NEWSLETTER

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FROM THE CHAIR

Martes conservation– Let's implement our vast knowledge

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One year ago, in Seattle, we met again – this was the 5th International *Martes* Symposium on the *Biology and conservation of martens, sables, and fishers: a new synthesis*. This was a most invigorating experience, where young and "older" *Martes* biologists reviewed their knowledge of species, challenged old paradigms, discussed new concepts, and identified upcoming challenges. In light of this new synthesis, I could come to only 1 conclusion: we know a lot about *Martes.* Obviously, there will always be more to learn about the biology of *Martes* species, but overall, we certainly know enough to take actions to ensure their conservation.

Yet, in spite of all our knowledge, I still see and hear about industrial development programs that impoverish or simply destroy living conditions for martens and fishers. Some governments consider the martens' impact on small game and rate them as pests. Others refuse to give special status to *Martes* metapopulations that suffer from continued habitat loss and risk of becoming extinct. Most of us do not have the power to influence politicians and industry. However, we can all take time to inform the public and environmental organizations about the ecological significance of maintaining landscapes and habitats that meet the environmental needs of martens and fishers. Too many times I have seen "specialists" asking for more research and assessments of proposed management guidelines, instead of endorsing guidelines that would change logging practices or harvest programs to ensure the future of habitats and populations. Ineptitudes in implementing what we know, and delays in correlating each and every management recommendation with a fitness index, often lead to the extirpation of populations and the loss of critical habitats. Too many times I have seen biologists failing to implement what we know because "we do not know it all."

After 15 years as Chair of the *Martes* Working Group, I am not disillusioned about our *raison d'être* – to facilitate communication among people with a common interest in *Martes* research, conservation, and management programs – our group will never exert influence on governments and agencies. This is due to the fact that we are a very small group and many of our members are not interested in a group that would become more vocal in expressing basic conservation and management measures for sables, martens, and fishers. As individuals, however, we should try to educate the public, other professionals, and organizations. We should speak up about wrong decisions and poor developments that will affect the welfare of martens, fishers, and all sympatric species. Our actions should reflect the enthusiasm that we all experienced at the 5th International Symposium of 2009 – we should implement our vast knowledge of *Martes*.

Since 2000, the *Martes* Working Group has benefited from the hard work of Erin O'Doherty as Treasurer and Membership Director. In 2004, Amie Mazzoni became our Newsletter Editor. Sincere thanks to both of them for their continued dedication.

Participants at the 2009 Symposium elected a new Executive. I am still Chair, and Jean-François Robitaille is still Webmaster. We were fortunate to recruit Bill Adair as Newsletter Editor, and Scott Yaeger as Treasurer and Membership Director. In order to better reach our membership, we also identified a series of Regional Representatives: Bill Krohn for Eastern North America, Sean Matthews for Western North America, Marina Mergey for Europe, and Michael Schwartz for the "rest of the world". If everything goes well, the next symposium should be in Poland in 2013 with Isabella Wierzbowska and Andrzej Zalewski as organizers. In the meantime, the Organizing Committee of the last symposium is working on the publication of an updated review of our knowledge of *Martes* biology.

FROM THE TREASURER AND MEMBERSHIP DIRECTOR

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Sometime during the excitement of the Seattle symposium last September, I raised my hand and volunteered to be the new Treasurer and Membership Director for the *Martes* Working Group. Although I have been involved with various fisher (*Martes pennanti*) research projects for a number of years, this was my first *Martes* symposium, and I was absolutely caught up in all the fantastic and exciting work being conducted by members around the world. Although I suspect that someday Gilbert's statement, "It is not much work…trust me," will be put to the test, I am thrilled to be a part of this group and contribute some of my time to keep it vibrant.

In the recent months, our on-line payment service with PayPal has been causing some members consternation, with extra charges and membership cancellation notices. We believe one of the problems may be that PayPal has difficulty dealing with the biennial nature of our membership. Because this service is convenient for members wanting to use credit cards, we are going to make a slight change in our approach and ask you to pay dues annually ($15.00 US).

As always, we waive fees for students to encourage their participation. Likewise, we do not want membership dues to be a roadblock for any fellow *Martes* enthusiast wanting to join, so please let interested parties know that we value and desire their participation and will work with those who feel the dues are a financial burden.

What are the dues for? They go towards putting on world-class symposia of your and my favorite Genus and, when possible, they are used to defray travel costs to some who would otherwise be unable to attend. Speaking of dues, it is time for most of us to renew our membership. Attached with this newsletter, please find a membership form, along with a list of current members, including payment status. Please update your membership and return this form to me. Do not hesitate to contact me if you have questions or suggestions. We want to provide a topnotch service for all of you.

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THE 5TH INTERNATIONAL *MARTES* SYMPOSIUM WAS A GREAT SUCCESS!

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The *Martes* Working Group convened the 5th International *Martes* Symposium at the University of Washington in Seattle from September 8-12, 2009. The Symposium Planning Committee was led by Keith Aubry, and included Bill Zielinski, Martin Raphael, Gilbert Proulx, and Steve Buskirk. The conference was attended by >120 people from 10 countries, including Japan, Russia, Poland, Ireland, Scotland, France, Italy, Spain, Canada, and the U.S. Based on the evaluations submitted by participants and the many compliments we received during the event, the 5th *Martes* Symposium was a great success in every regard!

The event began with an evening reception at the Burke Museum, which included a behind-the-scenes tour of the mammal collection, followed by 3 full days of technical presentations and our traditional banquet and raffle to raise funds for the MWG.

The Symposium was capped by an all-day field trip to the Olympic Peninsula to learn about the reintroduction of fishers (*Martes pennanti*) to Washington. In the Pacific states, the fisher is a candidate for listing under the federal Endangered Species Act, and it is listed as Endangered by the state of Washington, where the species is believed to have been extirpated by the mid-1900s. Four years ago, the state began the reintroduction of fishers to the Olympic Peninsula. Altogether, 90 fishers were translocated from British Columbia, with the last batch being released in early 2009. The field trip offered participants a first-hand look at the areas currently occupied by translocated fishers, and enabled visitors to see habitat conditions ranging from the alpine meadows on Hurricane Ridge in Olympic National Park, to 400-year-old lowland Douglas-fir (*Pseudotsuga menziesii*)/western hemlock (*Tsuga heterophylla*) forests near Lake Crescent on the west side of the Peninsula.

The Symposium Planning Committee is currently in the process of editing and overseeing the publication of a book from the invited papers presented at the Symposium entitled "Biology and Conservation of Martens, Sables, and Fishers: A New Synthesis". Unlike more recent volumes published from *Martes* symposia, this book will provide a synthesis of our current state of knowledge on the genus *Martes*. It will include 5 major sections: Evolution and Biogeography of *Martes*, Ecology and Management of *Martes* Populations, Ecology and Management of *Martes* Habitat, Advances in Research Techniques for *Martes*, and Conservation of *Martes* Populations. We are expecting to publish the book in late 2011.

Lastly, we would like to acknowledge those who provided financial support for the Symposium, including the USDA Forest Service, Western Section of the Wildlife Society, Washington Department of Fish and Wildlife, Roseburg Resource Company, Northeast Section of the Wildlife Society, Integral Ecology Research Center, and Telonics, Inc.

WESTERN NORTH AMERICA

Scaling, limiting factors, and plasticity in marten habitat selection

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Animals may select habitat quality across a range of spatial scales and in ways that may not be linearly related to environmental variables. Because of this, it is essential to evaluate habitat selection at a range of spatial scales and response shapes to reveal the true grain and relationship that characterizes the animals' response to landscape variability. Previous habitat relationship studies of *Martes americana* have not fully considered these scaling issues. We compared the effects of scaling on habitat selection for marten in 2 study areas (Washington and Oregon, USA). Specifically, we (1) quantified the difference in model performance between scaled and unscaled models, (2) evaluated the effects of variable scaling on the relative importance of variables, and (3) evaluated the effects of scaling on interpretation of the strength and nature of habitat relationships in the 2 study areas.

To achieve these aims, we performed mixed effects logistic regression based on telemetry observations from both study areas and 12 candidate habitat variables related to forest structure, topography, and habitat connectivity. We evaluated model performance based on a range of 8 spatial scales (mean value within a circular moving window of 90 m to 1350 m) and 7 response curve shapes (power functions from 0.2 to 5.0).

Our results indicate that the scaled models generally have higher predictive power and perform better than unscaled models when cross-validated. Moreover, we find important differences in the variables included in scaled compared to unscaled models, leading to alternative interpretations of habitat relations. Interestingly many of the variables identified were most strongly predictive of marten presence at large spatial scales and in non-linear relationships with habitat variables. This highlights the need to consider scaling, as most studies use a single and often fine-grain spatial scale while assuming linear habitat relations.

In addition to understanding the effects of scaling on model selection and performance, we are also evaluating the evidence for limiting factors in habitat selection in the scaled habitat models for the Washington and Oregon study areas. Specifically, we will test the hypothesis that martens may respond positively or negatively to a range of environmental conditions, but if those conditions are not present or not variable across the study area, the response would not be detectable. These two study areas are suitable for such an analysis because they represent very different habitats. In Washington, the landscape is topographically complex, with a range of forest structural conditions and low levels of forest fragmentation. In contrast, the Oregon study area is located on a plateau, with relatively low forest structural diversity (mainly small-diameter lodgepole pine [*Pinus contorta*] and ponderosa pine [*P. ponderosa*]), and high forest fragmentation.

Finally, we will also explore the evidence for plasticity in marten habitat selection in the 2 study areas. In particular, we are interested in whether the variables found to be important drivers of habitat quality across the 2 study areas are similar, or if martens instead find ways to adapt to available habitats in novel ways.

Fishers released in the northern Sierra Nevada of California: first year summary and observations

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Concern for the status of the fisher (*Martes pennanti*) in California stimulated a cooperative venture among the California Department of Fish & Game, US Fish & Wildlife Service, Sierra Pacific Industries (SPI; a private timber company), and North Carolina State University to translocate fishers into the northern Sierra Nevada (Fig. 1; Callas and Figura 2008). In 2009 the California Department of Fish & Game gave final approval for 40 fishers to be translocated over the next 3 years (2009-2012). Fishers were to be released onto the Stirling District, a 648-km^2 tract of land owned by SPI and managed for timber production and harvest. Commensurate with this action, fishers are to be studied intensively for the first 7 years post-translocation.

The primary objectives of this research are to (1) document survival, reproduction and use of land cover by released fishers as well as their descendants during the first 5 years following release; (2) predict use of habitat by fishers using 4 existing models and a model that we develop; (3) predict placement, sizes, and shapes of home range using models of optimal home range choice, (4) predict patterns of breeding by males from home range placement and familiarity with landscapes; and (5) use the results of items 1-4 above to provide the foundation for understanding the results of the translocation.

From December 2009 to February 2010, we translocated fishers from 4 different areas (separated by >20 km) located in northern California. We captured 20 fishers (12 females and 8 males) during our trapping efforts. We removed fewer than 5 animals from most locations, but we removed 5 animals from the Eastern Klamath area, which had been extensively monitored for 3 years. We conducted physical examinations, age estimation, and health testing for all captured fisher prior to translocation. All animals were tested for exposure to canine distemper virus and parvovirus, and all animals were vaccinated for rabies and distemper virus prior to release. We returned 2 females and 2 males to their original trapping locations because they were in poor physical condition or too young. One female fisher died in captivity. A definitive cause of death was not identified at necropsy (Clifford, unpublished data).

We released 9 female and 6 male fishers. Six fishers were estimated to be ≥3 years old; 6 were estimated to be 13-24 months old; and 2 were juveniles (<12 months). Average body weight of translocated females was 2.11 ± 0.27 kg (±SD) and males 4.08 ± 0.15 kg. Female fishers were surgically implanted with a Telonics 310L VHF transmitter (Telonics, Mesa, AZ) with an estimated battery life of 14 months. These transmitters weighed 40 g and were equipped with a mortality sensor. All surgeries were performed by a veterinarian employed by the California Department of Fish and Game. Male fishers were outfitted with Sirtrack KiwiSat 202 PTT (Argos) collars. These collars weighed 90 g, were on daily for 4 hours, and have an estimated battery life of 390 days.

We released 7 females and 6 males along the Butte Creek river drainage, which roughly bisects the Stirling District, and an additional 2 females along the West Branch of the Feather River. We released 4 females in December 2009, 3 females and 6 males in January 2010, and 2 females in February 2010.

We have monitored fishers actively (telemetry) and passively (motion-sensitive cameras) since release. We try to locate females daily with ground telemetry, and use fixed-wing aircraft to locate females that are difficult to find from the ground. All females survived until early June, but 3 females died between mid-June and August 2010. Bobcat (*Lynx rufus*) DNA was found on the remains of 1 fisher (Wengert, UC Davis, unpublished data), but the quality and quantity of the remains were insufficient to determine if a bobcat was the cause of mortality. One female was found dead in a water tank; the subsequent necropsy by a veterinary pathologist demonstrated the animal died from drowning (Clifford, unpublished data). Only the transmitter and minimal remains were located for the final female, and forensic investigation is pending. Although 1 male lost his collar in early February 2010, he has subsequently been photographed, confirming he was still alive in June 2010. We have not documented a male mortality. Recently, several transmitters (both VHF and Argos) have apparently failed and reduced our ability to track all animals. As of early October 2010, we are actively tracking 2 females and 1 male, and have photographed at least 2 other individuals recently.

During March and April 2010 we identified 5 female fishers using dens in both standing dead and live trees with cavities. Subsequently, we placed motion-sensitive cameras near these dens and photographed 4 females with a single kit each (Fig. 3). The remaining females showed no denning behavior. Additionally, we photographed males at the den locations of 4 of the denning females. The proximity and timing of male fishers to females in den trees is consistent with breeding behavior (Powell 1993).

The farthest distance females have moved from their respective release points averaged 9 km (range 4–26 km). Females have generally settled close (< 5 km) to their original release sites (Fig. 3a). Male fishers have moved farther, on average, than females (Fig. 3). For males, the average farthest distance moved from their release locations is 30 km (Fig. 3b; range 10–57 km). Generally, long-distance movements occurred within the first few weeks after release, although some males continued to make relatively large movements into July.

We have documented that fishers are consuming a wide variety of prey items. The remains of alligator lizards (*Elgaria coerulea*), which are locally abundant in some land cover types, have been found in the feces of fishers. Several sciurids, including gray squirrels (*Sciurus griseus*) and California ground squirrels (*Spermophilus beecheyi*), have been documented as prey items. Many squirrel species are abundant throughout land cover types that fishers are using. At 1 den tree we found the partially consumed remains of an unknown raptor chick (an owl or hawk; identification pending). Thus, fishers seem to use multiple types of prey, but we cannot currently suggest what foods are preferred or used most often.

We intend to translocate another 15 animals in autumn of 2010. We will release animals in close proximity to existing animals on the Stirling District, but in areas where other animals are infrequently located. Fishers that are currently residing on or near Stirling will be recaptured and outfitted with new transmitters, and we will trap and conduct hair-snare surveys to document new fishers born into the population.

Acknowledgements – This is a collaborative effort involving many groups that provide funding, logistic support, and technical assistance. The California Department of Fish and Game, U.S. Fish and Wildlife Service, Sierra Pacific Industries, and North Carolina State University compose the 4 key groups responsible for translocation and research on fishers in the northern Sierra Nevada. We acknowledge the following individuals from those groups as contributors to this update: Laura Finley and Scott Yaeger (U.S. Fish and Wildlife Service); Richard Callas, Deana Clifford, Pete Figura, Scott Hill, and Matt Reno (California Department of Fish and Game); Tom Engstrom, Ed Murphy, Cajun James, Dennis Thibeault, Amanda Shufelberger, Julie Kelley, and Khris Rulon (Sierra Pacific Industries). Mourad Gabriel and Greta Wenghart (University of California at Davis), Stu Farber (Timber Products Inc), Katie Moriarty, Rob Swiers, and Mary Talley have provided additional support and assistance. Mark Higley, Sean Matthews, Jeff Lewis, Rick Sweitzer, Craig Thompson, Willam Zielinski, and Wes Watts have shared their experience and knowledge during various stages of this effort.

Callas, R.L., and P. Figura. 2008. Translocation plan for the reintroduction of fishers (*Martes pennanti*) to lands owned by Sierra Pacific Industries in the northern Sierra Nevada of California. California Department of Fish and Game, Sacramento, CA, USA. 80 pp.

Powell, R.A. 1993. The Fisher: Life History, Ecology and Behavior, 2nd edition. University of Minnesota Press, Minneapolis, MN, USA.

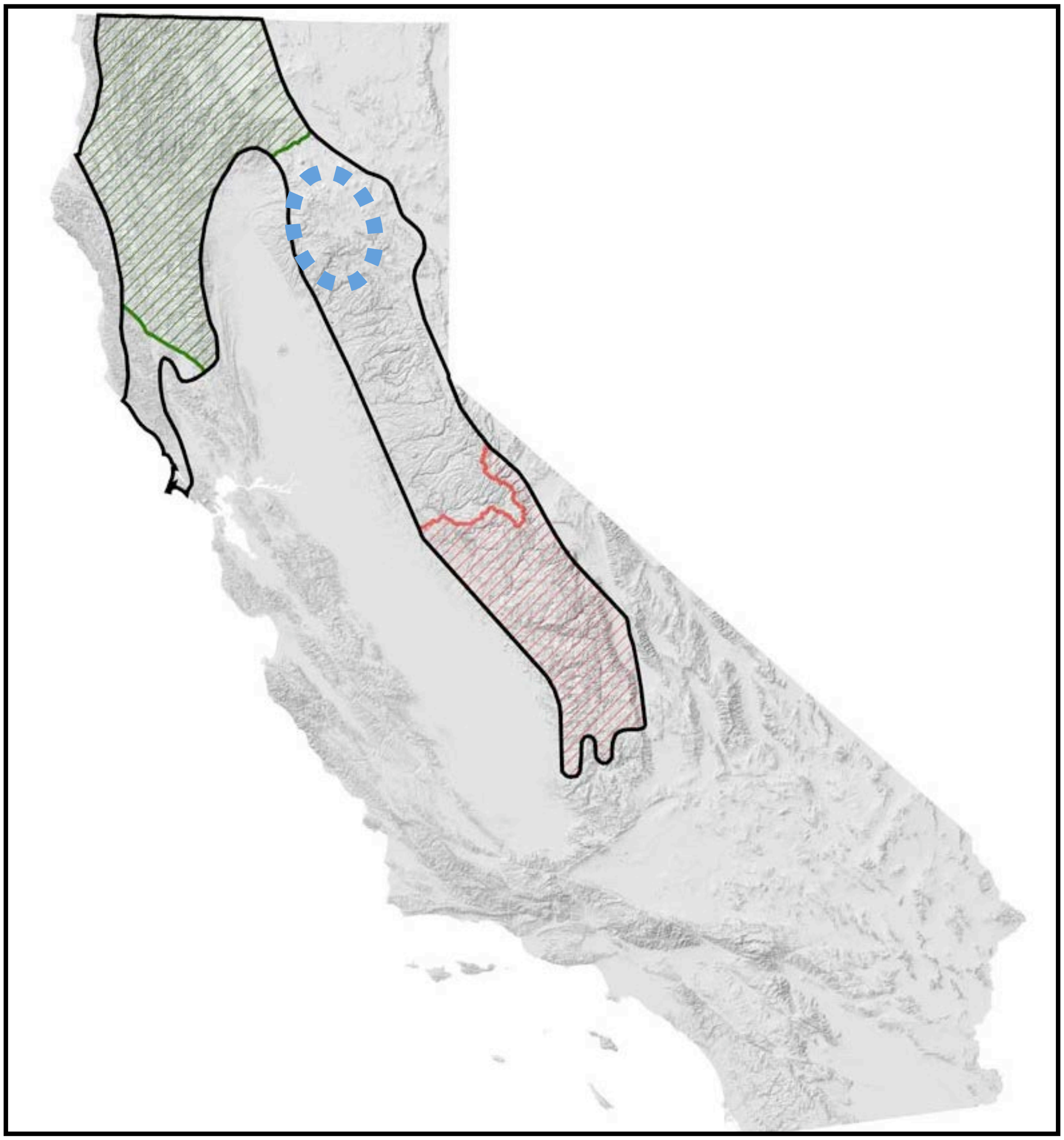

Figure 1. The historic (black outline), current Northern (green shading), and current Southern (red shading) distribution of fishers in California, and the general translocation area in the northern Sierra Nevada (blue dashed oval; source Callas and Figura 2008).

Figure 2. (Left) Female fisher D00B0 descending her maternal den tree with 1 kit in late June 2010; and (right) female fisher 199B9 descending her natal den tree with a single kit in late May 2010, on the Stirling District, northern Sierra Nevada, CA.

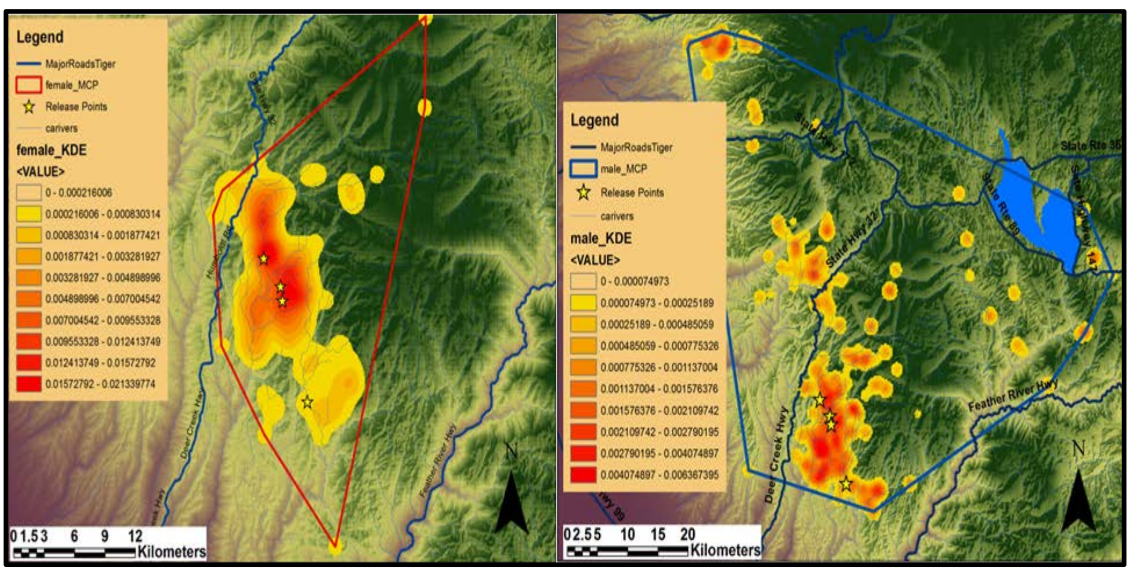

Figure 3. Kernel density estimate for female (left) and male (right) fisher location estimates on or near Stirling District, northern Sierra Nevada, CA from Dec 2009 – September 2010, with minimum convex polygon (MCP) for all locations for females (red polygon) and males (blue polygon). Yellow stars represent areas where fishers were initially released (note differences in scale between panels).

Effectiveness of rapid diagnostic tests to assess pathogens of fishers (*Martes pennanti*) and gray foxes (*Urocyon cinereoargenteus*)

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The following is the abstract from a paper published in the Journal of Wildlife Diseases 46(3) 2010, pp. 966-970.

Abstract – Wildlife managers often need to assess the current health status of wildlife communities before implementation of management actions involving surveillance,

reintroductions, or translocations. We estimated the sensitivity and specificity of a commercially available domestic canine rapid diagnostic antigen test for canine parvovirus and a rapid enzyme-linked immunosorbent assay for the detection of antibodies toward *Anaplasma phagocytophilum* on populations of fishers (*Martes pennanti*) and sympatric gray foxes (*Urocyon cinereoargenteus*). Eighty-two fecal samples from 66 fishers and 16 gray foxes were tested with both SNAP® PARVO rapid diagnostic test (RDT) and a nested polymerase chain reaction (PCR). Whole blood samples from 23 fishers and 53 gray foxes were tested with both SNAP 4Dx® RDT and immunofluorescence assays (IFAs). The SNAP PARVO RDT detected no parvovirus, whereas PCR detected the virus in 17 samples. Eleven samples were positive using the SNAP 4Dx RDT, whereas 46 samples tested by IFA were positive for *A. phagocytophilum*. Both RDTs had low sensitivity and poor test agreement. These findings clearly demonstrate the importance of validating RDTs developed for domesticated animals before using them for wildlife populations.

Habitat use and movement behavior of American martens (*Martes americana*) in response to forest management practices on the Lassen National Forest, California

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We are evaluating movement patterns of adult American martens (*Martes americana*) on the Lassen National Forest (LNF) to assess how they travel within and between forest patch types that vary in structural diversity. We hope to gain new insights on the effects of habitat fragmentation and potential barriers to marten movement on managed landscapes.

Our objectives are to (1) evaluate the effectiveness of existing habitat models that predict marten occurrence; (2) quantify the type, size and configuration of openings in managed forests through which martens are willing to move; (3) determine thresholds of "openness" that act as barriers to marten movement; and (4) evaluate the importance of specific micro-site features and potential interspecific interactions that may influence marten movement.

We are using a variety of observational and experimental methods to address our objectives. We are combining VHF radio telemetry (28 g, Holohil Ltd, Carp, Ontario), GPS collar deployments (35 g, Telemetry Solutions, Concord, California), and non-invasive techniques such as snow tracking and track plates. We are observing movement tracks using snow tracking and high-frequency GPS collar locations (1 location every 3-5 minutes). These tracks will be evaluated at 3 scales: (1) within home ranges, which vary in the amount of predicted habitat and potential fragmentation; (2) among and between patch types; and (3) by comparing micro-site characteristics between actual and random tracks (snow tracking only). For purposes of study design, we are classifying habitat according to structural attributes rather than by management prescription and age. Our structural patch classes include open (meadows, clear-cuts, shelterwood harvests), simple (thinning treatments), and complex (dense forest and predicted reproductive habitat).

We are using food-titration experiments to assess movement while statistically isolating confounding factors such as individual motivation. We are placing a 400-m linear row of track plates, spaced 50-m apart, that starts within the complex patch and extends into an open patch, simple patch, or another complex patch (as a control). Titration experiments provide a unique method of identifying an animal's willingness to travel into contrasting patch types by quantifying potential predation risk and energetic costs. We are also proposing to conduct short-distance (< 5 km) experimental translocations using a maximum of 15 adult males. Homing and experimental translocations have been used to systematically assess an animals' ability to cross a variety of landscapes with predefined potential obstacles. Forest specialists are generally more reluctant to enter gaps, and detour efficiency (the distance across the gap divided by the distance around the gap perimeter) predicts gap-crossing abilities for many species. These conditions are similar to dispersal conditions in novel terrain. Titrations began in fall 2010 and will continue until April 2012. Experimental translocations may begin in November 2010, pending approval, and would occur 2010-2011 in the snow-free months, except when breeding is expected (July-September).

Through this research we hope to improve prescriptions for management with respect to the size of gaps, presence of large woody material, and components of undergrowth. We aim to better understand what types of patches are permeable for marten movement. This is a cooperative research project funded by Lassen National Forest in California with assistance from Pacific Southwest Research Station Redwood Sciences Lab, Oregon State University, California Department of Fish and Game, and many hard-working technicians and volunteers.

If you have completed related work, or have suggestions, please contact Katie Moriarty (ktmoriarty22@gmail.com).

Overview and status of the Sierra Nevada Adaptive Management Fisher Project

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The Sierra Nevada Adaptive Management Project (SNAMP) Fisher Study is a long-term (7-8 year) study that was developed to assess whether or not increased levels of commercial thinning associated with fuel reduction management activities, conducted by the U.S. Forest Service as approved with the 2004 revisions to the 2001 Sierra Nevada Framework, may further imperil the Pacific fisher (*Martes pennanti*) in the southern Sierra Nevada, California.

Our study area is at the northern range limit of the southern Sierra Nevada fisher population in California, encompassing the area bounded by the Merced River in the north and the San Joaquin River in the south. Our primary research objectives are to estimate population parameters and determine limiting factors for fishers in the southern Sierra Nevada, and to assess life history responses of fishers to fuel reduction treatments in the aforementioned study area. The research project was launched in late September 2007. We have since used automatic digital cameras and information from 67 different captured/radiocollared fishers to begin to understand the distribution, home range activities, reproduction, dispersal, survival, and causes of mortality for this rare mammal across an area of approximately 1150 km^2.

The distribution of the Pacific fisher in our study area is constrained to a relatively narrow band of suitable habitat between 1060 m and 2130 m elevation. Within this area, the mean 90% Fixed Kernel home ranges of adult male and adult female fishers is around 26 km^2 and 53 km^2, respectively. On average, around 85% of the adult females in the study population produced kits over the last 3 years, and their fecundity was around 1.5 kits/female. We have documented 7 dispersal events so far; 4 young females moved an average of 10.7 km from their natal areas, compared to 18.5 km for 3 young male fishers. Annual survival of the adult-aged animals in the population has typically exceeded 0.70, whereas annual survival of the juvenile and subadult male segment of the population is only around 0.40. A total of 36 fisher mortalities have been documented, including 29 of our radio-collared animals. Based on detailed necropsies and DNA-based analyses of bite wounds, predation by bobcats (*Lynx rufus*) has been the most common source of mortality, followed by vehicle strikes on a local highway, and then disease (canine distemper). It is possible that the combination of "natural" sources of mortality, along with roadkill, is preventing fishers from expanding back into portions of their historic range north of the Merced River in Yosemite National Park. Although adult female survival was relatively high during each of the first 2 full population years, survival for this key segment of the population is below 0.60 at about midway through the current population year.

We are now about 3 years into the planned 7-8 year study period, and awaiting the start of a series of fuels reduction treatments by the USDA Forest Service. We anticipate having sufficient information on the population ecology of fishers in areas with fuel reduction activities for evaluating the effects of these types of forest management activities on Pacific fishers. More information on this study, including several recent presentations, can be found at http://snamp.cnr.berkeley.edu/.

Spatial scaling and multi-model inference in landscape genetics: *Martes americana* in northern Idaho

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The following is an abstract from a paper published in Landscape Ecology 25(10): 1601-1612 (2010) (DOI 10.1007/s10980-010-9525-7).

Abstract – Individual-based analyses relating landscape structure to genetic distances across complex landscapes enable rigorous evaluation of multiple alternative hypotheses linking landscape structure to gene flow. We utilize 2 extensions to increase the rigor of the individual-based causal modeling approach to inferring relationships between landscape patterns and gene flow processes. First, we add a univariate scaling analysis to ensure that each landscape variable is represented in the functional form that represents the optimal scale of its association with gene flow. Second, we use a 2-step form of the causal modeling approach to integrate model selection with null hypothesis testing in individual-based landscape genetic analysis. This series of causal modeling indicated that gene flow in American marten in northern Idaho was primarily related to elevation, and that alternative hypotheses involving isolation by distance, geographical barriers, effects of canopy closure,

roads, tree size class and an empirical habitat model were not supported. Gene flow in the Northern Idaho American marten population is therefore driven by a gradient of landscape resistance that is a function of elevation, with minimum resistance to gene flow at 1500 m.

Developing and testing a landscape-scale habitat suitability model for fisher (*Martes pennanti*) in forests of interior northern California

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Abstract – The fisher (*Martes pennanti*) is warranted for protection under the Endangered Species Act in the western United States and, as such, it is especially important that conservation and management actions are based on sound scientific information. We developed a landscape-scale suitability model for interior northern California to predict the probability of detecting fishers and to identify areas of important fisher habitat. Previous models have been extrapolated to this region, but our model was developed from the results of strategically planned detection surveys within the study area. We used generalized additive modeling to create a model that best distinguished detection (n = 55) from non-detection (n = 90) locations on the basis of environmental covariates. Four models were averaged to create a final model including the following variables: Amount of Dense Forest, Percent Hardwood, Medium & Large Trees, Structurally Complex Forest, Adjusted Elevation, Insolation Index, and Predicted Abundance of Mammalian Prey. This model was well calibrated and correctly classified fisher detections 83.6% of the time and absences (non-detections) 70.0%. Independent test data were classified less well; 76.2% and 53.0%, respectively, perhaps a result of differences in the spatial and temporal

characteristics of the data used to build versus test the model. The model is the first comprehensive portrayal of the distribution and configuration of habitat suitability in this region and provides managers a tool to monitor habitat change over time and to plan vegetation treatments. It also represents an example for the development of similar models for dispersal-limited mammals with large area needs, as well as other species associated with late-successional forests in northern California.

Understanding seasonal variation in detection of American martens on Lassen National Forest using radio-marked individuals and remotely triggered cameras

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The southern Cascades Mountains in California have a rich history of research on American martens (*Martes americana*). Habitat use patterns have been investigated using radio telemetry, landscape habitat suitability and habitat connectivity have been modeled, and seasonal variation in detection has been documented using summer and winter camera surveys. Unpublished work has demonstrated that even though martens are statistically less detectable at camera stations during the summer – most likely due to the removal of bait by black bears – this does not affect their significantly lower *occupancy* rates during the summer compared with the winter. Typically, breeding adults have strong fidelity to their home range for their lifetime and do not engage in significant seasonal changes in home range. Importantly, empirical landscape habitat suitability models created using winter survey data identify very different habitat areas compared to similar models developed using summer survey data. This has significant implications for decisions about how management activities affect the distribution and abundance of marten habitat.

Intensive monitoring of the fate of individual martens, via radio-telemetry, is necessary to understand the cause of the seasonal change in occupancy pattern. To achieve this objective, we radio-marked martens in areas where seasonal variation in detection was greatest. Capturing and collaring animals in these locations in the fall, and monitoring them until the following summer, will help determine whether individuals persist in these regions throughout the winter and into the summer (when they establish breeding home ranges), or whether they die there during winter/spring or move to other, more favorable, habitat prior to summer. We also deployed remotely triggered digital cameras, to determine the probability that marked animals that are in the vicinity of the cameras are detected by them. This will help establish whether the probability of detecting animals *whose locations are known* varies with season. Collecting radio-locations of resting and active animals, by season, may also help determine whether animals demonstrate significant changes in their use of space seasonally.

Results from this research will help determine how seasonal survey data can best be used to create an empirical habitat suitability model for this region. For example, do we use *all locations*, regardless of season of detection, to build these models, or do we focus on *detections collected during the summer* when the sample does not include the places where less-discriminating dispersers may be detected? Our primary objective is to understand the detectability and fate (survival) of American martens that appear to occupy some regions on the Lassen National Forest primarily during the winter. Secondarily, we will estimate the probability of detecting animals that are known, by virtue of being radio-marked, to occupy a camera survey grid during the period of its operation.

EASTERN NORTH AMERICA

Population ecology of American marten: impact of wind Farm development in high-elevation spruce-fir habitat in New Hampshire

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American martens (*Martes americana*) in the northeastern United States are commercially trapped under protective regulations in Maine and New York. In contrast, American marten remain scarce or even absent in suitable habitat in Vermont and New Hampshire, thereby warranting state listing as Endangered and Threatened, respectively. American marten populations tend toward instability and are affected by many factors, including incidental trapping mortality, human disturbance (Harrison *et al*. 2004). Because the American marten is a winter habitat specialist (Dumyahn *et al*. 2007), climate change is predicted to have measurable detrimental impact on the regional population (Carroll 2006). Marten are at their distributional edge in northern New England, and are presumed to be highly susceptible to habitat alteration and fragmentation of forested environments (Gibilisco 1994, Kelly 2005).

New Hampshire currently uses a combination of methods to monitor American marten distribution, including documented incidental capture by trappers, limited winter track surveys, and random public observations/reports. Unfortunately, this information does not allow for the accurate assessment of population density and habitat use that is necessary to adequately identify management issues and needs, formulate comprehensive management objectives, or identify potential threats. The New Hampshire Wildlife Action Plan (WAP 2005) identified 5 major threats to American marten: (1) unsustainable forestry operations and management; (2) development, especially associated with communication and wind infrastructure; (3) scarcity; (4) climate change; and (5) unregulated/incidental take, which is increasing.

The WAP (2005) identifies the American marten as a species of greatest conservation need that is highly dependent upon high-elevation spruce (*Picea spp.)* -fir (*Abies balsamea*) forest. In addition to being listed as Threatened in New Hampshire, American marten are of particular interest because of their potential as an "umbrella species." Martens should reflect the relative health of their habitat, and provide indirect evidence about the status of species with similar habitat use, specifically high-elevation spruce-fir. Species of high conservation concern that exclusively use or are highly dependent on high-elevation spruce-fir include Bicknell's thrush (*Catharus bicknelli*), spruce grouse (*Falcipennis canadensis*), and bay-breasted warblers (*Dendroica castanea*). Other notable species that use this habitat include blackpoll warblers (*Dendroica striata*), boreal chickadees (*Poecile hudsonicus*), white-winged crossbills (*Loxia leucoptera*), and three-toed woodpeckers (*Picoides dorsalis*) (WAP 2005).

Arguably, high-elevation marten populations act as source populations in New Hampshire and other mountainous regions in the northeast (i.e., Adirondack Mountains in New York). Impacts to source populations in critical high-elevation habitats would influence population stability and expansion, and reduce the ability of American marten populations to respond to the combined threats of incidental catch, forest disturbance, increased development, and climate change.

In mountainous regions of the northeastern United States, high-elevation (750 – 1000 m) spruce-fir forest will presumably be impacted most by wind farm development (WAP 2005). This habitat is characterized by a short growing season, harsh weather, shallow soil conditions, and frequent natural disturbance (e.g., blow downs and fir waves), and is very susceptible to atmospheric deposition (e.g., acid rain, mercury) and the effects of climate change. Despite the increasing demand and growing number of wind farms built and proposed in this habitat type in the northeast, no studies have documented their potential impact on American marten, which are protected in New Hampshire and Vermont, and projected to decline long term in New York and Maine.

This study will evaluate impacts on American marten associated with the proposed Granite Reliable Power Windpark (GRP Windpark; 33 turbines) to be built along approximately 19 km of a high-elevation spruce-fir ridgeline in northern New Hampshire. Importantly, American marten tracks were the most abundant found on survey transects during the site evaluation. Further, this study will provide valuable ecological data concerning population density, home range, and habitat use that is lacking in this critical and restricted habitat. Such information is required to address regional concerns and will complement current research in the Adirondack Mountains in New York (Jensen and Tabor 2006).

Our first field objective is to collect specific population metric data needed to manage and predict American marten population response in New Hampshire. These data are necessary to generate population estimates, develop a cost-effective method to index abundance and distribution, and compare/structure data collection and management strategies in other northeastern states.

Our second objective is to measure seasonal home range, movement, and habitat use of American marten in high-elevation spruce-fir habitat. This will allow for a detailed, quantitative examination of the importance of high-elevation spruce-fir habitats to American marten, and identification of related potential impacts/threats. More specifically, these data will help examine the potential impacts of the GRP Windpark on the distribution, density, and productivity of American marten, and be applicable to similar and related regional situations/habitat.

Proposed Methods – To achieve these objectives, we will live-trap up to 20 American marten within the study area; each will be marked with implantable passive-integrated transponder (PIT) and ear tags (York and Fuller 1997), and a VHF radio-collar. Hair samples will be collected from each in anticipation of future opportunities to conduct genetic analyses for a population density estimate. The PIT tags and radio-collar will be used to identify individual marten recaptured either in live traps or by remote cameras, or incidentally trapped. Population density and sex-age composition will be estimated from recapture rates in live traps and by using remote cameras at bait/scent stations. Radio-marked/ear-tagged animals will serve as marked individuals in capture-recapture analyses.

Location of marked marten will occur on a regular basis, with traditional ground telemetry when possible, as well as continuously with remote receiver units placed strategically within high-elevation spruce-fir habitat along the study ridgeline. The location data will be used to measure seasonal home range and habitat use, and to indicate use of high-elevation spruce-fir habitat. More specifically, these data will help evaluate the potential impacts of the GRP wind farm development in northern New Hampshire on the distribution, density, and productivity of American marten.

This part of the study will also help to assess the suitability of New Hampshire's landscape to sustain a viable American marten population. Specific landscape features to be used in this analysis will include elevation, snow depth, and forest characteristics; additional parameters will likely be added. In this assessment, habitat composition and characteristics can be varied in order to examine a range of potential impacts on habitat use, movement, and productivity of martens. Data for each feature will be examined at the finest resolution possible. This habitat assessment should help predict potential population densities relative to habitat characteristics.

Ideally, pre- and post-development telemetry data would provide the most useful comparisons to identify direct impacts of the GRP development. It is anticipated that individual marten will be monitored seasonally for 2 continuous years: 1 year each pre- and post-tower construction.

Current Status – Open traps (15) with remote cameras were baited in mid-September 2010, and all traps were visited by marten within 1 week. Marten continue to visit traps after weekly baiting (Fig. 1). It is anticipated that trapping and tagging will commence in mid-October 2010.

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Figure 1. American marten visiting a baited "open" trap in high-elevation spruce-fir forest in New Hampshire.

American martens and fishers in North Dakota: home on the prairie?

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Overview—American martens (*Martes americana*) and fishers (*Martes pennanti*) historically are reported to have occurred in forested portions of northeastern North Dakota (Bailey 1926, Adams 1961). These populations were eliminated because of overtrapping (Bailey 1926, Adams 1961), probably in combination with land clearing for agricultural development. Bailey (1926) noted that both martens and fishers were regularly trapped in forested regions in northeastern North Dakota in the early-1800s, but no longer appeared in harvest records after that period.

During the last 10 years (reports started accumulating in 1999 for fishers and 2004 for martens) there have been anecdotal reports of martens and substantiated reports of fishers (i.e., roadkills and accidental catches by fur trappers) in portions of north-central and eastern North Dakota. During the summers of 2007-2009 we conducted covered track plate and remote camera surveys to determine the presence of these species in the Turtle Mountains (2007) in north-central North Dakota and the Red River of the North drainage in eastern North Dakota (2008 and 2009).

Study region— The landscape in our study region is dominated by agricultural fields and pastures and is largely non-forested (>80%). The Turtle Mountains is a 1,680-km^2 plateau located in north-central North Dakota and southwestern Manitoba (NDGF 2006). The Turtle Mountains portion of North Dakota covers about 106,000 ha of rolling topography interspersed with hundreds of small lakes and wetlands (Henderson et al. 2002, Hagen et al. 2005). In contrast to the surrounding landscape, most of the Turtle Mountains region is forested—aspen (*Populus tremuloides*), bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), and paper birch (*Betula papyrifera*) are common tree species in the region (Stewart 1975, Bluemle 2002, and Hagen et al. 2005).

Portions of eastern North Dakota encompassing the Red River of the North drainage historically consisted of mainly tallgrass prairie, most of which has now been replaced with agricultural fields and other development (Renard *et al*. 1986, Hagen *et al*. 2005). Forested areas are limited to deciduous, semi-contiguous, fragmented patches, mostly occurring within riparian areas (with the exception of the Pembina Hills; Renard *et al*. 1986, Albert 1995, Hagen *et al*. 2005). Common tree species occurring in the riparian forests of eastern

North Dakota are green ash, American elm (*Ulmus americana*), eastern cottonwood (*Populus deltoides*), and willow (*Salix* spp.) (Bailey 1926, Renard *et al*. 1986, Hagen *et al*. 2005, Sovada and Seabloom 2005).

Approach—We surveyed the 2 study regions using a combination of covered track plates (Zielinski and Kucera 1995) and remote cameras (Cuddeback ® NoFlash, Expert, and Excite; Non Typical, Inc., Greenbay, WI and DLC ® Covert II Assassin; DLC Trading Co, Llc., Lewisburg, KY). At each station we used beaver (*Castor canadensis*) meat and lures comprised of beaver castor and skunk (*Mephitis mephitis*) essence as attractants; survey sites were monitored for 6-14 days.

American martens— We detected martens exclusively in the Turtle Mountains. Detections occurred at 31 of 180 (~17%) sampling locations and were distributed throughout the Turtle Mountains study area wherever forests were relatively contiguous (Figs. 1 and 2). Martens were not detected in small, isolated forested patches on the periphery of the Turtle Mountain region. The sampling effort provided no evidence of this population existing to the east in forested areas within the Red River of the North drainage. This population appears to be the result of 59 martens released by the Canadian Wildlife Service to the Canadian (Manitoba) portion of the Turtle Mountains during 1989 and 1990 (G. Armstrong, Manitoba Trappers Association, personal communication; D. Berezanski, Provincial Furbearer Manager for Manitoba Conservation, Canadian Wildlife Service, personal communication). Although the historic occurrence of martens in northeastern North Dakota seems relatively well established (Bailey 1926), we hesitate to call this release of marten into the Turtle Mountains a reintroduction, given the paucity of information substantiating their original distribution as including north-central North Dakota or south-central Manitoba. Regardless of historic representation, from our assessment a marten population appears relatively well established in the Turtle Mountain region of North Dakota.

Fishers—We detected fishers frequently and throughout a large portion of the Red River of the North drainage (115 of 307 [~37%] sites sampled during 2008-2009; Fig. 3), but not in the Turtle Mountains. Individuals representing the current population in North Dakota likely dispersed from Minnesota, which has had an expanding fisher population, as inferred from trapping records and verified sightings (Berg and Kuehn 1994; Erb 2005, 2010; Sovada and Seabloom 2005). The highest concentration of detections occurred in the northeast portion of North Dakota, and detections decreased as we surveyed southward (Fig. 3). Fishers did not limit their habitat use to large, contiguous riparian patches. In fact, fishers frequently were detected in small, lightly forested patches (100 [~87%] of the detections sites were in patches <50 ha), including forested portions of pastures (Fig. 4). The distribution of fishers along riparian forests in North Dakota necessitated travel across open areas such as agricultural fields, and on several occasions we photographed them moving through areas with no overhead cover (Fig. 5).

Concluding thoughts: Overall, the populations of martens and fishers seem well established in North Dakota, but they are isolated from one another. The fisher population is distributed much more widely than the marten population. Habitat conditions where marten were detected were not in our opinion unusual for the species, but suitable conditions quickly degrade at the margins of the Turtle Mountains region. We were surprised by the widespread distribution of fishers and their frequent occupation of small, isolated patches of deciduous forest. Occupation of small, isolated patches would have necessitated fishers to travel through non-forested areas in the landscape to achieve their current distribution. In contrast, martens were not detected in small, isolated patches beyond the periphery of the Turtle Mountains. Consequently, we suspect fishers are more likely to expand into the Turtle Mountains, and martens are less likely to expand into the Red River of the North drainage.

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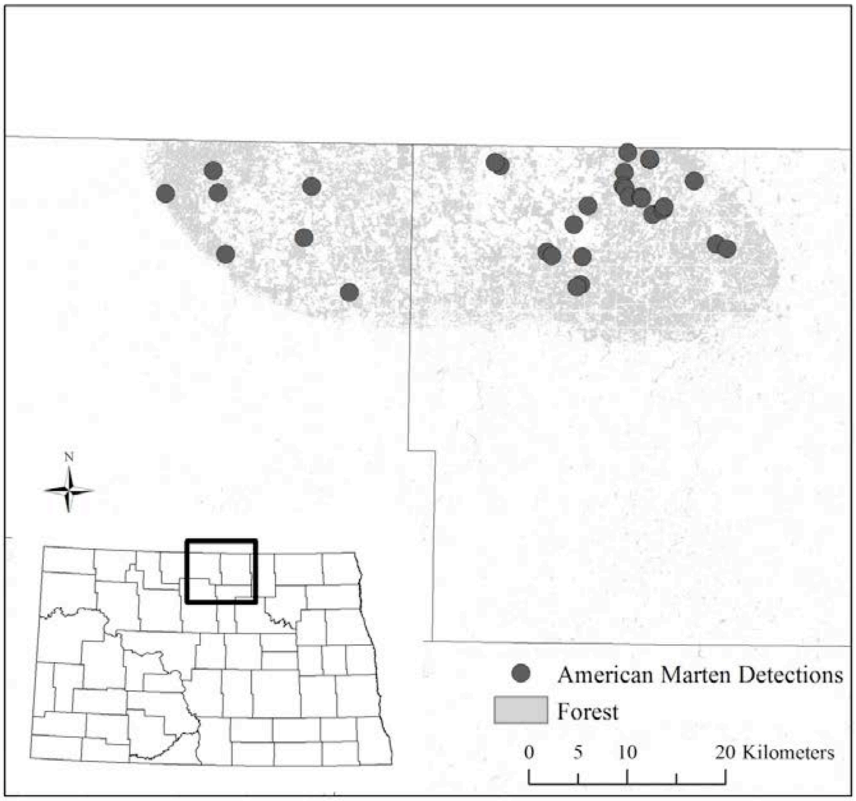

Figure 1. Location of American marten detections in the Turtle Mountains region of North Dakota, summer 2007.

Figure 2. American marten at a covered track-plate in Turtle Mountains region of North Dakota, summer 2007.

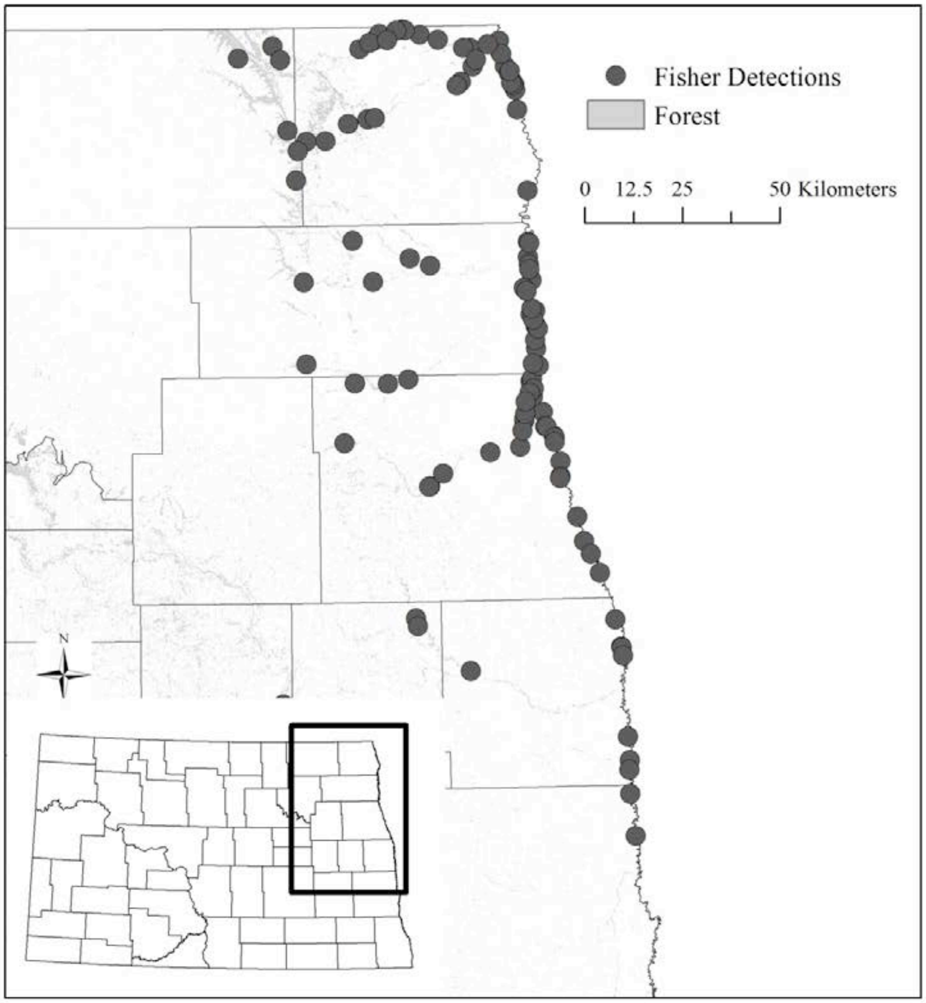

Figure 3. Distribution of fisher detections in eastern North Dakota, summers 2008-2009.

Figure 4. Fisher at a covered track-plate in a cattle pasture, northeastern North Dakota, summer 2008.

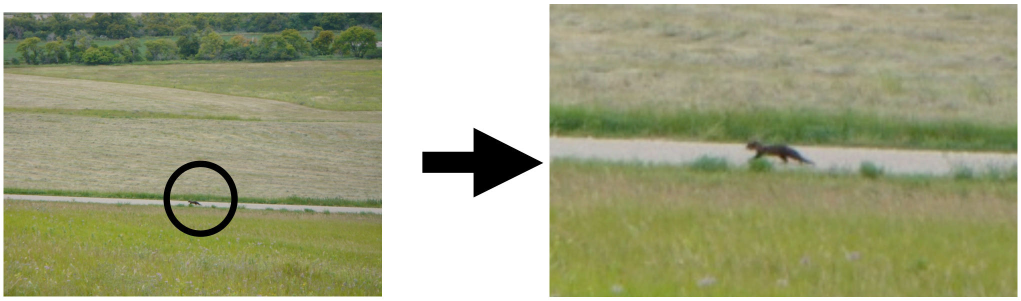

Figure 5. Fisher travelling through a non-forested area in southeastern North Dakota, summer 2009.

EUROPE

Estimation of European pine marten (*Martes martes*) population density in 2 contrasted landscapes

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In France, the European pine marten (*Martes martes*) is considered to be a pest species, and as such, may be trapped around houses and game farms. This status has been justified by the pine martens' occasional feeding on game species. However, as a carnivore having large space needs, we can expect that pine marten densities are typically low. Unfortunately, reliable data and knowledge about the state of pine marten populations are not available for management decisions. In order to clarify the state of this species in France, we have started a study on population density.

Because of their strong preference for forest habitat types, the persistence of pine marten populations may be threatened in fragmented forest landscapes, and habitat availability, rather than food availability, could be a limiting factor for pine marten populations (Graham and Graham 1994, Brainerd *et al.* 1995). Although we have demonstrated that pine martens can live in a fragmented landscape all year round, their home ranges are smaller in fragmented landscapes than in continuous forests (Mergey *et al.*, in press). Furthermore, we still lack information about the viability and dynamics of pine marten populations living in fragmented landscapes. Because density estimation could yield insight into this topic, we chose to compare population densities in a fragmented habitat and in a continuous forest.

The European pine marten's small size, elusive nature, and largely nocturnal habits make this species hard to observe. Few studies have attempted to measure densities of pine marten populations. The lack of direct observations represents a substantial deficiency. In addition, few of the indices that are typically used to establish presence are appropriate. In France, snow cover does not persist long enough to allow snow-tracking methods. Moreover, monitoring pine marten populations by counting scats along transects could be problematic, for instance because of misidentification of scat species or the heterogeneity of scat capture probabilities among different habitat types (Messenger and Birks, 2000). Therefore, mark-recapture methods that use genetic non-invasive material appear to be the best available for studying this elusive species (Miller *et al*. 2005). The mark-recapture method ensures more reliable density estimation by resampling the different habitats, and the genetic analysis of the scats avoids species misidentification. Our method requires 3 steps: sample collection, identification of genetic profiles, and density estimation based on statistics models.

Our sampling method consists of a systematic search for scats on 2 64-km^2 study sites: a large continuous forest (about 70,000 ha), and a hedged farmland where forested habitats (groves and hedges) are scattered across the landscape. This hedged farmland constitutes 12% of the study area. Each study site is divided into 16 4-km^2 squares. Each square is surveyed by walking along 2-km transects. Sampling sessions are repeated on both sites once per season.

The genetic profile of "captured" individuals is identified by DNA extraction from scats and amplification of 11 cross-species microsatellites and 1 sex molecular marker. Amplifications were repeated between 2 and 4 times to prevent genetic profiles being misinterpreted because of allelic dropout or false alleles.

Finally, the presence and absence of marked individuals during each session are used in mark-recapture models. Briefly, the selected model estimates the number of individuals present on the sampling area by analyzing the "capturability" of the marked individuals and the evolution of the proportion of marked and unmarked individuals during the successive passages.

We have completed 2 sampling sessions (March and June 2010). A total of 464 feces were collected in the 2 landscapes, with more feces collected in the fragmented habitat (216 vs. 54 in March, and 137 vs. 57 in June). The March session has been analyzed, but with disappointing results. Of 360 samples, 137 (about 38%) were successfully amplified for 5 to 12 microsatellites, while 154 gave no trace of marten DNA at all. Samples from the fragmented landscape yielded better results than those from the forest, with 40% versus 20% success. The September 2010 session has been used to improve and optimize our process, with respect to both the sampling step and the extraction/amplification step (conservation time of the feces, multiplex amplifications, etc.).

The March 2010 session revealed the presence of 39 distinct individual profiles in the fragmented landscape. For an area of 64 km^2, we estimated a population density of 6.1 individuals per 10 km^2. The data from scats collected in the forest yielded results that were too weak to be analyzed. This first estimation has to be strengthened by the mark-recapture method, but it is very similar to previous estimations made in other study areas. For example, Zalewski and Jedrzejewski (2006) estimated a density of 5.4 (3.6-7.6) individuals per 10 km^2 during the cold season in Poland.

Two other techniques will be developed to validate the genetic mark-recapture method: pine marten trapping and territory mapping (Fuller et al. 2001). Such data are available thanks to preceding studies conducted in the same study site. Comparing these results and density estimation in the 2 landscapes should allow us to identify the most reliable and the least expensive (time- and budget-consuming) method. Finally, the mark-recapture method could also be used to estimate mortality rate and space sharing.

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Stone marten (*Martes foina*) studies in central Spain

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Completed Research – My colleagues and I have completed a wide variety of investigations into stone marten (*Martes foina*) ecology and conservation. These studies are enumerated in the reference list below.

With respect to stone marten habitat selection, we have investigated the effects of habitat fragmentation on stone marten occurrence in wood patches, the importance of riparian woodlands to stone martens as a function of landscape composition, the importance of fruiting trees in the local distribution and abundance of the stone martens, and the effect of non-selective predator control on the regional occurrence of stone martens. We have also created sign-based landscape-scale habitat models for stone martens in central Spain. In addition, we have tested the different methods used to survey stone martens at the regional scale.

We have also investigated the stone marten's role in ecological communities. For example, we have evaluated the relative importance of stone marten compared to other mammals and birds in the seed-shadow pattern for a relict tree, the Spanish juniper (*Juniperus thurifera*). We have also examined habitat segregation between genets (*Genetta genetta*) and stone martens at local scale, and diet competition between genets and stone martens in Mediterranean ecosystems.

Research in Progress – We are continuing to examine many facets of stone marten ecology, including the effect of urbanization progress on the occurrence of stone martens at the regional scale, the regional distribution and abundance of stone martens as mediated by an intraguild predator, the eagle owl (*Bubo bubo*), and the importance of stone marten in the seed dispersal and regeneration process of juniper woodlands at different landscape scenarios. We are also currently comparing the effectiveness of sign surveys and camera-trapping for presence-only studies.

Future Research – Future explorations will expand on previous work, including a camera-trapping study of competition between genets and stone martens, an investigation of predation risk and habitat selection in areas with different densities of intraguild predators, and further study of seed dispersal effectiveness for several shrub species (beyond the Spanish juniper).

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Morphology and taxonomic status of the Cis-Ural sables

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Researchers have described up to 32 subspecies/varieties of the sable (*Martes zibellina*) (e.g., Ognev 1925, Kuznetsov 1941, Timofeev and Nadeev 1955, Anderson 1970, Heptner *et al*. 1967, Aristov and Baryshnikov 2001, Wozencraft 2005), resulting in an unduly complicated taxonomic structure for this species. We have recently obtained new data on the morphological properties of the Ural populations of the sable (craniometry, fur coloration, and phenetics). This information has enabled us to compare the morphological characteristics and verify the taxonomic status of these sable populations.

Materials and Methods – We studied 8 sable populations in the Urals. For comparison, we used several population groups of sable from Western Siberia and Altai. The geographical location of the studied samples is shown in Fig. 1.

To represent overall animal size, we used the condylobasal skull length (CBL) measured in adults older than 1 year of age. Skull sizes of 2688 sables (1441 males) were examined. We studied samples from the museum collections of the Moscow State University (Moscow), the Institute of Hunting and Fur Farming (Kirov, Novosibirsk, Krasnoyarsk, and St. Petersburg), Kazan State University (Kazan), Zoological Institute of Russian Academy of Sciences (St. Petersburg), and the Institute of Plant and Animal Ecology of the Ural Division of the Russian Academy of Sciences (Yekaterinburg). As an additional differential characteristic, we used the cranial epigenetic trait FFCI (foramen in fossa condyloidei inferior; Monakhov 2001, 2010) for 4377 sables (including 2344 males).

Because sable fur color has great practical importance, it is used here as a diagnostic criterion (see also Timofeev and Nadeev 1955, Heptner *et al*. 1967, G. Monakhov 1976, Pavlinov and Rossolimo 1979). Data for fur coloration are taken from official documents reporting the conclusions of fur merchandise experts from fur-harvesting companies (Vologda, Sarapul, Omsk, Novosibirsk, and Irkutsk). Here, we use the portion (percentage) of animals with bright-colored fur in a local population of sable as our coloration indicator. Sable fur coloration was analyzed for total of 415,455 pelts.

Descriptive statistics and cluster analyses were applied to the data. The distribution of sample sizes is provided in Table 1.

Results and Discussion – The distribution of the studied traits of sable in the specific area is polyclinal: cranial size increases from east to west; pelt color becomes darker from west to east, and the frequency of the FFCI phene increases from west to east (Table 2) (Monakhov 2006, 2010). The region discussed in this paper covers the western part of the species' range and is inhabited by mostly large, light-fur sable, although in some areas there are smaller forms with dark fur, mainly of reintroduction origin. Aboriginal Ural sables are characterized by a low expression of the FFCI phene (Table 1).

From Linnaean times, only 1 sable subspecies has been identified (the nominal Tobolsk sable *M.z. zibellina* L.) for the Urals and Trans-Ural. However, we conducted an analysis of morphological variability, taking into account the districts from Pechora to the Middle and Lower Ob River basin corresponding to the natural range of this subspecies. According to previously published data, in these territories only the Tobolsk sable subspecies *M.z. zibellina* has occurred. For a more complete picture, we have to compare the population groupings representing the neighboring subspecies' western part of the specific range (Table 3).

Analysis of morphological characteristics shows that 3 dimensional forms are represented in the studied territory, and they were classified in 3 different clusters, respectively (Tables 2, 4, and 5; Fig. 2). The largest in the western area are sables of south-western Altai and medium-sized sables from Kazym. These sables also have low frequencies of the FFCI trait and dark-colored skin (Fig. 2, cluster B).

All of the Ural proper samples were classified into the cluster C (Tables 4 and 5; Fig. 2). This cluster comprises large-sized sables with light fur. In addition to the Ural populations, this cluster also includes Kuznetsk Alatau, NE Altai, and two Yenisei groupings from Yartsevo and Chulym with light fur, the average expression of FFCI trait, and middle-sized skull. These sables dwell in another region and cannot be attributed to the Tobolsk subspecies of sable.

Cluster A is composed of small-sized, dark-furred, and high-frequency-FFCI-trait sable groupings of the Yenisei River basin (Podkamennaya Tunguska, Abakan, Sym-Elogui) and the Ob River basin populations of Vakh and Narym; moreover the last 3 are of Baikal-Region origin (Tables 4 and 5; Fig. 2). They, like the Kazym sable, occupy territory within the boundaries of the Tobolsk nominal subspecies and are markedly different from it in the studied morphological features. In our opinion, we follow Pavlinov and Rossolimo (1979) in that these groupings could be singled out into particular subspecies.

The expression of phenetic trait FFCI suggests the following: In populations of the Tobolsk subspecies, the mean trait expression is 22.4 ± 2.4% (range 11.0 – 50.0%) in males and 37.3 ± 3.3% in females (range 31.1 – 45.5%). For this character, the 6 populations of the Urals proper do not stand out from the group of Tobolsk subspecies populations (29.5% / 40.2%). The NE Altai sables (21.6% / 44.6%) exhibit almost the same frequency. In contrast, Narym sable (39.6% / 59.8%) and sables of Yenisei subspecies (39.3% / 59.1%) differ from the Tobolsk, Altai, and Sayan groups for the FFCI character. The introduced population of Kazym River (35.3% / 51.9%) is similar to these. The lowest expression of this trait recorded is in south-western Altai (8.0% / 19.0%).

Returning to the purpose of this communication, we should note that the Ural sable populations (Numbers 1-6 in Table 2) have a high proportion of light-colored pelts (at least 84-94%), CBL 84-86 mm in males and 77-79 mm in females, and expression of the FFCI trait 11 – 50%. These facts suggest that all of them belong to the Tobolsk subspecies *M. z. zibellina*.

As for the revision of the nominal subspecies *M. z. zibellina* for its territory among the Ural groups, there are several populations in the Ob River basin. Among them there are reintroduced populations of Baikal immigrants placed on the right bank of the Ob River in the 1940 and 1950s (Vakh, Kazym, Narym). Animals in these groups have significant differences in all examined morphological features, which complicates the task of allocating them to particular subspecies. However, this is the subject of separate study.

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Table 1. Number of sables in examined samples.

No.	Locality (Sample designation)	Condylobasal length ♂	Condylobasal length ♀	Expression of FFCI trait ♂	Expression of FFCI trait ♀	No. of pelts examined for coloration
1	Pechora River (PECH)	20	16	36	24	331
2	Sosva River (SOS)	9	11	10	11	372
3	Lozva River (LOZ)	56	48	130	123	8957
4	Tapsui River (TAP)	52	52	100	90	19200
5	Pelym River (PEL)	38	23	60	47	18987
6	Chernaya River (CERN)	27	23	67	67	1707
7	Kazym River (KAZ)	57	70	34	47	1443
8	Demyanka River (DEM)	137	116	167	138	15025
9	Ugan River (UGA)	148	146	326	279	46097
10	Pur River (PUR)	9	6			607
11	Taz River (TAZ)	32	20	109	78	675
12	Vakh River (VAKH)	163	128	272	242	10527
13	Narym Lowland (NAR)	93	92	134	107	111394
14	NE Altai Mts (NEALT)	52	44	97	65	17221
15	SW Altai Mts (SWALT)	94	81	88	84	2471
16	Kuznetsk Alatau Mts (KUZ)	37	25	36	25	17618
17	Sym and Elogui Rivers (SYM)	78	40	155	102	12471
18	Yarcevo Vicinity (YAR)	61	60	131	185	1822
19	Podkamennaya Tunguska River (PTUN)	106	88	128	131	96514
20	Chulym River (CHUL)	59	48	104	75	9978
21	Abakan River (ABAK)	113	110	160	113	22038
	Total	1441	1247	2344	2033	415455

Table 2. Examined characters of males and females in studied sable population groups.

No.	Locality (Sample designation)	Condylobasal length mm ± SE		Expression of FFCI trait % ± SE		Share of light-colored pelts, % ± SE
		♂	♀	♂	♀	
1	Pechora River (PECH)	86.05±0.51	78.04±0.51	36.1±8.0	37.5±9.9	92.4±1.5
2	Sosva River (SOS)	84.53±0.71	77.99±0.49	50.0±15.8	45.5±1,0	88.7±1.6
3	Lozva River (LOZ)	85.70±0.18	78.56±0.15	27.7±3.9	40.7±4.4	92.0±0.3
4	Tapsui River (TAP)	85.98±0.24	78.85±0.23	11.0±3.1	31.1±4.9	84.5±0.3
5	Pelym River (PEL)	85.33±0.30	78.59±0.29	11.7±4.1	34.0±6.9	87.9±0.2
6	Chernaya River (CERN)	85.84±0.54	78.09±0.51	31.3±5.7	41.8±6.0	93.7±0.6
7	Kazym River (KAZ)	84.62±0.23	77.30±0.22	26.5±7.6	34.0±6.9	38.9±1.3
8	Demyanka River (DEM)	84.88±0.16	77.70±0.14	18.6±3.0	36.2±4.1	84.6±0.3
9	Ugan River (UGA)	84.45±0.17	77.56±0.16	23.0±2.3	41.6±3.0	84.3±0.2
10	Pur River (PUR)	84.42±0.49	79.21±0.56	-	-	94.9±0.9
11	Taz River (TAZ)	83.14±0.33	76.10±0.31	40.4±4.7	60.3±5.5	78.0±1.6
12	Vakh River (VAKH)	82.43±0.14	75.55±0.16	36.4±2.9	55.4±3.2	47.8±0.5
13	Narym Lowland (NAR)	83.53±0.17	76.52±0.18	39.6±4.2	59.8±4.7	49.2±0.1
14	NE Altai Mts (NEALT)	82.83±0.23	75.09±0.20	21.6±4.2	44.6±6.2	85.1±0.3
15	SW Altai Mts (SWALT)	88.25±0.19	80.58±0.16	8.0±2.9	19.0±4.3	42.5±1.0
16	Kuznetsk Alatau Mts (KUZ)	84.26±0.33	76.94±0.36	36.1±8.0	41.7±9.9	82.5±0.3
17	Sym and Elogui Rivers (SYM)	83.39±0.21	76.10±0.31	41.3±4.0	52.9±4.9	46.8±0.4
18	Yarcevo Vicinity (YAR)	83.66±0.24	76.23±0.21	29.8±4.0	54.1±3.7	76.8±1.0
19	Podkamennaya Tunguska River (PTUN)	82.91±0.17	75.73±0.17	47.7±4.4	66.4±4.1	62.4±0.2
20	Chulym River (CHUL)	83.14±0.23	76.88±0.23	35.6±4.7	41.3±5.7	77.3±0.4
21	Abakan River (ABAK)	82.37±0.15	74.90±0.15	25.6±3.5	46.9±4.7	58.9±0.3

Table 3. Subspecies of sable, described for the western part of the specific range. Sources: 1 – Timofeev and Naddev 1955; 2 – Heptner *et al*. 1967; 3 – G. Monakhov 1976; 4 – Pavlinov and Rossolimo 1979; 5 - Aristov and Baryshnikov 2001; 6 - Wozencraft 2005.

Subspecies of sable *Martes zibellina*	Sources					
	1	2	3	4	5	6
M. z. zibellina Linnaeus	+	+		+	+	+
M. z. jeniseensis Ognev	+	+	-	+	+	+
M. z. averini Bashanov	+	+	-	+	+	+
M. z. altaica Jurgenson	+	+	+	+	-	+
M. z. tomensis Timofeev and Nadeev	+	+	-	+	-	+
M. z. jurgensoni Pavlinov and Rossolimo				-	-	+

Table 4. Cluster means of sable morphological characteristics.

Cluster	Condylobasal length (mm)		Expression of FFCI trait, %		Share of light-colored pelts, %
	♂	♀	♂	♀	
A	82.93	75.76	38.12	56.28	53.02
B	86.44	78.94	17.25	26.50	40.70
C	84.59	77.56	27.71	41.46	85.87

Table 5. Skull size (CBL) in the described subspecies of sable.
Sources: 1 – Timofeev and Naddev 1955; 2 – Pavlinin 1963; 3 – G. Monakhov 1976; 5 – Jurgenson 1947.

	Sources				
Subspecies of sable	1	2	3	5	Our data
M. z. zibellina	84.1/77.5	85.67/79.17	86.48/78.79	85.86/78.11 (4)	85.15/78.22
M. z. jeniseensis	83.0/77.0		82.73/75.46		82.91/75.73
M. z. averini			88.56/81.09		88.25/80.58
M. z. altaica	86.20/79.00		83.00/75.03	86.05/79.15	82.83/75.03
M. z. tomensis			83.20/76.12		83.53/76.52
M. z. jurgensoni	-	-	-	(Same as *averini*?)	-

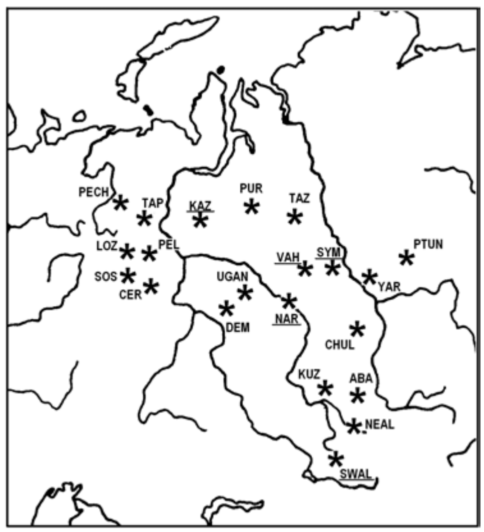

Figure 1. Geographic distribution of sable population groups. Designations are as described in Table 1. Underlined names indicate reintroduced populations.

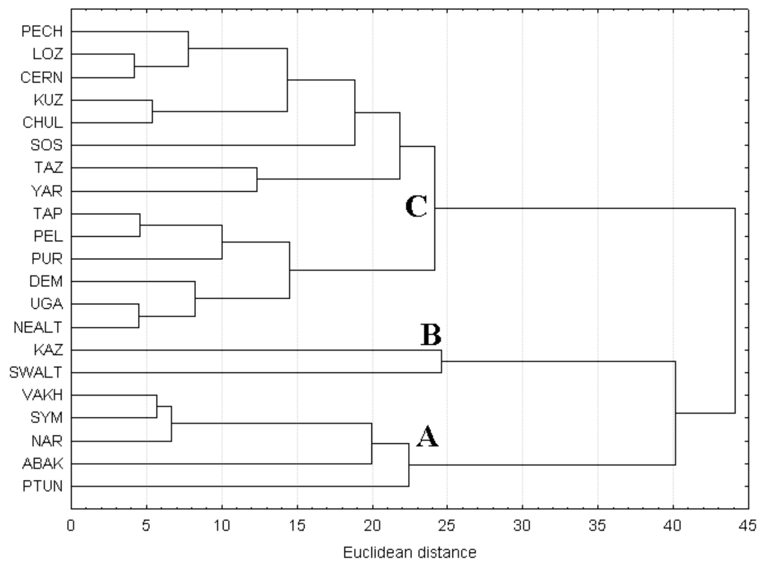

Figure 2. Classification of the studied groups of sable on the basis of a UPGMA cluster analysis.

Principles of population management of hunting *Martes* and other carnivores

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For harvested mammalian species, population stability is a desirable property. The inherent dynamics of natural populations can become a hindrance with respect to the economic aspect of the systematic development of fur species. As a consequence, hunting managers face a challenge: how to make the game industry work on a sustainable basis.

Population management tools have been proposed as a solution to this problem (Pavlov 1989, Glushkov *et al*. 1999). Watt (1971) and Shvarz (1974) have formulated basic principles of population management. The main purpose of managing exploited populations is to attain a stable or maximum (optimum) amount of game (commercial) production. This goal must be achieved without compromising the potential for population recovery.

Increasing or stabilizing population productivity can be accomplished through the creation of an optimal population structure and density. Shvarz (1974), used the term "ecological reserve" (population growth) to refer to the ability of populations to compensate for natural and hunting mortality without the destruction of the optimal structure (Pavlov 1989). Hunting quotas should correlate with an increase in population size, the estimation and prognostication of which is a necessary part of population management.

Methods for determining population growth for species of the genus *Martes* have been developed by Grakov *et al*. (1982) and Monakhov and Bakeev (1981). These methods use data on the age and sex structure of hunting samples, female fertility, and long-term data on population dynamics. In contrast, the methods of human influence (or control) on the population include changes in the intensity and direction of harvest in relation to different population groups, as well as the directional change of habitat (e.g. increasing food resources, reintroduction, and habitat conservation).

Although the approaches to population management for martens and sables were developed in 1980s and 1990s (Glushkov *et al*. 1999), further research in this direction is still relevant. Economic reforms following the termination of the state monopoly on the fur trade, and the resolution of free enterprise in the late 20th century, have led to the disintegration of the former system of fur industry and changing market relationships in this sphere. This has led to a diversification of hunting impacts on populations. In addition, many areas have undergone changes in habitat, mostly with the loss of quality as a result of logging, fires, building, mining, industrial pollution, and other factors (Monakhov and Domnich 2010).

In contrast, as a result of reduced trapping, many species have increased in number and have had a negative impact on the environment; some of these are occasionally even dangerous to humans. The press includes many examples. Sables are now commonly found in many Siberian villages. Expanding beaver populations have flooded economically important land and felled the trees onto roads. In some regions of Siberia, bears have absolutely no fear of people and enter towns and suburban cooperatives. These bears frequent landfills and roads, scaring and often attacking people. Increasingly, there are reports of increasing numbers of wolves, the impacts and damages of which are well known.

These observations suggest that additional research to develop new applications and capabilities is required. We proposed to develop new methods of game population management of carnivores, including projects that have already begun and projects that are planned for 2011-2012.

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Craniologic variability of pine martens, American martens, and sables

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The subgenus *Martes*, or true martens, shows a large morphologic similarity despite geographic isolation and varying ecological requirements. It is very difficult to distinguish pine marten (*Martes martes*), sable (*M. zibellina*) and American marten (*M. americana*) on the basis of skull characters. This peculiarity of the subgenus *Martes* offers the possibility for comparative analyses of homological cranial structures of the different species.

We studied 18 metric and 22 non-metric skull traits for 1408 sables from 18 geographic samples through the entire species area, 564 pine martens from 14 geographic samples in the European part of Russia, and 61 American marten skulls from 4 geographical samples in Canada and the USA (these from the craniological collections of the Russian Academy of Sciences Institute of Plant and Animal Ecology and Zoological Institute).

The results of a standard model of discriminant analysis suggest significant distances between the groups (${}_{min}F_{(41,\ 1966)} = 2.48$; $p<0.001$). The correct classification rate was

87.3%. Pine martens are largest in the Caucasus region; the smallest pine martens originate from the Perm region (Table 1). The largest sables were from Kamchatka; the smallest sables were from the Baykal region (Table 1). The largest American martens were from Alaska, whereas American martens from Ontario have smaller skull sizes (Table 1).

Sable, pine marten, and American marten differ from each other in the variability of craniological characteristics despite largely similar skulls. With respect to skull morphology, the American marten is intermediate between the sable and pine marten. All observed differences may be the result of specific microevolutions for 3 species of subgenus *Martes* after a hypothetical separation of their common ancestor area due to active mountain formation processes and transgressions of continents with global climate changes in the mid-Pleistocene (100,000 to 200,000 years ago).

Table 1. Largest and smallest pine martens (*M. martes*), sables (*M. zibellina*), and American martens (*M. americana*), as indicated by condylobasal skull length (CBL).

		Condylobasal skull length (CBL)	
Martes Species	Region	Males (♂) mm ± SE	Females (♀) mm ± SE
M. martes	Caucasus	85.4 ± 0.32	78.4 ± 0.32
	Perm	80.2 ± 0.73	73.2 ± 0.59
M. zibellina	Kamchatka	88.4 ± 0.27	80.1 ± 0.35
	Baykal	80.0 ± 0.21	73.7 ± 0.21
M. americana	Alaska	84.5 ± 0.70	75.7 ± 0.83
	Ontario	80.1 ± 0.89	70.1 ± 1.78

Ecology and abundance of the sable in north-west Yakutia

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The native population of the sable (*Martes zibellina*) in north-west Yakutia has been restored as a consequence of natural fecundity and protective activities during the 1930s through the 1950s. This population was studied in the 1950s (Tavrovsky 1958), but few studies have been conducted since.

We discuss an investigation of the abundance and ecological environment of the sable of north-west Yakutia that was conducted during 2003 – 2010. Our methods are typical of sable population studies (Timofeyev 1963 and others). We obtained 686 sable carcasses from hunters. The age of the sables was determined by counting annual layers in the cement of labial teeth (Clevezal 2007). The contents of stomachs and excretions were used to determine the food characteristics. Fatness was determined by the occurrence and mass of suet (Shwarz 1968). Fecundity was determined by the number of yellow bodies of pregnancy (Zaleker 1956) and by blastocytes in uterine horns (Tumanov 1988).

North-west Yakutia may have supported 26000 – 28000 sables in the 1960s (Tavrovsky 1973). Harvesting during that period removed 6200 – 8600 sables per year. The sable population had decreased to 11000 – 16000 sables by 1984-1988 (Belyk *et al*. 1990). Calculations based on data from 2003-2004 suggest that the common reserves for this species were 23000 – 25000 animal units, which is close to the level of 1960s (Safronov *et al*. 2006). Long-term sable pelt preparation data suggests that sables in north-west Yakutia exhibit 2- to 5-year cycles, and more extended 9- to 12-year waves of abundance.

The proportion of the sable population that was young averaged 69.9 ± 1.7% (range 51.9 – 85.1%) (Fig. 1). Overall, the proportion of young declined from 2003/2004 to 2009/2010 (Fig. 1).

The proportion of males in the sable population (53.2 ± 1.9%) significantly exceeded the proportion of females (46.8 ± 1.9%; $p<0.02$). Among young sables (n=480), the proportion of males (49.6 ± 2.3%) and the proportion of females (50.4 ± 2.3%) were approximately equal. However, among mature sables, the proportion of males (61.6 ± 3.4%) was significantly higher than the proportion of females (38.4 ± 3.4%; $p<0.01$). This disproportion in the senior age group of sables is due to the excessive mortality of senior females (Tumanov 2003).

Fecundity in 2004-2010 averaged 3.5 ± 0.2 yellow bodies per ovulated female (n=26). Expected fecundity was noticeably smaller – 2.8 ± 0.3 blastocytes per pregnant female. The difference between potential and expected fecundity was 20%.

The geographical situation and extreme living conditions of north-west Yakut highlights the singular importance of winter nutrition, which is largely limited to foods of animal origin. Only 20 types of winter nutriment were observed (Table 1). The occurrence of mammals in the feed of studied animals was as high as 98.8%; on average it was 92.6%. Red-backed voles (*Clethrionomys rutilus*) and meadow voles (*Microtus* spp.) were the dominant prey species. These species were observed in 72.9 – 90.3% (average 84.5%) of the stomachs and excretions examined.

Among the sables that were analyzed for fatness (n=672) in 2003 – 2010, suet was found in 28.1 ± 1.7% of the samples. An average of 25.7 ± 2.5% (range 9.4 – 53.1%) of females (n=311) possessed suet. For males (n=361), this index averaged 30.2 ± 2.4% (range 14.6 – 54.4%). Annual changes in this index related to feed provision are shown Fig. 2.

The ratable mass of suet averaged 1.04 ± 0.05 g/kg for all sables. Males (1.13 ± 0.08 g/kg; n=100) significantly exceeded females (0.91 ± 0.05 g/kg; n=68; $p<0.02$). This observation may be linked to the greater survival of males compared to females in northern taiga conditions.

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Table 1. Winter diet composition for sables of north-west Yakutia (*n* and % of occurrence). Data for 1950-1951 from Tavrovsky (1958); data from 1973 from Tavrovsky (1973).

	Diet composition: *n* (%)							
Type of food	1950-1951	1973	2003-2004	2004-2005	2005-2006	2006-2007	2007-2009	2003-2009
Northern red-backed vole (*Clethrionomys rutilus*)	41 (34.7)	94 (35.6)	207 (61.1)	12 (20.3)	16 (19.3)	7 (23.3)	3 (6.9)	245 (44.2)
Gray-sided vole (*Clethrionomys rufocanus*)	-	6 (2.2)	186 (54.9)	13 (22.0)	26 (31.3)	8 (26.7)	10 (23.2)	243 (43.9)
Root vole (*Microtus oeconomus*)	3 (2.5)	-	208 (61.4)	13 (22.0)	35 (42.2)	7 (23.3)	17 (39.5)	280 (50.5)
Meadow vole (*Microtus* spp.)	7 (5.9)	22 (8.3)	-	2 (3.4)	1 (1.2)	3 (10.0)	3 (6.9)	9 (1.6)
Wood lemming (*Myopus schisticolor*)	7 (5.9)	8 (3.0)	4 (1.2)	5 (8.5)	4 (4.8)	2 (6.7)	3 (6.9)	18 (3.2)
Murine rodents	21 (17.8)	52 (19.6)	9 (2.7)	6 (10.2)	-	2 (6.7)	6 (13.9)	23 (4.1)
Coney (*Ochotona* spp.)	12 (10.2)	20 (7.5)	1 (0.3)	1 (1.9)	14 (16.9)	8 (26.7)	6 (13.9)	30 (5.4)
Alpine hare (*Lepus timidus*)	7 (5.9)	22 (8.3)	-	1 (1.9)	-	-	-	1 (0.2)
Squirrel (*Sciurus* spp.)	2 (1.7)	14 (5.3)	1 (0.3)	-	-	-	-	1 (0.2)
Flying squirrel (*Glaucomys* spp.)	1 (0.8)	-	-	-	-	-	-	-
Chipmunk (*Tamias* spp.)	2 (1.7)	2 (0.7)	-	-	-	-	-	-
Shrewmouse (Soricidae)	3 (2.5)	6 (2.2)	-	3 (5.1)	-	2 (6.7)	2 (4.6)	7 (1.3)
Common weasel (*Mustela erminea*)	8 (6.8)	-	3 (0.9)	-	-	-	-	3 (0.5)
Least weasel (*Mustela nivalis*)	1 (0.8)	-	-	-	-	-	-	-
Muskrat (*Ondatra zibethica*)	-	-	-	1 (1.9)	-	-	-	1 (0.2)
Birds	40 (33.9)	61 (23.1)	3 (0.9)	1 (1.9)	2 (2.4)	1 (3.3)	2 (4.6)	9 (1.6)
Other animal feed	6 (5.1)	-	-	12 (20.3)	-	-	1 (2.3)	13 (2.3)
Fish (Pisces)	29 (24.6)	31 (11.7)	1 (0.3)	5 (8.5)	2 (2.4)	5 (16.7)	5 (11.6)	18 (3.2)
Insects (Insecta)	3 (2.5)	9 (3.3)	-	1 (1.9)	-	-	-	1 (0.2)
Bog whortleberry (*Vaccinium uliginosum*)	7 (5.9)	46 (17.5)	81 (23.9)	4 (6.8)	-	2 (6.7)	-	87 (15.7)
Red bilberry (*Vaccinium vitisidaea*)	1 (0.8)	1 (0.3)	-	-	1 (1.2)	-	-	1 (0.2)
Rosehip	1 (0.8)	1 (0.3)	-	-	-	-	-	-
Mushroom	2 (1.7)	21 (7.9)	-	-	-	-	-	-
Other substances	31 (26.3)	-	6 (1.8)	2 (3.4)	-	-	1 (2.3)	9 (1.6)
Total number of samples	118	264	339	59	83	30	43	554

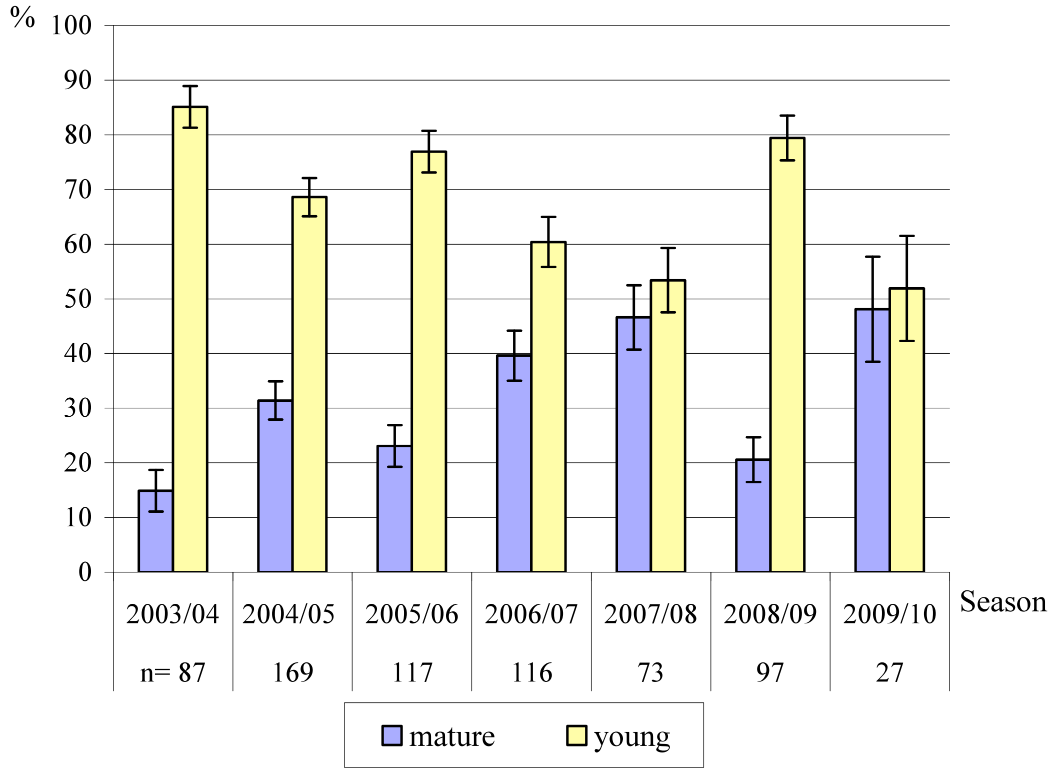

Figure 1. Changes in the ratable number of young sables (%) in populations of north-west Yakutia, from 2002 – 2010.

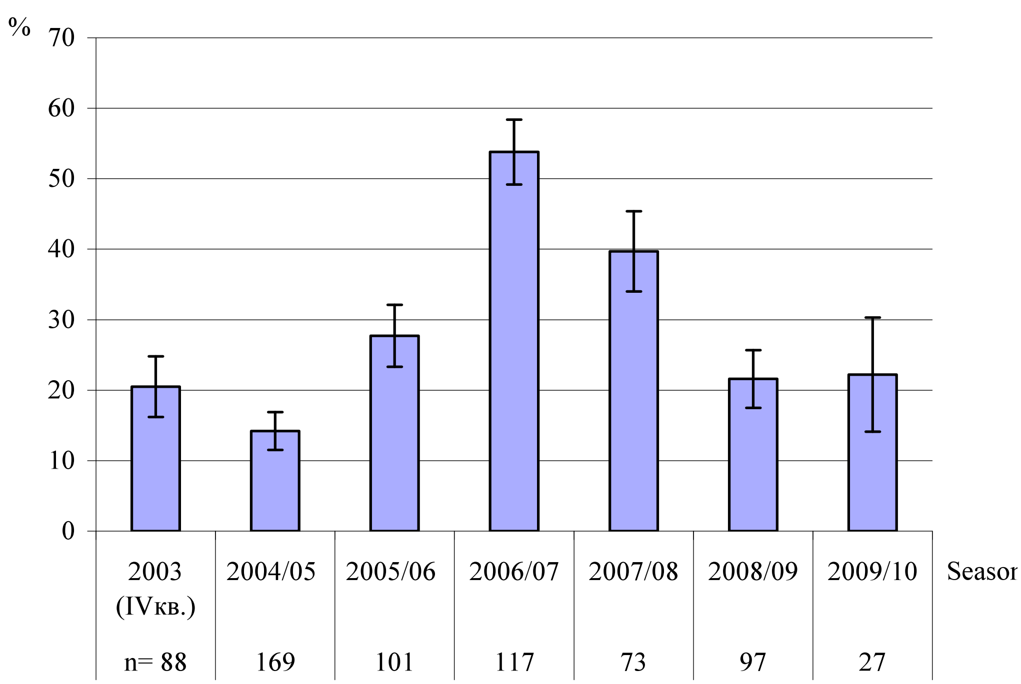

Figure 2. Changes in the ratable number of sables with suet (%) in north-west Yakutia from 2003 – 2010.

World

Biogeographical variation in the diet of Holarctic martens (genus *Martes*, Mammalia: Carnivora: Mustelidae): adaptive foraging in generalists

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The following is an abstract from a study published in the Journal of Biogeography, September 2010 (DOI: 10.1111/j.1365-2699.2010.02396.x).

Aim – Studies comparing feeding habits across a genus in different geographical regions or habitats can identify factors associated with adaptive feeding behavior, linking key ecological traits between consumers and their environment. We investigated biogeographical patterns in diet composition and trophic diversity across the genus *Martes* in relation to geographical range and environmental variables. We hypothesized that widely distributed opportunistic *Martes* species should demonstrate adaptive variations in dietary composition and trophic diversity relative to regional geographical location (e.g. latitude, elevation), environmental variation (e.g. temperature, rainfall, snow cover and primary productivity), and concomitant variation in food supply.

Location – Europe, Asia and North America.

Methods – We examined the dietary habits of martens (*Martes* spp.) using original data expressed as relative frequency of occurrence, and using principal components analysis (PCA) to extract the main gradients in diet composition. These were then used as response variables in regression analyses, predicted from latitude or elevation. Multiple regression analyses were performed to assess the influence of food types and environmental variables on the trophic diversity index.

Results – A clear latitudinal gradient in diet composition was observed. Small mammals were the primary food type, but were less abundant in the diet of martens at lower latitude and elevation. Vegetable matter and insects were consumed more frequently in southerly and/or lower-elevation localities. Trophic diversity was lower at higher elevation, and increased with a decline in consumption of the dominant food types, i.e. rodents, fruits, and insects. Trophic diversity also increased with increasing mean temperature.

Main conclusions – Biogeographical variations in feeding habits across the genus *Martes* proved to be associated with latitude, local climate (especially temperature regime), and the availability of alternative potential foods. On an extensive geographic scale, martens respond to varying food availability by adjusting their foraging strategy and thus should be considered facultative generalists. At the species level, however, different climatic variables emerged as differentially important, indicative of adaptations to local conditions. *Martes* species are opportunistic and flexible feeders, and thus their conservation requires informed management, mindful of how changes in environmental conditions might influence their varied food supply.

HELP WANTED

Capture, handling, and tagging *Martes* species

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I have been studying martens (*Martes americana*) and fishers (*M. pennanti*) for more than 20 years, primarily through the use of radio telemetry. I have had several hundred captures over that time and have monitored several dozen animals using telemetry, sometimes for many years (the longest one was followed for 5 years). During these years I have been aware of the potential negative consequences of capture and placing radio collars on wild animals and have tried to conduct my research in a manner to minimize these negative consequences.

I have had several experiences in my career dealing with capture and collar trauma. I radio-collared a female marten who pursued a deer mouse into a hollow tree. The collar was snagged on a piece of wood inside the tree and the marten died there. This was the first experience I had with a study animal dying because of my actions. It was not a nice feeling. I felt as if I had killed this animal in the course of a research project intended to help preserve the species. A few years later I captured a fisher as part of my PhD study. She was agitated in the trap and I probably should have just let her go. But instead I put her down with my standard dosage of ketamine and xylazine. Ten minutes later her breathing became very shallow and her heartbeat slowed Then, after about 20 minutes, her heart stopped and she died, I presume from capture myopathy. This, again, was very upsetting; another dead study animal directly due to my actions. Again, about 7 years ago, out team captured, collared and released a female marten. The next day she was found dead in a rock crevice with her collar lodged in the rocks. Again, an animal died due to our actions. The death of these 3 animals has stayed with me for all these years, and they remind me that our actions as researchers can have significant effects on the animals we study.

Recently Nick McCann, Pat Zollner, and I published the results of an adult marten survival analysis that was undertaken using the results of 15 years of marten monitoring based on telemetry. Our results show that adult survival was estimated at 81%, a figure that compares favorably with other survivorship estimates. It did not appear as if radio collars were having a significant impact on adult marten survival.

As I look back on my work with *Martes* species, and the role that radio-telemetry has played in that work, I feel that what has been learned (home range, habitat selection, survival, field metabolic rate, etc.) was worth the risks of capture and marking. After all, I have captured many animals and only 1 has died during capture or handling. I have collared and followed several dozen animals and only 3 have died as a direct result of the collar being caught or hung-up.

Martens are classified as an Endangered species in Wisconsin, with 2 small populations, of about 220 individuals in one population and less than 100 martens in the other. During my work with the smaller of these 2 populations I have documented a very low proportion of juveniles (< 1 year old) in my capture sample. On average about 10% of the animals that I capture each year for study are juvenile martens. This compares with 40 – 60% juveniles in many other samples (both harvest and research samples) throughout marten range. The lack of juveniles in this population is a problem that may be leading to a lack of recruitment and a very slow or non-existent population growth rate.

In addition to the apparent lack of recruitment to the populations documented through research trapping, I have searched for maternal dens every year that we have had radio-collared adult females. As any of you who have searched for den sites knows, this is no easy endeavor. Female martens are very secretive and cunning when it comes to selecting their den sites. It is common for me to track a female to a den location (say within 50 m) but to be unable to locate the exact spot of the den site. On average I have been successful in locating about 30% of the den sites I have attempted to locate. There may well have been other dens that I missed, but 30% is what I have found. It may be that I am not very good at finding these dens when they exist. But it may also be that the majority of adult females do not have young or maternal den sites.

During our deliberations about the status of martens in Wisconsin this lack of recruitment was discussed. Several possible hypotheses were put forward in an attempt to explain this low percentage of juveniles in the capture population or the low number of maternal dens located. The initial hypothesis was that low juvenile survivorship was reducing the number of young alive, and thus limiting the number of juveniles available for capture in the fall. However, during the course of our discussions a few other hypotheses were advanced, including the possibility that fecundity was negatively affected by capture and/or collaring.

Most radio collars used to study martens weigh between 30 – 40 g. Most female martens in Wisconsin weigh between 500 – 800 g, and males weigh between 900 – 1300 g. This puts the collar weight at between 2% and 8% of the body weight. I know from some of my energetics research that martens balance their body fat reserves on a near daily basis and do not store much energy in fat deposits. Thus, they are very sensitive to changes in energy demands or availability. Could an 8% increase in body mass be enough to prevent a female marten from carrying her young to successful parturition? Could this increased energetic demand be sufficient to produce the reduction in juvenile martens to such an extent that only 10% of the fall captures are juveniles, or that only 30% of the females have young each year?

A second hypothesis that has been proposed centers on disruption of hormonal systems by immobilizing drugs. There is some evidence that ketamine hydrochloride, administered in the winter prior to implantation, will produce hormonal imbalances that may lead to the early end of embryonic diapause, resulting in early implantation of the blastocysts and early parturition during winter instead of spring. Could the repeated capture and immobilization of female martens lead to a lack of reproduction that produces the observed consequences of reduced juvenile captures or reduced number of denning females (see Mills and Copland 1982, and Clark and Doughton 1983)?

I initially dismissed both of these hypotheses as unfounded speculation for *Martes* species. I had never seen any of these concerns discussed in published literature, except for some of the general cautions about capture and handling in books dealing with telemetry, and never any mention of hormonal disruptions. Yet, I thought it possible that others – like me – had not considered seriously that their research methods may in fact be affecting the outcome of their studies. Since most of you *Martes* researchers have thought about these things, would you be willing to share those thoughts?

After the 5th *Martes* Symposium I was asked to contribute to a paper reviewing demographics and population modeling of fishers and martens co-authored by Steve Buskirk and Jeff Bowman. We compared demographics between the 2 species in areas where they are trapped versus areas where they are not trapped. We were able to locate survivorship results for both trapped and untrapped populations, and we were able to locate measures of fecundity from trapped populations (mostly from counts of corpora lutea). However, we were only able to locate *a single study* with any data published on reproductive data from an untrapped marten population. This lack of published data made me reconsider my initial dismissal of this concern. Was this simply a coincidence, or was it possible that the effect of research methods on reproduction in *Martes* species could be a more pervasive problem?

Now my proposal: I understand that other authors of the 5th *Martes* Symposium book have collected the contact information for most people who have used radio telemetry to study *Martes* species. I am sure that many, if not most, of these research scientists have thoughts about the issue of negative consequences of capture, handling, and marking *Martes* species. Perhaps some of them have unpublished data on reproduction from field studies or other observations on capture impacts. I propose to survey these *Martes* researchers and to inquire as to their impressions or unpublished results regarding survival and reproduction on telemetered *Martes*. Since many of you reading this newsletter are among these researchers, I thought that I would give you all a heads-up that such a survey will be coming your way. Also, I thought that this article would induce others of you to think about this issue, and if you do have thoughts about it, to contact me with those thoughts. My goal would be to have results ready for presentation at the next International *Martes* Symposium.

All researchers must weigh the pros and cons of capture and handling of study animals. In the final analysis the information or insights gained about the species must out-weigh the inevitable negative consequences involved with these invasive techniques. There are no hard rules on when this occurs. It is incumbent on each of us to consider these tradeoffs and to attempt to quantify those risks to better understand their effects on population dynamics.

Please look for a questionnaire from me in the near future and take the time to share your thoughts.

Thanks.

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Request for information: *Martes* immobilization pharmacology

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Over the last month I've had conversations with a half-dozen wildlife and zoo veterinarians and another half-dozen wildlife professionals, all with experience with *Martes* captures and immobilizations. The only constant is that everyone has a different suggestion regarding drug combinations or dosages.

My curiosity about improved immobilization stemmed from an email from the Oregon State University veterinarian who wondered why I was using diazepam (valium), a tranquilizer and sedative used with ketamine. I have used this drug combination on the recommendation of other researchers with many years of experience. However, I have learned that most immobilization references do not recommend diazepam for mustelids, and in general these references recommend intravenous rather than the intramuscular administration that we have been using. There are alternative sedatives/tranquilizers that are used with ketamine, such as xylazine and dexmedetomidine with their antagonist (atipamezole), as well as Telazol. Each of these combinations has various side effects and potential problems.

Although there are several journal references and texts that provide recommended dosages of anesthesia (e.g., Kreeger and Arnemo 2007, Plumb 2008, AZA 2010), these are a poor substitute for experience. If you have the time, could you please email me a brief amount of information? I am curious about (1) what drug or drug combinations you have used for *Martes* anesthesia; (2) what dosage (mg/kg) you used of each drug; (3) why you are using that combination; and (4) if you have noticed problems during capture or with recovery. I am also interested in an approximate number of captures with immobilization and the frequency of capture (i.e. once, every 8 months, etc.).

In return for this information, I will write a summary for the next *Martes* newsletter. I can also send you a summary directly if requested. Thank you for your time.

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Plumb, D. C. 2008. Plumb's veterinary drug handbook. 6th edition. Blackwell Publishing, New York, New York, USA.

RECENT *MARTES* LITERATURE

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Balestrieri A., A. Ruiz-Gonzalez, L. Remonti, B.J. Gomez-Moliner, S. Genovese, L. Gola, and C. Prigioni. 2008. A non-invasive genetic survey of the pine marten (*Martes martes*) in the western River Po plain (Italy): preliminary results. Hystrix 19(1): 77-81.

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