NATIONAL PARK SERVICE - ALASKA REGION

DISTRIBUTION AND RELATIVE ABUNDANCE, POPULATION CHARACTERISTICS, AND HARVEST OF FURBEARERS IN GATES OF THE ARCTIC NATIONAL PARK AND PRESERVE

FINAL REPORT
NRFR AR-8808

1 AUGUST 1988

BY

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BACKGROUND

Furbearer management in Gates of the Arctic National Park and Preserve (GAAR) requires reliable information on furbearer populations and their harvest to make sound management decisions. Management has been hindered by sparce or poorly documented information. General reviews of the area indicated several furbearer species other than wolves occurred in GAAR and that lynx, marten, red foxes, and wolverines are the most important species harvested (Rausch 1953, Bee and Hall 1956, NPS 1987). Rausch (1951) reported on the use of furbearers by the Nunamiut Eskimos of the Anaktuvuk Pass region between 1949 and 1951. Recent information about populations and harvest throughout the region encompassing GAAR has been limited to pelt-sealing records for reported harvests of lynx, wolverine, river otter, and beaver and to trapper responses to yearly questionnaires (Ernest 1986). This information is too general and inadequate for furbearer management in GAAR.

The National Park Service (NPS) is required to protect fish and wildlife populations and habitat within GAAR (ANILCA section 201(4) and 16 USC 1 and other laws). To maintain populations that are healthy in the preserve and natural and healthy in the park, the NPS "will strive to maintain the natural abundance, behavior, diversity, and ecological integrity of native animals as part of their ecosystems" (NPS 1987:98). This will be accomplished by research and monitoring of wildlife populations and by management of "human uses and activities that affect such populations and their habitat" (NPS 1987:99). Human uses in GAAR, as allowed by ANILCA, include subsistence hunting and trapping in the park and preserve and non-subsistence hunting and trapping in the preserve. ANILCA requires that the consumptive uses permitted in GAAR be compatible with the maintenance of natural and healthy populations.

The NPS initiated a 2-year study of furbearer populations, other than wolves (Canis lupus), and of their consumptive use in GAAR and adjacent areas. This project was conducted by the NPS Alaska Regional Office - Division of Natural Resources in coordination and cooperation with GAAR. The purpose of the investigation was to establish a base of information concerning the distribution and relative abundance, population characteristics, and harvest of furbearers and to develop a long-term monitoring scheme to improve NPS resource management and its compliance with ANILCA. Specific objectives were:

1. To determine the distribution and relative abundance of furbearers; species of primary interest were lynx (Felis lynx), marten (Martes americana), red foxes (Vulpes vulpes), wolverines (Gulo gulo), beavers (Castor canadensis), and snowshoe hares (Lepus americanus);

2. To develop a monitoring methodology to provide furbearer population trend indexes;

3. To estimate furbearer harvest levels and define trapping patterns; determine the relationships of harvest with target species, pelt prices, numbers of trappers, access, and proximity to villages;

4. To determine population characteristics (including age and sex ratios, reproductive status, and general physical condition) of harvested furbearers.

The objectives of this study were not met in full due to the early departure from the project by the principal investigator. Objectives are suggested for future work to be conducted by GAAR staff in conjunction with region-wide furbearer research and management efforts of the Alaska Department of Fish and Game (ADF&G).

ACKNOWLEDGEMENTS

I wish to thank everyone who helped with this short but very interesting study. Layne Adams (NPS-ARO) established the project and provided constant support and encouragement throughout. Judy Alderson and the rest of the GAAR staff in Fairbanks provided logistic support and input on the project and furbearer program in GAAR. Kathy Mossestad helped with various jobs, and Mike Kunz and Pete Phippen helped with trapper interviews in Anaktuvuk Pass. Bob Ahgook (NPS) and Bob Stephenson (ADF&G) helped with carcass purchases and trapper interviews in Anaktuvuk Pass. The GAAR staff in Bettles, Bill Foreman, Mary "Jeff" Karraker, and Ken Springer, were very helpful with a multitude of logistic and office needs. B.J. Schmitz and the Kanuti National Wildlife Refuge kindly provided field quarters in Bettles. Bruce Dale and Brad Schultz (NPS-ARO) assisted with data analysis and equipment transfer. Dan Reed (ADF&G) consulted on analytical problems. Audrey Magoun (ADF&G) verified tooth aging data for marten. Debbie Golden assisted with carcass analysis. Don Glaser (Bran Air) flew reconnaissance flights, Buster Points (OAS) flew beaver surveys, and Dennis Miller (Caribou Air Service) skillfully flew aerial transects. Special thanks to all the trappers who gave their time and knowledge in participating with this study.

STUDY AREA

GAAR encompasses approximately 33,182 km^2 (12,425 mi^2) of essentially roadless wilderness, with 29,540 km^2 (11,019 mi^2) in the park and 3,642 km^2 (1,406 mi^2) in the preserve (NPS 1987). The only extensive private landholdings within park boundaries belong to the Native corporations of Anaktuvuk Pass and Arctic Slope Region. GAAR is bounded on the east by the Utility Corridor of the Trans-Alaska Pipeline and on the west by the Noatak National Preserve and the National Petroleum Reserve - Alaska. It lies north of the Arctic Circle and straddles the Brooks Range in northcentral Alaska, with an arctic environment to the north and a subarctic one to the south. The entire region is characterized by long, cold winters, short, warm summers, and light precipitation (NPS 1987). Average minimum and maximum temperatures range from -34°C to 21°C (-30°F to 70°F), with the south side of the Brooks Range being colder in the winter and warmer in the summer. Average yearly precipitation totals range from 13 to 45 cm (5 to 18 in), and average yearly snowfall ranges from 89 to 203 cm (35 to 80 in).

Vegetation in GAAR consists of 3 major associations: tundra, shrub thicket, and taiga or boreal forest (NPS 1987:51). Tundra is the most extensive association. Alpine tundra communities occur mainly in the higher elevations and moist tundra communities are predominantly in foothills and along northern drainages. Shrub thickets are scattered above treeline among several drainages to the north and northwest. Boreal forest occurs across the southern boundary of GAAR and extends north along several south-flowing drainages up to the continental divide, which is the northern limit of this vegetation type.

Besides lynx, marten, red foxes, wolverines, and beavers, the other furbearer species within GAAR are ermines (Mustela erminea, least weasels (M. rixosa), mink (M. vison), river otters (Lutra canadensis), muskrats (Ondatra zibethica) and occasionally arctic foxes (Alopex lagopus) and coyotes (Canis latrans) (Rausch 1953, and Bee and Hall 1956). Marten, mink, river otters, beavers, and muskrats reach the northern extensions of their ranges in GAAR (Burt and Grossenheider 1976). Lynx are usually associated with the taiga zone on the south side of the Brooks range but may occur as far north as the Arctic coast (Rausch 1953, Bee and Hall 1956). Furbearers utilize a variety of prey species in GAAR. Mammalian species as potential prey may include snowshoe hares, microtines (including northern bog, brown, and collared lemmings (Synaptomys borealis, Lemmus sibiricus, and Dicrostonyx torquatus) and red-backed, meadow, tundra, and singing voles (Clethrionomys rutilus, Microtus pennsylvanicus, M. oeconomus, and M. miurus)), and squirrels (such as hoary marmots (Marmota caligata), arctic ground squirrels (Spermophilus undulatus), and red squirrels (Tamiasciurus hudsonicus)). Moose (Alces alces), caribou (Rangifer tarandus), and Dall's sheep (Ovis dalli) may be used as carrion. Waterfowl, grouse, ptarmigan, and passerines are likely avian prey of furbearers.

GAAR contains portions of the following ADF&G game management units (GMU): 23, 24, 25A, 26A, and 26B. NPS permits trapping in GAAR, under state regulations and management by ADF&G, provided it does not become a "significant commercial activity" (NPS 1987:126). Subsistence trappers in GAAR must live in 1 of the following 10 resident-zone communities: Alatna, Allakaket, Ambler, Anaktuvuk Pass, Bettles/Evansville, Hughes, Kobuk, Nuiqsut, Shungnak, and Wiseman. Non-subsistence trappers have no residence requirement and may live in other communities, but they may only trap in the preserve.

METHODS

Furbearer Surveys

The principal method I used to determine the distribution and relative abundance of furbearers in GAAR was aerial survey. For furbearers other than beavers, I counted tracks in snow along systematically spaced, linear transects. The premise of the methodology was that the amount of animal sign, tracks in this case, was related to animal abundance (Caughley 1977). Relative values were used because the exact relationship between an animal and its tracks was unknown. I developed and tested the technique in a similar study conducted from 1984-1986 on furbearer populations in the Yukon Flats National Wildlife Refuge (Golden 1987), and it will continue to be tested there and in other areas to improve its effectiveness. I used the aerial survey procedure in GAAR to allow repeatable sampling across all areas except the most rugged, and I modified it to accommodate the topographic and climatic conditions in GAAR.

Transects were approximately 9 km (5.4 mi) apart and 3 km (1.8 mi) long. They were selected by using a dot-grid overlay of a map of GAAR. The starting point of a transect was the closest geographic feature that would be identifiable from the air within a 1.5 km (0.9 mi) radius of a grid dot. The direction of a transect was then chosen randomly to avoid preselecting the course. A random direction was only eliminated if its course was unflyable. A new direction was then selected. The transect end point also had to be an identifiable geographic feature located within a 3 km (1.8 mi) arc of the random direction.

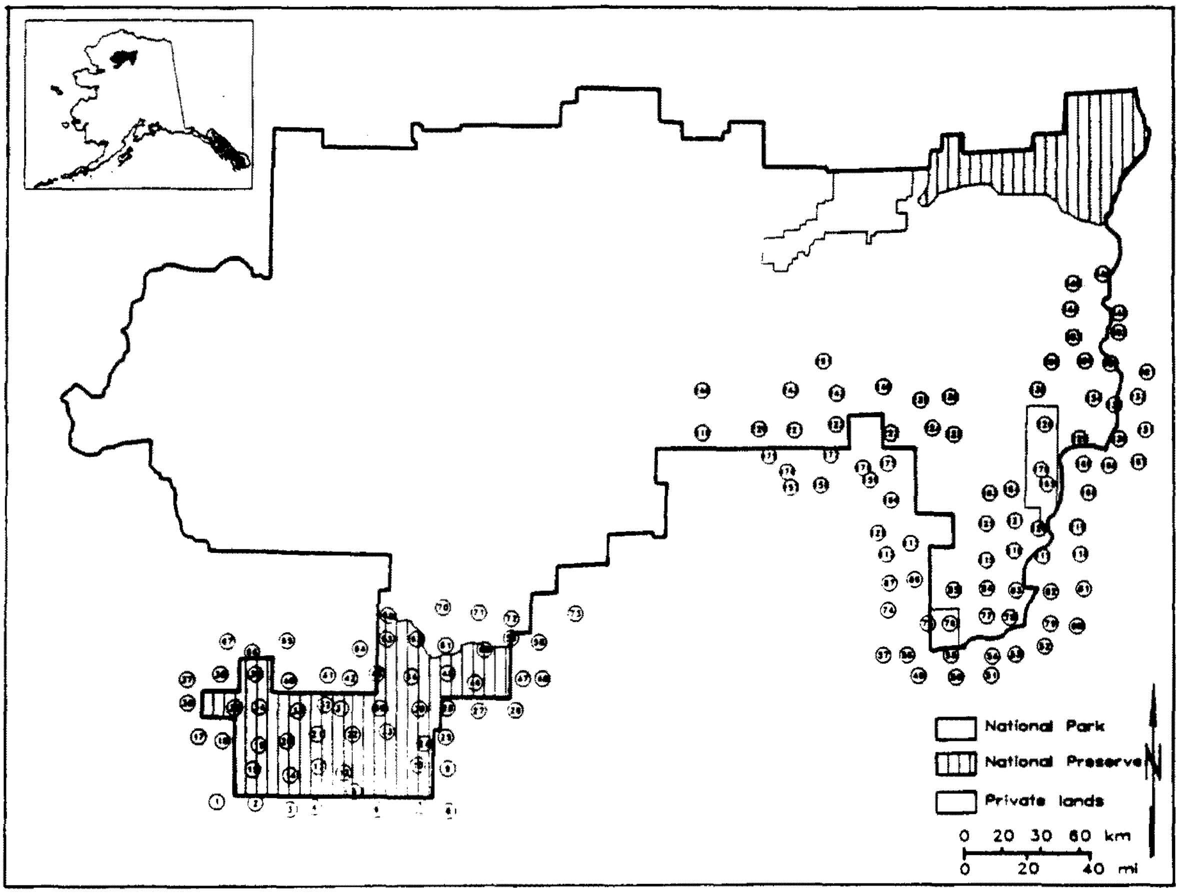

Figure 1. Aerial transects surveyed for furbearer tracks in Gates of the Arctic National Park and Preserve, March 1988.

I counted tracks of furbearers along 144 transects in and near the southwestern preserve area (West GAAR) and the eastern portion of the park south of the continental divide (East GAAR) (Fig. 1). These areas contained the most forested vegetation and were probably the best furbearer habitat in GAAR. They also incorporated most of the area used by trappers except those from Anaktuvuk Pass. Transects were sampled from 8-17 March 1988 in 6 days over 45.6 hours of flying, including transit time, for averages of 7.6 hours/day and 3 transects/hour. This was twice the time per transect anticipated prior to survey, and was most likely due to the time it took to fly over the rugged terain between transects.

I identified and counted tracks of lynx, marten, red foxes, wolverines, and snowshoe hares as they intersect each transect. Tracks were defined as a trail of footprints in the snow, and the transects they intersected were represented by the outside edge of the airplane ski. The number of tracks, estimated vegetation canopy cover, and the number of days since snowfall were the principal data to be gathered for each transect. Additional information was recorded on general snow conditions, weather, the presence of other animals, and general vegetation type.

Track density (tracks/km) was the unit of measure used to analyze relative abundance among transects. Original track densities were first corrected for the effects that different vegetation canopy covers (VCC) had on carnivore (c) and snowshoe hare (h) track sightability. Carnivore tracks were analyzed separately from hare tracks to differentiate predator from prey. Sightability correction factors determined from the Yukon Flats study (Golden 1987) were used as follows:

$$SCF_{c,h} = \sum_{v=1}^{4} (SR_{v(c,h)} * P_v),$$

where

SR = sightability ratio reciprocals (derived from Table 1),
v = VCCs bare (0% cover), light (1-24% cover), moderate (25-59% cover), and dense ($\geq$60% cover),
P = proportions of v along a transect,
and

$$\sum_{v=1}^{4} P = 1.0.$$

The effects the number of days after snowfall (DAS) had on track accumulation were equated among transects as tracks/km at 1 DAS by converting original track densities (OTD) at i DAS to estimated mean daily-track-accumulation rates:

$$\overline{TD}_{DAS} = OTD/iDAS.$$

Track sightability and accumulation adjustments were used in the following formula to determine corrected track densities (CTD) from OTDs for each furbearer species per transect:

$$CTD = \overline{TD}_{DAS} * SCF_{c,h}.$$

Table 1. Sightability ratios[a] of carnivore and snowshoe hare tracks among 4 vegetation canopy covers (VCC).

Species	VCC			
	Bare	Light	Moderate	Dense
Carnivore	0.712	0.667	0.318	0.172
Snowshoe Hare[b]	1.000	1.000	0.109	0.107

[a]Ratios modified from (Golden 1987), where an index of 1.0 indicated equality.
[b]Hare ratios for bare and light VCC were changed from 2.0 (the result of error) to 1.0 (the maximum possible).

Corrected track densities per transect were mapped to examine the overall distribution and relative abundance of furbearers. Track densities were compared as indexes of relative abundance based on quartiles of track density > 0 to indicate the presence or absence of patterns in furbearer distribution. Precision was gained through the examination of transects between West and East GAAR and among the general vegetation types alpine tundra, moist tundra, upland forest, and lowland forest. Comparisons among strata were analyzed using the Mann-Whitney U test with statistical significance considered at $\alpha = 0.20$.

Spring, from late February to mid April, is normally the period of time with the best snow, light, and weather conditions in this part of the Brooks Range. However, the start of the survey period was delayed 2 weeks due to cloudy weather and the end of the period was cut short by 20-30 mph winds that blew for several days and caused windpacked snow and unacceptable track visibility. Conditions did not improve before spring thaw. Although some areas in and near West and East GAAR could not be surveyed due to weather and time constraints, they should be able to be surveyed in the future under better conditions. Several attempts were made to survey the remainder of GAAR, however windpacked or scarce snow prevented tracks from being seen. Moderate to high winds are common in the northern and westcentral areas and would likely blow tracks away before surveys could be conducted effectively at almost any other time. Other methods of surveying furbearers under such conditions need to be explored.

On 20 April 1988, I examined the efficacy of determining wolverine distribution and relative abundance by identifying and counting their den sites. A. Magoun (pers. comm.) suggested this as a possible approach because her work in northwestern Alaska (Magoun 1985) indicated den sites were readily visible in the snow prior to spring thaw. Unfortunately the snow was too hard-packed or had been blown off completely so that it was impossible to follow wolverine tracks or to find any den sites.

I surveyed beaver lodges in the riparian areas of the Kobuk, Alatna, John, and North Fork Koyukuk River drainages (Fig. 2) from 26-29 September 1987 to determine the distribution and relative abundance of beavers in those areas. It took 18 hrs to fly all areas, including transit time. Because of its length and habitat diversity, I divided the Kobuk Drainage into the Lower and Upper

Kobuk. Beaver lodges, food caches, and signs of activity were recorded. The most reliable indicator of activity was the presence of a food cache near a lodge. I examined all water bodies within predetermined areas that represented the variety of beaver habitat in GAAR. Methods were similar to those described by Hay (1958), Swenson et al. (1983), Slough and Jessup (1984), and McLean (1986). The areas were flown via Super Cub after leaf-fall and before the ice became too thick to permit observations. I documented the presence of active and inactive lodges to compare their relative abundance and trend per year and for each drainage as well as their habitat associations (e.g., rivers, lakes, sloughs). Densities were measured as lodges/km^2 of area for those lodges on lakes, creeks, and sloughs, and as lodges/km of river for those lodges on river banks.

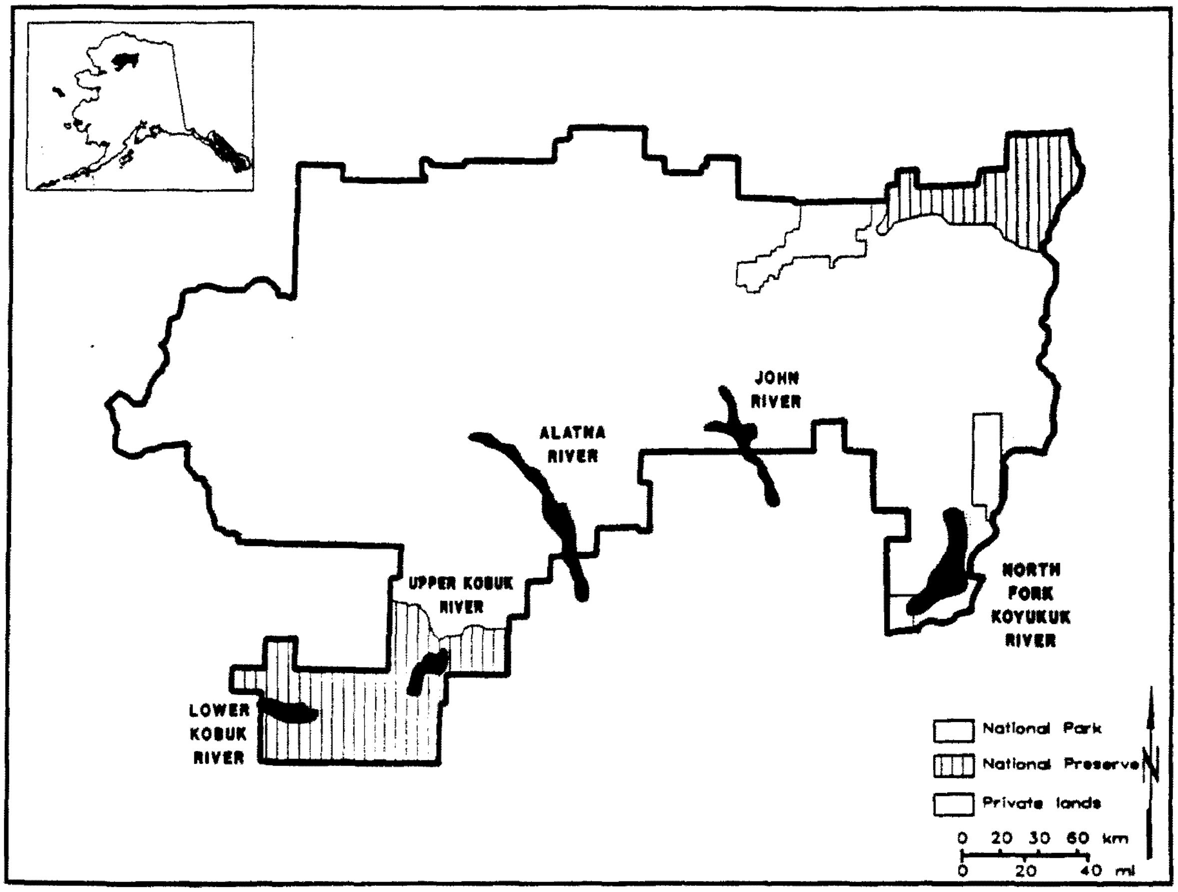

Figure 2. Beaver survey areas in Gates of the Arctic National Park and Preserve, 1987.

Trapper Interviews and Harvest Analysis

I interviewed 15 trappers who trapped in or near GAAR about where they trapped, what they saw and caught, and their observations of population fluctuations. I stratified the trapping areas into West, Central, and East GAAR, summarized interview results, and mapped known trapping areas to clarify furbearer trapping patterns and population trends in GAAR.

I also analyzed furbearer harvest data from ADF&G pelt-sealing records for trapping seasons 1984-85 through 1986-87. Species that are required to be sealed are lynx, wolverine, river otter, and beaver. Harvest records were examined through DBASE III databases, available from ADF&G, and summarized by species for minor harvest units, which are small divisions of GMUs or subunits and are based on drainages. I compiled data regarding number harvested, sex, age, method of take, and number of trappers. Results were compared with aerial survey data and used in interpreting the levels and patterns of furbearer harvest. They did not provide a complete record of harvest, however, and may have only represented a fraction of the number of animals actually harvested. Carcasses purchased from trappers in GAAR probably helped in reducing the discrepancies between reported and actual harvests for 1987-88.

Carcass Analysis

I examined and compared the ages, sexes, and general physical condition of harvested furbearers to gain a better understanding of the overall status of populations in and near GAAR. I purchased 342 carcasses of furbearers from 17 trappers in 3 areas: West GAAR (the Kobuk and Alatna River drainages), Central GAAR (the Killik, upper John, and Tinayguk Rivers, and other drainages in the vicinity of Anaktuvuk Pass), and East GAAR (the Wild/North Fork Koyukuk/Middle Fork Koyukuk/Dietrich River drainages). Prices paid were $10 for lynx, red foxes, and wolverines and $7 for marten, with an approximate limit of 50 carcasses/species/trapper. I measured and necropsied carcasses to document sex, diseases and parasites, and amounts of fat. I saved the skulls of all carcasses and extracted teeth for aging. One tooth from each animal was sent to Matson's Laboratory, Milltown, Montana, to be sectioned, stained, and read for age (shown as rings similar to increment cores from trees). Female reproductive tissues were frozen for later examination of luteal bodies and placental scars, which indicate reproductive activity.

RESULTS AND DISCUSSION

Distribution and Relative Abundance

Furbearers Other Than Beavers

Indexes of relative abundance based on corrected track densities (Table 2) were used to indicate areas of furbearer concentration or scarcity in GAAR (Figs. 3-7). Overall, marten and snowshoe hares had the highest track densities and wolverines and lynx had the lowest (Table 3). Red foxes, lynx, and hares appeared to be most abundant in East GAAR, whereas marten and wolverine track densities were highest in West GAAR (Table 4). Among 4 general vegetation types, all species had higher track densities in the forest communities than in tundra, although the latter were not as well represented among transects (Table 5). These track indexes can be compared with future surveys to analyze changes in distribution and relative abundance among strata and between years.

Table 2. Indexes of corrected track densities (CTD) for furbearers surveyed along 144 transects in Gates of the Arctic National Park and Preseve, March 1988. Indexes higher than None represent quartiles for transects with CTDs > 0, where Low ≤ 25%, Fair ≤ 50%, Good ≤ 75%, and High ≤ 100%.

Index	Red Fox	Marten	Wolverine	Lynx	Snowshoe Hare
None	0.00	0.00	0.00	0.00	0.00
Low	0.01-0.07	0.01-0.17	0.01-0.05	0.01-0.06	0.01-0.28
Fair	0.08-0.09	0.18-0.49	0.06-0.08	0.07-0.14	0.29-0.78
Good	0.10-0.21	0.50-1.29		0.15-0.21	0.79-2.32
High	0.22-2.30	1.30-7.57		0.22-0.73	2.33-34.86

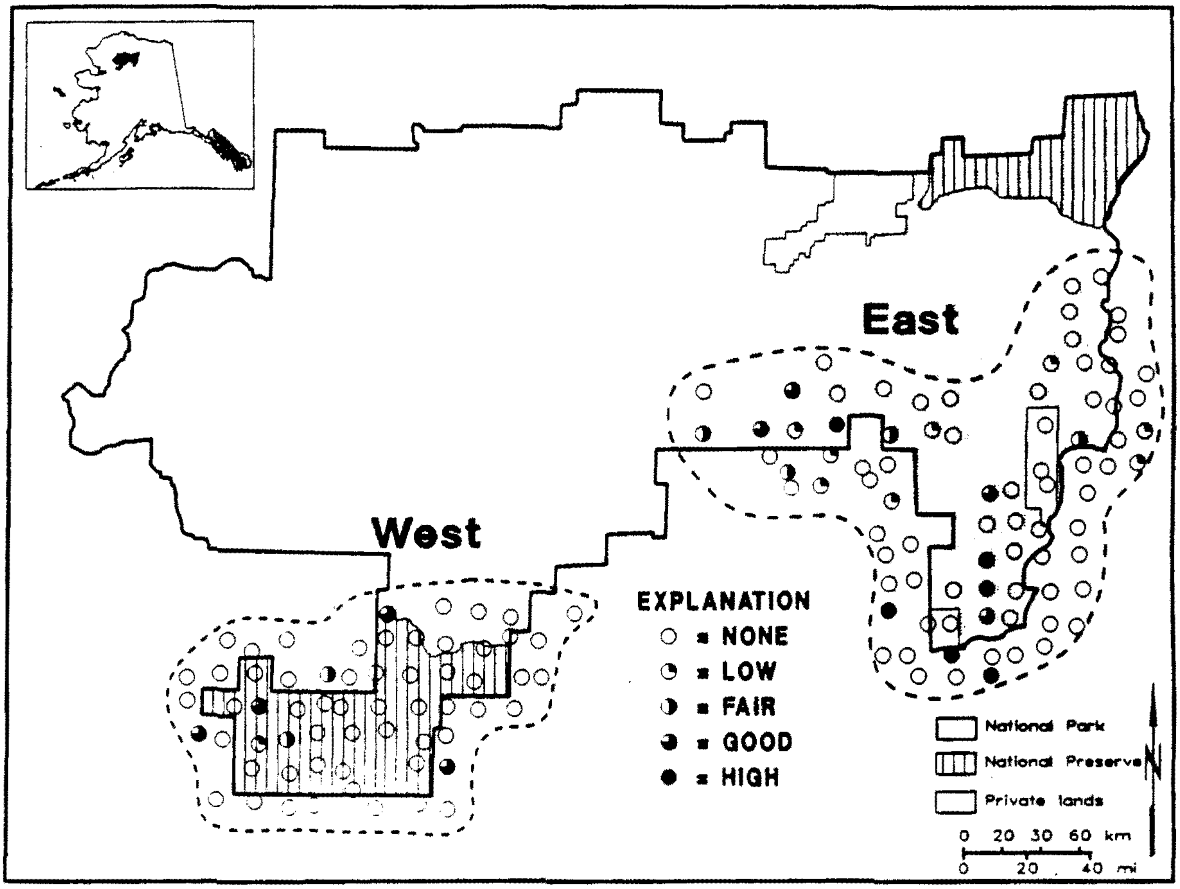

Figure 3. Red fox distribution and relative abundance in Gates of the Arctic National Park and Preserve, March 1988, shown as track density indexes with low-high representing quartiles of corrected track densities > 0.

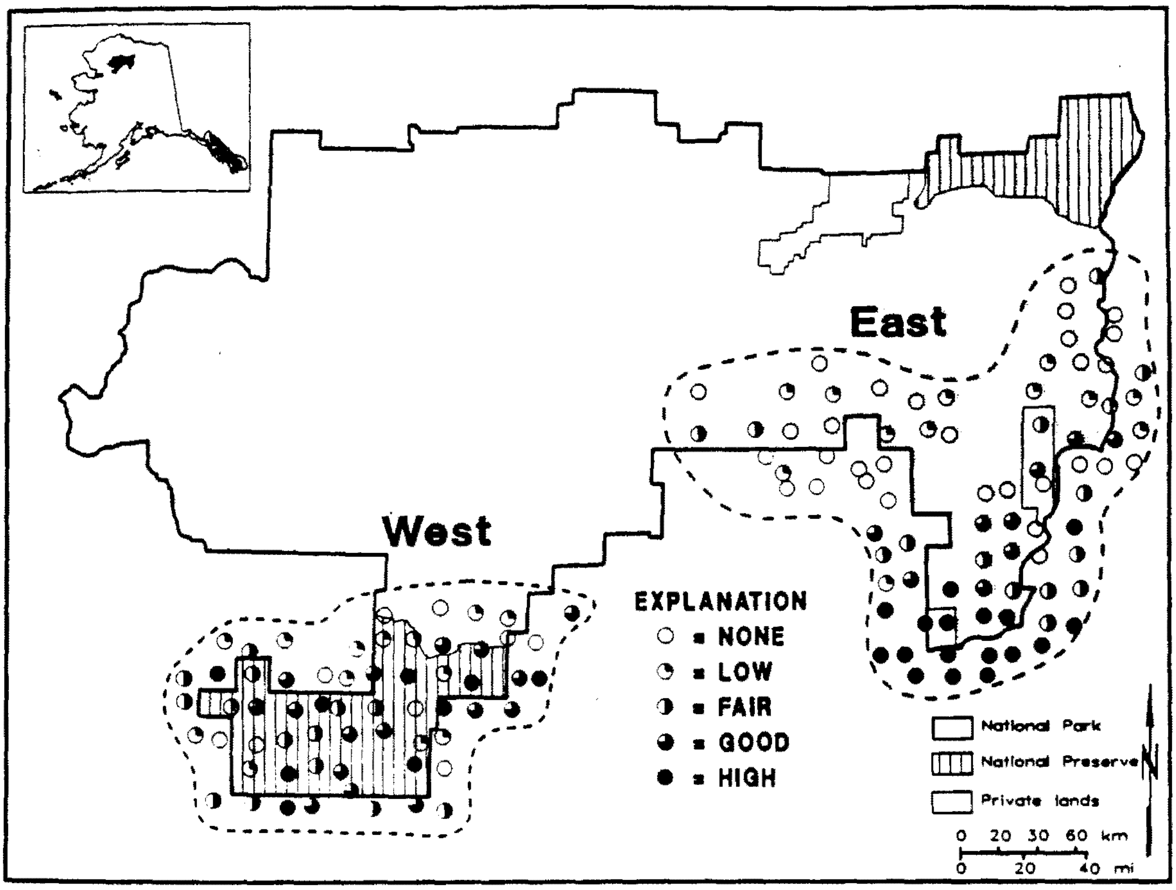

Figure 4. Marten distribution and relative abundance in Gates of the Arctic National Park and Preserve, March 1988, shown as track density indexes with low-high representing quartiles of corrected track densities > 0.

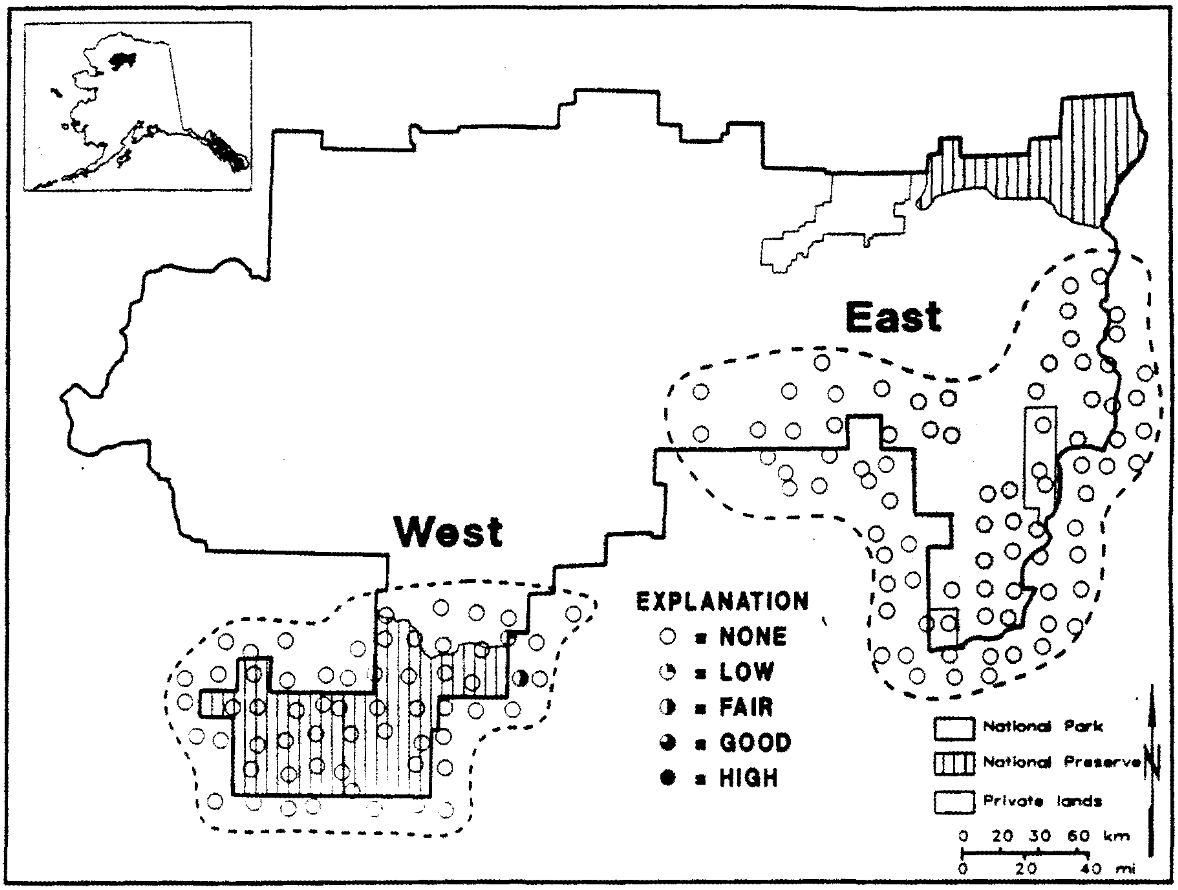

Figure 5. Wolverine distribution and relative abundance in Gates of the Arctic National Park and Preserve, March 1988, shown as track density indexes with low-high representing quartiles of corrected track densities > 0.

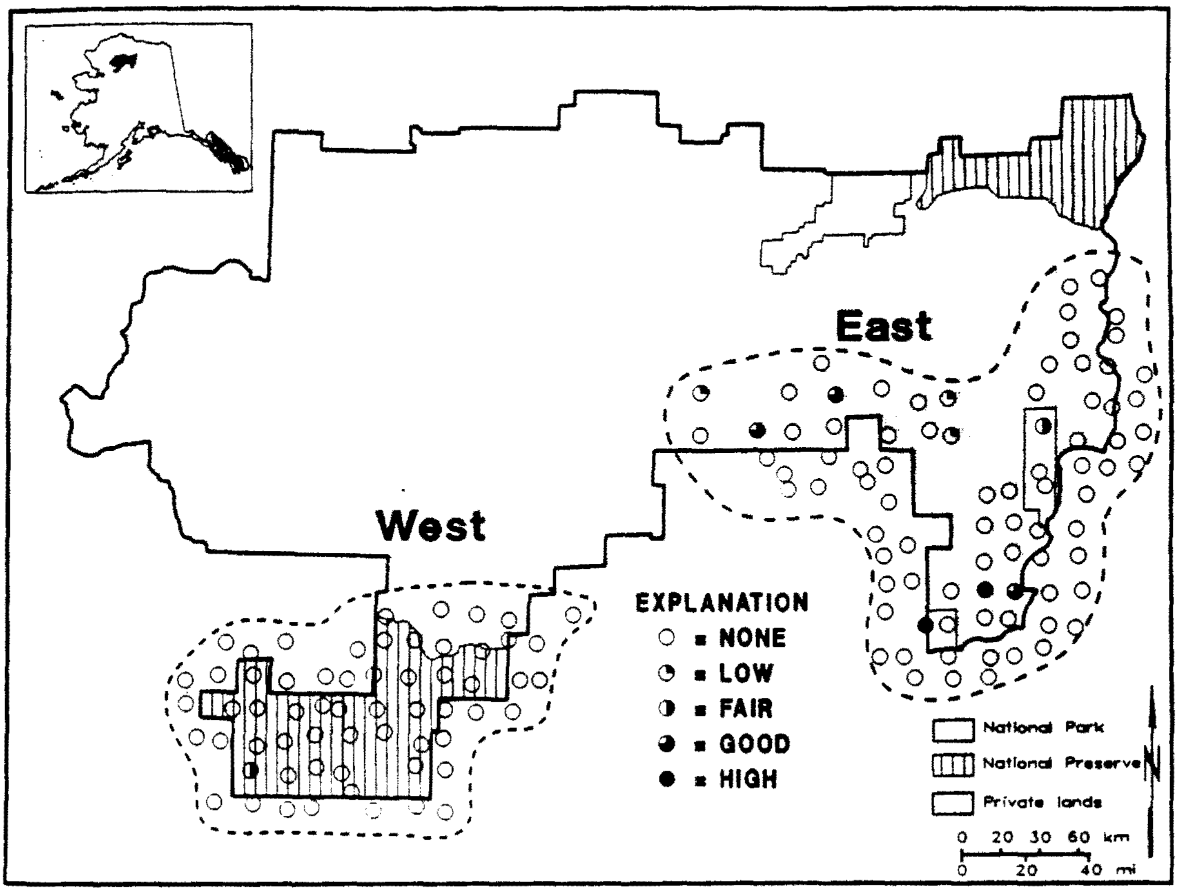

Figure 6. Lynx distribution and relative abundance in Gates of the Arctic National Park and Preserve, March 1988, shown as track density indexes with low-high representing quartiles of corrected track densities > 0.

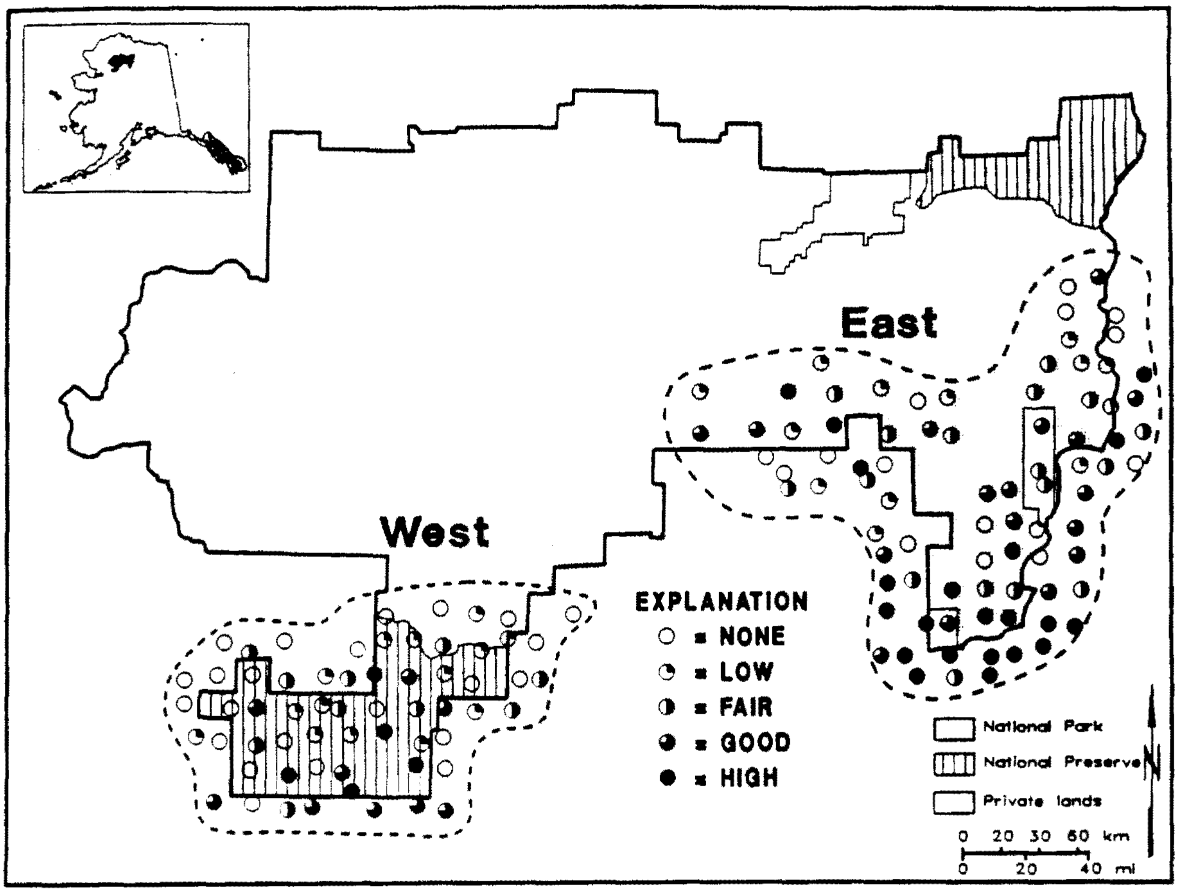

Figure 7. Snowshoe hare distribution and relative abundance in Gates of the Arctic National Park and Preserve, March 1988, shown as track density indexes with low-high representing quartiles of corrected track densities > 0.

Table 3. Percentage of transects (N)/corrected track density (CTD) index[a]/species of 144 transects surveyed in Gates of the Arctic National Park and Preserve, March 1988.

CTD Index	Red Fox	Marten	Wolverine	Lynx	Snowshoe Hare
None	80	26	99	93	26
Low	6	19	1	2	19
Fair	4	19		1	19
Good	5	19		2	18
High	4	18		1	18

[a]Based on CTDs in Table 2.

Table 4. Percentage of transects (N)/corrected track density (CTD) index[a]/species[b] of 144 transects surveyed in West and East Gates of the Arctic National Park and Preserve, March 1988.

Area/ CTD Index	Red Fox	Marten	Wolverine	Lynx	Snowshoe Hare
West N=61					
None	88	11	97	98	38
Low	2	23	2	0	23
Fair	3	21	2	2	16
Good	7	30	0	0	15
High	0	15	0	0	8
East N=83					
None	73	36	100	89	18
Low	10	16	0	4	13
Fair	5	17	0	1	20
Good	5	11	0	4	20
High	7	20	0	2	25

[a]Based on CTDs in Table 2.
[b]Red fox and hare CTDs were significantly higher in East GAAR, while marten were higher in West GAAR (Mann-Whitney U test, $P < 0.20$). Sample sizes of wolverine and lynx tracks/km among transects were too few to test.

Table 5. Percentage of transects (N)/corrected track density (CTD) index[a]/species[b] of 144 transects surveyed in 4 vegetation types in Gates of the Arctic National Park and Preserve, March 1988.

Vegetation Type/ CTD Index	Red Fox	Marten	Wolverine	Lynx	Snowshoe Hare
Alpine Tundra N=15					
None	93	86	100	100	53
Low	7	7	0	0	33
Fair	0	0	0	0	13
Good	0	7	0	0	0
High	0	0	0	0	0
Moist Tundra N=2					
None	50	50	100	100	50
Low	0	50	0	0	0
Fair	0	0	0	0	0
Good	50	0	0	0	50
High	0	0	0	0	0
Upland Forest N=92					
None	78	21	100	90	20
Low	8	18	0	3	14
Fair	5	20	0	2	20
Good	3	20	0	3	23
High	5	22	0	1	24
Lowland Forest N=35					
None	80	11	94	97	31
Low	3	23	0	0	26
Fair	3	26	3	0	20
Good	11	23	0	0	11
High	3	17	3	3	11

[a]Based on CTDs in Table 2.
[b]Mann-Whitney U tests ($P < 0.20$) indicated red fox CTDs were higher in upland forest than in alpine tundra, marten CTDs were higher in both forest types than in alpine tundra, and hares CTDs were higher in the forest types and highest in upland forest. Tests including moist tundra and wolverines and lynx were not conducted due to low sample sizes.

Compared with track densities in the Yukon Flats National Wildlife Refuge (YFNWR), those in GAAR were higher for lynx but lower for red foxes, marten, and hares (Table 6). GAAR also had consistently lower percentages of transects with species track counts > 0. In addition, the average densities of the vegetation canopy along transects indicated the area surveyed in GAAR had light to moderate cover compared with moderate to dense cover in the YFNWR (Table 7).

Table 6. Quartiles[a] of corrected track densities (CTD) > 0 for furbearers counted along transects (N) in Gates of the Arctic National Park and Preserve, March 1988, and YFNWR, March and April 1985. Values in parentheses = % N with CTD > 0.

Area/ Quartile	Red Fox	Marten	Wolverine	Lynx	Snowshoe Hare
GAAR					
N=144	(20)	(74)	(1)	(7)	(74)
I	0.07	0.17	0.05	0.06	0.28
II	0.09	0.49	0.08	0.14	0.78
III	0.21	1.29		0.21	2.32
IV	2.30	7.57		0.73	34.86
YFNWR					
N=343	(79)	(93)		(54)	(94)
I	0.11	0.21		0.05	0.36
II	0.21	0.50		0.08	0.81
III	0.47	0.97		0.14	1.63
IV	1.96	3.78		0.64	13.94

[a]Distribution of CTDs (> 0) divided into approximately 4 equal parts: I ≤ 25%, II ≤ 50%, III ≤ 75%, and IV ≤ 100%.

Table 7. Mean percentage of vegetation cover class (VCC)[a] length and of mean vegetation index (VI) that occurred along 3-km transects (N) surveyed in Gates of the Arctic National Park and Preserve, March 1988, and along 5-km transects surveyed in the YFNWR, March and April 1985.

Area	N	VCC				VI[b]
		Bare	Light	Moderate	Dense	
GAAR	144	18	32	38	13	30
YFNWR	343	9	9	47	35	50

[a]Bare = 0%, Light = 1-24%, Moderate = 25-59%, and Dense = 60-100% cover.
[b]$VI = \Sigma(\%VCC_i/\text{transect} * VCC_i \text{ midpoint})$, where midpoint for Bare = 0.00, Light = 0.12, Moderate = 0.42, and Dense = 0.80.

Vegetation canopy cover (VCC) alone cannot explain differences in track densities among transects or between areas. Much of the difference between study areas was probably because the YFNWR encompasses diverse and extensive furbearer habitat, whereas GAAR contains the northern limit of habitat for furbearers other than wolverines. Habitat diversity has been shown to be important for red foxes (Pulliainen 1981, Samuel and Nelson 1982), marten (Koehler and Hornocker 1977, Pulliainen 1981, Strickland et al. 1982, Magoun and Vernan 1986), lynx (McCord and Cardoza 1982), and snowshoe hares (Wolff 1980, Pietz and Tester 1983, Keith et al. 1984, Fuller and Heisey 1986). Habitat diversity is often stimulated by wildfire, which is frequent and widespread in the YFNWR (Foote 1983) but probably less so in GAAR. The higher track density of lynx in GAAR may have resulted in part from the approximate 10-year population cycle of lynx in YFNWR being near its lowest level in 1985 when surveys were conducted there (Golden 1987).

Beavers

The Lower Kobuk River had the highest density of active lodges (Act/km^2) among lakes, sloughs, and creeks, whereas the Alatna River had the highest densities along rivers (Act/km) and for all waterbodies combined (Act/km^2) (Table 8). The North Fork of the Koyukuk River also had higher active-lodge densities along rivers than either of the Kobuk areas, although the North Fork's combined density was lower than that for either Kobuk area. The John River was the 3rd largest area surveyed but had by far the lowest density of active lodges. The ratios of active:inactive lodges among the areas surveyed were as follows: Lower Kobuk = 1.8, Upper Kobuk = 2.3, Alatna = 3.0, John = 0.7, and North Fork = 2.2.

Comparisons of active lodge density and active:inactive lodges over time should be reliable indicators of beaver population dynamics, quality beaver habitat, and patterns of dispersal of beavers in GAAR. Densities of active beaver lodges in GAAR was similar to those reported for the Yukon Flats, where they ranged from 0.07-0.26/km^2 (Mclean 1986). The potential causes of differences in beaver density and the relationships of beavers with their habitat should be explored in future work in GAAR.

Table 8. Active (A) and inactive (I) beaver lodges for selected drainages in Gates of the Arctic National Park and Preserve, 26-29 September 1987. Activity was determined from the presence of food caches near lodges observed from the air.

Drainage	Area/Length (km^2)	(km)	Lake, Creek, Slough A	I	A/km^2	I/km^2	Rivers A	A/km	Combined Total A	I	A/km^2	I/km^2
Upper Kobuk	46	22	8	5	0.17	0.11	1	0.04	9	5	0.20	0.11
Lower Kobuk	87	26	19	9	0.22	0.10	2	0.08	21	9	0.24	0.10
Alatna	153	106	32	15	0.21	0.10	13	0.12	45	15	0.29	0.10
John	91	56	2	3	0.02	0.03	0	0.00	2	3	0.02	0.03
North Fork	234	57	33	17	0.14	0.07	5	0.09	38	17	0.16	0.07
Overall	611	267	94	49	0.15	0.08	21	0.08	115	49	0.19	0.08

Trapper Observations and Harvest of Furbearer Populations

Trapping areas mapped for 12 trappers in and near GAAR included most of the furbearer habitat in the southern and northeastern portions (Fig. 8). Trappers took advantage of furbearer habitat that was most accessible to them and that was available in terms of other trappers areas of use. Those trappers near the Dalton Highway generally had trapping areas near the road.

Some of the trappers from Anaktuvuk Pass only went as far from home as they could travel over a weekend because they had to be at their jobs on weekdays. Most of the trappers in southern GAAR stayed in their areas for extended periods. Access to trapping areas was made by snow machine, plane, or automobile and traplines were traveled by snow machine or walking.

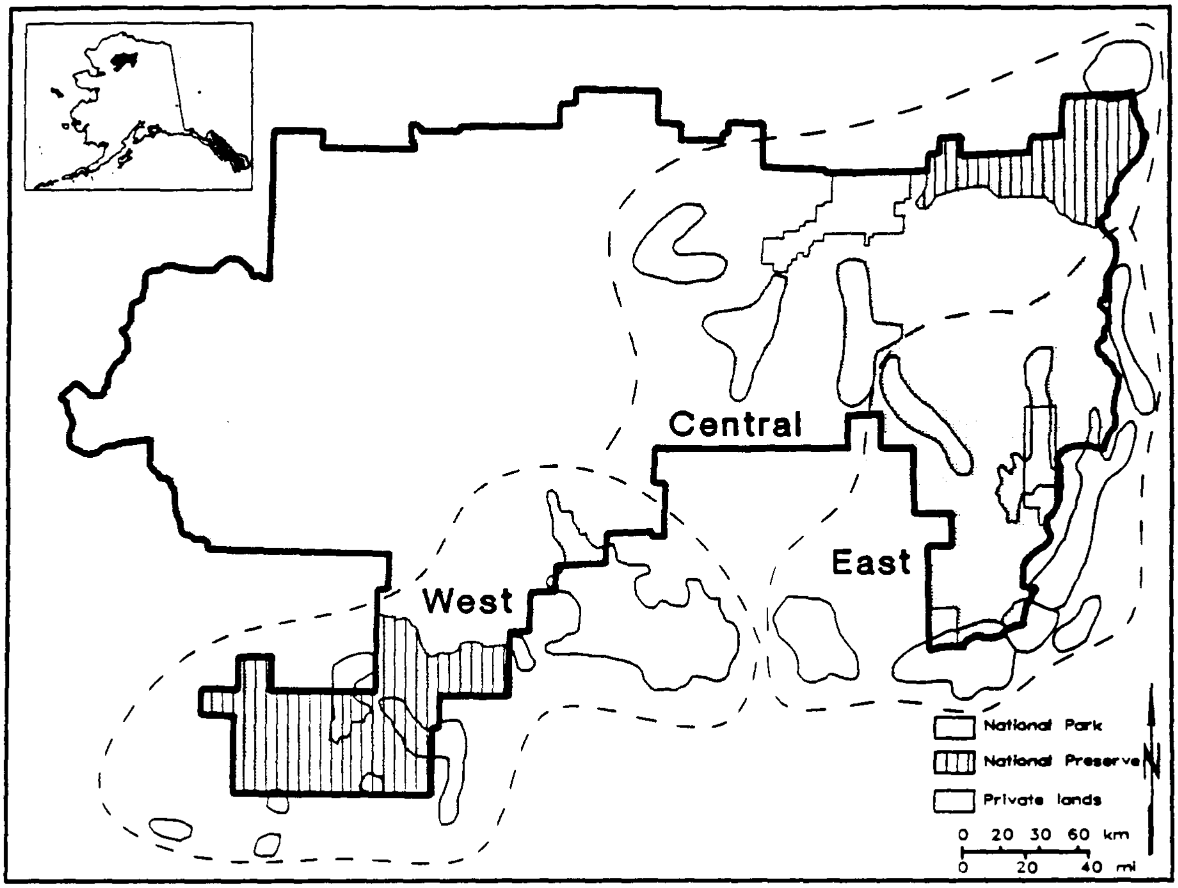

Figure 8. Trapping areas of 12 individual trappers in Gates of the Arctic National Park and Preserve, 1987-88.

Trappers centered their efforts on the most abundant and profitable species in their areas. Those in West and East GAAR primarily trapped marten and caught lynx, red foxes, and wolverines as the opportunity arose. Trappers in Central GAAR, however, only trapped the latter 3 species.

Trappers reported that the marten population level in 1987-88 and trend between 1986-87 and 1987-88 appeared to be moderate to moderately high and stable or increasing slightly in number overall in GAAR (Table 9). West GAAR probably contained the highest densities of marten and had the most favorable marten habitat within GAAR. One trapper from Wiseman (in East GAAR) said that prior to 4 years ago marten did not occur along the Dalton Highway north of

Coldfoot. He attributed their current presence to the regrowth of vegetation along the Middle Fork Koyukuk since the active mining days when much of the area was burned.

Lynx populations were generally considered low all over and have been low since about 1982 (Table 9). One trapper reported that lynx were as low in the Kobuk drainage in 1987 as when he first began trapping there in 1972. Two trappers from Wiseman said lynx were still numerous in several pockets at the heads of drainages. Of the remaining furbearer species, red foxes appeared to be moderately high and increasing in East GAAR, low and declining in West GAAR, and moderate and fairly stable overall. Wolverines were usually seen early and late in the trapping season in southern GAAR. Most of the trappers thought they were moderate to moderately low and stable in number. River otters were scattered along river drainages and were considered locally abundant and stable by 1 trapper from West GAAR and 1 from East GAAR. Beavers were thought to be high and increasing in all areas of GAAR.

Snowshoe hares were reported to be low in most areas used by trappers (Table 9), except for a few drainages along the Dietrich River. Their numbers crashed in 1982-83 but appear to be improving. A trapper from Wiseman said the hare population was as high as anyone had ever seen them prior to their last decline. He said the peak of their cycle extended a couple of years longer than normal. As a consequence of their abundance, the trapper said the brush had still not recovered from the heavy browsing by hares. Ptarmigan and grouse appeared to be improving rapidly in number but were still low to moderate in the areas trappers used.

Table 9. Indexes of furbearer population level[a] (L) in 1987-88 and trend[b] (T) between 1986-87 and 1987-88 based on trapper observations (N) for areas in and near GAAR.

Area	Red Fox L	Red Fox T	Marten L	Marten T	Wolverine L	Wolverine T	River Otter L	River Otter T	Lynx L	Lynx T	Snowshoe Hare L	Snowshoe Hare T	Beaver L	Beaver T
West	1.0	-1.7	5.0	1.7	3.7	0	5.0	0	1.0	-1.7			5.0	5.0
	(3)		(3)		(3)		(1)		(3)				(1)	
Central	2.0	0			1.7	0			1.0	0	1.0	5.0		
	(4)				(3)				(2)		(1)			
East	3.7	2.5	3.2	0.6	2.0	1.2	5.0	0	1.0	1.7	1.6	0.4	5.0	5.0
	(6)		(8)		(8)		(1)		(6)		(7)		(4)	
Overall	2.5	0.8	3.7	0.9	2.3	0.7	5.0	0	1.0	0.4	1.5	2.5	5.0	5.0
	(13)		(11)		(14)		(2)		(11)		(8)		(5)	

[a]Population levels: 5 = high, 3 = moderate, 1 = low.
[b]Population trends: 5 = increased, 0 = unchanged, -5 = decreased.

ADF&G pelt-sealing data were examined for harvest areas within and adjacent to GAAR for trapping seasons 1984-85 through 1986-87. Trappers are required to have an ADF&G representative seal all pelts of lynx, wolverines, beavers, river otters, and wolves, and the data are coded to specific minor drainages of GMU. There were 44 individual trappers who reported they trapped animals in and adjacent to GAAR during the 1986-87 season. Of those 44, 17 trapped within GAAR, 33 trapped in adjacent areas, and 6 trapped both in and outside GAAR.

It is important to note that pelt-sealing data represent only the reported harvest of furbearers. Lynx harvests are probably well documented because their high pelt price motivates trappers to sell them, virtually ensuring that they are sealed. However, other species such as wolverines and wolves, may have more value if used locally (perhaps for parka ruffs) and are often not reported (Magoun 1985, L. Adams and R. Stephenson: pers. comm.). Magoun (1985:142) believed that reported wolverine harvest in GMU 26 probably represented no more than about 50% and in some years as little as 10% of the actual harvest.

I believe there is value in the pelt-sealing data, though, as an indication of furbearer harvest trends and distribution. Of the lynx harvested in GAAR and nearby areas, only 27-32% were taken within GAAR (Table 10). There was a marked decline in the reported harvest between 1985-86 and 1986-87. This may have been partly a reflection of trapper's efforts to reduce their harvests in response to a request by the ADF&G. The harvest distribution of lynx during the last 3 years indicated that nearly all were taken from the eastern half of GAAR and adjacent areas (Fig. 9). The harvest of wolverines was relatively stable between 1984-85 and 1986-87 (Table 10) and it appeared to also occur predominantly in the eastern half of GAAR and periphery (Fig. 10). The reported harvest of beavers and river otters were both very light in GAAR all 3 years (Table 10). However, there was nearly a 400% increase in harvest of beavers adjacent to GAAR in 1986-87 compared with 1985-86. Many trappers took furbearers by shooting them, but the most common methods were trapping and snaring.

Table 10. Furbearers harvested (N) in and near GAAR from 1984-85 to 1986-87. Data obtained through Alaska Dep. of Fish & Game pelt-sealing records of reported harvest.

Year/Area	Lynx	Wolverine	River Otter	Beaver
1984-85				
GAAR Only	31	5	0	2
GAAR + Nearby	113	19	2	37
1985-86				
GAAR Only	39	11	0	0
GAAR + Nearby	120	24	1	44
1986-87				
GAAR Only	19	6	8	6
GAAR + Nearby	63	14	11	169

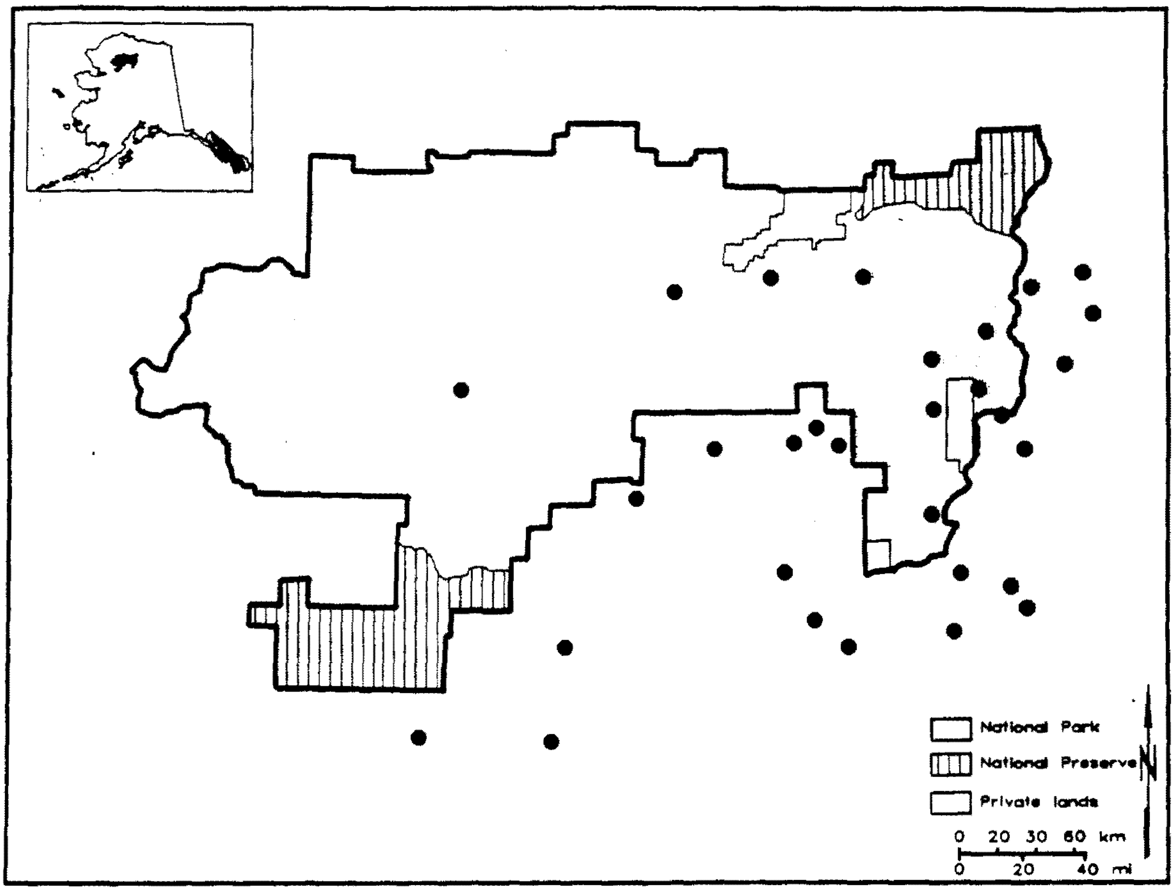

Figure 9. Lynx harvest locations in and near Gates of the Arctic National Park and Preserve for trapping seasons 1984-85 to 1986-87 combined. Dots represent Alaska Department of Fish and Game harvest units.

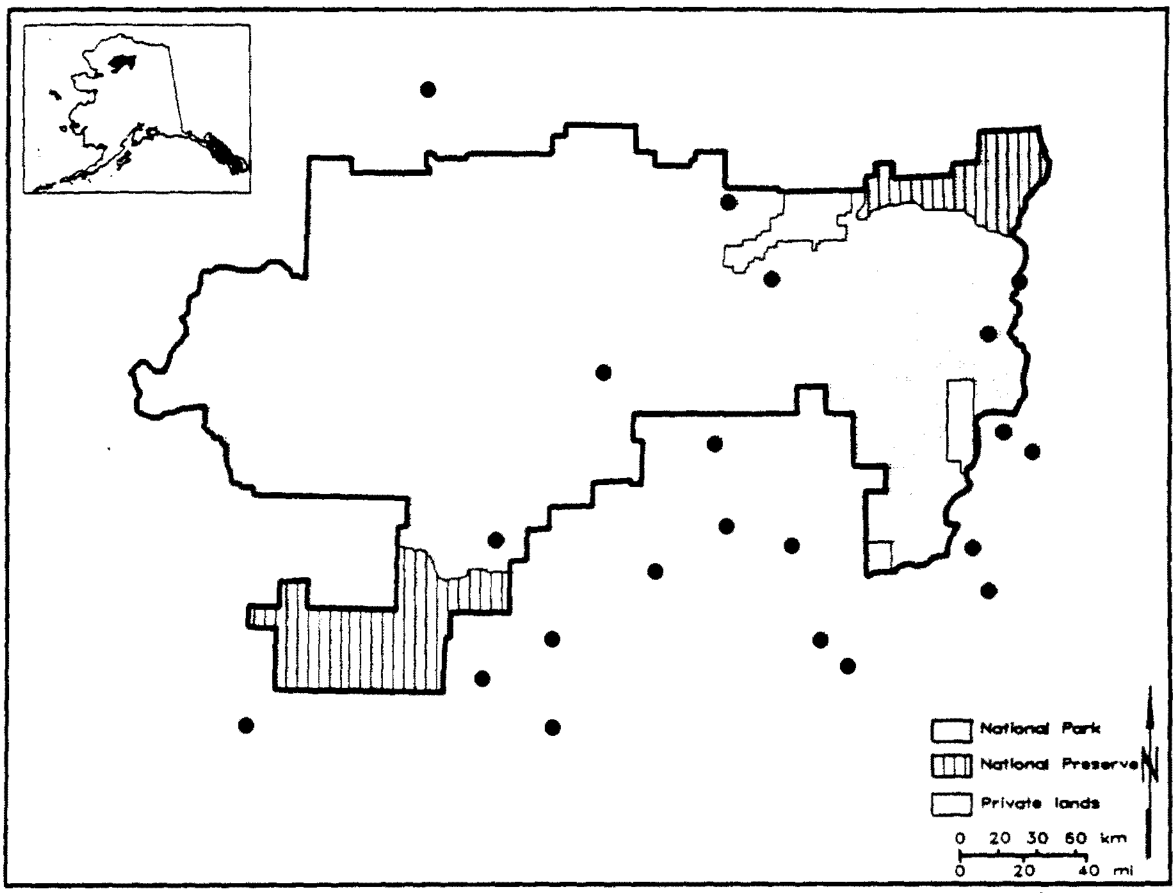

Figure 10. Wolverine harvest locations in and near Gates of the Arctic National Park and Preserve for trapping seasons 1984-85 to 1986-87 combined. Dots represent Alaska Department of Fish and Game harvest units.

Data on the harvest of marten and red foxes is limited to those acquired through trapper-interviews, carcass purchases, or fur buyer reports. The latter may be obtained through ADF&G records and can be useful if individual trappers and their areas of use are known. Records from furbuyer reports were not examined in this study but should be in future furbearer work in GAAR. All trappers in West and East GAAR concentrated primarily on trapping marten. Marten are relatively easy to catch and skin and have been selling for an average of $100/pelt. Lynx are also fairly easy to catch and may sell for $400-$600, but their populations have been too low recently to warrent much effort to catch them.

Population Characteristics

Trappers from GAAR supplied 342 carcasses of red foxes, marten, wolverines, lynx, and river otters, with marten comprising 80% of the total (Table 11). Contributing trappers from West GAAR caught only marten and river otters, those from Central GAAR caught only foxes, wolverines, and lynx, and those from East GAAR caught all the above except river otters.

Table 11. Sum and average/trapper of furbearer carcasses[a] purchased from trappers (N) for 3 areas in and near GAAR, 1987-88. Values only indicate the number of furbearers purchased not trapped, because contributions by individual trappers was limited to approximately 50 animals/species.

Area[b]	N	Red Fox M	Red Fox F	Red Fox T	Marten M	Marten F	Marten T[c]	Wolverine M	Wolverine F	Wolverine T[c]	Lynx M	Lynx F	Lynx T	R. Otter M	R. Otter F	R. Otter T
West																
Sum	3				105	63	168							3	4	7
Ave.					35	21	56							1	1.3	2.3
Central																
Sum	7	9	4	13				6	1	7	6	5	11			
Ave.		1.3	.6	1.4				.9	.1	1	.9	.7	1.6			
East																
Sum	7	3	2	5	44	28	107	2	4	7	10	7	17			
Ave.		.4	.3	.7	6.3	4.0	15.3	.3	.6	1	1.4	1	2.4			
Overall																
Sum	17	12	6	18	149	91	275	8	5	14	16	12	28	3	4	7
Ave.		.7	.4	1.1	8.8	5.4	16.2	.5	.3	.8	.9	.7	1.6	1	1.3	2.3

[a]M = male, F = female, T = total.
[b]West includes Kobuk and Alatna drainages; Central includes upper North Fork, upper John, Anaktuvuk, and Killik drainages; and East includes Dietrich, Middle Fork and North Fork Koyukuk, Wild, and lower John drainages.
[c]Includes carcasses of unknown sex.

Sex ratios of the furbearer carcasses analyzed favored males in each of the 3 areas sampled, with the exception of wolverines in East GAAR and river otters in West GAAR (Table 12). Harvests of more males than females is typical for furbearers; e.g., in Ontario, Canada, red fox ratios ranged from 46:31 and 50:27 males:females (Voigt 1987) and marten ranged from 48:52 to 74:26 males:female (Strickland and Douglas 1987). For the last 3 harvest seasons, trappers in and near GAAR have consistently taken more wolverine males than females (Table 13). Female lynx, however, have dominated males in the reported harvests of 1984-85 and 1985-86. This situation has been coincidental with declining populations elsewhere (Quinn and Parker 1987). Only 2 river otters were caught in 1984-85 and 1 in 1985-86, so sex ratios could not be calculated.

Table 12. Percentage of males:females for furbearers (N) caught by trappers in and near GAAR, 1987-88. Data were obtained from carcass analysis.

Area	Red Fox	Marten	Wolverine	Lynx	River Otter
West		63:37(168)			43:57(7)
Central	69:31(13)		86:14(7)	55:45(11)	
East	60:40(5)	61:39(72)	40:60(6)	62:38(17)	
Overall	67:33(18)	62:38(240)	67:33(13)	59:41(28)	43:57(7)

Table 13. Percentage of males (M):females (F):unknown sex (Unk) for furbearers harvested in and near GAAR from 1984-85 to 1986-87. Data were obtained from ADF&G pelt-sealing records of reported harvest.

Year/Area	Lynx			Wolverine			River Otter		
	M	F	Unk	M	F	Unk	M	F	Unk
1984-85									
GAAR Only	29	35	35	80	20				
GAAR + Nearby	30	44	26	68	32				
1985-86									
GAAR Only	20	23	56	64	9	27			
GAAR + Nearby	24	28	48	67	17	17			
1986-87									
GAAR Only	58	37	5	50	33	17	75	25	
GAAR + Nearby	41	36	22	50	36	14	73	27	

Age ratios indicated high numbers of juveniles:adults and juveniles:adult females for all species and areas sampled, with the exception of lynx (Table 14). The latter had relatively low proportions of juveniles, which is indicative of the generally low level and productivity of lynx just following the bottom of their population cycle in the GAAR area. The presence of up to 29% juveniles in the harvest at this point probably indicates that the population is beginning to increase. ADF&G harvest records indicated kittens (based on pelt lengths of < 34 in) comprised only 1% of the harvest in 1984-85 and 5% in 1985-86 and 1986-87.

Table 14. Percentage of juveniles (J):adults (A) and juveniles:adult females (AF)[a] of furbearers (N) caught by trappers in and near GAAR, 1987-88.

Area	Red Fox		Marten		Wolverine		Lynx		River Otter	
	J:A	J:AF	J:A	J:AF	J:A	J:AF	J:A	J:AF	J:A	J:AF
West			58:42 (168)	83:17 (118)					71:29 (7)	100:0 (5)
Central	69:31 (13)	90:10 (10)			71:29 (7)	100:0 (5)	0:100 (11)	0:100 (5)		
East	60:40 (5)	75:25 (4)	83:17 (107)	96:4 (93)	100:0 (7)	100:0 (7)	29:71 (17)	50:50 (10)		
Overall	67:33 (18)	86:14 (14)	68:32 (275)	89:11 (211)	86:14 (14)	100:0 (14)	18:72 (28)	33:67 (15)	71:29 (7)	100:0 (5)

[a]Juveniles were considered to be animals < 2 years old as determined by tooth cementum aging.

Age classes 0 to 1 comprised the largest proportion of red fox (Table 15), wolverine (Table 16), and river otter (Table 17) carcasses purchased from trappers. Older age classes are usually less common in population age structures, but for these 3 species the scarcity may have been due as much to the small sample sizes. The age structure of lynx indicates a depressed though probably increasing population (Table 18), but data from only 1 year are insufficient to accurately describe the status of a population. The 0 and 1 age classes were poorly represented especially in Central GAAR, which encompasses the most marginal habitat sampled for lynx carcasses. The gap between ages 1-5 may have resulted from a lack of kitten production during the lowest phase of the 10-year population cycle (Quinn and Parker 1987). The ages of marten carcasses reflects a generally healthy age structure, with a maximum age of 11 years (Table 19). Overall the proportions of ages 1 and 2 were somewhat lower than reported from Ontario, Canada (Strickland and Douglas 1987), and West GAAR had more older aged marten, especially females, than East GAAR (Fig. 11).

Table 15. Percentage of red foxes (N) per age class (years) by sex caught by trappers in and near GAAR, 1987-88.

Area/Sex	N	Age 0	1	2	3	4	5	6	7	8
Central										
Male	9	23	23						8	15
Female	4	23		8						
Total	13	46	23	8					8	15
East										
Male	3	40			20					
Female	2		20			20				
Total	5	40	20		20	20				
Overall										
Male	12	28	17		6				6	11
Female	6	17	6	6		6				
Total	18	44	22	6	6	6			6	11

Table 16. Percentage of wolverines (N) per age class (years) by sex caught by trappers in and near GAAR, 1987-88.

Area/Sex	N	Age 0	1	2	3	4	5	6	7
Central									
Male	6	28	28	14					14
Female	1	14							
Total	7	43	28	14					14
East									
Male	2		33						
Female	4	67							
Total[a]	7	57	43						
Overall									
Male	8	15	31	18					8
Female	5	38							
Total[a]	14	50	36	17					7

[a]Includes wolverines of unknown sex.

Table 17. Percentage of river otters (N) per age class (years) by sex caught by trappers in and near West GAAR, 1987-88.

Area/Sex	N	Age 0	1	2	3	4	5	6	7
Male	3		14		14				14
Female	4	28	28						
Total	7	28	43		14				14

Table 18. Percentage of lynx (N) per age class (years) by sex caught by trappers in and near GAAR, 1987-88.

Area/Sex	N	Age 0	1	2	3	4	5	6	7	8
Central										
Male	8						19	27	18	
Female	5						19	18	9	9
Total	11						18	45	27	9
East										
Male	10	12	16				12	12	18	
Female	7	12					18	6		6
Total	17	24	16				29	18	18	6
Overall										
Male	16	7	16				11	18	18	
Female	12	7					14	11	4	7
Total	28	14	16				25	28	21	7

Table 19. Percentage of marten (N) per age class (years) by sex caught by trappers in and near GAAR, 1987-88.

Area/Sex	N	Age 0	1	2	3	4	5	6	7	8	9	10	11
West													
Male	105	25	8	5	9	4	2	1	3	2	3		1
Female	63	22	4	3	5	2	2		1				
Total	168	47	12	8	14	6	4	1	4	2	3		1
East													
Male	48	46	2	6	1			1	1	1			
Female	33	36		1	1	2							
Total[a]	107	78	6	6	3	5		1	1	1			
Overall													
Male	153	32	6	6	6	2	2	1	2	2	2		1
Female	96	26	2	2	4	2	1		1				
Total[a]	275	59	8	8	9	5	3	1	3	1	2		1

[a]Includes marten of unknown sex.

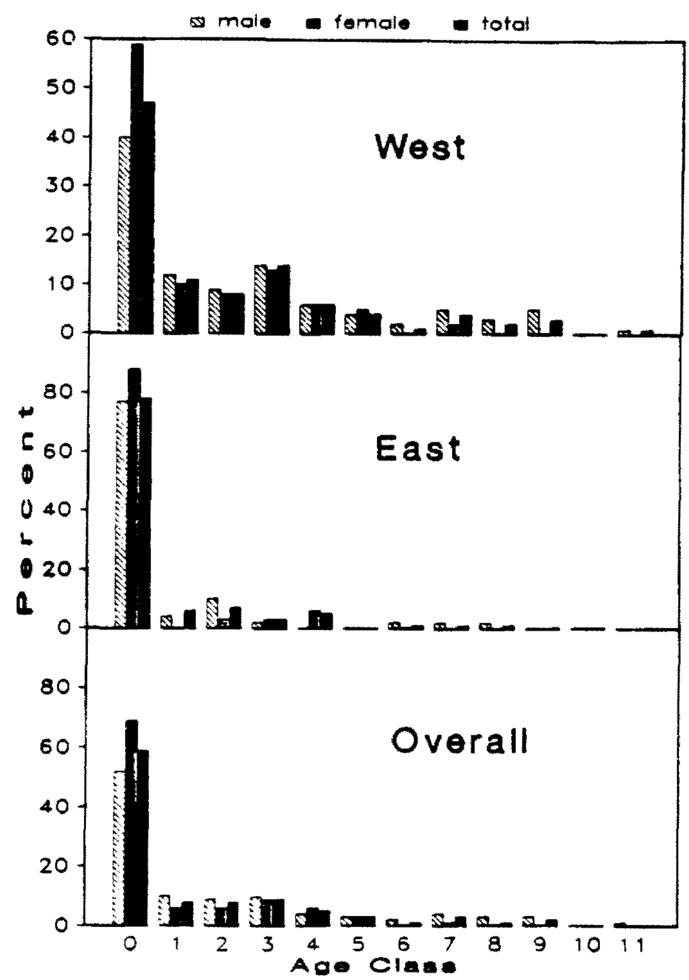

Figure 11. Percent males:females:total/age class for marten carcasses from West, East, and Overall Gates of the Arctic National Park and Preserve, 1988.

Visceral fat content of necropsied carcasses was also used to assess the vigor of furbearer populations in and near GAAR. Fat stores are usually an indication of general animal health, and visceral fat (found in the abdominal cavity) is easy to estimate for relative comparison intra- and interspecifically. Red foxes, marten, and wolverines all had scarce to moderate levels of visceral fat, and none of the species exhibited strong differences among the areas trapped (Table 20). It is apparently common for marten in interior Alaska to have low levels of free fat (A. Magoun: pers. comm.). Lynx, however, had moderate to abundant levels in both Central and East GAAR. Obviously the lynx living in and near GAAR had good prey abundance to supply adequate food.

Table 20. Mean visceral fat content of furbearers (N) caught by trappers in and near GAAR, 1987-88. Indexes of 0, 1, 2, or 3 indicate estimated amounts of none, scarce, moderate, or abundant fat, respectively.

Location	Red Fox	Marten	Wolverine	Lynx
West		1.7 (122)		
Central	1.5 (13)		1.9 (7)	2.8 (11)
East	1.6 (5)	1.4 (121)	1.7 (7)	2.6 (17)
Overall	1.5 (18)	1.4 (243)	1.8 (14)	2.7 (28)

CONCLUSIONS AND RECOMMENDATIONS

Aerial track counts, trapper observations, harvest records, and carcass analysis indicated that furbearer populations in and near GAAR were in good condition and under no apparent threat of overharvest. Marten were harvested more than other species, but the population appeared to be healthy despite being at its northern habitat limit. Track counts showed the highest densities of red foxes, marten, lynx, and snowshoe hares were in areas having the greatest trapping pressure. Trapper observations of furbearer relative abundance in GAAR generally correlated with track counts. It was apparent from interviews with trappers that they were very aware of furbearer population changes and that they responded accordingly to prevent overharvest of any particular species. The current known distribution of trappers in and near GAAR seems to be compatible with the ability of populations to withstand the pressure. This situation is not likely to change significantly given the density of trappers, their conscientious efforts, and their access to suitable areas.

It is not practical or reasonable to attempt to define the status of furbearer populations in GAAR based on only one year's data. Although initial indications are positive, the methodology used in this study to monitor populations and harvest should be continued. For example, lynx numbers appear to be increasing but their distribution, relative abundance, age and sex ratios, and harvest must be regularly documented to decipher the types and magnitude of changes that may occur in the population. No single technique is adequate to completely describe population dynamics, so it is necessary to use several techniques to document and verify real changes.

The aerial track survey was one of the most important tools used in this study, but it must be conducted by trained observers and requires further testing and development before widespread application. The technique will be used, tested, and modified by ADF&G in the Yukon Flats beginning in 1989. Results of that work will be available to GAAR for implementation. For the interim, I make the following recommendations to enact a program of monitoring furbearer populations and their uses that will meet the management needs of GAAR:

1. Further develop current relationships and establish new relationships with individual trappers who trap in and near GAAR;

2. On a yearly basis, seek trappers' knowledge and impressions of furbearer populations and document trapping areas;

3. Collect whole carcasses of lynx and skulls of marten, wolverines, and red foxes each year from trappers by paying a nominal fee; stress the importance of having trappers provide all information on specimen tags, particularly sex; have extracted canine teeth aged and preserve the reproductive tract of female lynx for later analysis;

4. On a yearly basis, examine ADF&G harvest data from pelt-sealing and furbuyer records to document areas of use, harvest, and methods of take by trappers;

5. Every other year, beginning in 1989, conduct beaver surveys as described in this report.

LITERATURE CITED

Bee, J. W., and E. R. Hall. 1956. Mammals of northern Alaska. Univ. of Kansas Museum Nat. Hist., Lawrence. 309pp.

Burt, W. H., and R. P. Grossenheider. 1976. A field guide to the mammals. Houghton Mifflin Co., Boston. 289pp.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York. 234pp.

Ernest, J. R. 1986. Results of 1984-85 trapper questionnaires. Pages 76-94 in B. Townsend, ed. Annual report of survey-inventory activities. Part XIV, Vol. XVI. Alaska Dep. Fish and Game. Fed. Aid in Wildl. Rest. Juneau.

Foote, M. J. 1983. Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. USDA For. Serv., Pacific Northwest For. Range Exp. Sta., Res. Pap. PNW-307. Portland, Oregon. 108pp.

Fuller, T. K., and D. M. Heisey. 1986. Density-related changes in winter distribution of snowshoe hares in northcentral Minnesota. J. Wildl. Manage. 50:261-264.

Golden, H. N. 1987. Survey of furbearer populations on the Yukon Flats National Wildlife Refuge. Final Rep. Coop. Agree. Proj. No. 14-16-007-84-7416. Alaska Dep. Fish and Game and U.S. Fish and Wildl.Serv., Fairbanks, Alaska. 86pp.

Hay, K. G. 1958. Beaver census methods in the Rocky Mountain region. J. Wildl. Manage. 22:395-402.

Keith, L. B., J. R. Cary, O. J. Rongstad, and M. C. Brittingham. 1984. Demography and ecology of a declining snowshoe hare population. Wildl. Monogr. 90. 43pp.

Koehler, G. M., and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitteroot Wilderness. J. Wildl. Manage. 41:500-505.

Magoun, A. J. 1985. Population characteristics, ecology, and management of wolverines in northwestern Alaska. Ph.D. Thesis. Univ. of Alaska, Fairbanks. 197pp.

_____, and D. J. Vernam. 1986. An evaluation of the Bear Creek burn as marten (Martes americana) habitat in interior Alaska. Final Rep., Coop. Agree. Spec. Proj. No. AK-950-CAH-0, Bur. Land Manage., Anchorage and Alaska Dep. Fish and Game, Fairbanks. 58pp.

McCord, C. M., and J. E. Cardoza. 1982. Bobcat and lynx. Pages 728-766 in J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America. The Johns Hopkins Univ. Press, Baltimore, Md.

McLean, L. S. 1986. Beaver food cache survey, Yukon Flats National Wildlife Refuge, Alaska, 1985. YFNWR Proj. Rep. No. 86-5. U.S. Fish and Wildl. Serv., Fairbanks, Alaska. 8pp.

NPS. 1987. Gates of the Arctic National Park and Preserve, Alaska -- general management plan/land protection plan/wilderness suitability review. USDI National Park Serv., Fairbanks, Alaska. 299pp.

Pietz, P. J., and J. R. Tester. 1983. Habitat selection by snowshoe hares in north central Minnesota. J. Wildl. Manage. 47:686-696.

Pulliainen, E. 1981. A transect survey of small land carnivore and red fox populations on a subarctic fell in Finnish Forest Lapland over 13 winters. Annu. Zool. Fenn. 18:270-278.

Quinn, N. W. S., and G. Parker. 1987. Lynx. Pages 682-694 in M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ontario Trappers Assoc., North Bay.

Rausch, R. 1951. Notes on the Nunamiut Eskimos and mammals of the Anaktuvuk Pass Region, Brooks Range, Alaska. Arctic 4(3):147-195.

_____. 1953. On the status of some arctic mammals. Arctic 6(2):91-148.

Samuel, D. E., and B. B. Nelson. 1982. Foxes. Pages 475-490 in J. A. Chapman and G. A. Feldhamer, eds. Wild Mammals of North America. The Johns Hopkins Univ. Press, Baltimore, Md.

Slough, B. G., and R. H. Jessup. 1984. Furbearer inventory, habitat assessment and trapper utilization of the Yukon River basin. Yukon River Basin Study Proj. Rep.: Wildlife No. 1. Wildl. Manage. Branch, Yukon Dep. Renew. Resour., Whitehorse, Canada. 87pp.

Strickland, M. A., and C. W. Douglas. 1987. Marten. Pages 530-546 in M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ontario Trappers Assoc., North Bay.

Strickland, M. A., C. W. Douglas, M. Novak, and N. P. Hunziger. 1982. Marten. Pages 599-612 in J. A. Chapman and G. A. Feldhamer, eds. Wild mammals of North America. The Johns Hopkins Univ. Press, Baltimore, Md.

Swenson, J. E., S. J. Knapp, P. R. Martin, and T. C. Hinz. 1983. Reliability of aerial cache surveys to monitor beaver population trends on prairie rivers in Montana. J. Wildl. Manage. 47:697-703.

Voigt, D. R. 1987. Red fox. Pages 378-392 in M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ontario Trappers Assoc., North Bay.

Wolff, J. O. 1980. The role of habitat patchiness in the population dynamics of snowshoe hares. Ecol. Monogr. 50:111-130.