Selecting Candidate Areas for Fisher (*Martes pennanti*) Conservation that Minimize Potential Effects on Martens (*M. americana*)

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Introduction

The literature is replete with references to the potential for negative competitive interactions between the congeneric fisher (*Martes pennanti*) and American marten (*M. americana*), usually with martens suffering from the interaction (e.g., Krohn et al. 1995, Krohn et al. 1997). The disadvantage held by martens in interference competition, however, is mitigated by snow depth which is a handicap to fisher movements (Krohn et al. 2004). Areas selected for fisher conservation action (e.g., habitat evaluation, potential reintroduction) should be chosen to maximize the probability of establishing a viable fisher population while at the same time minimizing the potential impact on martens. Although marten populations appear relatively secure in the Sierra Nevada, recent survey evidence suggests that they may be more poorly distributed in the southern Cascades/northern Sierra Nevada than they were in the early 1900s (Zielinski 2004, Zielinski et al. 2005a) and martens may be more vulnerable in this region. We identified candidate conservation areas for fishers by developing a method that considered, for each map unit (grid cell), its value as fisher habitat and as marten habitat. Those areas that had the highest fisher habitat value, but relatively low marten habitat value were considered optimal locations to consider for further assessment. Those units that had high fisher value, but were near locations with high marten value were considered less ideal. We discuss below the 2 models (the fisher and marten models) used as input to the assessment, and then describe how they were integrated to identify 2 general locations that best reconcile the goals of fisher and marten conservation in the northern Sierra Nevada.

Methods

The Fisher Model

Fishers no longer occur in the northern Sierra Nevada or the southern Cascades of California so the option of developing an empirical habitat model using the results of surveys (as done by Carroll et al. [1999] for northwestern California) was not possible. Furthermore, the Carroll et al. model included location-specific predictor variables (e.g., UTM coordinates) that would make it difficult to apply to new areas. Therefore, a new model was created (Seo et al., in prep.) using the results of systematic surveys that occurred in northwestern California, but using vegetation and topographic predictor variables that were thought to be generalizable to other areas in California. Using artificial neural network modeling (Manel et al. 1999), Seo et al. generated a predictive habitat suitability surface that was extended into the southern Cascades and northern Sierra Nevada, as far south as Calaveras Country (Fig. 1); a region we refer to as the study area. The final fisher habitat model is still in development, but we used a near-final version to generate a map of predicted fisher habitat suitability for this project. If the final selected model yields significantly different predictions, the current exercise can be easily updated using the new model.

The Marten Model

A regional model of marten habitat was developed using the California Wildlife-Habitat Relationships (CWHR) system (Mayer and Laudenslayer 1988), field survey results, and a digital vegetation dataset and focused on what we viewed as the most critical component: reproductive habitat. Only the CWHR forest types, size classes, and canopy closure classes representing high reproductive habitat suitability were included in this analysis (i.e., vegetation classes defined by CWHR as low (value = 1) and moderate (value =2) reproductive suitability were excluded). The majority of the vegetation types used in the model were consistent with the marten reproductive model from the CWHR system, however, the model was modified based on field experience and results from extensive systematic surveys conducted by USDA Forest Service, Pacific Southwest Research Station (1999 – 2002). Modifications included dropping Douglas-fir and

Montane Hardwood Conifer vegetation types as reproductive habitat and the adding the White fir type with size classes 4 and 5 and canopy closure classes M and D.

The CWHR habitat types were selected from the California Department of Forestry's (CDF) Fire and Resource Assessment Program (FRAP) land cover data (FRAP 2002). The Multi-source Land Cover Data, hereafter referred to as the FRAP vegetation data, is the most current and detailed vegetation data set available across multiple land ownerships for the southern Cascades and northern Sierra Nevada. The FRAP vegetation data were compiled from a variety of sources that include remotely sensed satellite imagery (e.g., Landsat Thematic Mapper) and field inventories of fine scale vegetation attributes. Accuracy assessment is conducted jointly by the USDA Forest Service Region 5 Remote Sensing Lab and CDF-FRAP. The accuracy assessment for categorical attributes was estimated at 88% for forest type (conifers), 82% for stand size class, and 78% for canopy closure. (http://www.fs.fed.us/r5/rsl/projects/mapping/accuracy.shtml). All vegetation types selected were combined into a single coverage representing high suitability habitat for marten reproduction. This vector coverage was then rasterized to a grid with a cell size of 100 meters, the original size of the FRAP vegetation grid.

Integrating the Fisher and Marten Models

The objective of this exercise was to use predicted habitat value for each species to select areas that had high predicted value for fishers and also the lowest predicted value for martens. Because individual map units (100 m) are too small to provide a biologically-relevant understanding of habitat value for these species, we assessed suitability for a much larger area centered on each map unit. Locations in the study area could then be identified that had the highest total value by subtracting the fisher value surrounding a unit from the marten value surrounding that same unit. This evaluation was conducted in Arc/Info using a moving 'window' function which calculated the total number of map units classified as habitat within a specified radius around each unit in the study area. First, however, it was necessary to report habitat condition for each species in a similar fashion. This was required because the original map units in the fisher model had a scaled numerical value for predicted habitat, whereas each map unit in the modified CWHR marten model was classified categorically as either habitat or non-habitat. To achieve a common denominator for both species we reclassified the fisher map so that predicted values $\geq$75 and $<$75 were classified as 'habitat' and 'non-habitat', respectively. The final step prior to analysis was to reconcile and standardize the map unit sizes for each species. The 1000-meter grid cells used in the fisher model were resampled to 100-meter grid cells to match the cell size of the marten habitat grid. The final result for each species was a grid map with 100-meter map units and with each unit assigned a value as either habitat or non-habitat.

The *focalsum* function in Arc/Info was used to calculate the total number of habitat units within a 22600-meter-radius (approximately 1600 km^2) circular window centered on each map unit in the study area. This resulted in a number assigned to each map unit that ranged from 0, if there were no habitat units in the window, to 160,552 if all units in the window surrounding it were classified as habitat. The final step was to combine the grids from each species to identify areas that had the highest fisher value that were also centered on areas that had the lowest marten value. The areas of potential fisher conservation value were created in Arc/Info Grid using map algebra by subtracting the marten focalsum grid from the fisher focalsum grid. The final grid had values ranging from -44771 to 62128, with the higher numbers indicating higher candidate fisher conservation value. A predicted candidate area map was generated by assigning to each range of predicted values a different color, from red (lowest candidate suitability) to green (highest candidate suitability).

Results and Discussion

The fisher and marten predicted suitability maps agreed well with the distribution of surveys where each species was detected (the black circles in Fig. 1, Fig. 2; from Zielinski et al. 2005a). This was encouraging because the survey data in the study area was either not directly involved in generating the habitat map (i.e., marten) or only contributed a small portion of the data used to develop the model (i.e., fisher). The highest predicted suitability for fishers was distributed in 3 general locations: northwestern Shasta County, central Plumas County, and central Placer and Nevada Counties. The highest predicted suitability for martens occurred at much higher elevations and had a focal area in southeastern Siskiyou County, one at the junction of

Lassen/Shasta/Tehama/Plumas Counties, and then a long, somewhat continuous area of high predicted suitability from southcentral Plumas County south to Alpine County. When these 2 species habitat maps were integrated to identify candidate fisher conservation areas, the selected locations resembled the highest fisher suitability areas (Fig. 3) and 2 locations were highlighted: a central Plumas County site and a site in central Placer/Nevada County. The primary difference between the fisher-only map and the candidate conservation area map is that the highest value candidate area in Placer County was centered more easterly than in the fisher-only map.

We view the areas selected in Figure 3 as *candidate* fisher conservation areas, in that they should be subjected to additional evaluation as to their on-the-ground suitability, and the implications of ownership to potential conservation activities. The current exercise was designed to identify general areas for consideration, not to identify specific areas for management action. Additional evaluations should include further examination of habitat value using aerial photo interpretation, field visits, and the application of other relevant habitat modeling tools (Zielinski et al. 2004, Zielinski et al. 2005b). Regional marten habitat connectivity should also be considered in selecting fisher conservation areas. For example, if the Plumas County candidate site is used as a fisher reintroduction location it would appear to be more disruptive to the goal of martens maintaining north-south continuity between the Sierra Nevada and the Cascades. We also suggest that the boundaries of each area be refined by considering the implication of ownership; of both the candidate area and the area surrounding it. Finally, although the models selected areas that should minimize the effect of applying fisher conservation goals on martens, new on-the-ground surveys for martens should be considered. The marten data used here to evaluate the model were collected at a resolution that may be too coarse to be assured that there are no small marten populations in the vicinity of selected candidate fisher conservation areas.

Although the areas identified in this exercise may be considered candidate locations for future reintroductions of fishers into the northern Sierra Nevada, the identification of these areas are just as important for planning for the restoration of habitat connectivity for fishers in the Sierra Nevada. This benefit can be achieved even in the absence of planning for reintroduction.

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Literature Cited

Carroll, C., W. J. Zielinski, and R. F. Noss. 1999. Using presence-absence data to build and test spatial habitat models for the fisher in the Klamath Region, U.S.A. Conservation Biology 13:1344–1359.

FRAP 2002, Multi-source Land Cover Data (v02_1). California Department of Forestry and Fire Protection. 8/19/2002. (http://frap.cdf.ca.gov/data/frapgisdata/select.asp).

Krohn W. B., K. D. Elowe, and R. B. Boone. 1995. Relations among fishers, snow and martens: development and evaluation of two hypotheses. The Forestry Chronicle 71:97-105.

Krohn, W. B., W. J. Zielinski, and R. B. Boone. 1997. Relations among fishers, snow and martens in California: results from small-scale spatial comparisons. Pages 211-232 in G. Proulx, et al., editors. *Martes*: Taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Krohn, W. B., C. Hoving, D. Harrison, D. Phillips, and H. Frost. 2004. *Martes* foot-loading and snowfall patterns in eastern North America: implications to broad-scale distributions and interactions of mesocarnivores. Pages 113-131 in D. Harrison et al. editors. Martens and fishers (*Martes*) in Human-Altered Environments: An International Perspective. Springer, New York, New York.

Manel, S., J. Dias, S. J. Ormerod. 1999. Comparing discriminant analysis, neural networks and logistic regression for predicting species distributions: a case study with a Himalayan river bird. Ecological Modeling 120:337-347.

Mayer, K. E., and W. F. Laudenslayer. 1988. A guide to wildlife habitats of California. California Department of Forestry and Fire, Sacramento, California, USA.

Seo, C., W. J. Zielinski, and F. Davis. In prep. Landscape habitat suitability of fishers (*Martes pennanti*) in California.

Zielinski, W. J. 2004. The status and conservation of mesocarnivores in the Sierra Nevada. Pages 185 – 194 in: D. Murphy and P. Stine, editors, Proceedings of the Sierra Nevada Science Symposium: Science for Management and Conservation.

USDA Forest Service, GTR PSW-GTR-193, Pacific Southwest Research Station, Albany, California USA.

Zielinski, W. J., R. L. Truex, G. Schmidt, R. Schlexer and R. H. Barrett. 2004. Resting habitat selection by fishers in California. Journal of Wildlife Management 68:475-492.

Zielinski, W. J., R. L. Truex, F. V. Schlexer, L. A. Campbell, and C. Carroll. 2005a. Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California. Journal of Biogeography 32: in press.

Zielinski, W. J., R. L. Truex, J. R. Dunk, and T. Gaman. 2005b. Using remotely collected forest inventory data to index the regional status of fisher resting habitat suitability in the Sierra Nevada, California. Ecological Applications: in press.

Figure Legends

Figure 1. Predicted fisher habitat suitability map derived from modeling conducted by Seo et al. (in prep.). Relative predicted suitability decreases from green to red (lowest). Circles represent survey results where <u>fishers</u> were either detected (closed circles) or not (open circles) after the application of a standard survey protocol (see Zielinski et al. 2005a for survey details).

Figure 2. Predicted marten habitat suitability map derived from modified CWHR model. Relative predicted suitability decreases from green to red (lowest). Circles represent survey results where <u>martens</u> were either detected (closed circles) or not (open circles) after the application of a standard survey protocol (see Zielinski et al. 2005a for survey details).

Figure 3. Candidate fisher conservation area map, created by subtracting predicted marten habitat suitability values from predicted fisher habitat suitability values (see text for details). Circles represent survey results where <u>martens</u> were either detected (closed circles) or not (open circles) after the application of a standard survey protocol (see Zielinski et al. 2005a for survey details).