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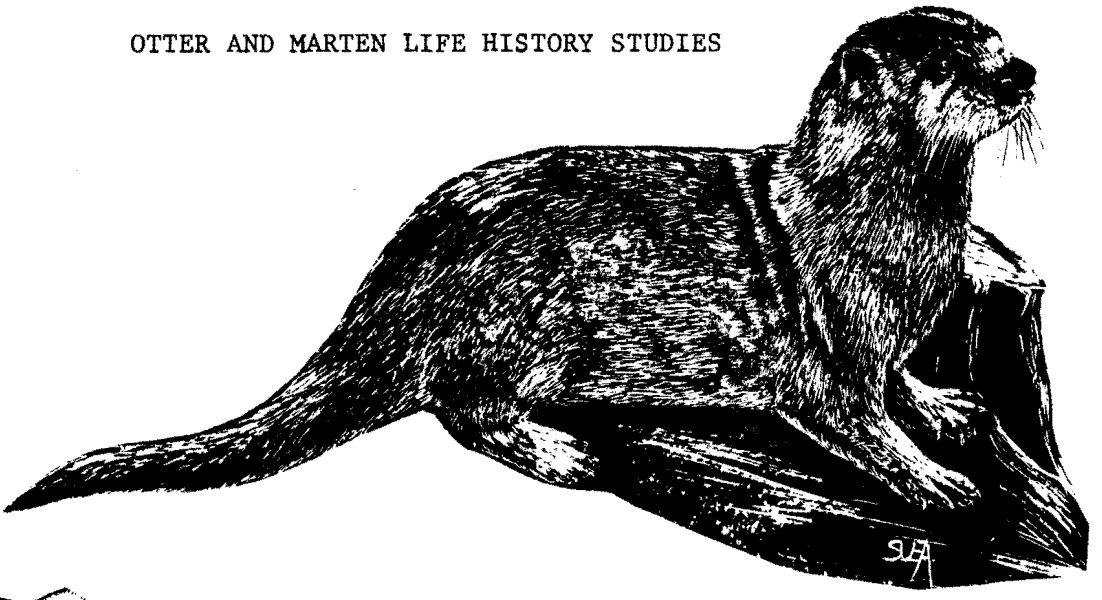
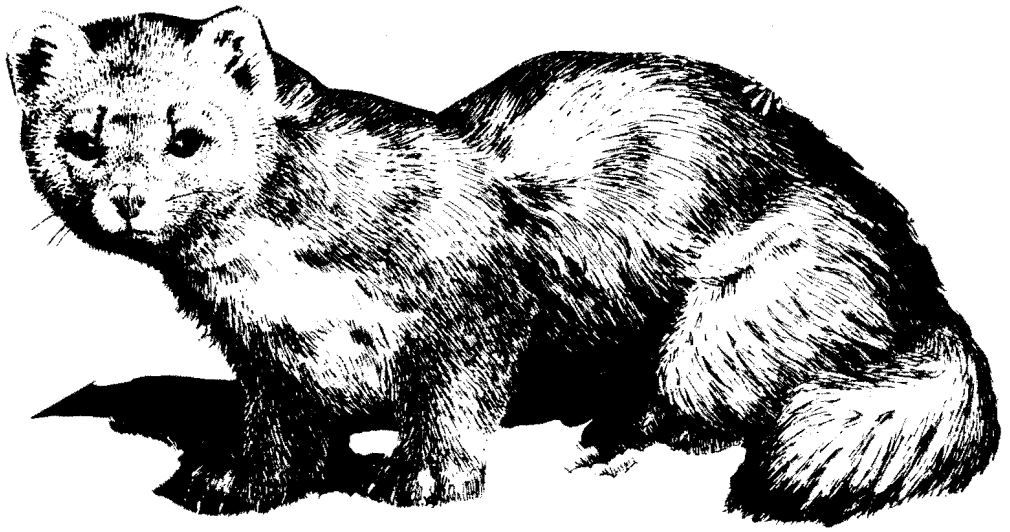
ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

OTTER AND MARTEN LIFE HISTORY STUDIES





BY
Loyal Johnson

STATE OF ALASKA
Jay S. Hammond, Governor

DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner

DIVISION OF GAME
Ronald J. Somerville, Director
Donald E. McKnight, Research Chief

Final Report
Federal Aid in Wildlife Restoration
Projects W-17-10, W-17-11, and W-21-1, Job 7.10R

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JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: Loyal Johnson

Project No.: W-17-10, W-17-11 and W-21-1 Project Title: Furbearer Investigations

Job No.: 7.10 R Job Title: Life History of Southeastern Alaska Land Otters and Marten

Period Covered: July 1, 1977 through June 30, 1980

SUMMARY

Marten and otter carcasses were purchased from trappers in Southeastern Alaska during the 1977-78 and 1978-79 trapping seasons. A total of 926 marten and 154 otters were acquired. These were autopsied; standard body measurements and weights were recorded; and pelvic girdles, skulls, reproductive tracts, femur bones, testes, and bacula were saved. Stomach contents from otters were also saved. Marten stomach contents were not saved. All specimens have been donated to the University of Alaska museum where they are available for further study. Ages of marten were determined by cranial characteristics and temporal muscle closure. Using that technique, males were segregated into four age groupings: young-of-year, yearling, 2-year-olds, and 3 years and older. It is possible to assign females into three age groupings: young-of- year, 1- and 2-year olds, and 3 years and older. Precise age determinations can only be made by tooth sectioning. Otters can only be accurately aged by tooth sectioning.

The funds and time available for this study were insufficient to do analyses of food habits, reproductive materials, or to section teeth for precise age determinations.

An extensive review of the literature on marten and otter was conducted. Little information is documented for marten and otter use of a coastal habitat such as occurs in Southeastern Alaska.

CONTENTS

BACKGROUND

OTTERS

The river or land otter (*Lutra canadensis*) is native to North America and occupies most of that continent except for the treeless arctic and arid southwestern United States (Palmer 1954, Hall and Kelson 1962). Being powerful swimmers and capable of rapid overland travel, otters can occupy all suitable habitat throughout their range. Hall and Kelson (1962) list 19 subspecies for North America.

Literature on river otters is scanty and most is quite old and of little scientific value (Osgood 1875, Nelson 1887, Petrof 1898, Dufresne 1946). Published descriptions of otters using a marine environment, such as coastal Alaska, are limited to brief accounts of observations in Dixon Harbor (Streveler et al. 1974, Streveler and Worley 1975, Scott 1977).

There are no recently published accounts to substantiate that this species is declining. Ingles (1947) reported them reduced "today" (1947) in California. Tabor and Wight (1977) reported decreasing catches from Oregon in the late 1960's but, based on modeling, concluded that the population was static. Melquist and Hornocker (1979) noted that an objective appraisal of activity patterns, movements, habitat preferences, and social behavior of wild, free-ranging otters is distinctly lacking. I was unable to find any reports describing home range sizes or densities of otters. Otters have undoubtedly suffered from the encroachment of civilization and/or industrialization in local situations, especially water pollution in industrialized areas. Nine states and one Canadian province reported otters to have been extirpated from their jurisdictions in a 1976 survey (Deems and Pursley 1978). All listed habitat destruction as the cause.

Reproductive biology of the otter is poorly understood, and the literature is scanty and conflicting. Being the captivating creatures they are, many otters have been raised and bred in captivity. It is from these circumstances that the published accounts of otter reproduction have been documented. However, these accounts are more frequently of the popular style rather than scientific (Park 1971). Liers (1951), in describing his

captive otters, reported that they breed in winter and early spring. He reported that female otters have a 42-46-day period of heat and that there is a 6-day cycle of active receptivity. Liers also reported that few male otters in captivity have the ability to successfully breed upon command during the rut and that males appear incapable of breeding until they are 5 to 7 years old even though both sexes are sexually mature at 2 years of age. Liers listed breeding records of four of his captive female otters, including one that whelped on four occasions during a 9-year period. The period between observed breeding and whelping varied from 9 months, 18 days to exactly 12 months. Three other females, ages 4, 4, and 8, showed intervals between observed breeding and whelping of 11 months, 20 days to 12 months. Wilson (1959) questioned the validity of Liers' data because of the artifacts of captivity. His own data, based on an examination of four pregnant females, supported a 61-day gestation period considered normal for the European otter (Lutra lutra) (Cocks 1881). Delayed implantation in the otter was not qualitatively documented until 1964 (Hamilton and Eadie 1964).

In a later report Liers (1958) retracted his earlier contention that otters are not sexually mature until they are 2 and presented an account of the breeding of a 16-month-old female followed by the birth of four pups 9 months, 18 days later on January 24.

Liers' reports then show a breeding season from January 1 through February 22 with birth dates from November 11 through January 16. Most instances of breeding occurred in January, and most whelping occurred in January. These breeding and whelping dates observed by Liers in captive otters are contrary to those observed in wild otters; i.e., females lactating or containing implanted embryos are not taken in the wild during winter months (pers. obs.). It appears that the artifacts of captivity may have altered the normal reproductive phenology of his animals.

Liers (1951, 1958) reported litter size to range from two to four young, with four being the most prevalent. All his data are for Minnesota otters.

A review of otter reproduction by Hamilton and Eadie (1964) noted the paucity of data on otter reproduction. Based on examination of carcasses of trapped otters in New York state, these workers reported that 10 of 12 females over 2 years of age taken between November 5 and December 20 showed breeding history, but no implanted blastocysts were recovered. No blastocysts were recovered after December 28, but no adult females were examined during January. They estimated the implantation date as late January-early February. Fetuses ranging in size from 76 mm (crown-rump) to 275 mm (total length) were recovered from adult females taken during the period March 12 to April 14.

Hamilton and Eadie's data showed that breeding takes place soon after birth in multiparous females in late March-early April

and at the same time for primiparous 2-year-old females. In summary, these workers found that New York otters mate in March and April and blastocysts implant the following January-February. Development proceeds rapidly upon implantation; and young, commonly two per litter, are born in March-April, for a gestation period of about 12 months. They also found that there was a close correlation between litter size of implanted fetuses (mean = 2.11) and corpora lutea (mean = 2.38).

Hamilton and Eadie (1964) reported finding no active spermatogenesis in males under 23 months of age, but all males over that age possessed mature spermatozoa in the epididymis (no specimens were available from May through October). They also reported that the testes of males regress in size following their first breeding season, but thereafter no such regression was noted.

Tabor and Wight (1977), working in Oregon on trapped otters taken between November 15 and February 15, found no evidence of breeding in 2-year-old otters, but found that females 3 years old and older breed annually. They found a high correlation between the number of corpora lutea (3.02), blastocysts (2.80), and implanted embryos (2.75). There was no significant difference in corpora lutea counts in otters 3 and 4-11 years of age. Seton (1929) reported that otters breed annually. Liers (1951) suggested his captive females did not breed annually.

Attempts to develop precise techniques for determining the ages of otters received little attention until recently. Hooper and Ostenson (1949) described a technique based on cranial and osteological characteristics which allowed segregation into four age groups: group 1 (comparable to otters up to about 9 months of age); group 2 otters in first and second year); group 3 (otters in third and fourth year); and group 4 (older). The size and shape of the baculum can only reliably be used to differentiate adults from immatures in otters (Friley 1949) and in other mustelids (Wright 1947, 1950). Tabor and Wight (1977) and Stephenson (1977) described techniques for sectioning canine teeth which provide specific ages of individual animals. These workers were hampered by a lack of known-age materials, but Stephenson reported high agreement between his few known-age animals and cementum annuli.

Longevity records for otters are scanty. Liers (1951) discussed one of his captive otters which was 16 years old. Stephenson (1977) aged two animals at 13 years using the cementum annuli technique, and Tabor and Wight (1977) reported one otter of 11 years of age on the basis of this technique.

The subjects of habitat requirements for the river otter and the impact of alteration of that habitat on otter populations has not been specifically reported in the otter literature. Liers (1951) described otter natal dens as being in burrows, cavities among tree roots, and vegetation thickets and mentioned that

these burrows are dug by other animals, whereas Seton (1929), quoting others, noted that they dig their own dens. Seton (1929) and Palmer (1954) provide the only written descriptions of otter habitat: Seton, "...where there are forests and water (pg. 675)" and "ideal surroundings in good-sized clear streams that abound with fish, and that are much varied in bank and bed with pools, rapids, log jams, and overhanging rocky banks (pg. 676)"; and Palmer "...all types of inland waterways, also marine coves, estuaries, and about islands (pg. 112)."

Liers (1951) and Seton (1929) noted that otters are territorial but, because of the distances they quickly travel, will occupy territories recently vacated by the death of previous occupants.

Reports on the feeding habits of otters are as scanty as are other documented aspects on this species' life. In Minnesota Liers (1951) listed their food as crayfish, frogs, turtles, aquatic insect larvae, angleworms, and fish, with crayfish being most desirable. He also noted that an otter can pass the skeletal remains of crayfish within an hour after ingestion. Lagler and Ostenson (1942) in Michigan reported that fish, crayfish, and amphibians constitute the majority of otters' foods and that forage or rough fish provide the majority of fish food. Palmer (1954), without quoting the source of his data, reported crayfish as the favorite food but also fish, shellfish, frogs, salamanders, turtles, earthworms, insects, snakes, muskrats, rabbits, and waterfowl. He noted that except in winter the otter eats less fish than is commonly realized, and those eaten are mainly nongame species. Greer (1955) in Montana reported the occurrence of fish in 93 percent of scats examined; invertebrates, 41 percent; amphibians, 18 percent; mammals, 6 percent; birds, 5 percent; and reptiles, 0.4 percent. Selection of fish species was not correlated to species diversity or abundance, but warm water species predominated. In California Ingles (1947) listed fish, frogs, crayfish, and young birds as being taken and further noted that "rough" fish predominated. Seton (1929), quoting a number of early popular accounts, reported the otter as predominantly a fish eater, especially trout and salmon, varying that diet with frogs, crayfish, and shellfish. Liers (1951) reported that, when fed a diet made up exclusively of fish, otters were ill and not in the best condition. In Alaska, Solf (1972) reported that otters secure their food in both fresh and salt water and that food items include snails, mussels, clams, sea urchins, insects, crabs, shrimp, octopi, frogs, a variety of fish, and occasionally birds, mammals, and vegetable matter. Sheldon and Toll (1964) in Massachusetts reported that warm water fishes and crayfish provide the bulk of otter diet and noted that salmonids were not utilized even though they were abundant.

Standard body measurements for otters are given by Hall and Kelson (1959) as: total length, 889-1,300 mm; tail, 300-500 mm; right hind foot, 100-146 mm; and weight, 5 to 10.02 kg with

females slightly smaller than males. Palmer (1954) listed measurements as: males, 965-1,397 mm; tail, 135-482 mm; and weight, 4.5-13.6 kg with females 30 percent smaller than males. Seton (1929) listed the otters total length as 1,010 mm; tail, 317 mm; hind foot, 102 mm; and weights ranging from 5.9-11.3 kg and 11.3 kg as being very heavy. Other than the weight of four individual animals, Seton did not provide location, sample size, date of collection, and age of specimens. A term fetus in New York measured: length, 275 mm; tail, 64 mm; hindfoot, 28 mm; and weighed 132 gm (Hamilton and Eadie 1964). Stephenson (1977) reported that otters from Ontario, Canada, attain full body weight and size by 4 years of age and that thereafter males show only slight size/weight increases and the female's weight actually decreases with age. Stephenson also reported that pelted carcasses of males and females averaged 81.0 and 80.4 percent of the total weight, respectively. The average weights of otters older than 1 year of age were 5.80 kg and 4.85 kg; total length and hind foot lengths were 1,095 and 1,045 mm; and 123 and 115 mm for males and females, respectively. Animals less than 1 year of age weighed 3.73 and 3.36 kg and measured 969 and 938 mm total length and 117 and 110 mm hind foot for males and females, respectively. Yearling animals were slightly smaller and lighter, except for hind foot lengths, than 2-year-old animals. These data are from otters taken by trappers from November to March.

MARTEN

The genus Martes occurs throughout the northern hemisphere (Marshall 1946). A single species inhabits North America and, at least in former times, occupied a range that coincided with the transcontinental coniferous forest (deVos 1952, Hagmeier 1956). Marten (*Martes americana*) distribution in Alaska coincides with that of climax spruce forests (Hagmeier 1956, Manville and Young 1965, Anon 1978, Shepherd 1978). Hall and and Kelson (1959) listed 14 subspecies for North America.

Marten are native to Southeastern Alaska but apparently did not occur naturally on the islands north of Frederick Sound or Prince of Wales Island. To provide jobs for unemployed Alaskans, monies were made available, starting in 1934, through the Bureau of Biological Survey and the Civil Works Commission to transplant or relocate various species, including marten (Alaska Game Commission 1935), in Alaska. Initial releases were made of *M. a. actuosa* (Hall and Kelson 1959) on Prince of Wales Island (10 animals) and Baranof Island (7 animals; 4 males, 3 females). Despite the small numbers released, the transplants succeeded in establishing marten at both release sites.

Efforts began in 1949 to establish marten on Chichagof Island when six animals, two males and four females, were captured on Baranof Island and released on Chichagof. That transplant was bolstered by the release of a total of 15 animals in the Pelican, Alaska, area during 1951 and 1952. The source of

the latter transplant stock was Southeast Alaska; Ketchikan (1 animal), Stikine River (6 animals), and Petersburg-Wrangell (5 animals). However, three animals, presumably *M. a. kenaiensis* (Hall and Kelson 1959), were obtained at Polly Creek near Anchorage (Elkins and Kelson 1954, Burris and McKnight 1973).

To protect the new introductions, no trapping season was allowed for marten on Baranof Island during the 1948-1949 and 1949-1950 seasons, and no trapping was allowed on Chichagof Island from 1948 through 1962. Apparently no such protective closure was ever effected for the Prince of Wales marten introduction. In addition to that specific closure, marten seasons were generally offered only on an alternate year basis from 1925 through 1962 over most of Alaska (Johnson 1978).

Despite the small numbers of animals released, all transplants succeeded in establishing marten on previously uninhabited islands. In fact, they have since spread to adjacent islands, such as Kruzof. This is particularly striking in light of the relatively low reproductive potential of this species. Populations of martens are now reasonably dense throughout Southeastern Alaska.

It is not known when or how marten became established on Admiralty Island, but the published accounts are conflicting. There are no records of transplants. Holzworth (1930) did not mention them in his account of mammalian fauna nor were they mentioned by Short (1964) or Williams (1952) in their account of trapping, homesteading, and travels there. One old-time trapper reports that they were absent until the late 1950's (Fred Manley, pers. comm.). However, there are five marten specimens in National Museum of Natural History which were reportedly collected by Alan Hasselborg, a noted Admiralty Island resident, on Admiralty Island in 1915 (Mrs. Joy Gold, Zoology Docent, Nat. Mus. Natl. Hist., pers. comm.). Swarth (1911) and Dufresne (1946) reported the species to be indigenous to Admiralty, and Hagmeier (1956) noted having examined specimens from there.

At the present time, marten are reasonably abundant on Admiralty Island. I personally observed a marten swimming several miles offshore from Baranof Island, and it is possible that the present Admiralty Island population is a natural extension from the population on the mainland, which is only a short distance away. It is an interesting observation that the present Admiralty Island population possesses very low quality fur which can readily be identified by experienced fur buyers (Don Davis, Juneau, Alaska; and Chuck Peterson, Sitka, Alaska, pers. comm.). This they attribute to the absence of red squirrels (*Tamiasciurus hudsonicus*) on Admiralty, which are supposedly the mainstay food item for marten. In fact, red squirrels were introduced to Baranof and Chichagof Islands as a food source for the marten introductions (Elkins and Nelson 1954). Squirrels are very abundant on Baranof, Chichagof, Kruzof, and adjacent islands but are not known to occur on Admiralty Island (pers. obs.).

As was common in early day wildlife transplants, there were apparently no formal attempts to monitor the success of the marten transplants. I have not been able to find any references on the subject other than an occasional harvest report. In addition, there is a notable lack of literature and knowledge on Alaskan marten in general and for Southeast Alaska in particular.

The reproductive biology of the marten is well understood. Wild female marten are not sexually mature as yearlings, but males are (Jonkle and Weckwerth 1963). Others (Walker 1929, Enders and Leekley 1941, Markley and Bassett 1942, Krott 1973) reported that they do not breed their first year of life. Archibald (1980) reported one in a sample of 88 adolescent females to have conceived and noted that to be the first documented breeding of an adolescent female. Breeding has been reported to occur from May-July (Walker 1929), June-July (Krott 1973), July-August (Ashbrook 1930, Pearson and Enders 1944, Jonkle and Weckwerth 1963), August (Brassard and Bernard 1939), and July-September (Ashbrook and Hanson 1927, Enders and Leekley 1941). Marten are induced ovulators (Ewer 1973). Typical of the mustelids, marten show delayed implantation (Hamlett 1935, Brassard and Bernard 1939, Wright 1942, Marshall and Enders 1942, Pearson and Enders 1944, Jonkle and Weckwerth 1963). Delayed implantation in marten was first described by Hamlett (1935). The long gestation period was well known and reported earlier (Ashbrook and Hanson 1927, Walker 1929). Parturition occurs in March-April (Ashbrook and Hanson 1927, Walker 1929, Ashbrook 1930, Brassard and Bernard 1939, Jonkle and Weckwerth 1963, Krott 1973) or May (deVos 1957). Blastocysts are free until at least January (Marshall and Enders 1942) and implant February-April with birth occurring within about 27 days after implantation (Jonkle and Weckwerth 1963). Litter sizes range from two to six and average about three (Ashbrook and Hanson 1927, Walker 1929, Ashbrook 1930, Jonkle and Weckwerth 1963, Mech and Rogers 1977, Strickland and Douglas 1978, Archibald 1980). Douglas and Strickland (1978) and Archibald (1980) reported slightly greater litter sizes, based on corpora lutea counts, in animals more than 2 years of age over yearlings.

Until recently techniques for age determination were imprecise and limited to observed osteological development. Dagg et al. (1975), using radiography on fall and winter-trapped marten in Ontario, Canada, determined that the distal femoral epiphysis of 142 specimens were fully closed by November, making it impossible to differentiate young-of-the-year from adults after that date. Marshall (1942 and 1951a), using the following measurements: (1) standard body measurements; (2) tooth development and wear; (3) fusing of sutures; (4) other skull measurements; (5) bacula weight; (6) occurrence of corpora lutea; and (7) character of sagittal crest of 107 marten trapped in central Idaho, determined that these measurements singly or in combination are useful only in separating marten into two age groups, immature and adult. Marshall (1942, 1951a), Lensink (1953a, 1953b), and Grakov (1962) reported similar findings on

the relationships between the degree of development of the sagittal crest and size and weight of bacula of males and reproductive tracts and/or breeding history of females. These findings are: males whose dried bacula weigh less than 200 mg will have an opening between the temporal muscles or at most a sagittal crest less than 20 mm in length; females with a separation between the temporal muscles will show no evidence of having bred, i.e., no corpora lutea or corpora albicans. Lensink (1953a) in Interior Alaska used the height and length of the sagittal crest to separate males into ages 1 through 5 and older. In females he used the width of the separation of the temporal muscle to differentiate young-of-the-year from 1-year-olds and the length of the sagittal crest to separate ages 2 through 5 and older. He had no known age specimens to authenticate that aging criteria to be correct. Quick (1956) concluded that female marten with sagittal crests 0-10 mm long represent young-of-the-year, 11-20 mm represent yearlings, 21-30 mm represent minimum breeding age, and over 31 mm represent older adults. Among males, 0-10 mm represent young-of-the-year, 11-30 mm represent youngish, and over 31 mm represent older age. These were not confirmed by comparison with known-age specimens.

In recent years M. A. Strickland (Regional Project Biologist, Parry Sound, Ontario, pers. corr.), R. Archibald (Fur Biologist, Yukon Game Branch, Whitehorse, pers. corr.), and M. K. Brown (New York State Dept. Env. Cons., Warrensburg, pers. corr.) have had encouraging results using cementum annuli techniques to determine ages of marten. However, they have been hampered by having few known-age specimens to verify their findings.

Analysis of marten reproductive tracts to determine fecundity rates has proved feasible (Marshall 1951b, Jonkle and Weckwerth 1963, Archibald 1980). There is evidence of a close correlation between corpora lutea counts and litter size (Marshall 1951b, Lensink 1953a). Recovery of identifiable blastocysts is contingent upon availability of specimen material before autolysis begins (J. J. Burns, pers. comm.).

Habitat requirements of marten in Southeastern Alaska are not known. Elsewhere within their range it has been reported that marten are creatures of mature forests (Seton 1929, Marshall 1951b, deVos 1952, Lensink 1953a, Hawley 1955, Francis and Stephenson 1972, Koehler et al. 1975, Clark and Campbell 1977, Koehler and Hornocker 1977, Mech and Rogers 1977, and Soutiere 1978). Alteration of the pristine forest can have significant impact on marten populations. Marshall (1951b) in Idaho, deVos (1952) in eastern Canada, and Mech and Rogers (1977) in Minnesota reconstructed the decline of marten populations following settlement with its attendant forms of land alteration, especially clearing, logging, and fire. Marshall (1946) reported little marten sign in winter in areas devoid of tree cover. In Canada deVos (1952) noted that marten were less abundant in second growth stands than in mature forests. Lockie (1964) traced a similar decline in the related pine marten (*M. martes*)

in Scotland. In response to a 1976 survey nine states and one Canadian province reported marten as extirpated from their jurisdictions. The reason for extirpation was given as habitat destruction (Deems and Pursley 1978). Koehler et al. (1975) in Idaho showed that marten prefer stands older than 100 years and that such a stand must have a canopy cover greater than 30 percent. Those authors also reported that marten will cross but not hunt in openings less than 300 feet in width during winter. They noted that marten were not observed to have crossed openings greater than 300 feet and that marten do not use "dog hair thickets" because of minimal small rodent populations. Soutiere (1978) observed marten tracks in openings as wide as 200 m. Habitat requirements in summer seem to be less rigid than in winter (Grinnell et al. 1937, Marshall 1946). Clark and Campbell (1977) in Wyoming reported that marten do not utilize harvested areas at least within 1 year following harvest. These authors further noted that in winter marten foraging was confined to dense, mature stands of coniferous forests. Koehler et al. (1975) and Steventon (1979) observed that in winter females are more reluctant to enter clear-cut areas than are males.

Koehler et. al. (1975) postulated that fire and man-made disturbances, such as logging, are normally negative factors because marten require large blocks of habitat. Russian studies showed that marten catches decrease following cutting of mature forests in which the cuts are of the magnitude of 65-75 percent of the total forested area (Grakov 1972) and that such reductions are related to a reduction of the marten's food source (Vaisfel'd 1972). Major (1979) reported a dramatic underutilization of regenerating clear-cuts by marten in Maine and postulates that decreased use is related to food availability rather than the psychological barrier of lack of overhead cover. Major's observations are based on radio-tracking of four adult resident marten and during summer months only. Martell and Radvanyi (1977) reported that clear-cutting of upland black spruce forests in northern Ontario produced a dramatic change in species composition of small mammals but may have caused little change in density. Red-backed voles (*Clethrionomys gapperi*) were most negatively impacted. Tevis (1956), Gashwiler (1970), Hoovan (1973), and Sims and Buckner (1973) have also documented reductions in vole populations following clear-cuttings, while Krefting and Ahlgren (1974) documented similar results following fire. These workers also noted significant increases in population densities of *Peromyscus* following disturbance. Clark and Campbell (1977) report that in Wyoming, logging causes changes in forest ground conditions with more intensive logging resulting in conditions becoming xeric. They further report that as sites change from mesic to xeric following logging, microtine rodents decrease while *Peromyscus* increase. An interesting concept in small mammal-reforestation relationships has been described by Maser et al. (1978) and Maser et al. (1978). They found small mammals, especially microtine species, to be critical to forest regeneration through the spread of mycorrhizal fungi. This is opposite the long-held opinion that the predatory food

habits on tree seeds of small mammals inhibits regeneration. Conversely, Monthey (1978) in Maine found catches of small mammals to be greater in clear-cut areas than in uncut soft wood forests. That author also noted that red-backed voles showed no response to clear-cutting. His study was of short duration and in most sampled areas immediately followed timber harvesting operations.

Soutiere (1978) in Maine reported that marten are not necessarily restricted to mature spruce-fir forests and can tolerate men and machines associated with logging. He further reported that clear-cuts are detrimental to marten populations, but suitable marten habitat can be provided if cuts "Retain a minimum of 25 percent of the area in spruce-fir forest cover having a basal area of at least 25 m^2/ha in pole stage and larger trees." Soutiere believed that nonoperable and immature timber, especially along watercourses and as islands within clear-cuts, are essential elements of marten home ranges. Overall, however, Soutiere's data shows marten populations in harvested areas to be only about one-third those in undisturbed forests. These findings should be of profound importance in land use planning in Southeast Alaska.

Seton (1929) and Cowan and MacKay (1950) reported the cyclic nature of marten populations (based upon harvest figures). From their food habits studies, Cowan and MacKay (1950) deduced that marten cycles are not related to similar and coincidental cycles in snowshoe hares (*Lepus americanus*) and the grouse family (*Tetraonidae*).

Natal dens are rarely found. One den located in a "rocky bank" in California was occupied for 6 years consecutively (Ingles 1947). A den with four young was observed about 60 feet above ground in a hollow fir tree on June 20, 1898, in southern California (Linsdale 1936). Pelikan and Vackar (1978) in Czechoslovakia found 16 dens of European pine marten over a 22-year intermittent search. All dens were appropriated woodpecker or squirrel holes in trees and were used only once.

Francis and Stephenson (1972) found three active dens, two in boulders and one in a hollow log. Seton (1929) described dens as being in hollow trees and at considerable height and that woodpecker nests may be appropriated. Seton quoted others as listing trees as preferred den sites but suggested that ground dens may also be excavated. Seton did not specify or imply if these were natal or resting dens.

Microtine rodents, especially red-backed voles, are reported as being the primary prey of marten (Cowan and Mackay 1950, Remington 1950, Newby 1951, Lensink 1953a, Hawley 1955, Lensink et al. 1955, Quick 1956, Lockie 1961, Murie 1961, Weckwerth and Hawley 1962, Clark and Campbell, 1977, Koehler and Hornocker 1977). The above cited reports noted that red squirrels and Peromyscus do not appear to be preferred food items for marten,

although Grinnell et al. (1937), Marshall (1946), and Newby (1951) reported that tree squirrels may at times be important. Berries and arthropods are seasonally important food items (Marshall 1942, 1946, 1951b; Cowan and MacKay 1950; Lensink 1953a, 1953b; Hawley 1955; Lensink et al. 1955; Weckwerth 1957; Murie 1961; Lockie 1961 (in Scotland); Weckwerth and Hawley 1962; Francis and Stephenson 1972; Clark and Campbell 1977; Soutiere 1978). The above studies all noted or implied the catholic nature of marten food habits, often dictated by prey distribution and abundance rather than preference.

There is little information in the literature on the size of marten. No information could be found on the species from coastal Alaska. Perhaps the classic example of the lack of data on the species is that contained in Youngman (1975) concerning the size of marten in the Yukon Territory, Canada, an area which the commercial trapping of marten was instrumental in human settlement..."No specimens are available from the Yukon with external measurements" (pg. 140).

Published weights and external measurements are summarized in Table 1. Those studies which followed individual animals through recapture observed considerable seasonal variation in weights and also variation in weights on successive captures (Hawley and Newby 1957, Mech and Rogers 1978, Soutiere 1978). Table 1 does not list those generalized published weights and measurements such as Palmer (1954) and Hall and Kelson (1959), for they do not give the source of the specimens or the season of the year. These data show whole weights of adult male marten to be about 990 g and females, 650 g, or about 34 percent smaller than males. The smallest marten were those described by Soutiere (1978) from Maine, which were about 30 percent smaller than the other published weights.

Longevity records are limited and with few exceptions are for captive animals. Markley and Bassett (1942) discussed a female that whelped at age 9 and mentioned an 11-year-old male. Hawley and Newby (1957) mentioned a 16 year old. Seton (1929) and Burton (1962) reported that a captive pair lived to 17 years. McDonald (1979) reported one 12-year-old male in a sample of 189 wild trapped marten examined in an age correlation study in Yukon Territory. Douglas and Strickland (1978) report both males and females as old as 14 years in the harvest in Canada. There are two skulls in the Alaska Department of Fish and Game office in Sitka from the old Petersburg experimental fur farm that are from 14-year-old animals.

Home ranges for marten have been determined through live trapping/ recapture studies and more recently radio telemetry. Published records of home range sizes are given in Table 2. Males were reported as occupying home ranges of about 2.6 km^2, which is about 60 percent greater than the 1.1 km2 of females. The published accounts of home range sizes were in agreement except that of Mech and Rogers (1977) in Michigan who found home

Table 1. External measurements of adult marten. Weights are of whole animals. Measurements in mm; weights in g.

Source	Location	Season	Males					Females				
			T.L.	T.	H.F.	Wt.	Sample Size	T.L.	T.	H.F.	Wt.	Sample Size
Grinnell et al. 1937	California	Summer	620	197.0	85	983	14	577.0	187.0	76	741	4
Marshall 1942	Idaho	Winter	644	208.6	-	-	-	590.5	190.4	-	-	-
Hawley 1955	Montana	Year-round	-	-	-	955	158	-	-	-	594	58
Hawley and Newby 1957	Montana	Year-round	-	-	-	1,006	69	-	-	-	635	20
Weckwerth and Hawley 1962	Montana	Year-round	-	-	-	920-1,160	-	-	-	-	525-680	-
Mech and Rogers 1977	Michigan	Year-round	-	-	-	885	4	-	-	-	672	1
Clark and Campbell 1977	Wyoming	Summer	-	-	-	1,198	72	-	-	-	735	24
Soutiere 1978	Maine	Winter	-	-	-	712	-	-	-	-	453	-
Archibald 1980	Yukon, Canada	Year-round	-	-	-	1,140	-	-	-	-	797	-

Table 2. Reports of home range size of resident marten.

Source	Location	Home Range		Remarks
		Male	Female	
Archibald 1980	Yukon, Canada	2.5 km^2	1.7 km^2	Telemetry, preliminary data
Clark and Campbell 1977	Wyoming	2.2 km^2	0.8 km^2	
Francis and Stephenson 1972	Ontario, Canada	3.6 km^2	1.2 km^2	
Mech and Rogers 1977	Michigan	15.7 km^2	4.3 km^2	
Hawley and Newby 1957	Montana	2.3 km^2	0.7 km^2	
Soutiere 1978	Maine	0.1 to 4.4 km^2*		Clear-cut forest
		0.1 to 2.3 km^2*		Old growth/partial cut
Steventon 1979	Maine	0.8 km^2		Two animals only

*Sexes combined.

ranges of males to be three times greater than females. These authors reported male home range sizes about five times greater than other accounts and females four times greater. It cannot be determined from their report why Mech and Rogers found such greater home range sizes. It is possible they included some data for transient specimens while the other reports are for resident animals only.

A disproportionate number of males in the catch of marten has been documented by numerous observers. Harvested males typically outnumber females by a ratio of about 1.6:1 (Grinnell et al. 1937; Parsell 1938; Twining and Hensley 1947; Yeager 1950; deVos 1952; Lensink 1953a, 1953b; Hawley 1955; Quick 1956; Hawley and Newby 1957; Clark and Campbell 1977; Soutiere 1978). Markely and Bassett (1942) reported the sex ratio at birth to be nearly 1:1 in captive marten. A similar at-birth ratio was reported by Yeager (1950). In heavily exploited populations Marshall (1946) and Quick (1956) reported a sex ratio of 1:1 while Francis and Stephenson (1972) found a 1:1 sex ratio in an unexploited population in Algonquin Park. Douglas and Strickland (1978) showed males of all ages to outnumber females of all ages by two to three times in the trapper catch in Ontario, Canada, on an exploited population.

Hawley and Newby (1957) and Archibald (1980) differentiated three groups of marten (resident, temporary resident, and transient) and noted the sex ratio of the resident group was about 1:1. Strickland and Douglas (1978) reported an increase in litter size in an exploited population. There are no data available to indicate the magnitude of the movements of the temporary residents and transient animals after they leave the study areas. Another sex ratio phenomenon that has been frequently observed in catches of marten is an increase in the percentage of females as the season progresses into January and February (Grinnell et al. 1937; Parsell 1938; Twining and Hensley 1947; Yeager 1950; Lensink 1953a, 1953b; Douglas and Strickland 1978).

Various authors have reported on the age structure of trapped marten. Lensink (1953a, 1953b) reported that 45 percent of the annual catch in Interior Alaska was young-of-the-year from an exploited population but that the percentage of adults increased markedly as trap lines were established in new areas. Strickland and Douglas (1978) reported that young contributed 50-60 percent of the catch in an expanding population in Canada. Hawley and Newby (1957) in Glacier National Park caught 30 percent young in their live trapping effort on an unexploited population.

Quick (1956) observed that the percentage of young of the year increased from 48 percent to 77 percent in successive years from an area that was trapped "exhaustively"; yet in an adjacent area subject to lesser trapping intensity the percentage of young in the catch did not show the same increase. Quick suggested

that it is possible to catch all the resident marten with excessive trapping and that the area will be repopulated by immigration of young transient animals from adjacent areas. This is supported by the observations of deVos (1951, 1952) and Hawley (1955). Hawley noted that the various sex and age classes can fluctuate widely from year to year in response to food supply. It is thus important to recognize that sex and age data from trapper-caught samples in a given year are not sufficient to draw quantitative or qualitative conclusions on a marten population.

Densities of marten populations fluctuate in response to fluctuations of food supplies (Weckwerth and Hawley 1962) and overexploitation (Grinnell et al. 1937, Marshall 1946, Cowan and MacKay 1950, deVos 1952, Quick 1956, Lockie 1964, Mech and Rogers 1977). Strickland and Douglas (1978) observed a very low and unexplained reproductive rate (only 7 of 24 adult females were pregnant) in northwestern Ontario, Canada, and speculated such may be the beginning of a downward population trend. Some areas are, of course, capable of supporting greater densities than others. Consequently, published density figures must be viewed with those concepts in mind. Densities of marten as reported in the older literature were estimates and were made on trapper catches, track counts, and other observations. Marshall (1942) estimated unexploited densities in Idaho of one animal per 2.59 km^2 but when exploited that could drop to one animal per 51.8 km^2. Seton's interviews and personal observations (1929) led him to suggest good habitat in North America could support 2.3 animals per km^2. More recent reports, based on calculations made from recovery of marked animals and/or telemetry, have provided much more factual density data. In Montana Weckwerth and Hawley (1962) measured densities that ranged from 0.92-1.66 per km^2. Francis and Stephenson (1972) in Ontario, Canada, recorded 0.8-1.2 marten per km^2. That was increased to 1.2-1.9 marten per km^2 by infusion of immature and transient animals into the population. Archibald (1980) recorded 0.6 marten per km^2 in the Yukon. Soutiere (1978) recorded 1.2 marten per km^2 in old-growth or selectively cut Maine forests but observed that densities drop to 0.4 marten per km^2 following clear-cutting. Pelikan and Vackar (1978) in Czechoslovakia estimated a midsummer population of 0.93 marten per km^2 based on observations of occupied natal dens. In Idaho, Marshall (1942) suggested a catch of one marten per 7.77 km^2 was a sustainable yield. deVos (1952) and Quick (1956) suggested a catch of about one marten per 5.18 km^2 was a sustainable yield. Quick hypothesized that the catch should not exceed the ratio of one young-of-the-year to one adult female.

Home range sizes have been determined by multiple recoveries of previously marked animals and more recently using radio telemetry. Findings of more detailed and extensive studies are summarized in Table 2. As was noted with population estimates, home range sizes are governed by many variables, including densities. It was observed that resident male marten generally occupy exclusive home ranges, but there may be an overlap of

resident males with resident females (Hawley and Newby 1957, Francis and Stephenson 1972, Clark and Campbell 1977, Steventon 1979). Pelikan and Vackar (1978) found one breeding pair of European pine marten per 590 ha in Czechoslovakia. No description was given of the successional status of the forest or the degree of exploitation of the marten population.

The value of reserves for protection and increases of marten through dispersal into adjacent overexploited areas of suitable habitat has been demonstrated (deVos 1951, Skinner 1979).

The limited published accounts show marten to be relatively free of parasites. Four authors reported marten to be the host of an unusual stomach worm, *Soboliphyme baturini* Petrow (Bezdek 1942, Marshall 1942, Newby 1951, Cheng 1967). Two other species of round worms have been identified, *Ascaris devosi* Sprent (deVos 1952) and *A. columnaris* Leidy (Marshall 1942). deVos (1952, 1957) listed two species of ticks, *Ixodes cookei* Packard and *I. texanus* (Banks), and two species of fleas, *Monopsyllus vison* (Bak) and *Megabothris atrox* (Jord). One Trichina cyst was observed in a marten from Arctic Village, Alaska (Dunagan 1957 in Hopla 1965).

OBJECTIVES

To determine the sex and age composition of land otters and marten harvested in Southeastern Alaska, to establish baselines of body growth in these species, to determine breeding history of harvested females of these species, and to conduct a thorough literature review.

PROCEDURES

Marten and otter carcasses were solicited from trappers throughout Southeastern Alaska. A reward incentive of $2 per marten and $5 per otter carcass was offered. Carcasses were gathered in Sitka, where they were autopsied. Standard body measurements (Anderson 1948) were taken, weights recorded, sex determined, and general physical well-being determined. Skull, bacula, testes, reproductive tracts, femurs, and pelvic girdles were collected, labeled, and refrozen. In 1977 muscle tissue samples were collected from marten for cessium 137 content determination. Gross parasitological examinations were made.

FINDINGS

A search of the literature revealed that very little quantitative or qualitative information is available on otters. The few published accounts conflicted on such basic knowledge as length of gestation period, breeding season, time of parturition, and even size of otters. No information could be found documenting otter habitat requirements nor could any data be

located describing any aspect of otter life history in a marine environment as occurs in Southeastern Alaska.

The literature review revealed that considerable research was conducted on marten in the 1940's and 1950's, when the demand for their furs was great. There was a lull in interest in marten when prices for its fur fell. In recent years there has been a resurgence of interest in the species, perhaps due to the high demand for its fur, but also the marten has been "found" as an engaging species upon which to conduct research. Research is now underway over most of the North American range of the species. Some research is a bit esoteric, but most is being directed at management created by habitat degradation problems and overutilization.

Most of the early studies were conducted on penned animals, particularly those describing the reproductive life history of the marten. Many studies dealt with the ecology of discrete and often isolated populations. No literature could be found on marten for Southeastern Alaska except a description of transplants. Many generalities and myths are reported and, unfortunately, repeated, particularly in the popular current literature on marten. A recent example is from Pulling (1973), "They are primarily tree animals and red (tree) squirrels are their favorite food" (pg. 211). Both those generalities are incorrect and contrary to literature which was readily available to that author at the time of his publication.

Life history, habitat requirements, food habits, and reproduction are well documented. No techniques were described for precise age determinations except for unreported ongoing research. Numerous reports documented impacts of habitat destruction on marten worldwide; and most reports described the reliance of marten on undisturbed, climax vegetation. No reports were located which described marten ecology in a coastal forest habitat like Southeastern Alaska.

Trapper response to this research program was excellent. A total of 926 marten and 154 otter carcasses was collected. Wendell Skaflestad of Hoonah; Mr. and Mrs. Ralph Fenner of Wrangell; and Mike, Kevin, and Martin Johnson of Sitka provided the majority of the specimen material.

The original intent of this study was to establish baseline data source on marten in Southeast Alaska. Specimen materials were secured from throughout Southeast but came primarily from Baranof and Chichagof Islands and the Wrangell area. Information to be obtained included: age and sex structure, standard body measurements correlated with sex and ages, food habits, and breeding history and to develop an aging technique and conduct a thorough literature review. The large sample size collected exceeded the capability and scope of the project.

Concurrent with this study, workers in Canada and New York developed a reliable aging technique for marten using sectioning of canine or premolar teeth. A sample of 32 teeth was cut by the Anchorage laboratory facility using the techniques noted above. The results were found to be reliable, so no further aging techniques were attempted. A reliable technique for accurately determining ages of river otters has also been developed, so no attempts were made to age otters. Instead, the skulls of all marten have been deposited with the University of Alaska museum where they are available for further study. Otter materials will be made available to a cooperative study which is to begin in 1981.

Reproductive tracts of females, bacula and testes of males, femur bones, and pelvic girdles were saved from all specimens. Stomach samples were taken from all otters when it appeared that the contents were a genuine food item and not something ingested while confined in the trap. The magnitude of this project was insufficient to allow time necessary to perform lab analyses of stomach contents and reproductive materials. These will be made available for future studies.

Standard body measurements of total length, tail length, hind foot (when available), and weight were recorded. These are summarized in Appendix I for marten. These specimens were all secured from trappers. Condition of specimens varied from fresh to badly autolyzed. Some were badly desiccated through long periods of storage. Consequently, the weights listed in Appendix I represent minimal data, for the above conditions would all tend to decrease the weights.

The mean carcass weight of all male marten examined was 876.3 g. The mean whole weight of males was 1,084.3 g. The largest male specimen weighed 1,319.2 g (carcass weight). The whole weight of that specimen would have been approximately 1,663.6 g (see below). The mean carcass weight of all females was 594.4 g while the mean whole weight of all females was 754.2 g (78 % of all whole female weights are for young-of-the-year). The largest female carcass weight was 912.2 g. The whole weight of that specimen would have been approximately 1,126.2 g. That specimen harbored 59 stomach worms.

When compared to the published weights of marten in North America, marten from Southeastern Alaska are about the same size as specimens from western North America, all of which were larger than those reported from Michigan (Mech and Rogers 1977) and Maine (Soutiere 1978).

Mean body weights are somewhat meaningless unless ages of animals are correlated with them. Thus, while time, finances, and facilities did not allow tooth sectioning for precise aging, marten were categorized into age groups following the sagittal crest criteria described by Marshall (1951a). Using this

technique, I found it possible to separate female marten into three age groups: young-of-the-year, young females (probably ages 1 and 2), and mature older females. It was possible to satisfactorily group males into four age groups: young-of-the-year, yearlings, 2 year olds, and mature (3 years plus).

When these ages were correlated with weights and measurements, it suggests this age criteria are valid (Appendix I) in separating young-of-the-year and 3 year and older, but, the criteria, including weights, cannot allow a clear-cut separation between yearling and 2-year-old animals.

The published accounts of weights of marten are either of carcasses or whole weights. In this study it was possible to weigh some specimens before they were pelted and again after pelting. These comparisons are given in Appendix I. These show that among males the mean carcass weights of young-of-the-year represent 85.9 percent of the whole weight while in males 1 and 2 years of age the carcass weight is about 77 percent of the whole weight. In older males the carcass weight represents 79.3 percent of the whole weight. In female young-of-the-year the carcass weight represents 77.8 percent of the whole weight while in 1- and 2-year-old females the carcass weight is 81 percent of the whole weight. No whole weights were available for adult females.

The literature on marten reports the species is vulnerable to trapping and that exploitation can have a marked influence on both sex and age data. In Alaska, where marten harvests are only casually monitored, there is little knowledge of trapping intensity an area has sustained. The marten carcasses collected for this study were obtained as noted above from a number of areas with trapping pressure varying from those that are trapped intensely annually to those which may be trapped infrequently. Unfortunately, I do not know the intensity of the trapping effort by area except for those intensively trapped areas adjacent to communities. Therefore, no definitive analysis of population status could be made from the carcasses collected under this study.

There are numerous published accounts which documented a disproportionate percentage of males in the catches of marten. This study supported those accounts in that males outnumbered females by 1.7:1, which is very close to the average of 1.6:1 as reported in the literature.

Carcasses examined in this study showed young-of-the-year to be the most frequently encountered age class, 46 percent of the total (34 % of males, 69 % of females). An interesting fact is that adult females represented only 3.9 percent of the total collection. Because of the lack of knowledge of the intensity of trapping pressure on the populations of marten from which these specimens were collected, no judgments can be made as to the

impact of trapping on the overall population within the study area.

The published data on parasites of marten appears to be very superficial, for casual examinations of marten have revealed considerable ectoparasitological information. Three species of fleas, *Chaetopsylla floridensis* (I. Fox), *Monopsyllus ciliatur protinus* (Jordan), and *Hystrichopsylla dippiei spinata* (Holland); one species of fur mite, *Lynxacarus mustelae* (Megnin); and one unidentified species of louse of the genus *Stachiella*, all heretofore unrecorded for marten, have been identified. The range of the tick *Ixodes texanus* (Banks) was extended to Alaska for marten. Three previously unreported ectoparasites from otter were also identified; the louse *Latagophthirus rauschi* (Kim and Emerson), a new species of fur mite, *Lynxacarus canadensis* (Fain and Yunker), and the flea *Chaetopsylla floridensis* (I. Fox) (G. E. Haas, pers. comm.; N. Wilson, pers. comm.; Haas et al. 1978, Haas et al. 1979; Haas et al., in press). These findings were published concurrent with this study but independent of it.

The stomach worm *Soboliphyme* was observed in 24 percent of the marten examined in this study.

Marten, badgers (*Taxidea taxus*), and wolverines (*Gulo gulo*) are unique among the mustelids in that they possess an abdominal skin gland. The function of this large, paired gland has not been investigated; or if it has, the findings have not been reported. The captions of Seton's (1929) illustrations of marten "musking" imply they are doing so with their anal glands, but the illustrations themselves suggest the abdominal gland may be involved. Hall (1926) examined abdominal glands in fresh and dried skins and provided descriptions but offered no suggestion as to their function. Grinnell et al. (1937) suggested scent marking with the abdominal gland is probably a territorial behavior. Lensink (1953a) found the gland useful in determining sex on dried, fur-out cased skins.

The abdominal gland is much larger and more conspicuous in mature animals and increases in thickness during the breeding season but by September returns to normal size (pers. obs.). Thus, it is concluded that the gland is related to breeding and perhaps territorial behavior. The function of this large and well-developed structure should be examined more closely as its role may be of great importance in gaining a better understanding of the species' use of its habitat.

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LITERATURE CITED

Alaska Game Commission. Annual reports, 1925-1937. Juneau. (mimeo.)

Anderson, R. M. 1948. Methods of collecting and preserving vertebrate animals. Nat. Mus. of Can., Bull. No. 69, Biol. Ser. No. 18.

Anon. 1978. Alaska's wildlife and habitat. Vol. II. State of Alaska Dept. Fish and Game.

Archibald, W. R. 1980. Marten progress report, No. 2. Yukon Wildl. Branch. (unpubl.) 30 pp.

Ashbrook, F. G. and K. B. Hanson. 1927. Breeding martens in captivity. J. Hered. 18(11):499-503.

_____. 1930. The normal breeding season and gestation period of martens. U.S. Dept. Agric. Circ. No. 107. 7 pp.

Bezdek, H. 1942. Studies on the nematode *Soboliphyme baturini* Petrow 1930. Trans. Am. Microscop. Soc. 61:398-403.

Brassard, J. A. and R. Bernard. 1939. Observations on breeding and development of marten, *Martes a. americana* (Kerr). Can. Field-Nat. 53(2):15-21.

Burris, O. E. and D. E. McKnight. 1973. Game transplants in Alaska. State of Alaska Dept. Fish and Game, Game Tech. Bull. No. 4.

Burton, M. 1962. Systematic dictionary of mammals of the world. Thos. Y. Corwell Co., New York. 307 pp.

Cheng, T. C. 1967. The biology of animal parasites. W. B. Saunders, Co., Philadelphia. 721 pp.

Clark, T. W. and T. M. Campbell. 1977. Short-term effects of timber harvests on pine marten behavior and ecology. Univ. of Idaho. (unpubl. rep.) 60 pp.

Cocks, A. H. 1881. Notes on the breeding of the otter. Proc. Zool. Soc., London. pp 249-250.

Cowan, I. McT. and R. H. MacKay. 1950. Food habits of the marten (*Martes americana*) in the Rocky Mountain region of Canada. Can. Field-Nat. 64(30):100-104.

Dagg, A. I., D. Leach, and G. Sumner-Smith. 1975. Fusion of the distal femoral epiphysis in male and female marten and fisher. Can. J. Zool. 53:1514-1518.

Deems, E. F., Jr. and D. Pursley, eds. 1978. North American furbearers: Their management, research and harvest status in 1976. Int. Assoc. of Fish and Wildl. Agencies. College Park, MD. 171 pp.

deVos, A. 1951. Overflow and dispersal of marten and fisher from wildlife refuges. J. Wildl. Manage. 15(2):164-175.

_____. 1952. Ecology and management of fisher and marten in Ontario. Ontario Dep. Land, For. Tech. Bull. 90 pp.

_____. 1957. Pregnancy and parasites of marten. J. Mammal. 38(3): 412.

Douglas, C. and M. Strickland. 1978. Changes in trapping seasons and their effect on the fisher and marten populations in central Ontario. N.W. Fur Managers Conf., Yellowknife, N.W.T. 10 pp.

Dufresne, F. 1946. Alaska's animals and fishes. A. S. Barnes & Co., New York. 297 pp.

Elkins, W. A. and U. C. Nelson. 1954. Wildlife introductions and transplants in Alaska. Proc. 5th Alaska Sci. Conf. 21 pp. (mimeo.)

Enders, R. K. and J. R. Leekley. 1941. Cyclic changes in the vulva of the marten. The Anat. Rec. 79(1):1-5.

Ewer, R. F. 1973. Carnivores. Weidenfeld and Nicolson, London. 494 pp.

Francis, G. R. and A. B. Stephenson. 1972. Marten ranges and food habits in Algonquin provincial park. Res. Rep. (Wildlife) No. 91. Min. of Natl. Resour., Ontario. 53 pp.

Friley, C. E. 1949. Age determination, by use of the baculum, in the river otter, *Lutra c. canadensis* Schreber. J. Mammal. 30(2):102-110.

Gashwiler, J. S. 1970. Plant and mammal changes on a clearcut in west-central Oregon. Ecol. 51(6):10181026.

Grakov, N. N. 1962. [(On methodology of determining the age of pine marten.)] *In* Problems of Zoological studies in Siberia. Knigoizdat: Gorno-Altaisk. pp 55-57. 1962. Referat. Zhur. Biol. 1963. No. 19I165.

_____. 1972. [(Effect of concentrated clear fellings on the abundance of pine marten (*Martes martes* L.)]. Bull. Moscow Nat. Biol. Ser. 1:14-23.

Greer, K. R. 1955. Yearly food habits of the river otter in the Thompson Lakes region, northwestern Montana as indicated by scat analysis. Am. Midl. Nat. 54(2):299-313.

Grinnell, J., J. S. Dixon, and J. M. Linsdale. 1937. Fur-bearing mammals of California. 2 Vols. Univ. Calif. Press, Berkeley. 1:184-210.

Haas, G. E., R. E. Barrett, and N. Wilson. 1978. Siphonaptera from mammals in Alaska. Can. J. Zool. 56(2):333-338.

_____., T. Rumfelt, L. J. Johnson, and N. Wilson. 1979. Siphonaptera from mammals in Alaska. Suppl. I. Can. J. Zool. 57(9):1822-1825.

_____., L. J. Johnson, and N. Wilson. (In Press) Siphonaptera from mammals in Alaska, Suppl. II, Southeastern Alaska. Proc. of Entomological Soc. of Brit. Col. Vol. 77:42-45.

Hagmeier, E. M. 1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70(4):149-168.

Hall, E. R. 1926. The abdominal skin gland of *Martes*. J. Mammal. 7(3): 227-229.

_____. and K. R. Kelson. 1962. The mammals of North America. The Ronald Press Co., New York. 1083 pp.

Hamlett, G. W. D. 1935. Delayed implantation and discontinuous development in the mammals. Q. Rev. Biol. 10:432-447.

Hamilton, W. J. Jr., and W. R. Eadie. 1964. Reproduction in the otter, *Lutra canadensis*. J. Mammal. 45(2):242-252.

Hawley, V. D. 1955. The ecology of the marten in Glacier National Park. Mont. State Univ. (unpubl., M.S. thesis.) 131 pp.

_____. and F. E. Newby. 1957. Marten home range and population fluctuations. J. Mammal. 38(2):174-184.

Holzworth, J. M. 1930. The wild grizzlies of Alaska. G. P. Putnam and Sons, New York. 417 pp.

Hooper, E. T. and B. T. Ostenson. 1949. Age groups in Michigan otter. Univ. Mich. Mus. of Zool., Occas. Pap. No. 158. 22 pp.

Hoovan, E. F. 1969. The influence of forest succession on populations of small mammals in western Oregon. *In* H. C. Black ed., Wildlife and reforestation in the Pac. N.W. School of For., Ore. St. Univ., Corvallis.

Hopla, C. E. 1965. Parasites of Alaskan vertebrates. Host-parasite index, between Dept. of the Army and Univ. of Oklahoma Research Inst., Norman, Oklahoma. 73 pp.

Ingles, L. G. 1947. Mammals of California. Stanford Univ. Press, Stanford. 258 pp.

Johnson, L. J. 1978. Pages 40-44 *In* R. H. Hinman ed. Annual report of survey-inventory activities. Part IV, Alaska Fed. Aid in Wildl. Rest. Proj. W-17-9. 194 pp.

Jonkle, C. J. and R. P. Weckwerth. 1963. Sexual maturity and implantation of blastocysts in wild pine marten. J. Wildl. Mgmt. 27(1):93-98.

Koehler, G. M., W. R. Moore, and A. R. Taylor. 1975. Preserving the pine marten, management guidelines for western forests. W. Wildl. 2(3): 31-36.

_____. and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitterroot Wilderness. J. Wildl. Manage. 41(3):500-505.

Krefting, L. W. and C. E. Ahlgren. 1974. Small mammals and vegetation changes after fire in a mixed conifer-hardwood forest. Ecol. 55(6): 1391-1398.

Krott, P. 1973. DIE FOZTPFLANZUNG DES EDELMARDES [*MARTES MARTES* L) IN FREIER WILBAHN. (THE REPRODUCTION OF THE PINE MARTEN (*MARTES MARTES* L.) IN THE WILD.] Z. Jagdwiss 19(3):113-117 (1 fig.), Sept. 1973. In German with French and English summ.

Lagler, K. F. and B. T. Ostenson. 1942. Early spring food of the otter in Michigan. J. Wildl. Manage. 6(3):244-254.

Lensink, C. J. 1953a. Population dynamics, movements, food habits, and habitat preferences for the marten in Interior Alaska. *In* Q. Prog. Rep. Surveys and Inventories. Alaska Fed. Aid in Wildl. Rest. Proj. W-3-R-8 8(1):53-79.

_____. 1953b. An investigation of the marten in interior Alaska. Univ. of Alaska. (unpubl. M.S. thesis.)

_____., R. O. Skoog, and J. L. Buckley. 1955. Food habits of the marten in interior Alaska and their significance. J. Wildl. Manage. 19(3): 364-368.

Linsdale, J. M. 1936. William H. Parkinson: California naturalist. J. Mammal. 18(1):30-37.

Liers, E. E. 1951. Notes on the river otter (*Lutra canadensis*). J. Mammal. 32(1):1-9.

_____. 1958. Early breeding in the river otter. J. Mammal. 39(3): 438-439.

Lockie, J. D. 1961. The food of the pine marten *Martes martes martes* in west Scotland. Proc. Zool. Soc., London 136(2):187-195.

_____. 1964. Distribution and fluctuations of the pine marten (*Martes martes* (L), in Scotland. J. Anim. Ecol. 33:349-356.

Major, J. T. 1979. Marten use of habitat in a commercially clear-cut forest during summer. Univ. of Maine. (unpubl., M.S. thesis.) 31 pp.

Manville, R. H. and S. P. Young. 1965. Distribution of Alaskan mammals. U.S. Bur. Sport Fish. and Wildl. Circ. 211. 74 pp.

Markley, M. H. and C. F. Bassett. 1942. Habits of captive marten. Am. Midl. Nat. 28(3):604-616.

Marshall, W. H. 1942. The biology and management of the pine marten in Idaho. Univ. Mich. (unpubl., Ph.D. thesis.) 107 pp plus App.

_____. 1946. Winter food habits of the pine marten in Montana. J. Mammal. 27(1):83-84.

_____. 1951a. An age determination method for the pine marten. J. Wildl. Manage. 15(3):276-283.

_____. 1951b. Pine marten as a forest product. J. For. 49(12); 899-905.

_____. and R. K. Enders. 1942. The blastocyst of the marten (*Martes*). Anat. Rec. 84(3):307-310.

Martell, A. M. and A. Radvanyi. 1977. Changes in small mammal populations after clearcuttings of northern Ontario black spruce forest. Can. Field-Nat. 91(1):41-46.

Maser, C., J. M. Trappe, and R. A. Nuusbaum. 1978. Fungal-small mammal interrelationships with emphasis on Oregon coniferous forests. Ecol. 59(4):799-809.

_____., J. Trappe, and D. Ure. 1978. Implications of small mammal mycophagy to the management of western coniferous forests. Trans. N. Am. Wildl. and Nat. Res. Conf. 43:78-88.

McDonald, E. J. 1979. Skull-age relationships of Yukon pine marten. Northern Alberta Inst. of Tech., Edmonton. 11 pp.

Mech, L. D. and L. L. Rogers. 1977. Status, distribution, and movements of martens in northeastern Minnesota. U.S. For. Serv., Res. Pap. N.C. 143. 7 pp.

Melquist, W. E. and M. G. Hornocker. 1979. Development and use of a telemetry technique for studying river otter. *In* F. M. Long, ed. Proc. Second Int. Conf. on Wildl. Biotelemetry, Laramie, WY.

Monthey, R. W. 1978. Relative abundance of mammals in commercially harvested forests in Maine. Univ. of Maine, Orono. (unpubl. Ph.D. thesis.) 64 pp.

Murie, A. 1961. Some food habits of the marten. J. Mammal. 42(4):516-521.

Nelson, E. 1887. Report upon natural history collections made in Alaska. Arctic series of publications, U.S. Army, Wash. Gov. Print. Off. No. III. pp 279-280.

Newby, F. E. 1951. Ecology of the marten in the Twin Lakes area, Chelan County, Washington. The State Coll. of Wash. (unpubl., M.S. thesis.)

Osgood, W. 1875. A biological reconnaissance of the base of the Alaska Peninsula. U.S. Dept. of Agric., Div. of Biol. Surv. N. Amer. Print. Off., 1904. p 45.

Palmer, R. S. 1954. The mammal guide. Doubleday and Co., Garden City, New York. 384 pp.

Park, E. 1971. The world of the otter. Lippincott Co., Philadelphia. 159 pp.

Parsell, J. A. 1938. Notes on marten management. U.S. For. Serv., Northern Region News (Missoula, Montana). 25 pp. (mimeo.)

Pearson, O. P. and R. K. Enders. 1944. Duration of pregnancy in certain mustelids. J. Exp. Zool. 95(1):21-35.

Pelikan, J. and J. Vackar. 1978. Densities and fluctuations in numbers of red fox, badger and pine marten in the "Bucin" forest. Folia Zool. 27(4):289-303.

Petrof, I. 1898. Report on the population, industries, and resources of Alaska. Tenth census, 1880, seal and salmon fisheries and general resources of Alaska. House of Rep. Doc., Wash. Gov. Print. Off. pp 56-66.

Pulling, A. V. (Pierre). 1973. Game and the gunner. Winchester Press, New York. 233 pp.

Quick, H. F. 1956. Effects of exploitation on a marten population. J. Wildl. Manage. 20(3):267-274.

Scott, W. 1977. Dixon Harbor biological survey: Final report on winter mammal and bird studies. Natl. Park Serv., Juneau. pp 48-56. (mimeo.)

Seton, E. T. 1929. Lives of game animals. Vol. 2, Part 2. Chas. T. Branford Co., Boston. pp 369-746.

Sheldon, W. G. and W. G. Toll. 1964. Feeding habits of the river otter in a reservoir in central Massachusetts. J. Mammal. 45(3):449-455.

Short, W. 1964. The cheechakoes. The Book Press, Brattlebro, Vermont. 244 pp.

Shepherd, P. E. K. 1978. The marten in Alaska. State of Alaska Dept. of Fish and Game, Wildl. Notebook Ser. Juneau. 1 p. (mimeo.)

Sims, P. and C. H. Buckner. 1973. The effect of clearcutting and burning of *Pinus barksiana* forests on the populations of small mammals in southeastern Manitoba. Am. Midl. Natl. 90(1):228-231.

Skinner, W. 1979. Status of the pine marten (*Martes americana atrata*) on the island of Newfoundland. Prepared for the committee on the status of endangered wildlife in Canada. Newf. Dept. of Tourism. Wildl. Div. (unpubl.) 11 pp.

Solf, J. 1972. The land otter in Alaska. State of Alaska Dept. Fish and Game, Wildl. Notebook Ser. Juneau. 1 p. (mimeo.)

Soutiere, E. C. 1978. The effects of timber harvesting on the marten. Univ. Maine, Orono. (unpubl., Ph.D. thesis.) 61 pp plus suppl.

Stephenson, A. B. 1977. Age determination and morphological variation of Ontario otter. Can. J. Zool. 55(10):1577-1583.

Steventon, J. 1979. Influence of timber harvesting upon winter habitat use by marten. Univ. Maine, Orono. (unpubl. M.S. thesis.) 25 pp.

Streveler, G., I. Worley, C. Terry, and R. Gordon. 1974. Dixon Harbor biological survey: Final report on the summer phase of 1973 research. Natl. Park Serv., Juneau. 240 pp. (mimeo.)

_____. and _____. 1975. Dixon Harbor biological survey: Final report on the summer phase of 1974 research. Natl. Park Serv. Juneau. 215 pp. (mimeo.)

Strickland, M. A. and C. W. Douglas. 1978. Some predictions for fisher and marten harvests for 1978-1979. Can. Trapper 7(2):18-19.

Swarth, H. 1911. Birds and mammals of the 1909 Alexander Alaska expedition. Univ. Calif. Publ. Zool. 7:9-172.

Tabor, J. E. and H. M. Wight. 1977. Population status of river otter in Oregon. J. Wildl. Manage. 41(4):692-699.

Tevis, L. 1956. Response of small mammal populations to logging of Douglas fir. J. Mammal. 37(2):189-196.

Twining, H. and A. Hensley. 1947. The status of pine martens in California. Calif. Fish and Game. 33(3):133-137.

Vaisfel'd, M. A. 1972. [(Effects of felling on the abundance of pine marten.)] Byull. Mosk. O-va Ispyt. Prir. Ofd. Biol. 77(5):29-39.

Walker, E. P. 1929. Evidence on the gestation period of martens. J. Mammal. 10(3):206-209.

Weckwerth, R. P. 1957. The relationship between the marten population and the abundance of small mammals in Glacier National Park. (unpubl. M.S. thesis, Univ. Montana, Missoula.) 72 pp plus App.

_____. and V. D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26(1):55-74.

Williams, J. P. 1952. Alaskan adventure. The Stackpole Co., Harrisburg, Pa. 299 pp.

Wilson, K. A. 1959. The otter in North Carolina. Proc. 13th Ann. Conf., S.E. Assoc. Game and Fish Comm. pp 267-277. (mimeo.)

Wright, P. L. 1942. Delayed implantation in the long-tailed weasel (*Mustela frenata*), the short-tailed weasel (*Mustela cicognani*), and the marten (*Martes americana*). Anat. Rec. 83(3):341-353.

_____. 1947. The sexual cycle of the long-tailed weasel (*Mustela frenata*). J. Mammal. 28:343-352.

_____. 1950. Development of the baculum of the long-tailed weasel. Proc. Soc. for Exp. Biol. and Med. 75:820-822.

Yeager, L. E. 1950. Implications of some harvest and habitat factors on pine marten. Trans. N. Am. Wildl. Conf. 15:319-334.

Youngman, P. M. 1975. Mammals of the Yukon Territory. Natl. Mus. of Can., Publs. in Zool. No. 10, Ottawa.

PREPARED AND SUBMITTED BY:

Loyal Johnson
Game Biologist

APPROVED BY:

Donald J. Sommerville
Director, Division of Game

Donald G. McKnight
Research Chief, Division of Game