Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report
1 July 1998- 30 June 1999

Ecology of Martens in Southeast Alaska

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ADF&G

Grant W-27-2
Study 7.16
December 1999

STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
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DIVISION OF WILDLIFE CONSERVATION
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RESEARCH PROGRESS REPORT

STATE: Alaska **STUDY NO.:** 7.16

COOPERATORS: Merav Ben-David, University of Alaska Fairbanks

GRANT NO.: W-27-2

STUDY TITLE: Ecology of martens in Southeast Alaska

PERIOD: 1 July 1998–30 June 1999

SUMMARY

We spent most of the report period on data management and analysis. Additional information was collected on den and resting site selection, and this aspect of the project was completed and reported. Other analyses will continue and be published later. During the past year, we monitored 14 radiocollared martens (7 males and 7 females). An additional 12 martens (8 males and 4 females) were captured and eartagged. During the entire study, we captured 311 martens (197 males and 114 females) a total of 1971 times. Of the captured animals, we put radiocollars on 183 individual martens (100 males and 83 females). The radiocollared martens were relocated 3422 times from small aircraft. On the primary study areas, we have located 137 radiocollared martens (86 males and 51 females) 2978 times for habitat selection analyses.

Natal dens usually were within the boles of trees or snags, or in hard logs. Maternal dens most often were beneath the roots of trees or snags or in hard logs. In summer and winter, martens most often rested beneath the roots of trees or snags. Martens used larger diameter and less decayed structures at dens than at resting sites. Such structures were much larger in diameter than like structures in the study area, and most contained a cavity caused by decay that was used by marten. Martens exhibited little selection for habitat surrounding dens and resting sites. Based on radiotelemetry, martens showed the greatest selection for large/MS (selection ratio = 1.39) and medium/MS habitats (selection ratio = 1.30). The mean selection ratios of these 2 habitats were not significantly different from each other, but both were significantly greater than any other habitat. Intermediate/MS stands (1.11) were selected less than the larger-sized habitats, but more than small/MS (0.72), single-storied (0.81), and nonforested sites (shrub = 0.20 and sparsely vegetated = 0.30). The largest difference in selection ratios was observed in the winter season when martens selected larger-sized habitats more frequently.

The snap-trap index indicated small mammal numbers increased about 40% from fall 1997, but the increase was completely by deer mice. The catch rate of long-tailed voles decreased to zero (0.9 to 0.0) captures/100 trap nights).

Key words: Chichagof Island, demographics, forestry, habitat use, martens, *Martes americana*, modeling, old-growth forests, population biology, Southeast Alaska.

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BACKGROUND

We have studied marten ecology in Southeast Alaska for 9 years from 30 June 1990 to 30 June 1999. In this report, we present some of the more significant information collected on each of the 10 specific study jobs. These topics will be elaborated on in subsequent scientific publications. Because of the fluctuating availability of funding and personnel, the amount of data collected for specific jobs varied among the years of the study. Initially, the study focused on landscape-level habitat selection. Subsequently, we have concentrated on marten population dynamics. During the later stages, we studied microhabitat selection at den and resting sites and finished our assessment of habitats on the study area, including an evaluation of the available landcover maps and their attributes.

Several study jobs required the periodic live trapping and tagging of martens on the primary study area on northeast Chichagof Island. We monitored the tagged martens to collect information on movements, demography, and habitat use. Additional demographic information was collected from martens caught by trappers on northeast Chichagof Island and other portions of Southeast Alaska.

American martens (*Martes americana*) have been associated with late-succession and old-growth forests across North America (Buskirk and Ruggiero 1994). Martens are among the most habitat-specific mammals in North America (Buskirk and Ruggiero 1994). In western North America, they are closely tied to mesic, old-growth, coniferous forests (Marshall 1951, Koehler and Hornocker 1977, Thompson and Harestad 1994). Old-growth forests are structurally diverse with a variety of tree sizes, dense multilayered canopies, and an abundance of coarse woody debris (CWD) (i.e., snags, stumps, and downed logs) (Samson et al. 1986, Boughton et al. 1991). Many marten populations have declined with the removal of forested habitat, increased human access, and unrestricted trapping (Clark et al. 1987). In Southeast Alaska, the Tongass National Forest (TNF) encompasses 80% of the land area. Although most of the original forested land was in an old-growth condition, industrial scale logging has converted large areas of old-growth forest habitat into clearcuts and second growth. The clearcutting of old-growth forests removes the forest canopy along with all aboveground structures including decadent live trees and snags. About 162,000 ha (400,000 acres) of old-growth habitat have already been logged on the TNF, nearly all by clearcutting. The new, revised Tongass Land Management Plan (TLMP) schedules an additional 274,000 ha (676,000 acres) of old-growth forests for timber harvest (USDA Forest Service 1997).

Other studies indicate that martens select for old-growth features when choosing reproductive den sites (Ruggiero et al. 1998) and resting sites (Wilbert 1992). Marten dens are any structures occupied by a mother and young (Henry and Ruggiero 1993), and resting sites are structures that independent martens use to rest between bouts of activity (Buskirk et al. 1989). Henry and Ruggiero (1993) described 2 types of dens. Natal dens are sites where kits are born, and maternal dens are all other dens occupied by the mother and kits. Large trees and CWD provide martens with cover from predators (Vernam 1987, Lindstrom et al. 1995) and inclement weather while resting (Buskirk et al. 1989, Martin and Barrett 1991) or denning (Hauptman 1979, Wynne and Sherburne 1984, Baker 1992, Ruggiero et al. 1998). Spaces under CWD provide access to subnivean foraging areas (Corn and Raphael 1992) and resting sites (Buskirk et al. 1989, Taylor and Buskirk 1994). Adequate availability of structures for denning and resting is probably important for marten population viability.

Clearcut logging, the predominant method of tree harvesting in western North America (Franklin and Forman 1987, Vance 1990), has negatively affected marten populations in many regions (Bergerud 1969, Campbell 1979, Major 1979, Soutiere 1979, Clark et al. 1987, Snyder and Bissonette 1987, Bissonette et al. 1989, Jones and Raphael 1992, Thompson and Harestad 1994). In typical clearcuts, all standing structures, such as live trees and snags, are felled. Although an abundance of CWD may exist immediately after clearcutting, the amount and size of CWD will decline as the slash and residual CWD decay (Franklin and Waring 1980, Tritton 1980). Because all trees have been removed, new large CWD will not be recruited into the stand with a 100-year timber rotation. Generally, martens avoid areas with little overhead cover (Buskirk and Ruggiero 1994), and abundant CWD in recent clearcuts probably is of little value to them. However, martens will use residual CWD in second-growth stands (Baker 1992), but how long these structures will remain useful to martens is unknown. Highly decayed CWD probably provides less value to martens (Wilbert 1992). New logs or snags of sufficient size to accommodate marten dens or resting sites may require over 200 years to grow (Harris 1984, Franklin et al. 1981). Currently planned 100-year timber rotation times on managed forests will not permit the formation of large CWD before the next cutting (USDA Forest Service 1997).

Martens are the most sought after fur animal in Southeast Alaska with an annual harvest of 2770 animals (average between 1984 and 1996, ADF&G unpubl. data, Douglas, AK). Trappers consistently report that martens are the most important species to them (ADF&G Trapper Questionnaire Statewide Report 1997). Because forest management activities were expected to affect population abundance and because pelts represent significant economic value to local residents, martens were selected as a management indicator species (MIS) for the revision of the TLMP (Sidle and Suring 1986). Although old-growth forests were identified as a special habitat, more information was needed on the specific habitat components used by martens. The TLMP (USDA Forest Service 1997) contained standards and guidelines for managing marten habitats on Forest Service lands. These standards required the retention of forest features important to martens in timber harvest areas, particularly in areas heavily affected by timber harvest. Additional information on forest features used by martens for denning and resting were needed for evaluation of the standards.

Density of marten populations has been linked to habitat quality (Soutiere 1979), specifically the availability of late succession forest features (Campbell 1979, Thompson and Harestad 1994). Island populations are naturally more vulnerable to extirpation because they are not augmented by immigration. When isolated marten populations are subjected to habitat degradation, densities may fall to the point that inbreeding, genetic drift, and stochastic events may contribute to extirpation (Buskirk and Ruggiero 1994). Martens have already disappeared on Cape Bretton Island, Nova Scotia, and are threatened on Newfoundland (Gibilisco 1994). In western North America, martens have been extirpated from the Tobacco Root Mountains of Montana; isolated populations in northern California and the Olympic Peninsula are threatened (Buskirk and Ruggiero 1994).

OBJECTIVES

This research was designed to describe the habitat and population ecology of martens on northeast Chichagof Island.

The specific study objectives (Jobs 1–8) are listed below.

1 Determine seasonal habitat use and selection patterns of a sample of martens living in logged and unlogged landscapes at the microsite, stand, and landscape level;

2 Determine the composition of habitats within the northeast Chichagof Island study area;

3 Evaluate the interagency habitat capability model;

4 Determine the demographic characteristics of marten populations on northeast Chichagof Island;

5 Determine marten movement and spatial patterns of martens on northeast Chichagof Island;

6 Determine the relative abundance of small mammal prey within the Chichagof Island study area;

7 Determine the seasonal diets of martens on northeast Chichagof Island; and

8 Evaluate whether the skull-size criteria developed by Magoun et al. (1988) correctly classify Southeast martens by sex and age.

STUDY AREA

We chose northeast Chichagof Island for the study because its topography and habitats were typical of northern Southeast Alaska. In addition, logging roads provided good access, part of the area had been logged, camp facilities were available at a Forest Service float house, and the area was relatively close to Juneau. The primary study area comprised lands adjacent to Salt Lake Bay (58° 56' N, 135° 20' E), located about 90 km (56 miles) west of Juneau and 26 km (16 miles) south of Hoonah (Fig. 1). The Salt Lake Bay study area (125 km^2) was bounded by Port Frederick to the north, Tenakee Inlet to the south, the portage (a narrow strip of land between the large water bodies) on the west, and the Game Creek and Indian River drainages on the east and north. In 1992 we extended the study into the upper Game Creek watershed (102 km^2), located north of Salt Lake Bay. Most of the study area was under the jurisdiction of the USDA Forest Service within the Chatham Area, Tongass National Forest. Habitats in the study area were further described in Flynn (1991).

About 7% of the Salt Lake Bay study area was logged from 1984 to 1988, and 27 km of logging roads were constructed. An additional 486 ha were clearcut from 1990 to 1992 (USDA Forest Service 1989). Logging activity began in June 1990 with the construction of about 10 km of logging road in the western portion of the study area. Two units were felled before a court injunction suspended all logging activity at the end of June 1990. The court lifted the injunction during August 1991, and logging resumed September 1991. Logging activity continued until 10 December 1991, and nearly one half of the units were felled. Logging activity was suspended for the winter and resumed in April 1992. All logging activity in the Salt Lake Bay area was completed by 31 October 1992.

The upper Game Creek watershed was the last major unlogged watershed on northeast Chichagof Island. Road building in the upper Game Creek drainage began in April 1992 with the construction of 1 bridge across the North Fork and 2 bridges across Game Creek. Road building continued at a rapid pace for the remainder of the year, and most of the planned road system was completed by winter. All the low-elevation cutting units were felled during summer and fall. During spring 1993, road building continued into the upper watershed of adjacent Seagull Creek. The remaining upper-elevation units in Game Creek were felled during 1993 and 1994, and all logging activity was completed by the end of 1995.

The marten trapping season on the northeast portion of Chichagof Island was closed for the 1990–1991 regulatory year because of depleted marten populations. The trapping seasons for mink and weasels were closed at the same time to prevent incidental take. The portion of northern Chichagof Island west of Port Frederick remained open with season dates from 1 December to 15 February. For the 1991–1992 trapping season, both portions of northern Chichagof Island (east and west of Port Frederick) opened on 1 December. On the northeast Chichagof Island, a federal subsistence regulation prohibited trapping with the use of a motorized land vehicle on federal lands.

The marten trapping season was closed by emergency order on 24 January 1992 because of overharvest concerns. During the 1992–1993 season, marten trapping on northern Chichagof Island was restricted to the month of December. The prohibition of trapping with the use of a motorized land vehicle on federal lands by federal subsistence regulation was extended to cover the west side of Port Frederick. For the rest of Unit 4, the marten trapping season ran from 1 December to 15 February with no additional restrictions. During 1993–1994, marten trapping seasons remained the same as the previous year's seasons.

For 1994–1995 the Federal Subsistence Board closed the recreational and subsistence trapping seasons for martens, mink, and weasels on Chichagof Island on federal lands because of low marten numbers. The state season on nonfederal lands remained the same, a 31-day season on northeast Chichagof Island during December and a 75-day season on the remainder of Chichagof beginning December 1. For 1995–1996 the Federal Subsistence Board established a 31-day trapping season, opening on December 1, for federal lands on Chichagof Island and prohibited the use of motorized land vehicles for trapping. During 1996–97, state trapping seasons remained the same as the previous seasons. All trapping regulations for the study area remained the same for the remainder of the study.

METHODS

Several jobs required the capture and radiocollaring of a sample of martens on the study area. We live-trapped martens throughout the year at permanent trap sites located systematically along the logging road system. Trap sites were usually about 500 m apart. Traps (Models 203 and 205, Tomahawk Live Trap Co., Tomahawk, Wisconsin USA) were baited with either strawberry jam, sardines, or venison scraps, covered with a green tarp, and placed under a log or the base of a tree at trap sites. We checked the traps daily. Captured martens were pressed in the end of the trap using a folded blanket, then injected with a mixture of 18.0 mg/kg ketamine hydrochloride (Vetalar) and 1.6 mg/kg xylazine hydrochloride (Rompun) for immobilization. For short-term chemical restraint, we used a dosage of 13.0 mg/kg of ketamine and 1.0 mg/kg xylazine. All captured martens were eartagged (Size 1, Style 1005, National Band and Tag Co., Newport, Kentucky USA), sexed, weighed, and measured. Two first premolar teeth were pulled for age determination by cementum analysis (Matson's Laboratory, Milltown, Montana USA). We drew a 3.0 cc blood sample from the jugular vein from most captured animals, separated the serum, and then froze both portions for future analyses for disease, diet, and pregnancy studies. We radiocollared some of the captured martens. In the early stages, we radiocollared every captured animal. During later years of the study, we primarily radiocollared adults. On female martens, we used 2 radiocollar types; each weighed about 35 g with an expected life of 12 months (Telonics MOD-073, Telonics, Mesa, Arizona USA and Lotek SMRC-4, Lotek Engineering, Newmarket, Ontario CAN). On males, we used a 49-g collar (Telonics MOD-080, expected life of 12–18 months). After a marten had recovered from the immobilization, we released it near the capture site. Martens recaptured during the same trapping session were released without additional processing. During subsequent trapping sessions, all recaptures were chemically restrained, weighed, and measured. We replaced radiocollars during the study as necessary.

We considered radiocollared martens that showed fidelity to a home range area a resident animal. Martens that moved over an area >2 home ranges within a season and covered areas occupied by other resident martens were labeled transients. We classified martens more than 1-year-old as adults. Young of the year, or birth-year martens, were juveniles.

JOB 1. HABITAT USE

Den and Resting Sites

Using aerial and ground telemetry, we located reproductive dens and resting sites of martens. If an adult female marten was located near the same place 3 or more times during the May–June denning period, we assumed it was at a den. We located the den structure by ground-tracking the female to the site when constant strength and location of radio signals indicated the target marten was stationary. We found resting sites in a similar manner. All the dens and resting sites were flagged in the field and marked on aerial resource photos. We digitized site locations on digital orthophotos to create a GIS point coverage. Each den/resting site was buffered with a 62-m radius circle to create a polygon coverage of the area around the site. We revisited the sites after the martens had abandoned the dens or left the immediate area. We measured habitat attributes within the polygons, using the same procedures as described below for random sites. The center plot was centered on the den/resting site.

We defined dens as any location occupied by a mother and kits. Further, we defined natal dens as dens occupied by mothers with kits younger than 6–8 weeks of age and not eating solid food, and maternal dens as dens occupied by mothers with kits older than 6–8 weeks of age that did consume solid food. We determined kit development based on 1) knowledge of their date of birth, 2) finding prey remains and kit-sized scats at the den, or 3) visual inspection of the kits. Prey remains and small scats indicated that kits were eating solid food. We defined resting sites as any site occupied by an inactive, independent marten for more than 30 minutes. We judged inactivity based on the triangulated location of the marten and constant strength of the radio signal. We defined summer resting sites as those used between 16 May and 15 September and winter resting sites as those used between 15 December and 16 May. We collected no data during the fall, or 16 September–15 December.

We evaluated whether martens selected specific habitats at den and resting sites defined by the size/structure landcover map derived from Landsat TM imagery. For each site used by martens, we determined the proportion of each map stratum inside a 62-m-radius circle centered on the site. We summed the area for each stratum across all used sites, and calculated the overall percentage of each habitat used. We computed the mean percent composition and 95% CI for clearcuts and for each forested habitat.

Habitat Selection Based on Radiotelemetry

During daylight hours throughout the year, we located radiocollared martens by using small aircraft (Mech 1974, Kenward 1987). Usually we used a Piper Super Cub aircraft. After we located an animal by circling in the aircraft, we plotted the marten's location on paper copies of high-resolution orthophoto maps (1:31,680 scale). We also described the habitat at each location while in the aircraft according to USDA Forest Service definitions of timber-volume class, stand size class, old-growth forest type, and physiographic location (riparian, upland, beach fringe, estuary fringe, subalpine, or alpine). At the office, we transferred the locations to mylar overlays on color aerial photographs (1:15,840 scale) for a permanent record. The locations were digitized on onscreen using digital versions of the orthophoto maps and geographic information system (GIS) software (ArcView 3.1) on a personal computer. We found that our location accuracy averaged about 100 m, based on blind comparisons of known locations.

We received additional attribute information for each location from the GIS. We obtained values for elevation, slope, and aspect for each location by sampling grids based on a digital elevation model of the study area. All attributes of the location were entered into a computer file. Each point location was buffered by 100 m to create a 3.12-ha circular polygon centered on the marten location. We intersected the marten location polygons with the landcover map to determine the composition of habitats around each telemetry location. We determined proportionate habitat use of individual martens by summing the area of each habitat type within their relocation polygons and dividing by their total area. We used location polygons instead of the points to incorporate telemetry and mapping error into the analyses. Polygons better describe habitat associations around the location. The landcover map and the availability of habitats within the study area are described in Job 2.

We defined habitat selection as the ratio of a habitat's proportionate use with its availability (Manly et al. 1993). Selection ratios were computed for each individual marten by dividing its proportionate use of each habitat by its availability in the study area. In order to compare selection among habitats, we computed a group's geometric mean selection ratio for each habitat and 95% confidence intervals using a weighted bootstrap (Manly 1991). The mean and CI were weighted by the size of the sample contributed by each marten in the group. Martens were grouped by sex and season. Marten relocations were grouped into the following seasons: fall = 16 September–15 December; winter = 16 December–15 May; and summer = 16 May–15 September.

JOB 2. HABITAT COMPOSITION

The composition of habitats within the study areas was determined from USDA Forest Service's GIS databases. We now have a library of GIS data files including landcover, timber type, soils, land status, streams, elevation, clearcuts, and roads. Because of problems with the accuracy of the timber-type map, we decided to use a landcover map developed from LANDSAT TM satellite imagery to delineate marten habitats. In 1995 the USDA Forest Service contracted with Pacific Meridian Resources to produce 3 landcover maps of northern Southeast Alaska using LANDSAT TM imagery (Pacific Meridian Resources 1995). The map types were size/structure, tree species, and canopy cover. The size/structure type was developed to distinguish forest stands by their density of trees by size class and to separate stands with multistoried canopies from single-storied.

We chose the size/structure map developed from LANDSAT TM imagery by Pacific Meridian Resources (1995) to define marten habitats. We selected the size/structure map for the analysis and further evaluation because we believed this map best represented the structural features of the forest. Forest structure provides important habitat components for wildlife species associated with forests, especially old-growth associated species (Sidle and Suring 1986). Because size/structure is usually correlated with the amount of overstory canopy closure, the size/structure map also provided us with a measure of canopy cover. Also, we preferred the Landsat TM data because the size/structure map had good spatial accuracy and a small (900-m^2) minimum mapping unit (because of the 30 x 30-m pixel size).

We received a polygon coverage of the Landsat TM size/structure map from USDA Forest Service staff. The polygon coverage was created from the raster landcover map by grouping similarly coded, adjacent pixels into polygons (Gary Fischer, USFS Juneau, personal communication). We collapsed the 17 size/structure categories into 5 forest strata and 3 primarily nonforested strata for 8 strata (Table 1).

The multistoried categories were large/multistoried (Large/MS), (Medium/MS), intermediate/multistoried (Intermediate/MS), and a combined small/multistoried and pole/multistoried class (Small/MS). We collapsed all of the single-storied classes into a single category called *single-storied* because the single-storied classes represented only a small proportion (2.9%) of the study area (Table 1). The three nonforest strata were shrub, sparsely vegetated (combined herbaceous, rock, and snow), and "recent clearcuts" (<25 years old). Recent clearcuts represented a specific habitat condition with known boundaries from USFS GIS data. Because some of the clearcuts were more recent than the 1992 satellite imagery, they had been mapped as other strata. Collectively, this stratum had been mapped as follows: Sparsely vegetated (6.4%), Shrub (34.0%), Large/MS (12.9%), Medium/MS (21.2%), Intermediate/MS (7.4%), Small/ MS (3.8%), and Single-storied (9.1%).

To collect information about the actual habitat characteristics of the landcover types, we visited randomly selected sites (stratified by the size/structure map) in the field and measured numerous habitat attributes. Habitat attributes included the density of live trees by size class, the density of snags by size class, the amount of down wood by size class, and the amount of understory cover. Thus, we obtained information on the actual structural attributes of habitats selected by martens. In addition, we collected information on the accuracy of the landcover maps. Our 1996 field data were provided to USFS staff and combined with their data for additional accuracy assessment (AA) evaluations (Fehringer 1997). We present additional AA information here based on our field data.

Sample selection—Random Sites

The size/structure map developed from LANDSAT TM imagery by Pacific Meridian Resources (1995) was used to define map strata. We collapsed the 17 size/structure categories into the previously described 5 forest and 3 nonforest strata.

We selected a random sample of 8 polygons within each stratum for field sampling (64 polygons). Only polygons at least 1.2 ha (3 acres) in size and within 0.6 km (0.4 mile) of the road systems at Salt Lake Bay or upper Game Creek were eligible for selection. Additionally, a 1.2-ha circle needed to fit completely within the polygon (Fig 2). Using GIS software, we printed the selected polygons on digital orthophoto maps and transferred them to resource photos (1:15,840), using the digital orthophoto maps for reference. We determined compass bearings and distances from known landmarks to the polygon centers from the digital orthophotos.

We designed this project to provide an evaluation of the LANDSAT TM map while minimizing costs. We restricted field sites to within reasonable walking distance (0.6 km) of access roads because funding for helicopter transport was unavailable. Some of the sites still required considerable effort because of crossing steep terrain. Volunteers were used extensively for field personnel, especially in 1997 after funding for field assistance was unavailable. We found that a field crew of 4 members worked most efficiently. One person measured the site attributes and recorded all of the plot data while 2 people measured trees. A fourth person completed the overstory canopy cover sheet and recorded logs. Usually, we completed 2 sites each day instead of the projected 3–4 sites. To maintain consistency, only 1 field crew was used at a time, and the same persons (R. Flynn or T. Schumacher) made the overstory estimates and completed the plot forms.

Data collection

A field crew located the polygons on the ground by walking the bearing and distance from known landmarks. We also used resource photos and a hand-held global positioning system (GPS) device to locate some plots. At each site, we estimated canopy cover by tree size class for the polygon, using the procedures established for training and accuracy assessment sites (Pacific Meridian Resources 1995). We used the same data sheets and criteria to determine the correct map labels for the polygon, including size/structure, species, and canopy cover. In addition, several site attributes were recorded near the polygon's center, including elevation (altimeter), aspect (compass), and slope (clinometer).

The vegetative characteristics for the polygon were measured using a cluster-sampling procedure similar to the USFS GRID project (USDA Forest Service 1995). Four sample points were established in each polygon. The first sample point was established near the polygon's center. We determined the location of this first sample point by pacing from the edge of the polygon toward its center, a distance equal to the radius of the polygon. Sample point 2 was located 36.6 m north of point 1, point 2 was located on a 120°-azimuth 36.6 m from point 1, and point 4 was located on a 240°-azimuth 36.6 m from point 1.

A single, 7.3-m fixed-radius plot was established around each sample point to measure tree, snag, and down wood attributes. For each tree >12.5 cm in diameter (live and dead), we recorded the species, height, diameter (dbh), status (whether live or dead), crown class, and decay category. We noted other habitat attributes such as elevated roots, squirrel middens, extensive cavities, etc. Instead of using transects to measure down wood, we recorded all logs within the plot including its species, length within the plot, diameter of each end, and decay class. Dead trees were considered snags.

A single, 5.64-m fixed-radius plot was established around the sample point to measure the understory. The composite cover of each shrub and herb species was estimated along with the average height of the shrub layer. A single, 2.0-m fixed-radius plot was established around the sample point to count all seedlings and saplings (trees<12 cm) by species.

Data analysis

All data were recorded on paper forms in the field. We obtained a data-entry program developed by USFS GRID project staff (USDA Forest Service 1995) to input the plot attribute data into a personal computer. Thus, our data structures and formats were similar to their data set. For our analyses, we converted the tree data into an SAS data set, using SAS statistical software (SAS Institute 1996).

We assigned landcover labels to the random sites, using criteria developed by Pacific Meridian Resources (1995). We evaluated map accuracy by comparing the field labels for sites to the map labels, using an error-matrix approach (Pacific Meridian 1995). The numbers of exact matches were tallied by landcover strata and expressed as the percentage classified correctly. In addition, an "acceptable" call was assigned to each field site using a "fuzzy logic" approach described by Pacific Meridian (1995). An acceptable call was given if the site was close (i.e., within 10% canopy cover) to the adjacent category. The numbers of acceptable matches were also tallied by landcover strata and expressed as the percentage classified correctly.

The den/resting site polygons were intersected with the size/structure polygon map to determine their composition by mapped landcover strata. Usually these polygons consisted of several pixel types, and we referred to them as mixed-pixel areas. A size/structure map label was assigned to each polygon, based on the labeling rules described by Pacific Meridian (1995).

For this evaluation, a tree was defined as a live or dead tree greater than 230 mm (9 in.) diameter at breast height (dbh) and taller than 2 m (6.6 ft). Thus, the tree data included live trees and snags, but not stumps. We computed 4 tree size-class variables from the field data for each site. We used the same dbh breaks to create tree size classes as were used to develop the size/structure map classification (Pacific Meridian 1995). We defined large trees as trees/snags greater than 820 mm (32.0 in.) dbh, medium trees were from 590 to 819 mm (23.0–31.9 in.) dbh, intermediate trees from 385 to 589 mm (15.0–22.9 in.) dbh, small trees from 230 to 384 mm (9.0–14.9 in.) dbh, and pole trees 125 to 229 mm (5–9 in.) dbh.

At each site, we summed the number of trees in each size class for the 4 subplots. Thus, the total area sampled at each site was 0.067 ha (0.165 acre), or 5.5% of the 1.2-ha polygon. Descriptive statistics (means and SEs) for the tree size-class variables were computed for each strata using SAS statistical software (SAS Inst. 1996). Separate sets of statistics were calculated for the random sites, den/rest sites, and combined data sets. The random and den/rest sites were compared with a series of t-tests of the tree-class variables by strata. Because none of the strata was significantly different (alpha = 0.05) between the site type for any tree-class variable, the random and den/rest sites were pooled for the rest of the analyses. In addition, the shrub, recent clearcut, and sparsely vegetated strata were combined into a single, nonforest stratum because these strata had few trees.

Differences among size/structure strata were evaluated for each tree size-class variable using a series of one-way analysis of variance tests (ANOVA) (SAS Institute 1996). We tested the hypothesis that the means for a tree-class variable were the same for all the map strata. If at least 1 of the strata was significantly different based on the ANOVA (alpha < 0.05), then Tukey's Studentized Range test was used to determine which strata differed (alpha = 0.1) for the tree size class. This analysis identified the map strata that were statistically different for at least 1 tree size-class variable. In addition, we identified the variable means that were significantly different for the comparison.

JOB 3. HABITAT CAPABILITY MODEL EVALUATION

The habitat capability model for martens in Southeast Alaska, developed by an interagency group of biologists (Suring et al. 1992), was evaluated in 2 ways using the general considerations listed by Schamberger and O'Neil (1986). During model testing, we compared habitat coefficient values with indices derived from scaling observed habitat selection ratios. Habitat selection indices for fall/winter/spring were compared to habitat capability coefficients in the marten habitat capability model (Suring et al. 1992).

JOB 4. POPULATION ECOLOGY

Each study area was live-trapped intensively during October and March to determine the sex and age composition of the martens. We recorded the time and location of all known deaths of radiocollared martens and attempted to retrieve carcasses of martens that had died naturally; we examined them for cause of death. We obtained the carcasses of many trapper-caught study animals. These carcasses were processed according to procedures established for the general collection of trapper-caught carcasses.

We surveyed martens on the Salt Lake Bay study area using mark-recapture methods (Seber 1982, White and Garrott 1990). For the survey, captured martens marked with only eartags or wearing failed collars were new individuals. Based on our earlier radiotracking data, we assumed that the population was closed (without emigration or immigration) during the 5-day trapping session and that each animal had an equal probability of being captured at least once during the trapping session. The study area was defined by the composite home ranges of resident martens (84 km^2). We computed a Lincoln–Petersen estimate of population number for a closed population, single mark-release experiment for each trapping session. Shortly before or after a trapping session, we located the radiocollared martens on the study area to determine the number of marked animals present during the trapping session. In the mark-recapture analysis, we used the number of radiocollared martens on the study area during the trapping session as n_1, the total number of martens captured as n_2, and the number of radiocollared martens recaptured as m_2. We used an Excel spreadsheet (Sterling Miller, personal communication, ADF&G, Anchorage), for the numeric analyses, including the population estimate, variance, and 95% confidence intervals from normally distributed data. In addition, we determined the minimum number of martens on the study area during the trapping session by adding the number of new captures to the number of previously radiocollared animals present. At this point, we did not determine whether all of the assumptions for a Lincoln–Petersen mark-recapture experiment were met in this situation.

We collected a large number of carcasses caught by trappers on northern Chichagof Island. Before the opening of the trapping season, we contacted trappers in Hoonah and Tenakee Springs and offered them $3.00 for each marten carcass delivered to us. Trappers were instructed to record the date and location of each capture and to freeze the carcasses immediately after skinning. Upon receiving the carcasses from the trappers, we kept them frozen until processing.

We weighed each carcass and assigned an index of internal and external fat content, using an ocular estimation procedure developed by Blundell and Flynn (1992, unpubl. report, ADF&G, Douglas, AK). We measured each skull according to Magoun et al. (1988) and classified the animal as juvenile or adult. We heated the skulls in water for 3 hours at 70° C, then extracted the lower canine and lower fourth premolar teeth. The teeth were stored frozen until sent to Matson's Laboratory (Milltown, Montana USA) for age determination by cementum analysis (Poole et al. 1994). We measured total, body, and tail lengths of each carcass, recording the method of skinning (i.e., feet skinned out or not). We examined stomachs for the presence of parasites, especially *Soboliphyme baturini* worms. We extracted the ovaries from the reproductive organs of females and preserved them in 10% formalin. All ovaries were washed in tap water and then sent to Matson's Laboratory (Milltown, Montana USA) for evaluation for the presence and number of corpora lutea (Strickland and Douglas 1987).

JOB 5. MOVEMENTS AND SPATIAL PATTERNS

Radiocollared martens were located from small aircraft, usually a Super Cub, about once every 2 to 4 weeks to monitor general movements (Kenward 1987). Aerial locations were plotted on high-resolution orthophoto maps (1:31,680 scale) and digitized as stateplane coordinates using a PC-based GIS computer program. We modeled home ranges of resident martens using the Movements Extension within ArcView GIS. We tested locations for independence (Swihart and Slade 1985) and examined outliers (Samuel et al. 1985). We calculated the locations and area of home ranges using approximately 95% convex polygons.

We spent little effort radiotracking transient martens off the primary study areas. We aerial searched the entire northeastern portion of Chichagof Island every few months to locate transient martens. We recorded the maximum distance traveled from initial capture sites and the maximum distance between relocations for each transient animal.

JOB 6. SMALL MAMMAL ABUNDANCE

We estimated the abundance of small mammals, excluding red squirrels, using a snap-trap index (Calhoun 1948). Transects were established in 3 stands: large-sized western hemlock old-growth stand; an intermediate-sized, mixed conifer/blueberry old-growth stand; and a recent clearcut (cut in 1987). We established 25 stations along each transect at 15-m intervals. Two Museum Special snap traps were placed at each station, baited with a mixture of peanut butter and rolled oats, and set for 3 consecutive nights (450 trap nights). We operated the traplines in September when small mammal populations were at their annual peak. We recorded the number of animals of each species caught per 100 trap nights.

JOB 7. SEASONAL DIETS

We collected marten scats at trap sites and opportunistically along roads and trails while working in the field. The scats were labeled and frozen for future analyses. We examined the scats for frequency of prey items.

Beginning in fall 1992, we drew a 2 to 3 cc sample of blood from the jugular vein of most captured martens. At camp the blood was spun at 3000 rpm in an electric centrifuge and the serum siphoned into a separate vial. The clotted blood cells were stored frozen and sent to Merav Ben-David, University of Alaska Fairbanks, for analysis of the stable isotopes of carbon and nitrogen (Schell et al. 1988, Ben-David et al. 1997).

JOB 8. EVALUATION OF FIELD SEXING AND AGING TECHNIQUE

We collected marten skulls from trappers operating on northern Chichagof Island to evaluate the field technique for sexing and aging martens proposed by Magoun et al. (1988). We recorded total skull length and length of temporal muscle coalescence for each specimen according to procedures of Magoun et al. (1988). A lower canine tooth and a lower fourth premolar were extracted from each skull for age determination by cementum analysis (Matson's Laboratory, Milltown, Montana USA). We grouped the skulls according to Magoun et al. (1988) and recorded percentages of each age class in the groups.

RESULTS AND DISCUSSION

During the past year, we monitored 14 radiocollared martens (7 males and 7 females) (Table 2). An additional 12 martens (8 males and 4 females) were captured and eartagged (Table 3).

During the entire study, we captured 311 martens (197 males and 114 females) 1971 times. Of the captured animals, we put radiocollars on 183 martens (100 males and 83 females). From small aircraft, we relocated the radiocollared martens 3422 times. On the primary study areas, we located 137 radiocollared martens (86 males and 51 females) 2978 times for habitat selection analyses.

JOB 1. HABITAT USE

Den and Resting Sites

Den Sites – From 1994 to 1998, we located 29 dens (15 natal, 14 maternal) used by 13 individual female martens. Natal dens usually were in cavities within the boles of trees or snags, or inside hard logs (Table 4). Maternal dens most often were in cavities beneath the roots of trees or snags, or inside hard logs. Natal and maternal dens differed in the types of structures used and the height of the den chamber above ground. Seven of 15 natal dens were in elevated sites within the boles of trees or snags. Only 3 natal dens were in root cavities, and a single marten used all of those dens. In contrast, 8 of 14 maternal dens were in root cavities. Hollow logs were used at 5 natal dens and 5 maternal dens. Mean height above ground was significantly higher at natal dens ($\bar{x}$ = 3.3 m) than at maternal dens ($\bar{x}$ = 0.4 m) ($F = 7.98$ df = 1,27, $p = 0.01$). Several researchers have reported that martens initially denned in trees and snags well above ground, but moved to dens near ground level as kits matured (Wynne and Sherburne 1984, Clark et al. 1987, Strickland and Douglas 1987, Raphael and Jones 1997). Presumably, locating natal dens above ground level minimizes the chance that predators will detect them, whereas locating maternal dens at ground level affords kits the opportunity to develop motor skills and defecate outside the den without the risk of falling.

Resting Sites – We located 52 resting sites (32 summer, 20 winter) used by 21 martens. During summer, martens rested in root cavities at 11 of 32 sites and within the boles of trees, snags, or stumps at 10 sites. They also rested in hollow logs at 5 sites, and on 4 occasions adult males rested on the ground in dense vegetation with no woody structure. In winter, martens always rested inside a woody structure. Thirteen of 20 winter resting sites were in root cavities, but martens also used cavities within the boles of trees or snags at 6 sites. We never found martens resting in hollow logs during winter. Martens rested in similar structures year-round, but relied more heavily on root cavities during winter.

Comparison of Den and Resting Structures

Many researchers have reported seasonal differences in the types of structures that martens used for resting. Elsewhere, martens rested in elevated sites during summer, often on limbs in trees and snags (Steventon and Major 1982, Wynne and Sherburne 1984, Spencer 1987). In winter, they most often rest in subnivean sites associated with coarse woody debris (CWD) (Steventon and Major 1982, Spencer 1987, Buskirk et al. 1989). Martens on northeastern Chichagof Island (NCI) rested in hollow logs during summer, and at 4 summer resting sites males rested on the ground without a structure. However, martens on NCI most often rested in root cavities during summer and winter. Most previous studies were in regions with continental climates with substantial seasonal differences in temperatures and precipitation. This seasonal change in environmental conditions probably accounts for the differences between summer and winter resting structures used by martens from those areas. However, the cool, wet, summer maritime climate of Southeast Alaska differs less from winter weather than do summers in areas with continental climates. Resting structures used by martens on NCI in summer and winter also differ less than elsewhere because seasonal weather differs less. This finding underscores the year-round importance of large-diameter woody structures to martens in this region.

Structures that martens used as dens differed from those used as resting sites. Martens used measurable structures at all sites except 1 den and 4 resting sites. The mean diameter of structures used as dens was significantly larger ($\bar{x}$ = 93 cm) than the mean diameter of those used as resting sites ($\bar{x}$ = 75 cm) ($F = 6.09$, df = 1,76, $p = 0.016$). Only Raphael and Jones (1997) have reported on denning and resting structures used by martens in the same study area. They found that in Oregon the mean diameter of denning structures was larger than the mean diameter of resting structures, but in Washington they did not differ. Martens probably use larger diameter structures for denning than for resting because of the added security from predators and shelter from inclement weather provided by larger structures. Security is particularly important at dens because they shelter kits, which are immobile and defenseless for the first 6–8 weeks of life. Larger diameter structures may provide a greater physical barrier to predators. Also, neonatal mammals often have difficulty thermoregulating (Withers 1992), and the greater insulation provided by larger diameter structures may enhance kit survival.

The distribution of decay classes for dead wood used as dens differed significantly from dead wood used for resting ($\chi^2 = 19.4$, df = 4, $p < 0.001$). When using dead structures as dens, martens chose structures in the early stages of decay, and when using dead structures as resting sites, martens most often chose structures in later stages of decay (Figure 1). Ten of 16 dead structures used as dens were in decay classes 1 or 2, whereas 25 of 30 dead structures used for resting were in decay classes 4 or 5.

Other reports also indicated that martens preferred structures in the early stages of decay when denning in dead wood. In Washington and Oregon, martens used structures in decay classes 1–3 at 100% and 75% of dens in dead wood, respectively (Raphael and Jones 1997). In Wyoming, martens preferred hard structures for dens (Ruggiero et al. 1998). Martens probably choose denning structures in the early stages of decay because of the protection they afford from predation relative to more decayed structures. Structures in decay classes 4 and 5 are soft and may be torn apart by predators, whereas structures in decay classes 1–3 remain hard like live trees, presenting a greater barrier to predators. Such protection is particularly important for young kits, which are immobile and defenseless. As kits mature and gain the mobility to avoid danger, the physical barrier provided by the den structure matters less.

Although martens elsewhere rested in a variety of decay classes, we were unable to find reports where martens preferred to rest in highly decayed structures. Martens in Washington rested in structures from all decay classes, but rarely used structures in class 5 (Raphael and Jones 1997). Martens in Wyoming preferred to rest in class 1 logs and avoided class 5 logs (Wilbert 1992). In California, Spencer (1987) reported that martens preferred to rest in snags that retained most of their bark, and Gilbert et al. (1997) found martens resting in sound snags and logs in Wisconsin. Why martens on NCI preferred to rest in highly decayed structures when dead structures in earlier stages of decay were common is unclear. However, this preference may be linked to the low risk of predation for independent martens on NCI. Any woody structure will offer protection from avian predators, but only relatively hard structures offer protection from mammalian predators. Potential marten predators like coyotes (*Canis latrans*) and red foxes (*Vulpes vulpes*) are absent from NCI, but common in other areas where martens have been studied. Brown bears (*Ursus arctos*) are the only mammalian predator on NCI larger than a marten, and although bears occur at a high density, they show little interest in martens. Therefore, martens on NCI may feel sufficiently secure using structures that afford less of a physical barrier to predators than martens in other areas. On NCI, martens may prefer more decayed woody structures for resting because these structures have other favorable properties, such as a more comfortable substrate or thermal advantage for resting.

Selection for Den and Resting Structures

Martens selected for specific size and decay features when choosing denning and resting structures. Martens used live trees at 12 dens and 17 resting sites. These trees ranged in size from 32 to 154 cm dbh ($\bar{x}$ = 83 cm). In the study area, the mean dbh for live trees was only 34 cm. Only about 6% of the trees in the study area were 83 cm dbh or larger (Fig. 2), and 95% confidence limits around means for used and available tree diameters did not overlap (Fig. 3). Overall, nearly 80% of live trees used by martens were from the largest 12% of trees in the study area.

Several indicators of decadence also helped to distinguish trees that were used by martens. Features such as dead or broken tops and holes in the bole often indicated that a tree had heart-rot and would have cavities within the bole that could be used by martens. Sixty percent of trees used by martens had dead or broken tops, while only 7% of the trees in the study area had these features. Thirty-one percent of trees used by martens had holes in the bole but only 5% of trees in the study area had similar holes. Such features are difficult to detect, especially in tall trees, so this probably is a low estimate. However, we believe that these are relatively rare features in live trees. Lastly, defoliation in live trees can also indicate decadence. We estimated the percent of crown defoliation on all trees measured for this study. Trees used by martens averaged about 20% crown defoliation, whereas trees available in the study area averaged only 4% defoliation.

Martens used snags at 4 dens and 9 resting sites. These snags had an average dbh of 88 cm and ranged from 31 to 170 cm. Mean diameter of snags available in the study area was 40 cm. Ninety-five-percent confidence intervals around the mean diameters of snags used by martens and snags available in the study area did not overlap (Figure 3). Mean dbh of snags associated with dens or resting sites was 88 cm. Only about 6% of snags in the study area were 88 cm dbh or larger. Overall, 75% of snags used by martens were from the largest 27% of snags available in the study area (Fig. 4).

Martens used stumps at 1 den and 11 resting sites. These stumps ranged in diameter from 53 to 124 cm ($\bar{x}$ = 77 cm). In the study area, the mean diameter of stumps was 49 cm, and 95% confidence intervals around the mean diameters of stumps used by martens and stumps available in the study area did not overlap (Figure 3). All stumps used by martens were larger than 65% of available stumps, and the mean diameter of stumps used by martens was larger than about 85% of stumps available in the study area (Fig. 5).

Martens used logs at 10 dens and 5 resting sites. In all cases martens used chambers within the log. Logs used by martens ranged in diameter at their large ends from 55 to 150 cm, with a mean of 86 cm. The mean diameter for the large end of logs in the study area was 36 cm. Ninety-five-percent confidence intervals around the mean diameters of logs used by martens and logs available in the study area did not overlap (Figure 3). All logs used by martens were larger than 75% of available logs, and the mean diameter of logs used by martens was larger than 95% of logs available in the study area (Fig. 6).

Our findings confirm that martens used the largest diameter woody structures available for denning and resting. Ruggiero et al. (1998) concluded that martens preferred to den in features characteristic of late-successional forests like large snags and logs. Raphael and Jones (1997) deemed large diameter to be the critical feature of denning and resting structures. Large diameter structures probably provide greater security from predators and shelter from inclement weather. However, within a single study area martens used structures with a range of diameters, and maximum tree sizes vary widely across marten habitat in North America. Therefore, although a minimum suitable bole diameter to enclose a chamber large enough for a marten exists, factors other than just diameter probably shape the choice of denning and resting structures.

Boles used by martens, especially those used as dens and winter resting sites, usually have a cavity caused by decay where martens den or rest. The combination of large diameter and presence of a useable cavity makes a bole suitable for denning or resting. To acquire both features, trees must first grow to a large size and then develop decay. Because bole diameter and decay develop with tree age, trees used as dens and resting sites by martens usually are very old as well as large. Therefore, the maintenance of marten populations in managed landscapes will depend on the continuous recruitment of old, large-diameter trees to serve as dens and resting sites.

The distribution of decay classes for dead wood used as dens differed significantly from available dead wood (χ^2 = 11.2, df = 4, p= 0.024). The distribution of decay classes for dead wood used as resting sites also differed from the distribution available in the study area (χ^2 =

30.4, df = 4, $p < 0.001$). At dens martens used more structures in decay class 1 and fewer in decay class 5 than expected (Fig. 7). At resting sites, martens favored structures in decay class 5 and avoided those in decay classes 1 and 2 (Fig. 8). Selection for hard structures at dens has been reported elsewhere (Jones and Raphael 1997, Ruggiero et al. 1998) and probably is related to security from predation. However, selection for soft dead wood at resting sites is new. Perhaps because of the low risk of predation by larger mammals, martens on NCI exploit a wider range of resting structures than martens elsewhere.

Selection Based on Mapped Habitats

Based on randomization, distributions of habitats around used sites did differ at dens compared to resting sites ($p = 0.016$) (Table 5). Dens had more area in clearcut, and resting sites had more small/MS forest. Habitat distributions around all sites used by martens did not differ significantly from the study area ($\chi^2 = 0.89$, df =5, $p = 0.97$). Further, we found no significant differences between habitat distributions at all den sites ($\chi^2 = 7.43$, df =5, $p = 0.19$) or all resting sites ($\chi^2 = 3.69$, df =5, $p = 0.59$) compared with distributions within the study area.

According to this analysis, habitat categories derived from the Landsat TM landcover map did not appear to delineate marten den and resting habitat well. These data will be further analyzed using procedures applied to the telemetry locations and published elsewhere.

Martens Use of Clearcuts

Martens on NCI denned or rested within clearcuts 7 times and at the edge of clearcuts 6 times. Martens in Washington and Oregon also denned and rested in slash piles associated with clearcut habitat (Raphael and Jones 1997), but other reports of martens denning or resting in clearcuts are rare. In general, recent clearcuts are considered poor habitat for martens because they lack structures suitable for denning or resting and provide little overhead cover (Buskirk and Ruggiero 1994). However, characteristics of clearcuts vary by region.

In Southeast Alaska, many of the boles in harvest units are not merchantable. Because slash and unusable boles are not piled or burned, large-diameter CWD often is abundant after clearcutting old-growth forest. Features of the old-growth forest that remain after timber harvest have been termed biological legacies (Franklin 1993). Slash and dense shrub regrowth provide overhead cover for martens, and in some years recent clearcuts had among the highest small mammal densities of any habitat sampled on NCI (ADF&G unpublished data). Also, clearcuts on NCI occurred as relatively small patches within a matrix of old-growth forest. Although regenerating clearcuts were not preferred as denning or resting habitat and were never used for resting in winter, they probably are better marten habitat than clearcuts in other regions because of the presence of biological legacies of the old-growth forest.

The number of years after harvest that clearcuts and associated CWD remain suitable as denning and resting habitat remains unknown. When using dead wood as the denning structure, martens in Southeast Alaska and elsewhere prefer CWD in the earlier stages of decay (Raphael and Jones 1997, Ruggiero 1998). Clearcuts in the study area were 5–14 years old. Baker (1992) reported martens denning under large decayed stumps in regenerating stands 10–40 years old, but she did not assign a decay class to these stumps. There are no published rates of decay for CWD in Southeast Alaska, and such rates likely vary by tree species, bole diameter, degree of decay prior to tree death, and site conditions. Hennon et al. (1990) reported that even decay-resistant yellow cedar snags showed decay of heartwood by 50 years after tree death and decayed into soft stumps and logs covered by vegetation by 100 years after tree death. Less decay-resistant species such as western hemlock probably decay sooner, especially logs in contact with the ground. Therefore, even large-diameter CWD remaining in clearcuts probably decomposes beyond the point that it is suitable as a denning structure in >50 years.

The period required for structures suitable for denning and resting to develop in second-growth stands also is unknown and likely varies with site conditions. Throughout their range, martens prefer to den and rest in large-diameter boles. However, large diameter alone does not make a structure attractive for denning or resting. Martens often use cavities within a bole, and wood decay is an essential precursor to cavity formation (McClelland and Frissell 1975). In Southeast Alaska, Kimmey (1956) found that few trees of any species less than 100 years old had decay, but 50% of western hemlocks over 200 years old contained decay. Therefore, age affects 2 important attributes of trees: size and internal decay. Trees attain sufficient size to accommodate denning and resting chambers of martens long before they form decayed interiors that allow chambers to form. Because residual CWD in clearcuts decomposes beyond stages used by martens for denning and because new structures with features suitable for dens and resting sites may take over 200 years to develop, clearcuts will remain poor marten habitat for denning and resting from ≤50 to ≥200 years postharvest.

Habitat Selection Based on Radiotelemetry

On the primary study areas, we located 137 radiocollared martens (86 males and 51 females) 2978 times to determine habitat selection. On northeast Chichagof Island, martens primarily used forested habitats (82%). They made little use of shrub fields (7.5%), recent clearcuts (6.8%), or sparsely vegetated habitats (4.2%). Among forested habitats, the medium/MS (28.6%) habitat had the greatest use followed by large/MS (18.9%) and intermediate/MS (18.5%). Small/MS (12.4%) and single-storied (3.0%) sites had limited use.

Martens showed the greatest selection for large- (selection ratio = 1.39) and medium-sized MS stands (selection ratio = 1.30). The mean selection ratios of these 2 habitats were not significantly different from each other, but both were significantly greater than any other habitat. Intermediate/MS stands (1.11) were selected less than the larger-sized habitats, but more than small/MS (0.72), single-storied (0.81), and nonforested sites (shrub = 0.20 and sparsely vegetated = 0.30).

For male martens, habitat selection ratios were similar to the pooled values previously described. Because of reduced sample sizes, more of the 95% CLs overlapped. However, male martens preferred large-sized stands (large/MS = 1.50 and medium/MS = 1.30) compared to intermediate/MS (1.12) and smaller-sized habitats (small/MS = 0.66). Although patterns were similar, female martens showed somewhat more variability in habitat selection than males. For females, fewer significant differences in selection were found; selection by females for intermediate/MS habitat (1.10) was not significantly different from large/MS (1.25) and medium/MS (1.31).

Martens showed the greatest selection for habitats during the winter season. Selection ratios for large/MS and medium/MS habitats were similar (1.53 and 1.40), but greater than all other types. Nonforest habitat (0.18), including clearcuts (0.36), had small selection ratios during the winter. Intermediate/MS (1.01), Single-storied (0.75), and Small/MS (0.56) habitats were in between. During summer, marten selection ratios were similar for large/MS (1.17), medium/MS (1.21), and intermediate/MS (1.00) habitats, but these habitats had larger ratios than all others. During fall, selection ratios were similar for all of the forested habitats, but these differed from the nonforested types. Thus, martens showed the largest selection among forested habitats during winter and summer, respectively. During the fall, little selection was observed among forested habitats. Selection ratios for nonforest habitats were always small, confirming that martens generally avoid nonforest.

JOB 2. HABITAT COMPOSITION

For the entire study, we sampled 65 stratified random locations and 67 sites centered on marten dens or resting sites. We exceeded our original target of 64 random sites. Because of the selection criteria, each random polygon contained only 1 type of size/structure pixel. However, the marten den/rest sites always contained several pixel types (2 to 7). Often, these polygons contained a variety of pixel types and varying proportions of pixel types. The map labels assigned to the mixed-pixel polygons depended on the labeling rules developed by Pacific Meridian Resources (1995). Because we did not change the labeling rules, we did not investigate how changing labeling rules would affect outputs.

Accuracy Assessment

For 65 random sites, the field label exactly matched the map label 55 times (85%) (Table 6). For only forest strata, the exact match was 78% (32 of 41). In each of the mismatches, the labels differed by only 1 size class. We found the poorest accuracy within the medium/MS (exact = 63%) and intermediate/MS (exact = 67%) strata. These strata appeared to be the most variable and difficult to map accurately. Fehringer (1997) also found relatively low map accuracy for the intermediate/MS type (acceptable = 63%). Additional plots are needed in these types to better determine whether they are "good" landcover types. The nonforest and small/MS strata were nearly 100% accurate. The LANDSAT TM procedures appeared to map these types well. We eliminated salt water from our study area because salt water can be accurately mapped from other GIS coverages. We mapped recent clearcuts from the USFS GIS coverage, so these sites were not used in the AA evaluation. Many of the recent clearcuts had been logged since the time of the LANDSAT TM image (August 1992).

Generally, we found greater overall map accuracy than reported by Pacific Meridian Resources (1995) and Fehringer (1997). We may have found greater map accuracy because our random sites were selected from homogenous areas greater than 1.2 ha. In addition, our sites were field-visited and tree attributes were measured. The AA sites selected for the original pilot project (Pacific Meridian Resources 1995) and supplemented by Fehringer (1997) were generally more heterogeneous than our random sites. In addition, the map labels for these sites depended on the labeling procedures for mixed-pixel polygons.

Our data indicated that mapping procedures used for the LANDSAT TM pilot project mapped larger (>1.2 ha), homogenous areas more accurately than heterogeneous areas. In addition, the polygon labeling rules for mixed-pixel areas need additional evaluation.

Habitat Attributes

We considered the mean numbers of trees and snags per plot by size class as a measure of habitat structure. We did not separate the trees by species or report live trees and snags separately. Other habitat attributes were measured (i.e., stumps, logs, and understory), but these data were not summarized for this report. These forest attributes all contribute to habitat quality for old-growth associated species.

The means for the tree-class variables by landcover strata for the random sites (Table 7) were similar to the den/rest sites (Table 8) (*t*-tests, alpha = 0.05). Consequently, we combined the random and marten den/rest sites for the remainder of the analyses (Table 9).

The landcover strata were significantly different for tree-class variables (ANOVA, alpha = 0.05). Because of the numerous comparisons, we summarized the landcover strata that differed by tree-class variable (Tables 10, 11). Generally, large/MS sites had more large trees and fewer intermediate and small trees. Medium/MS sites were well stocked with many trees of all size classes. Intermediate/MS sites were highly variable. Some sites had clumps of larger trees mixed with intermediate and small trees. Some intermediate/MS sites had only intermediate and smaller trees. Also, several of the intermediate/MS sites were misclassified; these sites added substantial variance to data for this stratum. Small/MS sites had few large trees and numerous small trees.

Some of the differences were obvious. The nonforest stratum had few trees of any size and differed from most other forest strata for nearly all variables. The single-storied sites we measured differed from all others because of the large number of intermediate and small trees present. Four of the single-storied sites resulted from natural wind throw, three resulted from 35-year-old clearcuts, and 1 was a misclassified small stand.

The magnitude of the differences among means was large in some cases, but the differences were not statistically significant because of large variances or small sample sizes. The intermediate/MS strata were the most variable and not different from medium/MS or small/MS strata. The other multistory strata were different for at least 1 tree-class variable. Large/MS differed from medium/MS (fewer intermediate trees), Intermediate/MS (more large trees), and small/MS for 2 variables (more large trees, fewer small trees). Medium/MS was also different from small/MS (more large and intermediate trees).

JOB 3. HABITAT CAPABILITY MODEL EVALUATION

In a previous progress report (Flynn 1991), we compared the habitat selection indices from this study to the habitat capability coefficients in the habitat capability model. No additional analyses were completed for this report.

JOB 4. POPULATION ECOLOGY

During the study, 183 radiocollared martens (100 males and 83 females) were relocated 3422 times from small aircraft. These radiocollared martens were monitored at least part of the year. We were not able to radiocollar all resident martens. Some of the eartagged martens were subsequently captured on the study area, indicating they were probably residents.

We had several good opportunities for mark-recapture trapping sessions during the study. These results will be published elsewhere.

JOB 5. MOVEMENTS AND SPATIAL PATTERNS

We located 183 radiocollared martens 3422 times to collect information on movements and spatial use patterns. The data were recorded and entered into a GIS data file. We will use GIS software to complete a comprehensive analysis of the movements and spatial use data. These results will be published elsewhere.

JOB 6. SMALL MAMMAL ABUNDANCE

Since 1990 we have trapped permanent transects at Salt Lake Bay and Game Creek to monitor trends in small mammal numbers. During September 1998, we trapped the 4 permanent trend transects at Salt Lake Bay and captured 51 Keen's deer mice, no voles, and 1 masked shrew in 600 trap nights. On transects 1–3, we caught 35 rodents (only deer mice) in 450 trap nights (7.8 captures/100 trap nights). The snap-trap index indicated small mammal numbers increased 40% from fall 1997. However, the catch rate for voles continued to decrease (0.9 to 0.0 captures/100 trap nights). The index for voles decreased for the third straight year from a high of 11.1 captures/100 trap nights in 1994. The catch rate for voles has fluctuated greatly during the study. The previous low for voles was in 1992 when none was captured.

Because vole numbers decreased sharply in each study area, the availability of an important food for martens was probably reduced again on northeast Chichagof Island during 1998–1999.

JOB 7. SEASONAL DIETS

No additional results were available. Previous results were published (see below).

JOB 8. EVALUATION OF FIELD SEXING AND AGING TECHNIQUE

We updated the data files, but no additional analyses were completed. We now have data on over 3100 martens. These data will be published elsewhere.

JOB 9. SCIENTIFIC MEETINGS AND WORKSHOPS

BEN-DAVID, M. AND R. W. FLYNN. 1999. Diet composition and reproductive performance in American martens: The role of alternative foods. Presented at the 84th Annual Meeting of The Ecological Society of America in Spokane. (See Appendix A)

JOB 10. REPORTS AND SCIENTIFIC PAPERS

BEN-DAVID, M., R. FLYNN, AND D. M. SCHELL. 1997. Annual and seasonal changes in diets of martens: evidence from stable isotope analysis. *Oecologia* 111:280–291.

HICKEY, JENA, R. W. FLYNN, S. W. BUSKIRK, K. G. GEROW, AND M. F. WILSON. In press. Mammalian predators as dispersers of seeds: an evaluation of the American marten, *Martes americana*. Oikos.

SCHUMACHER, T. 1999. A Multi-scale analysis of habitat selection at dens and resting sites of American martens in Southeast Alaska, M.S. Department of Zoology and Physiology, University of Wyoming, Laramie, WY. (See Appendex B)

ACKNOWLEDGMENTS

Many individuals contributed to the project, and we greatly appreciated their assistance. Our staff biometrician, Grey Pendleton, assisted with the statistical analyses and the fieldwork. Merav Ben-David collaborated on the diet analyses. Kimberly Titus provided project review and direction. Mary Hicks edited the report. Our USDA Forest Service cooperators, Ted Schenck, Chris Iverson, and Tom Schmidt, provided interagency coordination and arranged field support. Staff at the Hoonah Ranger District provided additional critical logistical support including bunkhouse space and transportation. Numerous volunteers contributed to the fieldwork.

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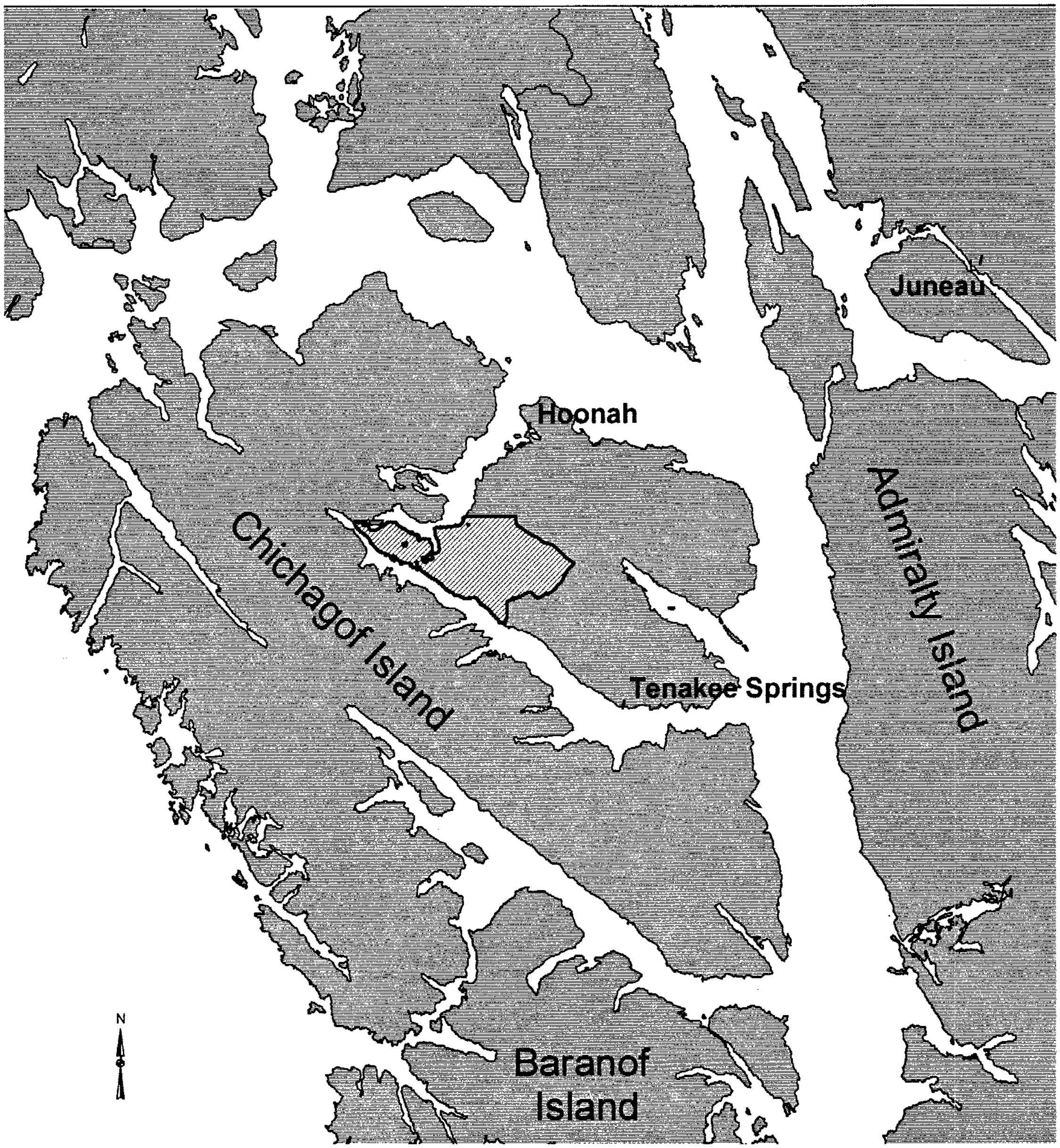

Figure 1. Location of the northeastern Chichagof Island study area.

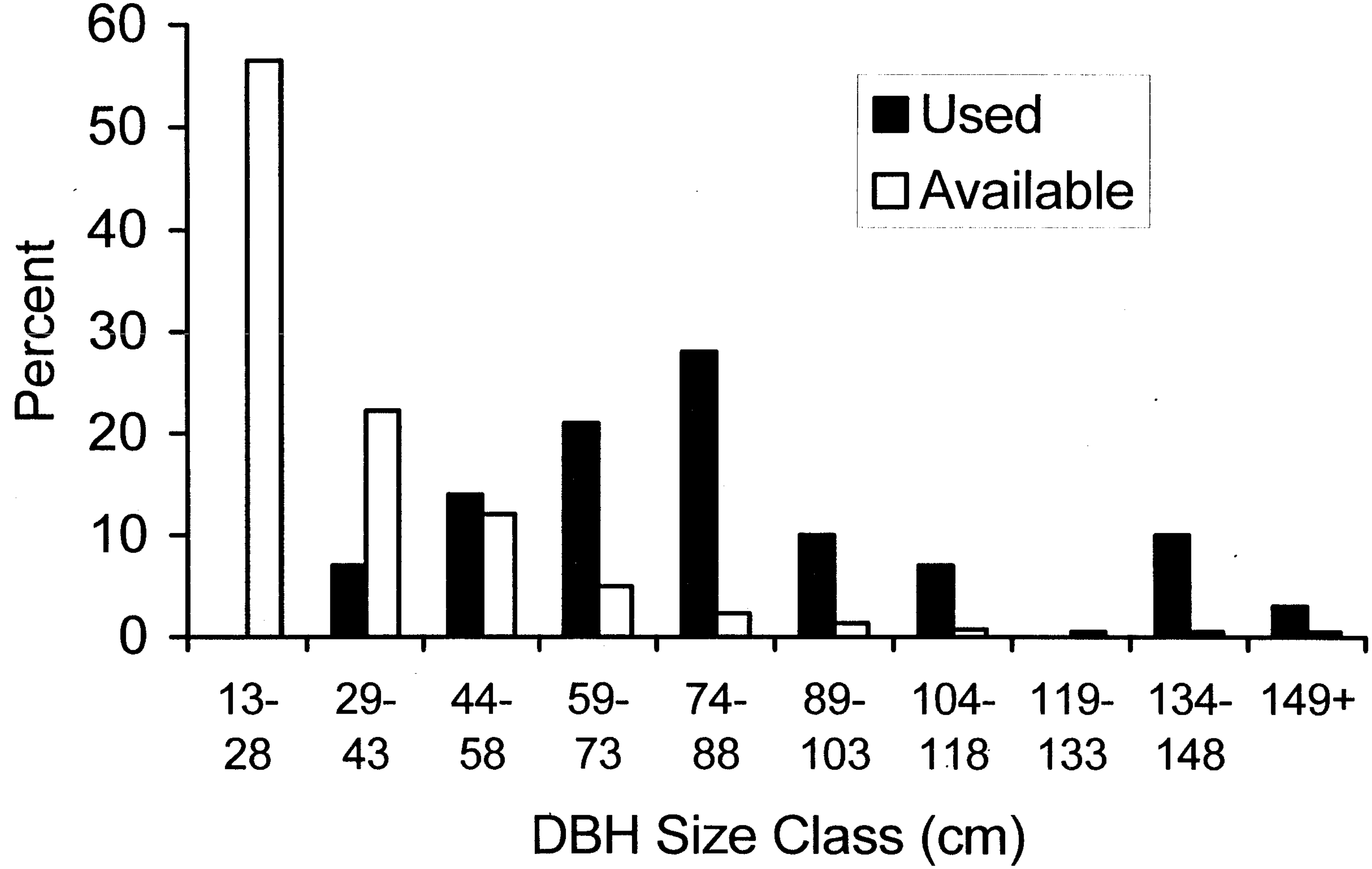

Figure 2 Distribution of dbh size classes for live trees used at dens and resting sites by American martens and trees available in the study area on northeastern Chichagof Island, Southeast Alaska 1994-1998

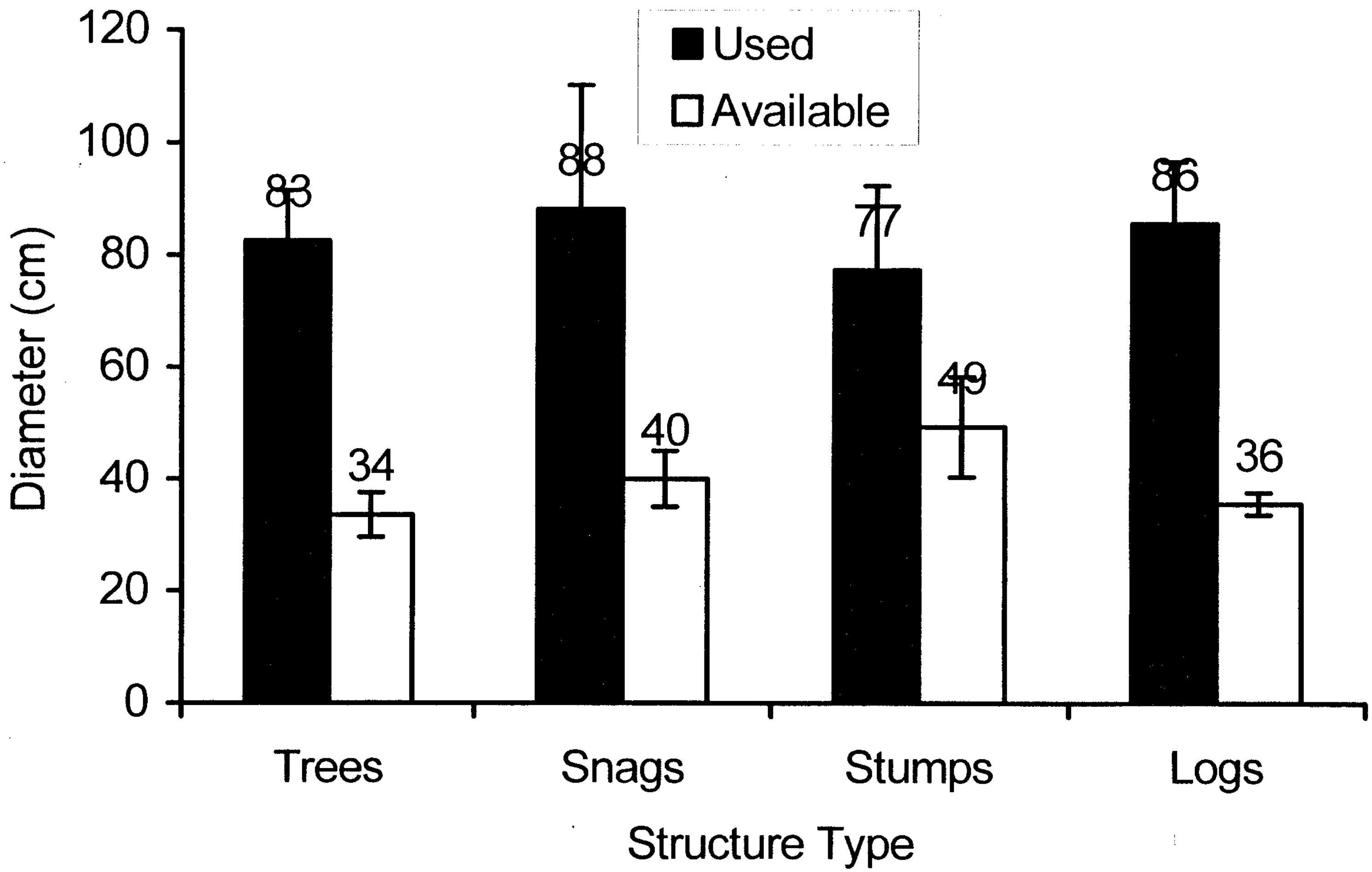

Figure 3 Mean diameters and 95% confidence limits for structures used as dens and resting sites by American martens and structures available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998

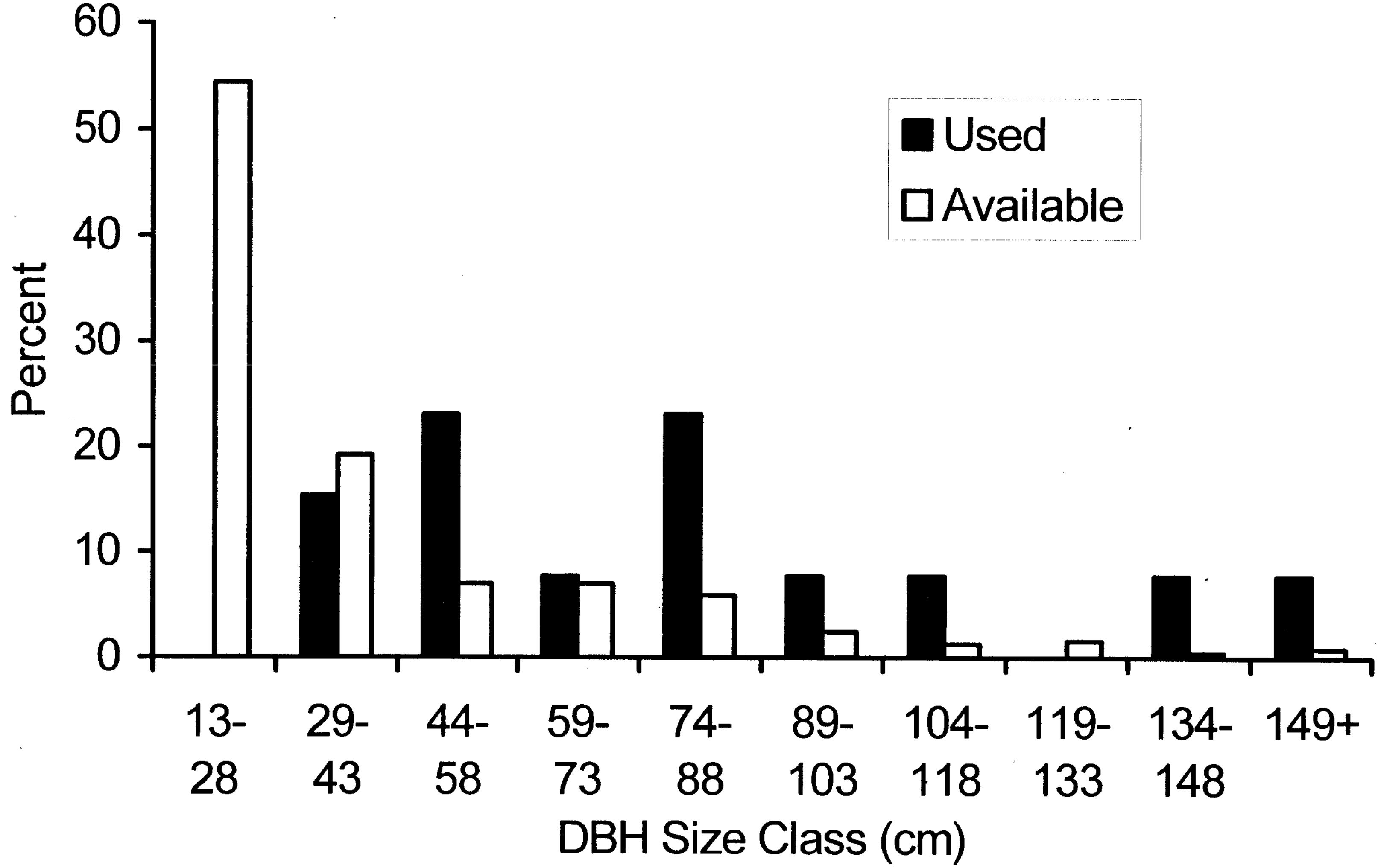

Figure 4 Distribution of size classes for snags used at dens and resting sites by American martens and snags available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998

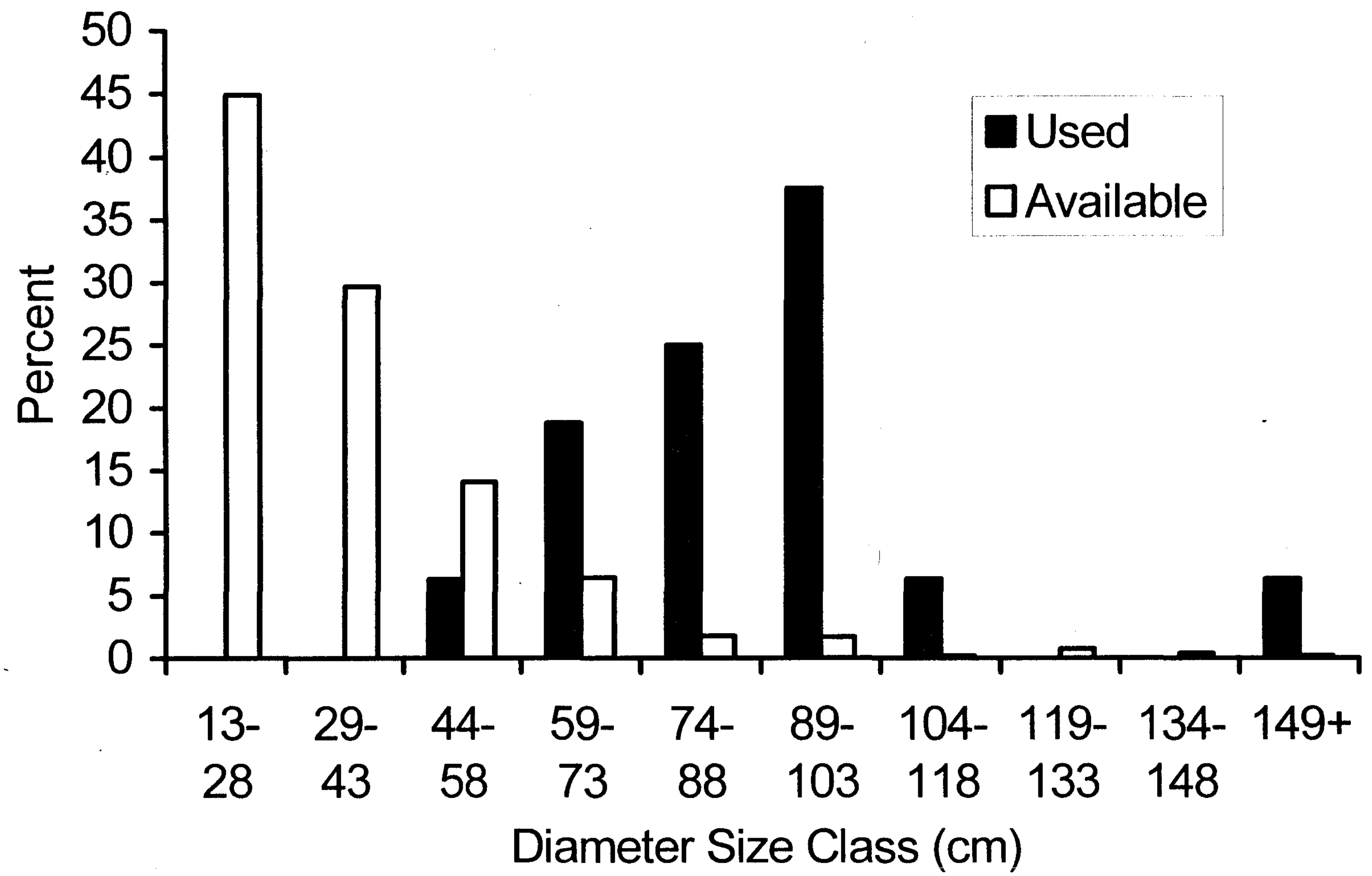

Figure 5 Distribution of large-end diameter size classes for logs used by American martens and logs available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998.

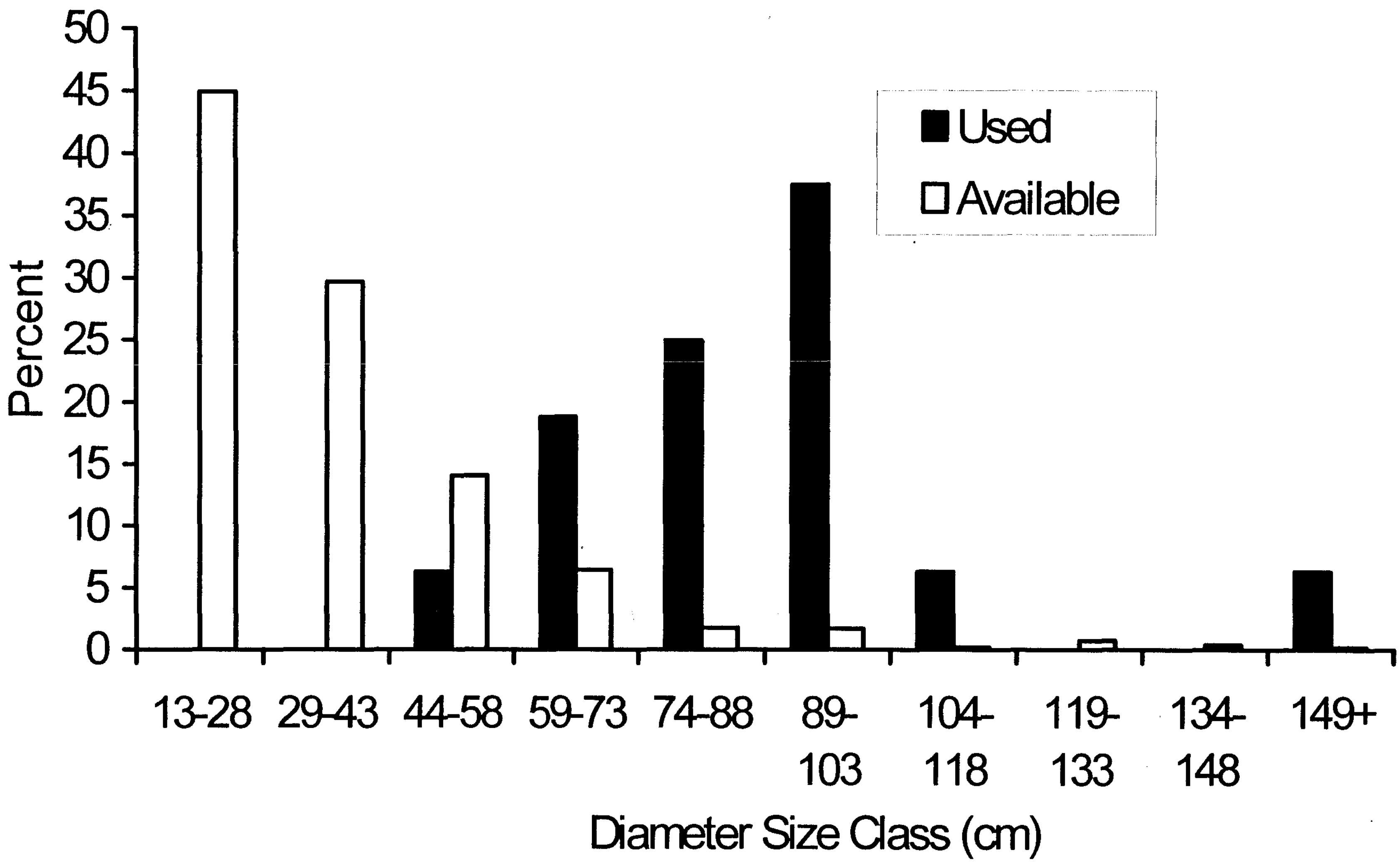

Figure 6 Distribution of large-end diameter size classes for logs used by American martens and logs available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998

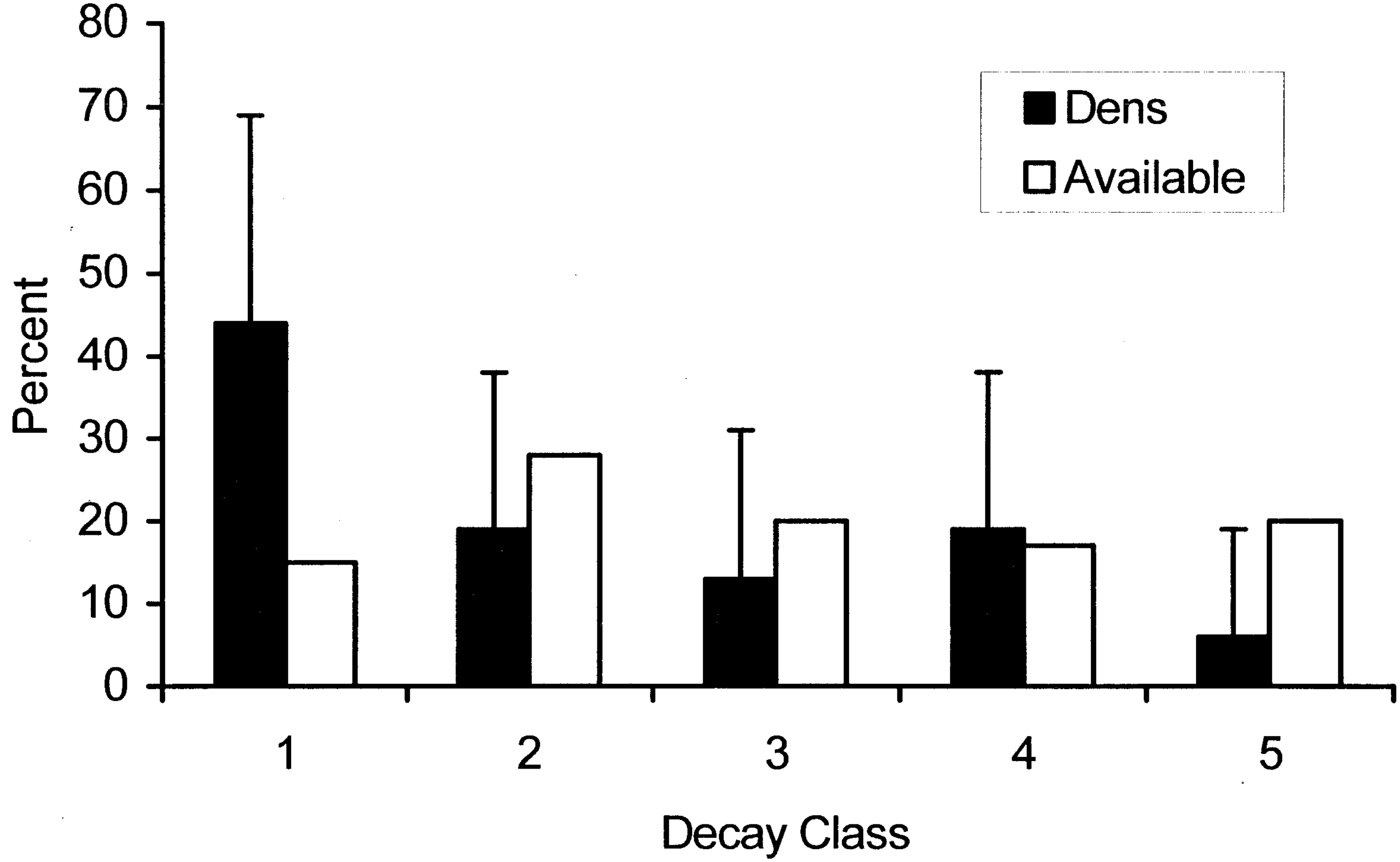

Figure 7 Distribution of decay classes (Thomas 1979) and 95% confidence limits for 16 structures used as dens by American martens and of structures available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998. Decay classes of structures used as dens differed from decay classes available in the study area ($X^2 = 11.2$, df = 4, $p = 0.024$)

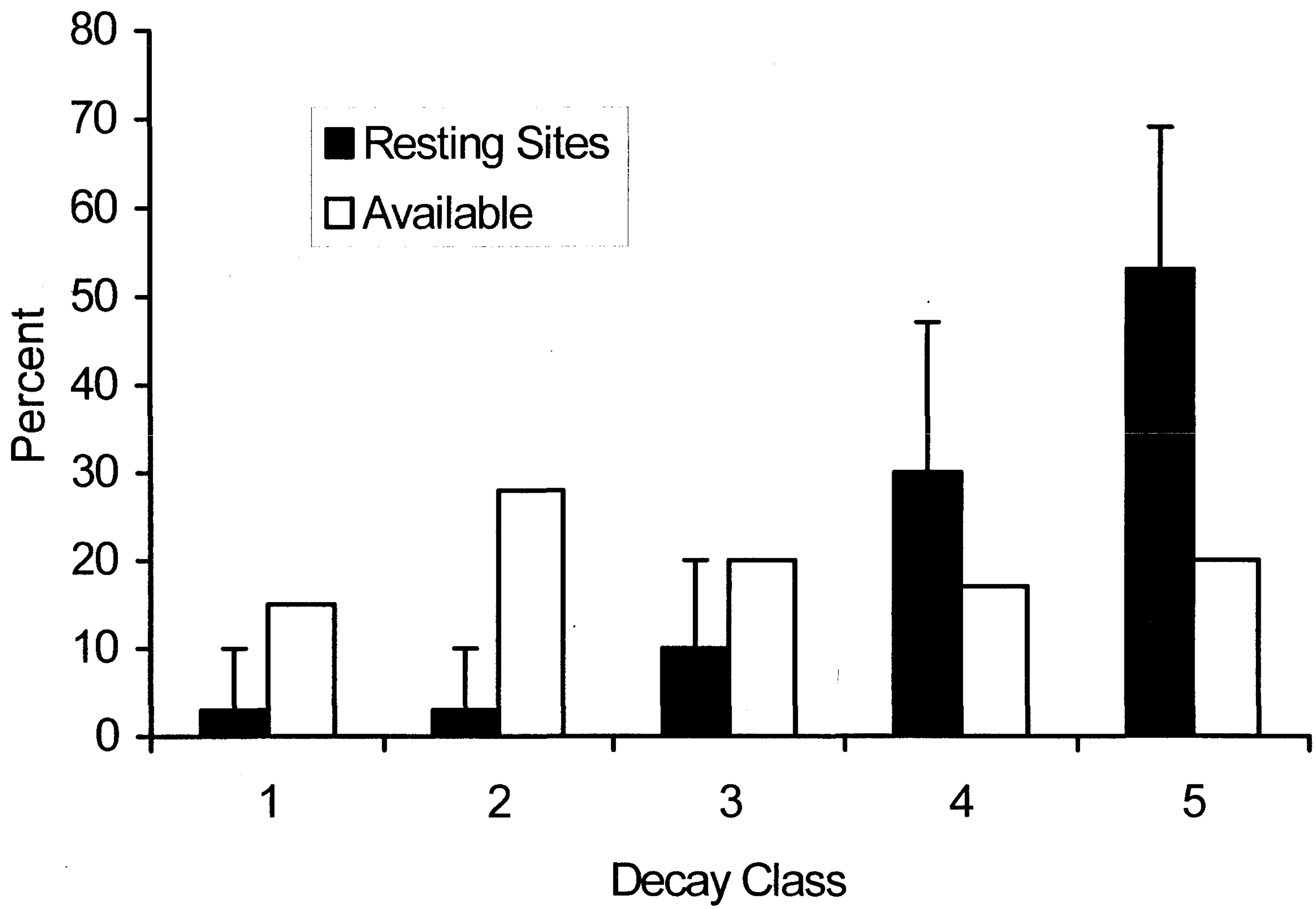

Figure 8 Distribution of the decay classes (Thomas 1979) and 95% confidence limits for 30 structures used as resting sites by American martens and of structures available in the study area on northeastern Chichagof Island, Southeast Alaska, 1994-1998. Decay classes used at resting sites differed from those available in the study area ($X^2 = 30.4$, df = 4, $p < 0.001$)

Table 1 Current composition of the Salt Lake Bay-Game Creek study area by LANDSAT TM size/structure strata, northeast Chichagof Island, Southeast Alaska

Strata	Map code	Nr of polygons > 1.2 ha	Area (acres)	Area (ha)	Percent (%)
Large/multistoried	13	291	5,833	2,361	11.6
Medium/multistoried	14	479	10,464	4,235	20.9
Intermediate/multistoried	15	327	7,683	3,109	15.3
Small-pole/multistoried	16,17	214	6,411	2,595	12.8
Singlestoried	6,7,8,9	46	1,470	595	2.9
Shrub	4	142	8,596	3,479	17.2
Sparsely vegetated	2,3,5	155	5,723	2,316	11.4
Recent clearcuts[a]	18	89	3,941	1,595	7.9
Totals		1,743	50,121	20,284	100.0

[a] Derived from USFS GIS data files, a subset of Sparsely vegetated (6.4%), Shrub (34.0%), Large/MS (12.9%), Medium/MS (21.2%), Intermediate/MS (7.4%), Small/MS (3.8%), and Singlestoried (9.1%) strata.

Table 2 Age, sex, and status of radiocollared martens monitored on northeast Chichagof Island, 1998–1999

Animal nr	Sex	Age class	Date first radiocollared	Nr of captures	Study[a] area	Residency[b] status	Survival status[c]
120	F	6	02/15/94	1	SLB	R	Censored
128	F	5	05/01/94	0	GC	R	Censored
149	F	4	09/28/94	0	GC	R	Censored
162	M	4	10/22/94	1	SLB	R	Censored
163	F	4	03/21/97	1	SLB	R	Censored
173	F	7	04/07/98	1	SLB	R	Censored
188	F	4	10/07/95	1	SLB	R	Censored
191	M	3	05/30/97	0	SLB	R	Censored
193	M	2	03/23/95	3	SLB	R	Censored
219	F	5	04/09/98	2	SLB	R	Censored
236	M	4	04/29/97	0	GC	R	Censored
273	M	3	03/01/97	7	SLB	R	Censored
282	M	4	05/26/97	3	SLB	R	Censored
299	M	2	06/13/98	5	SLB	R	Censored

[a] SLB = Salt Lake Bay and GC = Game Creek.
[b] R = resident or T = transient.
[c] The animal was considered censored for the survival analysis when the radio signal was not found after the month listed.

Table 3 Age and sex of other martens captured on northeast Chichagof Island, 1997–1998. These individuals were marked with only eartags

Animal nr	Sex	Age class	Date first captured	Nr of captures	Study[a] area	Status
297	M	3	10/22/97	2	SLB	Unknown
301	M	3	04/10/98	1	SLB	Unknown
302	M		08/02/98	1	SLB	Unknown
303	M		04/17/99	1	SLB	Unknown
304	M		04/18/99	1	SLB	Unknown
305	M		04/18/99	1	SLB	Unknown
306	F		04/18/99	1	SLB	Unknown
307	F		04/18/99	2	SLB	Unknown
308	F		04/18/99	1	SLB	Unknown
309	M		04/19/99	2	SLB	Unknown
310	F		04/20/99	1	SLB	Unknown
311	M		04/21/99	1	SLB	Unknown

[a] GC = Game Creek; SLB = Salt Lake Bay

Table 4 Types of structures used as dens and resting sites by martens on northeastern Chichagof Island, Alaska, 1994–98

Structure	Dens			Resting Sites					
	Natal	Maternal	All	Summer	Winter	Male	Female	All	All sites
Live tree	4	0	4 (14%)	4	1	1	4	5 (9%)	9 (11%)
Snag	3	0	3 (10%)	4	2	1	5	6 (11%)	9 (11%)
Log	5	5	10 (34%)	5	0	1	4	5 (9%)	15 (18%)
Root cavity	3	8	11 (38%)	11	13	6	18	24 (44%)	35 (43%)
Underground[a]	0	0	0	0	2	0	4	4 (7%)	4 (5%)
Logging Slash	0	1	1 (3%)	0	0	0	0	0 (2%)	1 (1%)
Stump	0	0	0	2	3	2	3	5 (9%)	5 (6%)
No structure[b]	0	0	0	4	0	3	1	4 (7%)	4 (5%)
Totals	15	14	29	32	21	15	32	53	82 (100%)

[a] Includes CWD under the surface of the ground or underground cavities created by decaying roots or logs.
[b] Sites where martens were lying on the surface of the ground not associated with any structure.

Table 5 Mean percentages (SE) of habitats within 62-m-radius (1.2 ha) around 28 dens and 38 resting sites used by martens compared with the availability of habitats within the northeastern Chichagof Island study area, Southeast Alaska. The 6 habitat strata were mapped using LANDSAT TM imagery

Strata	Used sites			
	Dens	Resting	All	Study area
Large/MS	19.3 (5.7)	15.5 (3.7)	17.1 (3.2)	16.3
Medium/MS	26.5 (5.3)	25.9 (3.4)	26.2 (3.0)	29.2
Intermediate/MS	19.7 (4.9)	27.4 (4.0)	24.2 (3.1)	21.5
Small/MS	10.0 (2.8)	24.7 (4.6)	18.5 (3.0)	17.9
Singlestoried	4.2 (1.7)	1.3 (0.6)	2.5 (0.8)	4.1
Clearcut	20.3 (7.0)	5.1 (3.0)	11.6 (3.5)	11.0

Table 6 Number of random field plots and exact matches with LANDSAT TM size class map

Landcover strata	Code	Nr of sites	Exact [a] matches	Percent
Shrub	4	8	8	100
Singlestoried	7,8	8	7	88
Large/MS	13	8	7	88
Medium/MS	14	8	5	63
Intermediate/MS	15	9	6	67
Small-pole/MS	16, 17	8	7	88
Recent clearcuts	18	8	8	100
Sparsely vegetated	2,3,5	8	7	88
Total		65	55	85

[a] Considering only forested types, the percentage of exact matches was 78%.

Table 7 Number of trees/snags by size class by LANDSAT TM mapped size strata for random sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	Nr plots	Nr large[a] trees		Nr medium[b] trees		Nr interm.[c] trees		Nr small[d] trees		Nr pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Singlestoried	8	0.4	0.3	1.9	0.7	9.0	2.0	22.2	2.9	32.1	8.0
Large/MS	8	2.9	0.5	3.0	0.9	5.0	0.8	7.8	2.1	8.4	2.7
Medium/MS	8	2.0	0.6	2.8	0.7	7.1	1.4	9.5	1.1	14.0	2.5
Intermediate/MS	9	1.2	0.6	2.6	0.7	6.6	0.9	10.4	1.9	15.6	4.0
Small-pole/MS	8	0.4	0.2	0.8	0.6	2.5	0.9	12.9	2.8	17.9	2.6
Recent clearcuts	8	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.0
Sparsely vegetated	8	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.6	0.6

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 8 Number of trees/snags by size class by LANDSAT TM mapped size strata for marten den/rest sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	Nr plots	No. large[a] trees		Nr medium[b] trees		Nr interm.[c] trees		Nr small[d] trees		Nr pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	0										
Singlestoried	0										
Large/MS	9	2.8	0.7	2.7	0.4	3.0	0.7	4.9	0.9	7.3	2.0
Medium/MS	20	2.4	0.4	3.2	0.4	5.3	0.8	7.8	1.1	13.5	2.4
Intermediate/MS	21	1.4	0.4	2.7	0.5	5.8	0.7	10.4	1.3	14.7	1.7
Small-pole/MS	9	0.7	0.4	2.1	0.4	5.9	1.1	12.4	2.2	16.6	2.4
Recent clearcuts	7	0.0	0.0	0.8	0.6	1.3	0.8	1.7	1.2	2.8	1.5
Sparsely vegetated	0										

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 9 Number of trees/snags by size class by LANDSAT TM mapped size strata for all sites, northeast Chichagof Island, Southeast Alaska. Plots represent the aggregation of 4 0.017-ha subplots per site or 0.07 ha

Landcover strata	Nr plots	Nr large[a] trees		Nr medium[b] trees		Nr interm.[c] trees		Nr small[d] trees		Nr pole[e] trees	
		$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE	$\bar{x}$	SE
Shrub	8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Singlestoried	8	0.4	0.3	1.9	0.7	9.0	2.0	22.2	2.9	32.1	8.0
Large/MS	17	2.8	0.4	2.8	0.5	3.9	0.6	6.2	1.1	7.8	1.6
Medium/MS	28	2.3	0.3	3.0	0.3	5.8	0.7	8.3	0.8	13.6	1.8
Intermediate/MS	30	1.3	0.3	2.6	0.4	6.0	0.6	10.4	1.0	14.9	1.7
Small-pole/MS	17	0.5	0.2	1.5	0.4	4.3	0.8	12.6	1.7	17.2	1.7
Recent clearcuts	15	0.0	0.0	0.5	0.3	0.6	0.4	0.8	0.6	1.5	0.8
Sparsely vegetated	8	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.6	0.6

[a] Large trees > 819 mm diameter at breast height (dbh)
[b] Medium trees = 590–819 mm dbh
[c] Intermediate trees = 385–589 mm dbh
[d] Small trees = 230–384 mm dbh
[e] Pole trees = 125–229 mm dbh

Table 10 Mean numbers of trees/plot by tree size class for each map strata. All map strata differed significantly for at least one tree-class variable (ANOVA, alpha = 0.01)

Tree-class variable[1]	Strata means[2]				
Nr large trees					
	Large/MS	Medium/MS	Intermediate/MS	Small/MS	SS	NF
	2.8^{a}	2.3^{ab}	1.3^{bc}	0.5^{cd}	0.4^{cd}	0.0^{d}
Nr medium trees						
	Medium/MS	Large/MS	Intermediate/MS	SS	Small/MS	NF
	3.0^{a}	2.8^{ab}	2.6^{ab}	1.9^{abc}	1.5^{bc}	0.0^{c}
Nr intermediate trees						
	SS	Intermediate /MS	Medium /MS	Small/MS	Large/MS	NF
	9.0^{a}	6.0^{ab}	5.8^{ab}	4.3^{b}	3.9^{b}	0.1
Nr small trees						
	SS	Small/MS	Intermediate/MS	Medium/MS	Large/MS	NF
	22.2	12.6^{a}	10.4^{ab}	8.3^{bc}	6.2^{c}	0.4
Nr pole trees						
	SS	Small/MS	Intermediate/MS	Medium/MS	Large /MS	NF
	32.1	17.2^{a}	14.9^{ab}	13.6^{ab}	7.8^{b}	1.0

[1] Tree classes defined are as follows: Large trees = number of trees > 820 mm diameter at breast height (dbh); Medium trees = number of trees 590–819 mm dbh; Intermediate trees = number of trees = 385–589 mm dbh; Small trees = number of trees 230–384 mm dbh; Pole trees = number of trees 125–229 mm dbh

[2] Strata means with the same letter were not significantly different (Tukey's Studentized Range test, alpha = 0.1). SS = singlestoried and NF = nonforest strata.

Table 11 Means of vegetative characteristics for each map strata. All map strata differed significantly for at least one tree variable (ANOVA, alpha = 0.01)

Tree variable[1]	Strata means[2]				
Tree height (m)					
Large/MS	SS	Medium/MS	Intermediate/MS	Small/MS	NF
24.7^{a}	22.6^{ab}	20.4^{b}	19.2^{b}	14.5	1.9
QMD (cm)					
Large /MS	Medium/MS	Intermediate/MS	Small/MS	SS	NF
63.3	57.0^{a}	50.4^{ab}	40.9^{ab}	39.4^{b}	9.1
Basal area (m^2)					
Large/MS	Medium/MS	SS	Intermediate/MS	Small/MS	NF
5.03^{a}	4.80^{ab}	4.19^{ab}	3.93^{ab}	2.57^{b}	0.19
Basal area of TSHE (m^2)					
SS	Large /MS	Medium/MS	Intermediate/MS	Small /MS	NF
2.84^{a}	2.58^{ab}	2.00^{bc}	1.47^{c}	0.41^{d}	0.04^{d}
Basal area of CHNO (m^2)					
Small /MS	Medium /MS	Intermediate /MS	Large/MS	NF	SS
1.00^{a}	0.70^{a}	0.61^{ab}	0.08^{bc}	0.02^{c}	0.0
Basal area of TSME (m^2)					
Intermediate/MS	Medium/MS	Large /MS	Small/MS	SS	NF
0.51^{a}	0.50^{a}	0.49^{a}	0.48^{a}	0.16^{b}	0.01

[1] Includes all live and dead tress > 229 mm DBH and >2 m in height. QMD = quadratic mean diameter, TSHE = *Tsuga heterophylla*, CHNO = *Chamaecyparis nootkatensis*, TSME = *Tsuga mertensiana*

[2] Strata means with the same letter were not significantly different (Tukey's Studentized Range test, alpha = 0.1)

Table 5 Mean percentages (SE) of forested habitat in 6 habitat strata detected by LANDSAT TM imagery within 62-m-radius (3 acre) plots around 28 dens and 38 resting sites used by American martens and available within the northeastern Chichagof Island study area, Southeast Alaska, 1998

Strata	Used sites			Study area
	Dens	Resting	All	
Large/MS	19.3 (5.7)	15.5 (3.7)	17.1 (3.2)	16.3
Medium/MS	26.5 (5.3)	25.9 (3.4)	26.2 (3.0)	29.2
Intermediate/MS	19.7 (4.9)	27.4 (4.0)	24.2 (3.1)	21.5
Small/MS	10.0 (2.8)	24.7 (4.6)	18.5 (3.0)	17.9
Singlestoried	4.2 (1.7)	1.3 (0.6)	2.5 (0.8)	4.1
Clearcut	20.3 (7.0)	5.1 (3.0)	11.6 (3.5)	11.0

APPENDIX A

DIET COMPOSITION AND REPRODUCTIVE PERFORMANCE IN AMERICAN MARTENS: THE ROLE OF ALTERNATIVE FOODS

Presented at the 84th Annual Meeting – The Ecological Society of America. August 1999. Spokane, WA, USA.

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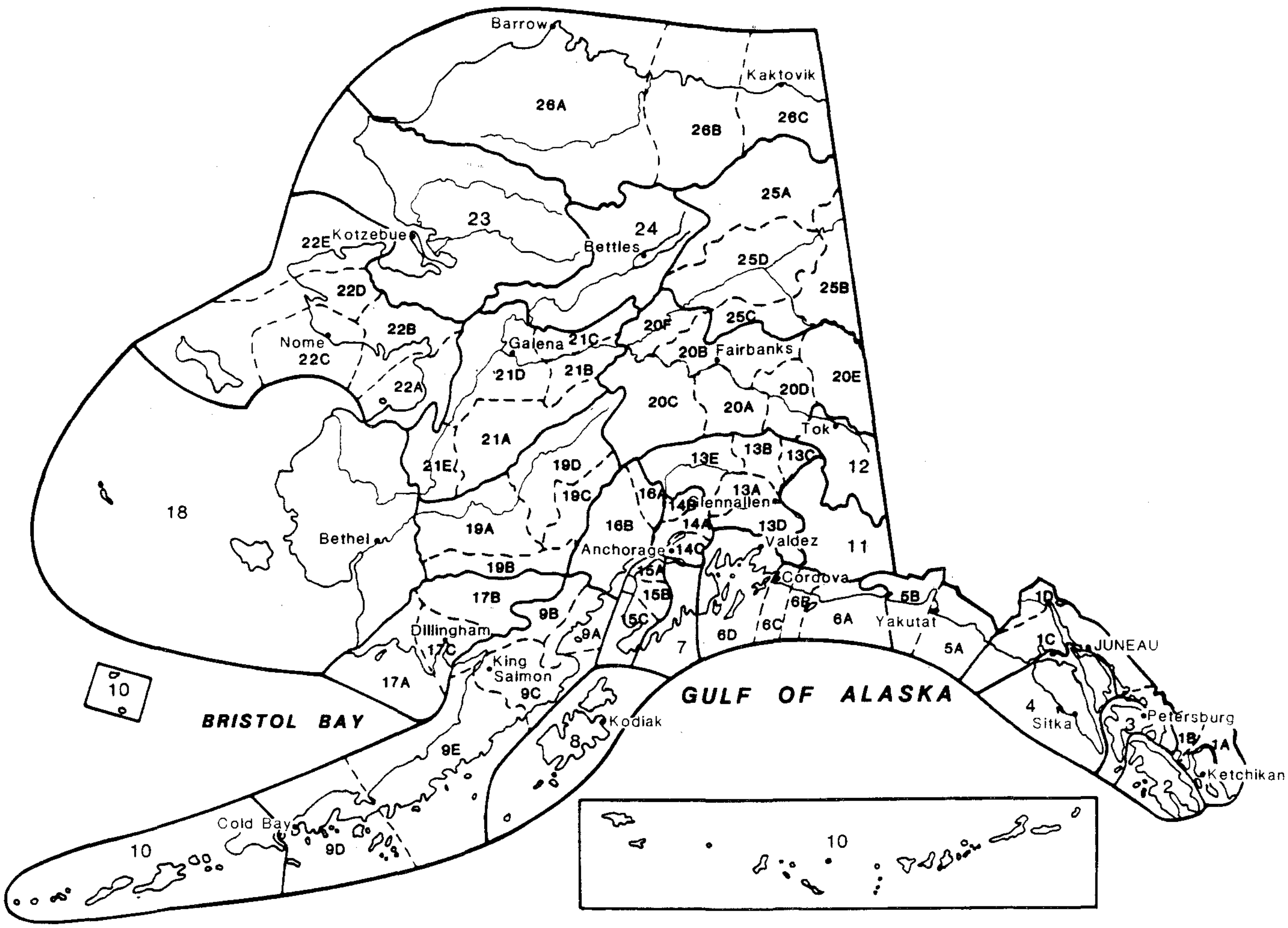
Previous studies have established a positive relationship between body condition and reproductive performance in several species of mammals. Among small mustelids, which have a limited ability to accumulate fat reserves, optimization of food intake through diet selection may partially determine reproductive success of females. In this study, we investigated diet composition, body condition, and reproductive performance of female martens (*Martes americana*) in Southeast Alaska from 1992 to 1998. Concurrently, we monitored abundance of small rodents in our study area. Stable isotope analysis of blood was used to indicate diet for 250 live-trapped martens, and percentages of prey in the diet were calculated using a dual-isotope, multi-source mixing-model. Body condition was determined from body weight as well as values of BUN, ketone bodies, glucose, and lactate levels in blood serum. Reproductive status of female martens was established from blood progesterone levels. We were unable to detect a relation between diet selection and the parameters of body condition. While age and season had a significant influence on progesterone levels in blood of female martens, no relation was established between progesterone levels and diet composition. Our results suggest that although small rodents were preferred by martens, other alternative foods such as squirrels, birds, salmon carcasses, deer carcasses, and intertidal organisms allowed martens to maintain body condition and reproduce successfully even in years when preferred foods were not readily available.

APPENDIX B

Schumacher, Thomas V. 1999. A Multi-scale Analysis of Habitat Selection at Dens and Resting Sites of American Martens in Southeast Alaska. M.S., Department of Zoology and Physiology, University of Wyoming, Laramie, WY.

I investigated habitat selection at dens and resting sites of American martens (*Martes americana*) at 3 spatial scales, a 44-m-radius stand, a 7.3-m-radius patch, and the structure used by the marten, on northeastern Chichagof Island, Southeast Alaska from 1994-1998. Specifically, I studied whether martens chose different habitat features at dens that at resting sites, whether martens exhibited selection for habitat features at these sites compared to available forested and clearcut habitat, and whether martens were more selective of habitat features as scale decreased. I located 29 dens (15 natal, 14 maternal) used by 13 martens and 52 resting sites (32 summer, 20 winter) used by 21 martens. Natal dens usually were within the boles of trees or snags, or in hard logs. Maternal dens most often were beneath the roots of trees or snags or in hard logs. In summer and winter martens most often rested beneath the roots of trees or snags. Martens used larger diameter and less decayed structures at dens than at resting sites, but habitat surrounding dens and resting sites differed little. Martens exhibited little selection for habitat surrounding dens and resting sites, but most of the study area was in old-growth condition. However, martens strongly selected denning and resting structures. Such structures were much larger in diameter than like structures in the study area and most contained a cavity caused by decay that was used by the marten. My findings demonstrate the importance of old, large-diameter structures to martens for use as dens and resting sites and help to explain the necessity of maintaining numerous, well-distributed old-growth features in marten habitat, and providing for their recruitment through time.

Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve, and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge, and attitudes for responsible hunting. Seventy-five percent of the funds for this report are from Federal Aid.

WILDLIFE RESTORATION

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