American Marten

The American marten (*Martes americana*) is currently designated as a sensitive species for the Pacific Southwest Region of the Forest Service and is of concern due to historic trapping, loss of habitat, and subsequent declines in both population and distribution (USDA 2004). Local concern over marten was elevated when the research paper Historical and contemporary distributions of carnivores in forests of the Sierra Nevada, California, USA (Zielinski et al 2005) concluded from the data and predictive models that there appeared to be a gap in marten distribution ranging from the area south of Lassen Volcanic National Park (LVNP) to near the Plumas and Tahoe National Forest boundary. In collaboration with PSW Redwood Science Lab, Conservation Biology Institute and Oregon State University, several marten monitoring and habitat modeling efforts were initiated in 2006 and are planned to continue through 2012.

Seasonality of Detection

**Project Lead: Bill Zielinski, PSW Redwood Science Lab, Arcata, CA**

Previous work demonstrated that marten are detected, and occupy areas of Lassen National Forest (LNF), at different rates depending on season. Because different areas are occupied at different times of the year, it is vital to understand the basis for this variation before creating a single, recommended habitat model. The primary objective of this work is to understand the detectability and fate (survival) of martens that appear to occupy some regions on the LNF primarily during the winter. A secondary objective is to 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. Marten were trapped in the fall and winter of 2009/2010, specifically during the dispersal season, radio-collars were attached to 12 animals (10 males: 2 females). All captures were within two sample areas where previous data had been obtained on seasonal detection rates at camera-detection grids (i.e., Humboldt Peak and Swain Mountain). Six of the 10 animals (60%) that could be aged were estimated to be either young of the year or one-year old. By the time monitoring had concluded on the original 12 animals (23 September 2010), 6 were known to be alive (50%) and they had spend various amounts of time off, and back on, the original camera survey grids. Though the data are still being analyzed most of the radio-marked animals were detected at one or more camera stations during the winter season. A final report will be submitted to the HFQLG monitoring team in 2011 which addresses seasonal variation in summer and winter probabilities of detection, fate over the course of the year, and evidence as to year-round occupancy or temporary residence by dispersed young animals.

Predicting Habitat Suitability

**Project Leads: Heather Rustigian-Romsos and Wayne Spencer, Conservation Biology Institute, Corvallis, OR**

The objective of this project was to generate a habitat suitability model for marten on LNF to assist with project site planning. This effort differs from previous efforts on LNF (Kirk and Zielinski, 2009) in its scale and grain, source data for derivation of forest-related variables, and development of separate seasonal models of habitat suitability.
**Summer Model** - A highest ranking marten occurrence model was developed using summer-only survey data (Figure 1). Predicted probability of marten occurrence in summer tends to increase with increased elevation, decreased distance to perennial water sources, precipitation, decreased patch extent, and increased amounts of land cover in structurally complex, red fir and lodgepole pine forests and increased area of plantations. The inclusion of PLANTATION as a positive predictor of marten probability of occurrence in 4 of the top 6 summer models was unexpected. These areas are largely classed as Sierran mixed conifer, Eastside pine, Ponderosa pine, and Jeffrey pine, with diameter at breast heights of 6-11 inches, and canopy closures of 25-39%. These plantations were pre-1992 and go back as far as 1932, but most were planted between 1981 to 1991 and 1961 to 1970. The weighted average of six best summer-only models predicts high probability of marten occurrence within Lassen Volcanic National Park and east of the park in the Caribou Wilderness and adjacent areas of Lassen National Forest. In addition, a small swath of high probability occurs in the southern portion of the forest in the vicinity of Butt Mountain. One small high-probability patch occurs in the Thousand Lakes Wilderness in the northwest portion of LNF.

**Winter Model** – A highest ranking marten occurrence model was developed using winter-only survey data (Figure 1). According to this model, predicted probability of marten occurrence in winter tends to increase with increased elevation, increased stream density, precipitation, and increased amounts of land cover in structurally complex, red fir and lodgepole pine forests. The weighted average best ten winter-only models predicts a similar distribution of marten occupancy as the averaged summer models, but with significantly more area predicted to have high probability of occupancy. Nearly four times as much suitable habitat is predicted for winter than for summer, using 50% probability of occupancy to define suitable habitat. Predicted suitable winter habitat covers 90,280 ha, of which 61% (55,551 ha) is within the LNF administrative boundary. Predicted suitable summer habitat covers only 25,709 ha of the study area, of which 40% (10,420 ha) is within the LNF administrative boundary.

Suitable habitat predicted by the averaged summer model is constrained to smaller patches at somewhat higher elevations than the averaged winter model. Mean elevation for suitable habitat predicted by the summer-only model is 2,257m (7,403ft), compared to 2,074m (6,714ft) for the winter-only model. The 232 patches of suitable habitat predicted by the summer-only model have an average area of 111ha (274ac), while the winter-only model predicts 92 patches of suitable habitat with an average area of 981ha (2,423ac). The dominant cover type for both summer and winter models is red fir, comprising 46% of predicted suitable summer-only habitat and 36% of predicted suitable winter-only habitat. Differences in vegetation between the summer and winter models appear to reflect elevation differences. These results appear to support the hypotheses of Kirk and Zielinski (2009) that summer habitat may be more limiting to martens, and that during winter, martens may (1) shift or expand their home ranges down slope into a broader range of habitat conditions, or (2) that these winter expansions represent dispersing individuals that were unable to establish a home range in higher elevation habitats that are occupied year-round by resident animals.

**CBI Recommended Use of these Models** - No habitat or occupancy model provides a perfect representation of the areas important to supporting a species. Models and the maps they delineate should be used as decision-support tools in combination with additional information, including detailed field evaluations of habitat quality and connectivity. Biologists experienced with marten
habitat evaluations should be consulted on projects within, adjacent to, or between suitable or occupied marten habitat. Moreover, all maps presented in the CBI report were static depictions based on existing data. The distribution of suitable and occupied marten habitat in the study area is dynamic and will change in response to disturbances (e.g., fires, vegetation management), forest succession, and population processes. Models should be periodically rerun as conditions change and additional marten occupancy data become available.

- Evaluate projects relative to both summer and winter season maps to best understand their potential impacts to marten habitat. They are also useful for understanding the seasonal patterns in marten occupancy.

- Summer habitat is likely the most limiting to the marten population, not only because it is less extensive than habitats occupied during winter, but also because it supports adults during the breeding season. It may be important for projects to be particularly careful not to adversely affect habitat quality in these areas.

- The expanded area of occupancy during winter, which includes more lower-elevation habitats, is also likely important to sustaining the marten population. However, these lower-elevation forests are more likely to be used by dispersing juveniles during winter as they search for suitable areas to settle.

- Forest management actions intended to sustain or enhance marten populations should strive to maintain and increase the size, structural diversity, and density of forest cover in lodgepole pine, red fir, and other conifer types in and adjacent to currently suitable marten habitat.

- Efforts should be made to sustain and increase habitat value in forest stands lying between currently suitable marten habitat. The intent should be to maintain better connectivity between occupied habitat areas so that martens can disperse between them to maintain an interconnected metapopulation, rather than small isolated populations that are more prone to extirpation.

- The large area of suitable and occupied marten habitat centered on Mount Lassen should be better connected to the smaller occupied polygons elsewhere in the study area via habitat that is suitable, at least during winter, for marten occupancy or dispersal.

**Habitat Connectivity Modeling**

**Project Leads: Tom Kirk and Bill Zielinski, PSW Redwood Science Lab, Arcata, CA**

Broad-scale habitat connectivity is critical to population viability for species with specialized habitat preferences and limited dispersal abilities, such as the American marten. Maintaining sufficient connectivity for successful movements between populations is essential because martens are particularly vulnerable to habitat loss and fragmentation. We used Geographic Information Systems (GIS) to map “Least-cost Corridors” using habitat preference data, which represents the most effective movement pathways available for martens (Kirk and Zielinski, in prep). Specifically, we modeled functional habitat connectivity, which measures the relative ability to traverse heterogeneous landscapes by assigning “resistance values” based on the use or avoidance of different vegetation types.
Modeling results show that primary dispersal corridors cross through the HFQLG pilot project area (Figure 2). Our regional-scale modeling includes all known marten populations on the Lassen, Plumas, and Tahoe National Forests, highlighting the region’s importance for north-to-south movements. Modeling habitat connectivity with GIS represents a substantial improvement over previous efforts which ignored the functional aspects of likely dispersal pathways and modeled habitat connections without regard to the locations of existing marten populations or specific habitat reserves. Fine-scale modeling of specific treatments/prescriptions on habitat connectivity and use of landscape genetic techniques to assess gene-flow between populations (to validate corridor use) are recommended.

This work uses GIS as a habitat connectivity modeling tool; however, because fine-scale, empirical information on vegetation types used by dispersing martens is currently unavailable and remains a research priority, we relied primarily on vegetation structure to assign resistance values and used an existing expert opinion model, the California Wildlife Habitat Relationships (CWHR) system, after being modified to include regional knowledge of marten habitat associations. Least-cost corridor modeling is easy to update with the latest spatial data and when new information from research on marten movement ecology becomes available it can be readily incorporated.

**Marten Movement Ecology**

**Project Leads: Katie Moriarty and Clint Epps, Oregon State University, Corvallis**

PhD student Katie Moriarty and adviser Clint Epps are conducting a field study titled *Habitat use and movement behavior of American martens (Martes americana) in response to forest management practices on the Lassen National Forest*. This is a cooperative research project funded by the Forest Service with assistance from PSW Redwood Sciences Lab, Oregon State University, California Department of Fish and Game, and many hard-working technicians and volunteers.

Moriarty and Epps have begun evaluating movement patterns of adult martens on LNF to assess how they move within and between forest patch types that vary in structural diversity. The intent is to gain new insights on the effects of habitat fragmentation and potential barriers to marten movement on managed forest landscapes.

Objectives of the study 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.

Moriarty and Epps are using a variety of observational and experimental methods to address the study objectives. They are combining VHF radio telemetry, GPS collar deployments, and non-invasive techniques such as snow tracking and track plates. They are observing movement tracks using snowtracking and high-frequency GPS collar locations (1 location every 5 minutes). These GPS collars are the smallest made for mammals and this is the first study project to
effectively use the collars on martens, which will provide them with new information on marten movement and behavior. Moriarty and Epps are using food-titration experiments to assess movement while statistically isolating confounding factors such as individual motivation. Titration experiments provide a unique method of identifying an animal’s willingness to travel into contrasting habitat patch types by quantifying potential predation risk and energetic costs. They are also proposing short-distance experimental translocations (< 5-km) using a maximum of 10 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, such as marten, are generally more reluctant to enter gaps, and detour efficiency (distance across gap divided by distance around gap perimeter) predicts gap crossing abilities for many species. These conditions are similar to dispersal conditions in novel terrain.

Through this research improved prescriptions for management are anticipated with respect to size of gaps, presence of large woody material, and components of undergrowth. Forest managers will have a better understanding regarding what types of habitat patches are permeable for marten movement.

**Marten Reproductive Habitat Analysis**

**Project Leads: Tom Kirk, PSW Redwood Science Lab, Arcata, CA and Colin Dillingham, HFQLG Monitoring Team, Plumas NF, Quincy, CA**

Female martens are highly selective for reproductive habitat features such as natal and maternal den sites, which typically occur in large diameter trees. Such structural attributes are closely associated with dense, late-seral forest types, making them disproportionately important (Buskirk and Powell 1994). These forests are more critical to marten persistence than those providing only cover or foraging opportunities. In this analysis reproductive habitat was defined based on a statistically valid resource selection model (Kirk and Zielinski 2009), which includes primarily high-elevation, late-seral forests with the greatest canopy cover (Figure 3).

The CWHR system was used to identify vegetation types associated with the marten’s most important life history requirement, reproduction (green); and assessed their distribution across the HFQLG pilot project area. The distribution and amount of treatments/prescriptions were evaluated to determine which may alter mature and late-mature forest stands, while focusing on specific areas with high marten densities.

Results show that suitable reproductive habitat, although fragmented into smaller patches, is widespread across the western portion of the HFQLG project area and at higher elevations. The majority of treatments occur outside marten population centers, limiting their impact. The habitat connectivity analysis and this reproductive habitat analysis are complimentary analyses in that they point out the importance of both maintaining sufficient late seral habitat suitable for reproduction and the connections between occupied habitat patches.
Figure 1. Overlap of averaged best winter-only and summer-only models (using 50% probability of detection to portray marten habitat).
Figure 2 Least-cost corridors (green) representing likely dispersal pathways for American martens cross the HFQLG pilot project boundary (tan). Designated Wilderness areas (orange) and marten population centers (white) are depicted.
Figure 3 American marten population centers (white) and reproductive habitat (green) relative to treatments (red), Designated Wilderness areas (orange) and HFQLG pilot project boundary (tan).