

MARTEN HABITAT PREFERENCES IN THE NORTHERN SIERRA NEVADA

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Escalating harvest of remnant old-growth forests in the Pacific Northwest has precipitated concern for marten (*Martes americana*) as an old-growth dependent species (Meslow et al. 1981). Although recent studies have increased our understanding of marten habitat requirements (Koehler and Hornocker 1977, Soutiere 1979, Steventon and Major 1982), little in-depth research has been done in the Pacific states. Also, the influences of specific forest attributes on marten selection of resting and foraging sites have been insufficiently quantified. This study details marten selection of resting and foraging habitats in the northern Sierra Nevada.

STUDY AREA

Marten were studied in the 40-km² Sagehen Creek Basin in Tahoe National Forest, Nevada County, California. Elevations range from 1,880 to 2,620 m. Summers are short and dry with great diurnal temperature variations; winters are long and nocturnally cold, but with mid-day temperatures often above 0 C. Most of the 91 cm of annual precipitation falls as snow. Average winter snow pack is 112

cm at 1,950 m elevation and may be substantially deeper at higher elevations.

Xeric areas are dominated by Jeffrey pine (*Pinus jeffreyi*) and mixed Jeffrey pine-white fir (*Abies concolor*) (Jeffrey pine associations). Mixtures of lodgepole pine (*P. contorta*) and white fir (mixed conifer associations) dominate below 2,050 m elevation (lower basin). Above 2,050 m elevation (upper basin), red fir (*A. magnifica*) dominates, with admixtures of mountain hemlock (*Tsuga mertensiana*) and western white pine (*P. monticola*) (red fir associations). Moist areas, comprising about 5% of the drainage, are dominated by lodgepole pine and a dense cover of sedges, forbs, and willow shrubs (*Salix* spp.) (riparian lodgepole associations). Large brushfields resulting from wildfire cover one-third of the study area.

METHODS

We captured 14 marten (7M:7F) in Tomahawk livetraps (National Live Trap Co., Tomahawk, Wis.) and radio-collared 6 (2M:4F). Four of these (1M:3F) were located several times each week using hand-held, 2-element Yagi antennas (Telonics Inc., Mesa, Ariz.), yielding 213 observations from July 1979 through August 1980. Observations were classified as "active" or "resting" using signal variability prior to and during the location attempt (Spencer 1981). Pre-observational monitoring of activity ensured that observations in which a marten was inadvertently chased into or out of a refuge by the observer were not misclassified. The obser-

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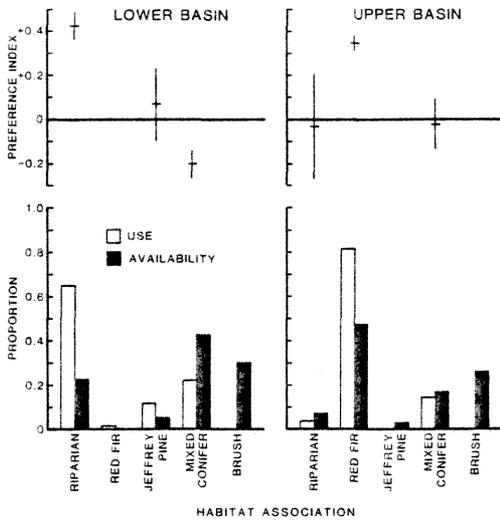


Fig. 1. Marten preferences for habitat associations in the upper and lower Sagehen Creek Basin, California. The histogram illustrates relative use and availability of habitat associations within marten home ranges; preference index is relative use minus relative availability with 95% confidence intervals (Strauss 1979).

vation point (locus) was flagged, and marten behavior, weather, and habitat were recorded.

We classified marten loci to 1 of 5 habitat associations (Jeffrey pine, mixed conifer, red fir, riparian lodgepole, or brush) for comparison with 170 control plots randomly located within marten home ranges (Spencer 1981). Relative use and availability of habitat associations were determined within each home range. The results were pooled and Strauss' (1979) Preference Index and chi-square contingency tests were used to determine marten resting and foraging habitat preferences. Because red fir is primarily found above 2,050 m elevation, preferences were assessed separately above and below this elevation.

Of the 213 marten loci, 187 (131 resting, 56 active) were considered precise enough (within 5 m) for detailed habitat analyses. During summer 1980, we mea-

sured 17 habitat variables on 0.04-ha circular plots centered on these loci and on 106 of the 170 control plots; the other 64 control plots were characterized by Raphael (1980).

Using pooled data from the 0.04-ha marten-use and control plots, we calculated discriminant functions (Klecka 1975) to indicate habitat attributes important in the selection of resting and foraging sites. Unfortunately, Raphael (1980) excluded 1 variable that we measured, the presence or absence of Douglas' squirrel (*Tamiasciurus douglasii*) feeding sign, thus precluding its use in discriminant analyses. Strauss' (1979) Preference Index was used to quantify univariate preferences for the important microhabitat attributes; chi-square, *t*, and *F* tests were used for univariate tests of significance ($P < 0.05$, unless otherwise expressed).

RESULTS

Below 2,050 m elevation, marten strongly preferred riparian lodgepole pine associations and selected against brush, mixed conifer, and Jeffrey pine associations (Fig. 1). Riparian areas were used more for activity than resting, and mixed conifers were used more for resting than activity. In the upper basin, marten strongly preferred red fir associations both for resting and activity.

A discriminant function ($r^2 = 0.33$; $P < 0.001$) and univariate preference analyses (Figs. 2, 3) indicated selection by marten for tall, dense forest stands that were near meadows and that had many large snags, stumps, and logs. Below 2,050 m elevation, rest and activity sites were discriminated by a function based on percent herbaceous cover, percent canopy closure, and distance to nearest meadow ($r^2 = 0.25$; $P < 0.001$); marten there hunted primarily beneath dense forest canopy near meadow edges, or in riparian lodgepole

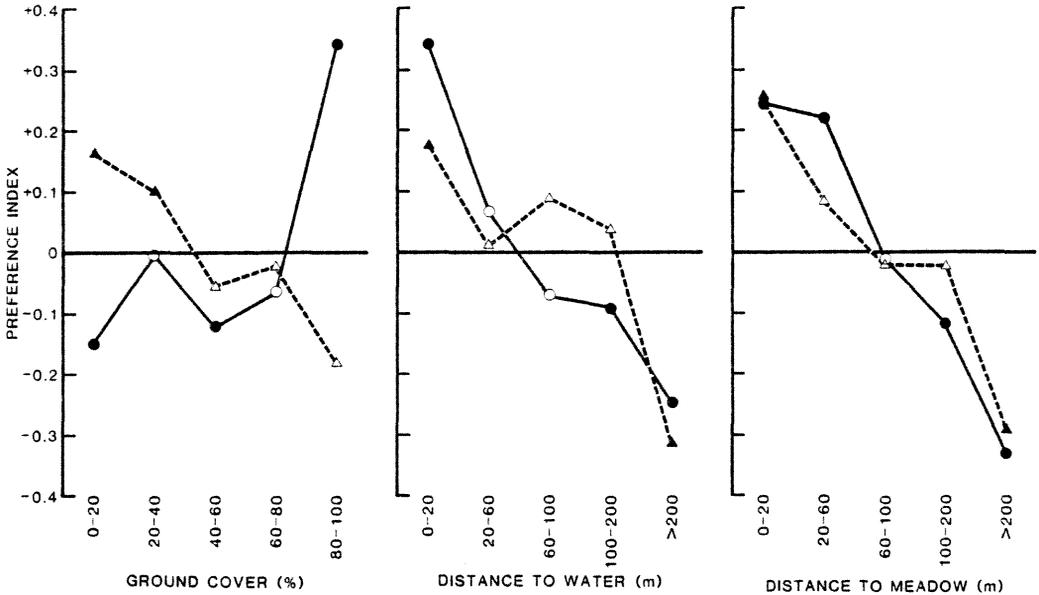


Fig. 2. Marten preferences for ground cover, distance to water, and distance to meadows in the Sagehen Creek Basin, California. Solid lines represent data from the lower basin; dashed lines represent data from the upper basin. Preference index is relative use minus relative availability (Strauss 1979); solid symbols indicate preferences different ($P < 0.10$) from zero.

forests having lush herbaceous cover. They sometimes rested in or close to foraging areas, but often moved from lodgepole stands to resting sites in older, fir-dominated stands with little ground cover. In contrast, there was no notable difference between rest and activity sites in the upper basin; both were concentrated near meadows in dense old-growth red fir stands that typically have little herbaceous cover.

Univariate preference analyses indicated a greater affinity for old-growth characteristics by marten at upper elevations; however, marten throughout the study area preferred stands with 40–60% canopy closure at both resting and foraging sites, and avoided stands with less than 30% closure (Fig. 3). Marten also preferred to be within 60 m of a meadow, especially while active, and rarely used sites more than 400 m from meadows. Fi-

nally, marten preferred activity and resting sites having Douglas' squirrel feeding sign (χ^2 , $P < 0.001$). Both squirrels and marten preferred red fir and riparian lodgepole pine associations; however, even within these habitats marten selected areas having squirrel sign.

DISCUSSION

Incidental observations of marten in California indicate that they are most abundant in old-growth fir forests (Schempf and White 1977, Verner and Boss 1980), so preference for this type was not unexpected. However, whereas marten sightings are also common in high elevation lodgepole forests (Schempf and White 1977, Hargis 1981), preference for lodgepole pine at elevations below the red fir zone was heretofore undocumented. This preference undoubtedly reflects the high prey availability in riparian lodge-

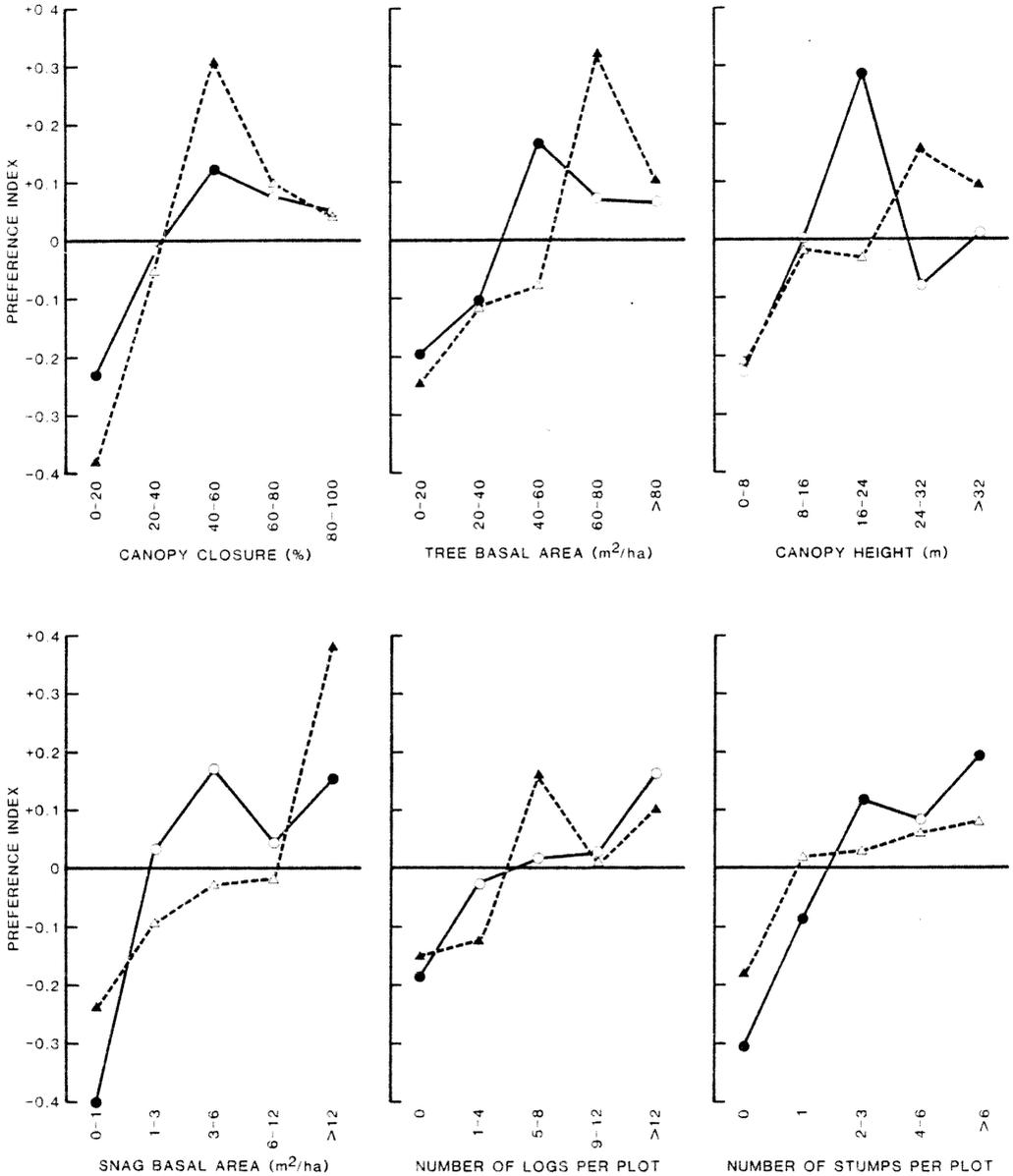


Fig. 3. Marten preferences for canopy closure, tree basal area, tree canopy height, snag basal area, log density, and stump density in the Sagehen Creek Basin, California (explanations are as given for Fig. 2).

pole associations, since *Microtus* spp., the pre-eminent year-round marten prey at Sagehen Creek (Zielinski 1981), are most abundant in lush herbaceous vegetation.

The lower Sagehen Creek Basin has been protected from livestock grazing since 1968. The heavy grazing pressure exerted on riparian areas in most Sierran forests

may explain the paucity of marten sightings in them.

Marten avoided open areas during all seasons, contrary to their reported use of openings during summer elsewhere (Dice 1921, Grinnell et al. 1937, Marshall 1951, Streeter and Braun 1968, Koehler and Hornocker 1977, Soutiere 1979). Snow-tracked marten rarely ventured more than 10 m into meadows (Spencer 1981) and radiolocations were all beneath forest canopy. Similarly, in a study 10 km northwest of Sagehen Creek, Simon (1980) found heavy use of meadow edges by marten, but not of meadow interiors. Because they offer cover as well as food, lodgepole forests with herbaceous understory are more beneficial to marten than large meadows. Riparian lodgepole forests also support prey species not found in meadows (e.g., Douglas' squirrel) and trees provide marten with subnivean access (Marshall 1951, Koehler et al. 1975, Simon 1980, Hargis 1981, Steventon and Major 1982). Finally, trees aid in prey detection by marten during summer; we witnessed marten using trees and logs as elevated hunting perches from which to spot and pounce on prey in dense vegetation.

Although marten exploit lodgepole forests for food, they apparently require nearby old-growth stands to provide dens. Marten at Sagehen Creek preferred to rest in large diameter ($\bar{x} = 102 \pm 23$ cm dbh), highly decayed fir snags, both summer and winter (Spencer 1981). Consequently, marten foraging in riparian areas often moved upslope into adjacent mixed conifer or red fir stands to rest. These stands were not always extensive, and were used by marten only if they were proximal to food-rich habitats and could be reached without crossing large openings. Thus, small, scattered pockets of old-growth fir forest may provide adequate marten habitat if supplemented by meadows or ripar-

ian habitats with forested access. However, extensive old-growth fir forests are the mainstay of marten populations in the Pacific states (Verner and Boss 1980, Mellow et al. 1981). These forests provide all marten requisites, since they have many excellent den sites (Spencer 1981) and sciurids and other favored marten prey are abundant in them (Verner and Boss 1980, Zielinski 1981).

Koehler et al. (1975) reported that, during winter, marten avoid stands with less than 30% canopy closure. They also suggested that marten avoid extremely dense stands that suppress herbaceous cover. Our findings corroborate their thesis in the lower Sagehen Basin, where herbaceous cover appeared to be the most important factor in marten foraging site selection. However, the dense red fir stands used by marten in the upper basin had little ground cover; in fact, percent herbaceous cover seems inversely correlated with marten habitat preferences there (Fig. 2). Nevertheless, marten foraging in old-growth stands concentrated their activity near meadows, perhaps due to greater abundance of snowshoe hare (*Lepus americanus*) and microtines there.

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