AN INVESTIGATION OF MINK IN INTERIOR AND SOUTHEASTERN ALASKA

A

THESIS

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MASTER OF SCIENCE

By

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ABSTRACT

Mink populations were studied in interior Alaska during 1955, 1956 and 1957, and in southeastern Alaska during 1957.

Large mink population fluctuations occur in interior Alaska; the food level probably is a contributing factor. Steel trapping in the Huslia study area apparently is not limiting the population.

Steel trapping in coastal southeastern Alaska, conducted on an alternate year basis during recent years, greatly reduces the mink population. However, mink numbers increase greatly during the breeding season following a trapping season, probably to such an extent that reduced production results during the next breeding period.

Mink tend to restrict their travel to shorelines. Reduced surface travel occurs in the Huslia area during periods colder than -10°F.

Mammals account for over half of the food items ingested by mink in the Huslia study area. The food levels are unstable. In coastal southeastern Alaska, invertebrates constitute most of a mink's diet. The food levels are relatively stable.

No definite bait preference, other than a preference for fresh instead of putrid baits, was noted during the live-trapping operations.

Premating travel of mink in the Huslia study area commences during March, with copulation occurring about middle or late April and whelping about mid-June.

Mink do not construct their own dens.

Nursing females have activity ranges generally not exceeding one mile in length. The females lose weight during the nursing period.

An average production of two young per adult occurred in the Huslia study area during 1956.

Collapsible wire live-traps are satisfactory for live-capturing mink. Metal strap tags are satisfactory for studies of short duration.

Factors other than trapping control mink populations in the Huslia area. Regulations permitting maximum harvest are recommended. In coastal southeastern Alaska, trapping greatly reduces the population. Further investigations are necessary to determine the feasibility of annual trapping seasons.

PREFACE

The mink study in interior Alaska was initiated by Mr. Robert A. Rausch, under the direction of Dr. John L. Buckley, in June, 1955. Mr. Rausch conducted the initial field work during 1955 and assisted the author in the summer field work during 1956. The study was undertaken largely with Federal Aid in Wildlife Restoration funds under Pittman-Robertson Project W-3-R, the Alaska Game Commission.

The sources of nomenclature for mammals are Miller and Kellogg's <u>List of North American Mammals</u> for scientific names and Rand's <u>Mammals of Yukon, Canada</u> and Bee and Hall's <u>Mammals of Northern Alaska: on the Arctic Slope</u> for common names; the source for birds is the <u>A.O.U. Check-list of North American Birds</u>; and the sources for plants are Hulten's <u>Flora of Alaska and Yukon</u> for scientific names and Kelsey's <u>Standardized Plant Names</u> and Anderson's <u>The Flora of Alaska and Adjacent Parts of Canada</u> for common names.

The author wishes to express his appreciation to the following individuals who aided in the conduct of the study and the preparation of the manuscript:

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INTRODUCTION

The quest for furs stimulated the early exploration and settlement of Alaska. After severely exploiting the once abundant populations of marine mammals on the Alaskan coast, the Russian fur traders pushed into the interior to tap the extensive populations of land furbearers. English fur traders under the Hudson Bay Company banner were simultaneously penetrating the Alaskan wilderness from the east. Harvesting these large populations of furbearers was the sole industry in Russian Alaska.

Land furbearers continue to be important contributors to the economy of native peoples of Alaska. In a few villages, proceeds from trapping are the basis of the cash economy, supplemented only by donations from welfare and charitable organizations. During the fiscal year 1956, mink pelts were second only to beaver pelts in the estimated cash value of furs (Buckley 1957:17). Even during a period of decreasing emphasis on trapping, the mink fur resource is still important.

The importance of the mink fur resource dictates that a biologically sound management program be employed. Such a program requires more knowledge of the ecology of wild mink than now exists. The present study contributes information about wild mink populations in both interior Alaska and coastal southeastern Alaska.

The objectives of the present study are as follows: to determine the population composition, density and movements; to ascertain the food and habitat requirements and reproductive habits; and to evaluate the effects of harvest regulations on mink.

The studies were conducted during the period 1955 to 1957, with the following intervals devoted to field study in interior Alaska: June 26 to September 11 and November 5 to December 13, 1955; August 15 to September 20 and November 5 to December 16, 1956; and July 29 to September 26, 1957. Field study in coastal southeastern Alaska was conducted from January 1 through March 14 and October 15 through November 25, 1957. The initial field studies during 1955 were made by Mr. Robert A. Rausch, but subsequent investigations were conducted by the author.

Many different methods were employed to garner information about mink. Live-trapping and tagging, one of the principal methods used, gave information on most phases of mink ecology; scat analysis furnished data on food habits; carcass and pelt analysis provided information about population composition; and observations of mink tracks, "sign", den sites, etc., furnished much general information.

TAXONOMY

Mustela vison Schreber, the mink, is indigenous to North America. Miller and Kellogg (1955) place the mink, along with extinct *Mustela macrodon* (Prentiss), in the subgenus *Lutreola* Wagner of the genus *Mustella* Linnaeus. Fourteen subspecies of *Mustela vison* are listed for North America (*Ibid*.), two of which, *Mustela vison ingens* (Osgood) in central Alaska and *Mustela vison nesolestes* (Heller) in southeastern Alaska, were represented in the present study.

Simpson (1945) places the genus *Mustela* is the subfamily Mustelinae Gill, the family Mustelidae Swainson, the superfamily Canoidea Simpson, the suborder Fissipeda Blumenbach and the order Carnivora Bowditch. The genus *Mustela* dates from the Upper Miocene in North America.

THE STUDY AREAS

Study areas were established in both interior Alaska and southeastern Alaska.

Interior Alaska

The study area in interior Alaska is located within the Koyukuk Fur Management Area. This area, located approximately 250 airline miles northwest of Fairbanks, comprises the lower reaches of the Koyukuk River watershed from 10 airline miles upstream from Alatna to about 25 miles downstream from Huslia. The study area is located about 30 airline miles north-northwest of Huslia, the nearest village, and is situated on the north fork[1] of the Huslia River, a tributary of the Koyukuk, one of the main feeders of the Yukon River (Fig. 1).

The study area, located on the 400 square mile hunting, trapping, and fishing grounds of the Huslia natives, occupies a 26 airline-mile stretch of the North Fork River (Fig. 2). The area is not uniform in width, for the many curves in the river and the streams, ponds and sloughs of the area form a discontinuous pattern of mink habitat; the placement of traps and the intensity of observation were influenced by this pattern. However, a 3.5 mile-wide strip, with the river in the center, encompasses the entire study area.

Topography. -- The study area, oriented in a northwest-southeast direction, is situated in the flat valley of the Huslia River. The valley

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[1]Hereafter referred to as North Fork River.

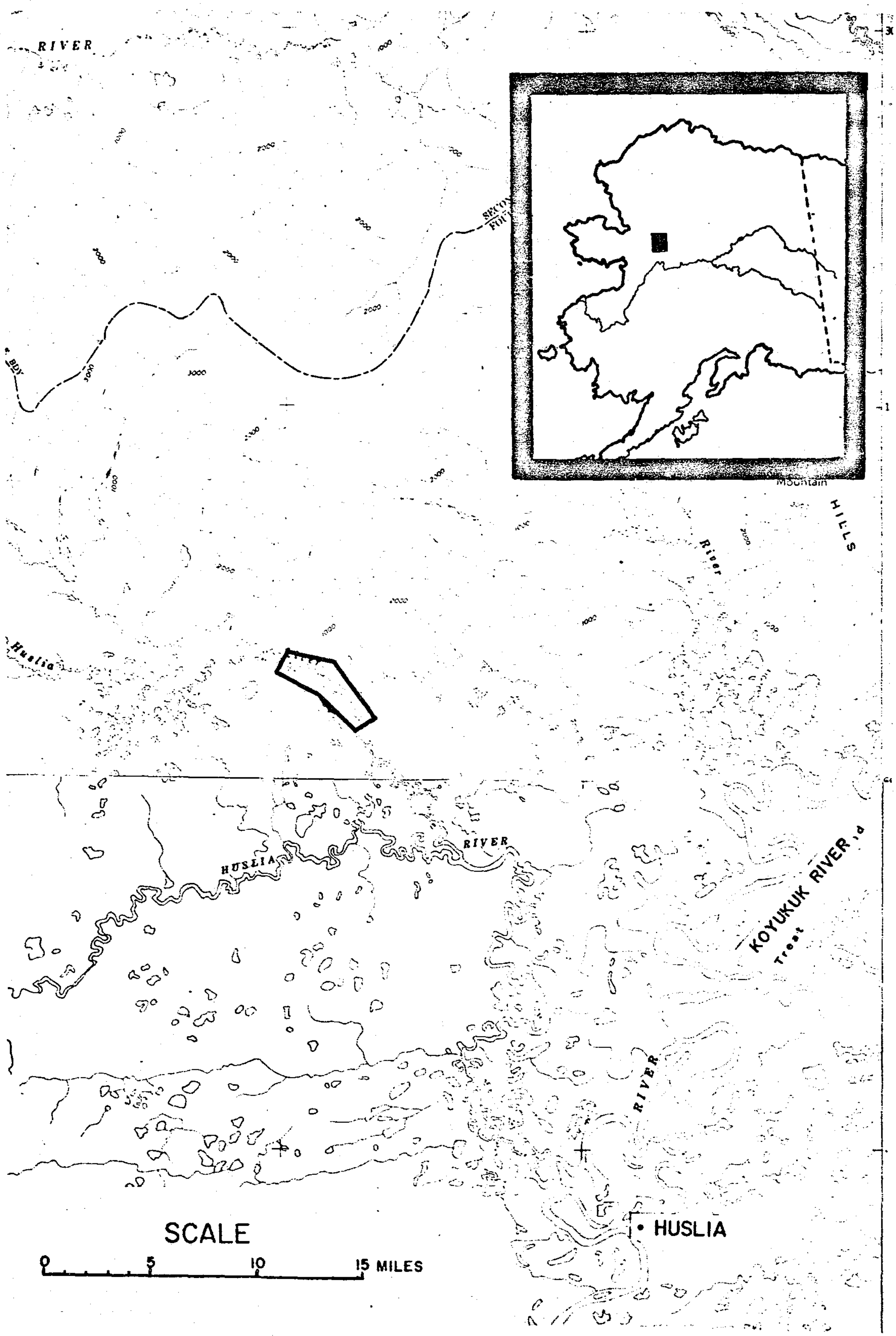

Figure I. Location of the Huslia Study Area, interior Alaska.

Figure 2. The Huslia Study Area, interior Alaska, with the 1956 effective trapping area outlined.

floor extends only two miles northeast of the study area, and at that point the steep, talus slopes of the Huslia Mountains rise abruptly. The only irregularities in the valley floor for a distance of 30 miles to the southwest are a few small hills between the north and south forks of the Huslia River. The Purcell Mountains, 20 to 30 miles to the northwest, contain the headwaters of the North Fork River. To the east and south the valleys of the Huslia and Koyukuk Rivers merge, and at this confluence, the combined valleys extend 50 miles east-west.

Land-Water Relationship. -- The numerous bogs, sloughs, ponds, lakes and streams which dot the area result from poor drainage created by the level aspect of the land and from perennially frozen ground. Most of the bodies of water are small and shallow; some are larger, however, and over six feet in depth. Also, along the river many ox-bow lakes are formed by the continuous shifting of the river channel and by the formation of new channels. The land-water relationship can be seen in Fig. 3.

Climate. -- The study area has a continental climate, with cold, dry winters and warm summers. Sudden and large temperature changes occur. The number of frost-free days averages about 100 a year. Information on the weather of the Huslia area is taken from the records of the two nearest recording stations, Hughes and Galena. Hughes, located approximately 50 miles to the east in the narrow valley of the Koyukuk River, is surrounded by hills, and the average temperatures recorded there are probably colder than those of the North Fork River region. The snow depths at Hughes are comparable to those observed on the study area.

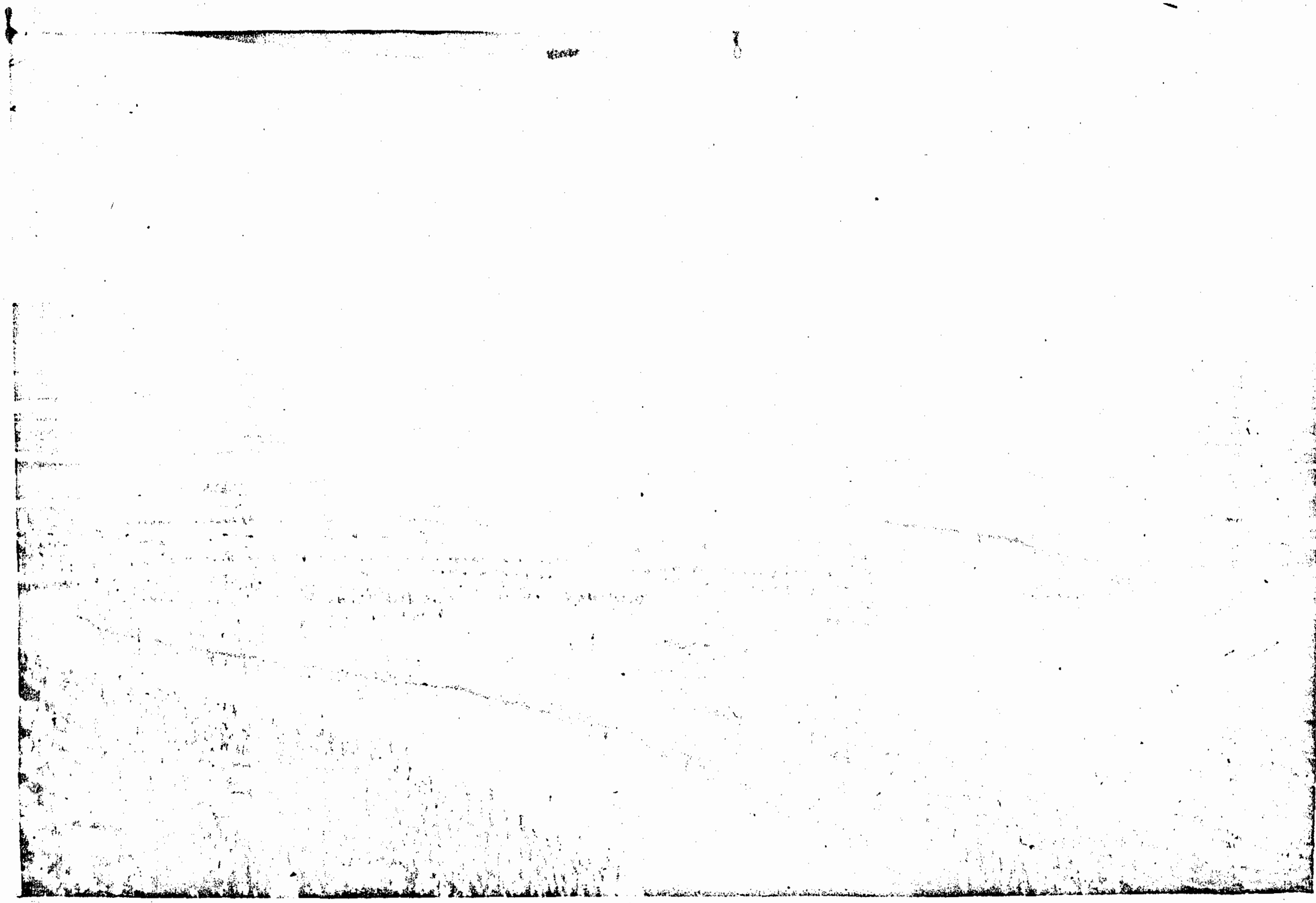

Figure 3. Land-water relationship in the Huslia Study Area, interior Alaska.

Galena, located 80 miles to the south in the broad valley of the Yukon River, has slightly warmer temperatures and less snow than does the study area.

Cold temperatures prevail during much of the year. The Hughes and Galena monthly average temperatures and the highest and lowest monthly averages recorded during the seven year period 1950 through 1956 are listed in Table 1. During seven months of the year, the monthly average temperature is colder than freezing, with subzero averages recorded during three months. The coldest month based on data gathered since the inception of records is December (-8.8° F) for Hughes and January (-9.3° F) for Galena. The lowest monthly average recorded during the seven year period occurred during December, with averages of -32.0° F and -28.5° F for Hughes and Galena respectively. July is the warmest month, having averages of 59.7° F and 61.3° F for Hughes and Galena respectively.

The average monthly precipitation and the highest and lowest averages recorded during the period 1950 through 1956 are listed in Table 1. June, August, and September are the months of heaviest precipitation, accounting for nearly 60 per cent of the total yearly precipitation. Although winter precipitation is small, snow depths of over two feet are common in late winter (Table 2), for the snow is light and powdery and not subjected to extensive thaws. Significant differences in snow depths occur from one year to the next. For example, the December maximum snow depths in Hughes during the 1953-1954 and 1955-1956 winters were 9 and 30 inches respectively, a difference of nearly two feet.

Table 1. Summary of mean monthly temperatures and precipitation, and highest and lowest monthly mean temperatures and precipitation recorded by the United States Weather Bureau at Galena and Hughes, Alaska

	Temperatures						Precipitation					
	Galena 1944-1956	Galena 1959-1956		Hughes 1945-1956	Hughes 1950-1956		Galena 1946-1956	Galena 1950-1956		Hughes 1946-1956	Hughes 1950-1956	
Month	Avg.	Lowest (degrees F)	Highest	Avg.	Lowest (degrees F)	Highest	Avg.	Lowest (inches)	Highest	Avg.	Lowest (inches)	Highest
Jan.	-9.3	-23.9	-0.2	-8.0	-23.3	-1.0	0.77	0.10	1.40	0.70	0.10	1.82
Feb.	-2.4	-20.0	-3.7	-4.5	-22.7	-3.1	0.81	0.18	2.27	0.89	T	3.00
Mar.	3.9	- 8.0	12.4	3.7	- 5.0	11.7	0.74	0.11	1.28	0.65	0.14	1.59
Apr.	25.2	14.4	29.9	21.1	17.1	29.6	0.17	0.02	0.83	0.09	T	0.27
May	43.4	35.0	48.9	47.6	34.2	50.2	0.63	0.21	1.38	0.76	0.35	1.61
June	58.3	53.5	59.4	56.0	55.3	60.0	1.69	0.34	2.33	1.38	1.02	3.80
July	61.3	57.3	64.0	59.7	58.4	64.1	2.69	0.69	2.81	2.27	0.06	3.23
Aug.	52.1	52.5	58.2	53.1	50.9	58.3	2.84	1.06	4.50	2.94	1.67	5.30
Sept.	44.2	39.0	45.3	41.8	39.3	43.6	2.37	1.10	2.77	1.67	0.31	4.40
Oct.	27.1	14.1	28.9	24.2	11.7	27.9	0.54	0.18	0.88	1.16	0.46	1.72
Nov.	4.4	-12.0	15.5	1.5	-16.2	14.3	0.64	0.21	1.40	0.96	0.37	1.47
Dec.	-7.1	-28.5	-2.9	-8.8	-32.0	2.2	0.87	0.60	1.10	0.62	0.10	2.23

Table 2. Monthly range of snow depths in inches recorded by the United States Weather Bureau during the winters of 1953-1954 through 1956-1957 at Galena and Hughes, Alaska

Location-Month	1953-1954 Min.	1953-1954 Max.	1954-1955 Min.	1954-1955 Max.	1955-1956 Min.	1955-1956 Max.	1956-1957 Min.	1956-1957 Max.
Galena								
October	0	3	0	3	0	5	1	7
November	1	3	1	3	3	15	7	14
December	5	8	3	8	12	22	14	19
January	7	9	9	13	18	23	19	30
February	9	11	12	14	20	35	19	27
March	9	16	14	24	22	23	28	35
April	T	13	24	30	3	29	0	35
Hughes								
October	0	2	0	3	0	11	5	11
November	2	5	3	11	11	18	11	13
December	5	9	14	17	18	30	13	14
January	9	15	17	18	29	31	14	17
February	15	19	15	32	32	38	29	37
March	18	31	15	35	37	44	34	37
April	4	29	29	35	3	32	3	34

Vegetation. -- Hydrophytic vegetation is the most striking and prevalent flora in the area. Along lakes, sloughs, ponds and streams, in bogs, and in recurrently flooded lowlands, moisture-loving vegetation flourishes. Mesophytic vegetation prospers only on the well-drained sites. Only a few types are contiguous over large areas; most are interspersed throughout the area in small, discontiguous, but sharply defined plots. The more widespread, contiguous types, such as the sedge tussock ("niggerhead") type, are generally located a half mile or more from the river. The contunually shifting river channel produces many local changes in soil and moisture conditions, creating such diverse conditions that no single type is sufficiently adaptable to flourish in all situations.

A willow-alder border type is very common along streams and rivers and around small bodies of water. Alder [*Alnus crispa* (Ait.) Pursh] and willows are dominant in this border, but bluejoint reedgrass [*Calamagrostis canadensis* (Michx.) Beauv.] and various species of *Carex*, among them beaked sedge (*C. rostrata* Stokes) and water sedge (*C. aquatilis* Wahlenb.), are abundant. In certain situations, willow and alder are absent, and nearly pure stands of bluejoint reedgrass or beaked sedge occur. Generally, the latter species grows profusely in the wetter areas.

Nearly pure stands of alders grow between small sloughs or at the edge of sandbars on the North Fork River. Some stands are very thick and over 10 feet high. In the understory, prickly rose (*Rose acicularis* Lindl.) and American red currant (*Ribes triste* Pall.) are often present. The alders are replaced by willows on many of the sandbars.

Bogs are prevalent in the area. Black spruce [Picea mariana (Mill.) B.S.P.] forms a sparse overstory in many of the bogs, while in the understory mosses, black crowberry (Empetrum nigrum L.) and mountain cranberry (Vaccinium vitis-idaea L.) often form solid mats. In other, wetter areas, the black spruce is absent and only the mat-formers remain. When water supported, such bogs are termed "quaking" bogs.

Extensive sedge tussock bogs are present in the area, generally occurring more than a quarter mile form the river. Various species of Carex, often including round-fruited sedge (Carex rotundata Wahlenb.), creeping sedge (C. chordarrhiza Ehrh.), and sheathed sedge (C. vaginata Tausch.), cottongrass (Eriophorum spp.) and mosses are the more conspicuous forms present.

Stands of dwarf birch (Betula nana L. and B. glandulosa Michx.) and bog bilberry (Vaccinium uliginosum L.) are common in the area, and occupy wet lowlands. Most stands are over a foot in height, and thick. Some of the stands are quite extensive. Sedges are often associates in the wetter areas.

Two mesohpytic types are found on the area; a white spruce-paper birch and a black spruce-aspen-lichen association. The white spruce-paper birch type occurs on well-drained sites, often situated very close to the river. White spruce [Picea glauca (Moench) Voss] and paper birch (Betula papyrifera Marsh) are the dominant species in the latter; adler is often present. A large number of species generally comprise the understory, but at times cloudberry (Rubus chamaemorus L.) or mountain cranberry form almost pure stands.

The other mesophytic type, black spruce-aspen-lichen, occurs on well drained, sandy deposits and is not extensive in the area. Black spruce and quaking aspen (*Populus tremuloides* Michx.) form an even, thick overstory, with an understory composed of a thick mat of lichens.

Coastal Southeastern Alaska

Southeastern Alaska is a region of rugged, mountainous islands, separated by fjord-like waterways. Many islands, even those only a mile in length, have peaks over 3,000 feet high.

No well-defined study area was established in southeastern Alaska; however, investigation was concentrated in the Petersburg-Wrangell area. Only the beaches were studied, for the mink populations are largely restricted to a 10 yard wide strip adjacent to the beach.

The beaches vary from long, sloping mud flats to cliffs. In most areas the dense forest types grow almost to the very edge of the high-water mark, but in a few locations the muskeg type is present. Few large streams occur on the islands, but those present often have small tidewater flats at their mouths.

Four tides, two low and two high, occur during each 25 hour period. In the Petersburg-Wrangell area the amplitude of the tides is very large, with tides of over 15 feet occurring more than half the time. The highest flood tides are greater than 20 feet, and the lowest ebb tide is about -4 feet.

Climate. -- Coastal southeastern Alaska enjoys a moderate climate, because of the influence of the warm Japanese current. Precipitation is heavy throughout the year, fog is common, and a cloud cover is usual, but the temperatures generally remain in a narrow range well above freezing.

The average monthly temperature is below freezing only during December, January, and February (Table 3). It is lowest in January (28.6° F) and highest in July (55.7° F). The growing season for the years from 1950 to 1956 varied from 120 to 182 days.

Heavy precipitation occurs in the Petersburg area (Table 3). Most occurs during fall and winter, but even during the driest month, June, an average of 4.71 inches of rain falls. Much of the precipitation during winter falls as snow. However, large variations in snow depth exist from one year to the next. Table 4 shows the depths during the period January through March forthe years 1955 and 1956. The maximum snow depth in 1955 was only 15 inches, but in 1956 a maximum depth of 83 inches was recorded.

Vegetation. -- Forests, containing much merchantable timber, cover most of the islands in southeastern Alaska to altitudes of 2,000 to 3,000 feet. Sitka spruce [*Picea sitchensis* (Bong.) Carr.], yellow cedar [*Chamaecyparis nootkatensis* (Lamb.) Spach.], and hemlock [*Tsuga heterophylla* (Raf.) Sarg. and *T. mertensiana* (Bong.) Sarg.] are the dominant species (Palmer 1942). Alders, [*Alnus crispa* (Ait.) Pursh and *A. oregana* Nutt.], sometimes attaining tree height, occur along the streams. Under this tall overstory, mosses and shrubs occur. Palmer (1942) lists the following important shrub species: red huckleberry [*Vaccinium parvifolium* Smith], blueberry [*Vaccinium ovalifolium* Smith and *V. alaskensis* Howell], trailing

Table 3. Summary of mean monthly temperatures and precipitation, and highest and lowest monthly mean temperatures and precipitation recorded by the United States Weather Bureau at Petersburg, Alaska

	Temperature (degrees F)			Precipitation (inches)		
	1934-1956	1950-1956		1934-1956	1950-1956	
Month	Average	Lowest	Highest	Average	Lowest	Highest
Jan.	28.6	10.5	33.1	9.73	1.07	11.08
Feb.	30.3	25.3	35.3	7.09	4.44	17.00
Mar.	34.8	28.9	35.0	7.18	2.36	9.01
Apr.	40.8	33.7	40.2	6.98	5.48	11.27
May	47.8	43.1	48.4	5.60	3.72	9.83
June	53.5	50.1	55.1	4.71	1.54	6.54
July	55.7	53.7	59.2	5.44	2.17	8.64
Aug.	55.2	52.7	55.9	7.49	1.51	13.99
Sept.	50.9	47.7	51.3	11.48	4.87	14.55
Oct.	42.9	39.4	46.0	16.97	7.64	22.78
Nov.	35.9	25.9	42.2	12.31	5.53	16.09
Dec.	31.1	20.6	35.3	10.10	3.88	16.96

Table 4. Minimum and maximum snow depths (in inches) recorded during comparable periods in 1955 and 1956 at Petersburg, Alaska

	1955		1956	
Month	Min.	Max.	Min.	Max.
January	0	15	4	17
February	0	7	3	26
March	6	15	10	83

bramble [Rubus pedatus Smith], buckbrush [Menziesia ferruginea Smith], salmonberry [Rubus spectabilis Pursh], American devilsclub [Oplopanax horridus (Sm.) Miq.] and currant [Ribes bracteosum Dougl. ex Hook and R. laxiflorum Pursh].

Scattered throughout the forest type is the muskeg type. This is characterized by small, shallow pools, and a sparse overstory of lodgepole pine [Pinus contorta Loud.], hemlocks and yellow-cedar. Mosses and sedges provide the ground cover. Many hydrophytes are present in the shallow pools.

A very thin border type is present between the beach proper and the forest or muskeg type. This strip, only a few feet wide, is characterized by alders, rye grass [Elymus arenarius mollis (Trin.) Hult.], and sedges.

POPULATION COMPOSITION AND DENSITY

The condition of a wild animal population can be inferred if the composition and density are known. This information, important from both an ecological and management aspect, makes possible an evaluation of the effects of trapping on a population. Various methods were employed in gathering pertinent data.

Live-trapping and steel-trapping returns were the most productive sources of information (see LIVE-TRAPPING AND TAGGING and STEEL-TRAPPING METHODS, PRESSURES AND EFFECTS for methods). Track and sign counts were also used to determine population density, but data from these sources are often misleading, for other conditions, such as winter temperatures and water level fluctuations, influence the amount of observable sign left by the animals.

Age Determination Methods

The age determination methods depend on the type of specimen involved. For skinned carcasses, a method originated by Greer (1956) for Montana mink was used. The absence or presence of a femoral tubercle and zygomatic arch suture are the diagnostic characters and the following key was used:

A - Tubercle absent on both femurs and suture absent on both zygomatic arches -- adult;

B - Tubercle present on either femur and suture absent on either zygomatic arch -- adult;

C - All other combinations -- juvenile.

I correctly classified 31 of 33 known-age ranch mink carcasses using this method, indicating an accuracy of about 94 per cent. The key was further checked by comparison with the baculum age determination method described below. Of 183 males aged by both methods, only three received different classification, indicating a high degree of accuracy.

The above key can be used for both male and female carcasses, but a faster and slightly more reliable method, baculum conformation, was used for males. The baculum of an adult male is massive and has an enlargement at the proximal end; the baculum of a juvenile is smaller and does not have the enlargement (Petrides 1950; Elder 1951; Lechleitner 1954). This method proved about 98 per cent accurate when tested by the author on known-age mink. Greer (_op_. _cit_.) reports 99.7 per cent accuracy using the baculum method on 298 known-age ranch mink.

Age determination of live mink requires diagnostic characteristics other than condition of the zygomatic arches and femurs if, as in the present study, portable X-ray equipment is unavailable or impracticable. Baculum conformation still applies, for any sizeable enlargement of the proximal end is discernable by lightly squeezing the penile sheath. Dentition serves as an age criterion during August and early September; the young have both deciduous and permanent canines at this time, or noticeable scars after shedding the deciduous canines. The condition of the mammae provides information about the age of females; lactating adults have larger mammae than do juveniles. Not all live-trapped mink could be positively aged, however.

Huslia Study Area

Population Composition. -- Only four of the 57 mink captured during the three summers of live-trapping were classed as adult males, producing an adult male:adult female ratio of 24:100. So low an incidence of adult males seems improbable, so that the accuracy of age determination might be questioned. A glance at Table 5 shows that many mink were only tentatively classified, but consistent misclassification of adults as juveniles would have to occur if the age classification is at fault. This seems unlikely, for during most of August juveniles and adults can be readily separated by dental characteristics alone.

McCabe's (1949) work indicates that adult males are not easily caught. Trapping on the 1,100 acre University of Wisconsin Arboretum during winter, McCabe caught 23 mink, only 4 of which were males and none of which was aged. Ritcey and Edwards (1956), however, readily caught adult males while live-trapping along 1.2 miles of stream in British Columbia. Of 31 live-trapped mink sexed and aged by them, 14 were adult males, and only 2 were adult females. The 14 males were captured over a three-year period at five trap sites. The present study also lasted for three years, but over 100 trap sites were used along 12.6 airline miles of stream. Considering the size of area covered and the number of females captured, the capture of only four adult males during the present study is surprising.

Of the four adult males caught in the North Fork River area, only one was recaptured. Ritcey and Edwards also had low recpature rates on adult males. They surmised that the study area was only a small part of the large hunting areas of males, and hence the males seldom crossed the study area. This explanation seems unsatisfactory for the present study, for the study area appears sufficiently large to include much of a male's

Table 5. Sex and age data for mink captured during the three summers of live-trapping on the North Fork River study area

Year	Total	Males	Females	Juveniles	Adults	Juvenile Males	Adult Males	Juvenile Females	Adult Females
1955	25	7	18	14(5)*	11	6(1)*	1	8(4)*	10
1956	18	9	9	13(2)*	5(1)*	7(1)*	2(1)*	6(1)*	3
1957	14	7	7	9(4)*	5(2)*	6(3)*	1(1)*	3(1)*	4(1)*
Totals	57	23	34	36(11)*	21(3)*	19(5)*	4(2)*	17(6)*	17(1)*

-Ratios-

Year	Juveniles: 100 adult	Males: 100 females	Juveniles: 100 adult females	Juvenile males: 100 juvenile females	Adult males: 100 adult females
1955	136:100	39:100	140:100	75:100	10:100
1956	260:100	100:100	433:100	116:100	67:100
1957	180:100	100:100	225:100	200:100	25:100

*The figure in parenthesis is number of individuals in total group only tentatively aged.

range, thus bringing the mink into frequent contact with the numerous live-traps set on the area. Apparently, the adult males become "trap shy" after being caught, a view also held by many commercial trappers.

The ratio of juveniles to adult females reveals the success or failure of the reproductive segment of the population. The 1955-1957 ratios vary greatly, partially because of actual population composition changes and partially because of sampling error.

The 1955 live-trapping catch yielded a juvenile:adult female ratio of 140:100, indicating low net production. A comparison of the 1954-1955 and 1955-1956 steel-trapping season returns also indicates low production during 1955. During the 1954-1955 commercial season, the two native trappers trapping the study area and the area adjacent to it caught over 50 mink; during the 1955-1956 season, the catch was 15 mink (1 tagged). Adverse weather (deep snow and severe cold) during the latter season partly accounts for the low catch, but probably a smaller mink population also was partly responsible.

Live-trapping during 1956 yielded a catch of 18 mink, with a juvenile: adult female ratio of 433:100. The ratio indicates higher production and/or survival rate for 1956 than for 1955, but direct comparison is difficult for the live-trapping periods were not the same for the two years. The 1956-1957 steel-trapping catch was quite low, however. The two trappers caught only seven mink (two tagged), but adverse weather restricted their trapping operations to one-third of the area normally trapped. Mink sign under the ice and on top of abandoned beaver houses indicated that a fair mink population was nevertheless present, and the two native trappers believed the population was higher than for the preceding year.

The 1957 live-trapping catch produced a juvenile:adult female ratio of 225:100. Superficially, a reduced productivity is indicated. The 1957 season had a number of peculiarities, however, so that the reliability of the data is doubtful. For instance, the juvenile male:juvenile female ratio is 200:100, admittedly from a very small sample (only nine juveniles caught). Also, the capture pattern is peculiar. From August 14 to September 20, a 38 day period, seven mink were captured: from September 21 to September 26, a 6 day period, seven mink were captured. Half the catch occurred during the last 6 days of a 44 day period. Weather conditions may have induced these different capture rates. From August 14 to September 17, high temperatures prevailed and baits spoiled rapidly, but from September 18 to the end of the trapping period, cold temperatures helped preserve the baits. Possibly, bait freshness during the second period contributed to the higher success rate, and continued trapping might have increased the total catch considerably.

Only small samples are available for the 1955-1956 and 1956-1957 steel-trapping seasons, because of the small mink catches and the reluctance of natives to give mink carcasses to the investigator. Greer (op. cit.) states samples of 300 mink or more are necessary to achieve high levels of significance. Of 33 carcasses collected, 25 (only 19 of which could be aged) were obtained during the 1955-1956 season and 8 during the 1956-1957 season. The data are presented in Table 6. The small sample size dictates that only the juvenile:adult and male:female ratios be considered, for these are the only ratios based on the entire sample.

A juvenile:adult ratio of 90:100 exists for the 1955-1956 trapping season returns. This low ratio, and the low juvenile:adult female ratio of 140:100 of mink live-trapped during 1955, indicate low productivity for the year.

The juvenile:adult ratio for the 1956-1957 season, 700:100, is much higher than the preceding year's ratio, but, unfortunately, the ratio is based on a sample consisting of only eight individuals: one adult and seven juveniles. Nonetheless, the ratio suggests a highly productive season, as does the high juvenile:adult female ratio, 433:100, for the 1956 live-trapping catch.

The male:female ratios for the two trapping seasons, based on sex determination of 43 pelts in 1955-1956 and 52 pelts in 1956-1957, are 290 and 247:100 respectively. Greer (op. cit.), analysing the results of two Montana trapping seasons, found male:female ratios of 137:100 and 136:100 for the two seasons, which are substantially lower than are the ratios for the Huslia area. Possibly, the high Huslia ratios result from more surface movements by the males, with the females confining their movements to areas under the ice. Such behavior would make the males more susceptible to trapping. This high catch of males during the steel-trapping season reduces their numbers, making fewer males available during the live-trapping periods.

Table 6. Sex and age data for mink carcasses collected in the Huslia, Alaska, vicinity during the 1955-1956 and 1956-1957 trapping seasons

	1955-1956	1956-1957	Ratios	1955-1956	1956-1957
Mink captured	25*	8	Juvenile:adult	90:100	700:100
Males	19	6			
Adults	7	1	Juv.:adult female	300:100	No adult females
Juveniles	7	5			
Females	6	2	Juv. male:juvenile female	350:100	250:100
Adults	3	0			
Juveniles	2	2			
Total adults	10	1	Adult male:adult female	233:100	No adult females
Total juveniles	9	7			

*Six carcasses inadvertently destroyed, so only 19 carcasses aged.

Population Density. -- An accurate census is essential in determining population fluctuations and densities. Dice (1931), discussing the methods of censusing animals, states (p. 376) "To count the less conspicuous forms and those less restricted to one locality is practically impossible," but he further states (p. 381), "By the development of a proper field technic, which must be more or less different for each kind of mammal, it seems possible to secure indices of abundance for any given species." The first quotation is indeed fitting for mink; counting mink in their native habitat is virtually impossible. The second offers a solution: the population index. An index reveals relative abundance and population trends but not population densities.

Census Methods. -- Track counts as population indices show little promise in the Huslia area, for water levels during summer and temperatures during winter influence the amount of sign present. Considering the summer first, tracks depend largely on the water levels in the river. As the water levels drop, wet, undisturbed mud, silt and sand banks which are excellent media for mink tracks are exposed. However, when the water levels rise, the banks are covered. The live-trapping period during 1957 illustrates the effect of adverse water levels. During August the juveniles were moving only short distances from the den site and were making few tracks on the exposed river banks. During early September increased juvenile travel occurred simultaneously with rising water levels, eradicating tracks as they were made. The river began dropping on September 18, but immediately thereafter cold weather prevailed, resulting in frozen river banks and no tracks. However, the native trappers, who are thoroughly familiar with the area and who make daily observations, predict the success or failure of the coming trapping season from the amount of mink sign near small stream mouths.

Temperature largely governs the extent of surface movement of mink during the winter months (see MOVEMENTS). When the temperature remains below -10°F, very little surface movement occurs, resulting in low track counts and an unreliable index. Possibly, track counts during March would be useful for, according to the native trappers, extensive mink movement occurs at this time.

Mink population densities fluctuate greatly in the Huslia study area, as catches by the two native trappers indicate. The 1954-1955 trapping season produced over 50 mink, with the natives reporting abundant sign still present after cessation of trapping. The 1955-1956 season yielded only 15 mink, with very little mink sign present at any time. The 1956-1957 season catch was only seven mink, but the catch was affected by adverse weather conditions, which restricted trapping efforts to only one-third of the normal trapping area. Mink sign was fairly abundant on the area throughout the season, indicating that a fair population was present, but was restricted to sites such as abandoned beaver houses and open spaces under the ice that were relatively inaccessible to the trapper. Considering only the 1954-1955 and 1955-1956 seasons, the large difference in catch indicates a radical fluctuation in population density. The fluctuation is vividly illustrated by the total number of mink pelts purchased by the two traders in the village of Huslia; during the 1954-1955 season the traders purchased about 700 pelts, but during the next season fewer than 100 were purchased.

The 1956 live-trapping operation and the 1956-1957 steel-trapping season provide information on mink densities. The densities derived from such calculations, although not acceptable as absolute, give an indication of the magnitude of population density, and provide a basis for comparison with other areas and with other years.

The data from the 1956 season are used because the steel-trapping returns of two tagged individuals indicate that negligible movement of mink occurred; the necessary assumption is that no movement into or out of the area had occurred. Other necessary assumptions are that differential mortality has not occurred and that tagged and untagged mink are equally difficult to catch.

Hayne (1949a) states that home range can be determined by using the greatest distance between capture points. Inasmuch as most traps were placed along the North Fork River, the traps do not form a grid, or any semblance of a grid, so that most captures extend more or less in a line. Hence, the greatest distance between capture sites is the only available measure of home range. Burt (1943) defines home range as that area traversed by the individual in its normal activities of food gathering, mating and caring for the young. During this discussion the more restricted term activity range will be substituted for home range, for only the area frequented by an individual during summer, fall, and early winter will be considered.

The size of the area effectively live-trapped was determined by adding a border strip equal to one-half the length of a mink's activity range to each side of the area saturated with traps. The average activity range is computed by adding the greatest distance between points of capture for all mink captured twice or more, and dividing the sum by the number of mink involved. Thus the movement patterns of adults and juveniles combine to form the activity range. The data from all three live-trapping periods are used, for the movement patterns of mink during the three periods appear similar, giving a much larger sample on which to base the activity ranges.

Table 7 shows the distance between furthest captures and the computation of average activity range. The length of this area is computed to be 0.6 miles. When a strip half this length is added to each side of the trap line, and to both ends, the effective trapping area is defined, as shown in Fig. 2. This area is about 16 square miles.

The live-trapping operation on this area during 1956 yielded a catch of 18 mink, 3 of which died from exposure, leaving 15 mink for use as the tagged segment in a Lincoln Index method of population size estimation (Lincoln 1930; Hayne 1949b). The 1956-1957 steel trapping in the area produced five mink, two of which were tagged. The five mink are the recapture segment of the tag-recapture method. Hence, $P = \frac{yz}{x}$, where "P" is estimated total population, "y" is the number of mink tagged and released, "z" is the total number of recaptured mink and "x" is the

Table 7. Determination of border strip surrounding trap line based on greatest distance between capture sites of 27 live-trapped mink

Mink	Sex	Age	Times Captured	Greatest Distance Between Capture Sites (Miles)
1955				
2301-2302	F	Adult	5	0.4
2307-2308	F	"	8	0.8
2309-2310	F	"	2	0.3
2313-2314	F	"	2	0.0
2315-2317	F	"	6	1.2
2321-2322	M	Juvenile	3	0.7
2323-2324	M	"	3	0.3
2325-2326	F	Adult	2	0.3
2341-2342	F	Juvenile	5	0.8
2343-2344	M	"	7	0.2
2347-2348	M	Adult	2	0.9
2349-2350	M	Juvenile	4	0.2
2352-2353	M	"	2	0.1
2358-2359	F	"	3	0.7
2362-2363	F	"	3	0.6
2366-2367	F	"	4	0.2
1956				
2374-2375	M	Juvenile	6	0.2
2383-2384	F	"	4	2.2
2385-2386	M	"	5	0.2
2388-2389	M	"	3	0.4
2390-2391	F	"	6	1.6
2392-2393	F	Adult	2	0.3
2394-2395	F	Juvenile	3	0.3
2400-2401	M	"	2	0.3
2408-2409	F	Adult	2	0.0
1957				
2416-2417	F	Juvenile	2	0.0
2430-2431	M	"	6	3.2
27 mink				16.4 miles

16.4 : 27 = 0.6 miles per mink
The border strip equals one half of 0.6 miles or 0.3 miles.

number of recaptured animals with tags. Using the formula, a population size of 35 mink is estimated, giving a density of 2.2 mink per square mile.

This density figure is not to be construed as an accurate measure of mink densities on the area. Instead, it serves as a basis for comparison with other areas.

Coastal Southeastern Alaska

A total of 247 skinned mink carcasses was collected from the Petersburg-Wrangell area throughout the 1956-1957 trapping season. Many trappers contributed carcasses, the size of individual contributions ranging from 1 to 71. The capture dates of many were unknown, but enough information and evidence generally were available to fix capture within 5 to 10-day periods. Dried pelts also were examined to secure sex and age data, but the data sheets were lost when the patrol vessel used in the operation was destroyed by fire. The age determination methods described previously were followed throughout.

Population Composition. -- The sex and age ratios of the 247 carcasses are listed in Table 8. Immediately apparent is the male:female ratio of 201:100, a ratio heavily favoring males. Many trappers in coastal southeastern Alaska claim that they employ trapping methods selective for males, thereby maintaining a large stock of breeding females. Also, some trappers state that they release a small percentage of females caught during the season, but the author doubts that the practice is followed extensively, even by its most ardent advocates.

Table 8. Sex and age data and ratios of 247 mink carcasses collected during the 1956-1957 trapping season in the Petersburg-Wrangell area of coastal southeastern Alaska

Total number carcasses	247	Juveniles:adults	83:100
Juveniles	112	Males:females	201:100
Adults	135		
Total number males	165	Juvenile:adult females	233:100
Juvenile males	78		
Adult males	87	Juvenile females: adult females	71:100
Total number females	82		
Juvenile females	34	Juvenile males: adult males	90:100
Adult females	48		
		Juvenile males: juvenile females	229:100
		Adult males:adult females	181:100

Many investigators report a preponderance of males in trappers' catches, attributing it to the larger range of males. Greer (op. cit.) noted that as the Montana trapping season progressed, the male:female ratios reflected a progressive decline of males and an increase of females. Yeager (L950:326) and Quick (1956:272) noted the same for marten. These observations indicate that because of their greater range, the males are reduced at a more rapid rate than the females, resulting in a ratio increase favoring females. Assuming no differential mortality rate other than trapping, and a 100:100 natal sex ratio, an even, or essentially even, male:female ratio in the trapping catch would indicate very heavy trapping pressures or methods especially selective for females, which would reduce to insignificance the influence of the greater range of males. On that basis, the 201 males:100 females ratio of the southeastern Alaska mink catch implies a large residual population of females, and moderate trapping pressures.

The juvenile:adult ratio is only 83:100 (Table 8). This low ratio indicates a year of low productivity, yet large mink catches occurred throughout the Petersburg-Wrangell area, with some of the trappers evaluating the 1956-1957 trapping season as "one of the best." The 1956-1957 season, however, followed a 22-month closed season, so that mink populations had increased through two breeding periods. Hibbard (1957), analyzing trapping returns of North Dakota mink, believes one should expect a decrease in the number of juveniles per adult among mink harvested in a year of normal trapping pressure following one of light trapping pressure. He only explains that (p. 413), "In years when the pressure is light, such as in 1955, there is a higher survival of all animals and the next spring's breeding stock is increased accordingly." Even with an increased breeding stock if the reproductive rate remains the same, other things being equal, the age ratios will remain the same. With decreased productivity the number of juveniles per adult decreases, however.

Two other ratios also are indicators of productivity: the juvenile: adult female and the juvenile female:adult female. The juvenile:adult female ratio cannot be indiscriminately used, however, for an unbalanced sex ratio or a higher capture rate for one sex, which occurred in the catch from southeastern Alaska, would bias it. Thus, the juvenile female:adult female ratio is a better index to productivity; and, again assuming a 100:100 natal sex ratio, multiplying the juvenile female: adult female ratio by two should provide a more realistic ratio. This procedure provides a ratio of 142:100 which is much lower than the sample ratio of 233:100.

This derived ratio of 142:100, when compared with ratios given by Greer (op. cit.) for Montana mink, accentuates the low rearing success during 1956. For the 1953-1954 trapping seasons, Greer reports ratios of 363:100 and 420:100 respectively, which he apparently considers normal for that area. On that basis, reduced production must have occurred during 1956 in southeastern Alaska, a year of closed season on mink trapping. If low production occurred during 1956, high production must have occurred during 1955, for the 1956-1957 trapping season was successful. Possibly, the 1955 breeding population, although greatly reduced by the large catches made during the 1954-1955 trapping season, had very high production and survival, so stocking the area that decreased production resulted in 1956.

Population Density. -- Mink population densities are not uniform throughout coastal southeastern Alaska but vary according to the quality and quantity of available habitat. The following discussion of densities will include only those areas thought to be good mink habitat.

The mink catch per unit area indicates that high mink densities exist. Figure 4 shows the mink catches reported by trappers in the Petersburg-Wrangell area. In an analysis of these densities, it must be remembered that only a narrow belt, approximately 10 yards in width, adjacent to the beach is utilized by mink. The density measurement used is the number of mink per mile of beach.

Catches of 10 or more mink per mile of beach are common (Fig. 4). Some of the larger catches during the 1956-1957 season are as follows: 130 mink from 10 miles of beach in Duncan Canal, Kupreanof Island; 165 mink from 15 miles of beach near Whale Pass, Prince of Wales Island; and 152 mink from 10 miles of beach at Louise Cove, Kuiu Island. All of these catches averaged more than 10 mink per mile of beach, with the highest average slightly more than 15.

Information on post-trapping densities is available for the 10 miles of beach in Duncan Canal that yielded 130 mink (Fig. 4). During early March, 1957, the author conducted track counts on four segments of beach totaling three-fourths mile on the day following a fall of snow, which minimized the chance of counting successive tracks of the same individual.

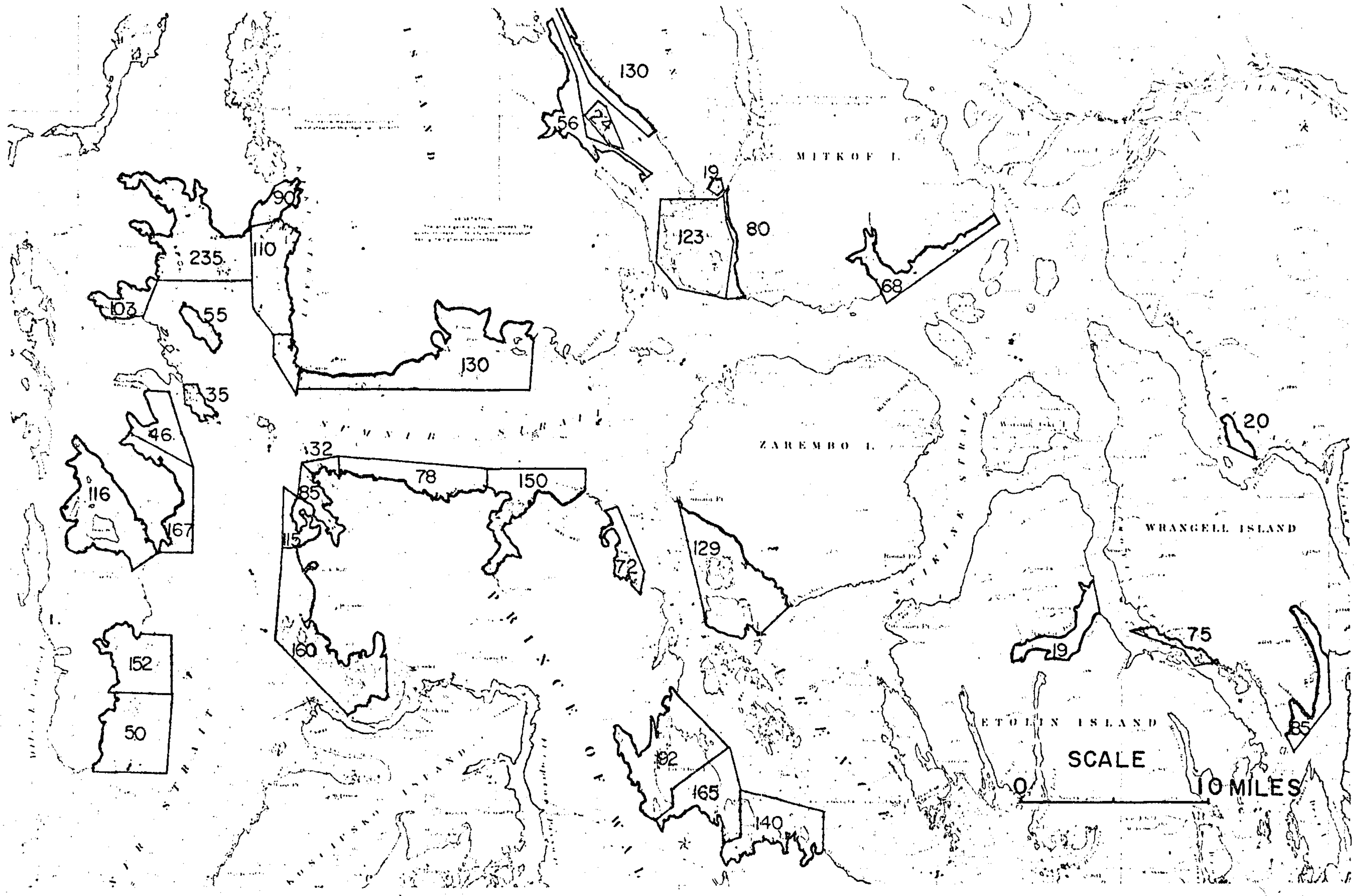

Figure 4, Mink catches recorded in the Petersburg-Wrangell area during the 1956-1957 trapping season.

All tracks were followed from the point of emergence to the point of disappearance, thus ensuring that different sections of the same track were not tabulated as separate tracks. The track counts showed eight mink still present on the area. This limited sample indicated a fairly large residual population. Whether this sample is typical of conditions throughout most of southeastern Alaska is questionable, but the sample reveals that on the 10-mile segment in Duncan Canal densities of 20 or more mink per mile of beach prevailed before trapping. The segment in Duncan Canal falls between the "best" and "poorest" categories of mink habitat, and trapping pressures on the area were of medium intensity.

Compared with the mink densities in interior Alaska, the densities in southeastern Alaska are high. Possibly the high stable food level in the coastal area is the primary cause of this large difference in densities.

The mink populations in interior and southeastern Alaska differ greatly in composition and density. The interior Alaska population, which is steel-trapped each year, contains a large proportion of young; densities of about 2.2 mink per square mile occur during the summer. The southeastern Alaska population, which is steel-trapped in alternate years, contains a preponderance of adults two years after a trapping season; densities of 20 mink per mile of beach may occur at that time.

MOVEMENTS

The movement patterns of mink are difficult to determine because of the secretive nature and nocturnal habits of the animal. An additional difficulty is encountered during the winter in interior Alaska, for during this period mink live and travel under the ice.

Huslia Study Area

Movement patterns of mink differ between ages and sexes, as well as between seasons.

Movement of Adults. -- Observation of tracks and other sign provided most of the information on movement of adults. Adult females, particularly nursing females near a den, were the only adults consistently captured by live-trapping. Only four adult males were captured, and of these only one was captured twice, at sites 0.8 of an airline mile apart (1.8 river miles).

Movements of Males and Non-lactating Females. -- Mink tend to follow water courses closely during the summer months. Ritcey and Edwards (1956) also noted this movement pattern with British Columbia mink. Most travel occurs along the very edge of lakes, ponds, sloughs and rivers, just within the edge of the vegetative cover if the vegetation extends to the water's edge, or on open mud or sand strips along the water's edge if the water has receded. Mink will travel "overland" from one slough system to another if the systems are very close, but such travel is largely confined to "small-game" trails, formed by beavers or muskrats.

On a number of occasions the author observed mink traveling along the edge of a stream or slough. Every hole, nook and cranny is investigated by the animal. If an impassable area, such as a cut bank or very thick vegetation, is reached, the mink enters the water and swims around it. In one instance, a mink hunting along the edge of a 200-foot wide slough crossed the slough three times in a twenty-minute period, presumably because of the thick stands of Calamagrostis sp. encountered.

The winter conditions in the Huslia area are not conducive to surface travel by mink, but the very conditions that hamper surface travel create miles of subnivean passageways for them. After freeze-up, when surface drainage ceases, the water levels of streams and all stream-drained sloughs, ponds and lakes drop, creating open areas termed "sushinetz" (plural "sushintzi") by Russian workers (MacLennan 1957:86), under the ice near shore. In some stream and slough systems, sushintzi continue almost uninterrupted for miles.

Surface travel during winter is dependent primarily on temperature, and not snow depth. During a two-week period in mid-November, 1956, when the temperature remained about -35°F, only one set of fresh mink tracks was noted on the southern half of the study area. On November 21, temperatures warmer than 0°F occurred, and five sets of fresh mink tracks were noted in the same area, of which one set continued on the surface for a distance of three-fourths of a mile. In general, surface travel becomes more frequent when the temperature is warmer than -10°. This winter surface travel, as opposed to summer surface travel, is less restricted to water courses. More cross-country travel between slough systems occurs, and its direction is largely independent of the now obliterated "small-game" trails. One set of tracks, followed for two miles, crossed three slough systems before disappearing in an opening in an abandoned beaver house.

The daily movement patterns of adult male and female mink are incompletely known. The belief that males range farther than females is widely held, and data from steel-trapping in the Huslia area support this belief. Although the natal sex ratio of mink is essentially 100: 100 (Enders 1952), the sex ratios of steel-trapped mink show a preponderance of males, being essentially 300:100 for both the 1955-1956 and 1956-1957 trapping seasons. There is no indication that the trappers in the Huslia area intentionally employ selective trapping methods, or that a differential mortality rate exists with mink. Thus, the most logical explanation is that males range more widely than females and are therefore more susceptible to steel-trapping.

The late winter and early spring movements of mink were not observed by the investigator. However, native trappers report seeing much evidence of surface travel by mink during March, a period when crusted snow and moderate temperatures provide favorable conditions for surface travel by mink. Restlessness preceding the mating period probably stimulates mink to do considerable traveling. The extent and length of such travel is not known.

Movements of Nursing Females. -- Most of the information on movements and activity ranges of nursing females was gathered during the summer of 1955. The sources of information were live-trap, trail, track and sight records obtained during late June, July and August.

The movements of the female, at least in the vicinity of the den, are essentially confined to the trails radiating from the den. The trails follow the shores of lakes, sloughs, ponds and streams, resulting in many miles of mink trails in a relatively small area. One or more of the trails are used daily, but no pattern or sequence of use was noted. A female would not likely use one trail one day, another the next, etc.

The size of the area frequented by females with young, termed <u>activity range</u> is this discussion, can roughly be delimited using mink sign and live-trap data. The limited recaptures of individual females do not permit defining the maximum activity range, but the limits of the area most intensively used can be determined. Hence, a so-called "minimum activity range" is ascertained.

In considering the activity range, it must be remembered that mink restrict their movements to shore areas, rarely making extensive hunting sorties far from water. Thus, the extent of the habitable or foraging area within the plot is the important feature of activity range, and a 100-acre plot containing a small, very winding stream has much more foraging area than does a plot of equal size containing a small, straight stream that runs directly across the plot. This fact must be remembered in a comparison of the ranges of two individuals.

The activity ranges were determined for only 5 of the 10 females captured during 1955, for insufficient data were available in 5 instances. The activity ranges of the five females are presented diagrammatically in Figure 5. These diagrams represent the area as indicated by the live-trap, trail, track and sign records.

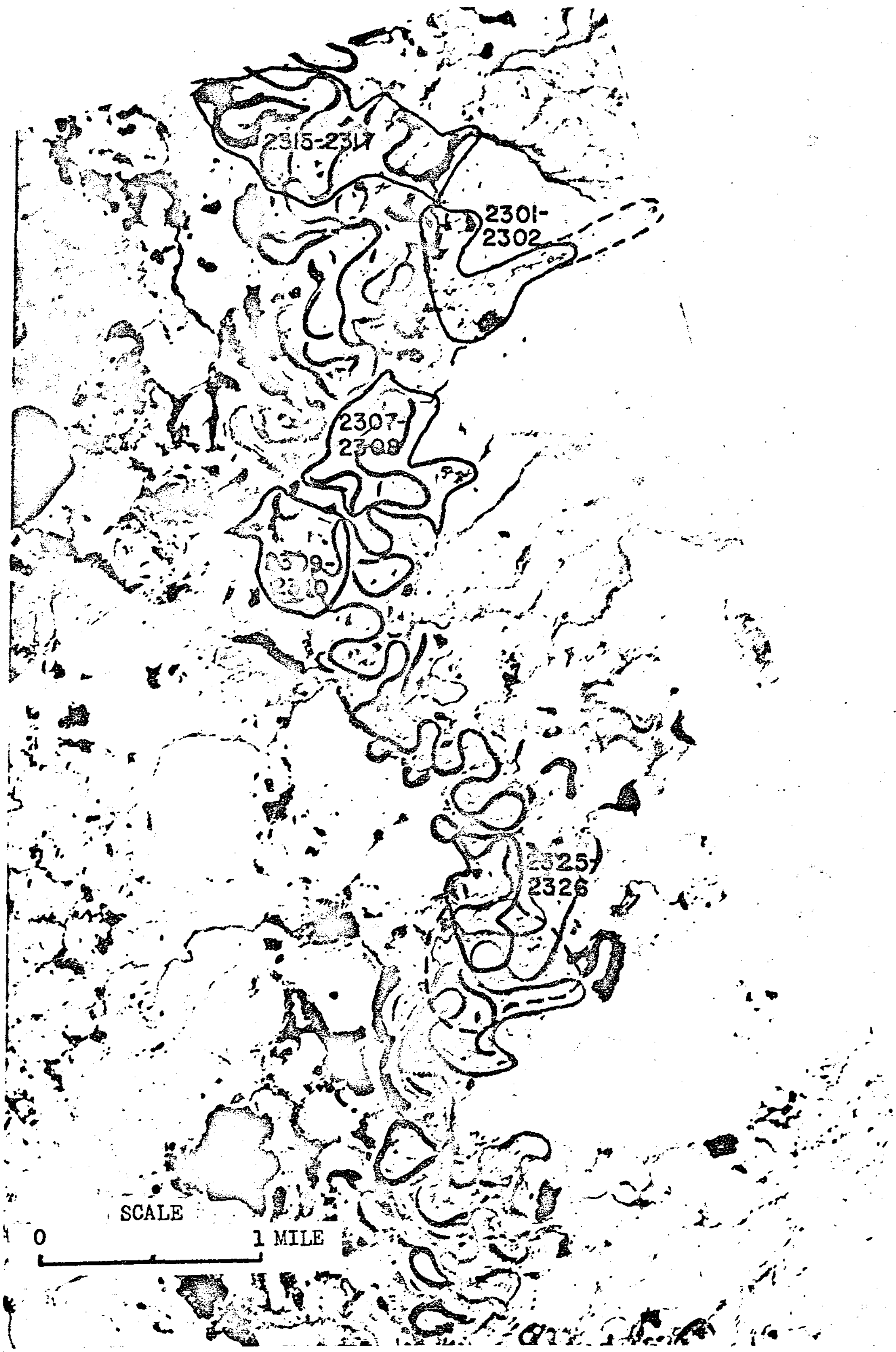

Figure 5. The mid-summer activity ranges of five lactating female mink captured during 1955, Huslia Study Area, interior Alaska.

The area utilized by a female during the period of rearing young is not large. As can be seen in Figure 5, the largest activity range, the range of female 2315-2317, is 1.2 miles at its greatest length. The activity range of female 2301-2302 is slightly larger if the calculated area is included, extending 1.3 miles at its greatest length. Judging from the den site location of female 2301-2302, foraging must have occurred in the calculated area, but inclusions must be questioned, for no live-traps were set there. The farthest capture from the den site of this female was slightly over one-half mile.

Female mink are not known to exhibit territorial behavior to the extent of physically defending an area against other female mink, but the diagrams representing the activity ranges suggest that there is little overlap of the ranges of nursing females.

Movement of Juveniles. -- During the first summer of live-trapping, two young mink were captured on August 8 in a live-trap placed near a den opening. That date represents the earliest catch of any young and indicates, roughly, the date of first emergence from the den. The two young still had the conformations and behavior of very young animals, being short, chubby and relatively unafraid. Commercial mink ranchers state that young first appear from a nest box at five to six weeks of age. The two live-trapped young probably were captured within a week of first emergence, so they would be about seven weeks of age at capture.

Young do not move far from the den site during the first two to three weeks after emergence. Trails by the den are investigated, but excursions over a few hundred feet in length are not taken. By the end of August, however, the young are moving greater distances. One young female, number 2383-2384, was recaptured on August 26, 1.0 river mile (0.7 air-line mile) from the den site.

Juveniles show conflicting movement patterns. Figure 6 shows the movement patterns, from first to last capture, of seven juveniles. Mink 2343-2344(A), 2349-2350(B), 2374-2375(C), and 2385-2386(E), remained in the same slough system containing the natal den site throughout the live-trapping period. Mink 2383-2384(D), and 2390-2391(F) ranged much more widely, but they still frequented the natal den site. Mink 2430-2431(G) shows yet another pattern. This juvenile male was first captured September 1 and last captured September 26; the first capture site is located 7.5 river miles (3 air-line miles) above the last. The intervening captures, in chronological order, progressed downstream from the first capture site. Apparently, this juvenile was shifting its activity area slowly downstream. Such phenomena may be more prevalent than the live-trapping data suggest. Track counts indicate that such shifts occur often. A maze of fresh mink tracks, determined by live-trapping as made by juveniles, appear for a few days along one stretch of river bank, but, abruptly, no more fresh tracks are seen. However, a nearby stretch of bank soon has an abundance of fresh tracks, indicating that activity has been shifted to this new site.

Juveniles could travel extensively immediately after "freeze-up," when the ponds and streams have a thin coat of ice and the ground has a thin layer of snow, for travel would be very easy at this time. Trapping

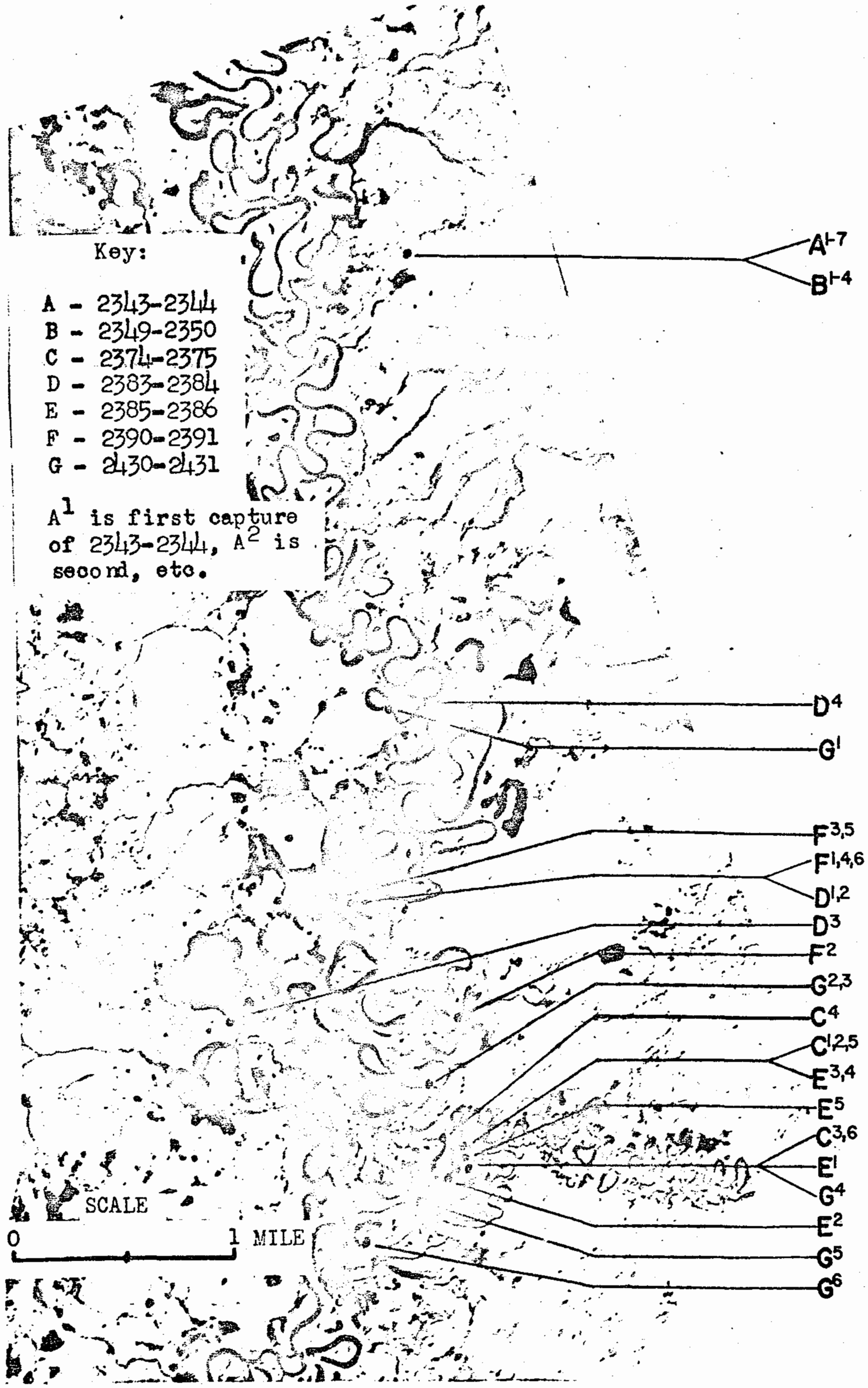

Figure 6. The late summer and early fall movement patterns of seven juvenile mink live-trapped on the Huslia Study Area, interior Alaska.

season returns of tagged individuals are the only source of information available on "post-freeze-up" movements, but only three tagged juveniles were recovered during two steel-trapping seasons. Of the three individuals, one juvenile male had traveled 10 air-line miles, but the other two, a male and a female, were within one-fourth mile of the live-trapping site.

Factors Influencing the Extent of Mink Movement. -- Weather conditions and food supply probably are the two primary factors influencing mink movements in the Huslia area. The effect of weather has been discussed partially; very low temperatures during the winter curtail surface travel by mink. Deep snows create difficult travel conditions for mink, and tend to decrease surface travel. Inclement weather during the warmer portions of the year also affects mink movements. On September 19, 1956, eight live-traps, checked by the author prior to noon and again at 1730, captured two mink during the heavy snows that fell during the afternoon. The mink started hunting early, probably influenced by the inclement weather.

The food supply level could be even more important. During a period of low food supply, mink may be forced to travel greater distances in search of food any may move into new areas. A hint of such behavior is gained from the trapping season returns of the three tagged individuals. During 1955-1956, microtines were low in numbers, and the only tagged mink captured during this period had traveled 20 river miles from the tagging site. During 1956-1957, the microtine population was much higher, and the two tagged mink captured during this period were captured within one-fourth mile of the tagging site. This disparity in distance traveled possibly is influenced by the different food levels present.

Coastal Southeastern Alaska

Only fragmentary information is available on the movements of coastal southeastern Alaska mink. The well-worn mink trails paralleling the beaches indicate that mink movement along the beaches does occur. Also, trappers report some mink movement up the larger streams during the summer. However, the extent and duration of these movements are not known. Transitory snow cover curtailed observations on local mink movements during January, February and the first half of March, 1957. However, during January and February, movement appeared to be limited. Numerous tracks, evidently made by feeding mink, emerged from dens within the vegetative cover and led to the intertidal zone. A few of the tracks paralleled the beach for distances of 100 to 200 yards, but most re-entered dens in the vegetative cover within 100 yards from the point of emergence. Often, the points of emergence and re-entry coincided. Apparently, extensive movements were the exception rather than the rule during this period.

During the first half of March, the movement pattern changed somewhat. Although many of the tracks still followed the pattern described above, a few paralleled the beach for distances of two miles or more, at times following trails in the woods and at times the beach proper. The investigator followed one set of tracks for two and one-quarter miles before he had to cease tracking.

FOOD HABITS STUDY

Food is often the factor limiting predator populations. If the types of food utilized by a predator are known, the predator population fluctuations often can be forecast by observing the changes in the prey populations.

Huslia Study Area

The food level in the Huslia study area may be the most important factor determining mink population densities. Both the microtine and hare population densities fluctuate violently and, inasmuch as many of the other food sources are seasonal, food levels are not stable. The identification of prey species and the determination of their availability and population densities are essential to an understanding of mink population dynamics. During the present study, mink scat analysis furnished most of the information on food habits.

The habitat type and location of each scat was noted at the time of collection. Determining the time of deposition proved difficult, except for very fresh scats, and the attempt to catalog the scats on a seasonal basis was abandoned. Thus, the food habits study depicts the yearly feeding pattern, and not the seasonal variations and fluctuations, which are probably the most important elements of a food habits pattern.

The scats were placed separately in plastic bags when collected, and a few drops of formaldehyde added to stop any bacterial breakdown of hair medullae. When analyzed, the parts of the scat were mechanically separated and inspected macroscopically. This inspection generally was sufficient to separate the items into six major food groups: mammal, bird, fish, vegetation, insect and mollusk. Hairs found in the scats were compared, both macroscopically and microscopically, with middorsal and midventral samples of hair from known prey species. Teeth found in scats were compared with teeth from known specimens. The identification of the vole-lemming group was based solely on dental characteristics.

A notation of the uneaten food remains found at 14 natal den sites was also made. Prey brought to the den by the adult female contributed most of the uneaten remains.

The number of trap nights per mink capture tabulated according to type of bait used, *i.e.*, bait preference, was determined for the three live-trapping seasons. Although the information on bait preference was gathered incidental to the live-trapping operation, it should indicate preferences if they exist in relation to the baits offered.

Scat Analysis. -- Some 360 scats were collected and analyzed, 224 during 1955 and 136 during 1956. Tables 9 and 10 analyze the two samples.

Mink consumed a wide variety of foods; the scats contained the remains of mammals, birds, fishes, insects, mollusks, and vegetation. Three of the food groups--mammals, birds, and fishes--accounted for over 85 percent of the total occurrences of food items. The occurrence of less frequent items such as snails and clams may be due to accidental ingestion during consumption of other foods. In order to assign a more realistic value to such food groups, the food items were tabulated relative to the number of other items occurring in a scat as well as by percent of total occurrence.

Table 9. Occurrence of mink food items in 224 scats collected summer, 1955, on Huslia study area

Item	Alone	With 1 Other Item	With 2 Other Items	With 3 Other Items	Total	Percent of 330 Items
	Number of Times Occurring (Percent in Parentheses)					
Mammals						
Voles-lemmings	43 (58)	25 (33)	6 (8)	1 (1)	75	23
Snowshoe hares	27 (53)	20 (39)	3 (6)	1 (2)	51	16
Muskrats	17 (77)	3 (14)	2 (9)	-	22	7
Red squirrels	4 (36)	5 (46)	1 (9)	1 (9)	11	3
Shrews	1 (33)	2 (67)	-	-	3	1
Mink	1 (100)	-	-	-	1	(T)
Unidentified mammals	-	4 (100)	-	-	4	1
Total mammals	93 (61)	52 (34)	6 (4)	2 (1)	167	51
Birds	17 (55)	12 (39)	1 (3)	1 (3)	31	9
Fishes	25 (30)	48 (57)	10 (12)	1 (1)	84	25
Insects	-	3 (43)	3 (43)	1 (14)	7	2
Mollusks	-	2 (67)	1 (33)	-	3	1
Total animal food					292	88
Vegetation	-	24 (63)	12 (32)	2 (5)	38	12
Total	135 (60)	77 (33)	13 (6)	2 (1)	330	100

Table 10. Occurrence of mink food items in 136 scats collected summer, 1956, on Huslia study area

Item	Number of Times Occurring (Percent in Parentheses)					
	Alone	With 1 Other Item	With 2 Other Items	With 3 Other Items		Percent of 204 Items
Mammals						
Voles-lemmings	14 (32)	25 (57)	4 (9)	1 (2)	44	22
Snowshoe hares	7 (70)	3 (30)	-	-	10	5
Muskrats	22 (61)	13 (36)	1 (3)	-	36	18
Red squirrels	-	-	-	-	-	-
Shrews	-	1 (100)	-	-	1	(T)
Unidentified mammals	3 (30)	4 (40)	1 (10)	2 (20)	10	5
Total mammals	46 (46)	46 (45)	6 (6)	3 (3)	101	50
Birds	22 (69)	7 (22)	2 (6)	1 (3)	32	16
Fishes	6 (14)	29 (67)	6 (14)	2 (5)	43	21
Insects	-	10 (59)	6 (35)	1 (6)	17	8
Mollusks	-	-	2 (100)	-	2	1
Total animal food					195	96
Vegetation	1 (11)	4 (45)	2 (22)	2 (22)	9	4
Total	75 (55)	48 (36)	10 (7)	3 (2)	204	100

Mammals appear most frequently in both samples, accounting for half of the total occurrences. The group next highest in percent of occurrence is fish, with percentages of 25 and 21 for 1955 and 1956 respectively. These two groups--mammals and fishes--jointly account for nearly three-fourths of the total occurrences. The next most important group, birds, has percentages of 9 and 16 for 1955 and 1956 respectively. The remaining three groups--insects, vegetation, and mollusks--combined, have percentages of occurrence of only 15 and 13 for 1955 and 1956 respectively, and in only one scat were these the sole constituents. In that scat, vegetation, consisting of the leaves and berries of *Rubus chamaemorus* L. and *Chamaedaphne calyculata* (L.) Moench, formed the entire contents.

The three food groups having the highest percentages of total occurrence--mammals, birds, and fishes--are also the groups having the highest occurrence in "single item" or "two item" scats. Over 50 percent of the scats containing bird or mammal remains are "one item" scats. The large amount of undigested remains associated with these two groups contributes to this high "one item" incidence.

An inspection of Tables 9 and 10 reveals that insects, vegetation and mollusks very rarely make up the whole scat. Volumetrically, these groups contribute little to a mink's diet. Sealander (1953) feels that vegetation is taken incidentally by mink and is not a regular part of the diet.

Voles and lemmings contribute nearly 25 percent of the total food items. These relatively high percentages are all the more significant because these small microtines were near, or at, a low in population density during 1955. *Microtus* sp. (mainly *Microtus oeconomus macfarlani* Merriam and *M. pennsylvanicus tananaensis* Baker) and *Clethrionomys rutilus dawsoni* (Merriam) contributed over 75 percent of the small microtine occurrences. *Lemmus trimucronatus alascensis* Merriam contributed about 15 percent and *Synaptomys borealis dalli* Merriam less than 10 percent.

Snowshoe hares (*Lepus americanus dalli* Merriam) and muskrats (*Ondatra zibethicus spatulatus* Osgood) follow small microtines in frequency of occurrence, but the pattern is not the same for both samples. In the 1955 sample, hares and muskrats contributed 16 and 7 percent of the occurrences respectively, but in 1955, muskrats contributed 18 percent and hares 5 percent. This reversal of importance undoubtedly reflects changes in muskrat and hare populations. During 1955, the muskrat population was very low, but during 1956, a noticeable increase occurred. The incidental catching of muskrats in live-traps during 1955 and 1956 confirms this increase; during 1955, 1,497 trap nights resulted in a catch of 2 muskrats, but during 1956, 801 trap nights yielded a catch of 14 muskrats. Concurrently, the hare population crashed from a high in 1955 to a low in 1957. These two population shifts would thus change the availability of the two species.

The low incidence of shrews in both samples is not due to a low shrew population, for shrews were abundant during the three seasons of live-trapping. Other workers also report a very low indidence of shrews in mink diets (Sealander 1943; Wilson 1954). Murie (1936) found that

Michigan foxes ate few of the shrews they caught, attributing the low incidence to unpalatability caused by the glands of shrews. Apparently, mink also find shrews unpalatable.

Red squirrel (Tamiasciurus hudsonicus preblei A. H. Howell) contributed three percent of the mammalian occurrences in the 1955 sample, but none in the 1956 sample. Sealander (1943) and Hamilton (1936 and 1940) found no evidence of squirrel utilization by mink, and Wilson (1954) reports only slight utilization. Squirrels, apparently, are a minor segment of the diet.

No consistent effort was made to identify by species the bird remains in the scats, but casual observations revealed various species of waterfowl, passerines and grouse, with waterfowl and grouse (notably willow ptarmigan, Lagopus lagopus L.) most abundant.

The fishes were not specifically identified. However, the following species inhabit the area and are probably eaten: northern pike (Esox lucius L.), fresh water ling cod (Lota lota Hubbs and Schultz), Arctic grayling (Thymallus signifer Richardson), dog salmon (Onchorhynchus keta Walbaum), suckers (Catastomus sp.), whitefish (Coregonus sp.), cottids (Cottus sp.), lamprey (Entosphenus sp.) and probably blackfish (Dallia pectoralis Bean).

None of the scats contained frog remains, yet a large number of frogs (Rana sylvatica cantabrigensis Baird) are present in the area. Hamilton (1936 and 1940) found that mink in New York State do prey on frogs, with a rate of occurrence of less than 6 percent during the summer, but he states, "In view of the great number [of frogs] present, it is rather surprising that so few frogs were eaten" (1940:82). Sealander (1943), however, found much higher rates of occurrence, with the stomach and intestines of winter mink in southern Michigan yielding percentages of 23 and 10 respectively. These figures indicate frog remains are less readily recognized after passing the stomach, a condition which may contribute to the total lack of frog incidences in the present study inasmuch as only scats were analyzed.

Food Remains at Den Sites. -- Uneaten food remains littered the entrances to dens containing young mink. At 14 natal dens, remains of the following prey species appeared: various species of passerines and waterfowl, Arctic grayling, northern pike, ling cod, dog salmon, snowshoe hare, and muskrat.

Bait Preferences. -- The palatability and availability of food types govern the food habits of most animal species. Considered here are the bait preferences exhibited by mink during the three summers of live-trapping.

The investigator's choice of bait and its placement were largely governed by availability. Baits used consisted of the following species: raven (*Corvus corax* L.), various species of grouse and waterfowl (heads and wings only), northern pike, snowshoe hare, and muskrat. Using the bait type available at the moment resulted in haphazard bait placement and a variety of baits at each trap location.

Lack of acceptance of putrid baits was noticed during the live-trapping periods. Ritcey and Edwards (1956), in work conducted in British Columbia, also found that putrid baits were not readily accepted by mink. Apparently mink prefer fresh baits, necessitating bait changes every other day when temperatures were 50^{o}F or warmer. This preference for fresh baits probably biased bait selection, for fish baits putrify more quickly than do bird or mammal baits.

One property of baits, odoriferousness, is not considered here. However, that property may be very important, for the "success" of a bait may be partly related to the distance odor emanates from it.

Trap nights and mink catch for each type of bait are tabulated in Table 11. The three summers of live-trapping are divided into several shorter periods, assuring more uniform weather conditions within a period, and resulting in a more comparable basis for determining the number of trap nights per mink capture for the various bait types.

In general, no definite preferences are exhibited. Fairly large differences in the number of trap nights per mink capture do exist within certain periods, however, and the differences for bird and fish baits during the periods September 9 to 18, 1956, and August 14 to September 1, 1957, are especially interesting. The ratios are roughly reversed for the two periods. During the first period, the trap nights per mink capture for bird and fish baits were 38 and 8 respectively. During the second period, the ratios were 49 and 187 for bird and fish respectively. Apparently mink "preferred" fish during the first period and bird during the second. Cool temperatures prevailed throughout the first period, thus ensuring that all baits remained fresh. Consequently, freshness did not influence selection during the first period. Freshness may have influenced selection during the second period, however, for it was one of

Table 11. Mink capture data for three main bait types used during three summers of mink live-trapping on the Huslia study area, Alaska

Year and period	Bait type: Bird — Trap nights	Bird — Mink captures	Bird — Trap nights per capture	Hare — Trap nights	Hare — Mink captures	Hare — Trap nights per capture	Fish — Trap nights	Fish — Mink captures	Fish — Trap nights per capture	Weather Conditions
1955										
6/26-7/10	16	0	-	173	2	86	71	0	-	Rainy; warm.
7/23-8/21	25	2	12	959	22	29	0	0	-	Alternate clear-dry, cloudy-rain; warm.
9/2-9/11	53	9	6	190	25	7	0	0	-	Rainy; cool.
Totals and averages	94	11	9	1,322	60	22	71	0	-	
1956										
8/14-9/1	173	4	43	269	9	30	8	1	0	Rainy; warm.
9/2-9/8	82	7	12	62	6	10	58	6	10	Clear, dry; warm during day, cool during night.
9/9-9/18	77	2	38	0	0	-	54	7	8	Mostly cloudy; rain and snow; cold.
Totals and averages	332	13	26	331	15	22	120	14	9	
1957										
8/14-9/1	245	5	49	0	0	-	374	2	187	Rainy; warm.
9/2-9/8	18	0	-	0	0	-	116	2	58	Cloudy, dry; warm during day, cool during night.
9/9-9/26	264	8	33	0	0	-	0	0	-	First half-rainy, cool. Second half-dry, cold.
Totals and averages	527	13	41	0	0	-	490	4	124	
TOTALS AND AVERAGES	953	37	26	1,653	75	22	681	18	38	

high temperatures. Inasmuch as bird baits remain fresh longer than fish baits, the preference for bird baits during the second period may be due not to an actual desire for bird flesh, but to a preference for fresh instead of putrid baits.

Changes in Food Levels. -- The quantity and types of food available to mink in the Huslia area fluctuate both seasonally and annually. This discussion of food levels will be limited to the three most important food groups: mammals, birds and fishes.

Spring, Summer and Fall Food Levels. -- Food levels during spring, summer and fall should be sufficient, even though nursing females require additional food during summer. Populations of the three principal food groups reach their yearly peaks during summer, and thus foraging by minks should be comparatively easy.

Small microtines are probably especially susceptible to predation in late spring, immediately after the snow cover has disappeared and before the vegetation is of sufficient height to afford concealment. In the summer the dense vegetation undoubtedly makes microtines less available, but this decrease in availability should be more than offset by the appearance in the population of juvenile voles, lemmings, hares and muskrats, for juveniles generally are more susceptible to predation than are adults.

Large populations of fish are present in the ponds and streams of the Huslia area. Dog salmon spawn in the streams, and the spent fish provide an accessible and abundant food source during part of the summer. Northern pike abound in the area, and while lying in the shallows of small ponds and sloughs are available to mink. Ling cod also inhabit the area, and at times they are trapped by falling water after invading extremely shallow areas. Populations of Arctic grayling, suckers, whitefish, cottids and probably blackfish are also present, but the availability of these species is unknown.

The bird group has the greatest seasonal fluctuation. Large numbers of migrants, including many species of waterfowl, utilize the area each summer for rearing their young. That mink prey on nesting waterfowl, and their eggs and young, is attested to by Sowls (1955) and many others. Sharptail grouse (*Pedioecetes phasianellus* L.), ruffed grouse (*Bonasa umbellus* L.) and spruce grouse (*Canachites canadensis* L.) also nest in the area, but their populations are not large and their availability as prey species is unknown. In general, however, the summer population of birds in the Huslia area is large, and various species, especially those nesting on the ground, should be available to mink.

Winter Food Levels. -- The winter food levels are more difficult to evaluate, for the mink and most of the prey species remain under the ice and snow cover. At present, winter food levels and availability are largely unknown.

Considering the foot or more of snow usually present during the winter in the Huslia area, the microtine segment of the mammalian population may appear unavailable to mink. However, such may not be true. As winter progresses sushintzi form, buckling the ice. A check under the ice in these areas reveals abundant microtine droppings on the dry shore, with numerous tracks and trails noticeable in the frost. Microtine droppings are present even in the mink trails leading through the buckled ice to the sushintzi. At two of the sites inspected during December, 1956, including one where a mink was sighted, constant usage by mink had soiled the trails a dirty brown color, yet large amounts of fresh microtine droppings were found. During this period of close association of small rodents and mink, microtines probably are very susceptible to predation.

Lowering water levels and increasing ice covers throughout the winter may create insecure conditions for muskrats in some of the marginal habitat sloughs and ponds. Errington (1943) indicates that these conditions in Iowa result in muskrat mortality. Buckley (1953) indicates that in parts of interior Alaska a 65 percent mortality among adult muskrats may occur from one summer to the next, and, presumably, predation accounts for part of the mortality. The actual extent of muskrat utilization by mink in the Huslia area is unknown.

Snowshoe hares probably contribute little to a mink's winter diet. A hare can maneuver with ease through deep, soft snow, but such a task is slow and laborious for a mink. The poor conditions for surface travel, coupled with the fact that mink seldom travel on the surface during the colder portions of the winter make hares essentially unavailable to mink during the winter.

The predator-prey relationship of mink and fishes during the winter is unclear. The spawning populations of salmon have, of course, disappeared by this time. The availability and extent of utilization of the remaining fish populations is unknown. Probably local conditions, such as depth of water, size of surface area and types of fishes present, determine whether or not a body of water has an available population of fishes. Radical differences may exist between various bodies of water, so that specific investigations of local conditions are needed to present an accurate picture of the winter availability of fishes. Some general comments can be made, however. Fishes are less active and consume less food during the colder portions of the year than during the warm months, with some fishes becoming semidormant during winter (Eddy and Surber 1943). Also, shallow ponds and sloughs dry, or freeze to the bottom, and the fishes are forced to seek larger bodies of water or deeper holes. In some shallow ponds, fishes are undoubtedly trapped by falling water levels. Thus some changes increase and some decrease fish availability.

The wintering bird populations are less varied and much smaller than the summer populations. Grouse, principally willow ptarmigan, are the only birds that could be classed as winter prey species, and their availability is unknown.

Yearly Changes in Food Levels. -- Food level changes from year are most noticeable in the mammal food group. Both fish and bird numbers undoubtedly do change yearly, but such changes probably are not of sufficient magnitude to seriously affect the food level. Changes in the mammal populations are of a much greater amplitude, and these changes can create critical food levels.

Rausch, the investigator during 1955, observed very little microtine sign during that summer; more than 300 trap nights produced only four microtines. Apparently the microtine populations were very low. During the summers of 1956 and 1957, the situation changed. Microtines were very evident everywhere, and 2,700 trap nights in 1957 yielded 65 microtines. The trapping results for the two years are not directly comparable, for the traps set during 1955 were placed where microtine sign was evident, but during 1957 the traps were evenly spaced over nine one-acre plots, with the placement of the traps being governed more by mechanical spacing than by small rodent sign. Thus the difference in success for the two trapping periods is even more significant. Apparently microtines increased from a very low to a high population in just one or two years. These large fluctuations are common in Arctic microtine populations (Rausch 1950).

Both muskrat and snowshoe hare numbers fluctuate violently. Winter kill due to extreme ice thicknesses probably accounts for most muskrat population changes. Snowshoe hares are known as a cyclic species. Their populations fluctuate greatly in Alaska (Buckley 1954). Such sizable population reductions at times make unavailable an otherwise abundant food source.

In a consideration of the importance of the mammal food group as a whole, concurrent lows in small-microtine, muskrat and hare populations would have a very depressing effect on mink numbers. Food is probably the principal factor limiting mink populations in the Huslia area.

Coastal Southeastern Alaska

Compared with the fluctuating mammal populations that contribute so much to the diet of interior Alaska mink, the food supply in coastal southeastern Alaska is stable. No food habit studies were conducted in southeastern Alaska, but even the most cursory examination reveals striking differences between diets of coastal southeastern and interior Alaska mink.

Mink of coastal southeastern Alaska are predatory creatures of the littoral zone. They are frequently seen feeding on various forms of invertebrates during nocturnal low water. This littoral animal life forms the bulk of the diet.

Probably the only vertebrates consumed in significant amounts are fishes, but even so the quantity of vertebrate food consumed is probably only a fraction of the invertebrate food utilized. Many marine fishes abound along the beaches, but they are probably relatively unavailable to mink. The only readily available source of fish would be the spent and spawning salmon of the large streams, and even these would be available during a short period and to the few mink moving up the streams. The inedible remains of many invertebrates litter the area near mink den sites. Remains of blue mussels (*Mytilus edulis* Linn.), clams (including butter clams, probably *Saxidomus giganteus* Deshayes), sea urchins (*Strongylocentrotus* sp.), and Dungeness crabs (*Cancer magister* Dana) are the most common items. Undoubtedly, many other invertebrates also are consumed.

The food levels are high and probably quite stable in coastal southeastern Alaska. Some seasonal fluctuation occurs among the fishes, but the invertebrate populations probably remain rather stable throughout the year. In some of the sheltered bays food availability may fluctuate during the winter, however, for these sheltered bays freeze during the colder portions of the winter. At such times, mink in those areas may be forced to move to open beaches.

Year to year fluctuations in food levels are probably slight. The littoral zone is very productive, containing a large number of species. Consequently, population fluctuation in a few species does not materially change the total amount of available food. This stability, coupled with the productivity of the area, ensures that food, at least on the more suitable beaches, is not limiting.

REPRODUCTIVE BIOLOGY

Only scanty information is available in the literature concerning wild mink mating activities, den site preferences, and the behavior and development of the young. A knowledge of these facets of a mink's life is essential to an understanding of the life history and ecology of mink and to wise management of the mink fur resource.

Huslia Study Area

Travel and logistic difficulties precluded any investigations on the study area during the mink mating period. However, incidental information from live-trapping and observations from native trappers permit approximate delimitation of the breeding season.

Mating Activity. -- Extended movements of male mink during late winter, according to Marshall (1936), relate to mating behavior in part at least, and such movements during March are consistently reported by native trappers in the Huslia area. These movements probably reflect the premating restlessness of male mink.

Enders (1952:719), studying mink reproduction but dealing solely with ranch mink, states:

> Late February, March and the first week in April are usually considered the breeding season because it is during this period that the animal will copulate....'Yukon' mink are said to breed about two weeks later than "Quebec" or 'Eastern' mink, but individual variation is often greater than this.

Data from the Petersburg Experimental Fur Farm, Petersburg, Alaska, indicate that ranch mink on the farm mate from the middle of March to about the middle of April.

The earliest capture of juveniles sheds some light on whelping dates. As mentioned previously, two young were captured on August 7 at approximately seven weeks of age. Thus whelping occurred about the middle of June. If Pearson and Enders' (1943) estimate of a 51 day gestation period is used, copulation must have occurred during middle or late April.

This information permits these limited conclusions: Extensive movements of males probably occur during March and are due to premating restlessness. Mating occurs during middle or late April. Parturition occurs during mid-June, and the young first emerge from the dens in early August.

Natal Den Sites. -- Den site selection by females probably occurs shortly before the young are born. Whether the den site selected is just one of the sites normally frequented by the female, or a site with special features specifically selected for raising the young, also is unknown. Probably the former is true, for evidence of utilization during November and December, 1956, was noted at two sites.

Fourteen active mink dens were found during the three summers of live-trapping, nine during 1955, three during 1956 (one active during 1955 also) and two during 1957. All were located in the northernmost seven miles of the study area, for this segment was searched intensively for dens (Fig. 7). Finding a den before the young emerge requires careful and diligent search, for very little sign is present. After the young emerge, however, sign becomes much more plentiful and obvious, and dens are more readily located.

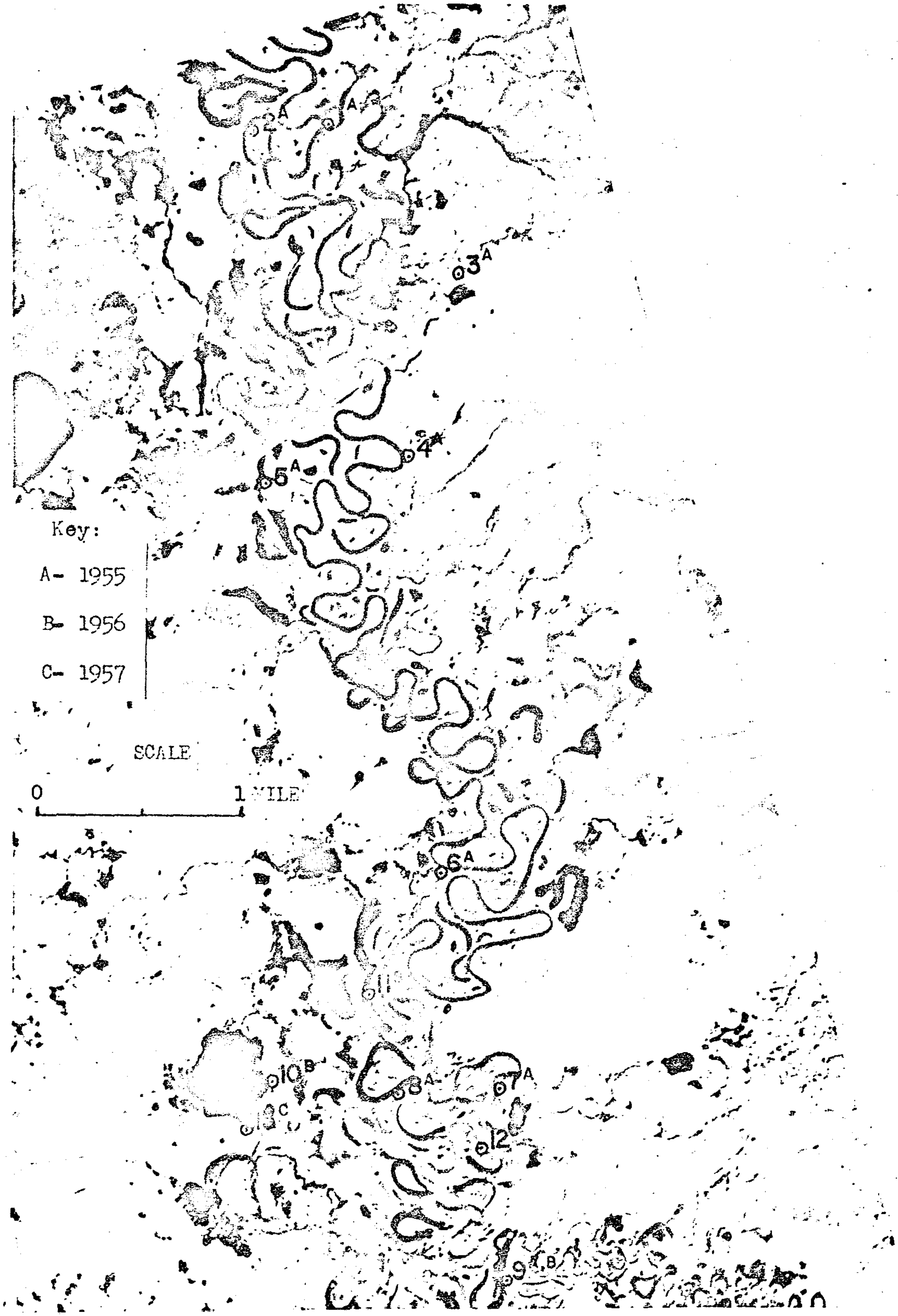

Figure 7. The location of natal dens found during three summers of live trapping, Huslia study area, interior Alaska.

All the dens were situated near bodies of water. Of the 14 sites, 3 were located on the banks of the North Fork River, 9 on the shores of ponds and lakes, 1 on a small drainage from a slough, and 1 on a small stream. The small number of dens on the North Fork River is due perhaps to high, fluctuating water levels in the river during May, making otherwise seemingly choice den locations untenable. A characteristic of the sites is their location above summer high-water levels.

The dens usually are in proximity to a number of vegetation types supporting a varied animal population on which the mink prey. Probably this proximity to several types is not due to mink preference or selection, but to the interspersion and discontinuity of vegetation types. The dense vegetation also adds concealment.

Adult females utilize a variety of sites for raising young. Apparently, they do not construct their own dens but inhabit vacated or appropriated muskrat, beaver and, occasionally, squirrel dens, and in addition, naturally occurring crevices such as frost folds and breaks. The 14 dens found were situated as follows: 5 in appropriated or abandoned muskrat bank dens on sloughs; 2 in inactive beaver houses; 2 in drift piles against high cut banks of the North Fork River; 1 in the folds of a cut bank, North Fork River; 1 in frost faults or folds on a small hillock bordering a small stream; 1 in an appropriated or abandoned squirrel den beside an overflow outlet of a small slough; 1 under a brush pile and alder roots on the shore of a small pond 100 feet from the North Fork River, and 1 in the folds of a drainage channel bank. Obviously, mink denning habits are quite adaptable.

A multiplicity of entrances characterizes mink dens. Marshall (1936) also noted multiple entrances in dens in southern Michigan. Of the 14 dens located on the study area, all had at least two entrances and two had five entrances. A large scat pile was generally present near one of the entrances.

A number of rather obvious mink trails led to the den after it had been occupied for a few weeks. At most sites inspected, two obvious trails existed, one paralleling the shore in one direction and the other in the opposite direction. Apparently the female restricts her movements in the vicinity of the den to these trails.

Dense stands of vegetation surround and cover most of the dens. Because they are situated near a body of water, vegetation characteristic of a shore line usually is present. Calamagrostis sp. furnished the thickest cover, occurring at all but one of the sites. Other prominent species included white spruce, black spruce, alder, willows, birches, mountain cranberry, bog bilberry, Beauverd spiraea [Spiraea beauverdiana Schneid.], cloudberry, Hudson's Bay tea [Ledum palustre decumbens (Ait.) Hult.], Labrador tea [Ledum palustre groenlandicum Oeder], sedges, mosses, crowberry [Empetrum nigrum L.], marsh cinquefoil [Potentilla palustris (L.) Scop.] and lichens. Many other species were also present in small amounts.

The adult females probably frequent throughout the year the site at which they reared young. However, most intensive utilization occurs during the period of rearing the young, which extends from June through the first half of August. Restriction to the natal den site decreases after August as indicated by fewer fresh tracks and scats.

The length of stay at the natal den apparently varies greatly among the young. During 1955, juvenile males 2343-2344 and 2349-2350 were still frequenting the natal den on September 11 and 8 respectively, for they were captured within a few hundred yards of it.

During 1957, a juvenile male, 2430-2431, was last captured on September 26, at a point 7.5 river miles (3 airline miles) downstream from the first capture site. Four intervening captures occurred, each of which progressed downstream from the first capture site. Apparently this juvenile had abandoned the natal den and was not yet established in any one locality. Litter size possibly influences the length of utilization. Young in a large litter, because of friction among themselves, possibly leave the site of whelping earlier than does a juvenile from a one-kit litter. The data gathered from live-trapping indicate that differences do occur, but whether or not litter size is the cause is unclear.

Evidence of den utilization increases after the young emerge. The vegetation becomes trampled, forming a clear area around the entrance. Scats are not so restricted to one spot, and the odor of rotting flesh is present at the den openings. Also, the uneaten remains of birds, mammals, and fishes litter the area around the entrances.

<u>Number of Young Raised Per Female</u>. -- The number of young each adult female raises to weaning is difficult to ascertain in wild mink populations. The number of active mammae per adult female possibly indicates the relative size of a litter, but assumptions regarding the number of active mammae used by one juvenile must be made. The terms <u>active</u>, and <u>enlarged</u>

Table 12. Condition of mammae of adult female mink live-trapped during three summers of live-trapping on the Huslia study area, Alaska

Mink	Date	Condition of mammae	Remarks
		1955	
2301-2302	June 30 August 3	8 active 8 active	Raised 3 young.
2303-2304	July 7	6 active	Probably killed by otter.
2307-2308	July 25	6 active	Injured in rabbit snare. Raised at least 1 young.
2309-2310	July 26	6 active	Den vacated early August.
2313-2314	July 31	4 showing wear; 2 enlarged	Two young captured at den site.
2315-2317	August 1	6 active	No information about number of young.
2325-2326	August 10	3 showing wear	Raised at least 2 young.
2331-2332	August 10	No data	No remarks.
2335-2336	August 11	No active mammae	Raised no young.
2364-2365	September 7	3 enlarged	No information about number of young raised.
		1956	
2379-2380	August 19	3 showing wear	No information about number young raised.
2392-2393	September 3	3 enlarged	Raised at least 2 young.
2408-2409	September 18	No active or enlarged	Raised no young.

Table 12. (Continued)

Mink	Date	Condition of mammae	Remarks
		1957	
2434-2436	September 21	2 enlarged	No information about number young raised.
2439-2440	September 23	2 enlarged	No information about number young raised.
No tags	August 30	3 enlarged	Died in trap.

mammae are used in this discussion. Active mammae are those lactating; enlarged mammae are those that were active for essentially the entire nursing period, i. e. from June to August, and as a result have larger nipples than do mammae not used during nursing. Table 12 contains the data on mammae.

Live-trapping rather conclusively demonstrated which females and young were associated with two successful dens, Dens 1 and 3 (Fig. 7). At Den 1, female 2313-2314 was captured on July 31 and August 19, 1955. The female had four active mammae when first captured, but only two were still enlarged when she was last captured (Table 12). At this den site only two young were captured, 2352-2353 and 2360-2361. Thus the number of young raised corresponded to the number of enlarged mammae present on August 19. On the other hand, at Den 3 female 2301-2302, captured five times, had eight active mammae as late as August 3. Intensive live-trapping about the den yielded only three juveniles, presumably all that were raised at that site. This female had a greater number of active mammae than young, but at a later date the two figures may be more in accord. Probably most or all of the mammae lactate at parturition, with a decrease in the number as nursing progresses, in part because of a restriction of nursing to certain mammae and in part because of a decrease in litter size through postnatal mortality. This decrease in number of active mammae as nursing progressed appeared regularly. Unfortunately, extensive data from individual females are lacking but a comparison of females caught during June and July with those caught after the first week in August illustrates this decrease (Table 12). Adult females having no enlarged mammae either lost their litter soon after parturition or were barren.

None of the females captured after August 9 had more than three enlarged mammae. Probably the postnursing number of enlarged mammae closely approximates the number of young weaned. Assuming that it does, two females raised three young each and one raised two young during 1955; two females raised three young each during 1956; and two females raised two young each during 1957. The average production for these animals is 2.6 young per female. This average is based only on females that raised young and does not include barren females. The live-trapping returns for 1955 tend to confirm the supposition; 10 adult females and 14 juveniles were captured, giving an average of 1.4 young per adult female. A consideration of all three seasons, however, results in an average of 2 juveniles per adult female.

Intensive live-trapping around dens furnished data on the number of juveniles raised per den, which is another measure of the number raised per adult female. At four den sites during the 1955 and 1956 live-trapping operations, the number of young per den was determined. At two of the den sites live-trap captures revealed which female utilized the den; female 2313-2314 occupied Den 1 and 2301-2302 Den 3. Definite association of females and dens at the other two sites was not possible. Female 2313-2314 has already been considered in regard to litter size, but her den is included nonetheless.

Dens 1, 3, and 7 during 1955 and Den 9 during 1956 harbored a known number of young (Fig. 7). At dens 3, 7, and 9, three young per den were produced, and at Den 1, two young were produced, giving an average of 2.8 young per den site. This figure approximates the figure of 2.6 young per adult female based on enlarged mammae counts.

The average of 2 young per adult female based on the three summers of live-trapping is slightly lower than the figure of 2.6 based on counts of enlarged mammae, or the figure of 2.8 based on live-trap catches around dens. The last two methods do not include all adult females, barren as well as productive, or all dens, successful and unsuccessful. If data were available on all females and all dens, the average number of young per adult female, or per den site, would probably approximate the figure of 2 based on the live-trapping data. This figure of 2 represents the young weaned per adult female.

The average of two young per adult female for the Huslia study area and the averages for ranch mink show surprising similarity. Large scale production on ranches may average 3.5 kits weaned per litter, but many never achieve this figure (Enders, 1952). Enders cites one rancher with 25 years experience who insists that over the years a ranch average of three kits per female is usual. Gunn (1949) gives 2 to 2.5 as the general average production of females. On the basis of these reports, production in the wild at times compares favorably with production on ranches.

Development of Young. -- Young mink in the wild cannot be observed until they emerge from the den at five or six weeks of age. By time of emergence they are already quite large. The first capture of any young occurred on August 7, 1955. The two young, both males, numbers 2321-2322 and 2323-2324, were captured together in a trap set by a scat pile about 10 feet from a den opening. The female attempted unsuccessfully to release the young by digging under the trap and tipping it over; this was the only instance of attempted rescue. After the young had been tagged, measured and released, the female moved the young to a new den.

The two juveniles has a behavior pattern typical of very young animals. They were not afraid and could be easily handled with bare hands, for they did not attempt to bite. Neither young emitted musk, but they both had a strong den odor of rotting flesh. Both young were quiet when handled, except for a short, high-pitched squeak uttered by 2321-2322. When released about 10 feet from the den entrance, the young were confused, not knowing in which direction to proceed. After a minute or two, one finally found the trail to the entrance and returned to the den. The other was easily caught by the author and deposited in the den entrance.

The behavior exhibited by these two young reveals that they are not cautious or afraid when first emerging from a den. At such a time the young would be vulnerable to predation, but no instances of predation were noted. However, a native in the area reported that during August a dog returned to camp on each of two consecutive nights carrying a small dead mink it presumably had killed.

The two juveniles were small and chubby and still retained their deciduous teeth when first captured on August 7. Juvenile 2321-2322 had a total length of 386 mm., a hind foot of 56 mm., and a weight of 15 oz. Juvenile 2323-2324 had a total length of 395 mm., a hind foot of 58 mm. and a weight of 16 oz. About a month later the total length had increased 140 mm., the hind foot length 12 mm., and the weight more than 8 ounces.

The measurements given above indicate that the young develop rapidly. Enders (1952), working with ranch mink, found that young grow very rapidly, with males exhibiting a more rapid growth than females. During the live-trapping period in 1955, repeated measurements of juveniles were made to determine their size changes. Table 13 contains the measurements. Tail measurements are not included in the table, for frequent recaptures of adult females revealed that the tail measurement is not reliable on live, squirming mink. For example, the tail length recorded for a juvenile male was 160 mm. on September 6 and 147 mm. on September 9, a 13 mm. decrease in three days. The hind foot measurement, checked repeatedly, was reliable, and the total length measurement showed only slight variation.

Juveniles grow rapidly until early September, as the size and weight changes of the two juveniles discussed above show. The rate of growth slows down perceptibly during early September, however. The hind foot growth of juvenile males 2343-2344 and 2358-2359 and juvenile female 2366-2367 serve as examples: from September 6 to September 9, 2343-2344 showed no increase, with only a two millimeter increase occurring for the 23-day period August 17 to September 9; 2358-2359 had a hind foot growth of one millimeter from September 5-10; and 2366-2367 showed a one millimeter increase for the four-day period September 7-11 (Table 13). This

Table 13. Size changes of some juvenile mink recaptured during the three summers of live-trapping on the Huslia study area Alaska

Tag number	Date	Weight (oz.)	Hind Foot (mm.)	Total length (mm.)
		Males		
2321-2322	8/7/55	15	59	386
	9/6/55	26	69	535
2323-2324	8/7/55	16	58	395
	9/8/55	24	69	540
2343-2344	8/17/55	21	63	470
	9/6/55	30	65	555
	9/9/55	28	65	555
2349-2350	8/19/55	21	69	485
	9/7/55	31	69	555
2352-2353	8/21/55	35	67	552
	9/7/55	40	72	572
2372-2373	9/14/55	35	76	650
	12/6/55[a]	38	76	655
2398-2399	9/10/56	34	71	566
	12/2/56[a]	27[b]	69[b]	588[b]
		Females		
2358-2359	9/5/55	26	59	527
	9/10/55	22	60	531
2366-2367	9/7/55	19	54	528
	9/11/55	17	55	530
2383-2384	8/23/56	20	64	503
	12/11/56[a]	18[b]	64[b]	537[b]

[a]Captured by native trappers during steel-trapping season.

[b]Measurements based on skinned carcass.

decrease in rate of growth concurs with Enders' (1952:719) findings that ranch kits grow rapidly for the first eight weeks and then more slowly thereafter. He further states that young ranch mink reach sub-adult size by the end of November. Sub-adult size is apparently attained slightly earlier in the Huslia area. The three tagged mink caught during steel-trapping seasons show very little change in hind foot length. Juvenile male 2372-2373, live-trapped September 14 and steel-trapped December 6, showed no change. Juvenile male 2398-2399, live-trapped September 10 and steel-trapped December 2, showed a two millimeter decrease, but the December 2 measurement was of a skinned instead of a whole carcass, probably accounting for the loss. Juvenile female 2383-2384, live-trapped on August 23 and steel-trapped on December 11, showed no change, but because the December 11 measurement was based on a skinned carcass, a one or two millimeter growth probably had occurred. Using hind foot length as the criterion of development, mink in the Huslia area reach essentially sub-adult size in late September.

The juvenile mink displayed various stages of tooth replacement. The incisors and canines were easily observed in live mink, but molariform teeth were not, unless the mink's mouth was opened wide and the lips pushed back, a procedure difficult to accomplish in the field with live mink. Consequently, observations on dental replacement were limited to the incisor and canine teeth.

The information on tooth replacement is less complete for incisors than for canines, but the pattern of replacement of lower versus upper incisors is fairly complete. The data on replacement are contained in Table 14.

Table 14. Data on replacement pattern of canine and incisor teeth in juvenile mink live-trapped on the Huslia study area, Alaska

Tag number	Sex	Date	Status of dentition
2321-2322	M	8/7/55	Milk dentition throughout.
2323-2324	M	8/7/55	Milk dentition throughout.
2343-2344	M	8/17/55	Milk canines present; permanent canines erupted.
		9/6/55	Permanent dentition complete; scars of shed milk canines not visible.
2349-2350	M	8/19/55	Milk and permanent upper canines present; permanent lower canines.
2352-2353	M	8/21/55	Permanent canines only; scars from milk canines obvious.
2374-2375	M	8/19/56	Milk and permanent canines present. Permanent canines only; no scars from shed milk canines.
2377-2378	F	8/19/56	Milk and permanent canines present; milk incisors.
2383-2384	F	8/23/56	Milk and permanent upper canines, lower permanent; permanent upper incisors, lower milk.
		8/26/56	Permanent canines only, scars from shed milk canines visible; incisors permanent.
		9/9/56	Permanent dentition complete; no scars visible.
2385-2386	M	8/26/56	Canines permanent; scars from shed milk canines visible.
2388-2389	M	8/31/56	Canines and incisors permanent; scars from milk canines visible.
2390-2391	F	9/1/56	Dentition permanent; scars from shed canines barely visible.

The replacement of deciduous incisors occurs during the latter part of August. Female 2377-2378 still had deciduous incisors on August 19, so that replacement had not yet started. Female 2383-2384 still retained the deciduous lower incisors on August 23, but the upper incisors were permanent. By August 26, this female had permanent lower incisors also. The data indicate that replacement of upper incisors occurs first, with all permanent incisors present by the end of August.

Canine tooth replacement apparently commences before August 17, as permanent canines had erupted in male 2343-2344 by that date. The permanent canines grow alongside the deciduous, and simultaneous presence of both permanent and deciduous canines was noted frequently. Some of the dates of this occurrence are as follows (Table 14): male 2374-2375 and female 2377-2378 had both sets on August 19; male 2349-2350 had both sets in the upper jaw but only permanents in the lower on August 19; and female 2383-2384 had both sets in the upper jaw, but only permanents in the lower jaw on August 23. Replacement occurs rapidly, for by August 26 female 2383-2384 had shed her deciduous upper canines also. As noted in Table 14, all records after September 1 show only permanent canines present.

The lower canines are replaced first, a pattern opposite to the one observed for incisors. Scars formed at the site of the deciduous canines persist for a few days, but probably for less than two weeks. For example, female 2383-2384 shed her deciduous upper canines during the period August 23-26 (Table 14), yet by September 6 no scars remained.

An interesting aspect of mink tooth replacement is the observation that in less than two weeks transition from deciduous to permanent canines occurs without even a temporary loss of effective canines which are essential for the survival of this carnivore.

Weight Changes of Adult Females During Nursing. -- Weight changes occur in adult females during the nursing period, which extends from mid-June to early August. Weights of the four adult females caught over a long enough period to provide sufficient data on weight changes are presented in Table 15. Weights decreased until early and mid-August, undoubtedly because of the strains of nursing and of securing fresh food for the young. The weight increases after mid-August reflect the decreased demands of the young, which are practically self-supporting by this time.

Coastal Southeastern Alaska

Breeding movements and den site locations are the two topics discussed in this section on coastal southeastern Alaska mink. (Data on the number of enlarged mammae per adult female, collected during the 1956-1957 trapping season were lost when fire destroyed the data sheets.)

Beginning of Breeding Movements. -- The movements of mink in coastal southeastern Alaska are presented in the section on movements as is evidence on the increased movements during early March. Numerous trappers also report increased mink movements at that time. This increase probably results from pre-mating restlessness.

Den Locations. -- Observations indicate that the more suitable areas for mink are rocky, fairly steep, but not bluffy, beaches. On such a

Table 15. Weight changes of lactating adult female mink live-trapped on the Huslia, Alaska Study Area during 1955.

Tag number	Date	Weight (ounces)	Remarks
2301-2302	June 30	33	Raised 3 young.
	July 24	30	
	Aug. 18	24	
2307-2308	July 25	26	Injured in a rabbit snare on August 2.
	Aug. 9	19	
	Aug. 12	20	Raised at least one young.
2313-2314	July 31	32	Raised two young.
	Aug. 19	28	
2315-2317	Aug. 1	28	Number of young raised now known.
	Aug. 11	27	
	Aug. 14	27	
	Aug. 18	27	
	Aug. 19	28	
	Sept. 9	29	
2325-2326	Aug. 10	22	Raised at least two young.
	Aug. 14	24	

beach food is uncovered at low tides close to protective shore areas, and the rocks furnish additional cover. Two such areas: 10 miles of beach at Louise Cove, Kuiu Island and 15 miles of beach at Whale Pass, Prince of Wales Island, produced a total catch of 317 mink--an average of 12 mink per mile of beach. A slightly sloping beach has an extensive area uncovered at low water (southeast Alaska tides of over 15 feet are common), leaving the feeding areas exposed for a considerable distance from protective cover along the shore. Consequently, mink populations are low along these beaches. At the other extreme, a bluffy beach offers very little available food even at low tides, so that here also populations are low.

The shore areas above the suitable beaches contain abundant den sites; crevices in rocks, rock piles and cavities under tree roots are utilized. The author located many such sites, two of which had served as natal dens. These two dens showed evidence of intensive use; abundant fecal deposits and well-worn trails were still present in October. These two dens occupied level, vegetated but rocky points that protruded into the narrow straits between two large islands. Both sites fell just within the vegetative cover of Sitka spruce, and each had three entrances, all three consisting of rock crevices at one site, and two consisting of rock crevices and one of a squirrel hole under spruce roots at the other. All three entrances at each site would fit within a six-foot circle. Mean high tides approached to within 10 feet laterally of the most seaward entrance at one site and within 6 feet at the other. Trails from the entrances led to the water's edge, and presumably, to the feeding areas in the intertidal zone.

LIVE-TRAPPING AND TAGGING WILD MINK

Only limited information about the effectiveness of live-trapping and tagging wild mink is available in the literature. The present study contributes data pertaining to the suitability of live-traps and tags.

Live-Trapping

Wire mesh, single door, live-traps manufactured by the National Live-trap Company were used. These traps are all-metal, light weight, collapsible and easily transported and handled. They have the following dimensions: length 19 inches, height 6 inches, width 6 inches and size of mesh approximately 1 inch. Mink usage governed trap placement; known mink dens, muskrat runways, abandoned beaver houses, game trails, and the shores of ponds, sloughs, lakes and streams, received most attention. After placement, the traps were concealed with the vegetation and debris at hand, for experimentation indicated that traps concealed so as to blend with their surroundings were more successful than traps less carefully prepared.

A discussion of the baits used in the traps appears in the Food Habits section.

Live-Trapping as a Capturing Method. -- The intensive live-trapping operations during the present study furnish an excellent basis for evaluating the effectiveness of live-traps. Traps were set for a total of 3,595 trap nights, 3,376 in interior Alaska and 219 in southeastern Alaska. In the process 59 mink were captured 135 times, 133 captures of 57 mink being in interior Alaska and 2 captures of 2 mink occurring in southeastern Alaska (Table 16). The number of trap nights per capture and the number of trap nights per individual mink caught are 27 and 61 respectively. A comparison with the results of two other mink live-trapping studies is revealing. McCabe (op. cit.), working in Wisconsin, used wooden live-traps modified with metal doors after the first year of live-trapping. During the first year of live-trapping, 1,070 trap nights produced a catch of 17 mink, or 63 trap nights per individual, a figure quite comparable to the 61 recorded during the present study. Trapping success decreased during the next three years, however, and the reason for the decrease was described by McCabe as follows (p. 421):

> The prime cause of failure in subsequent years I believe to be attributed to the galvanized metal door on traps. While we had a mechanically perfect trap, there was apparently added to it a feature that repelled mink. Many traps containing the choicest of baits and located in the best of sites were by-passed day after day. The aversion of mink for metal is well known among fur trappers. For lack of time we have never been able to verify this with our part metal traps.

Metal traps identical with the traps used in the present study were apparently used with success by Ritcey and Edwards (op. cit.) in British Columbia, however. Their live-trapping, conducted after July with fresh baits, produced a total of 93 captures of 31 mink during 556 trap nights. This gives a ratio of 6 trap nights per capture and 18 trap nights per individual mink caught. These ratios are considerably smaller than McCabe's, or those of the present study, but many variables make direct comparison impossible. Nevertheless, the data reveal that the aversion of mink for metal, if such aversion exists, is not so great as to make metal traps useless.

Table 16. Data on trap nights and success ratios during the live-trapping operations on the Huslia, and the Petersburg-Wrangell, Alaska Study Areas.

Item	Huslia study area 1955	1956	1957	Total	Petersburg-Wrangell 10/16-11/11, 1957	Totals Both Areas
Trap nights	1497	801	1078	3376	219	3539
Mink captured	25	18	14	57	2	59
Total captures*	71	42	20	133	2	135
Trap nights per mink	60	44	77	59	110	61
Trap nights per captures*	21	19	54	25	110	27

* Includes initial captures plus recaptures

Live-trapping operations in interior Alaska during 1955 commenced on June 26, nearly two months earlier than in the succeeding two years. One feature was readily apparent during late June and early July; adult female mink repeatedly by-passed the traps without entering. Even traps placed near an occupied den were by-passed daily by the female using that den. That condition did not exist during late July and August. In general, capturing adult females is difficult during June and early July, but by late July and August, when the nursing demands of the young decrease, the adult females readily enter traps.

The live-traps in the Huslia study area captured over four times more adult females than they did adult males (Table 17). Females probably are more numerous than males, but it is doubtful that they are four times more numerous. Recapture data, although very limited, shed some light on this difference in captures of males and females. Adult females were captured an average of 2.3 times and adult males 1.3 times. These data imply that adult females are more easily captured than are adult males.

Comparison of the live-trapping data for juveniles and adults furnishes information on the ease of capture of these two age groups. In Table 17 the data for 1955 are included for only the period August 15-September 9, making the data more nearly comparable for the three years. The inclusion of data collected prior to August 15 would bias the findings, for juveniles are still either in the den or moving only short distances from it, and are not available for trapping. Thus, only information collected after the young are moving greater distances from the den can

Table 17. Capture and recapture data of mink sex and age groups during the three summers of live-trapping on the Huslia Study Area, Alaska

Sex and age group	Total	1955 Entire Period	1955 Aug. 15 Sept. 9*	1956	1957
Total catch					
Initial capture	57	25	20	18	14
Recaptures	76	46	28	24	6
Adult males					
Initial capture	4	1	1	2	1
Recaptures	1	1	1	0	0
Adult females					
Initial capture	18	10	5	4	4
Recaptures	24	20	4	4	0
Juv. males					
Initial capture	20	6	6	7	7
Recaptures	32	14	12	12	6
Juv. females					
Initial capture	15	8	8	5	2
Recaptures	19	11	11	8	0

*Captures prior to August 15 are ignored in this column, so the first capture of a mink after August 15 is considered the initial capture.

be used. If that information is used, the number of captures per individual are 2.5 and 1.5 for juveniles and adults respectively. The number of captures per juvenile is 67 per cent higher than the figure for adults, indicating that juveniles enter a trap more readily than do adults.

Trap Mortality. -- Twelve mink, nine juveniles and three adults, died in live-traps during the trapping operations. Rainy weather, with air temperatures colder than 55°F., caused the most mortality, accounting for eight deaths, six on the Huslia study area and two in southeastern Alaska. Rain, seeping through the vegetation covering a trap, penetrates the ruffled fur of a mink fighting the trap, destroying the insulating properties of the fur and chilling the mink. Heavy fog can also be detrimental. An adult female died in a trap placed in a well-protected site under a log in southeastern Alaska. Clear weather and temperatures warmer than 45°F. prevailed during the night of capture, but heavy fog during the morning hours thoroughly chilled the mink. Death resulted. Exposure is the term applied to this type of mortality.

Covering a trap with vegetation or birch bark (often dislodged when a mink fights the trap) or placing the trap under an overhanging bank helps somewhat, but wind blows some mist and rain into the traps. High humidity accompanying the rain contributes to the chilling, and often a mink urinates in the trap, dampening the inside of the trap as well as itself.

A mink can withstand only a few hours of chilling. A large adult female captured on August 30, 1957, entered a live-trap during the night and remained in the trap until noon. The air temperature remained near 50°F. all night, increasing slightly during the day. No rain fell until 0600, at which time light showers commenced and continued throughout the morning. The trap was checked at noon, six hours after the rain started, and by that time the thoroughly dampened female was beyond recovery, lying immobile in the trap and exhibiting difficulty in breathing. The animal died one hour later despite all efforts to dry and warm it. The author attempted to save other mink suffering from exposure, but after a certain level of exposure is reached, recovery seems impossible. Paralysis of the hind quarters occurs first, and a general slowing of all reactions appears. Gradually the entire animal becomes paralyzed, and death ensues.

All the skulls from mink killed by exposure show broken upper canine teeth. Apparently the mink fight frenziedly to escape after becoming chilled, biting the trap with such vigor that the canines are broken at the gum line. Such fighting undoubtedly weakens the animals and contributes to their death.

Other causes also produced mortality. A juvenile male, 2430-2431, found dead in a live-trap on September 26, 1957, died during a night of clear, 0°F. weather. The mink, lying in a tight curl and frozen solid when found, was dry and fat. No grass for a nest was available in the trap, so the mink had no protection from the cold. Severe cold probably killed it.

Another juvenile male died in a live-trap on August 28, 1957, during dry weather and temperatures warmer than 55°F. When found, the mink was dry, but had a large wad of grass lodged in its throat. This trap was last checked at 0900, August 27. The mink was found dead at 1630, August 28, over 30 hours later. Possibly, the mink entered the trap early in the evening on August 27, thus spending many hours in the trap without water. After becoming dehydrated (the first thing many mink do after being released from a trap is drink from the nearest available water), the mink probably ate the wet grass lining the bottom of the trap, eventually choking on a large mass of vegetation. Autopsy revealed no other cause of death.

One other mink, juvenile male 2400-2401, died in a live-trap. This male died from drowning when the trap he entered slipped into two feet of water.

The only extensive mortality factor in live-trapping is exposure. Such mortality could be reduced by using larger live-traps, thus permitting placement of copious quantities of grass inside a trap, by not trapping during rainy periods, and by using a trap having a waterproof cover that extends part way down the sides.

Tagging

National Band and Tag Company size No. 1, style 1005, strap tags were used to tag all live-trapped mink. A tag was placed in each ear, generally in the postero-ventral region. The tags were embedded as deeply in the ear as possible, but not so deep as to crimp the outer edge of the ear.

Five tag losses were recorded on 28 recaptured mink, and all occurred during the first summer of live-trapping. Some of the losses are attributable to improper placement of tags; other losses probably were caused by the violent trap fighting of mink. Three tagged animals were captured three months after tagging, during steel-trapping seasons, and all three had intact tags. An adult female live-trapped during 1957 had a slit in one ear, possibly caused by a lost tag, but the other ear was normal. Perhaps a torn ear can heal completely, leaving no evidence of a lost tag. This factor could partly account for the lack of tagged mink recaptures during succeeding years. For investigations of three to four months duration, however, the tags have proved satisfactory.

STEEL-TRAPPING METHODS, PRESSURES AND EFFECTS

Knowledge of the steel-trapping methods, pressures and effects, which differ greatly from area to area, is essential in managing a population of fur-bearers.

Huslia Study Area

The trapping methods employed by the natives in the Huslia area show little change from year to year. Long spring, steel-traps, No. 1-1/2, are used almost exclusively, and are not baited. Typical sites trapped are abandoned beaver houses, exposed muskrat runs, entrances to mink dens, holes under tree roots and in banks, and cracks and holes in collapsed ice leading into sushintzi. Abandoned beaver houses receive the most attention, however. Seemingly choice sites such as sushintzi are seldom trapped.

Dog drawn sleds transport the trappers over the trapline. As a result, traplines are quite stable, for the sled trails are seldom changed. Ponds, sloughs and streams on the trails thus receive more trapping attention than those more removed. Generally, however, sled trails extensively cover an area and miss few localities. Most traplines are checked every second or third day, but some are checked scarcely once a week.

Trapping Pressures. -- The primary method of controlling trapping pressure is through trapping season regulation. The trapping seasons from 1940-1941 through 1956-1957 applicable to the Huslia study area are listed in Table 18.

Table 18. Mink trapping season regulations pertinent to the Huslia Study Area and the Petersburg-Wrangell Area (from Alaska Game Commission Regulatory Announcements)

	Huslia Study Area		Petersburg-Wrangell Area	
Year	Season	Days	Season	Days
1940-41	11/16-2/20	97	Closed	0
1941-42	" "	97	12/10-1/10	32
1942-43	11/16-2/28	105	" "	32
1943-44	11/16-2/29	106	1/6 - 2/5	30
1944-45	11/1-1/31	92	Closed	0
1945-46	11/16-2/28	105	12/16-1/15	31
1946-47	" "	105	Closed	0
1947-48	11/16-1/31	77	12/16-1/15	31
1948-49	" "	77	Closed	0
1949-50	12/1-3/15	106	12/16-1/15	31
1950-51	11/16-1/31	77	Closed	0
1951-52	" "	77	12/16-1/15	31
1952-53	" "	77	12/20-1/24	36
1953-54	" "	77	Closed	0
1954-55	" "	77	12/20-1/20	32
1955-56	" "	77	Closed	0
1956-57	" "	77	12/15-1/20	37

The natives during recent years have worked during the summer months on construction or mining projects, often earning enough money to support themselves throughout the year. Consequently, the emphasis and dependence on trapping has decreased, and often only cursory trapping occurs. Hence, abundant summer employment means reduced trapping pressures. Also, most emphasis is placed on catching the fur-bearer netting the highest returns, resulting in decreased trapping pressure on mink during years of low mink prices.

Climatic conditions influence trapping pressures. During periods of deep snow dog sled travel, the primary means of travel during the winter months, becomes slow and laborious because the trails must be opened for the teams. Temperatures of -40°F. and colder make travel dangerous and difficult. These restrictions on travel result in smaller, less frequently checked, traplines. Hence, winters of deep snow and low temperatures result in lower trapping pressures.

Trapping Effects. -- Trapping success varies markedly from one year to the next. The 1954-1955 season was the most successful season in recent years, according to natives in Huslia. About 700 pelts were purchased that year by the two traders in the village. One of the largest catches was of 98 mink by a trapper covering 30-40 miles of trapline. This trapline followed a small river closely, so the catch per mile of trapline, or river, was essentially three. Thus even during a successful season, the most successful trapper has a rather low catch per unit area.

The last two seasons, in 1955-1956 and 1956-1957, produced only small catches. The number of pelts purchased by both traders was fewer than 100 for each season. The trapper mentioned above caught approximately 20 and 10 mink during the 1955-1956 and 1956-1957 seasons, respectively. These catches averaged less than one mink per mile of trapline.

The two natives trapping the study area and the area immediately adjacent to it, caught over 50 mink during the 1954-1955 season. This catch was one of their largest, yet both trappers reported abundant mink sign still present after the season. During the next summer's live-trapping operation, 11 adult mink were captured on the study area, which totalled less than a quarter the size of the area steel-trapped by the two natives. These two observations reveal that a large breeding population remained.

The percentage of tagged animals captured during the steel-trapping seasons sheds some light on the effects of the trapping seasons. Only 1 of the 21 mink tagged during 1955, and alive after the live-trapping operations ceased, and 2 of the 15 tagged during 1956, were recaptured during the steel-trapping seasons. The percentages of recaptures, 5 and 13 per cent for 1955 and 1956 respectively, are very low and indicate that steel-trapping does not take a heavy toll of the population. The author doubts that steel-trapping has any appreciable effects on the population.

Coastal Southeastern Alaska

The climate and physiography of coastal southeastern Alaska require trapping methods that are notably different from those in interior Alaska. The trapping pressures and effects in coastal southeastern Alaska are also quite different.

Trapping Methods. -- The majority of the trapping parties, generally consisting of two or three individuals, utilize a fishing (troll) boat for quarters during the trapping season. The fishing boat is secured in a suitable anchorage near the trapping grounds, and a skiff is subsequently used to check the trapline. Areas that do not have suitable anchorages or that have beaches subjected to heavy winds and seas are not heavily trapped, but the suitable areas are, often with one party trapping 10 to 15 miles of beach.

Both baited and nonbaited sets are used. The baited sets, placed in a small "cubby" built of either rock or wood, are located near the high tide mark or at the edge of the vegetation cover. Frozen herring, probably *Clupea harengus pallasi* Vallenciennes, is the most common bait, but clams and birds are also used. The nonbait sets are normally located in the mink trails at the edge of the vegetation cover. About 100 to 150 size No. 1-1/2, long spring, steel-traps are set by each party.

Trapping Pressures. -- The trapping seasons for coastal southeastern Alaska have changed frequently. Table 18 lists the 1940-1941 through 1956-1957 seasons.

A profitable commercial fishing season coupled with low mink fur prices undoubtedly decreases the number of mink trappers and reduced trapping pressures result. Conversely, an unprofitable fishing season and high fur prices stimulate trappers and increased trapping pressures ensue. However, many individuals trap regardless of the fur prices, tending to stabilize the trapping effort.

Climatic factors essentially do not effect the trapping pressures. Heavy snows and winds often hinder trapping efforts, but prolonged curtailment of trapping does not result.

Large catches are common in coastal southeastern Alaska. Figure 4 illustrates some of the catches per area. In the section on Population Density a few catches per area are listed. The catch per mile of beach, however, is probably the best index of success, with catches of 15 mink per mile of beach on record.

Trapping Effects. -- The large mink harvest greatly reduces the size of the mink population. However, one reproductive season replaces much of the loss. During the 1956-1957 season, which followed a closed season, 247 mink carcasses were collected from trappers, and sex and age ratios were determined. The data are presented in the section on Population Composition and Density. Suffice to say, the data indicate low production during 1956, yet large populations were present during the trapping season that fall. Therefore, high production must have occurred during 1955, possibly creating such high densities that reduced production resulted in 1956. Other factors may have been influencing production during 1956, however, and further investigations are needed to reveal the true relationship of trapping pressures and population size.

MANAGEMENT

A sound management program is flexible, changing as the various "indicators" in a population or habitat dictate. It presupposes a knowledge of the biology and ecology of the species, and particularly the specific population being managed. The reproductive potential and realized production, mortality factors and effects, habitat peculiarities and changes, population composition, inter- and intra-specific relationships, and life history data form only a fraction of the information needed to establish a biological basis for management.

A program must be practical in addition to being biologically sound. It must fit, insofar as possible, the needs and preferences of the people as well as the dictates of the species managed, for an impractical program can seriously decrease the esthetic and economic returns from a wild population. In mink management, economic returns greatly influence the management program.

Dissimilar Populations

The two populations of mink studied differ greatly. The habitats they occupy are very dissimilar. The Huslia area is an inland area dotted with small bodies of water and subjected to a continental type of climate; the coastal southeastern Alaska section consists of marine beaches and a moderate marine type of climate. The population levels also differ greatly. The Huslia area has mink densities of about 2.2 mink per square mile during a below average year; the coastal southeastern Alaska area has densities of 20 mink per mile of beach during a year following a closed trapping season. Large food differences exist for the two areas. In the Huslia area, food levels fluctuate greatly; in coastal southeastern Alaska, food levels are high and stable. The trapping pressures also vary. The trapping pressures on the Huslia area are much lower than those for coastal southeastern Alaska, and consequently, the effects differ. These differences illustrate the dissimilarity of the two populations and preclude the use of identical management programs for the two areas.

Management Recommendations

Environmental manipulation is seldom economically feasible, especially for populations managed solely for economic returns. Thus regulation of trapping pressures serves as the primary management tool.

Huslia Area. -- The present trapping pressures are not limiting the population; the food levels appear to cause the fluctuations. If mortality from other factors limits the population, then the trapping pressures should be arranged so as to harvest the surplus normally removed by other factors. Commencing the harvest as soon as feasible after the reproductive season decreases the time period during which the other mortality factors are operative, thus ensuring that most of the surplus is removed through human harvest.

Mink trapping efforts in the Huslia area are hindered by deep snow and extreme cold, with the peaks of severity for low temperatures and for snow depths being December and February-March respectively. Therefore, initiating trapping at the earliest possible date is advisable, for maximum trapping effort is thus possible during favorable weather.

Conditions of fur limit the season, however; attainment of pelt primeness should govern the starting date and loss of primeness the closing date. At present, the starting date for the Huslia area is November 16. Investigations should be initiated to determine the date of primeness, with trapping commencing slightly prior to complete pelt primeness. In this manner the largest economic returns would be gained, for an increased harvest would offset the reduced price of the slightly unprime pelts. The season should remain open until the fur loses its primeness, as it does during January according to local fur buyers.

Coastal Southeastern Alaska. -- The management problem in coastal southeastern Alaska involves regulation of trapping pressures. The trapping methods and pressures in this area are very effective, undoubtedly capable of greatly reducing the mink population. A recent result has been the closing of mink seasons in alternate years. The data gathered to date indicate that the population increases greatly the first productive season following a trapping season. It perhaps does not reach the population level present after two breeding seasons and no open season, but possibly rises to such a level that reduced production results the second year. Therefore, from a total production standpoint, a season each year seems advisable. Another consideration, however, is the outfitting expense of the trappers versus the trapping returns. The cost of outfitting remains the same each year regardless of a yearly or an alternate-year season, yet the yearly returns presumably would be smaller with yearly seasons. Possibly the net returns would be larger if trapping were allowed every other year, for the outfitting expenses would only be half as large.

Other information is also needed for a sound management program including the reproductive rates at different population levels, the extent and rate of repopulation of locally depleted areas and the extent of such areas, the actual carrying capacity of the beaches, and pre- and post-season mink population densities. The fact that only limited knowledge exists about the mink of coastal southeastern Alaska is readily apparent.

LITERATURE CITED

American Ornithologists' Union. 1957. Check-list of North American birds. 5th Edition. Baltimore: American Ornithologists' Union. 691 pp.

Anderson, J. P. 1943-1952. Flora of Alaska and adjacent parts of Canada. Parts I-IX. Iowa State College Jour. Sci.

Bee, J. W. and E. R. Hall. 1956. Mammals of northern Alaska: on the Arctic slope. Univ. of Kansas Mus. of Nat. History, Lawrence. 309 pp.

Buckley, J. L. 1953. Preliminary report of muskrat investigations in Alaska. Unpublished report in Alaska Cooperative Wildlife Research Unit, Quarterly Report, 5(2): 5-18.

____________. 1954. Animal population fluctuations in Alaska - a history. N. Amer. Wildl. Conf. Trans., 19:338-354.

____________. 1957. Wildlife in the economy of Alaska. Biological papers of the University of Alaska. Number 1 (Revised). 33 pp.

Burt, W. H. 1943. Territoriality and home range concept as applied to mammals. Jour. Mamm., 24(3): 346-351.

Dice, L. R. 1931. Methods of indicating the abundance of mammals. Jour. Mamm., 12(4): 376-381.

Eddy, S. and T. Surber. 1943. Northern fishes. The Univ. of Minn. Press, Minneapolis. 276 pp.

Elder, W. H. 1951. The bacculum as an age criterion in mink. Jour. Mamm., 32(1): 43-50.

Enders, R. K. 1952. Reproduction in the mink. (Mustela vision). Proc. of the Amer. Philosophical Soc., 96(6): 691-755.

Errington, P. L. 1943. An analysis of mink predation upon muskrats in north-central United States. Iowa Agr. Expt. Sta. Res. Bull. 320: 798-924.

Greer, K. R. 1956. Mink age and sex ratios. Comp. Rpt. Fur Res. Survey and Invest., May 1, 1955-April 30, 1956. Mont. Fish and Game Comm. 80 pp.

Gunn, C. K. 1949. Mink ranching. Canadian Dept. Agri. Tech. Bull. 74: 1-60.

Hamilton, W. J. Jr. 1936. Food habits of the mink in New York. Jour. Mamm., 17(2): 169.

_______________. 1940. The summer food of minks and racoons on the Montezuma marsh, New York. J. Wildl. Mgmt., 4(1): 80-84.

Hayne, D. W. 1949(a). Calculation of size of home range. Jour. Mamm., 30(1): 1-18.

________. 1949(b). Two methods for estimating population from trapping records. Jour. Mamm., 30(4): 399-411.

Hibbard, E. A. 1957. Age ratios in wild mink populations. Jour. Mamm., 38(3): 412-413.

Hulten, E. 1941-1950. Flora of Alaska and Yukon. Parts 1-10. Lunds Atskrift N.F. Avd. 2.

Lechleitner, R. R. 1954. Age criteria in mink, <u>Mustela</u> <u>vision</u>. Jour. Mamm., 35: 496-503.

Lincoln, F. C. 1930. Calculating waterfowl abundance on the basis of banding returns. U. S. Dept. Agric. Circular. 118: 1-4.

MacLennan, J.M., translator. 1957. Translations of Russian game reports. Vol. 1. (Beaver, 1951-55). Can. Wildl. Serv., Ottawa. 109 pp.

Marshall, W. H. 1936. A study of the winter activities of the mink. Jour. Mamm., 17(4): 382-392.

McCabe, R. A. 1949. Notes on live-trapping mink. Jour. Mamm., 30(4): 416-423.

Miller, G. S. Jr. and R. Kellogg. 1955. List of North American recent mammals. U. S. Nat. Mus. Bull. 205. 954 pp.

Murie, A. 1936. Following fox trails. Univ. of Michigan Press, Ann Arbor. 45 pp.

Palmer, L. J. 1942. Major vegetative types of southeastern Alaska. USFWS, U. S. Dept. of Interior, Juneau, Alaska. 16 pp. Processed.

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

Petrides, G. A. 1950. The determination of sex and age ratios in fur animals. Amer. Midl. Nat., 43(2): 355-382.

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

Rand, A. L. 1945. Mammals of Yukon. National Mus. of Canada. Bull. 100. 93 pp.

Rausch, R. 150. Observation on a cyclic decline of lemmings (Lemmus) on the Arctic coast of Alaska during the spring of 1949. Arctic, 3(3): 166-177.

Ritcey, R. W. and R. Y. Edwards. 1956. Live-trapping mink in British Columbia. Jour. Mamm., 37(1): 114-116.

Sealander, J. A. 1943. Winter food habits of mink in southern Michigan. J. Wildl. Mgmt., 7(4): 411-417.

Simpson, G. G. 1945. The principles of classification and a classification of mammals. Bull. Amer. Mus. of Nat. Hist. Vol. 85. 350 pp.

Sowls, L. K. 1955. Prairie ducks; a study of their behavior, ecology, and management. Stackpole Co., Harrisburg, Pa. 193 pp.

Wilson, K. A. 1954. The role of mink and otter as muskrat predators in northeastern North Carolina. J. Wild. Mgmt., 18(2): 199-207.

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