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Ecology of Martens in Southeast Alaska

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SUMMARY

Initial field work on the project was completed with the capture and radio collaring of 28 martens (*Martes americana*) (21 males and 7 females) on the northeast Chichagof Island primary study area in 1,345 trap nights. The captured martens consisted of 16 juveniles (12 males and 4 females) and 12 adults (9 males and 3 females). Fifteen radio-collared martens (12 males and 3 females) were resident on the study area; resident martens were mostly adults (80%). The estimated density of resident martens on the primary study area was 0.39 martens/km^2.

Habitat use by the radio-collared martens was recorded at 193 aerial locations during the fall/winter season. Martens were found to select higher-volume old-growth forest types (Class 5 and 6) at low elevation (<240 m), primarily western hemlock and western hemlock/Alaska cedar associations. Low-volume old-growth forests were used as available (Class 4) or avoided (Class 3). Nonforest types, including clearcuts, were not used.

A preliminary evaluation of the habitat capability model was completed based on the observed habitat selection by radio-collared martens. Martens selected timber-type class 6 greater than the model predicts. Clearcuts appeared to have little habitat value. Also, the density of resident martens on the study area appeared to be about 30% lower than model assumptions.

Home range size (95% convex polygons) of 8 resident adult males averaged 6.23 km^2; 3 females had home ranges averaging 4.43 km^2. Transient martens, both males and females, travelled extensively. The maximum distance travelled from capture sites averaged 26.1 km for males and 22.5 km for females.

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

CONTENTS

INTRODUCTION

This report contains information collected during the first year of ecological research on martens on northeast Chichagof Island, southeast Alaska. The radio collaring of a sample of martens in the study area was the primary emphasis of the first reporting year. The movements and habitat use of these animals were studied. Because several martens were captured midway in the time period, sample sizes varied substantially among animals. During spring 1990, study design for the project, along with some preliminary field work, were completed. Field techniques and procedures were tested and further refined.

Although designed as a broad ecological study, the project has been divided into 10 specific jobs. Progress on each job will be presented separately. During this report period, all jobs were active, but the emphasis was on jobs 1, 4, and 5.

Some aspects of this study were partially supported by the USDA Forest Service, Alaska Region, through contract 43-0109-9-0749, including jobs 1, 2, 3, 5, and 6. A similar progress report has been prepared to satisfy Forest Service reporting requirements.

BACKGROUND

Martens have been associated with late-successional and old-growth forests across much of North America (Weckwerth and Hawley 1962, Koehler et al. 1975, Mech and Rogers 1977, Soutiere 1978, Steventon and Major 1982, Spencer et al. 1983, Snyder and Bissonette 1987, Bissonette et al. 1989, Buskirk et al. 1989). Typically, marten populations have declined with the removal of forested habitat, increased human access, and unrestricted trapping (Clark et al. 1987). In southeast Alaska, martens have been the focus of the fur industry with an average annual harvest of 2,770 animals between 1984 and 1988 (ADF&G unpubl. records, Douglas). Because forest management activities were expected to affect population abundance and marten pelts represented significant economic value to local residents, martens were selected as a management indicator species (MIS) for the revision of the Tongass Land Management Plan (TLMP) (Sidle and Suring 1986, USDA Forest Service 1990). Old-growth forests were identified as a special habitat for the species in southeast Alaska where the Tongass National Forest encompasses more than 90% 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. About 162,000 ha of old-growth habitat have already been logged on the Tongass National Forest, and the current Tongass National Forest Land Management Plan (TLMP) schedules an additional 708, 000 ha (USDA Forest Service 1990) to be logged.

Old-growth conifer forests provide martens with important habitat components including high percentage overstory canopy cover, snags, fallen logs, trees with exposed root systems, and abundant understory (Clark et al. 1987). Old-growth forests often support abundant small mammal prey because of the lush shrub and forb vegetation and structural diversity of the understory. Overstory canopy cover provides martens with protection from potential predators (Clark et al. 1987). Old-growth forests provide important microsites for martens, including resting and denning sites in large live trees, snags, and down wood (Buskirk 1984, Clark et al. 1987, Buskirk et al. 1989). Because little fat can be stored (Buskirk and Harlow 1989), martens need to select for resting that will conserve body heat (Buskirk et al. 1988).

Several studies have documented the negative impacts of logging on marten populations (Soutiere 1978, Campbell 1979, Steventon and Major 1982, Snyder and Bissonette 1987, Thompson and Colgan 1987a, Bissonette et al. 1988). These impacts include the removal of overstory cover, the loss of coarse woody debris (standing snags and down wood), reductions in prey abundance and hunting efficiency, greater habitat fragmentation, and increased human access. In particular, clearcutting old-growth forest removes all of the forest canopy and standing dead wood which have been found to be important components of marten habitat. As clear-cut stands begin to generate in southeast Alaska, the overstory canopy closes after 15 to 25 years, smothering understory forbs and shrubs which provide important habitat for small mammal prey (Harris 1968; Van Horne 1981, 1982). Eventually, the large down wood in the regenerating stand decays and disappears, further reducing the habitat value for martens and small mammal prey. In addition to the stand-level effects to habitats, forest management has landscape-level effects such as road construction into previously roadless areas and habitat fragmentation (Franklin and Forman 1987, Bissonette et al. 1989). Logging roads greatly increase trapper access to martens; this can result in overexploitation. Bissonette et al. (1989) recognized the need for landscape-level management for martens including the maintenance of large habitat patches and movement corridors.

The Forest Service needs to assess the effects of forest management activities on potentially affected wildlife species in forest-level and project-level plans. A habitat capability model is being developed by an interagency group to quantitatively assess the impact of land management activities on marten (Suring et al. 1988). Because of the lack of field studies on martens in southeast Alaska, the habitat capability model is based on assumptions about marten habitat relationships inferred from studies conducted elsewhere. The assumed habitat relationships in the model need to be compared with field data from studies in southeast Alaska before the effects of forest management activities on marten populations can be predicted with higher confidence.

Several models have been developed to evaluate marten habitat (Allen 1982, Patton and Escano 1983, Spencer 1982, Ritter 1985, Suring 1987, Suring et al. 1988, E. Lofroth and Banci 1991). These models recognize the importance of late-successional coniferous forests with high overstory canopy cover, standing dead wood, and large coarse woody debris. The Suring et al. (1988) model also incorporated a factor relating road density to the effectiveness of habitats to provide cover from humans. Current habitat capability models have not been evaluated rigorously, although some efforts at field testing have been made (Spencer 1982). Laymon and Barrett (1986) found untested habitat capability models to perform poorly. A good study design is critical in evaluating models. Laymon and Barrett (1986) recommended that a study design include the following: 1) a study area with the full range of habitats, 2) an unbiased sample of study animals, 3) more than 1 test measure, and 4) data from more than 1 year.

Although martens are opportunistic feeders and their diet includes a wide variety of plant and animal matter (Strickland and Douglas, 1987), most studies have found small mammals to be important foods (Clark et al. 1987). Voles, especially *Microtus* sp., usually comprise the highest proportion of the diet (Clark et al 1987). Nagorsen et al. (1989) found small mammals, deer, birds, and salmonid fish the major food items of martens on Vancouver Island. In the Yukon, Slough et al. (1989) found marten diets comprised mostly of microtine rodents. Marten population declines have been related to population declines of prey species (Weckwerth and Hawley 1962, Thompson and Colgan 1987b). Small mammal populations, especially *Microtus* sp., often fluctuate greatly from year to year. Populations trends and habitat relationships of small mammals in southeast Alaska have received little study. Reid and Warner (1980) and Russell (1988) reported the results of small mammal trapping in clearcuts on Chichagof Island as part of USDA Forest Service administrative studies on seedling regeneration.

Although indigenous on only the mainland and a few islands, martens are now common throughout most of southeast Alaska (Johnson 1981). During 1930-1950, martens were introduced to Prince of Wales, Chichagof, and Baranof islands (Burris and McKnight 1973, Johnson 1981). Although no records of transplants to Admiralty Island exist, martens may have escaped from a fur farm on nearby Windfall Island in 1918 (Beier 1987). Currently, martens are common on Admiralty Island. Red squirrels (*Tamiasciurus* *hudsonicus*) were introduced to Chichagof and Baranof islands during 1930-31 to provide a food source for the newly released martens (Burris and McKnight 1973).

The taxonomy of martens in southeast Alaska is unclear. According to Hall and Kelson (1959), the mainland is occupied by 2 subspecies of the *americana* group - *M. a. kenaiensis* north and west of Lynn Canal and *M. a. actuosa* south to about the Canadian border - while the islands are all listed as *M. a. nesophila* of the *caurina* group. Apparently, Hall and Kelson (1959) didn't realize that most of the island populations were established from martens transplanted from the mainland. Giannico and Nagorsen (1989) found 3 morphological groups among the Pacific coast martens that they examined - a Queen Charlotte Islands group, southeast Alaska group, and a Vancouver Island and coastal British Columbia group. They concluded that the subspecies *nesophila* be applied only to Queen Charlotte Islands populations, and Vancouver Island and coastal British Columbia martens were aligned with *M. a. caurina*. Because martens in southeast Alaska showed some affinities with the *americana* subspecies group, the *caurina* and *americana* types may intergrade here.

OBJECTIVES

This research is designed to describe the habitat and population ecology of martens on northeast Chichagof Island. The information obtained from this study will be used to evaluate the interagency habitat capability model.

The specific study objectives (jobs 1-8) are as follows:

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

7. Determine the winter diet 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

Southeast Alaska consists of rugged mountains, numerous islands, and conifer-dominated temperate rain forest. Mountains rise from the sea to over 1,400 m. The climate is maritime with cool, moist weather. The annual precipitation in the Juneau area ranges from 135 cm at the airport to 236 cm downtown. Heavy snow accumulations often occur in winter; higher elevations are snow-covered for 7 to 9 months of the year. The natural vegetation is dominated by temperate rain forest, one of the world's most limited ecosystems (Alaback 1988), interspersed with muskegs and alpine tundra. Because of the lack of frequent, large-scale, catastrophic natural disturbance, the rain forests of southeast Alaska are predominantly in an old-growth condition (Alaback and Juday 1989). Sitka spruce (*Picea sitchensis*) or western hemlock (*Tsuga heterophylla*) dominate the overstory of most plant associations on productive sites (Martin 1989, Alaback and Juday 1989, Samson *et al.* 1989). Poorly drained sites often contain mountain hemlock (*Tsuga mertensiana*), Alaska cedar (*Chamaecyparis nootkatensis*), or western red cedar (*Thuja plicata*). The understory, depending on site conditions, may be dominated by shrubs such as blueberry (*Vaccinium* spp.), rusty menziesia (*Menziesia ferruginea*), or devil's club (*Oplopanax horridum*); bunchberry (*Cornus canadensis*), trailing raspberry (*Rubus pedatus*), and skunk cabbage (*Lysichitum americanum*) are common forbs.

The northeastern portion of Chichagof Island was chosen as the study area because the topography and habitats were typical of northern southeast Alaska including a substantial amount of logged and unlogged areas. Also, a logging road system provided access to portions of the area, lodging facilities were available through the USDA Forest Service, and the area was relatively close to Juneau. The area adjacent to Salt Lake Bay (58^0 56'N, $135^0$20'E), located about 56 miles west of Juneau and 16 miles south of Hoonah, was selected as the primary study area. Because several martens moved off the primary study area after capture, the remainder of northern Chichagof Island was treated as a secondary study area.

The primary study area included about 130 km^2 in USDA Forest Service Value Comparison Units (VCUs) 202, 222, and 223 on the Hoonah and Sitka ranger districts on the Chatham Area of the Tongass National Forest. The primary study area was bounded by Port Frederick to the north, Tenakee Inlet to the south, a narrow portage between the large water bodies on the west, and the Game Creek and Indian River drainages on the east (Fig. 1). Most habitats typical of northern southeast Alaska occur on the study area including a range of physiographic types from beach fringe to alpine.

Habitats were defined based on criteria developed according to the USDA Forest Service, Alaska Region. Timber volume classes were as follows: Class 3 = 0-20 thousand board feet (mbf)/ha, Class 4 = 20-50 mbf/ha, Class 5 = 50-75 mbf/ha, Class 6^+ = >75 mbf/ha. Nonforest was an area with <10% forest canopy cover at a height >3 m. Clearcuts were considered a nonforest type. Physiographic types were defined as follows: beach fringe = within 150 m of shoreline; riparian = the ecological riparian zone or within 30 m of stream bank which ever was greater; low uplands = <240 m elevation excluding the beach fringe and riparian; high uplands = between 240 and 450 m elevation excluding the riparian; subalpine = forested lands >450 m elevation; and alpine = nonforest >610 m. Old-growth forest types were defined according to Boughton et al. (In press), and second-growth forest types were stands that did not meet the criteria of old-growth forest.

Some habitats are relatively rare including second-growth forest (<1%) and high volume old-growth forest (5.4%). About 7% of the primary study area was logged during 1984 to 1988, and 27 km of road were constructed. Under the current timber operating plan (USDA Forest Service 1989), an additional 486 ha are scheduled for clearcut logging this year. About 10 km of new logging road were built in June 1990 to prepare for the planned logging. An injunction issued by the Appeals Court, 9th Circuit, suspended all logging activity between July 1990 and June 1991. The court injunction was lifted for the Salt Lake Bay units during June 1991, and the Forest Service has cleared them for clearcut logging in September 1991.

Twenty-one martens (5 males, 6 females, 8 unknown) were introduced to Chichagof Island between 1949 and 1952 (Elkins and Nelson 1954). The animals were captured from several geographic areas including Baranof Island (4, original population source was Cape Fanshaw), the Stikine River (5), Wrangell Island (4), Mitkof Island (2), Ketchikan (1), and the Anchorage area (3). All transplanted martens were released near Pelican. Red squirrels (*Tamiasciurus hudsonicus*) were introduced at several sites on Chichagof Island in 1930 (Elkins and Nelson 1954) to establish a food source for the martens.

Recreational and subsistence trapping seasons for martens, mink, and weasels on northeast Chichagof Island were closed during 1990-91 because of depleted marten populations. The portion of northern Chichagof Island west of Port Frederick remained open. Previously, northeast Chichagof Island was trapped quite heavily along the beach fringe and logging road system, including the Salt Lake Bay area. Although all martens taken in southeast Alaska have required sealing by the Department since 1984, vague geographic reporting by trappers has made it impossible to determine how many martens have been trapped on the primary study area during recent years.

On Chichagof Island, the small mammal fauna probably consists of only 5 species - Sitka mouse (*Peromyscus sitkensis*), long-tailed vole (*Microtus longicaudus*), tundra vole (*Microtus oeconomus*), masked shrew (*Sorex cinereus*), and red squirrel. In addition to martens, the larger terrestrial mammal fauna of the study area included mink (*Mustela* *vision*), land otters (*Lutra canadensis*), short-tailed weasel (*Mustela erminea*), brown bear (*Ursus arctos*), and Sitka black-tailed deer (*Odecoilus hemionus sitkensis).*

METHODS

Most study jobs required the capture and radio collaring of a sample of martens on the primary study area. Martens were live-trapped on the study area throughout the year at 64 permanent trap sites located systematically along the logging road system. Traps (Models 203 and 205, Tomahawk Live Trap Co., Tomahawk, WI) were baited with strawberry jam during the summer and sardines during the remainder of the year, covered with a green tarp, and placed under a log or the base of a tree at trap sites. The traps were checked at least daily. Captured martens were run into a holding cone and immobilized with a mixture of 10 mg/kg ketamine (Ketaset) and 2 mg/kg xylazine (Rompun) (Archibald and Jessup 1984). All captured martens were ear tagged (Size 1, Style 1005, Natl. Band and Tag Co., Newport, KY), sexed, weighed, measured, and a first premolar pulled for age determination by cementum analysis (Matson's Lab., Milltown, MT). An injection of tetracycline (25 mg/kg) was given as an antibiotic and to provide a mark in calciferous tissues (Strickland and Douglas 1987). All martens were radio collared (Telonics, Mesa, AZ). A 40 g radio collar (MOD-070, expected life of 9 months) was placed on females and a 55 g radio collar (MOD-080, expected life of 12 months) was placed on males. After a marten had recovered from the drugs, it was released at the capture site. If a marten was recaptured within 1 month, it was released without processing. After a month had passed, all recaptures were reprocessed. Because of the short radio life, radio collars were replaced on several animals during the year.

An attempt was made to capture all resident martens in the study area to determine sex and age composition. Animals that showed high site fidelity throughout the period were considered residents. Martens that showed short-term site fidelity (less than a year but more than 3 months) were considered temporary residents. Martens that remained on the study area for less than 3 months and showed no site fidelity were called transients. Martens greater than 1 year-of-age were considered adults, and young-of-the year animals were called juveniles.

Job 1. Habitat selection. Radio-collared martens were located from small aircraft (Mech 1974, Kenward 1987) during daylight hours throughout the year. A Piper Super Cub aircraft was used mostly. Each located marten was assigned to a relatively homogenous stand, and the location of the stand was plotted on high resolution orthophotoquad maps (1:31,680 scale) while circling in the aircraft above the location. The forest-stand type for each location was described using 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). After returning to the office, the locations were transferred to mylar overlays on color aerial photographs (1:15,840 scale) of the study area for future photo interpretation work. Universal Transverse Mercator (UTM) coordinates were determined for each location using a digitizer with the orthophotoquad maps. Additional stand-level habitat attributes were recorded from the orthophotoquad maps including elevation and aspect.

Habitat selection was determined by comparing the proportionate use of habitats with their availability (see Job 2) in the study area (Neu et al. 1974, White and Garrott 1990). Data collected during September through April 1990-91 were considered to represent inter season habitat use. Because of small sample sizes for individual animals, all locations for all animals were pooled for this report. In future analyses, the habitat use of each animal will be compared with the availability of habitats within its home range area and the entire primary study area. A Chi-squared goodness-of-fit test was used to test the null hypothesis that habitats were used by martens in proportion to their availability. If the null hypothesis was rejected, then each habitat was evaluated separately for selection using Bonferroni normal statistics (Neu et al. 1974, Byers and Steinhorst 1984, White and Garrott 1990). Ivlev's (1961) index of electivity (E_t), scaled to vary from 0.00 to 1.00, and Manly's measure of preference (Manly et al. 1972, Shesson 1983) were computed for each habitat category to characterize the degree of selection of a particular habitat. Habitat capability indices (HCI), based on each selection index, were computed by dividing the selection index for each habitat by the maximum index value for that index (e.g. $HCI_i = E_{t\,i}/E_{t\,max}$).

Job 2. Habitat composition. The composition of habitats, described by timber type and physiographic type, for the stand-level analysis was generated by staff of the USDA Forest Service from their geographic information system (GIS) "points" database for VCUs 202, 222, and 223. Although the VCU boundaries did not match the primary study boundaries exactly, the composition of habitats in the areas was assumed to be similar for this report. Information on the abundance of old-growth forest types was not available from this database. This GIS "points" database was created especially for the TLMP Revision project by systematic computerized sampling of the timber-type maps with the elevation contours and physiographic types identified. Each point sample represents the midpoint of a 8.1-ha hexagon.

The proportion of habitats in the study area was considered a measure of habitat availability. Additional landscape attributes such as roads, corridors, stand size, and composition of adjacent stands will be collected next year for evaluating landscape-level effects.

Although the accuracy of the timber volume class data was unverified, it was the only mapped information available. The accuracy of the data base will be investigated during the next year by visiting several stands on the ground. If the database appears inaccurate, the study area will be remapped using a combination of standard remote sensing and ground verification techniques next year.

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. 1988) was evaluated in 2 ways using the general considerations listed by Schamberger and O'Neil (1986). The emphasis of testing will be on the assumptions used and variable values instead of overall outputs. Habitat selection indices for the fall/winter season were compared with habitat capability coefficients in the marten habitat capability model (Suring et al. 1988). Also, the estimated density of adult resident martens on the primary study area was compared with assumptions in the model.

Job 4. Population characteristics. An attempt was made to live-trap all resident martens on the primary study area. The sex and age structure of resident martens were compared with transient martens captured in the primary study area. The time and cause of any mortality of radio-collared martens during the report period was recorded.

The density of male martens on the primary study was estimated by computing the inverse of the mean home range size of resident males ($D = 1 / x_{male}$, where D = density and x = mean home range size for males). Female density was calculated similarly. The density of resident martens was estimated by summing the estimated density of resident males and females ($D_{total} = (1 / x_{male}) + (1 / x_{female})$.

Job 5. Spatial patterns and movements. Home ranges of resident martens were estimated from radio-telemetry locations (Kenward 1987). Radio-collared martens were located from small aircraft once a week depending on weather conditions. Although a substantial number of locations were obtained from the ground, these data were not analyzed during this report period. Aerial locations were plotted on high resolution orthophotoquad maps (1:31,680 scale) and recorded as Universal Transverse Mercator (UTM) coordinates. Marten home ranges were modeled using the computer program HOME RANGE (Ackerman et al. 1990). Locations were tested for independence (Swihart and Slade 1985) and outliers examined (Samuel et al. 1985). Several methods of delineating home range were evaluated including the harmonic mean method (Dixon and Chapman 1980) and 100% and 95% convex polygons (Ackerman et al. 1990). Core areas within home ranges were examined (Samuel et al. 1985b), but most animals had too few relocations for reliable estimates. Harmonic centers of activity were plotted (Ackerman et al. 1990).

The maximum distance travelled from initial capture sites was recorded for each transient animal, and the mean distance for males and females compared. Transient martens were difficult and expensive to locate because of their extensive travels and the limited range of the radio transmitters. The entire secondary study area was searched each month from aircraft to locate transient martens.

Job 6. Small mammal abundance. The preliminary information on the relative abundance of small mammals, excluding red squirrels, was determined using a snap-trap index (Calhoun 1948). Transects were established in 2 stands: 1 western hemlock old-growth stand and a 5-year clearcut. Twenty-five stations were established along each transect at 15-m intervals. Two Museum Special snap traps were placed at each station, baited with peanut butter, and set for 3 consecutive nights. The traplines were operated in early September when small mammal populations should be at their annual peak. Data were recorded as the number of animals of each species caught per transect and per 100 trap nights.

Job 7. Winter diet. Marten scats were collected at trap sites and as they occurred opportunistically along roads and trails. The scats were labelled and frozen for future analyses. Carcasses were not collected from trappers operating near the study area this year.

Job 8. Evaluation of field sexing and aging technique. Skulls of trapper-caught martens were collected during 1989-90 from several areas in the Ketchikan area by Robert Wood. These were collected to evaluate the field technique for sexing and aging martens proposed by Magoun et al. (1988). Total skull length and length of temporal muscle coalescence were recorded for each specimen according to methods by Magoun et al. (1988). A lower canine tooth was extracted for age determination by cementum analysis (Matson's Lab., Milltown, MT). Data will be analyzed according to Magoun et al. (1988) and compared with samples from other parts of Alaska.

RESULTS AND DISCUSSION

During the 1990-91 biological year, 28 martens (21 males and 7 females) were captured 50 times on the primary study area in 1,345 trap nights (Table 1). The highest capture rate was recorded during early winter (November through January), and the highest capture rate for new animals was during November. All captured martens were radio collared, weighed, and aged (Table 2). Only 1 new resident marten was captured after 10 January.

Job 1. Habitat use and selection. To determine habitat use, radio-collared martens were located 193 times from small aircraft during the fall/winter season to determine habitat use. No significant differences were found in the use of timber volume class, old-growth forest type, or physiographic types by resident and transient martens (X^2 = 1.4, 5.2, and 1.4; $P > 0.27$). Also, no significant differences were found between males and females (X^2 = 4.3, 1.4, 9.1; $P > 0.11$). Thus, all observations were pooled for the remainder of the analyses.

Martens showed significant selection for timber volume class ($X^2 = 69.4$; $P < 0.001$) with greater than expected use of classes 5 and 6 (Table 3). Class 3 old-growth forests and nonforest types, including clearcuts, were avoided. Class 4 stands were used in proportion to their availability. Class 6 stands were usually western hemlock or Sitka spruce old-growth forest types, and the Class 5 stands were primarily western hemlock, western hemlock/Alaska cedar, and mountain hemlock old-growth forest types.

Martens selected low-elevation upland habitats and avoided subalpine/alpine areas. Riparian/beach fringe (16.1%) and high-elevation upland habitats were used similarly to their availability (Table 4). Although beach fringe habitats were not preferred, 33% of the radio-collared martens were located in beach fringe habitats. Because streams in the primary study area are small, riparian habitats constituted a small portion of the study area.

Although the availabilities of the old-growth forest types were unknown, the more productive western hemlock, western hemlock/Alaska cedar, mountain hemlock, and Sitka spruce types appeared to be the preferred marten habitats on northeast Chichagof Island during winter. Western hemlock/Alaska cedar old-growth forests were used the most frequently (41%) by martens. Marten also frequently used western hemlock forest types (35%) (Fig. 2). Mixed conifer types, which were abundant, were little used (10%).

More information on the selection of old-growth forest types will be collected during subsequent years of study. Emphasis will be on measuring individual variation in habitat selection.

Job 2. Habitat composition. Information on the composition of habitats in the primary study area was provided by staff of the USDA Forest Service from their GIS "points" database. Only information on timber volume class and physiographic type were available for this report period (Tables 3, 4). Although the accuracy of these data was unverified, it was the only information available for this report period. The accuracy of the data base will be investigated during the next year by visiting several stands on the ground. If the database appears inaccurate, the study area will be remapped using a combination of standard remote sensing and ground verification techniques in conjunction with USDA Forest Service staff. Also, the abundance of old-growth forest types on the primary study area will be estimated using similar procedures. Additional landscape attributes such as roads, corridors, and stand size will be collected next year to evaluate landscape-level effects.

Job 3. Habitat capability model evaluation. A comparison of the habitat capability coefficients in the habitat capability model with the habitat selection indices from this study (Table 5) indicate that the coefficients for several habitat categories were substantially different. Although the model evaluation is preliminary, available information indicates that model capability coefficients need adjustment. Using Ivlev's rescaled electivity index as a measure of habitat capability, old-growth Class 6 was found to have a higher selection index compared with Class 5 (1.00 vs. 0.86) and should be given a higher value. In the model, Classes 5, 6, and 7 were considered to have similar value. Nonforest types, including clearcuts, were not used by radio-collared martens. The capability of clearcuts (i.e. seedling/sapling stand age) should be reduced to 0.00.

Second-growth forest was not adequately evaluated because of the low availability of this forest type (6%).

If rescaled Manly's preference indices are used as the measure of habitat capability instead of Ivlev's, the model's capability coefficients would need greater adjustments (Table 5). Habitats would be ranked in the same order but the values would be different. Class 6 stands would have a relatively greater habitat capability compared with the lower timber volume classes. Manly's preference index has better statistical characteristics (Lechowicz 1982) and biological interpretation (Heisey 1985) and probably should be used as the measure of habitat capability.

The model assumed that beach fringe and riparian habitats have a 10% higher suitability than upland habitats. Radio-collared martens showed no selection for beach fringe and riparian habitats, and this distinction should probably be dropped from the model.

The habitat capability model assumed that the capability of high-elevation upland habitats is 60% of low-elevation uplands and subalpine forests have no value. Although radio-collared martens selected low-elevation uplands, used high-elevation uplands as available, and avoided subalpine/alpine habitats, the selection may be more related to the distribution of old-growth forest types than elevation. The more productive forest types are generally found more frequently at lower elevation, especially below 240 m elevation. Although used less than available, subalpine forests (i.e. elevations > 450 m) were used occasionally (2.6%), so these habitats have some value to martens, especially Class 4 and 5 stands of mountain hemlock old-growth forest. Subalpine forest stands are often highly fragmented by nonforest, especially avalanche slide areas, and the habitat value to martens is probably reduced.

The habitat capability model assumed an average density of 1.54 martens/km^2 in habitats with the highest capability (HCI = 1.0). This density assumption predicts an average density of 0.63 martens/km^2 on the primary study area. The estimated density of resident adults from this study was 0.39 martens/km^2 or 62% of the predicted density. The marten population on the primary study area may not be at carrying capacity, so the capability of the area may be slightly higher than observed during 1990-91. Based on the preliminary results from this study, I recommend that the assumed densities in the habitat capability model be reduced by 30% and redefined to represent only resident martens. Transient martens travel extensively and probably are not reproductively active, so they should not be counted when determining capability.

Job 4. Population characteristics. Of the 28 martens captured on the primary study area, 21 were males and 7 were females. Fourteen martens (11 males and 3 females) were classified as residents, and 3 males were temporary residents that left the primary study area in spring (Table 6). The remaining 11 martens (7 males and 4 females) were transients that spent little time on the primary study area and travelled extensively during the period. One male marten (#11) was relocated only once after capture and assumed to have left the primary study area immediately. Most resident male martens on the primary study area had probably been captured because the capture rate for new martens decreased towards the end of the period (Table 1). Most resident males were captured several times (Table 2), and most of the available space was occupied by resident males. Conversely, all resident females probably had not been captured because the total number captured was low and the radio-collared resident females occupied little of the available landscape.

The age structure of the captured martens was relatively young (Fig. 3) with a young:100 adult ratio of 57:100. Only 18% of the martens were 3^+ years old, the usual age of sexual maturity. Resident martens were mostly 1 year-of-age or older (79%), and only 3 residents were juveniles (21%). I suspect that 1 resident marten classified as a juvenile by cementum aging was actually a yearling (#9) based on skull characteristics. Transient martens were all juveniles, and temporary residents were yearlings (67%) or juveniles (33%). The young age structure of the resident martens on the primary study area probably reflects a recent history of overexploitation by trapping.

Only 2 radio-collared martens (1 juvenile male and 1 juvenile female) died during the period; both were caught by trappers on the west side of Port Frederick during the trapping season. Male marten #8 was captured in beach-fringe forest on 14 January 1991 in Mud Bay about 38 km from its capture site. Female #17 was captured on 15 December 1990 in beach fringe forest on the west side of Port Frederick, 16 km from its capture site. These 2 martens were the only animals in the area open for trapping during the open season. All other radio-collared martens were known to be alive on 30 June 1991, except #11. This information suggests that survival was generally high in the area closed to trapping, but mortality was quite high in the area open to trapping.

The estimated density of resident adults on the primary study area was 0.39 martens/km^2 (males = 0.16/km^2, females = 0.22/km^2) based on mean home range size. This density estimate does not include 2 juvenile males (#20, #23), which appeared to have small home ranges tucked between resident adult males, because insufficient information was collected to estimate their home range sizes. The marten population on the primary study area appeared near carrying capacity because 2 temporary residents (#14, #22) and 11 transients did not remain there.

Job 5. Spatial patterns and movements. Home ranges were modelled for resident martens with an adequate number of relocations (Table 7). About 20 independent locations appeared to adequately describe home ranges using the convex polygon method. Harmonic mean estimates were quite variable, and sample sizes were probably not adequate for this method. Because almost every animal had 1 location outside of its "usual" use area, 95% convex polygons were used to represent home ranges.

Home range size of adult males was larger (t = 1.1, P = 0.076) and more variable than that of adult females (CV = 48% and 24%). Although the mean home range size of adult males (6.23 km^2, 95% CI = 4.17-8.29) was larger than adult females (4.4 km^2, 95% CI = 3.23-5.63), the 2 older females (#10 and #19) had home ranges larger than 4 males (Fig. 4). Female marten #25, a yearling, had the smallest home range (3.2 km^2). Home range size of males was larger (t = 1.1, P = 0.076) and more variable than females (CV = 48% and 24%). To fully understand home range size, more resident females need to be radio collared. The male with the largest home range (#16) used 2 watersheds separated by a high mountain ridge with a substantial amount of nonforest vegetation.

Adult martens showed little intrasexual overlap of home ranges described by 95% convex polygons (Fig. 5, 6). Two juvenile male martens (#20 and #23) appeared to have small home ranges tucked among resident adult males. Although adult male marten #5 overlapped about 25% with both adjacent resident adult males (#4 and #21), harmonic centers of activity were well separated (Fig 5) with 2.35 km between martens #5 and #21 and 1.74 km between martens #5 and #4. Adult female home ranges showed no overlap (Fig. 6) with 2.58 km between centers of activity of adjacent female martens #10 and #19.

Home ranges of adult male and female martens showed substantial overlap. Female marten #10's home range was almost completely within the home range of male #6. Likewise, the home of range of female #19 was within the home range of male #15. Female #25 overlapped somewhat with male #16. No radio-collared male overlapped with the remainder of #25's home range, but this area may have been occupied by an uncollared male.

Transient martens spent little time on the primary study and travelled extensively. Both sexes travelled similarly with no significant difference between mean maximum distance travelled from capture site (Table 8). Based on this sample, 67% of the transient martens in a population could be expected to move up to 34.8 km. Because of the short transmission range of the radio collars, transient martens were difficult and expensive to locate. Although an attempt was made to locate all radio-collared martens every month, actual relocations were sporadic. Some of the transients appeared to have established home ranges at a different location, and these animals were easier to monitor. Several transients appeared to temporarily locate in an area before moving to a new location, often a great distance away. Some transients moved substantially between each relocation.

Job 6. Small mammal abundance. During September 1991, 35 small mammals (20 Sitka mice, and 15 long-tailed voles) were captured on 2 transects in 294 trap nights (11.9 captures/100 trap nights). One transect was located in a 4-year-old clearcut at 150 m elevation; the other transect was located in a western hemlock/well-drained, old-growth stand at 90 m elevation. More small mammals were captured on the clearcut transect (16.0 vs. 7.6 captures/100 trap nights). Species composition was similar on both transects with a slightly higher percentage of Sitka mice captured on the old-growth transect (64% vs. 54%).

Small mammal data from other studies on northeast Chichagof Island used different methodologies (Reid and Warner 1980, Russell 1988) making comparisons difficult. Russell (1988) trapped a 10 X 10 grid with 2 snap traps spaced 9.1 m apart for 5 days. Using this technique in a recent clearcut, Russell (1988) captured 5.5 long-tailed voles/100 trap nights and 0.5 Sitka mice/100 trap nights. Reid and Warner (1980) estimated long-tailed vole densities in clearcuts at 8 to 31 per ha and Sitka mouse densities at 4 to 12 per ha based on 6 live-trapping grids during summer 1980. This information suggests that long-tailed vole densities in the area were similar or higher compared with 1988, and Sitka mouse densities appeared greater. The small mammal trapping will be expanded greatly during the next report period to include more habitats and replicates.

Job 7. Winter diets. Twenty marten scats were collected in the primary study area and frozen for future analyses.

Job 8. Evaluation of field sexing and aging technique. Seventy-six marten carcasses were collected by Robert Wood from local trappers in the Ketchikan area. The skulls of these martens were measured and a canine tooth extracted for cementum aging. Audrey Magoun remeasured the skulls and reviewed the cementum ages. These data will be analyzed and evaluated during the next report period.

Job 9. Scientific meetings and workshops. A paper titled 'Marten research in southeast Alaska' was presented at the Northern Furbearer Conference held in Fairbanks, Alaska in April 1991. During 29 May to 1 June 1991, an international Symposium on the Biology and Management of Fishers and Martens held in Laramie, Wyoming, was attended. The project leader participated in a panel discussion on marten habitat management.

Job 10. Reports and scientific papers. Besides completing this progress report, a draft paper titled "Conservation of martens in southeast Alaska" was prepared. This paper will be published by the USDA Forest Service, Alaska Region, Juneau, Alaska as a chapter of a document titled 'Conservation of forest wildlife in southeast Alaska'. This paper will form the basis of the viability analysis for the Tongass National Forest Land Management Plan. Also, a draft technical report on "Definitions for Old-growth forests in southeast Alaska" was prepared in conjunction with participation in the Regional Old-growth Definition Task Group.

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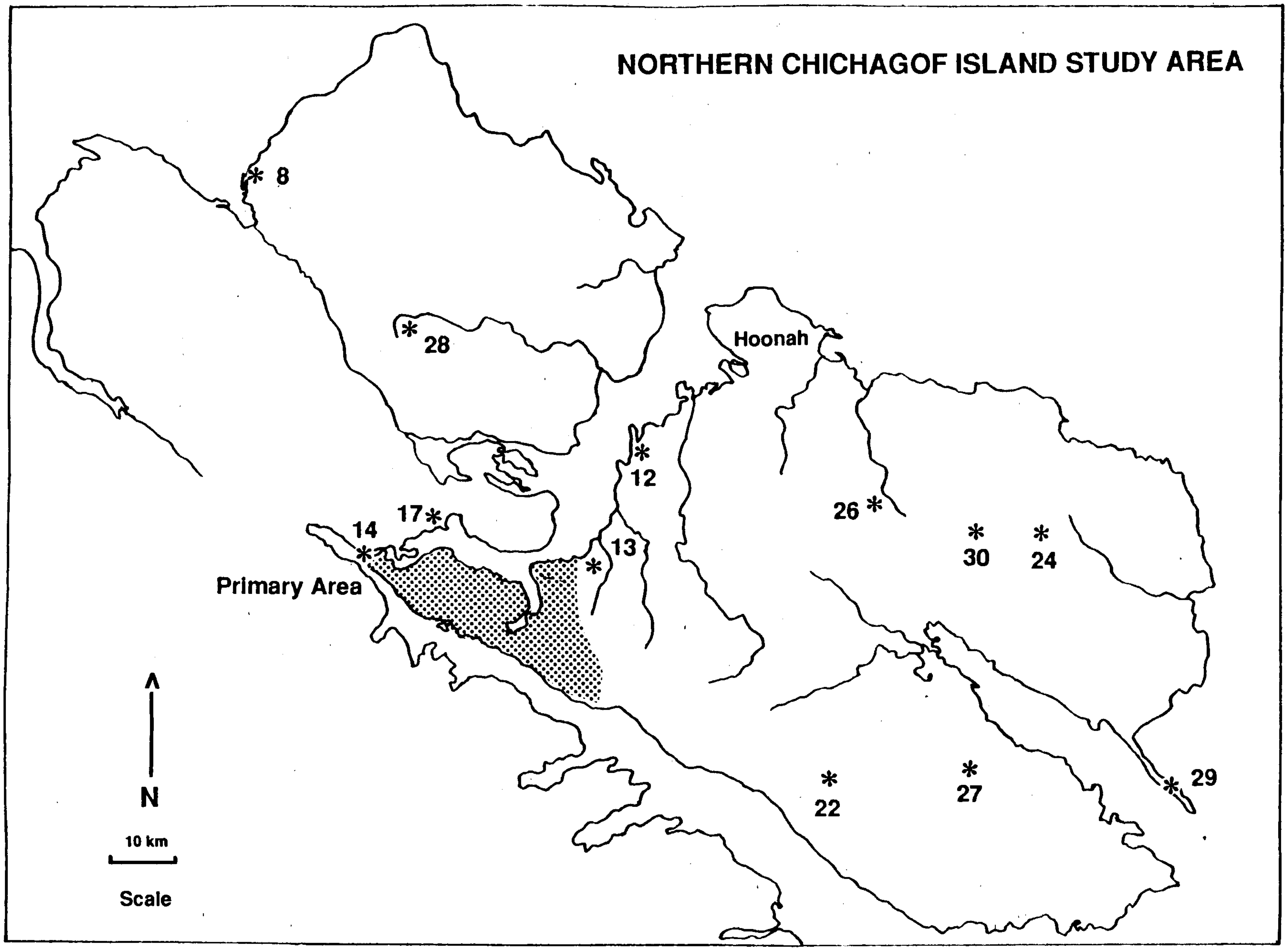

Figure 1. Location map of northern Chichagof Island study area showing the primary study area and the last locations of transient martens.

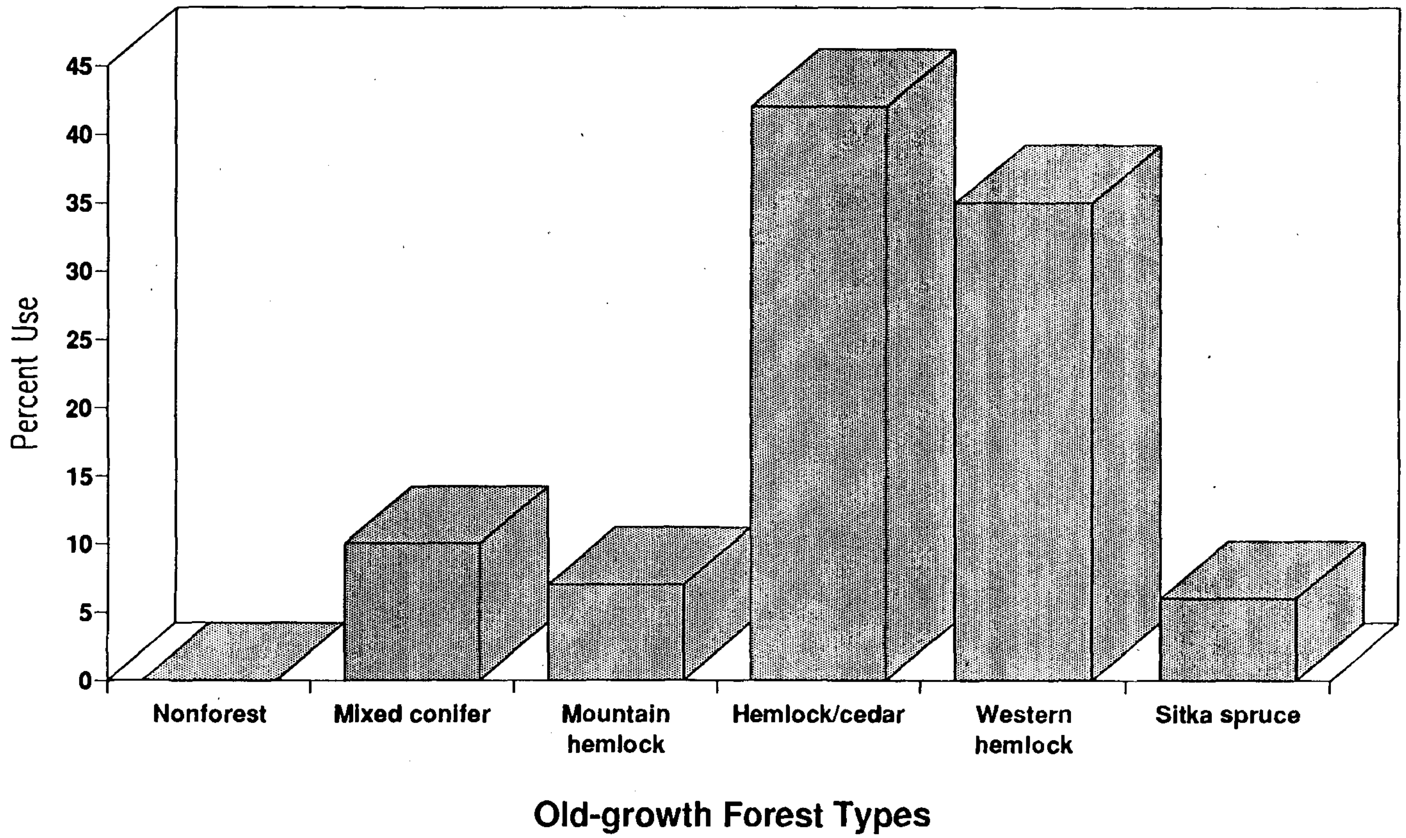

Fig. 2. Use of old-growth forest habitats by radio-collared martens on northeast Chichagof Island during the fall/winter 1990-91.

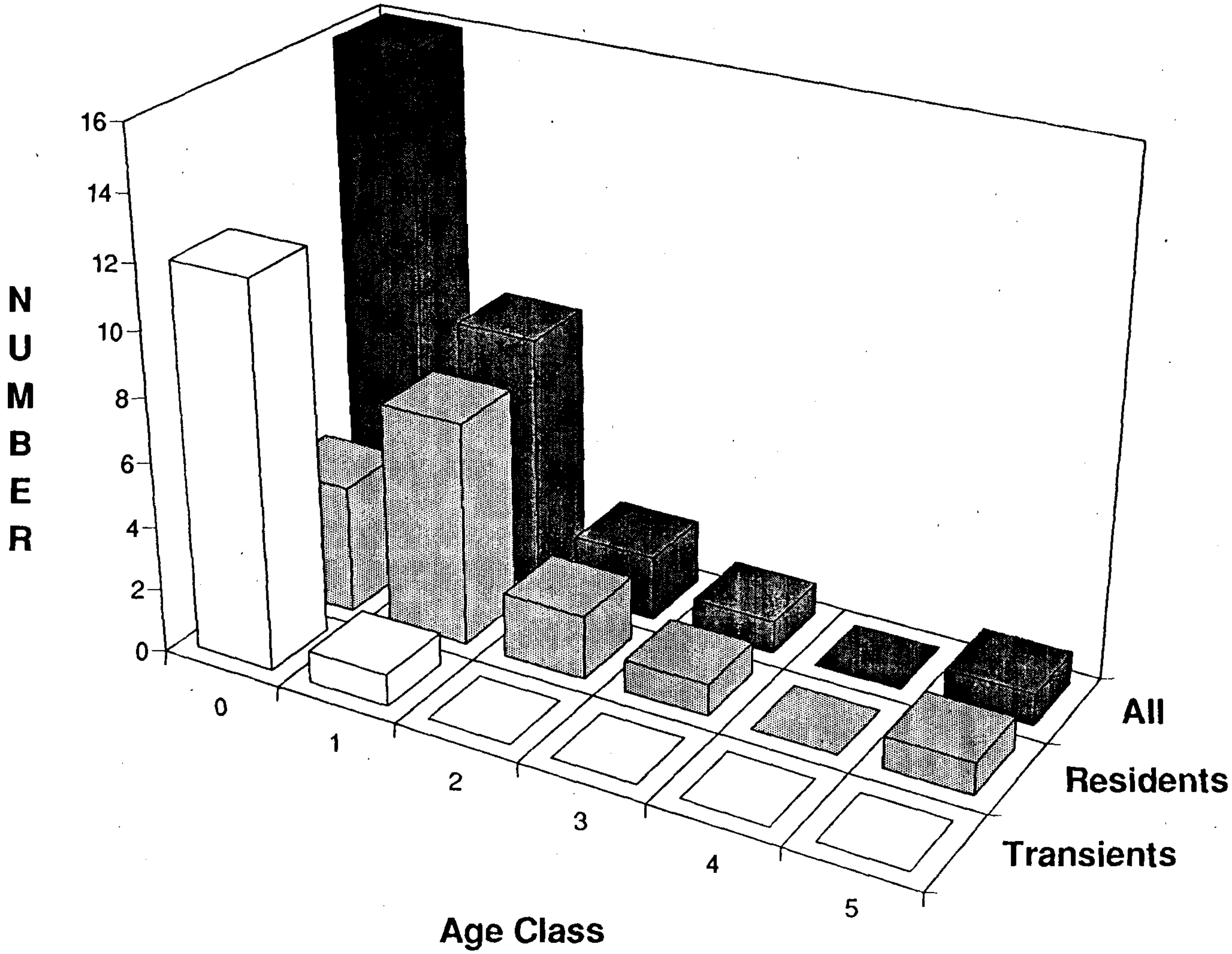

Fig. 3. Age structure of martens captured on northeast Chichagof Island during 1990-91.

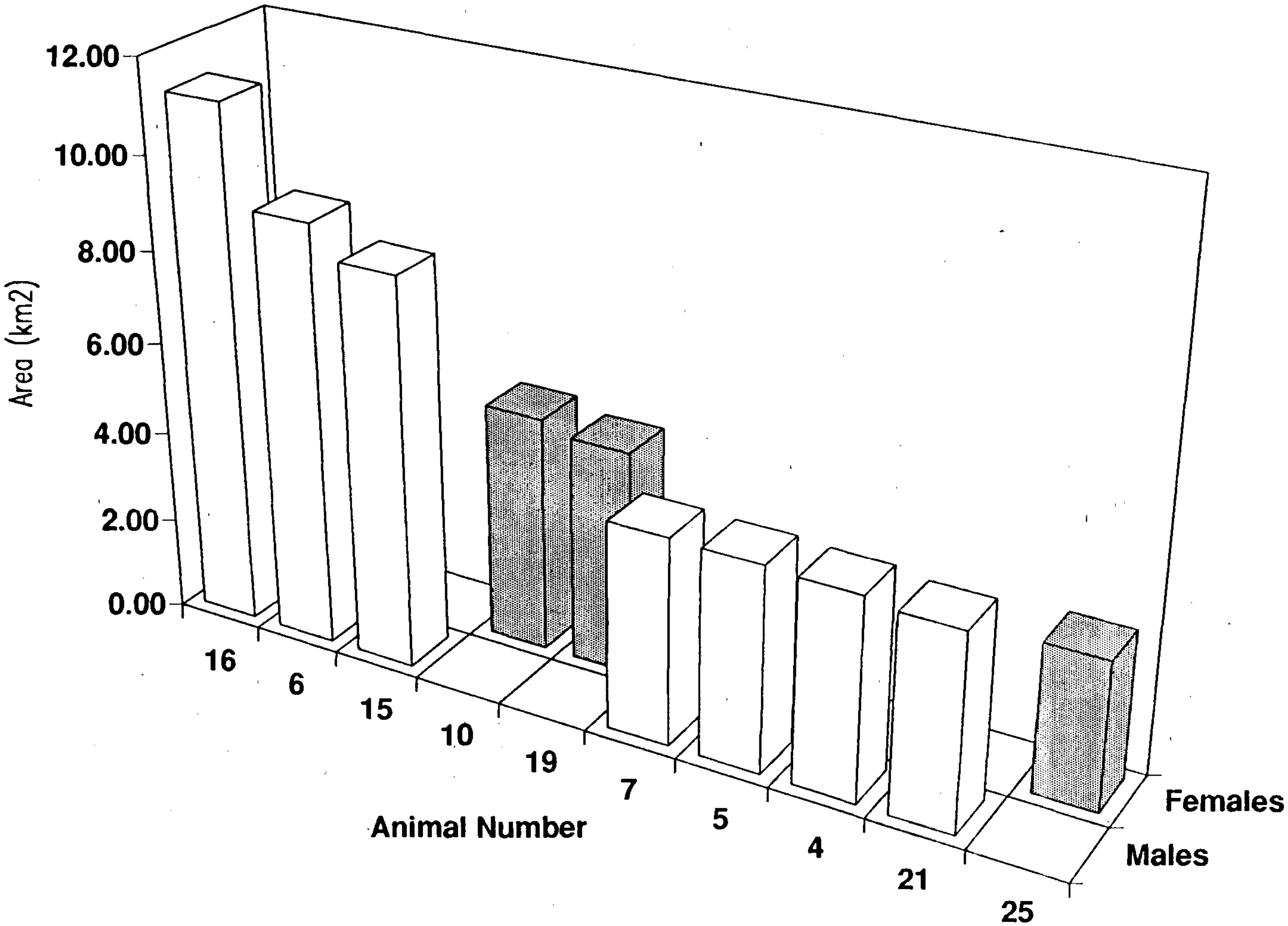

Fig. 4. Home range size of adult male and female martens on northeast Chichagof Island based on 95% convex polygons.

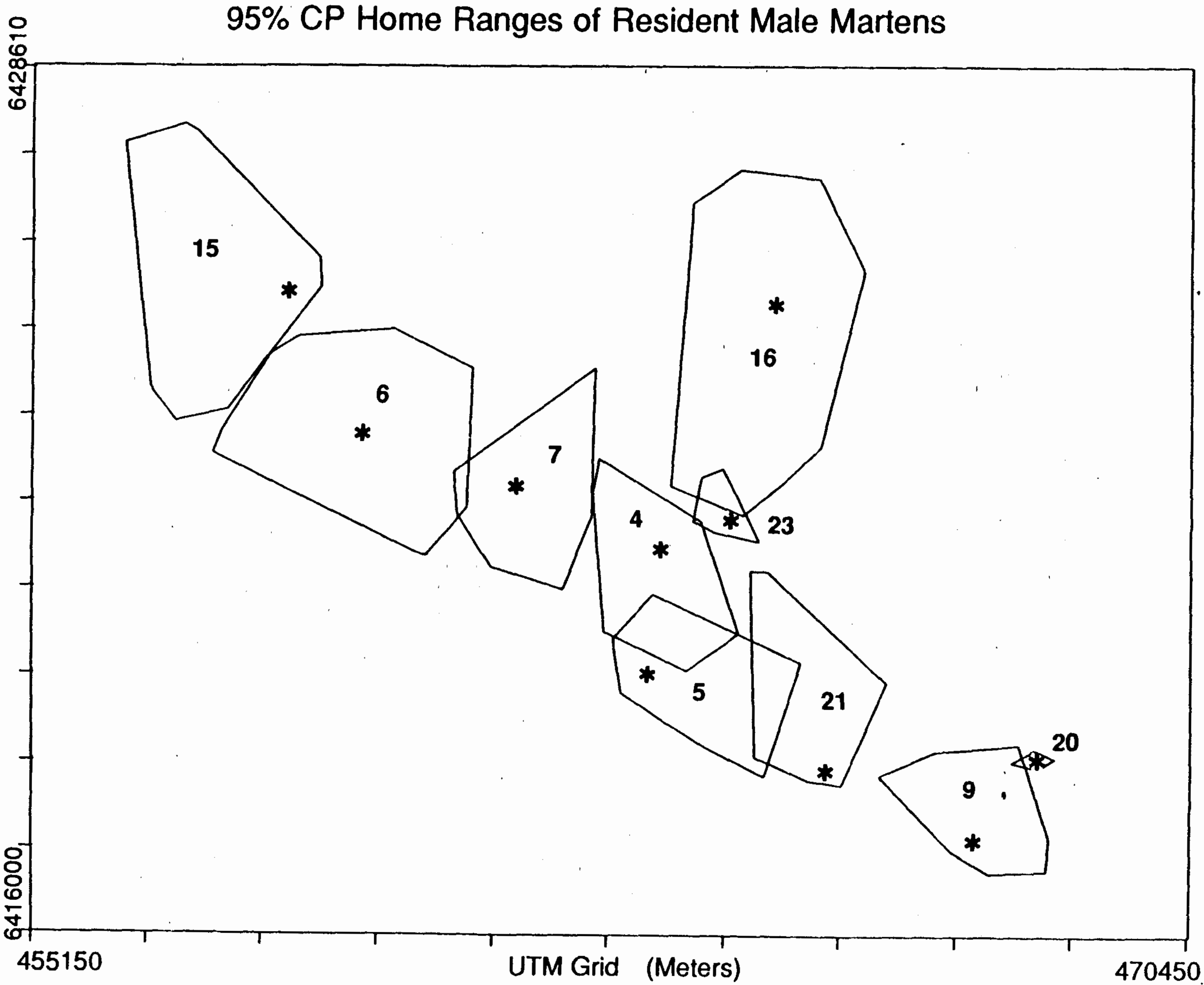

Fig. 5. Home ranges of resident male martens on northern Chichagof Island based on 95% convex polygon method. Harmonic centers of activity are also shown.

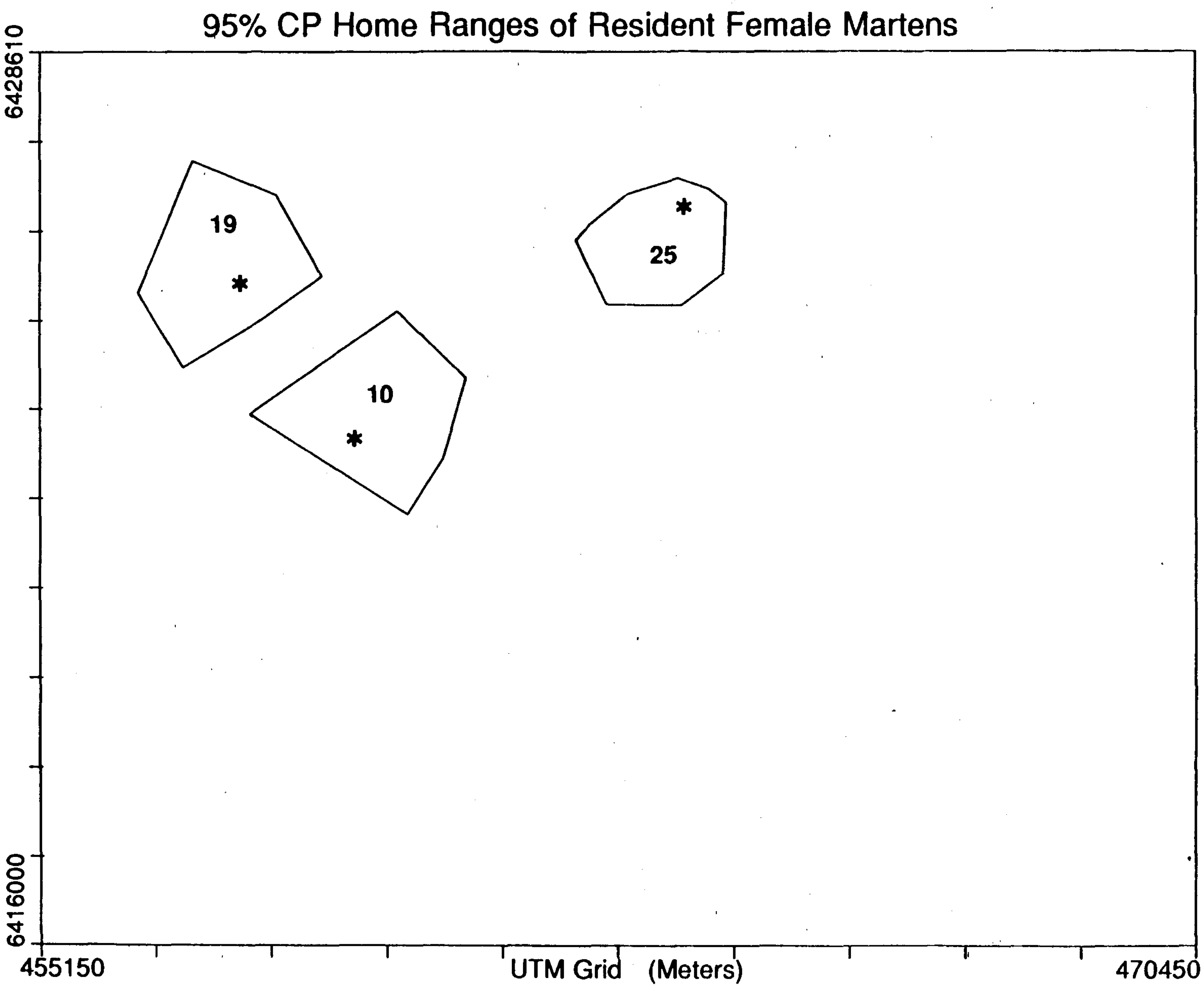

Fig. 6. Home ranges of resident female martens on northern Chichagof Island based on 95% convex polygon method. Harmonic centers of activity are also shown.

Table 1. Live-trapping effort and success rates for martens on northeast Chichagof Island, southeast Alaska during 1990-91.

Month	No. of trap nights	Total captures	Captures/ 100 trap nights	New captures	New captures\ 100 trap nights
June	149	3	2.0	3	2.0
July	88	2	4.5	2	4.5
August	0	0	0.0	0	0.0
September	196	2	1.0	2	1.0
October	213	8	3.8	5	2.3
November	115	9	7.8	6	5.2
December	42	3	7.1	2	4.8
January	197	15	7.6	5	2.5
February	44	1	2.3	1	2.3
March	90	3	3.3	0	0.0
April	129	2	1.6	1	0.8
May	82	2	2.4	1	1.2
Totals	1,345	50	3.7	28	2.1

Table 2. Martens captured on northeast Chichagof Island during 1990-91. Age class determined by tooth cementum analysis. For residency status: R = resident, TR = temporary resident, and T = transient.

Marten number	Sex	Age class	Mean weight (g)	Date collared	No. of captures	Status
4	M	1	1150	06/13/90	2	R
5	M	1	1180	06/14/91	3	R
6	M	2	1150	06/15/90	4	R
7	M	1	1320	07/27/90	1	R
8	M	0	1130	07/28/90	1	T[1]
9	M	0	1267	09/14/90	5	R
10	F	2	820	09/21/90	1	R
11	M	0	1180	10/11/90	1	T[2]
12	M	0	1080	10/11/90	4	T
13	F	0	730	10/26/90	1	T
14	M	0	1040	10/26/90	1	TR[3]
15	M	1	1070	10/28/90	1	R
16	M	3	1270	11/17/90	1	R
17	F	0	850	11/18/90	1	T[4]
18	M	1	1160	11/19/90	1	R
19	M	5	720	11/20/90	1	R
20	M	0	1110	11/10/90	2	R
21	M	1	1380	11/21/90	2	R
22	M	1	1100	12/07/90	3	TR[5]
23	M	0	1250	12/08/90	3	R
24	F	0	800	01/09/91	1	T
25	F	1	850	01/10/90	1	R
26	M	0	1150	01/10/90	1	T
27	M	0	1410	01/11/90	1	T
28	F	0	770	01/11/91	2	T
29	M	0	1020	03/01/91	1	T
30	M	0	1245	04/24/91	1	T
31	M	0	1270	05/14/91	1	R

[1] Killed by trapper on 1/14/91 about 37.6 km from capture site.
[2] Never relocated.
[3] Resident until 4/15/91.
[4] Killed by trapper of 12/15/90 about 16 km from capture site.
[5] Resident until 5/07/91.

Table 3. Habitat selection by radio-collared martens on northeast Chichagof Island during fall/winter 1990-91 by timber volume class. Chi-squared = 69.4, $P < 0.001$.

Habitat[a]	N	Use (%)	CI	Availability (%)	Selection[b]	Ivlev's[c] index	Manly's index
Old-growth forest							
Class 6+	30	15.5	6.7	5.4	+	0.74	0.45
Class 5	95	49.2	9.3	28.4	+	0.63	0.27
Class 4	53	27.5	8.3	20.6	0	0.57	0.21
Class 3	15	7.8	5.0	17.2	-	0.31	0.07
Nonforest	0	0	0.0	27.8	-	0.00	0.00

[a] Nonforest includes clearcuts.
[b] Pluses indicate positive (+) selection, minuses (-) indicate avoidance, and zero (0) indicates no selection based on Bonforroni's simultaneous confidence intervals ($\alpha < 0.05$).

Table 4. Habitat selection by radio-collared martens on northeast Chichagof Island during fall/winter 1990-91 by physiographic type. Chi-squared = 29.4, $P < 0.001$.

Habitat[a]	N	Use (%)	CI	Availability (%)	Selection[a]
Beach fringe/					
Riparian	34	17.6	6.7	16.1	0
Low upland	104	54.1	8.8	33.3	+
High upland	47	24.2	7.6	27.2	0
Subalpine/alpine	8	4.1	3.5	23.4	-

[a] Pluses (+) indicate positive selection, minuses (-) indicate avoidance, and zero (0) indicates no significant selection based on Bonforroni's simultaneous confidence intervals ($\alpha < 0.05$).

Table 5. Comparison of habitat selection indices for radio-collared martens on northeast Chichagof Island during fall/winter 1990-91 with coefficients in habitat capability model.

	Current study		Habitat capability model
	Ivlev's index[a]	Manly's index[a]	
Old-growth forest			
Class 6+	1.00	1.00	1.00
Class 5	0.86	0.60	1.00
Class 4	0.77	0.47	0.70
Class 3	0.41	0.16	0.30
Clearcut	0.00	0.00	0.20
Second-growth	0.00	0.00	0.10
Nonforest	0.00	0.00	0.00

[a] Rescaled so largest value = 1.00

Table 6. The sex and residency status of martens captured on northeast Chichagof Island, southeast Alaska, during 1990-91.

Status	Males	Females	Total
Resident	11	3	14
Temporary resident	3	0	3
Transient	7	4	11
Totals	21	7	28

Table 7. Home range estimates for adult resident martens on northeast Chichagof Island, southeast Alaska, 1990-91. Mean 95% convex polygon home range size of males was larger compared with females (t=1.1, P=0.076).

Animal no.	*N*	Convex polygon (km^2)		Harmonic mean (km^2)	
		95%	100%	75%	95%
Males					
04	26	4.40	5.61	4.87	7.40
05	28	4.47	5.62	4.79	8.21
06	25	9.18	10.85	12.52	16.96
07	23	4.51	8.70	6.46	12.98
09	22	3.21	3.85	2.86	5.06
15	17	8.51	9.12	2.73	8.36
16	16	11.26	16.69	16.42	31.96
21	17	4.26	6.68	5.08	10.93
Means		6.23	8.39	6.97	12.73
SD		2.97	4.04	4.90	8.60
CV		0.48	0.48	0.70	0.68
Females					
10	24	5.16	6.18	4.57	7.14
19	20	4.91	4.97	3.35	6.48
25	20	3.22	3.38	3.34	4.70
Means		4.43	4.84	3.75	6.11
SD		1.06	1.40	0.71	1.26
CV		0.24	0.29	0.19	0.21

Table 8. Maximum travel distances from capture sites of radio-collared transient martens on northeast Chichagof Island, southeast Alaska during 1990-91. No significant differences were observed between males and females ($t = 0.67$, $P > 0.5$).

Animal	Distance (km)
Males	
08	40
12	20
14	8
22	19
26	22
27	27
29	42
30	31
Mean	26.1
SD	11.4
Females	
13	21
17	15
24	32
28	22
Mean	22.5
SD	7.1
Grand mean	24.9
SD	9.9

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