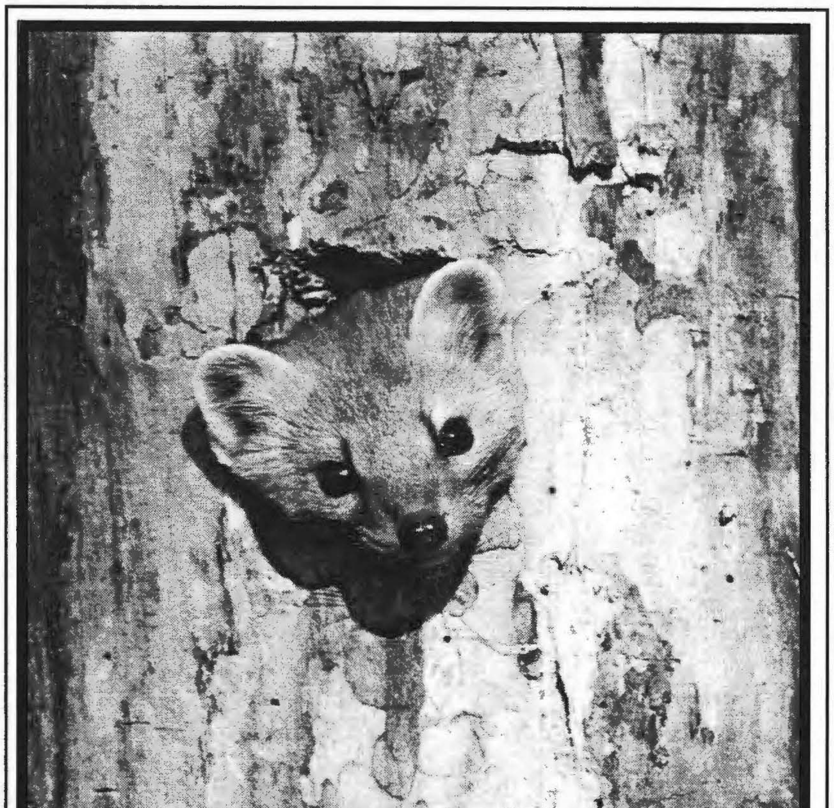
Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report
1 July 1994-30 June 1995

# Ecology of Martens in Southeast Alaska

Rodney W. Flynn
Thomas Schumacher




Grant W-24-3
Study 7.16
December 1995

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Frank Rue, Commissioner

DIVISION OF WILDLIFE CONSERVATION
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Mary Hicks
Publications Specialist
ADF&G, Wildlife Conservation
P.O. Box 25526
Juneau, AK 99802
(907) 465-4190

# RESEARCH PROGRESS REPORT

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

**COOPERATORS:** Ted Schenck, Kris Rutledge, U. S. Forest Service; Jim Faro, ADF&G, Merav Ben-David, UAF

**GRANT NO.:** W-24-3

**STUDY TITLE:** Ecology of martens in Southeast Alaska

**PERIOD:** 1 July 1994-30 June 1995

## SUMMARY


During the fifth year of field work on this project, we captured 44 martens (*Martes americana*) (25 males and 19 females) on the Salt Lake Bay study area, 22 martens (13 males and 9 females) in Upper Game Creek, and 15 martens (7 males and 8 females) in the Freshwater Bay area, northeast Chichagof Island. At Salt Lake Bay we radiocollared 6 new martens (4 males and 2 females) and eartagged 21 others. At Game Creek we radiocollared 6 new captures (2 males and 4 females) and eartagged 12 others. Altogether, we monitored 54 martens (28 males and 26 females) at least part of the year. The estimated density of martens on the Salt Lake Bay study area in March 1994 increased about 96% from March 1994. During March 1995, we estimated that about 45 martens, or 0.54 martens/km$^2$, were on the Salt Lake Bay study area. The increase in numbers resulted from more resident juveniles on the study area and more transient juveniles and yearling martens traveling through the study area. Seven martens with active radiocollars (1 male and 6 females) died during the period. Five deaths (1 male and 4 females) resulted from natural causes, and 2 female martens died from exposure during our trapping. No one trapped the primary study area at Salt Lake Bay this year.

We recorded habitat use of the radiocollared martens at 715 aerial locations during the year. Habitat selection data were not analyzed for this report.

Our snap-trap index for small mammal numbers showed a substantial increase (about 3 times) over last year's. The catch rate for long-tailed voles (*Microtus longicaudus*) increased from 0.0 to 8.0 captures/100 trap nights. Because small mammals are an important food source for martens, the higher snap-trap index indicated an increase in food availability.



**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 completed a fifth year of ecological research on martens in Southeast Alaska. This report contains a brief presentation of information collected from 1 July 1994 to 30 June 1995, or the 1994-1995 biological year. The study consists of 10 specific jobs, and progress on each job is presented separately. During this report period, all jobs were active with an emphasis on jobs 1, 4, and 5. Each year, we have periodically live trapped the study areas on northeast Chichagof Island and studied the movements, demography, and habitat use of the captured martens. Additional demographic data was from trappers operating on Chichagof Island. This study was partially supported by the USDA Forest Service, Chatham Area, through purchase order number 43-0109-9-0749. We also submitted this report to Forest Service personnel to satisfy their reporting requirements.

Martens have been found associated with late-succession 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 2770 animals from 1984 and 1988 (ADF&G unpubl. records, Douglas, AK). 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 old growth, industrial-scale logging has converted large areas of old-growth forest habitat into clear-cuts 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 for clearcut logging (USDA Forest Service 1990). Additional background information on the study can be found in Flynn (1991).

## OBJECTIVES

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

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 habitat are typical of northern Southeast Alaska, including a substantial amount of logged and unlogged areas. 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° 56'N, 135° 20'E), 90 km (56 miles) west of Juneau and 26 km (16 miles) south of Hoonah, was selected as the primary study area. The upper Game Creek watershed, located directly north of Salt Lake Bay, was added as a second primary study in 1992. Because several martens moved off the primary study areas after capture, the entire northern portion of Chichagof Island was treated as a secondary study area.

The Salt Lake Bay study area included 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 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 and north (Fig. 1). The upper Game Creek study area included about 102 $km^2$ in VCUs 203 and 204 on the Hoonah Ranger District. Most habitats typical of northern Southeast Alaska are in the study areas including a range of physiographic types from beach fringe to alpine. Habitats in the study area are 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 clear-cut from 1990 to 1992. (USDA Forest Service 1989). Logging activity began in June 1990 with the construction of about 10 km of logging road. Two units were felled before a court injunction suspended all logging activity at the end of June 1990. The court injunction was lifted during August 1991, and logging resumed September 1991. Logging activity continued until 10 December and about one half of the units were felled. Logging activity was suspended for the winter and resumed again 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 a bridge across the North Fork and 2 bridges across Game Creek. Road building continued at a rapid pace for the remainder of the year. 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, and the remaining upper-elevation units in Game Creek were felled during 1993 and 1994.

Recreational and subsistence trapping seasons for martens, mink, and weasels on the northeast portion of Chichagof Island were closed for the 1990-1991 regulatory year because of depleted marten populations. The portion of northern Chichagof Island west of Port Frederick remained open with season dates from 1 December to 15 February. The trapping season for both portions of northern Chichagof Island opened on 1 December for the 1991-1992 season. On northeast Chichagof Island, trapping with the use of a motorized land vehicle was prohibited on federal lands by federal subsistence regulation. The trapping seasons for marten, mink, and weasels were closed by emergency order on 24 January 1992 because of concern about the overharvest of martens. During the 1992-1993 season, marten trapping on northern Chichagof Island was allowed during 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 remainder of Unit 4, the marten trapping season ran from 1 December to 15 February with no additional restrictions. Marten trapping seasons remained the same in 1993-1994, but the season was closed on federal lands by the federal subsistence board for 1994-1995.

## METHODS

Most study jobs required the capture and radiocollaring of a sample of martens on the primary study area. Martens were live trapped throughout the year at permanent trap sites systematically located along the logging road system. Trap sites were usually about 500 m apart. Traps (Models 203 and 205, Tomahawk Live Trap Co., Tomahawk, WI) were baited with strawberry jam during summer and sardines the rest of the year, covered with a green tarp, and placed under a log or the base of a tree at trap sites. We checked the traps at least daily. Captured martens were run into a holding cone and immobilized with a mixture of 18.0 mg/kg ketamine hydrochloride (Vetalar) and 1.6 mg/kg xylazine hydrochloride (Rompun). 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 ear- tagged (Size 1, Style 1005, National Band and Tag Co., Newport, KY), sexed, weighed, and measured. Two first premolar teeth were pulled for age determination by cementum analysis (Matson's Laboratory, Milltown, MT). We drew a 3.0 cc blood sample from the jugular vein from most captured animals, separated the serum, then froze both portions for future analyses for disease, diet, and pregnancy studies. All captured martens were radiocollared (Telonics, Mesa, AZ). A 30 g radiocollar (MOD-070, expected life of 8 months) was placed on females and a 49 g collar (MOD-080, expected life of 12-18 months) was placed on males. After a marten had recovered from the immobilization, we released it near the capture site. Martens recaptured during a trapping session were released without additional processing. During a subsequent trapping session, all recaptures were chemically restrained, weighed, and measured. We replaced radiocollars as needed, and the collars on several animals were replaced during the year.

We attempted to capture all resident martens on the study area to determine the minimum number present and the sex and age composition of the resident population. Martens present on a study area throughout the year were considered resident animals. Temporary residents were present on a study area for less than a year. Martens that remained on the study area for less than a month and showed no site fidelity to a home range area were considered transients. Martens more than 1-year-old were considered adults unless otherwise identified. Young-of-the-year animals, or birth-year martens were called juveniles.

Job 1. Habitat use. We located radiocollared martens from small aircraft (Mech 1974, Kenward 1987) during daylight hours throughout the year. Mostly, we used a Piper Supercub aircraft. After an animal was located, we assigned it to a relatively homogenous habitat patch while circling in the aircraft. The location was plotted on high-resolution orthophoto maps (1:31,680 scale). The habitat patch 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). We transferred the locations to mylar overlays on color aerial photographs (1:15,840 scale) of the study area for future photo-interpretation work. Additional attribute information was recorded from the orthophoto maps including Universal Transverse Mercator (UTM) coordinates, elevation, slope, and aspect.

Habitat selection will be determined by comparing the proportionate use of habitats with the their availability (see Job 2) in the study area (Neu et al. 1974, White and Garrott 1990). We considered data collected from September through May to represent habitat use during the fall/winter/spring season. 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 will be used to test the null hypothesis that habitats were used by martens in proportion to their availability. If the null hypothesis is rejected, then each habitat will be evaluated separately for selection using Bonferroni normal statistics (Neu et al. 1974, Byers and Steinhorst 1984, White and Garrott 1990). Ivlev's index of electivity ($E_t$) (Ivlev 1961), scaled to vary from 0.00 to 1.00, and Manly's measure of preference (Manly et al. 1972, Chesson 1983) will be computed for each habitat category to characterize the degree of selection of a particular habitat. Habitat capability indices (HCIs), based on each selection index, will be computed by dividing the selection index for each habitat by the maximum 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 volume class and physiographic type, for the stand-level analysis was generated by Forest Service staff from their geographic information system (GIS) "points" database for VCUs 202, 222, and 223. Information on the abundance of old-growth forest types as described by Boughton et al. (1992) was unavailable from this database. The GIS "points" database was created especially for the TLMP Revision project by systematic computerized sampling of the timber volume class maps with the elevation contours and physiographic types identified. Each point sample represented the midpoint of an 8.1-ha hexagon.

We will consider the proportion of habitats on the study area as a measure of habitat availability. To evaluate landscape-level effects, we will collect additional landscape attributes such as roads, corridors, stand size, and composition of adjacent stands. In future analyses, these effects will be evaluated.

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), will be evaluated in two ways using the general considerations listed by Schamberger and O'Neil (1986). During model testing, we will compare habitat coefficients values with observed habitat selection indices. Habitat selection indices for fall/winter/spring will be compared with habitat capability coefficients in the marten habitat capability model (Suring et al. 1992). We will compare the estimated density of adult resident martens on the primary study area with values predicted by the model.

Job 4. Population ecology. Each study area was trapped intensively several times during the year to determine the sex and age composition of martens. We recorded the time and location of all known deaths of radiocollared martens. We attempted to retrieve the carcasses of several martens that died naturally and examined them for cause of death. The carcasses of most trapper-caught study animals were retrieved. 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). Captured martens with only eartags or failed collars were treated as new individuals. We assumed that the population was closed during the 5-day trapping session and 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 $km^2$). Marten density on the primary study area was estimated by mark-recapture trapping sessions. We computed a Lincoln-Petersen estimate of population number for a closed population, single mark-release experiment for each trapping session. During a trapping session (at least shortly before or after), we located all of the radiocollared martens on the study area to determine the number present. The size of the study area was defined by the collective home range areas of the resident collared martens. 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 collared martens recaptured as $m_2$. We used an Excel spreadsheet, originally developed by Sterling Miller (pers. commun., Alaska Department of Fish and Game, Anchorage), for the numeric analyses. including the population estimate, variance, and 95% confidence intervals using a normal distribution. Also, the minimum number of martens on the study area during the trapping session was determined by adding the number of new captures to the number of previously radiocollared animals present. Because the entire Salt Lake Bay study area was not trapped each session, we split the study area into eastern and western portions. Each portion was about the same size. At this point, we have not determined whether all of the assumptions for a Lincoln-Petersen mark-recapture experiment were met in this situation. Next year we will further evaluate the appropriateness of our methods.

We estimated the survival rate of radiocollared martens using the Kaplan-Meier product limit estimator as described by Pollock et al. (1989) for the staggered-entry design. We converted a Lotus spreadsheet obtained from Pollock et al. (1989) to Excel for the numeric analyses. A monthly time step was used to develop annual survival functions. Animals not located for more than 1 month were considered censored observations and eliminated from the analysis at the next time step. Marginal survival functions were constructed for trapping and nontrapping causes by treating deaths from causes other than the group being examined as censored observations (Pollock et al. 1989).

We attempted to collect the carcasses from all martens trapped on northern Chichagof Island. Before the opening of the 1 December trapping season, a letter was sent to everyone who had trapped on northern Chichagof Island during the past 3 years. Trappers were offered $3.00 for each carcass received and instructed to record the date and location of capture and to freeze the carcasses immediately after skinning. Upon receiving the carcasses from the trappers, we kept them frozen until processing. All the carcasses were examined within 2 months of capture.

We weighed each carcass and assigned an index of internal and external fat content, using an ocular estimation procedure developed by Blundell (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. The skulls were heated in water for several hours, then the lower canine and premolar 4 extracted. The teeth were stored frozen until sent to Matson's Laboratory (Milltown, MT) for age determination by cementum analysis. Total, body, and tail lengths of each carcass were measured along with the method of skinning (i.e., feet skinned out or not). We examined the stomachs of each carcass for the presence of parasites, especially *Soboliphyme baturini* worms. The stomach contents were frozen for future diet evaluation. We extracted the ovaries from the reproductive organs of females and preserved them in 10% formalin. All ovaries were sent to Matson's Laboratory (Milltown, MT) for evaluation for the presence and number of corpora lutea (Strickland and Douglas 1987).

<u>Job 5. Spatial patterns and movements</u>. We estimated home ranges of resident martens from radiotelemetry locations (Kenward 1987). Radiocollared martens were located from small aircraft, usually a Supercub, about once a week depending on weather conditions. Aerial locations were plotted on high resolution orthophoto maps (1:31,680 scale) and recorded as Universal Transverse Mercator (UTM) coordinates. We modeled marten home ranges 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). For this report, we calculated the area of home ranges using 100% convex polygons. For the final report, several methods of delineating home range will be evaluated including the harmonic mean method (Dixon and Chapman 1980) and 75%, 95%, and 100% convex polygons (Ackerman et al. 1990). Core areas within home ranges will be examined (Samuel et al. 1985*b*).

In order to locate transient martens, the entire northern portion of Chichagof Island was searched monthly from aircraft. We recorded the maximum distance traveled from initial capture sites and the maximum distance between relocations for each transient animal. We compared the mean distance traveled by males and females. Transient martens were difficult and expensive to locate because of their extensive travels and the limited range of the radio transmitters.

Job 6. Small mammal abundance. The abundance of small mammals, excluding red squirrels, was estimated using a snap-trap index (Calhoun 1948). Transects were established in 3 stands: a productive western hemlock old-growth stand; an unproductive, mixed conifer/blueberry old-growth stand; and a 7-year-old clear-cut. 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. We operated traplines in September when small mammal populations should be at their annual peak. We recorded the number of animals of each species caught per transect and per 100 trap nights.

Job 7. Seasonal diets. Marten scats were collected at trap sites and opportunistically along roads and trails. The scats were labeled and frozen for future analyses.

Beginning in fall 1992, blood samples were drawn from the jugular vein of captured martens and sent to Merav Ben-David, University of Alaska Fairbanks, for analysis of stable isotopes of carbon, nitrogen, and sulfur (Schell et al. 1988). As part of her Ph.D. dissertation, Ben-David will compare the stable isotope signatures of the marten blood samples with the signatures of samples collected from potential food items to infer marten diet composition (Ben-David 1992).

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 premolar 4 were extracted from each skull for age determination by cementum analysis (Matson's Laboratory, Milltown, MT). We will compare the skull measurements according to Magoun et al. (1988).

## RESULTS AND DISCUSSION

During biological year 1994-1995, we captured 44 martens (25 males and 19 females) on the Salt Lake Bay study area 62 times. Twenty seven of the captured martens (16 males and 11 females) were handled for the first time (Table 1). Because funding was less than previous years, we radiocollared only 6 of the new captures (4 males and 2 females). The other 21 martens (12 males and 9 females) were eartagged. In upper Game Creek, we caught an additional 22 martens (13 males and 9 females) (Table 2). Only 4 of these martens had been handled last year. All captured martens were weighed, measured, and aged by cementum analysis (Table 3). We radiocollared 6 of the new captures (2 males and 4 females) and eartagged 12 of the martens were (Table 4.)

For the first time, we trapped in the 2 adjacent watersheds to the east, the Freshwater Bay drainages and Indian River, where the U. S. Forest Service was planning a timber sale. In this area, we captured 15 martens (7 males and 8 females) and radiocollared 7 (1 male and 6 females).

Job 1. Habitat use. Radiocollared martens were located 715 times from small aircraft during the year to determine habitat use. This information was recorded, plotted on aerial photographs, and entered into a computer file. The coordinate file was converted to an Arc/Info GIS coverage by US Forest Service personnel. We did not complete additional analyses for this report. More information on the selection of habitats will be collected next year and included in the final report.

In the spring of 1995, we began collecting data on habitat preferences by marten females during the spring/summer denning period. We attempted to locate marten dens by walking in on stationary radioed females. Dens were distinguished from rest sites by repeated use over several days and the presence of latrines and prey remains. We also attempted to see young whenever possible. Dens and rest sites were flagged so they could be revisited for habitat measurements. We distinguished between natal dens where kits were born and maternal dens where kits were later moved. Den status was determined by telemetry, time of year, and evidence of the presence and age of kits.

Our preliminary efforts in 1994 produced 1 definite and 1 possible natal den and 2 maternal dens. Marten #77 was tracked to a possible natal den in a cavity under a hemlock tree on 18 May; however her radio failed soon afterward and results were inconclusive. Marten #130 was tracked to a natal den in a cavity 25m up a large hemlock tree on 18 May. She was later located at a maternal den under roots of a rotten stump with a large latrine on 8 June. Another maternal den of an unknown female was found under the roots of a hemlock tree at Seagull Creek on 8 June. Three large kits were present, but there was no adult female.

Four natal dens were found in 1995. Marten #84 was found inside a hollow log on 9 and 11 June. She had been in the area since 12 April. We believe this was a natal den because no scat or prey remains were found. Marten #128 was found inside a hollow rotten log on 16 May. The den was accidentally stepped on and two 3- to 4-week-old kits were seen as 128 carried them away. Marten #158 was found denning in a cavity 6m up a mountain hemlock on 21 May. One 4- to 5-week-old kit was seen in the den on 5 June. Marten 138 was found denning in a large hollow hemlock log on 20 June; disturbed, she brought out 1 kit about 4 weeks old.

Four maternal dens were found in 1995. Marten #52 was tracked to a cavity under the roots of a large cedar tree on 9 June. Worn trails, fresh kit-sized scats, and lots of prey remains, mostly voles, were present. The kits were not seen. Marten #128 was tracked to a cavity under a spruce tree on 1 June. No evidence of kits was seen, but they were probably still too young to be active outside the den or eating solid food. On 21 June, marten #128 was located under the roots of a spruce tree in open forest. Worn trails and latrines with kit-sized scats indicated the presence of kits. Marten #158 was tracked to a large hollow hemlock log in the middle of a 2-year-old clearcut. Two latrines were present and we saw 1 kit.

Budget problems precluded aerial telemetry and fieldwork from mid April until early June and denning attempts and failures probably went undetected. Martens 24, 48, 56 and 159 were also tracked during the summer of 1995, but they were never found at a den. Radiocollars on martens 89 and 120 failed at the beginning of the denning season, and their activities were unknown. Live-trapping efforts in late July and early August revealed that 2-year old martens 89 and 120 had nursed young this summer; whereas older females 24 and 48 showed no evidence of having nursed during 1995.

Of 6 natal dens so far discovered, 3 were in hollow logs, 2 were in cavities up live trees, and 1 was under the roots of a live tree. Of 6 maternal dens found, 5 were under the roots of live trees and 1 was inside a hollow log. Dens were in forest with a variety of canopy cover classes and tree sizes, but dense understory vegetation was usually present especially in areas with little canopy cover.

All den sites were flagged and marked on aerial photos, so they could be revisited for intensive habitat measurements next year. A protocol for measuring habitat at these and other dens and further efforts to locate dens are planned for 1996. We will also locate summer rest site and document habitat at random points to determine if marten actively select for den sites and if they are more selective in their choice of dens than rest sites.

Job 2. Habitat composition. We received several GIS data files from US Forest Service staff including landcover, streams, clearcuts, and roads. Next year, we will collect additional landscape attribute information from aerial photos and gather additional US Forest Service data. This information will be further analyzed for the final report with the use of GIS software.

Work was initiated with the US Forest Service on remapping the vegetation of the study area using LANDSAT TM satellite information. The US Forest Service has hired a consultant for the pilot study. We spent a week in the field to discuss classification procedures and identify study plots. Because of problems with the accuracy of the timber-type map, we are hopeful the LANDSAT TM technology will provide an improved vegetation map for the habitat analysis. The consultant will complete the initial pilot study in early 1996. Additional evaluation work is scheduled for later in 1996. The new vegetation map should be available for our use in 1997.

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 was reported in a previous progress report (Flynn 1991). No additional analyses were completed during this report period.

Job 4. Population ecology. Of the 54 radiocollared martens monitored during at least part of the year, 28 were males and 26 were females. We classified 21 martens (11 males and 10 females) as residents on the Salt Lake Bay study area (Table 5). Ten martens (8 males and 2 females) captured at Salt Lake Bay were transients and spent little time there. In upper Game Creek, 14 martens (7 males and 7 females) were classified as residents, and 1 male was a transient. Because of the extensive live trapping in both study areas, most of the resident martens were probably captured.

We had one opportunity for a good mark/recapture trapping session during the year. During March 1995, we estimated that 45 martens (95% CI = ±12.4) were on the Salt Lake Bay study area for a density of 0.54 martens/km$^2$. In contrast, we estimated 23 martens (95% CI = ±2.4) on the area in March 1993, or a density of 0.27 martens/km$^2$ (Flynn and Schumacher 1994). Thus, the number of martens on the Salt Lake Bay study area increased about 96% from March 1993 to March 1994. The increase in population numbers resulted from more juvenile and transient yearling animals on the study area. New juvenile and yearling martens were captured throughout the year, and only 1 new capture was older than 1 year.

We recorded 7 deaths of radiocollared martens (1 male and 6 females) during the period. Five deaths (1 male and 4 females) resulted from natural causes unrelated to human activities. Two deaths were related to our trapping and handling. One eartagged marten was caught by a trapper. Little trapping effort was expended on northern Chichagof Island this year, and no one trapped within the primary study areas.

In 1994 we collected 100 marten carcasses from northern Chichagof Island. About 32% of the sample were juveniles (Table 6). All of the adult females had ovulated (Table 7).

Job 5. Spatial patterns and movements. Radiocollared martens were aerially located 715 times to collect information on movements and spatial use patterns. The data were recorded and entered into a GIS data file. Because of problems converting some of the data to a new coordinated system, we were unable to determine annual home ranges for this report. Next year we will use GIS software to complete a comprehensive analysis of the spatial use data.

Similar to previous years, transient martens of both sexes spent little time on the primary study areas and traveled extensively. Because of the short transmission range of the radiocollars, transient martens were difficult and expensive to locate. Because of costs, we spent less effort searching for transient martens and little search effort on the west side of Port Frederick.

Job 6. Small mammal abundance. During September 1994 we captured 85 deer mice and 36 long-tailed voles on 3 transects in 450 trap nights (26.8 captures/100 trap nights). The snap-trap index indicated small mammal numbers had increased substantially (3.3 times) since last year after several years of low numbers (Fig. 3). Long-tailed voles showed the greatest increase in number (0.9 to 8.0 captures/100 trap nights). Because small mammals, especially voles, usually compose a large part of martens' diets, the increase in small mammal numbers probably resulted in a greater availability of preferred foods on northeast Chichagof Island for martens during biological year 1994-1995.

Job 7. Seasonal diet. We collected 53 blood samples from live-trapped martens throughout the year for stable isotope analysis. Merav Ben-David analyzed the blood samples at the

University of Alaska Fairbanks. The results will be presented in her Ph.D. thesis, scheduled to be completed May 1996. An abstract of a paper that we have prepared is included as Appendix A. We will discuss the results further in the next report.

Job 8. Evaluation of field sexing and aging technique. We collected another 512 marten skulls from trappers throughout Southeast Alaska including Admiralty, Baranof, Chichagof, and Prince of Wales islands. We recorded cementum ages for each animal and measured the skulls. We now have data from a total of 1761 skulls. These data will be analyzed and evaluated for the final report.

Job 9. Scientific meetings. No meetings were attended.

Job 10. Reports and scientific papers.

Ben-David, M. and R. Flynn. In press. Diet composition and reproductive performance in American martens: the role of alternative foods. *In* G Proulx. and H. Bryant (eds.) Integrating Martes in forest management. Proceedings of the second Martes Symposium. Edmonton, Alberta.

## ACKNOWLEDGMENTS

Many individuals contributed to the project, and we greatly appreciate their assistance. Several volunteers contributed to the field work including Jeff Uhlich, Shelly Szepanski, and Richard Bloomquist. Merav Ben-David collaborated in the field and contributed to the diet analyses. Phil Mooney assisted with the capture work in the Freshwater Bay area. Trooper David Jones, Fish and Wildlife Protection, provided logistical support and office space in Hoonah. Kimberly Titus provided project review and direction. Mary Hicks edited the report. Our USDA Forest Service cooperators, Ted Schenck, Ellen Campbell, and Kris Rutledge, arranged for financial assistance and provided many useful ideas. The Hoonah Ranger District provided additional field support.

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Prepared by:

Rodney W. Flynn
Wildlife Biologist III

Thomas Schumacher
Fish and Wildlife Technician III

Submitted by:

Kimberly Titus
Research Coordinator
Regional Supervisor

Approved by:

Wayne Regelin, Director
Division of Wildlife Conservation

Steven R. Peterson, Senior Staff Biologist
Division of Wildlife Conservation

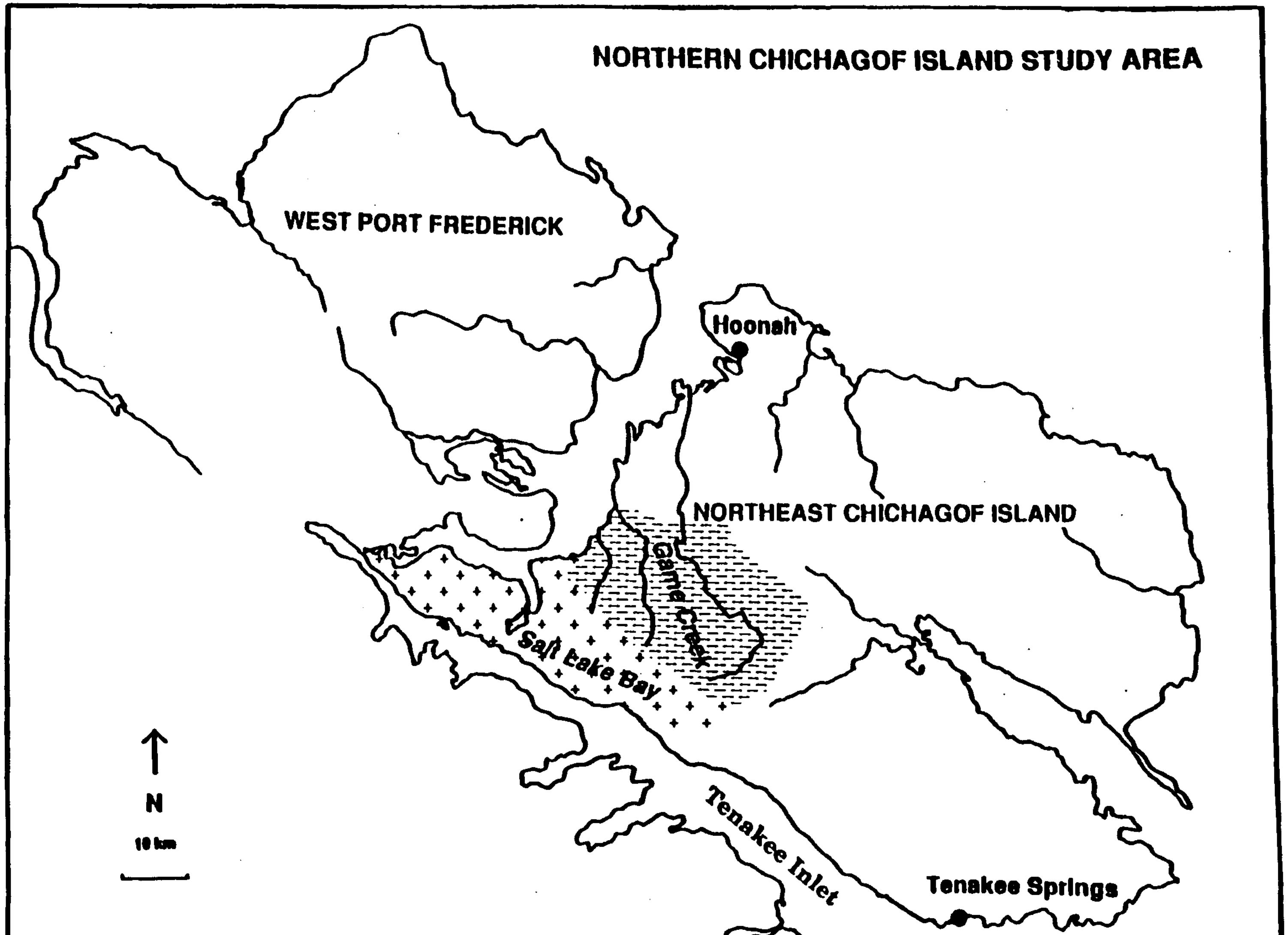



Figure 1. Location map of northern Chichagof Island study areas. The primary study areas at Salt Lake Bay and Upper Game Creek are indicated by cross-hatching.

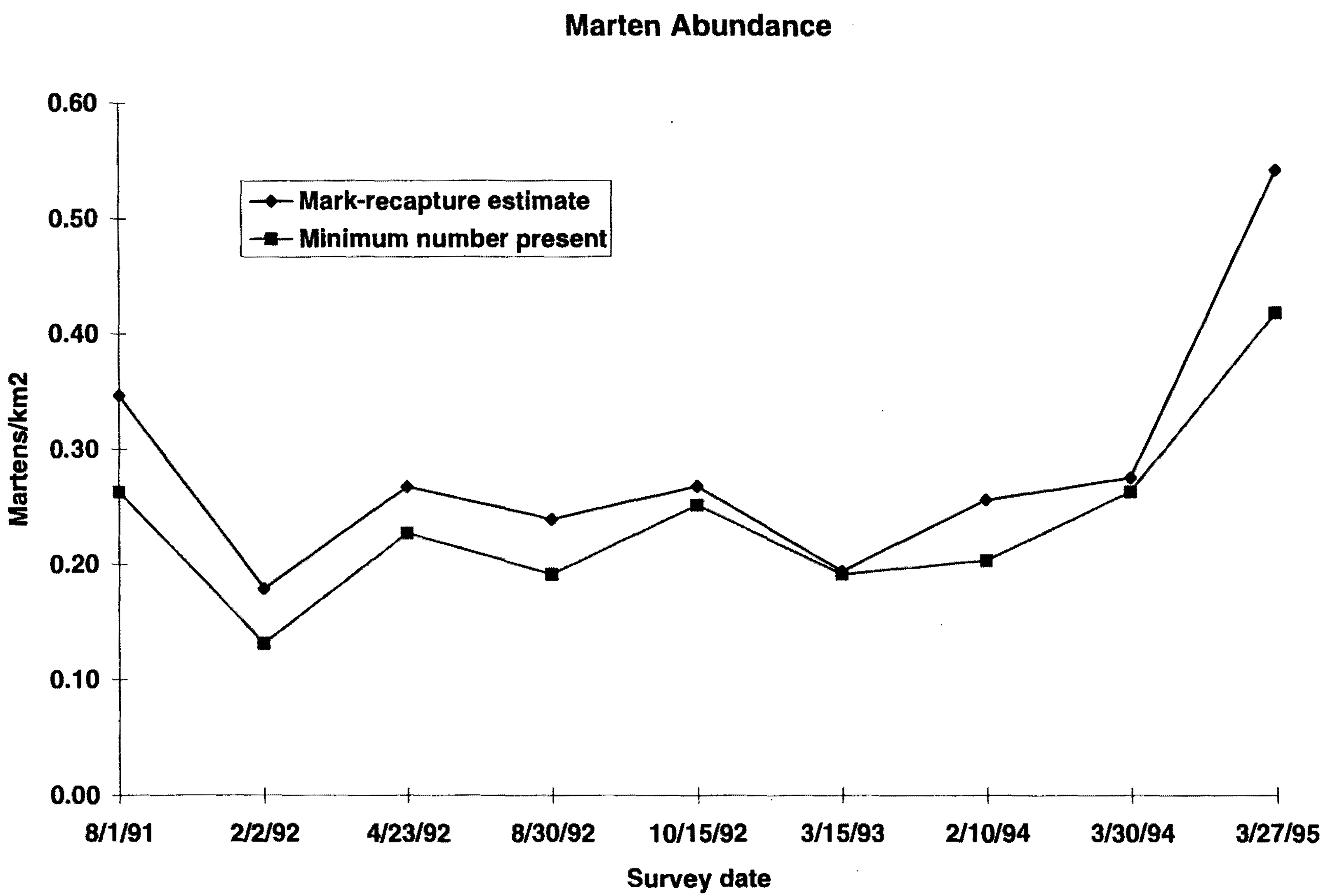



Figure 2. Density of martens on Salt Lake Bay study area, northern Chichagof Island, 1991-1995

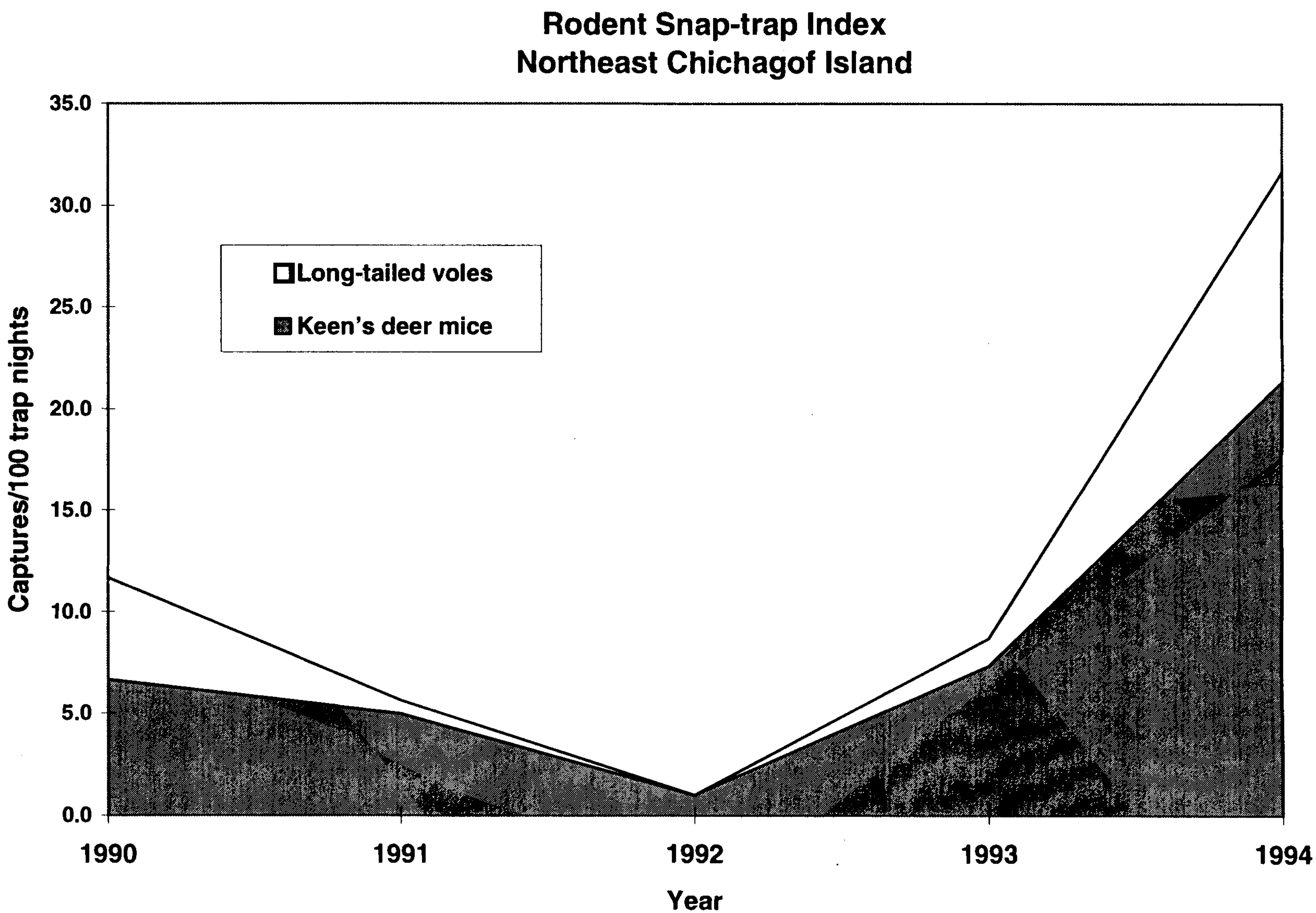



Figure 3. Snap-trap indices for Keen's deer mice and long-tailed voles on northeast Chichagof Island, 1990-1994.

Table 1. Live-trapping effort and success rates for martens on Salt Lake Bay study area, northeast Chichagof Island, Southeast Alaska, 1994-1995.

| Month | No. of trap nights | Total captures | Captures/ 100 trap nights | New captures | New captures/ 100 trap nights |
|---|---|---|---|---|---|
| June | 0 | | | | |
| July | 0 | | | | |
| August | 0 | | | | |
| September | 0 | | | | |
| October | 194 | 13 | 6.7 | 6 | 3.0 |
| November | 0 | | | | 1.3 |
| December | 89 | 18 | 20.2 | 7 | 7.9 |
| January | 0 | | | | |
| February | 82 | 6 | 1.0 | 1 | 1.2 |
| March | 152 | 29 | 19.1 | 13 | 8.5 |
| April | 0 | | | | |
| May | | | | | |
| Totals | 517 | 62 | 12.0 | 27 | 5.2 |

Table 2. Live-trapping effort and success rates for martens on Upper Game Creek study area, northeast Chichagof Island, Southeast Alaska, 1994-1995.

| Month | No. of trap nights | Total captures | Captures/ 100 trap nights | New captures | New captures/ 100 trap nights |
|---|---|---|---|---|---|
| June | 0 | | | | |
| July | 0 | | | | |
| August | 0 | | | | |
| September | 0 | | | | |
| October | 278 | 15 | 5.4 | 13 | 4.7 |
| November | 156 | 12 | 7.7 | 5 | 3.2 |
| December | 0 | | | | |
| January | 0 | | | | |
| February | 0 | | | | |
| March | 0 | | | | |
| April | 0 | | | | |
| May | 0 | | | | |
| Totals | 434 | 34 | 7.8 | 18 | 6.4 |

Table 3. Age, sex, and status of radiocollared martens monitored on northeast Chichagof Island, 1994-1995.

| Animal no. | Sex | Age class | Date collared | No. of captures | Study[a] area | Residency[b] status | Survival status[c] |
|---|---|---|---|---|---|---|---|
| 4 | M | 5 | 06/13/90 | 1 | SLB | R | Survived |
| 24 | F | 4 | 01/09/91 | 1 | SLB | R | Survived |
| 36 | M | 4 | 08/02/91 | 2 | SLB | R | Survived |
| 45 | M | 5 | 11/16/91 | 3 | SLB | R | Survived |
| 48 | F | 3 | 02/02/92 | 1 | SLB | R | Survived |
| 52 | F | 5 | 03/05/92 | 2 | SLB | R | Survived |
| 56 | F | 5 | 04/27/92 | 3 | SLB | R | Survived |
| 58 | F | 4 | 04/28/92 | 3 | SLB | R | Natural Death - Dec. |
| 60 | M | 4 | 05/01/92 | 0 | SLB | R | Natural death - Dec. |
| 77 | F | 4 | 11/10/92 | 1 | GC | R | Censored - March |
| 80 | M | 5 | 01/15/93 | 2 | SLB | R | Survived |
| 84 | F | 3 | 04/27/93 | 3 | SLB | R | Survived |
| 88 | M | 1 | 09/26/93 | 7 | SLB | R | Survived |
| 89 | F | 1 | 09/26/93 | 3 | SLB | R | Survived |
| 91 | M | 1 | 10/17/93 | 0 | GC | R | Censored - Jan. |
| 94 | M | 1 | 10/20/93 | 0 | GC | T | Censored - Aug. |
| 101 | M | 1 | 10/29/93 | 2 | GC | R | Survived |
| 102 | M | 1 | 10/29/93 | 3 | SLB | R | Censored - April |
| 107 | M | 1 | 11/09/93 | 1 | GC | R | Survived |
| 109 | M | 1 | 11/18/93 | 0 | GC | R | Censored - March |
| 112 | M | 1 | 12/09/93 | 0 | SLB | T | Censored - Dec. |
| 113 | M | 1 | 12/09/93 | 0 | SLB | T | Censored - June |
| 114 | M | 2 | 12/10/93 | 7 | SLB | R | Survived |

Table 3. Continued.

| Animal no. | Sex | Age class | Date collared | No. of captures | Study[a] area | Residency[b] status | Survival status[c] |
|---|---|---|---|---|---|---|---|
| 115 | F | 2 | 12/11/93 | 0 | SLB | T | Censored - Aug. |
| 117 | M | 1 | 12/11/93 | 0 | SLB | T | Censored - June |
| 119 | M | 2 | 02/13/94 | 0 | SLB | T | Censored -Dec. |
| 120 | F | 2 | 02/15/94 | 6 | SLB | R | Survived |
| 121 | M | 1 | 03/29/94 | 0 | SLB | T | Censored - June |
| 123 | F | 1 | 04/02/94 | 0 | SLB | T | Censored -Dec. |
| 124 | M | 1 | 04/02/94 | 0 | SLB | R | Survived |
| 125 | M | 1 | 04/04/94 | 0 | SLB | T | Censored - March |
| 128 | F | 1 | 10/07/94 | 2 | GC | R | Survived |
| 129 | M | 4 | 05/02/94 | 1 | GC | R | Censored - March |
| 130 | F | 10 | 05/04/94 | 2 | GC | R | Natural death - Feb. |
| 137 | F | 1 | 07/16/94 | 1 | IR | R | Censored - Jan. |
| 138 | F | 1 | 07/19/94 | 1 | FWB | R | Survived |
| 139 | F | | 08/26/94 | 1 | FWB | R | Natural death - Jan. |
| 140 | M | | 08/30/94 | 1 | FWB | R | Survived |
| 144 | F | 0 | 09/01/94 | 2 | FWB | R | Censored - March |
| 145 | F | | 09/02/94 | 1 | FWB | R | Natural death - Sept. |
| 146 | F | | 09/02/94 | 1 | FWB | R | Censored - Dec. |
| 148 | F | 0 | 09/15/94 | 1 | FWB | R | Natural death - Sept. |
| 149 | F | 0 | 09/28/94 | 1 | GC | R | Censored - March |
| 150 | M | 0 | 10/02/94 | 3 | GC | R | Survived |
| 151 | M | 0 | 10/03/94 | 2 | GC | R | Survived |
| 158 | F | 5 | 10/05/94 | 1 | GC | R | Survived |

Table 3. Continued.

| Animal no. | Sex | Age class | Date collared | No. of captures | Study[a] area | Residency[b] status | Survival status[c] |
|---|---|---|---|---|---|---|---|
| 159 | F | 1 | 10/06/94 | 1 | GC | R | Censored - March |
| 161 | F | 1 | 10/07/94 | 1 | GC | R | Survived |
| 162 | M | 0 | 10/22/94 | 2 | SLB | T | Survived |
| 165 | F | 0 | 10/25/95 | 3 | SLB | R | Natural death - Jan. |
| 166 | M | 0 | 10/26/95 | 1 | SLB | T | Censored - March |
| 175 | F | 0 | 12/11/95 | 2 | SLB | R | Survived |
| 179 | M | 0 | 12/12/95 | 2 | SLB | R | Survived |
| 193 | M | 0 | 3/23/95 | 2 | SLB | R | Survived |

[a] SLB = Salt Lake Bay and GC = Game Creek.

[b] R = resident, TR = temporary resident, OR = other resident, T = transient, and U = undetermined.

[c] The animal was considered censored for the survival analysis when the radio signal was not found after the month listed.

Table 4. Age and sex of martens only ear tagged on northeast Chichagof Island, 1994-1995.

| Animal no. | Sex | Age class | Date captured | No. of captures | Study[a] area | Status |
|---|---|---|---|---|---|---|
| 134 | M | 0 | 07/12/94 | 1 | IR | UNK |
| 135 | M | | 07/15/94 | 1 | IR | UNK |
| 136 | M | 3 | 07/16/94 | 1 | IR | UNK |
| 141 | F | 4 | 08/30/94 | 1 | FWB | UNK |
| 142 | M | 0 | 08/31/94 | 1 | FWB | UNK |
| 143 | M | 2 | 08/31/94 | 1 | FWB | UNK |
| 147 | M | 1 | 09/15/94 | 1 | FWB | UNK |
| 152 | M | 0 | 10/03/94 | 1 | GC | UNK |
| 153 | M | 0 | 10/03/94 | 2 | GC | UNK |
| 154 | M | 0 | 10/04/94 | 2 | GC | UNK |
| 155 | F | 0 | 10/04/94 | 1 | GC | UNK |
| 156 | M | 0 | 10/07/94 | 3 | GC | UNK |
| 157 | M | 0 | 10/05/94 | 1 | GC | UNK |
| 160 | M | 0 | 10/07/94 | 3 | GC | UNK |
| 163 | F | 0 | 10/24/94 | 2 | SLB | UNK |
| 164 | M | 0 | 10/24/94 | 1 | SLB | UNK |
| 167 | M | 0 | 10/26/94 | 4 | SLB | UNK |
| 168 | M | 0 | 11/08/94 | 2 | GC | UNK |
| 169 | M | 0 | 11/08/94 | 3 | GC | UNK |
| 170 | M | | 11/10/94 | 2 | GC | UNK |
| 171 | F | 0 | 11/12/94 | 1 | GC | UNK |
| 172 | M | 0 | 11/12/94 | 1 | GC | UNK |
| 173 | F | 3 | 12/10/94 | 1 | SLB | UNK |
| 174 | M | 1 | 12/10/94 | 1 | SLB | Trapped - Dec. |
| 176 | M | 0 | 12/11/94 | 1 | SLB | UNK |
| 177 | M | 0 | 12/11/94 | 2 | SLB | UNK |
| 178 | M | 0 | 12/11/94 | 1 | SLB | UNK |
| 180 | M | 0 | 2/17/95 | 1 | SLB | UNK |
| 181 | M | 0 | 3/19/95 | 1 | SLB | UNK |
| 182 | F | 0 | 3/19/95 | 1 | SLB | UNK |
| 183 | M | 1 | 3/21/95 | 1 | SLB | UNK |
| 184 | F | 1 | 3/19/95 | 2 | SLB | UNK |
| 185 | F | 0 | 3/19/95 | 2 | SLB | UNK |
| 186 | F | 0 | 3/20/95 | 3 | SLB | UNK |

Table 4. Continued.

| Animal no. | Sex | Age class | Date captured | No. of captures | Study[a] area | Status |
|---|---|---|---|---|---|---|
| 187 | F | 0 | 3/20/95 | 1 | SLB | UNK |
| 188 | F | 0 | 3/20/95 | 1 | SLB | UNK |
| 189 | M | 0 | 3/21/95 | 2 | SLB | UNK |
| 190 | M | 0 | 3/22/95 | 1 | SLB | UNK |
| 191 | M | 0 | 3/22/95 | 1 | SLB | UNK |
| 192 | F | 0 | 3/23/95 | 1 | SLB | UNK |

[a] GC = Game Creek; IR = Indian River; FWB = Freshwater Bay; IR = Indian River

Table 5. The sex and residency status of martens monitored on northeast Chichagof Island, Southeast Alaska, 1994-1995.

| Status | Males | Females | Total |
|---|---|---|---|
| Salt Lake Bay | | | |
| Resident | 11 | 10 | 21 |
| Game Creek | | | |
| Resident | 7 | 7 | 14 |
| Transients | | | |
| Captured at SLB[a] | 8 | 2 | 10 |
| Captured at GC[b] | 1 | 0 | 1 |
| Freshwater-Indian River | | | |
| Resident | 1 | 7 | 8 |
| Totals | 28 | 26 | 54 |

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

Table 6. Age distribution of martens captured by trappers on northern Chichagof Island, Southeast Alaska, during 1994-95.

| Age class | Males | | Females | | Totals | | Females (%) |
|---|---|---|---|---|---|---|---|
| | *N* | % | *N* | % | *N* | % | |
| 0 | 20 | 20.0 | 12 | 12.0 | 32 | 32.0 | 37.5 |
| 1 | 14 | 14.0 | 11 | 11.0 | 25 | 25.0 | 44.0 |
| 2 | 18 | 18.0 | 6 | 6.0 | 24 | 24.0 | 25.0 |
| 3 | 8 | 8.0 | 3 | 3.0 | 11 | 11.0 | 27.3 |
| 4 | 2 | 2.0 | 0 | 0.0 | 2 | 2.0 | 0.0 |
| 5 | 1 | 1.0 | 1 | 1.0 | 2 | 2.0 | 50.0 |
| 6 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | |
| >6 | 2 | 2.0 | 2 | 2.0 | 4 | 4.0 | 50.0 |
| Totals for ages >0 | 45 | 45.0 | 23 | 23.0 | 68 | 68.0 | 33.8 |

Table 7. Mean counts of corpora lutea and percentage of females with corpora lutea by age class on Chichagof Island, Southeast Alaska, 1994-95. Female martens with corpora lutea were considered pregnant.

| Age class | No. females examined | % females pregnant | Corpora lutea per pregnant female | | Corpora lutea per female | |
|---|---|---|---|---|---|---|
| | | | $x$ | SE | $x$ | SE |
| 1 | 3 | 100 | 3.00 | 0.58 | 3.00 | 0.58 |
| 2 | 0 | | | | | |
| 3 | 0 | | | | | |
| 4 | 0 | | | | | |
| 5 | 1 | 100 | 5.00 | | 5.00 | |
| 6 | 0 | | | | | |
| >6 | 0 | | | | | |
| Totals | 4 | 100 | 3.50 | 0.65 | 3.50 | 0.65 |

## APPENDIX A

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

MERAV BEN-DAVID, Alaska Cooperative Fish and Wildlife Research Unit, University of Alaska Fairbanks, Fairbanks, Alaska 99775, USA

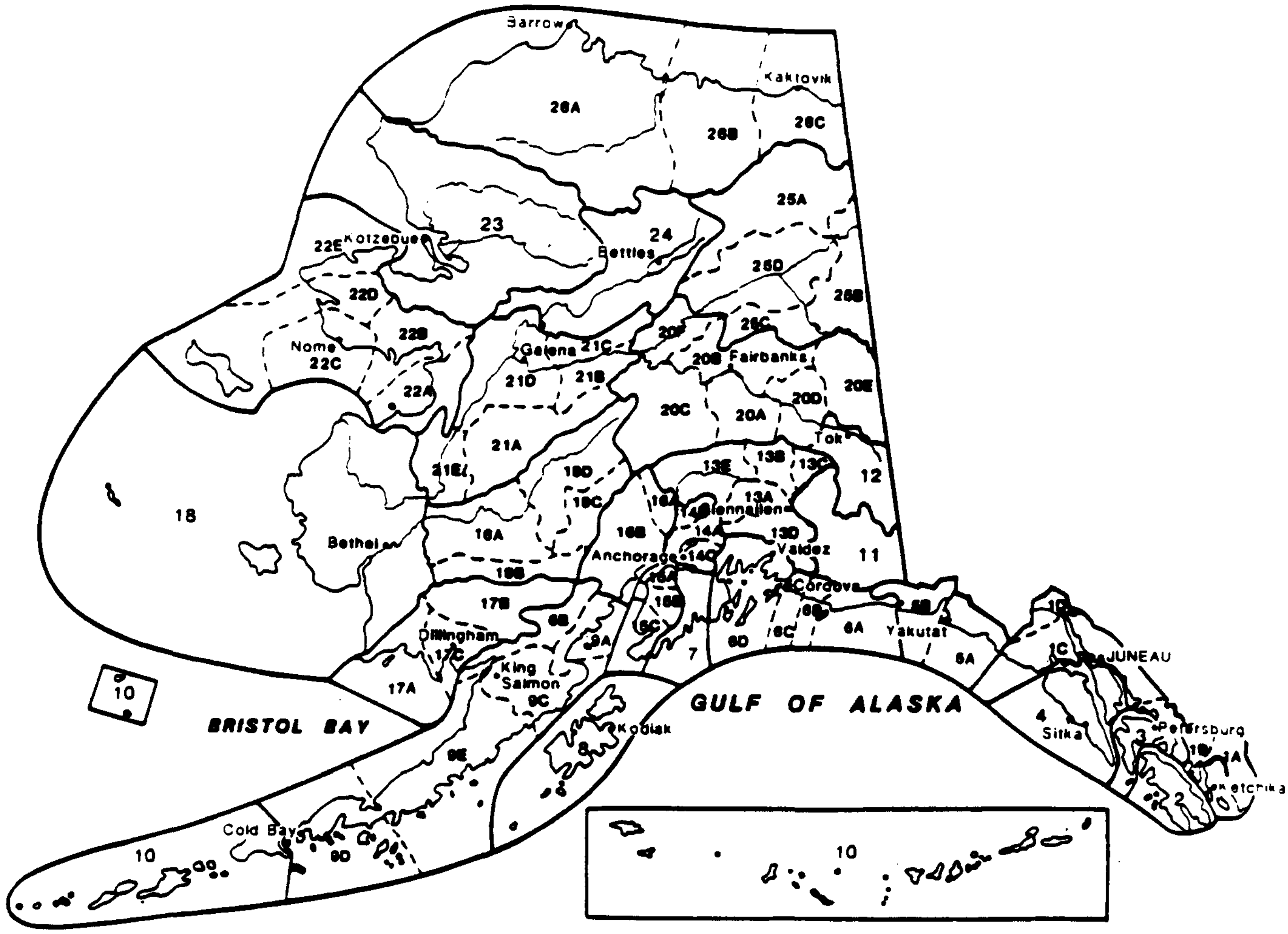
RODNEY W. FLYNN, Alaska Department of Fish and Game, Douglas, Alaska 99824, USA

*Abstract*: Reproductive performance in females of many mammalian species is reduced with diminishing resources. In addition, previous studies have established a positive relationship between body condition and reproductive performance in several species of mammals. Among small mustelids with 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*) during mating, pre-implantation, gestation, and lactation in Southeast Alaska from 1991 to 1994 in view of changes in numbers of small rodents. Stable isotope analysis of blood and muscle tissue was used to indicate diet for 75 live-trapped martens and 160 marten carcasses, and percentages of prey in the diet were calculated using a dual-isotope, multi-source mixing model. Reproductive status of female martens was established using counts of corpora lutea for carcasses and from blood progesterone levels for live females. Body condition was determined from weight and fat scores for carcasses and from body weight for live females. Concurrently, we monitored abundance of small rodents in our study area. 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 some female martens to maintain body condition and reproduce successfully even in years when preferred foods were not readily available.

**Key words:** American marten, *Martes americana*, diet, reproduction, body condition, implantation, corpora lutea, progesterone, stable isotope ratios, $\delta^{13}C$, $\delta^{15}N$, Alaska.

In press. *In* G Proulx. and H. Bryant (eds.) Integrating Martes in forest management. Proceedings of the second Martes Symposium. Edmonton, Alberta.

# Alaska's Game Management Units



The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manfacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program distributes funds to states using a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum of 5% of revenues collected each year. The Alaska Department of Fish and Game uses its funds to help restore, conserve, and manage wild birds and mammals. These funds are also used to educate hunters to develop skills and attitudes for responsible hunting. Federal Aid funds paid for 75% of this study.