drove park creation, motivated by the exceptional biodiversity of the Osa's virtually untouched lowland forests, where abundant large mammals included jaguar, puma, Baird's tapir, white-faced and collared peccary, and four monkey species. Corcovado's establishment had no local constituent support, relying on an international environmental coalition of San José and U.S. scientists, Costa Rican natural resources administrators, and U.S. NGOs. The park impinged on land-use and hunting activities of the Osa's subsistence farmers. For many years, locals were excluded from park-related policymaking and felt no identification with its conservation goals. My environmental history study asks: How have conservation-related concerns and interests of the Osa's local population changed since the mid-1980s, when crises such as a goldminer invasion finally compelled conservation administrators to address local relations. How have changing demographics bolstered local conservationism, and have these local constituency changes worked in favor of long-term conservation of Osa ecosystems and animals? I have addressed these questions through archival and field-based research, oral history interviews, and review of natural and social science publications. An increasingly diverse Osa population has supported a new local conservationist constituency since the 1980s-90s. Local groups lead recycling, clean-water, and estuarine ecosystem protection efforts; locally-based projects support Osa ecotourism initiatives that depend on faunal abundance. Today's Osa conservation

regimes depend on community participation, in environmental education programs, the new conservation management plan, and even scientific research addressing effects on Osa mammals of poaching, sylvatic disease, and forest-to-agriculture conversion. My Osa case study indicates that even where protected areas are created without local support or in the face of local opposition, such support still can be generated--or self-generate--later, and ultimately will become critical to stable, long-term biodiversity and wildlife conservation.
