Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report
1 July 1997 – 30 June 1998

FURBEARER MANAGEMENT TECHNIQUE DEVELOPMENT

Howard N. Golden

Schumacher Marten

Job 1 — Distribution and Trend of Marten, Lynx, and Snowshoe Hare Populations

Job 2 — Densities, Trend, and Harvest Potential of Wolverine Populations

Job 3 — Distribution, Trend, Habitat Use, and Harvest Potential of Coastal River Otter Populations

Applying the Lynx Tracking Harvest Strategy through Rule-Based Modeling

Grant W–27–1
Study 7.18
August 1998

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This is a progress report on continuing research. Information may be refined at a later date.

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

RESEARCH PROGRESS REPORT

STATE:	Alaska	**Study:** 7.18

COOPERATORS: Merav Ben-David, Pamela Groves, R. Terry Bowyer, and Gail Blundell, University of Alaska, Fairbanks; Earl Becker, Alaska Department of Fish and Game

GRANT: W–27–1

STUDY TITLE: Furbearer Management Technique Development

JOB TITLES:

1. Distribution and Trend of Marten, Lynx, and Snowshoe Hare Populations
2. Densities, Trend, and Harvest Potential of Wolverine Populations
3. Distribution, Trend, Habitat Use, and Harvest Potential of Coastal River Otter Populations
4. Applying The Lynx Tracking Harvest Strategy through Rule-Based Modeling

PERIOD: 1 July 1997–30 June 1998

SUMMARY

Each of the 4 jobs in this comprehensive study represents a separate research project to address the development of furbearer management techniques in Southcentral Alaska.

Job 1. We developed a plan to establish aerial transects through a Visual C++ program to count tracks in snow of lynx, marten, and snowshoe hares. This program will be a modification of another program developed for moose surveys. We will design the program to establish a set of systematically placed 3- to 5-km-long linear transects across a variety of terrain and vegetation types. Transect endpoints will be GPS coordinates that will allow aircraft pilots to follow a transect course. We will develop the software during autumn 1998 and test it during winter 1998–99.

Job 2. Snow and weather conditions were unsuitable for capturing new wolverines, conducting tests of the sample-unit probability estimator (SUPE), or conducting population density estimates. We again modified our plans to test the accuracy of the SUPE in estimating wolverine density and made progress in updating location data from radiotelemetry observations to enable movements and home range analysis. In addition, survival data were recalculated after a trapper killed the remaining radiocollared wolverine in January 1998. Of the 22 wolverines captured in this study, none is currently radiocollared (Table 2.1). We know of 11 study animals that have died. Harvest by hunters or trappers accounted for the loss of 9 animals, 7 within and 2 outside the Talkeetna Mountains study area. Mean ages of wolverines at capture were 1.6 years for females (s = 0.7 year) and 2.2 years for males (s = 1.1 years). Mean ages when animals were lost or died were 2.8 years for females (s = 1.5 years) and 2.6 years for males (s = 1.5 years). The oldest wolverines were a 5.5-year-old female (TF1) and a 5-year-old male (TM5). Home range sizes varied widely, 172–739 km^2 for females and 53–

662 km^2 for males, but ranges of males ($\bar{x}$ =486 km^2, s = 228 km^2) were not significantly larger than those of females ($\bar{x}$ = 417 km^2, s = 208 km^2) (t = 0.564, P = 0.584, df = 11). We observed both sexes mainly in the foothills and lower- to mid-elevation slopes (760–1770 m) between the crest of the Talkeetna Mountains to the west and the lake flats of the Nelchina Basin to the east. Survival rates of radiocollared yearling and adult wolverines in the Talkeetna Mountains averaged 0.71 annually (s = 0.26) and 0.85 semiannually (s = 0.21). Survival was not significantly higher in summer (Apr–Sep) ($\bar{x}$ = 0.94, s = 0.13) than in winter (Oct–Mar) ($\bar{x}$ = 0.75, s = 0.25) (t = 1.386, P = 0.238, df = 4) when wolverines were most susceptible to harvest from trapping. The 95% confidence intervals on the survival rates were large, ranging between 0.09 and 0.31 (± 60–92%) and averaging 0.16 (s = 0.07).

Job 3. We assessed the habitat of 58 latrine sites and 293 random sites along approximately 107 km of shoreline between Sadie Cove and Kasitsna Bay on the south side of Kachemak Bay. Summary statistics indicated latrine sites had more shallow vegetated slopes and more bedrock in the intertidal substrate than random sites. Stepwise logistic regression analysis is underway to determine river otter use of the available shoreline habitat sampled in Kachemak Bay. We found 83% of all latrine sites were in Tutka Bay, and 75% of those were located in the upper half (SE end) of the bay. We found only 2 latrine sites in Sadie Cove, 1 in Kasitsna Bay, and none in Little Tutka Bay, which lies between Tutka Bay and Kasitsna Bay. We monitored the movements of 4 radiomarked otters by boat and airplane, accumulating 137 locations (range 23–44) for the 2 females and 2 males. The 2 female river otters (F1 and F2) seemed to restrict their movements to Tutka Bay. We found 1 male, M2, outside Tutka Bay only once, but the other male, M1, was found in Sadie Cove or in Kasitsna and Jakolof Bays on several occasions. For DNA and food habits analysis, we used 157 scats, all ≤ 3 days old, collected among 23 latrine sites during 5 sample periods in summer 1996. We are collaborating with researchers at the University of Alaska Fairbanks to analyze river otter scat for DNA microsatellites to estimate river otter density and use of latrine sites by individual animals. Pacific Identifications in British Columbia is analyzing river otter diet from the remains of food items in the scat.

Job 4. I prepared a user guide to installing and running the model, LynxTrak, and distributed a runtime version of the model to potential users. The model and guide are under review.

***Key words*:** Density estimation, DNA microsatellite, expert system, food habits, *Gulo gulo*, habitat use, harvest, latrine site, *Lepus americanus*, line-intercept sampling, *Lutra canadensis*, lynx, *Lynx canadensis*, marten, *Martes americana*, movements, quadrat sampling, relative abundance, river otter, rule-based model, sample unit probability estimator, snowshoe hare, survival, wolverine.

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STUDY BACKGROUND

This is the third progress report in a comprehensive program to develop furbearer management techniques by (1) evaluating the scope of species-specific management problems, (2) designing methods to address specific management needs, (3) testing the reliability and usefulness of those methods, (4) refining methods where necessary, and (5) facilitating the implementation of suitable techniques. This research study currently encompasses 4 projects, or jobs, that represent furbearer management issues of concern in Southcentral Alaska. The goals of these 4 jobs are as follows:

1. Develop ground and aerial techniques for counting tracks in winter to monitor the distribution and trend of marten (*Martes americana*), lynx (*Lynx canadensis*), and snowshoe hare (*Lepus americanus*) populations in Southcentral Alaska.

2. Assess the accuracy of density estimation techniques and develop techniques to monitor the trend and harvest potential of wolverine (*Gulo gulo*) populations in Southcentral Alaska.

3. Develop techniques to index river otter (*Lutra canadensis*) populations, determine the availability and use of their habitat, and assess their harvest potential in coastal environments of Southcentral Alaska.

4. Develop a rule-based lynx management model to use in the lynx-tracking harvest strategy.

JOB 1 — DISTRIBUTION AND TREND OF MARTEN, LYNX, AND SNOWSHOE HARE POPULATIONS

During this reporting period, we developed a plan to establish aerial transects through a Visual C++ program to count tracks in snow of lynx, marten, and snowshoe hares. This program will be a modification of another program developed for moose surveys (W. Testa, TRACK1 program for aerial radio tracking, Alaska Department of Fish and Game, unpublished report). We will use a Windows CE platform on a HP620LX palmtop computer to run the aerial transect program. We will design the program to establish a set of systematically placed 3- to 5-km-long linear transects across a variety of terrain and vegetation types. Transect endpoints will be GPS coordinates that will allow aircraft pilots to follow a transect course more easily than flying between geographic features as described by Golden (1987, 1988). We will develop the software during autumn 1998 and test it during winter 1998–99.

JOB 2 — DENSITIES, TREND, AND HARVEST POTENTIAL OF WOLVERINE POPULATIONS

Golden et al. (1993*a,b*) and Golden (1996) provided background for this project. Work was planned for Jobs 2.1 and 2.2 but snow and weather conditions were unsuitable for capturing new wolverines, conducting tests of the sample-unit probability estimator (SUPE) (Becker

1991, Golden 1997, Becker et al. 1998), or conducting population density estimates. We made progress during this report period in updating location data from radiotelemetry observations to enable movements and home range analysis. In addition, we recalculated survival after a trapper killed the remaining radiocollared wolverine in January 1998.

OBJECTIVES

2.1 To assess the accuracy and relative precision of wolverine density estimates derived from line-intercept and quadrat sampling techniques.

2.2 To estimate the densities and trends of wolverine populations in different areas of Southcentral Alaska.

2.3 To determine if relationships exist between trends in wolverine density and trends in wolverine harvest, food availability, and abundance of large predators.

2.4 To estimate sustainable harvest levels of wolverine populations in Southcentral Alaska.

STUDY AREAS

The primary area is the eastern Talkeetna Mountains, which lie between the Chugach Mountains and Alaska Range and form the western Nelchina River basin. A description of this area is presented in Golden (1996). Study areas in the Kenai Mountains and Wrangell Mountains are described in Golden et al. (1993*a*,*b*).

METHODS

Job 2.1. Tests of Wolverine Density-Estimation Techniques

We did not conduct tests of the density estimation technique this year due to unfavorable snow and weather conditions.

Job 2.2. Wolverine Density and Trend Counts

We did not conduct density and trend counts this year because (1) they were of secondary priority to testing the density estimation technique and (2) snow and weather conditions were unfavorable in the primary count areas adjacent to the Talkeetna Mountains study area.

Job 2.3. Wolverine Harvest and Habitat Relationships

We updated the ArcInfo database to analyze movements and habitat associations of radiocollared wolverines in ArcView. We measured home range sizes from pooled observations of wolverines with at least 10 locations. We calculated 95% minimum convex polygons (MCP) after removing obvious outliers through an animal movement extension for the GIS program ArcView (Hooge and Eichenlaub 1997).

Job 2.4. Wolverine Population Model

We updated the estimated survival of radiocollared yearlings and adults using the Kaplan–Meier procedure modified for staggered entry of additional animals (Pollock et al. 1989). This procedure accounted for animals that were lost due to dispersal or to radiotransmitter failure and allowed for the addition of newly marked animals. We estimated survival rates for 6-month periods beginning in April 1992 and extending for 6 years to March 1998. We also calculated mean annual survival and mean survival for summer (April–September) and winter (October–March).

RESULTS

Job 2.1. Tests of Wolverine Density-Estimation Techniques

There were no results to report for this job due to unfavorable snow and weather conditions. Plans for modifying test procedures are described in the Discussion section.

Job 2.3. Wolverine Harvest and Habitat Relationships

Of the 22 wolverines captured in this study, none is currently radiocollared (Table 2.1). We do not know the fate of 11 study animals because we lost the radiosignal of 7, 2 others shed their radiocollars, and 2 either shed their collars or died. We have no evidence that hunters or trappers killed these animals because none of the radio collars or ear tags has been recovered through the state's pelt-sealing requirement. The remaining 11 study animals have died. Trappers and hunters accounted for the loss of 9, 7 within and 2 outside the Talkeetna Mountains study area. The latter 2 wolverines probably dispersed. Of the 2 mortalities not due to hunting or trapping, we believe wolves killed 1 female, and another female probably died from complications related to collaring (Golden 1997).

The study animals at time of capture were generally subadults (<2 years old) or young adults. Mean ages were 1.6 years for females (s = 0.7 year) and 2.2 years for males (s = 1.1 years) (Table 2.2). Mean ages when animals were lost or died were 2.8 years for females (s = 1.5 years) and 2.6 years for males (s = 1.5 years). The oldest wolverines were a 5.5-year-old female (TF1) and a 5-year-old male (TM5).

We monitored the movements of study animals for an average of 17.0 months for females (s = 13.6 months; range = 2–39 months) and 7.8 months for males (s = 5.5 months; range = 1–16 months). We recorded 273 locations for females, averaging 30.3 locations/individual (s = 31.0 locations), and 205 locations for males, averaging 15.8 locations/individual (s = 12.8 locations). Home range sizes varied widely, 172–739 km^2 for females and 53–662 km^2 for males, but ranges of males ($\bar{x}$ = 486 km^2, s = 228 km^2) were not significantly larger than those of females ($\bar{x}$ = 417 km^2, s = 208 km^2) (t = 0.564, P = 0.584, df = 11) (Table 2.3). We observed both sexes mainly in the foothills and lower- to mid-elevation slopes (760–1770 m) between the crest of the Talkeetna Mountains to the west and the lake flats of the Nelchina Basin to the east (Figs. 2.1 and 2.2).

Job 2.4. Wolverine Population Model

Kaplan–Meier survival rates of radiocollared yearling and adult wolverines in the Talkeetna Mountains averaged 0.71 annually (s = 0.26) and 0.85 semiannually (s = 0.21). Survival was not significantly higher in summer (Apr–Sep) ($\bar{x}$ = 0.94, s = 0.13) than in winter (Oct–Mar) ($\bar{x}$ = 0.75, s = 0.25) (t = 1.386, P = 0.238, df = 4) when wolverines were most susceptible to harvest from trapping (Table 2.4). The survival function of an individual wolverine from the beginning of the study to 6 months was 1.00 and dropped to 0.33 at 1 year (Fig. 2.3). It then continued to decline gradually to 0.00 at 6 years. Between 3 and 4.5 years, survival was relatively constant at 0.21 (Table 2.4). We truncated the 95% confidence intervals at 0.00 (lower) and 1.00 (upper). Between those extremes, the 95% confidence intervals on the survival rates were large, ranging between 0.09 and 0.31 (± 60–92%) and averaging 0.16 (s = 0.07) (Table 2.4).

DISCUSSION

Job 2.1. Tests of Wolverine Density-Estimation Techniques

There has been a continuing trend of light snowfall, generally poor survey conditions, and rapid loss of study animals in the Talkeetna Mountains. Because of this trend, we again modified our plans to test the accuracy of the SUPE in estimating wolverine density. We will no longer use radiocollared animals to assist in assessing the SUPE (Becker et al. 1998). Instead, we will estimate the density of wolverines in a test area (not necessarily the Talkeetna Mountains study area) within 24 hours following a snowfall sufficient to cover all old tracks. We will survey the same sample units for 3–5 consecutive days to look for tracks of wolverines not detected during the SUPE on day 1. We will assess the technique's accuracy by measuring the proportion of animals detected by the SUPE among the total number counted (Golden 1997).

Job 2.3. Wolverine Harvest and Habitat Relationships

Large size and wide variation in wolverine home ranges is common, and there is usually a substantial difference reported between female and male ranges. Mean home range sizes for Talkeetna males of 486 km^2 and females of 417 km^2 in this study were similar to those reported for other areas where the MCP method was used. Hornocker and Hash (1981) reported average annual home ranges of 388 km^2 for females and 422 km^2 for males in a mixed forest-alpine habitat in northwestern Montana. Gardner (1985) estimated home ranges for adult male wolverines of 353 km^2 during winter and 385 km^2 during summer in a mixed forest-alpine area northwest of and adjacent to the Talkeetna Mountains study area. For this same area, Whitman et al. (1986) found the average home range of 535 km^2 for males was significantly larger than that of 105 km^2 for females. Magoun (1985) reported the annual home ranges of wolverines in a tundra environment in northwest Alaska were 103 km^2 for females and 666 km^2 for males. In a mixed forest-alpine habitat in Yukon Territory, Banci and Harestad (1990) reported home range sizes of 76–269 km^2 for females and 209–412 km^2 for males. Copeland (1996) reported a similar annual home range of 348 km^2 for female wolverines in a mixed forest-alpine habitat in central Idaho. However, males in the same area had exceptionally large home ranges that averaged 2,149 km^2. Food availability may be the primary influence of wolverine movements and home range size (Hornocker and Hash 1981).

Job 2.4. Wolverine Population Model

Our survival estimates were lower than those predicted by Magoun (1985) for a hypothetical population of wolverines, based on her data from an essentially unharvested population in northwestern Alaska. For example, she estimated survival at 1.00 for years 1 and 2, 0.50 for year 3, then a gradual decline to 0.19 for year 13, which was the maximum known age of a wolverine. The comparatively low survival of wolverines in the Talkeetna Mountains probably reflects the relatively high harvest in that area. The high degree of variability in survival estimates for the Talkeetna Mountains population was due to the low sample size of 22 wolverines and the large number of censored animals (Pollock et al. 1989). It precluded survival estimates by the Kaplan–Meier procedure for sex and age class and for shorter periods.

We believe we met most of the assumptions of the Kaplan–Meier procedure specified by Pollock et al. (1989). We were able to randomly sample animals of a particular sex and age class by capturing all but 2 animals through helicopter darting. We made no effort to select certain individuals, although we probably caught more males than females because males ranged more widely and may have been more vulnerable to our capture techniques. We met the assumption that survival times were independent for different animals because wolverines are generally solitary and young may be independent before the age of 1 year. Except for the study-related death of TF2, we believe it is unlikely that capturing the study animals or their wearing a radio collar influenced their survival. We were careful to censor animals randomly by not considering their fate in the decision (Pollock et al. 1989). Wolverines were censored when we lost contact with them, even if they were later harvested and reported as killed, or if their death was probably capture-related. We censored 1 adult male when his radio collar stopped transmitting after 1 month. We added him back into the survival model when he was recaptured and radiocollared the following year. He was finally marked as dead when he was trapped about a year later while still radiocollared. We censored a yearling female because her death was capture-related, and we censored 1 female and 2 males killed by trappers because we lost their radiosignals before they were trapped. In defining a time origin, we began our calculation of survival in April when the first study animals were captured, kits had been born, and the trapping season had ended. Because of the small sample size, we were unable to assess quantitatively whether or not we met the assumption that newly tagged animals had the same survival function as previously tagged animals.

RECOMMENDATIONS

This study should continue another year to accomplish planned objectives. During the next report period, we will focus on completing the evaluation of the accuracy of the SUPE for wolverines and on comparing the efficacy of the TIPS and SUPE through simulation modeling. We will extend movement analyses to measure home range, using the adaptive kernel and harmonic mean methods (Kie et al. 1996, Hooge and Eichenlaub 1997) that should more accurately portray wolverine movement. We will measure home range size relative to cumulative location, degree of home-range overlap among concomitant wolverines, and spatial and temporal differences in movement patterns. We will also further analyze survival through logistic regression and develop a model to estimate wolverine sustainable yield.

ACKNOWLEDGEMENTS

S. Bowen, K. Koenen, B. Scotton, and W. Testa assisted with data collection. R. Strauch helped with GIS files. E. Becker, C. Schwartz, and R. Strauch gave analytical advice. J. Lee and H. McMahon provided fixed-wing aircraft support.

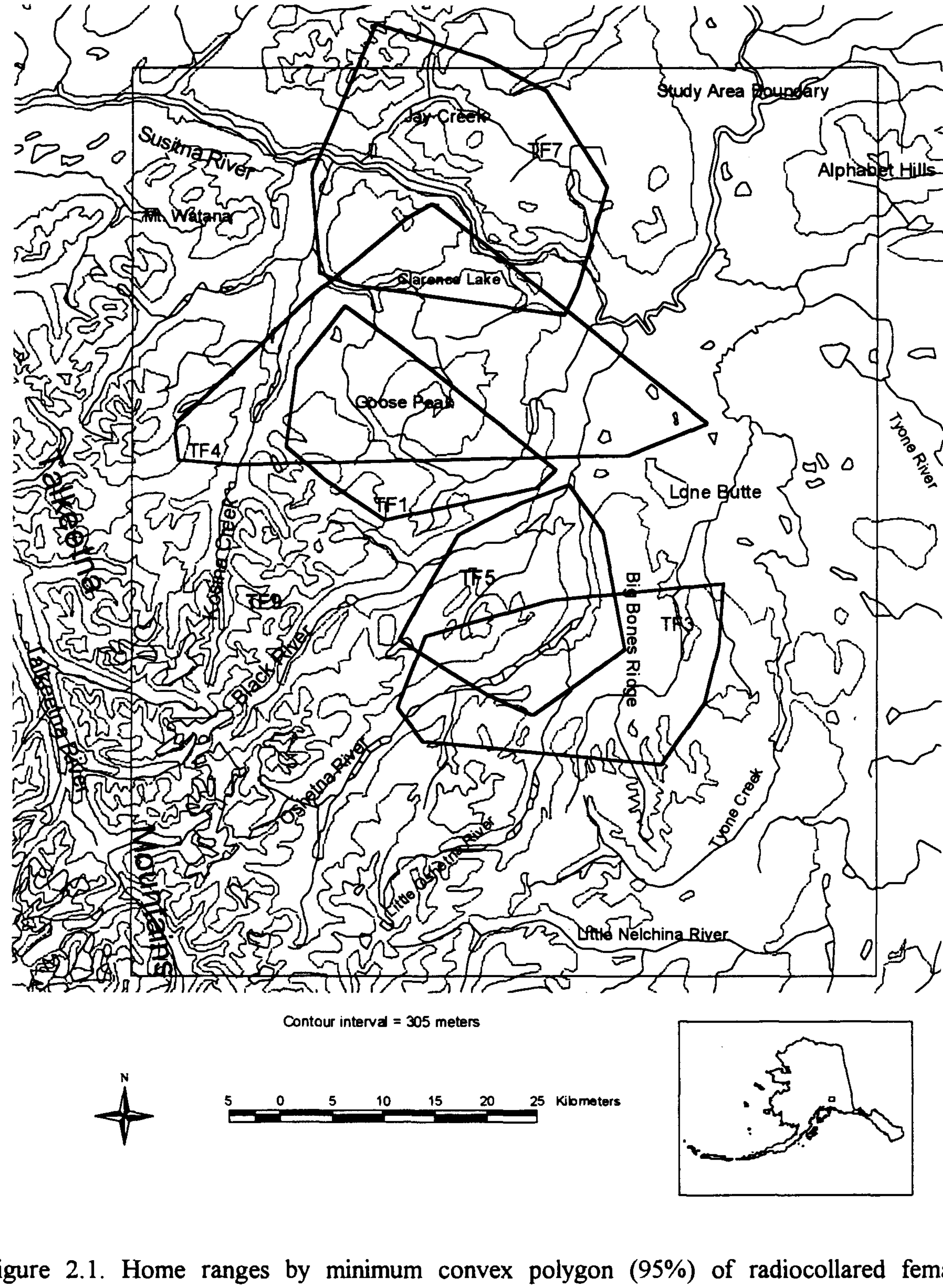

Figure 2.1. Home ranges by minimum convex polygon (95%) of radiocollared female wolverines with at least 10 observations in the Talkeetna Mountains, Alaska, April 1992–October 1997.

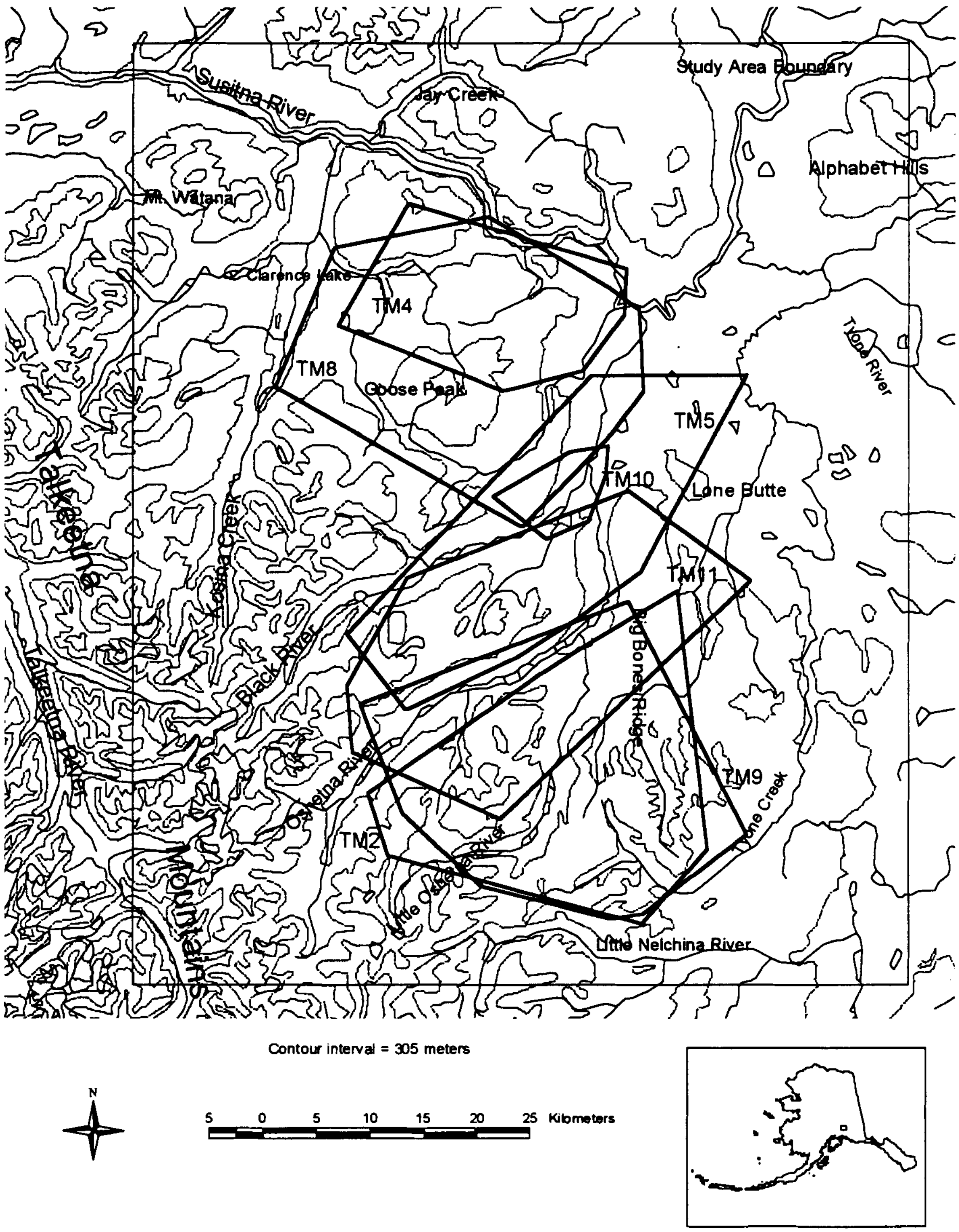

Figure 2.2. Home ranges by minimum convex polygon (95%) of radiocollared male wolverines with at least 10 observations in the Talkeetna Mountains, Alaska, April 1992–October 1997.

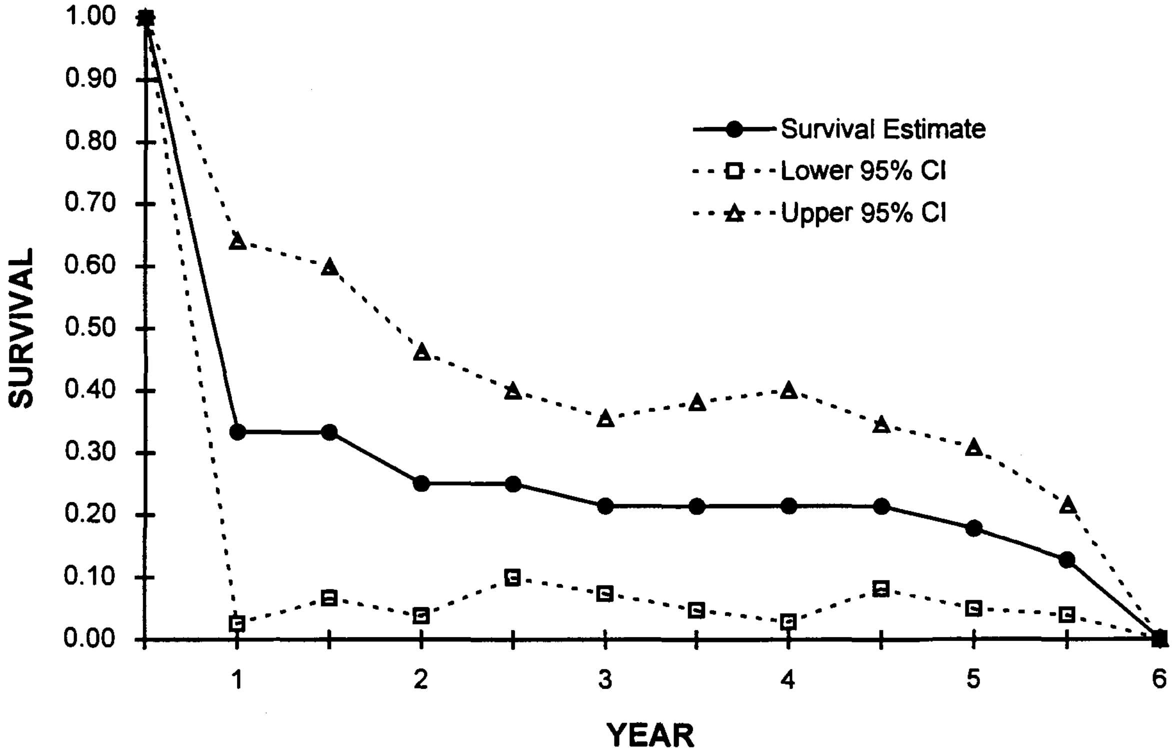

Figure 2.3. Kaplan-Meier survival function (modified for staggered entry of additional animals) for radiocollared wolverines in the Talkeetna Mountains, Alaska, April 1992–March 1998.

Table 2.1. Status of radiocollared wolverines captured in the eastern Talkeetna Mountains study area, 1992–1998.

					Hunter/Trapper Take		Loss to	Current
Sex	Nr	Active Signal	Shed Collar	Lost Signal	Inside Area	Outside Area	Other Death	Status Unknown[a]
Females	9	0	1	1	4		2	1
Males	13	0	1	6	3	2		1
Total	22	0	2	7	7	2	2	2

[a] At the time this report was prepared, the radiotransmitters of these 2 animals were on mortality mode, indicating the wolverines either shed their collars or died.

Table 2.2. Physical characteristics of wolverines captured in the eastern Talkeetna Mountains, April 1992 through March 1997.

Animal nr	Sex	Date of Capture	Age[a] yrs	Weight kg	Body Length cm	Tail Length cm	Total Length cm	Head Circum. cm	Neck Circum. cm	Heart Girth cm
TF1	F	4/20/92	3	10.0	76.0	22.0	98.0	32.5	29.0	44.5[b]
TF2	F	4/21/92	1	9.5	76.0	20.0	96.0	31.0	28.0	41.0
TF3	F	4/3/93	2	10.0	84.0	22.0	106.0	35.0	31.5	42.5
TF4	F	3/6/94	1	10.0	80.0	10.4	90.4	34.4	30.3	40.0
TF5	F	3/7/94	1	11.5	78.5	18.5	97.0	34.0	32.5	46.5
TF6	F	3/27/94	1	11.6	81.2	19.5	100.7	33.5	31.0	42.5
TF7	F	3/14/96	2	11.0	82.0	21.5	103.5	33.5	30.0	39.0
TF8	F	3/1/97	1	9.5	82.5	11.5	94.0	31.5	28.0	35.0
TF9	F	3/1/97	2	12.0	84.0	22.0	106.0	32.0	31.0	41.0
$\bar{x}$			1.6	10.6	80.5	18.6	99.1	33.0	30.1	41.3
s			0.7	1.0	3.1	4.5	5.4	1.4	1.6	3.3
TM1	M	4/18/92	1	15.0	91.0	20.0	111.0	38.0	36.0	46.0
TM2	M	4/19/92	4	18.0	91.0	20.5	111.5	38.0	37.0	47.0
TM3	M	3/3/93	2	15.0	88.0	23.0	111.0	37.5	36.5	47.5
TM4	M	3/3/93	3	15.0	82.0	21.0	103.0	37.0	36.5	45.5
TM5	M	3/28/94	4	14.5	89.0	17.5	106.5	37.5	36.5	47.0
TM6	M	3/28/94	2	14.5	95.5	18.5	114.0	37.0	35.5	48.0
TM7	M	3/19/95	1	15.0	88.5	21.5	110.0	37.0	34.2	41.5
TM8	M	3/19/95	1	14.5	92.0	14.0	106.0	37.0	32.5	42.0
TM9	M	2/17/96	3	16.2	83.0	18.0	101.0	37.0	38.0	49.0
TM10	M	2/17/96	2	12.8	92.0	21.0	113.0	33.0	31.0	46.0
TM11	M	3/13/96	3	15.5	88.5	21.5	110.0	37.5	35.5	47.0
TM12	M	3/1/97	1	14.8	91.0	20.0	111.0	37.0	34.5	55.0
TM13	M	3/1/97	1	14.8	88.0	20.0	108.0	35.0	34.0	41.5
$\bar{x}$			2.2	15.0	89.2	19.7	108.9	36.8	35.2	46.4
s			1.1	1.2	3.6	2.3	3.8	1.4	1.9	3.6

[a] Age was determined from cementum annuli of premolars.

[b] The heart girth measurement for TF1 was taken from her second capture of 20 April 1993.

Table 2.3. Home ranges (km^2) by minimum convex polygon (MCP) pooled for all locations of radiocollared wolverines with at least 10 observations in the Talkeetna Mountains, Alaska, April 1992–October 1997.

Animal	Age[a]	Monitoring Period	Months	Locations	95% MCP
Females					
TF1	A	Apr 1992–Jan 1995	33	53	300
TF2	SA	Apr 1992–Mar 1993	11	9	
TF3	A	Apr 1993–Nov 1994	19	31	408
TF4	A	Mar 1994–Jun 1996	27	30	739
TF5	A	Mar 1994–Jul 1997	39	101	306
TF6	SA	Mar 1994–May 1994	2	5	
TF7	A	Mar 1996–Jun 1997	15	29	579
TF8	SA	Mar 1997–Jun 1997	3	4	
TF9	A	Mar 1997–Jul 1997	4	11	172
Males					
TM1	SA	Apr 1992–Oct 1992	6	7	
TM2	A	Apr 1992–Oct 1993	10	23	575
TM3	A	Mar 1993–Apr 1993	1	7	
TM4	A	Mar 1993–Apr 1994	13	23	300
TM5	A	Mar 1994–Jul 1995	16	15	526
TM6	SA	Mar 1994–Mar 1994	1	2	
TM7	SA	Mar 1995–Jul 1995	4	3	
TM8	A	Mar 1995–May 1996	14	40	646
TM9	A	Feb 1996–Nov 1996	9	28	662
TM10	SA	Feb 1996–Apr 1996	14	24	53
TM11	A	Mar 1996–Jan 1997	10	29	641
TM12	SA	Mar 1997–Apr 1997	1	2	
TM13	SA	Mar 1997–Jun 1997	3	2	

[a] Age based on cementum annuli of premolars; A = adult, SA = subadult. Animals classified as adults were either >2 years old at initial capture or reached that age during monitoring.

Table 2.4. Kaplan–Meier survival estimates (modified for staggered entry of additional animals) for radiocollared wolverines in the Talkeetna Mountains, Alaska, April 1992–March 1998.

Years	Time Period[a]	Nr At Risk	Nr Deaths	Nr Censored	Nr New Added	Survival Estimate	95% CI
0.5	Summer 1992	4	0	1	0	1.00	1.00–1.00
1.0	Winter 1992–93	3	2	0	3	0.33	0.03–0.64
1.5	Summer 1993	4	0	1	1	0.33	0.07–0.60
2.0	Winter 1993–94	4	1	0	5	0.25	0.04–0.46
2.5	Summer 1994	8	0	1	0	0.25	0.10–0.40
3.0	Winter 1994–95	7	1	3	2	0.21	0.07–0.35
3.5	Summer 1995	5	0	1	0	0.21	0.05–0.38
4.0	Winter 1995–96	4	0	0	4	0.21	0.03–0.40
4.5	Summer 1996	8	0	2	0	0.21	0.08–0.35
5.0	Winter 1996–97	6	1	2	4	0.18	0.05–0.31
5.5	Summer 1997	7	2	3	0	0.13	0.04–0.22
6.0	Winter 1997–98	1	1	0	0	0.00	0.00–0.00

[a] Summer = Apr–Sep; winter = Oct–Mar.

JOB 3 — DISTRIBUTION, TREND, HABITAT USE, AND HARVEST POTENTIAL OF COASTAL RIVER OTTER POPULATIONS

Golden (1996) provided background for this project. During this report period, we focused on Kachemak Bay research: (1) updating databases of the movements of radiomarked river otters, (2) evaluating latrine sites and random sites for habitat characteristics and updating those databases, (3) analyzing scats of river otter to determine food habits, and (4) analyzing DNA microsatellites from the river otter scats to identify individual otters. We will use DNA microsatellite analysis to understand river otter use of latrine sites and scat deposition rates relative to otter abundance.

OBJECTIVES

3.1 To determine if latrine site use and fecal deposition rates are precise indicators of river otter abundance in coastal areas of Southcentral Alaska.

3.2 To determine which habitat features are most important in defining coastal river otter habitat.

3.3 To evaluate food habits of river otters relative to habitat types and geographic area.

3.4 To estimate sustainable harvest levels of river otter populations in coastal environments of Southcentral Alaska.

STUDY AREAS

The Kachemak Bay study area lies between Kasitsna Bay and Sadie Cove, with the center of activity in Tutka Bay. Habitat features in this part of Kachemak Bay are similar to those described by Bowyer et al. (1995) for western Prince William Sound. Several areas of Kachemak Bay have been developed for housing, which is generally within 100 m of the coastline.

METHODS

Job 3.1. Latrine Site Use and Fecal Deposition Rates by River Otters

We are collaborating with Drs. Pamela Groves and Merav Ben-David at the University of Alaska Fairbanks (UAF) to analyze river otter scat for DNA microsatellites (Groves and Ben-David 1997). This procedure extracts DNA from river otter intestinal cells shed within their feces to generate DNA profiles or fingerprints that are specific to individual animals. Microsatellites are hypervariable, noncoding regions of short repeats within DNA that vary in size. They can serve as genetic markers because the regions may be amplified and their sizes compared among individuals with the aid of appropriate markers through polymerase chain reaction products and specific microsatellite primers.

For the DNA analysis, we used 157 scats, all ≤ 3 days old, collected among 23 latrine sites during 5 3-day sample periods in summer 1996 (Golden 1997). We extracted small amounts

(1–2 ml) of feces from each sample for analysis through the automated sequencer in the DNA Core Lab at the University of Alaska Fairbanks.

Job 3.2. Habitat Selection and Movements of River Otters

We assessed the habitat of 58 latrine sites and 293 random sites along approximately 107 km of shoreline between Sadie Cove and Kasitsna Bay on the south side of Kachemak Bay. We selected latrine sites by searching the shoreline for entrance points and signs of use by river otters, such as scats and burrows (Testa et al. 1994, Bowyer et al. 1995). We originally selected 300 random sites to survey from 5,367 possible locations spaced at 20-m intervals along the 107-km shoreline. We used 20-m intervals because that is the diameter of the area surveyed at each site (Bowyer et al. 1995). We were unable to sample 7 of the sites (mainly at the upper end of Sadie Cove) due to extremely low water even at high tide. The 293 random sites surveyed represented approximately 5% of the available habitat. We measured several features that Bowyer et al. (1995) and Ben-David et al. (1995) found significant for river otter and mink (*Mustela vison*) habitat in Prince William Sound. We added estimates of canopy cover and the presence of burrow sites to the site assessments (Table 3.1). Stepwise logistic regression analysis is underway to determine river otter use of the available shoreline habitat sampled in Kachemak Bay (Bowyer et al. 1995, Ben-David et al. 1995).

We monitored the movements of 4 radiomarked otters by boat and airplane, accumulating 137 locations (range 23–44) for the 2 females and 2 males. Locations were recorded on 1:63,360-scale maps, digitized, and imported into an ArcView database.

Job 3.3. Food Habits of River Otters Among Habitat Types

For diet analysis, we used the remaining portions of the 157 river otter scats used in the DNA microsatellite analysis. We sent the scats to the Marine Mammal Lab at the University of British Columbia for cleaning through an elutriation process. The cleaned scats were then sent to Pacific Identifications in Victoria, British Columbia for identification of food items (Golden 1997). This analysis is underway and is expected to be completed by October 1998.

Job 3.4. River Otter Population Model

This job was not addressed during this reporting period.

RESULTS AND DISCUSSION

Job 3.1. Latrine Site Use and Fecal Deposition Rates by River Otters

The DNA analysis of the river otter scats from Kachemak Bay is underway and we expect it to be completed by December 1998. We will use the results to attempt to estimate river otter density and use of latrine sites by individual animals. We will follow the procedure described by Groves and Ben-David (1997) to estimate river otter density using the identification of individuals from DNA microsatellites to conduct a mark-resighting analysis of population density. They used the initial collection of scats at the latrine sites as the marking occasion. A resighting occasion was the subsequent collection of scats from latrine sites several days after the initial collection. They repeated this process several times to produce capture histories they will use to estimate population density (M. Ben-David, University of Alaska Fairbanks, pers. commun.). Their analysis is in progress and is expected to determine specific criteria (e.g., the need for closure) that may be required for accurate estimates. For the Kachemak Bay study, we will attempt to identify individual otters and develop capture histories from scats collected in early summer 1996. However, we expect the results to be preliminary because we did not design our scat collection procedures to estimate density. We collected scats that had accumulated over 3-day periods that were separated by 3-week periods to measure scat deposition rates among latrine sites (Golden 1997). We plan to conduct a density estimate in Kachemak Bay in June 1999, using procedures prescribed by Groves and Ben-David (1997), pending the outcome of their analyses.

Job 3.2. Habitat Selection and Movements of River Otters

Probably because bays and inlets along the south side of Kachemak Bay tend to lie in a NW-SE direction, the aspect of most latrine sites (71%) was NE, SW, or W, whereas only 45% of random sites had one of those aspects (Fig. 3.1). Summary statistics indicated latrine sites had more shallow vegetated slopes and more bedrock in the intertidal substrate than random sites (Table 3.2). We found 83% of all latrine sites were in Tutka Bay, and 75% of those were located in the upper half (SE end) of the bay. We found only 2 latrine sites in Sadie Cove, 1 in Kasitsna Bay, and none in Little Tutka Bay, which lies between Tutka Bay and Kasitsna Bay (Fig. 3.1). The coastlines of Little Tutka and Kasitsna Bays are populated with a substantial number of houses and recreational cabins. Such dwellings are scattered lightly elsewhere in the study area. Many dwellings sit on likely locations for river otter latrine sites.

The 2 female river otters (F1 and F2) seemed to restrict their movements to Tutka Bay (Fig. 3.2). We found one male, M2, outside Tutka Bay only once, but we found the other male, M1, in Sadie Cove or in Kasitsna and Jakolof Bays on several occasions. We will complete movements and home range analyses during the next report period.

RECOMMENDATIONS

We recommend continuing the Kachemak Bay phase of this project for another year to analyze scat contents, movements, food habits, and habitat data. We will examine the possibility of estimating river otter density in Kachemak Bay with the DNA microsatellite technique using scats collected in 1996 (Groves and Ben-David 1997). We will focus further fieldwork on river otters in Prince William Sound in cooperation with 2 University of Alaska Fairbanks studies.

ACKNOWLEDGEMENTS

J. Faro and L. Faro documented most of the latrine sites. K. Koenen and C. Curgus helped with habitat assessment in Kachemak Bay. B. Scotton, S. Murley, and R. Strauch assisted with development of data entry and GIS files. G. and S. Christen provided housing in Kachemak Bay. J. DeCreft conducted radiotelemetry flights in Kachemak Bay and Prince William Sound.

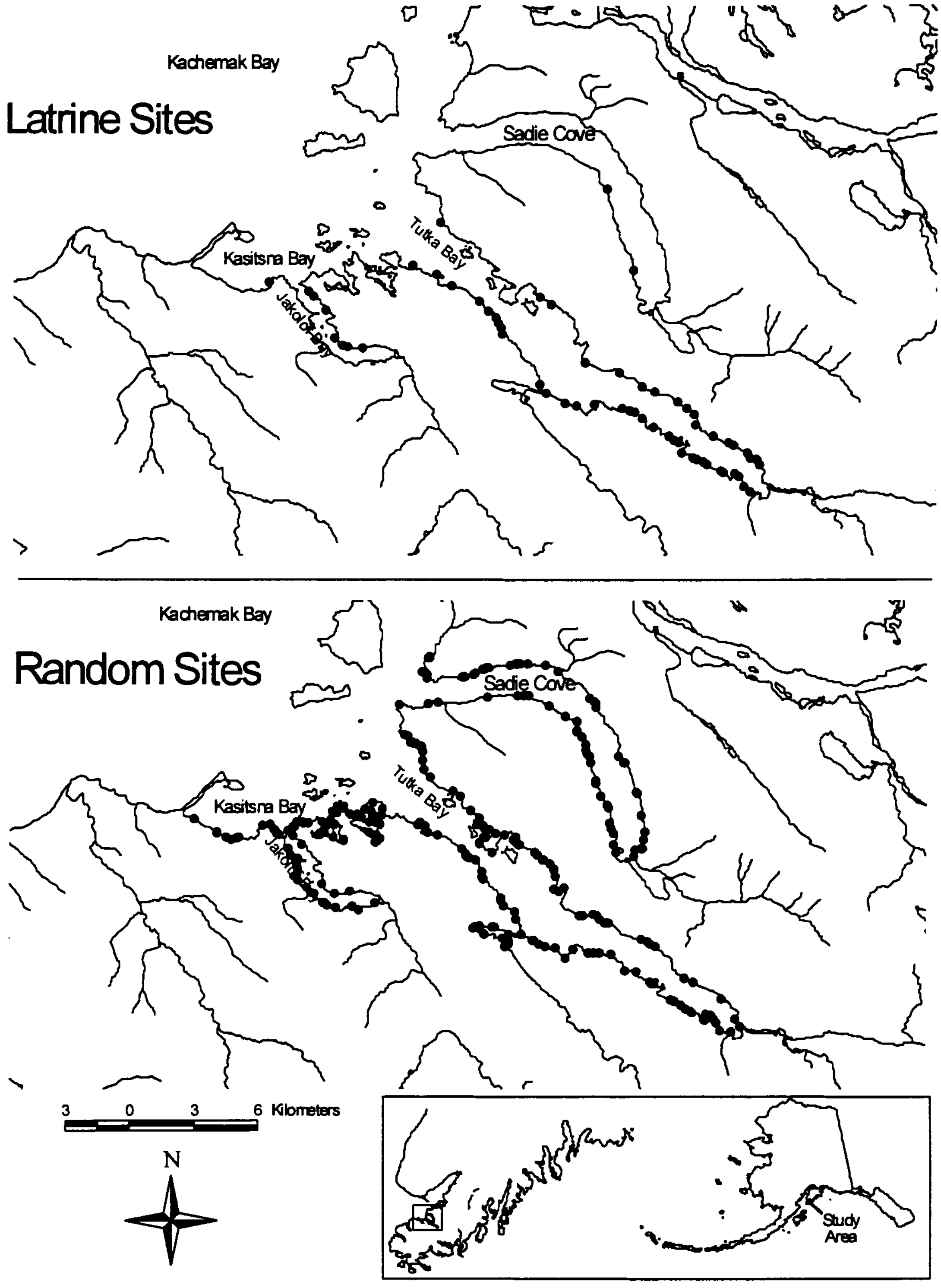

Figure 3.1. River otter latrine sites and random sites evaluated for habitat availability in Kachemak Bay, Alaska, April 1995–June 1998.

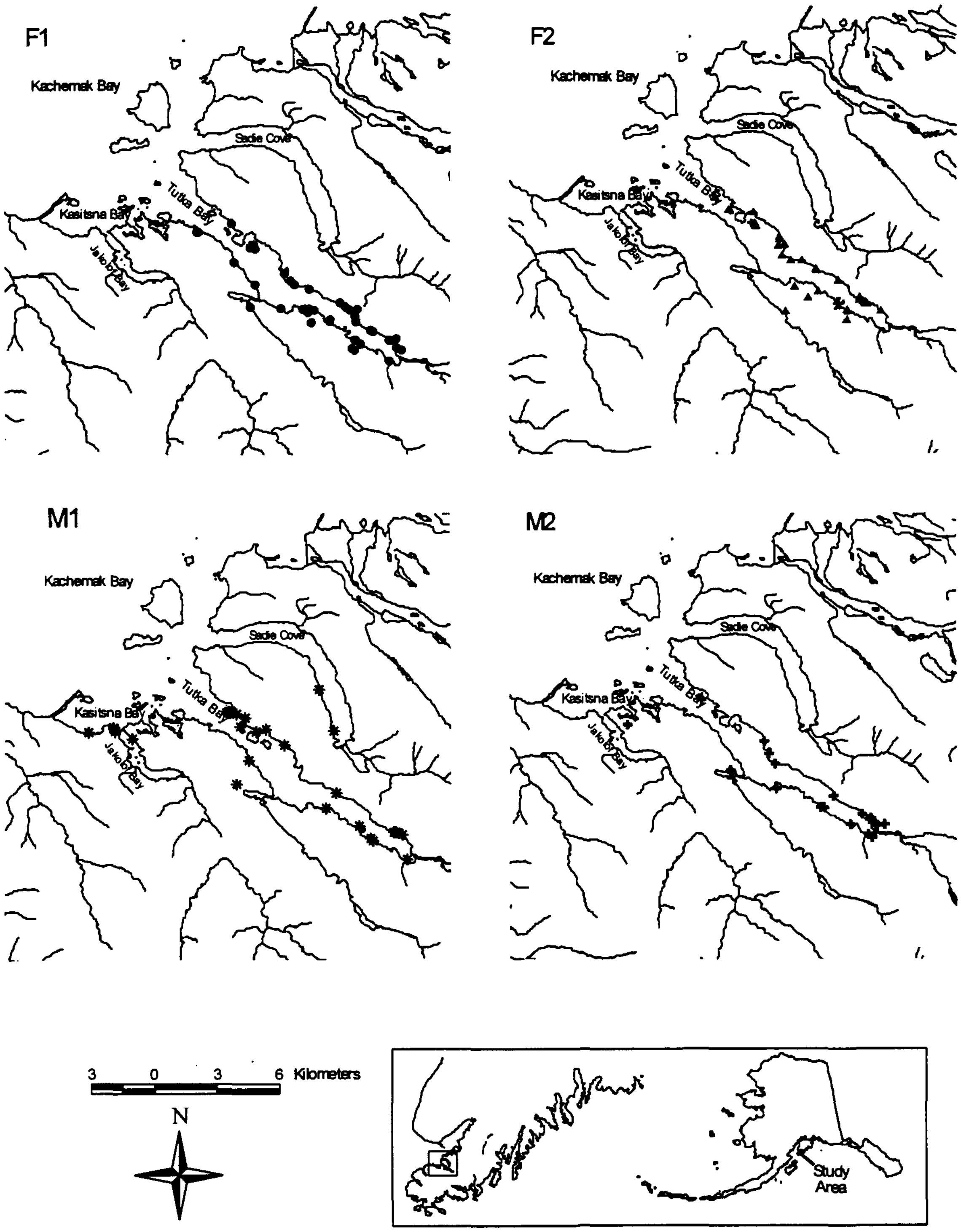

Figure 3.2. Locations of radiomarked female (F) and male (M) river otters in Kachemak Bay, Alaska, May 1995–May 1997.

Table 3.1. Definitions of habitat characteristics assessed at river otter latrine sites and randomly selected sites along the coast in Kachemak Bay and Prince William Sound, Alaska, summer 1997.

Habitat Characteristic	Description	Assessment Level
Aspect	Dominant direction of the shoreline as established with a compass.	N, NE, E, SE, S, SW, W, NW
Exposure	Severity of wave action to which the site could be exposed.	Protected, Moderate, Exposed
Vegetated and Tidal Slopes	Vegetated slope is the portion of the site above mean high tide and tidal slope is the portion of the site below mean high tide.	Degree of slope measured to the nearest 5° interval
Intertidal Substrate	Sand (<0.5 cm diam.), gravel (0.5–10 cm diam.), small rocks (10–25 cm diam.), large rocks (25 cm–6 m diam.), bedrock (>6 m)	Five ranked categories to the nearest value: 0 = 0%, 1 = 25%, 3 = 75%, 4 = 100%
Vegetation Canopy Cover	Proportion of overstory canopy cover provided by trees and understory canopy cover provided by shrubs	% Overstory, % Understory
Vegetation Old-Growth	Proportion of old-growth trees (i.e., stems) composing the forest overstory	Five ranked categories to the nearest value: 0 = 0%, 1 = 25%, 3 = 75%, 4 = 100%
Burrow Sites	The number of potential burrow sites and evidence of past use	Five ranked categories: 0 = no sites; 1 = 1–3 sites, little or no use; 2 = 4+ sites, little or no use; 3 = 1–3 sites, signs of use; 4 = 4+ sites, signs of use

Table 3.2. Shoreline habitat characteristics sampled at river otter latrine sites and random sites in Kachemak Bay, Alaska, summer 1997.

	Latrine Sites (n = 58)		Random Sites (n = 293)	
Habitat Characteristic[a]	$\bar{x}$	s	$\bar{x}$	s
Coastline Topography				
Aspect (E–W)[b]	0.271	0.778	0.080	0.795
Aspect (N–S)[b]	0.197	0.749	0.080	0.836
Exposure (ranked 0–2)	1.8	0.8	2.0	0.8
Vegetated Slope (°)	28.0	13.3	45.4	24.6
Tidal Slope (°)	27.2	10.3	24.7	17.0
Intertidal Substrate (ranked 0–4)				
Sand	<0.1	0.1	0.3	0.9
Gravel	0.4	0.6	0.7	1.0
Small Rocks	0.9	0.7	0.9	0.8
Large Rocks	0.9	0.8	1.2	1.0
Bedrock	1.8	1.5	0.9	1.3
Vegetative Cover				
Overstory (%)	79.7	17.1	70.2	28.2
Understory (%)	45.2	22.5	50.0	29.8
Old Growth (ranked 0–4)	3.1	1.0	2.4	1.4
Burrows (0–4)	1.3	1.1	0.1	0.4

[a] Habitat characteristics are described in Table 3.1.
[b] Directional data were sine-cosine transformed.

JOB 4 — APPLYING THE LYNX TRACKING HARVEST STRATEGY THROUGH RULE-BASED MODELING

I prepared a user guide (Appendix) to installing and running the model, LynxTrak, and distributed a runtime version of the model to potential users. The model and guide are under review.

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Prepared by:

Howard N. Golden

Wildlife Biologist III

Submitted by:

Donald E. Spalinger

Research Coordinator

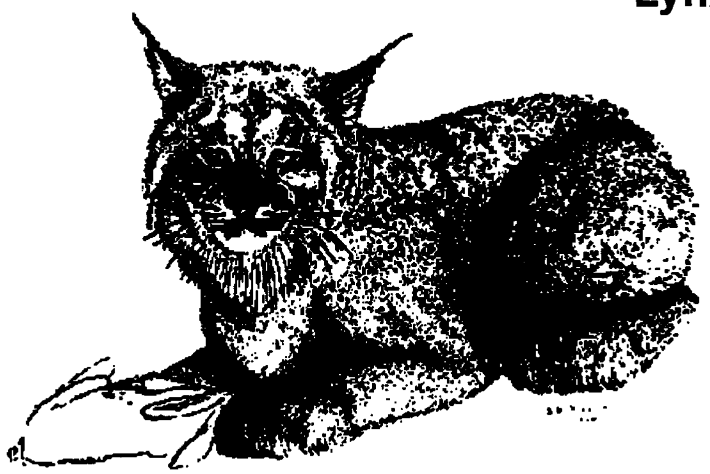
Approved by:

for Wayne Regelin, Director
Division of Wildlife Conservation

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

LynxTrak

An Expert-System Model for Lynx Management in Alaska



Version 1.0
December 1997

Alaska Department of Fish and Game

INSTALLING AND RUNNING LYNXTRAK (Ver. 1.0)

Your copy of **LynxTrak** is a runtime version contained in the self-extracting file **lynxtrak.exe** for either Windows 95 or Windows 3.1 on the disks provided.

INSTALLATION:

1. Insert the disk into drive a:
2. In Windows Explorer (Windows 95) or File Manager (Windows 3.1), create a new directory on your hard drive called **LynxTrak** or another name if preferred.
3. Copy **lynxtrak.exe** to this new directory.
4. Double-click on **lynxtrak.exe** to unzip the files. All the files needed to run the model are now available in the **LynxTrak** directory. The 2 active files you will use are **exsysp.exe** (the runtime program shell) and **lynxtrak.rul** (the expert-system model).

PROGRAM ACTIVATION:

1. In Windows Explorer (Windows 95) or File Manager (Windows 3.1), double-click on the file **exsysp.exe** (turquoise-colored icon). This will launch the runtime version of the program shell.

2. From the main menu bar, open **lynxtrak.rul**. A new window will appear with the button **Run Expert System** at the bottom of the screen. Click once on **Run Expert System** to launch the model **LynxTrak**.

In Windows 95 you can also activate the program by setting up an icon on your start-up menu. To do this, click on the Windows **Start** button at the bottom of your screen. Under **Settings**, click on **Task Bar** and then **Start Menu Programs**. Click on **Add** and enter the path for the file **exsysp.exe** (use the browse feature if you do not remember the correct path), then click on **Next** to name the shortcut. I suggest you rename it **LynxTrak**. Click on **Finish**. The icon for **exsysp.exe** and the name **LynxTrak** should appear under **Programs** on the **Start Menu**. Clicking once on the icon will launch the program file **exsysp.exe**. Follow steps 1 and 2 above to activate the model **LynxTrak**.

RUNNING LYNXTRAK:

- **LynxTrak** begins with a brief introduction about how the model works and what the user should expect from it. Click once on the button **Continue** to move to the next screen where you will begin entering your input into the model. The user input items and the order in which they are addressed by the model are shown in **Appendix A** of the accompanying manuscript, **An Expert–System Model for Lynx Management in Alaska**.
- Because the rules in the model use an if–then format, the questions the model asks are expressed as statements with fill-in-the-blank answers. Most questions are qualifiers and have multiple–choice answers provided. Answer the questions by either clicking on the correct answer with your mouse or by typing in the corresponding number of the correct answer. For example, if the area you are interested in is Unit 13, you can either click on that answer or type in the number 5 in the space provided. You may need to use the scroll bar on the right side of the window to view all possible answers. Most questions allow only 1 value, which will be indicated at the top of the window by the phrase "Select ONLY ONE value." A few of the questions are variables for which you will need to enter your data directly. For example, the question labeled HABITAT will ask you to enter "The amount (km^2) of lynx habitat in the area." After you answer the question, click **OK** or hit the enter key.
- At any point while you are running the model, you may examine the known data, the rules being addressed, and the sources for the values presented by clicking on **Question** on the main menu bar. **Known Data** will tell you what input you have entered so far. **Why** will tell you the rule being tested and which **If** questions have been answered (black type) and which ones have yet to be tested (blue type). Untested rules are bordered in blue, false rules in red, and true rules in lime green. You may examine the source of any **If** statement by clicking on it and then clicking on **Source**. **Notes**, shown in the light blue box at the bottom of the **Why** window, are available for the first 50 rules. Future versions of the model will contain more notes as well as references. Notes may be viewed by using the scroll bar to the right, which can be activated by first clicking on the **Prev** or **Next** buttons. You may also look backward or ahead to other rules by clicking on **Jump** in the

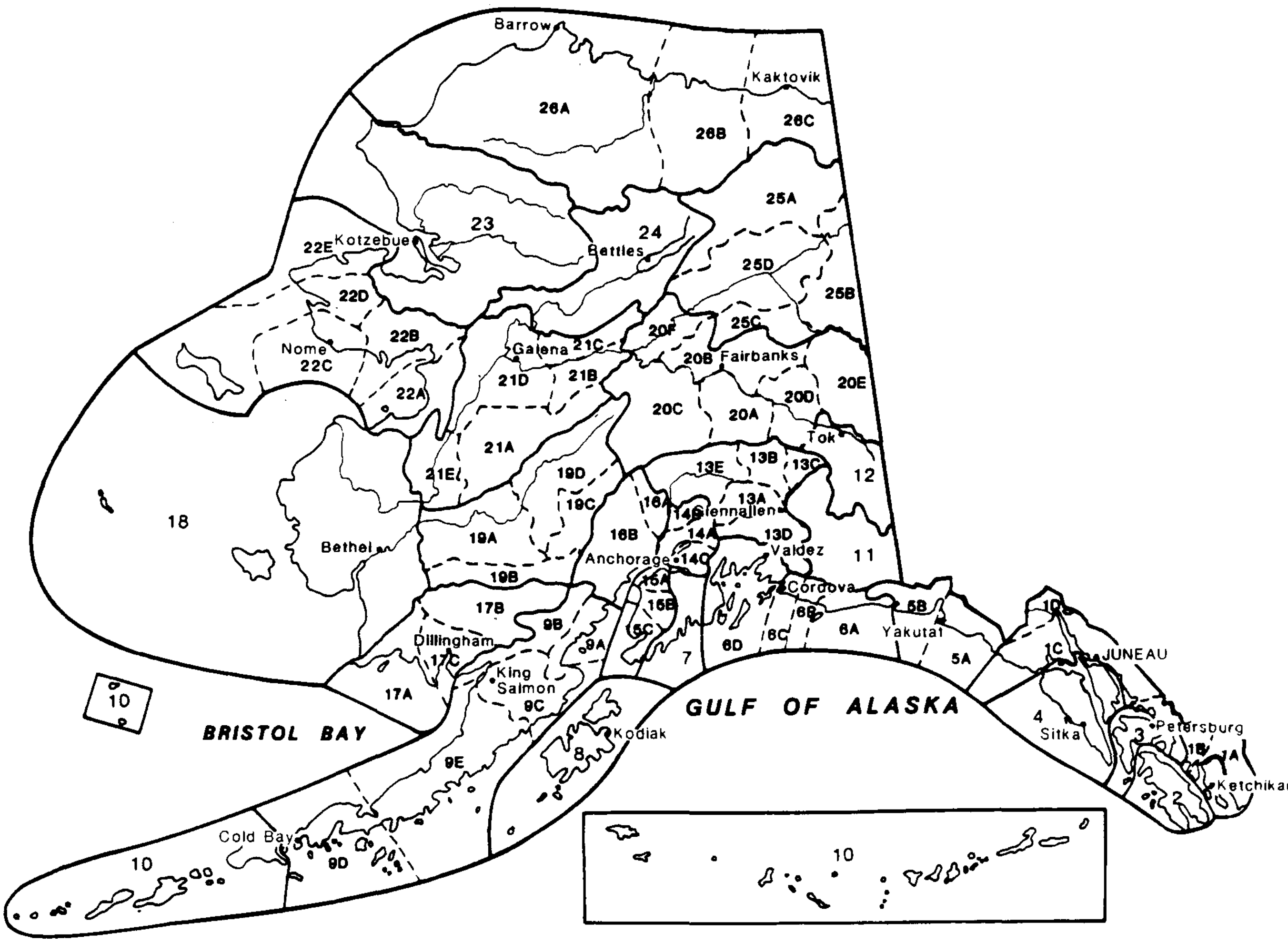
Why window or on **Display Rule** on the main menu bar. When you are ready to continue with the model, click **OK** to close the **Question** windows.

- Please note that you will not have access to 3 items on the main menu bar: (1) **Explain Question** and (2) **Undo Prev. Answer** under **Question** and (3) **Help** under **Options**. However, you can record notes in **Notebook** under **Options** on the main menu bar and you may save or recover your input in **Save Input** and **Recover Input** under **Question** on the main menu bar.
- After you have answered all the questions, the model will present the results based on your input. This is the complete record of your input, and you may want to save it for future use. **Choices** are shown in capital letters with the confidence values presented to the right. The **Qualifiers** you answered are followed by your response in capital letters. The **Variables** that the model calculated and those you answered directly are shown by their names in capital letters and their descriptions followed by the derived or given answer. If you want to see how each variable was derived, click on it and then on **How** on the bottom menu.
- To help you make the best decision on modifying the lynx season, you should rerun the model a few times after changing some of your input. You may want to bracket your input to consider possible extremes. To make input changes, click on **Change/Rerun** on the bottom menu. Next, click on the qualifier or input variable you want to change and then click **Change**. The original input window for that question will appear. Select your new answer and click **OK**. You can change as many of your original responses as you want before rerunning the model. When you are satisfied with your new input, rerun the model by clicking **Run** on the bottom menu. The results will again be presented as described above, except the previous choices and their confidence values will be shown to the right of the new values for comparison. Some of the old choices may not show because of the new input. You can see all of the old choices for the previous run by clicking on **All** on the bottom menu.
- To end your run, click on **OK** in the Results window. The program will ask if you want to run the model again. Click **Yes** to rerun it and **No** to exit the program.
- If you want to terminate the run before it is completed, click on **Close** or **Exit** under **File** on the main menu bar. Click on **OK** for each error message that appears until you see just the opening screen or the program closes completely.

TECHNICAL SUPPORT:

Howard Golden
Alaska Department of Fish and Game
333 Raspberry Rd.
Anchorage, AK 99518
Phone: (907) 267-2177
Fax: (907) 267-2433
howardg@fishgame.state.ak.us

Alaska's Game Management Units



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

Schumacher **Marten**