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# DEVELOPMENT OF LYNX POPULATION ESTIMATION TECHNIQUES

by
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## SUMMARY

Lynx (*Lynx canadensis*) population density, track occurrence, movements, and food habits were studied in 2 areas in the Tanana Valley in Interior Alaska. Eleven adult lynx (5 males, 6 females) were radio-collared and monitored for periods ranging from 7 days to 22.5 months. Lynx were relocated on 531 occasions. The home ranges of resident lynx ranged in size from 51.8 $km^2$ (20 $mi^2$) to 145 $km^2$ (56 $mi^2$). The movements of male lynx appeared to be more extensive than those of females, and lynx that were followed for periods of months often showed seasonal shifts in their focus of activity. Some of these shifts seemed to be associated with mating activity. This report includes detailed descriptions of movements associated with the mating season.

Estimated population density was 1 lynx per 26-61 $km^2$ (10-23.6 $mi^2$) during early and midwinter in the Tok study area. In the Wood River area, density was estimated at 1 lynx per 17-33 $km^2$ (6.7-12.9 $mi^2$) during early winter, and 1 lynx per 38-41 $km^2$ (14.7-15.8 $mi^2$) in late winter. Annual mortality rates from trapping appeared to be high, ranging from 55% to 100% of radio-marked lynx.

Winter track counts appear to provide the most promising method of monitoring lynx populations. Lynx tracks are readily identifiable from the ground and, with adequate snow and sunlight, from the air. The distinguishing characteristics of lynx tracks in various snow conditions are described in this report, and recommended procedures for track counts are presented. The relationship between lynx track frequency and lynx population has been evaluated. It appears that where topography and habitat are similar, relative to trails or transects, track frequency does reflect population density.

Information on sex and age composition, nutritional and reproductive condition, and body weight was obtained from 65 carcasses obtained from trappers. Food habits of lynx were determined from carcass necropsies and from analyses of scats and prey remains collected during field work. Lynx preyed extensively on snowshoe hares (*Lepus americanus*) (despite generally low numbers of hares), but also preyed on microtine rodents, birds, red squirrels (*Tamiascurius hudsonicus*), red foxes (*Vulpes vulpes*), caribou (*Rangifer tarandus*), and Dall sheep (*Ovis dalli*).

Key words: Interior Alaska, lynx, *Lynx canadensis*, population ecology, population estimate, survey, tracks, transect, predation.

CONTENTS



## BACKGROUND

In the North American range of the lynx (Lynx canadensis), it has become apparent in recent years that more refined management could measurably benefit lynx populations. The combination of increased human population in the North and a marked rise in lynx pelt value during the last decade has heightened trapping of lynx. The lynx, along with the marten (Martes americana), stands apart from other furbearers because it can be caught with relative ease. There is a strong concern among trappers and wildlife biologists alike that harvests should be more closely regulated.

The ecology of lynx has become increasingly well known; the cyclic fluctuations of lynx and snowshoe hare (*Lepus americanus*) populations have been studied (Keith 1963, Fox 1978, Finerty 1979, Winterholder 1980), and food habits, movements, and reproductive biology are, to varying degrees, known (Saunders 1961, Nava 1970, Nellis et al. 1972, Berrie 1973, Brand et al. 1976, Brand and Keith 1979, Parker et al. 1983*b*, O'Connor 1984).

Reliable estimates of lynx numbers have been determined in only a few relatively small areas through intensive field work (Iurgenson 1955, Brand et al. 1976, Parker et al. 1983*b*, Ward 1985). Still to be developed is a rapid and economical method of determining lynx population status over large areas. The lack of adequate population data and the resultant inability to evaluate the effects of harvest remain significant problems. A primary goal of this study was to explore potential ways of determining relative and/or absolute lynx abundance and to develop a technique that has broad applicability in Alaska.

Despite the widespread occurrence of lynx in northern parts of North America and their high value in the fur industry, there have been relatively few studies that have endeavored to describe the changes in the behavior and ecology of individual lynx and lynx populations that occur during the course of an entire snowshoe hare population cycle. This report summarizes 3 years of observations of lynx movements, food habits, productivity, survival, and mortality in areas where snowshoe hares were low and/or declining. The status of efforts to develop an enumeration technique is also summarized.

## OBJECTIVES

To develop criteria for aerial and on-the-ground identification of lynx tracks in snow.

To determine the sightability of lynx trails in snow from the air and ground in different habitats.

To obtain information on movements, home range, and dispersal of individual lynx.

To determine travel routes in relation to habitat.

To assess the timing and extent of movements in relation to season, weather, and snow conditions.

To determine the population density and productivity of a lynx population.

To develop and test various types of aerial and ground survey techniques and to develop a method for determining lynx abundance in relative and/or absolute terms.

## STUDY AREAS

During winter 1982-83, field work was conducted in an area 16 km (10 mi) south of Tok, Alaska, in the Tok River valley (Fig. 1). Intensive field work occurred in a 487 $km^2$ (188 $mi^2$) portion of the Tok River valley. This area extended from 3 km (2 mi) south of Tok approximately 29 km (18 mi) to the vicinity of the Tok River bridge and included the 3-4 mi wide Tok River valley floor and adjacent hillsides with elevations ranging from 550 m (1,800 ft) to 915 m (3,000 ft). The area is vegetated by spruce (*Picea* spp.) and mixed spruce-aspen (*Populus tremuloides*) forest with a scattering of willow (*Salix* spp.) and alder (*Alnus* spp.) thickets. Additional information was obtained from trappers in the upper Tanana Valley and the Fortymile and Ladue River drainages. Because of a dramatic decline in lynx numbers and the high mortality of radio-collared lynx due to trapping, field work in the Tok area was discontinued after winter 1982-83.

Between 28 October and 28 November 1983, I attempted to capture lynx and monitored lynx track occurrence in the Moose Creek area between the Chena and Tanana Rivers, 32 km (20 mi) east of Fairbanks. Lying between Moose Creek and Beaver Creek, this area is part of the Yukon Training Area owned by the U.S. Army and administered by the Natural Resource Office at Ft. Wainwright. With the permission of that office, I was able to use part of an area that had been closed to trapping for several years to protect sensitive recording equipment. The surrounding area is heavily trapped, with lynx being a commonly trapped species, and comprises rolling hills between 180 m (600 ft) and 360 m (1,200 ft) in elevation. Vegetation is a mixture of spruce, paper birch (*Betula papyrifera*), aspen, alder, and willow. An extensive trail system exists in the area.

In late February 1984, I located a study area 64 km (40 mi) south of Fairbanks, along the Wood River (Fig. 2). With the cooperation of Mr. Jim Smith, who has trapped in the area since the late 1960's, trapping efforts were conducted along a 40-km (25-mi) trail which included parts of the Rex and Bonnifield Trails and the Wood River, beginning on 13 March 1984. This area consists of mixed mature spruce and hardwood stands in the vicinity of the Wood River, open spruce muskeg, and aspen/spruce parkland on higher elevations south and west of the Wood River. The study area is bounded on the east by the 1980 Blair Lakes burn and is between 215 m (700 ft) and 360 m (1,200 ft) in elevation.

In addition to intensive field work in the aforementioned area, trappers in Ft. Yukon, Tok, Delta, Nenana, and Fairbanks were contacted for information on the status and history of lynx populations.

## METHODS

Efforts to capture and radio-mark lynx and monitor track occurrence near Tok were carried out between 14 October and 16 December 1982 and again between 10 February and 17 March 1983. During these periods, a 24-km (15-mi) route was traveled daily by truck and snowmachine to check traps and record the occurrence of tracks along roads and trails. During the period 17 December-10 February, only live traps remained in operation and these were checked every 2-3 days. Lynx were captured using from 12 to 22 live traps (Tomahawk Live Trap Co., Tomahawk, Wis.) and, during early winter, up to 40 No. 1-1/2 coil-spring leghold traps with padded jaws (Woodstream Corp., Lititz, Pa.). Trapped lynx were immobilized with ketamine hydrochloride (Parke-Davis and Co., Detroit, Mich.), acepromazine maleate (Ayerst Laboratories, Inc., New York, N.Y.), and atropine sulfate (Med-Tech, Inc., St. Joseph, Mo.) at dosages of approximately 11 mg/kg, 0.55 mg/kg, and 0.055 mg/kg, respectively. Drugs were administered with a pole syringe; radio collars (Telonics, Mesa, Ariz.) were attached; and lynx were weighed, measured, and released.

When intensive field work was in progress, radio-collared lynx were relocated once or twice daily, primarily from the ground through triangulation using hand-held 3-element Yagi or directional "H" antennae (Telonics, Mesa, Ariz.). Aerial relocations were obtained with Piper PA-18 aircraft using dual 3-element Yagi antennae.

The activity patterns of radio-marked lynx in the Tok study were monitored as opportunities arose using a battery-operated activity monitor consisting of a portable strip chart recorder, a TDP-2 digital data processor, a TR-2 receiver, and a 3-element Yagi antenna supplied by Telonics. The activity monitor was stationary at a site 50 m (150 ft) above the Tok River valley floor. The monitor operated continuously when a radio-marked lynx in the Tok River valley was within range, recording changes in signal period and amplitude. The length of "active" and "rest" periods was determined from tracings on chart paper which advanced at a rate of 4.66 in/hr. Based on tests with a radio-collared domestic dog, this instrument appeared to give an accurate picture of times when lynx were active and inactive.

The tracks of lynx and other mammals, made under various snow conditions, were measured, sketched, and photographed to determine the ease with which lynx tracks can be differentiated from those of other animals during aerial and ground transects. Track photographs were also obtained as an aid in instructing observers conducting future transects.

The visibility of lynx tracks during low-level aerial surveys was evaluated by flying transects with PA-18 aircraft across areas in which the occurrence of lynx trails was known from intensive ground work.

Lynx track occurrence in the Tok study area was monitored by cruising the highway and the "hillside road" (Fig. 1) at speeds of 5-16 km/hr (3-10 mi/hr), depending on light conditions and the density of vegetation adjacent to the road or trail. The visibility of tracks along the highway was high due to the lack of trees or shrubs within 10 m (33 ft) of the paved surface. The location of lynx trails and direction of travel were drawn on 1:63,360 maps. After being recorded, lynx trails were obliterated so they would not be recounted.

The methods used to capture lynx, monitor their movements, and determine track frequency in the Moose Creek and Wood River areas were similar to those used in the Tok study area. However, in the Moose Creek area, only live traps were used because the area was visited only every 2-3 days.

Field work was conducted briefly in the Moose Creek area between 28 October and 28 November 1983, when the occurrence of lynx tracks was monitored on 29 km (18 mi) of trails. Although a few lynx appeared to use the area, none were captured, and the occurrence of tracks declined markedly following the capture of 3 lynx by trappers near the border of the study area. Because of a scarcity of lynx after 12 November and the high level of trapping activity in the surrounding area, field work in this area was discontinued on 28 November.

Both live traps and No. 1-1/2 padded leghold traps were used to capture lynx in the Wood River area. Procedures used to immobilize and radio-collar lynx were identical to those used in 1982-83. Travel in both areas was by snowmachine, and PA-18 and C-185 aircraft were used to aerially relocate marked lynx.

Field work in the Wood River study area was conducted from 13 March to 5 April and 5 November to 4 December 1984 and from 1 March to 6 April 1985. During March 1984 and 1985, a trapline consisting of a 40-km (25-mi) triangular route including portions of the Bonnifield and Rex Trails and the

Wood River (Fig. 2) was used. This route was traveled daily to minimize the amount of time lynx spent in traps. The location and orientation of lynx tracks encountering these trails was recorded on 1:63,360-scale maps. During November and December 1984, a lack of snow precluded extensive snow-machine travel and trapping efforts were largely limited to a 11-km (7-mi) portion of the Wood River and the northern 3 km (2 mi) of the Bonnifield Trail. From 30 to 40 leghold traps and 10 to 20 live traps were used to capture lynx during periods of field work. Resident trappers cooperated in the Wood River study. James and Douglas Smith of Gold King Creek provided considerable assistance during capture efforts and also radio-collared and released 2 lynx during periods when I was absent from the study area.

The records of lynx trails encountering or crossing the trails used in the Tok, Moose Creek, and Wood River study areas were used to show the rate of accumulation of tracks in each study area. Lynx sometimes traveled on trails for as much as several hundred meters, or crossed a trail several times in the space of several meters. In these cases only 1 track crossing was "scored" for the purpose of estimating track frequency.

Lynx carcasses were obtained from trappers on a voluntary basis. The skinned carcasses were frozen until they could be necropsied. Measurements were obtained for weight, contour body length, tail length, heart girth, and canine length. The depth of subcutaneous fat on the sternum, flank, and lower abdomen (inguinal fat) was measured and the xiphoid fat was removed and weighed. The amount of visceral fat (or omental fat) was classified as absent, scarce, moderate, or abundant.

To classify lynx condition as "good" or "poor," I added the values for xiphoid, inguinal, and subcutaneous fat to obtain a general index to condition. Lynx with a fat index of 15 or less were arbitrarily classified as being in "poor" condition, while those with greater fat deposits were classified as "good." An index of less than 15 usually meant a lynx had little or no subcutaneous or inguinal fat and only a light deposit of xiphoid fat. Excluded from the analysis were lynx that I knew had been held in traps for more than a few days and thus had lost considerable fat reserves or were emaciated. However, the data are still affected by the fact that most lynx went from 1 to 5 days without eating; fat reserves were at least slightly diminished in most lynx carcasses.

In most cases, stomach and intestinal contents were identified macroscopically, but a reference collection of prey skins, skeletons, and hair slides was sometimes used to aid in identification. Female reproductive tracts were collected.

Uterine horns were split and examined macroscopically for the presence of placental scars or fetuses. Ovaries were fixed in 10% formalin for at least several days before being sectioned at 1-mm intervals and examined for luteal bodies of previous cycles and for recent corpora lutea. Skulls were collected, boiled, and cleaned, at which time a lower canine was collected. The roots of lower canines were decalcified, sectioned with a cryostat, stained using standard techniques, and annuli were counted to determine age (Crowe 1972).

## RESULTS AND DISCUSSION

### Movements of Radio-collared Lynx

#### Tok Study Area:

Two male and 2 female lynx were radio-collared in the Tok study area during 1982 (Table 1). These lynx survived only 6 to 49 days before being harvested by trappers, despite the fact that the 2 most active trappers in the immediate area cooperated in the study and avoided making sets specifically for lynx.

All 4 lynx were captured near the center of the study area within 3 km (2 mi) of each other. Three were caught within 0.4 km (0.25 mi) of each other, and 2 (T-1 and T-2) were caught at the same site 12 days apart. Capture locations and subsequent relocations for each lynx are shown in Figs. 3-6. Although these animals were monitored for only short periods, the movements of 1 male (T-1) spatially overlapped areas used by 2 female lynx which, in turn, largely overlapped each other. The occurrence of tracks of other lynx also indicate a great deal of spatial, and probably temporal, overlap among lynx traveling in the area. For example, during October and November, tracks of several single lynx and at least 1 female with kittens were observed in the same area used by 3 of the radio-collared lynx. Observations of tracks in the study area in general also suggested that lynx distribution was not uniform or predictable.

Male lynx T-4, captured on 30 November, traveled widely, rarely remaining in a local area for more than 2 successive days. The low and declining hare population probably created instability in the lynx population as shown by changes in track occurrence. The scarcity of prey may have been reflected in the movements of the 2 male lynx which moved out of the Tok River valley in early December, and in the poor nutritional condition and extremely high susceptibility to traps of female T-3.

The average distance between successive daily locations (cruising radius) ranged from 2.1 to 3.0 km (1.3 to 2.0 mi) for the 4 lynx (range = 0.4-5.6 km [0.25-3.5 mi]), excluding what appeared to be dispersal movements by the 2 males. During dispersal, straightline movements averaged 6.5-8.0 km (4-5 mi) per day. Previously reported 24-hr movements of lynx have ranged from approximately 1.6 to 2.6 km (1.0 to 1.6 mi) (Saunders 1963, Nellis and Keith 1968). These figures are similar to the 24-hr movements observed in the present study. The daily cruising distance traveled (actual distance covered) by lynx has ranged from approximately 4.8 to 11.3 km (3 to 7 mi), and in North American studies has averaged approximately 8 km (5 mi) (Iurgenson 1955, Saunders 1963, Nellis and Keith 1968, Parker et al. 1983b). The relatively direct movements observed for the dispersing lynx are similar, although not strictly comparable, to the daily cruising distances of resident lynx cited above.

Activity Patterns of Lynx in the Tok Study Area:

Lynx activity patterns were monitored for 302.9 hr during the Tok study. The signal of adult male T-1 was monitored for 228.2 hr, and records of activity were obtained for adult females T-2 (36.8 hr) and T-3 (37.9 hr). Periods of activity ranged from 0.2 to 16.6 hr and periods of rest ranged from 0.25 to 6.0 hr, with most bouts ranging in length from 0.5 to 6.0 hr. The proportion of total time during which each of the 3 lynx was active was 67.2% (male T-1), 53.0% (female T-2), and 61.5% (female T-3), with a combined rate of 64.8% activity and 35.2% rest. A statistical analysis is being done to determine whether there are meaningful differences in activity patterns during 4 periods of the day including midday (0900-1500), evening (1500-2100), midnight (2100-0300), and morning (0300-0900).

Wood River Study Area:

Seven lynx, 3 males and 4 females, were radio-collared in the Wood River area (Table 2). The home range boundaries for 6 lynx, based on the innermost 95% of relocations, are shown in Fig. 7. Known locations for each lynx are shown in Figs. 8-24. With 1 exception, lynx collared in this area occupied fairly stable home ranges ranging in size from 65 to 210 $km^2$ (25 to 81 $mi^2$) with a mean of 121 $km^2$ (46.6 $mi^2$) (Table 2). When only the innermost 95% of the relocations were used, home range size ranged from 32 to 119 $km^2$ (20 to 46 $mi^2$) for 5 resident lynx, with a mean of 77 $km^2$ (29.7 $mi^2$). The data suggest that males W-1 and W-3 used home ranges that were slightly larger than those used by females, while the range of male W-6 was comparable to that of 2 resident females.

Resident lynx generally moved around their normal home ranges in an unsystematic way that resulted in regular visits to most parts of their range. Occasionally, lynx moved 8 to 16 km (5 to 10 mi) beyond their normal home ranges but returned within a few days.

To explore the seasonal patterns of home range use by lynx, I plotted locations obtained during 3- to 5-mo periods as shown in Figs. 8-24. Because individual lynx were monitored for various lengths of time, the monthly groups vary somewhat. Some lynx showed what appeared to be seasonal shifts in movements, the most obvious being those shown by male W-1. This lynx often traveled as far as 16 km (10 mi) to the north from March to August 1984, but appeared to abandon this area during September and thereafter restricted his travels to a more southerly area (Figs. 8-12). Female W-2 (Figs. 13-17) shifted the focus of her movements from the Bonnifield Creek area in March 1984 to the Rex Trail and Japan Hills areas in later months. As described below, male W-3 traveled in the area east of the Bonnifield Creek area briefly during March 1985 (Fig. 18).

The reasons for these changes in habitat use are not entirely clear, although mating activity probably accounts for those observed during March. A decline in hare numbers and the search for prey may well have accounted for some of the observed movements. Lynx home range has been shown to increase as hare density declines (Ward 1985). Also, approximately 55% of the early winter population was trapped in 1983-84, allowing considerable change in population spatial organization.

There appeared to be a pattern of spatial separation among adult male and female lynx, with males maintaining separation from other males, and females from other females. In contrast, the home ranges of males and females overlapped almost totally. However, a number of unmarked lynx used the study area. If their movements were known, the observed pattern of home range relationships could change substantially.

Dispersal:

Only 1 radio-collared lynx dispersed from its home range. Adult female W-4 traveled extensively east and south of the Wood River study area during April and May 1985 (Fig. 20). This lynx was radio-collared south of the Japan Hills on 22 January 1985 and during the following 2 mo used a relatively small home range of approximately 47 km$^2$ (18 mi$^2$) along Bonnifield Creek at the north edge of the Japan Hills (Fig. 7). Because no sign of lynx activity was observed in this area during the preceding winter, W-4 probably moved into this area from outside the study area, or from elsewhere within it, sometime between April and October 1984, when tracks were first observed. Female W-4 left the Bonnifield Creek area on approximately 31 March and was located on 2 April near the east end of the Japan Hills, approximately 13 km (8 mi) east of the area used during midwinter.

During the next 44 days, W-4 traveled east, then northeast and southwest (Fig. 20), covering a minimum straightline distance of 169 km (105 mi), with a minimum average straightline movement of 3.9 km/day (2.4 mi/day). The actual extent of her movements was likely considerably greater, because only 8 relocations were obtained during this period. Despite periodic searches during summer 1985, the movements of W-4 after 14 May are unknown.

Habitat Use in the Wood River Study Area:

Habitat in the Wood River area is a highly varied mosaic of vegetation types. Much of the area is characterized by a mixture of hardwood and coniferous forest of highly variable density and composition. Pure stands of either hardwoods or spruce rarely extend for more than a few hundred meters before gradually or abruptly changing into another type of habitat. Most of the area was burned in the early 1930's (W. Waugaman, pers. commun.). It appears that revegetation proceeded in a variable manner, in part because of highly variable drainage patterns.

In an effort to generally quantify habitat use by lynx, I examined the frequency with which 6 radio-collared lynx were aerially relocated in 8 different vegetation types. Of 283 aerial locations, 120 (42.4%) were in mixed spruce/hardwoods, 41 (14.5%) were in dense black spruce (Picea mariana), 37 (13.1%) were in pure hardwoods, 36 (12.7%) were in spruce muskeg, 22 (7.8%) were in white spruce (P. glauca), 18 (6.4%) were in tall shrubs, 2 (0.7%) were in low shrubs, and 7 (2.5%) were in forest within 100 m (110 yd) of active beaver (Castor canadensis) ponds during summer. Male lynx W-1 was the only lynx located at beaver ponds, which are scarce and limited in distribution, and his home range encompassed almost all colonies present.

These data probably reflect both habitat availability and habitat selection by lynx. Approximately 80% of the area is covered by continuous forest, which is reflected in the high frequency with which lynx were found in forested terrain.

An avoidance of large openings was apparent. Lynx were never relocated in the series of large openings that cover an area approximately 1.6 km (1 mi) wide and 16 km (10 mi) long near the west side of the Wood River. They did cross this area, but usually traveled through patches of forest when doing so. Although lynx were commonly located near the edge of the 1980 Blair Lakes burn on the eastern edge of the study area, they were never relocated more than a few hundred meters into the burn and then were found in small unburned inclusions.

Reproductive Activity:

Observations in the Wood River area provided some indications of the timing of the lynx breeding cycle. From mid-March through early April 1984, 2 radio-collared lynx, an adult male and adult female, were relocated daily. Triangulation from the ground indicated that both lynx were in the same general location west of the Bonnifield Trail from approximately 26 to 29 March (Figs. 8 and 13). It is possible this short-term proximity was associated with courtship and breeding activity. Subsequently, the lynx occupied separate home ranges. It is not known whether female W-2 produced kittens, but she was not accompanied by kittens the following winter.

Additional indications of breeding activity were observed between 18 and 27 March 1985. On 18 March, male W-6 was aerially located 3.2 km (2 mi) south of the Rex Trail and was observed resting within approximately 1 m (3 ft) of another, slightly smaller, lynx. Both animals were lying down, facing each other, in a small opening. Tracks indicated the pair had traveled approximately 5 km (3 mi) south during the previous 2 days. W-6 was a fully mature male and, because indications of adult lynx traveling together at other times of year were rare, I suspect his associate on this occasion was an adult female.

The movements and observations of males W-1, W-3, and female W-5 indicated mating activity occurred after mid-March. On the evening of 18 March ground telemetry indicated male W-1 and female W-5 were in close proximity and may have traveled together for at least a few hours. By the morning of the 19th they were separated by at least 3.2 km (2 mi). On 19 March, male W-3 left his normal home range and moved abruptly 8 km (5 mi) eastward to an area commonly used by female W-5 and male W-1. On 20 March, he traveled 8 km (5 mi) to the northwest along the west bank of the Wood River before returning to the south on 21 March. On both 20 and 21 March, ground triangulation indicated that he was within 0.8 km (0.5 mi) of male W-1 for a period of several hours. Both males moved south and were located no more than 0.4 km (0.25 mi) apart on the morning of the 21st. During this period, female W-5 had moved south and on the 21st was located approximately 0.8 km (0.5 mi) south of the 2 males. I could not determine whether she joined them. On 22 March, male W-1 had moved 2.5 km (1.5 mi) north, while male W-3 and female W-5 were located in the same area and appeared to remain together, or at least very near each other, on both 22 and 23 March. During this period, bearing and signal strength were identical for W-3 and W-5. By 24 March, however, male W-3 had moved 3.2 km (2 mi) west to the Gold King Creek area near the center of his home range and female W-5 had moved 4 km (2.4 mi) northwest where she was aerially relocated within 180 m (200 yd) of male W-1, along Bonnifield Creek west of the Bonnifield Trail. W-1 and W-5 remained together from 24 through 26 March, traveling north and then southeast approximately 5 airline km (3 mi) during 3-1/2 days. On 27 March, W-1 and W-5 separated, with W-5 moving south to the center of her home range. These observations show that W-5 associated with at least 1 male (W-1) and possibly another (W-3) between 22 and 26 March.

Female W-5 produced kittens in late May or early June and was accompanied by 2 kittens during the following winter. Aerial observations during early summer suggested her movements became localized on or before 28 May. She was relocated on 3 different days (28 May, 11 June, and 15 June) at the same site in mixed mature spruce and birch forest where numerous windfalls were present, and I think she established a den in this area.

The timing of breeding and parturition suggested by these observations is in agreement with previous studies that showed breeding peaked in the 3rd week of March, with parturition occurring in late May and early June after a 60-70 day gestation period (McCord and Cardoza 1982). My observations also suggest that males may associate during the breeding season, and that a number of males may court a single female, as has been reported previously (McCord and Cardoza 1982).

During the mating season, I found 2 lynx beds showing a small amount of blood associated with estrus. One bed was made on the night of 20 March and found on 21 March; the other bed was investigated on 22 March but had been used 2-3 days earlier. These beds were approximately 0.8 km (0.5 mi) apart. One was located in mature spruce forest and tracks in the area showed that at least 2 lynx had used the area. The other, and most recent, bed was in the center of a courtship site on an open gravel bar along the Wood River. Tracks showed that 2 adult lynx had traveled extensively, both running and walking along the river edge before walking 300 m (328 yd) down the course of the river to an area where a mating attempt occurred. This site was a circular area 2 m (2.2 yd) in diameter, entirely covered with lynx tracks, in the center of which was a lynx bed containing a small amount of estrus blood. There were 12-15 tufts of lynx hair scattered around the site and 1 lynx scat near the periphery. It appeared the lynx spent perhaps an hour or more at the site, with the female lynx bedded down, before returning the way they had come. Males W-1 and W-3 were both in this area on the evening before this encounter took place and either one may have been involved. The identity of the female lynx is unknown, but W-5 may have traveled north 3.2 km (2 mi) during the night and participated. However, an unmarked female could easily have been involved.

Lynx Harvest and Population Levels in the Wood River Study Area

Based on trapper reports and harvest records, it is apparent that lynx numbers in the Wood River area were high during the early 1970's and declined in the mid-1970's following a decline in showshoe hares. The next cyclic peak in lynx numbers occurred during the early 1980's but appears to have been of lower amplitude than the 1970's peak. This pattern applied to much of Interior Alaska in general, as well the Wood River area.

Available data on trapper harvest in the Wood River area indicate lynx harvest ranged from 0 to 102 during the past 17 years (Table 3). There are no reliable data available for 6 winters from 1971-72 through 1976-77, but J. Smith estimates that he caught at least 20 lynx annually during this period.

The harvests listed for the years prior to 1980 occurred in an area larger than that used during succeeding years. A trail extended from Gold King Creek south to Mystic Creek and then down the Wood River to the Rex Trail during those years. This area constitutes approximately 259 $km^2$ (100 $mi^2$) of potential lynx habitat in addition to the 971 $km^2$ (375 $mi^2$) area shown in Fig. 2.

The highest harvests occurred from 1969 to 1973. Trappers in adjacent areas also took large numbers of lynx during the early 1970's. For example, 3 trappers took a total of 100, 276, and 70 lynx on the Tanana Flats north and east of the study area in 1971-72, 1972-73, and 1973-74, respectively (R. Long, pers. commun.). To the west of the study area, on the Rex Trail and north to Nenana, 2-3 trappers took at least 150 lynx in winter 1971-72 or 1972-73 (J. Smith, pers. commun.). Other trappers in Game Management Unit (GMU) 20A also report large catches of lynx, often ranging from 50-100 per trapper, during this period.

In comparison with the early 1970's peak, lynx populations and harvest in the 1980's were apparently lower. Pelt sealing records show the highest total harvests in GMU 20A occurred in 1981-82 and 1982-83 with 102 and 115 lynx, respectively, being taken. These figures are considerably lower than annual harvests in the early 1970's, as indicated by the trapper reports cited above. By comparison, 102 lynx were taken in the Wood River study area alone during winter 1969-70.

The causes for the lower numbers are probably several. There is a consensus among biologists and other observers that hare numbers during the early 1980's peak did not approach those of the previous 3 peaks. According to J. Smith, however, hare numbers in the study area have not cycled as markedly as in other areas, with moderate numbers of hares, and lynx, present even during areawide "lows." Even if hare numbers in the study area were at a level comparable to the 1970's high, the low hare peak in surrounding areas may have resulted in less immigration as lynx populations increased.

It appears that a movement of lynx into the study area occurred during winter 1982-83, when lynx harvest in GMU 20 peaked. J. Smith caught 21 lynx in the study area during this winter, but approximately 90% of them were caught in February 1983 when a large number of lynx apparently immigrated.

Trapping harvest has likely exerted a strong influence on lynx populations in and around the study area. The study area has been heavily trapped for 15 of the last 17 years. Although lynx have maintained a presence in the area, density during the most recent peak was lower than in the 1970's, and in winters 1983-84 and 1984-85 lynx numbers were the lowest J. Smith has ever observed.

Lynx mortality from trapping was quite high in both study areas. As mentioned above, all 4 lynx radio-marked in the Tok study area were trapped within 49 days of being released. In the Wood River area, estimated trapping mortality was 55% in 1983-84. In 1984-85, when J. Smith tried to avoid catching lynx, trapping mortality declined to an estimated 17.7%.

These mortality rates are similar to those indicated by previous studies of lynx in areas where trapping occurs, and also support the opinion of experienced trappers who believe that trapping mortality is high in trapped areas. Nellis et al. (1972) reported that 3 of 9 lynx tagged in Alberta were trapped within 1 year, but the fate of the remaining 6 is unknown. Mech (1980) determined that at least 7 of 14 radio-marked lynx in Minnesota were killed by humans. In Manitoba, 5 lynx marked in a National Park were all trapped outside the park boundaries within 27 months (Carbyn and Patriquin 1983). Parker et al. (1983b) reported that 13 (65%) of an estimated 20 lynx in a study area on Cape Breton Island were trapped during 1 trapping season. Ward (1985) radio-marked 11 lynx in a sanctuary (closed to hunting and trapping) in the southwestern Yukon between February 1982 and June 1984. Seven of these lynx were trapped when they traveled outside the sanctuary and only 2 of 9 lynx that left the sanctuary during the open trapping season were not trapped. Trapping mortality of marked lynx was 71% and 33%, respectively, during 2 winters. In the most heavily trapped area on the Kenai Peninsula, Alaska, Bailey et al. (1986) estimated trapping mortality rates at 65-80%.

Population data for the Wood River area in 1983-84 and 1984-85 are presented in Table 4. Early winter numbers were derived by adding the known harvest to the number of lynx, both marked and unmarked, that were estimated after 20-35 days of field travel in late winter. Estimates are based on a combination of aerial and ground radio-locations of marked lynx (2 lynx in March 1984, 6 in March 1985) and concurrent observations of tracks along 97 km (60 mi) of trails (the 40-km [25-mile] loop in the best lynx habitat was covered daily), and I am confident they closely reflect actual numbers. These figures are based on the assumption that lynx that were trapped or otherwise accounted for were residents, which means they may, to some extent, overestimate resident numbers.

Table 5 summarizes lynx population size and composition and gives resulting population estimates for areas A, B, and C within the Wood River area. The population densities are based on the assumption that lynx enumerated during field work represented the population in the 971 $km^2$ (375 $mi^2$) area (area A) shown in Fig. 2 or in areas B and C within this larger area. The boundary of area A was established 9.7 km (6 mi) from the trails used to capture lynx and gather population data. This is approximately half of the greatest linear dimension of the largest home ranges used by marked lynx, and approximates the greatest dimension of smaller home ranges. On the southern edge of the area, however, I used the 909 m (3,000 ft) contour, above which radio-marked lynx and lynx tracks were not observed. This generally coincides with timberline.

A range of densities for a 777-$km^2$ (300-$mi^2$) area (area B) is provided in Table 5. In this case the boundary of the Blair Lakes burn is used as the eastern boundary, and an area of 122 $km^2$ (47 $mi^2$) south of the Japan Hills is deleted from the area. General observations indicated that lynx activity was limited or absent in both areas.

The lower densities, based on the 971 $km^2$ (375 $mi^2$) area, should be viewed as representing average density over large areas that include some marginal habitat. Densities based on the 777 $km^2$ (300 $mi^2$) area represent moderate to good lynx habitat in the study area.

One additional set of densities was calculated for a 570 $km^2$ (220 $mi^2$) area (area C) that included only the portion of area B within 9.7 km (6 mi) of the 40-km (25-mi) loop on which track occurrence was measured. For the purpose of comparing track frequency and density in the Wood River and Tok areas, 4 lynx (a female and her 3 kittens) were excluded from the Wood River density calculation in 1985 because they were not known to cross the 40-km (25-mi) loop.

Estimated density in area A ranged from 1 lynx/29.5 $km^2$ (1 lynx/11.4 $mi^2$) in early winter 1983-84 to 1 lynx/69.4 $km^2$ (1 lynx/26.7 $mi^2$) during late winter in 1983-84 and 1984-85. Comparable densities for area B were 1 lynx/23.6 $km^2$ (1 lynx/9.1 $mi^2$) and 1 lynx/55.4 $km^2$ (1 lynx/21.4 $mi^2$), whereas for area C there were 1 lynx/17.4 $km^2$ (1 lynx/6.7 $mi^2$) and 1 lynx/40.7 $km^2$ (1 lynx/15.7 $mi^2$). These densities are comparable to those estimated during the low phase of the lynx-hare cycle in good lynx habitat in other parts of North America (Brand et al. 1976; Bailey, unpubl. data).

## Winter Track Counts as an Index to Population Status

### Lynx Track Identification:

Lynx tracks are readily identifiable, and the potential for confusion with tracks of other species is relatively small. Although the appearance of lynx tracks varies somewhat with snow depth and hardness, terrain, and gait, this variation is overshadowed by other characteristics that are remarkably consistent.

Observations during ground trailing show that lynx rarely deviate from their normal gait, a walk, and usually only to briefly pursue prey. I estimate that lynx travel at a walk over 90% of the time. This trait enhances reliable identification of tracks from both air and ground.

The track pattern made by lynx while walking can be described as an offset line of distinct, nearly round impressions in the snow. The diameter of individual tracks ranges from approximately 9.2 to 12 cm (3.5 to 4.5 in), while the distance between successive prints ranges from 30.5 to 79 cm (12 to 28 in) with a straddle (distance between the outside edges of prints made by the right and left feet) of between 16 and 24 cm (6 and 9 in). In new, soft snow, lynx tracks may be 16-21 cm (6-8 in) deep, but in older and slightly crusted snow, they rarely sink more than 10.6 cm (4 in). The small "load on track" and the deliberateness with which lynx place their feet result in little or no drag mark on either end of the track. This characteristic contrasts with other mammals of similar size, e.g., red foxes (*Vulpes vulpes*) and coyotes (*Canis latrans*).

Some lynx trails, especially those made immediately after a heavy snowfall, show noticeable drag marks that elongate individual track impressions to 21-26 cm (8-10 in). However, the basic characteristics of the trail are retained.

Another distinguishing characteristic of lynx trails is their meandering nature. Lynx rarely travel in a straight line for more than a few meters. This is in contrast with other animals, especially canids, which often travel in a more direct fashion. Lynx travel most directly across openings but, even then, leave an easily identifiable trail.

There are some possibilities for confusing lynx tracks with those of other species. During early and midwinter, the play behavior of kittens accompanying a female lynx can create a network of trails that, when viewed from the air, can be mistaken for a small pack of wolves (*Canis lupus*). The track made by a running lynx can be similar to that of a running wolf, and even experienced aerial trackers have temporarily misidentified the trails of a group of lynx.

To stay on top of deep but slightly crusted snow, red foxes often shorten their stride, which widens their trail, and lift their feet more deliberately, creating a track pattern that at 1st glance resembles that of a lynx. Although this can briefly confuse an inexperienced aerial observer, the characteristics that differentiate fox and lynx tracks can be quickly learned.

Although wolverine (*Gulo gulo*) tracks are usually distinguished by drag marks, the diagonal pairing of tracks, or erratic changes in gait and travel direction, there is some possibility for confusion with lynx tracks. The track made by a relatively large wolverine when walking closely resembles that of a lynx, especially in old, coarse snow where the claw marks of the wolverine are not evident.

Sightability of Lynx Tracks:

During ground surveys, lynx tracks intersecting trails are readily detectable under most conditions. Where vegetation is dense or a clear area of at least 1 m (3 ft) is not present along the transect, the speed of travel must be reduced.

The sightability of tracks from the air was evaluated by conducting an aerial survey over an area previously surveyed on the ground. This test occurred along the highway south of Tok between the Tok and Little Tok Rivers. After a heavy snowfall on 18 February 1983, signs of lynx activity were noted in this area; by the morning of 23 February, I saw 27 lynx trails intersecting the west side of the highway along a

8.9-km (5.5-mi) segment during a ground survey. The roadside in this area is cleared of mature trees for a distance of approximately 9-15 m (30-50 ft), although dense saplings occur within a few meters of the road in some areas. I aerially surveyed this area at midday on 22 February with a PA-18 aircraft at a speed of 128 kph (80 mph) and an altitude of 90-120 m a.g.l. (300-400 ft) with direct but low-intensity light. During a single pass along the west side of the road, the pilot and I detected 25 (92.6%) of the 27 lynx trails present. During subsequent aerial surveys and also during radio-tracking flights, it was apparent to me that, as the brief sightability test indicated, lynx tracks were readily visible in open and semi-open habitat. Lynx trails are also visible in hardwood and mixed spruce-hardwood forests, although the difficulty of sighting them increases with increasing timber density and height.

Although lynx often travel through dense cover, they readily cross open and semi-open habitat while traveling. My observations, and those of trappers, suggest that when lynx encounter trails they often follow them at least briefly and sometimes for as much as a mile before reentering cover. Highways and other relatively wide openings are crossed directly more often than trails are. Lynx are not attracted to open areas to the same extent as foxes, coyotes, and wolves. Because lynx habitat in Interior Alaska is diverse with a mixture of open, semi-open, and dense plant communities, the chance of failing to detect lynx during intensive track surveys is small.

During winter 1982-83, snowshoe hares declined to a low level in the vicinity of Tok. Hare populations were also relatively low in the Wood River area during winters 1983-84 and 1984-85. The relative scarcity of hares probably allowed for maximum sightability of lynx tracks because snow was minimally disturbed and lynx were largely unable to follow hare trails.

Observations of Track Frequency:

The occurrence of lynx tracks along ground or aerial survey routes during winter appears to offer a practical index to lynx numbers. Fig. 25a shows the cumulative number of lynx tracks per kilometer that crossed regularly traveled trails in the Tok study area during October-December 1982, the Moose Creek study area in October-November 1983, and the Wood River study area during March 1984 and 1985. Because the trails in the Tok and Wood River areas were traversed daily, the occurrence of snow after an initial snowfall is ignored. This was done because there are often periods of weeks without significant snowfall in Interior Alaska, particularly during late winter, and because future track counts will, by necessity, be done at varying intervals following snowfall.

Tok Study Area:

The frequency of tracks in the Tok study area increased from 0.67/km (1.07/mi) on day 7 to 9.4/km (15.18/mi) on day 64 (Fig. 25a). The rate of track accumulation was consistent, averaging 0.15 crossings/km/day (0.24/mi/day). The absence of new tracks on day 18 and day 21 corresponded with marked changes in weather: a sudden drop in temperature from -23 C to -34 C on day 18, and rain, sleet, and snow on day 21. Temperatures dropped from -9 C to -32 C on day 34 and to -45 C on day 37, perhaps accounting for the low occurrence of new lynx tracks during this period. These weather conditions appeared to reduce lynx activity. Although no additional tracks were noted on day 30, weather was not noticeably inclement during this period.

The slight increase in rate of accumulation between days 40 and 53 may reflect increased lynx activity. During this period, lynx seemed to travel more extensively, possibly due to a decreasing food supply. Lynx tracks were observed in areas rarely used earlier in the winter, such as in the open white spruce-aspen mixed forest on the flats south and west of Tok. The apparent increase in activity presaged a marked decline in activity during midwinter beginning about day 58 (Fig. 25a). Although observations during midwinter are limited, they suggest lynx activity lessened, both in the study area and in the upper Tanana Valley in general. Intensive field work was resumed on 10 February 1983. During the next 36 days of monitoring no lynx trails were observed along the Tok River survey route, although 1 trail was observed in the study area during an aerial survey. During the same period, lynx became generally scarce in the surrounding area, according to trappers.

Table 6 provides track occurrence information contributed by various trappers and obtained during 2 aerial surveys in the Tok area. Two trapper reports were obtained in November, and the remaining 3 reports and 3 aerial surveys represent observations in February and March. With 1 exception, these data show a pattern of population decline similar to that observed in the intensive study area. It was apparent that by February 1983 lynx tracks were rare in the vicinity of Tok. Some lynx persisted in localized areas, however, as indicated by the occurrence of over 1.9 tracks/km (3/mi) on a 13-km (8-mi) section of a survey route on the Little Tok River. The relative abundance of lynx sign in this area corresponded with a local abundance of snowshoe hares. A survey of roadside hare tracks on 21 February showed 5.6 tracks/km (9.1/mi) in the Little Tok area, compared with 1.3 tracks/km (2.1/mi) in the Tok River study area 16 km (10 mi) to the north.

## Moose Creek Study Area:

Following a fresh snowfall on 28 October, the number of lynx trails that crossed 29 km (18 mi) of trails increased by an average of 0.04 tracks/km/day (0.06/mi/day), reaching an average by 12 November of 1 new track encountered each day for every 2.1 km (1.3 mi) of trail examined (Fig. 25a). Between 12 and 28 November, after 3 lynx were trapped within 3 km (2 mi) of the area's boundaries, only 1 fresh track was noted in the study area, suggesting that trapping quickly affected lynx numbers.

## Wood River Study Area:

The rate of track accumulation in the Wood River area during March 1984 was similar to that observed near Tok (Fig. 25a). Frequency was 0.58/km (1/mi) on day 7 and 1.5/km (2.4/mi) on day 16. A year later tracks accumulated more slowly, reaching only 0.93/km (1.48/mi) on day 16.

## Track Frequency as an Index to Lynx Population Density:

Data on population density and track occurrence in the Tok and Wood River areas provide a basis for evaluating and developing an index to lynx population size. To make meaningful comparisons between areas and years, I employed certain assumptions to calculate density and track frequency values that are representative of various situations and allow for meaningful comparisons between the 2 areas.

First, I excluded data from a portion of the Wood River area where lynx sign was infrequently seen. The Tok survey route traversed habitat that was uniformly good for lynx. Lynx track occurrence was fairly uniform along this 24-km (15-mi) route. In contrast, a 9.4-km (5.8-mi) portion of the Wood River survey route showed no signs of lynx use in late winter 1984 and only scattered and temporary signs of use in 1985. For this reason, I calculated 2 sets of track frequency values for the Wood River area. One is based on the entire 40-km (25-mi) route and the other excludes the 9.4 km (5.8 mi) of trail that showed little or no use by lynx. The latter track frequency values were compared with those obtained in Tok.

Second, I also revised lynx population size and density estimates to make meaningful comparisons. During the Tok study, I made weekly estimates of population size based on known locations of radio-marked lynx, the occurrence of tracks, and group size (in the case of female lynx with kittens). These estimates ranged from 8 to 19, and in an earlier report (Stephenson 1984), I estimated that density ranged from 1 lynx per 5 to 18 km² (3 to 7 mi²). However, these estimates were based on a study area size of only 145 $km^2$ (56 $mi^2$). Lynx in the Tok area were radio-tracked for only short periods, and the extent of lynx movements was underestimated. Based on the movements observed in 1984 and 1985 in the Wood River area, I expanded the area used to calculate population density in the Tok area. As in the Wood River area, the new boundary of the Tok study area is 9.7 km (6 mi) from the trails used to capture lynx and gather population data, except that timberline was used as the boundary in the southern portion of the area. Based on the resulting area of 487 $km^2$ (188 $mi^2$), revised estimates of early and midwinter lynx population density in the Tok area are 1 lynx per 26-61 $km^2$ (10-23.5 $mi^2$). By comparison, early winter density in area C on the Wood River area ranged from 1 lynx per 17.4 to 33.4 $km^2$ (6.7 to 12.9 $mi^2$) and late winter densities ranged from 1 lynx per 38.1 to 40.7 $km^2$ (14.7 to 15.7 $mi^2$).

Population density estimates for area C were used in analyzing the relationship between population density and track frequency in the Wood River area and for comparison with the Tok data. Because track frequency was measured over a 16-day interval in the Wood River area, and during a 64-day interval in the Tok study, only the 1st 20 days of the Tok data have been plotted in Fig. 25b and used in comparing track frequency values. In a similar fashion, a population estimate (9 lynx) resulting from intensive monitoring of tracks and radio-collared lynx during the 1st 21 days of the Tok study (early winter 1982) was used to evaluate the relationship between track frequency and population density. Estimated population density in the Tok study area during this period was 1 lynx per 54.1 $km^2$ (1/20.8 $mi^2$).

The track frequency values obtained in the 2 study areas are presented in Table 7 and Fig. 25. To assess the variation in the rate of track accumulation in the 3 samples, the mean number of track crossings/km/day was calculated, as was standard deviation and standard error for the various sample periods (Table 8).

I used a Student's $\underline{t}$ test to evaluate differences in mean rates of track accumulation in the Tok and Wood River study areas in different years for comparable trail lengths. The track accumulation rate observed in Tok was significantly greater than in the Wood River area in 1985 (24 vs. 40 km trail, $\underline{P} < 0.05$; 24 vs. 30.6 km trail, $0.05 < \underline{P} < 0.10$; 16-day sample in all cases). The 19-day sample from Tok also showed a significantly higher ($\underline{P} < 0.05$) accumulation than the Wood River in 1985. Track accumulation near Tok was also significantly higher than in the Wood River in 1984 (24 vs. 40 km trail, $0.10 < \underline{P} < 0.20$). The Wood River track accumulation values were significantly higher ($0.10 < \underline{P} < 0.20$) in 1984 than in 1985.

The difference between the Wood River 1984 and 1985 samples is correlated with a similar difference in estimated lynx population density (1/38.1 $km^2$ vs. 1/57 $km^2$), whereas the difference observed between the Tok and Wood River samples is not. Population density in the Tok study was estimated at 1 lynx/54.1 $km^2$ (1/20.8 $mi^2$), whereas density in the Wood River area in 1984 was estimated at 1 lynx/38.1 $km^2$ (14.7 $mi^2$). The lack of correlation in the latter case could be due to a number of factors. Because radio-collared lynx in the Tok area persisted for at most a few weeks, the Tok population estimate is the least reliable, and density may have been higher than estimated. Another possible explanation is that topography in the Tok study area tended to concentrate lynx movements in the vicinity of the trails along which tracks were monitored. Trails in the Tok study area were located near the western edge of the narrow Tok River valley (Fig. 1), which could have a funneling effect on lynx movements. Trails used in the Wood River area traverse a greater variety of habitat types which could result in a lower rate of track accumulation at a given population density compared with the Tok area. The Wood River data indicate that where topography and habitat are similar relative to trails or transects, track frequency does reflect lynx population density.

Variation in daily track accumulation was high, with standard deviation being nearly equal to the mean in each sample year. The relatively large variation in track accumulation from day-to-day indicates that if a single survey of track abundance is to be used as an index to population, a long interval following snowfall will provide a better index than will a short one. For example, densities calculated from a survey conducted 20 days after snowfall will reflect density better than one conducted only 3 days after snow, because the day-to-day variability would tend to average out with the increased number of days. However, when other animals such as hares, moose (Alces alces), or caribou (Rangifer tarandus) are abundant, the sightability of lynx tracks can decrease dramatically as time passes after a snowfall. For example, when hares are at peak abundance, it can be difficult to see lynx tracks without closely examining hare trails which are often traveled by lynx. When other mammals are abundant, it would probably be advisable to conduct track surveys within 3-10 days after snow.

The speed of travel during ground surveys should also be reduced as the abundance of other tracks increases. When other tracks are extremely abundant it may be necessary to walk, ski, or snowshoe transects to accurately determine lynx track frequency. Under these conditions aerial transects should probably be flown within a few days after snow. The day-to-day variability also suggests that longer transects will provide a better index than will short ones.

Variation in daily track accumulation rates appeared to be proportional to track density, indicating that a given proportional change in lynx density should be equally detectable at either high or low population levels. It follows that an absolute change in numbers will be more difficult to detect at high density than at low density.

Surveys in the Tok and Wood River areas were done in good lynx habitat during periods when lynx numbers were low or declining. For this reason, the population densities and track frequencies measured encompass only a small part of the range of lynx densities that occur in various habitats during various parts of the cycle. Large areas of marginal habitat have a far lower track frequency during low phases of the cycle (Table 6), while good habitat will show a much higher rate of track accumulation during high phases. Thus, the potential to use track occurrence as an index to lynx abundance cannot be fully explored with the available data. The track accumulation technique does, however, have promise, particularly because changes in lynx numbers during a lynx-hare cycle are often large and should be easily detected, even if density cannot be precisely determined.

Despite the apparent usefulness of track counts in determining population status, certain aspects of lynx behavior may affect the accuracy of this method. First, lynx sometimes walk precisely in an existing lynx trail. Saunders (1963) and Parker et al. (1983b) noted that groups of lynx often traveled single file through habitat where prey was scarce, but dispersed where prey was more abundant. However, at least at low or moderate population densities, I do think the potential for missing lynx crossings due to track following is small. This is because lynx precisely follow other lynx only a small percentage of the time and also because it is extremely rare for lynx to both encounter a trail and leave it by following an existing lynx track. Lynx rarely cross an established trail without altering their line of travel somewhat, and usually travel on it for varying distances.

Second, lynx sometimes appear to be attracted to trails and other narrow openings and more or less follow them for some distance. This can result in a locally high occurrence of tracks along a survey route, but density estimates based on these tracks may not be representative of a larger area. For instance, a female lynx with at least 2 kittens crossed a 2.4-km (1.5-mi) section of highway near Tok 8 times, creating a maze of trails. Hares sometimes concentrate their activity in the early successional vegetation along roads and trails. This can attract lynx to these areas, especially when hares are scarce in less favorable habitat. The potential error in density estimates based on tracks that could result from this behavior, or from the occurrence of relatively small "pockets" of abundance, is a major problem only if transects are short or few in number. In the course of traversing aerial or ground transects, unusual concentrations of tracks would be obvious and should, of course, be considered in interpreting track survey results.

Track frequency data are not available from any of the previous studies in which lynx numbers were estimated (G. Parker, pers. commun.; L. Keith, pers. commun.). However, Klepinger et al. (1979) reported track counts from 3 areas in northern Wisconsin where bobcat (Lynx rufus) density was estimated to range from 1 per 13 to 26 $km^2$ (5 to 10 $mi^2$). Counts were conducted in each area during 3 winters along road transects 31-68 km (19-42 mi) long, and occurred during the night after a snowfall that ended by 1800 hrs. Each transect was counted on more than 1 occasion during each winter. The number of bobcat tracks ranged from 0 to 0.05 per km (0 to 0.08/mi). In the Wisconsin study, a decline in tracks in 1 area corresponded to a pronounced decline in harvest during the 3 winters in which track counts were conducted. However, subsequent experience with bobcat track counts suggests they are highly variable from year to year and do not accurately predict population levels (which are thought to be relatively stable) or harvest (W. Creed, Wisc. Dep. Nat. Resour., pers. commun.). This is attributed to the generally low occurrence of roads through the best bobcat habitat (conifer swamps) and the low occurrence of tracks on transects (approximately 0.02 tracks/km). The results of my study suggest the Wisconsin transects were conducted too soon after snow to be representative.

Karpowitz and Flinders (1979) report that bobcat track crossings of a 45-km (27.9-mi) transect in Utah averaged 0.09/km/day (0.15/mi/day). Van Dyke et al. (1986) evaluated the relationship between mountain lion (Felis concolor) tracks and population density and concluded that track counts may be a reliable estimator of relative abundance.

In British Columbia and the Northwest Territories, lynx track occurrence was reported to range from approximately 0.01 to 0.6 tracks/km/day (0.02 to 0.98 tracks/mi/day) in 8 studies from 1973 to 1979 (Penner 1979). In 1 study area in the Liard River Valley, British Columbia, track occurrence in various habitat types ranged from 0 to 3.88 tracks/km/day (0 to 6.25 tracks/mi/day) during 1979, with the highest frequency in a recent burn. Track frequency in most of the forest and shrub habitat types within this area ranged from 0.2 to 0.39 tracks/km/day (0.32 to 0.63 tracks/mi/day), and lynx were thought to be relatively abundant and increasing in numbers, as were hares (Penner 1979).

In the Yukon River basin, track counts have been used to measure the relative abundance and habitat preferences of furbearers in 3 study areas (Slough and Jessup 1984). Track transects were located in various habitats and were surveyed at varying intervals after snow in 1982 and 1983. Lynx track occurrence ranged from 0.001 to 0.12 tracks/km/day (0.002 to 0.20 tracks/mi/day) with some statistically significant differences in track frequency between areas and between years. The highest lynx track frequencies were observed in local areas where lynx were known to be abundant.

In a study of lynx-snowshoe hare relationships near Kluane Lake in the Yukon Territory, Ward (1985) recorded the daily number of fresh lynx trails crossing each 600 m (656 yd) of transect after a fresh snowfall. These data were gathered in an area with relatively high lynx numbers. He reported track frequencies of 1.3, 2.0, and 8.3 tracks/km/day (2.1, 3.2, and 13.4 tracks/mi/day) in 3 areas that had different levels of hare abundance. The highest track accumulation occurred where hares were approximately 7 times more abundant than in surrounding areas.

The criteria used by Slough and Jessup (1984) and Ward (1985) to enumerate lynx trails was different than that used in my study. In their study, when lynx recrossed the trail a number of times within a short distance, each encounter with a transect was tallied, unless the lynx trail did not go out of sight and it was apparent the trails were made by the same lynx. This method would result in a higher apparent rate of track accumulation than would the method I used.

Aerial transects to count tracks are being used to determine the distribution and relative abundance of red fox, marten, and lynx populations on the Yukon National Wildlife Refuge (H. Golden, unpubl. data). This effort involves 343 randomly selected aerial transects 5 km (3 mi) in length. The sightability of tracks from the air will be determined by covering a number of test transects on the ground on the same day. Uncorrected values for lynx track intercepts observed during late winter 1985-86, in 3 strata, range from 0.28 to 0.55 tracks/km (0.45 to 0.89 tracks/mi). However, these data have not yet been corrected for sightability or interval following snowfall. In addition, track intercepts were enumerated in a manner similar to that used in the Yukon track counts.

Recommended Procedures for Track Counts:

Under certain conditions, track counts can provide a meaningful index to the status of lynx populations. The following points should be considered when designing and conducting lynx track counts:

1. Track Identification--Inexperienced observers should spend at least a week studying tracks on the ground in areas where all Interior Alaska furbearers are present. Ideally, this should be done in the company of someone knowledgeable about tracks. This type of experience, plus a study of track photographs and discussion with experienced observers, would be the best preparation for ground and/or aerial track surveys. An observer inexperienced in aerial surveys should initially fly with a pilot who can identify tracks.

2. Survey Routes--Survey routes should sample a variety of habitats and be conducted in terrain and vegetation that allow careful scrutiny of the snow. For ground transects, likely routes include established trails, roads, creeks, rivers, ridgetops, seismic lines, and firebreaks. Once established, survey routes should be carefully recorded on maps so they can be retraced at a later time. The length and spacing of transects depends on the purpose of a survey. Monitoring populations over large areas requires that transects sample all potential habitat.

3. Snow Conditions--Snow accumulation and weather conditions should be monitored and recorded before and during surveys. Any snowfall sufficient to obscure or obliterate old tracks provides one of the essential conditions for a survey. Track visibility generally increases as winter progresses and dense herbaceous cover and low brush are increasingly covered by snow, thereby making tracks more visible. When conditions are less than optimum, the speed of ground surveys should be reduced to accommodate low sightability.

4. Timing Relative to Snowfall--The relatively large variation in mean daily track accumulation indicates that track counts conducted a long time after snowfall will better represent lynx population status. However, this consideration must be balanced against the decline in track sightability that accompanies the increase in the tracks of other animals. When hares, moose, or caribou are abundant, an interval of 3-10 days after snow is probably optimal.

5. Light--Direct sunlight makes tracks more visible and is generally required for aerial track surveys. However, ground surveys can be effective even with low intensity light if the rate of travel is reduced. Ground surveys can also be accomplished at night with artificial light. Snowmachine and highway vehicle headlights create high track visibility. Highway vehicles can be highly effective at night, especially if headlights are augmented with additional lights. I found that auxiliary work lights mounted on a portable roof rack, and oriented to illuminate the roadsides, provided for exceptionally high visibility of tracks. With adequate lighting, night surveys may have advantages over daytime surveys.

6. Influence of Weather on Lynx Movements--A period of extreme cold or wet weather following a snowfall appears to reduce lynx activity. Weather conditions should be taken into account when interpreting track counts.

7. Status of Lynx and Prey Populations--During periods of snowshoe hare abundance or scarcity when lynx numbers have stabilized at high or low levels, the comparability of track counts should be fairly high. However, I suspect that during the later stages of a snowshoe hare population decline, temporary increases in activity and wider ranging habits of lynx could create a relatively high frequency of trails compared with a similar density of lynx in a more stable population.

## Sex and Age Composition of Trapped Lynx

During winter 1982-83, 44 lynx carcasses were obtained from trappers, primarily in the Tok area. An additional 21 carcasses were examined during winters 1983-84 and 1984-85. Twelve were contributed by trappers in the Fairbanks area and 9 originated from the Fort Yukon-Circle area. The sample included 26 males, 38 females, and 1 for which sex could not be determined (Table 9). The disproportionate number of females may be due to the small sample size. However, sex ratios in bobcats and lynx show wide variation (McCord and Cardoza 1982).

Only 2 kittens occurred in this sample. Numerous trappers and furbuyers reported a low occurrence of kittens in Interior lynx populations between 1982 and 1985. For example, a furbuyer in the Tok area, Mr. David James, found only 1 kitten in a collection of 157 lynx caught during the 1982-83 season in the Tok-Northway-Eagle area. The occurrence of kittens was reported to be considerably greater during the 2 or 3 winters prior to 1982-83, when hares were much more abundant. These data agree with the results of other studies showing a very low occurrence of kittens during periods of snowshoe hare decline and scarcity (Brand et al. 1976, O'Connor 1984).

Based on cementum age, the ages of 40 lynx caught in 1982-83 (primarily near Tok) ranged from 18 to 46 months. The age distribution of the sample is very young with most lynx in the 1-3 year age classes and none over 4 years old. The number of lynx assigned to the 18-22 month, 30-34 month, and 42-46 month age classes were 16, 19, and 5, respectively. The absence of lynx older than 4 years may be attributable to the high mortality rate of lynx due to trapping and also to the small number of lynx that were born during the previous low in the hare cycle from the mid- to late 1970's.

It appears that in lynx the 1st cementum layer forms during the 2nd winter of life (Saunders 1961, Crowe 1972, Nellis et al. 1972, Brand and Keith 1979). However, there is probably variation in the time of formation, and lynx trapping seasons are long in most areas. The likelihood that a lynx trapped in winter will show the most recently formed or forming cementum line varies. For these reasons, a lynx showing no cementum lines could be either a kitten or a yearling, while 1 cementum line could indicate either a yearling or a 2-year-old. Kittens, however, can be distinguished based on body size. Because there were no kittens in the 1982-83 collection, the specimens with no lines visible were classed as yearlings, as were specimens showing 1 line.

## Body Weight and Nutritional Condition

Lynx were weighed whole when possible, but carcasses obtained from trappers were usually weighed after skinning. To convert skinned weights to whole weights, the former were multiplied by 1.2, as indicated by the relationship between whole and skinned weights of 4 lynx (3 males, 1 female). Excluding lynx that were emaciated, the average weight of adult females ($n$ = 25, $\bar{x}$ = 20 lbs, SD = 3.1, range = 14-24 lbs) was less than for adult males ($n$ = 21, $\bar{x}$ = 24.9, SD = 4.54, range = 17-35). These weights are in the range reported for other North American lynx, and the sexual dimorphism in size is similar to that reported for lynx and bobcats (McCord and Cardoza 1982).

The nutritional condition of 65 lynx was determined from measurements of subcutaneous, inguinal, and xiphoid fat reserves. In the 1982-83 sample (primarily from the Tok area), 18 lynx (12 females, 6 males) were in good condition, 15 (9 females, 4 males) were in poor condition, and 12 (8 females, 4 males) were emaciated from being held for extended periods in traps. In the 1983-84 and 1984-85 samples combined, 17 lynx (8 females, 9 males) were in good condition, 2 (both females) were in poor condition, and 3 (2 females, 1 male) were emaciated.

Inguinal fat depth ranged from 0 to 30 mm, subcutaneous fat depth from 0 to 25 mm, and xiphoid fat weight ranged from 0 to 225 grams. However, only 1 lynx, an unusually large 16 kg (35 lb) male, had xiphoid fat weighing over 70 grams.

Despite the low or declining status of snowshoe hare populations in most areas, a considerable number of lynx managed to maintain at least some fat reserves, and many were in good condition. There are, however, at least some indications of nutritional stress. Eight of the 15 lynx classed in poor condition in 1982-83 were known to have been either shot, snared, or removed from traps within a day or two of being trapped. These lynx had little or no fat reserve and were obviously in a negative energy balance.

Young lynx tended to be in poor condition. In the 1982-83 sample, 7 of 13 (54%) lynx that were from 18 to 34 months old were in poor condition compared with 4 of 16 (25%) lynx 30 months or more old (overlap in these classes due to cementum line formation is explained in a previous section). These results agree with those obtained by Parker et al. (1983b) for lynx, and Parker and Smith (1983a) for bobcats on Cape Breton Island. These authors found an increase in fat deposits at least to 4 years of age in lynx and to 1.5 to 2.5 years in bobcats. They showed that fluctuations in lynx body weight were correlated with fluctuations in fat reserves, and that a decline in lynx carcass weights coincided with a decline in snowshoe hares.

Reproductive Condition of Female Lynx

The reproductive tracts of 33 female lynx revealed a low rate of ovulation and breeding compared with rates during periods of hare abundance (Table 10). Of 24 yearling and adult females examined during 1982-83, only 4 had recent placental scars indicating pregnancy during 1982. Three other females had corpora lutea but no placental scars, and 17 showed no signs of previous ovarian activity. Nine adult females were examined in 1983-84 and 1984-85; 5 showed recent placental scars, 4 showed corpora lutea, 1 showed developing follicles (late February), and 1 showed no sign of ovarian activity. The later collection was composed of relatively old females, which may account for the higher rate of reproductive activity. Although this is a small sample, the low rate of reproductive activity among yearlings compared with older females is consistent with earlier studies (O'Connor 1984).

The mean number of corpora lutea in 11 adult females was 5.9 (range 2-12) and the mean number of recent placental scars in 8 adults was 3.5 (range 3-4). These values are similar to those observed among adult females during the low phase of the cycle in the 1960's (O'Connor 1984).

Food Habits

The stomach and intestinal contents of 62 lynx were examined. In all areas snowshoe hares were the most common prey, occurring in 30 (68%) of 44 stomachs containing food (Table 11). Other food items, in declining order of occurrence, were microtine rodents (13.6%), birds (9.0%), red squirrels (*Tamiasciurus hudsonicus*) (4.6%), and ungulates

(4.6%). Scat analysis revealed snowshoe hare remains in 86.8% of 38 lynx scats collected on the Wood River area from March 1984 through April 1985 (Table 12). Other food remains identified were red squirrel (13.2%) and beaver (2.6%). In contrast, the analysis of 29 fox and coyote scats collected in this area during the same period show a greater occurrence of microtines, moose (carrion), porcupine (Erithizon dorsatum), and birds, although hares were the most common food item, occurring in 38.9% of 18 fox scats and 45.5% of 11 coyote scats (Table 12).

During field work in the Tok and Wood River study areas, the remains of 7 snowshoe hares, 1 ruffed grouse (Bonasa umbellus), and 1 red squirrel killed by lynx were located incidentally. In the Tok area, the remains of 4 hares killed by lynx were examined. In at least 3 cases the hare had been approximately 50% eaten before being cached, and in 2 cases it is known that the lynx returned to eat the remaining edible portions. In 1 case, the lynx returned in less than 24 hours to consume the cached remains. In 2 and possibly 3 cases where remains were cached, the front quarters of the hare, including the head, shoulders, and thorax, were consumed first and the hindlegs and abdomen were cached. After lynx had abandoned hare kills, the remains included only 1 or more feet, a few patches of hide, and the stomach and intestines.

In the Wood River study area I found the remains of 3 hares, 1 ruffed grouse, and 1 red squirrel that had been consumed by lynx. In each case the prey had been almost completely consumed. In the case of the squirrel, only the posterior 5 cm (2 in) of the tail remained. In 1 case, the remains of a hare killed by a radio-collared female lynx were examined within 12 hr, and it was apparent the edible portions of the hare had been consumed in 1 feeding.

The importance of snowshoe hares may be underestimated somewhat by frequency of occurrence in scats because hares are larger than some other prey, such as squirrels and microtines, and therefore have a lower proportion of identifiable remains relative to weight (Floyd et al. 1978). Thus, the actual importance of snowshoe hare in the winter diet is greater than the occurrence in scats suggests.

The analysis of scats and digestive tracts, as well as the limited number of kills found, indicate snowshoe hares were the most important prey of lynx despite the low or declining status of hare populations in the study areas. The major alternative foods included microtines, red squirrels, and birds. This is similar to the findings of Brand et al. (1976) in Alberta where, during winters of hare scarcity, hares continued to be the single most important food for lynx, constituting 40-75% of prey biomass, but with squirrels, grouse, carrion, and small mammals composing the remainder of the diet. In addition to the predation on small game animals documented above, I obtained records and reports of a number of cases in which lynx killed red foxes, caribou, and Dall sheep. These are discussed in Appendix A.

Both ruffed grouse and spruce grouse (Dendragapus canadensis) are known to be regularly preyed upon by lynx (Brand et al. 1976). The stomach of a lynx captured in the Suslota River drainage contained ptarmigan (Lagopus sp.), and 1 trapper (D. Cramer) reported finding the remains of a ptarmigan killed by a lynx near Suslota Lake. Tracks showed the ptarmigan was captured while roosting in snow. A number of trappers report that lynx are often found at or above timberline in areas where hares are scarce but ptarmigan are abundant, which suggests that ptarmigan are sometimes important prey for lynx.

## RECOMMENDATIONS

The results of this study suggest that winter track counts are a feasible method of determining the population status of local lynx populations in Interior Alaska. It appears this method can also provide approximate estimates of lynx population density, but additional efforts should be made to monitor track occurrence when lynx numbers are relatively well known from ground and/or radio-tracking studies. Obtaining track counts when lynx populations are high is particularly important because there has not yet been an opportunity to obtain comparative data during the high phase of the lynx-hare cycle.

Lynx population density and track occurrence should be measured annually in the Wood River study area so that data representative of the low, increasing, and high phases of the population cycle are obtained.

The method of enumerating lynx tracks encountering transects should be standardized so that investigators in various parts of North America can obtain comparable data.

This and other studies have shown that mortality rates from trapping are high in lynx populations inhabiting areas where trapping occurs, suggesting that untrapped refugia play a major role in maintaining and rebuilding populations over large areas. To better assess the intensity of trapping in various parts of the state, a concerted effort should be made to obtain and consolidate information on trapline distribution and use. Although considerable information of this type is available, information from more remote areas is limited. The cooperation of area biologists should be sought in this effort.

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Many people contributed to the success of this study. I am especially indebted to Mr. Dan Grangaard of Tok and Mr. Jim Smith of Gold King Creek. Dan generously allowed me to use one of his better traplines for the Tok study, provided critically important help and advice during the early stages of field work, and freely shared a wealth of knowledge and ideas about lynx ecology. Jim cooperated in a similar manner by providing the use of a portion of his trapline in the Wood River area. He also assisted in field work and helped in radio-collaring lynx. Douglas Smith also provided considerable assistance during field work on the Wood River area. Tok area biologist Dave Kelleyhouse offered helpful advice and allowed part of the Tok office to be the field headquarters for the Tok study. Clay Hogan of North Pole was also extremely helpful in providing the use of his cabin as a base camp for Wood River field work. I also thank Junior Kerns and Steve Harrington of the Ft. Wainwright Natural Resource Office for their help in arranging for the use of the Moose Creek study area.

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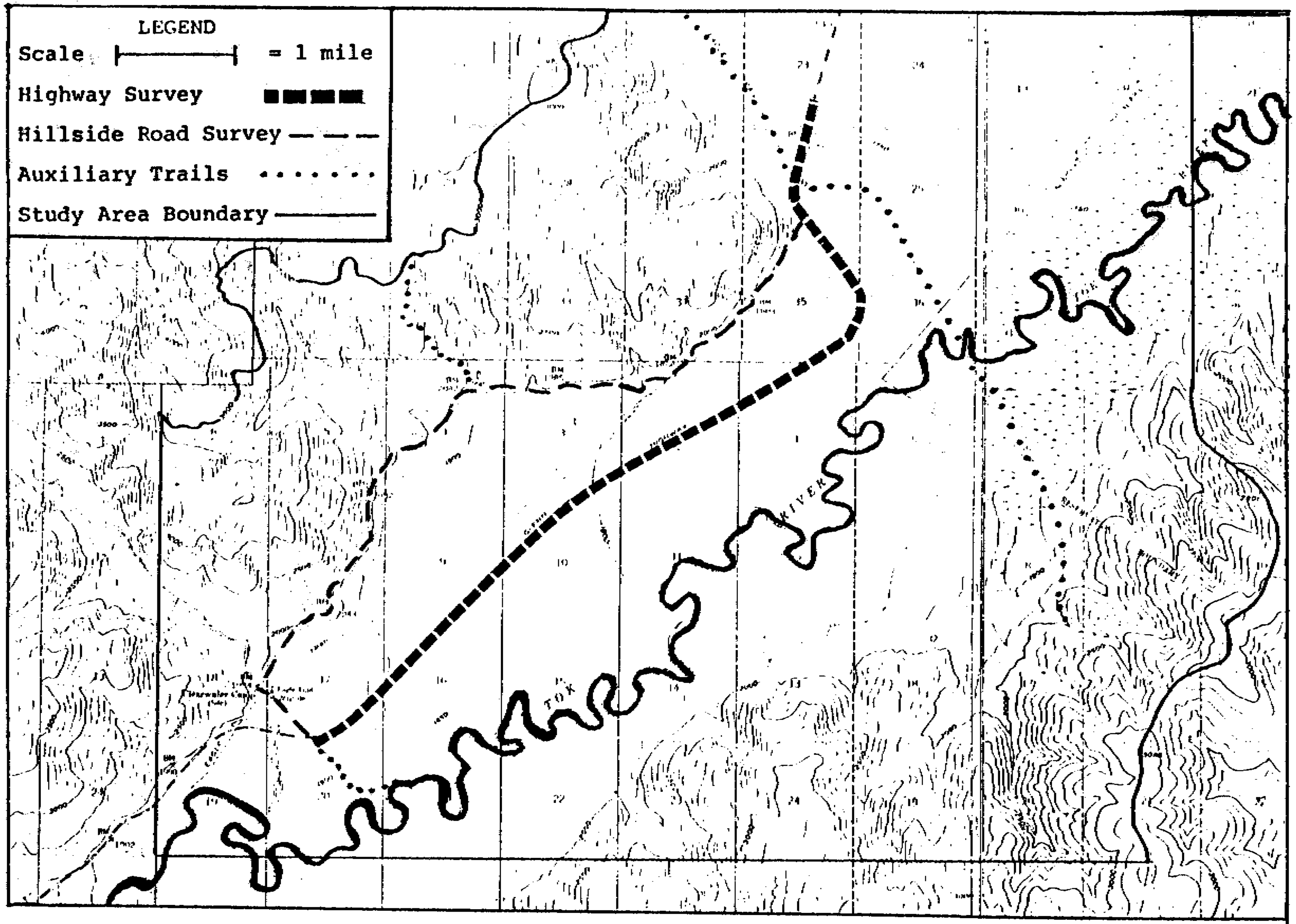


Fig. 1. Map of Tok River lynx study area showing daily track survey routes and auxiliary trails.

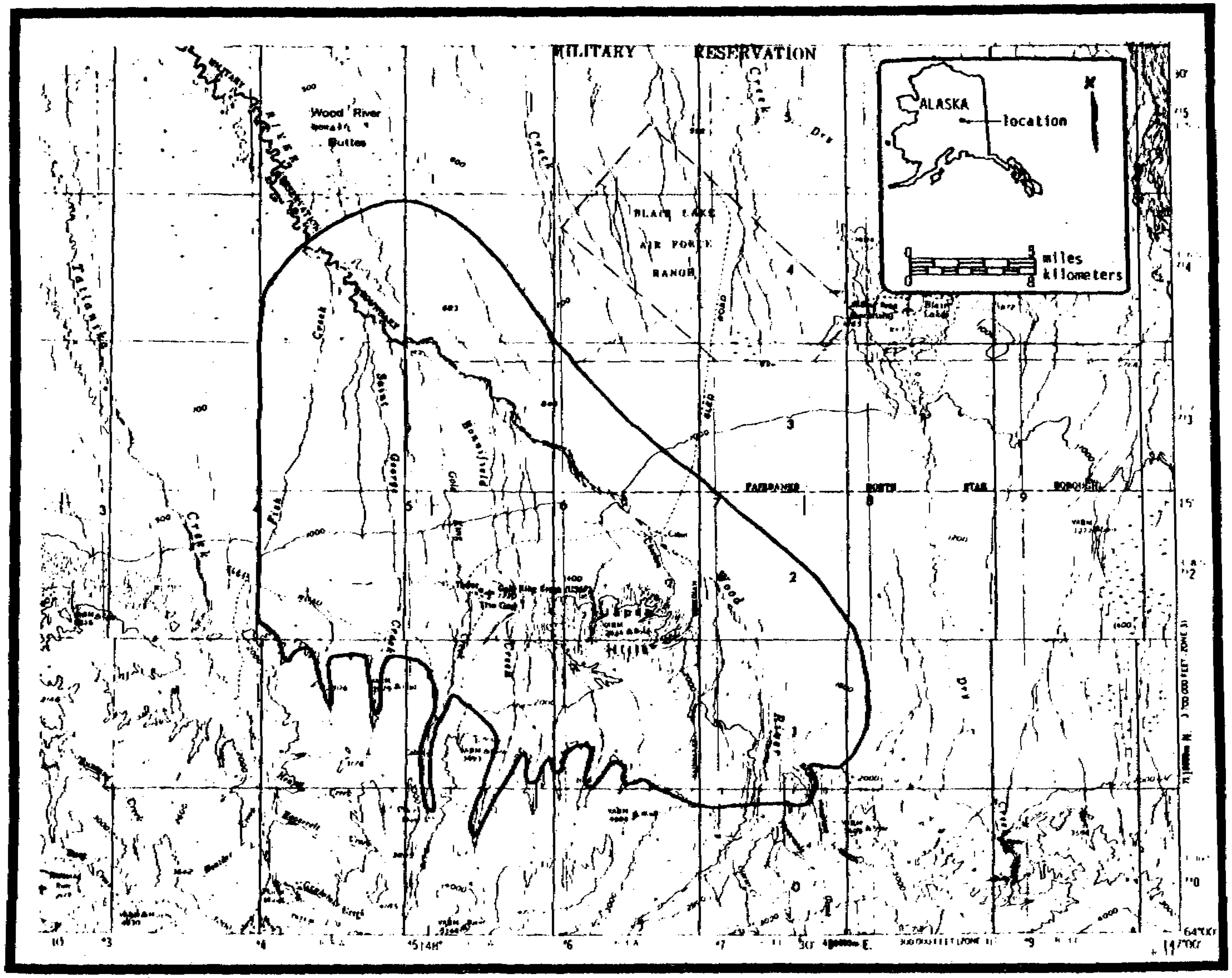


Fig. 2. Topographic map showing boundaries of Wood River lynx study area.

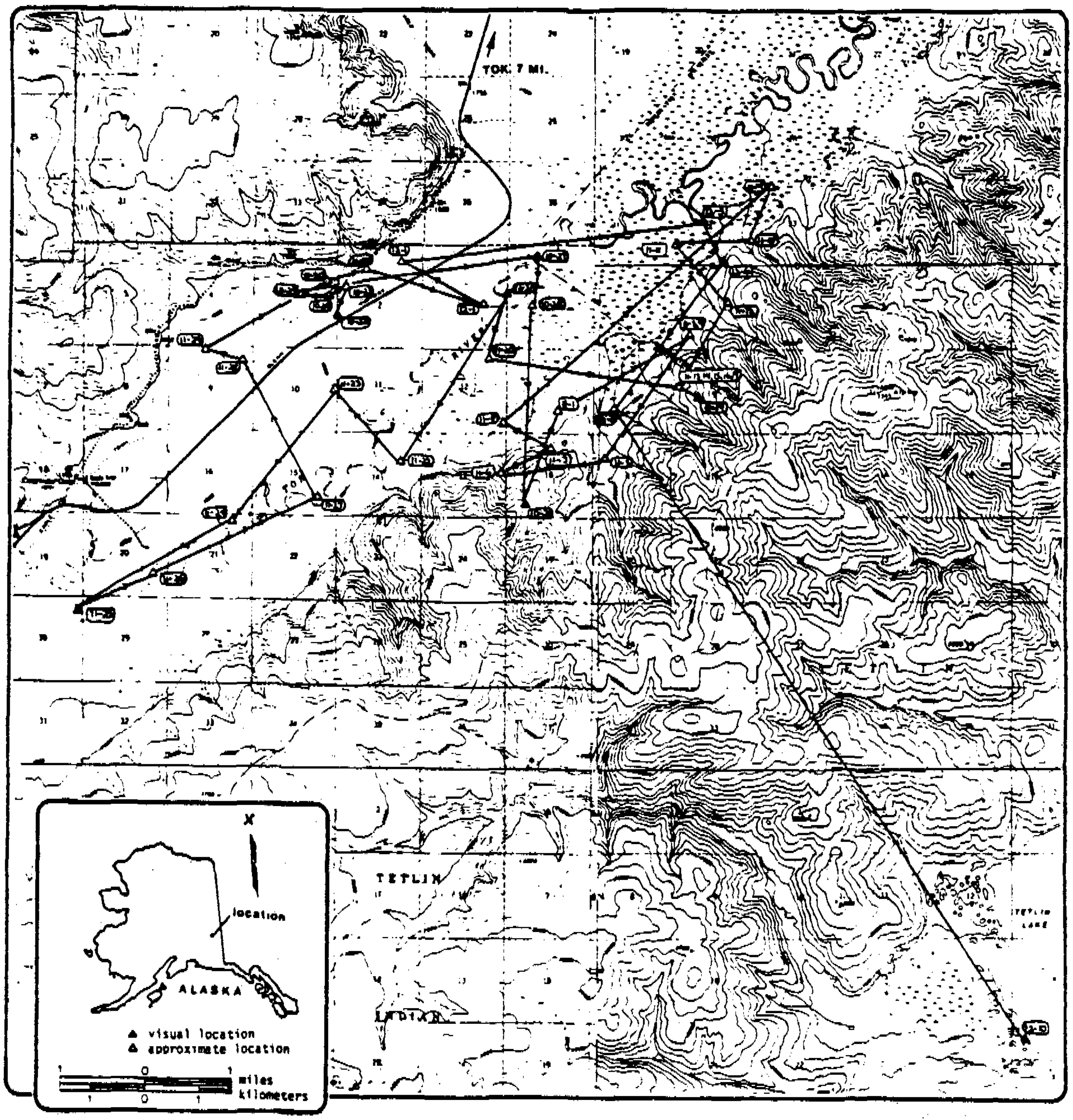


Fig. 3. Locations of radio-collared male lynx T-1 (Herbie) near Tok, Alaska, 22 October-10 December 1982. Month and day are noted for each location.

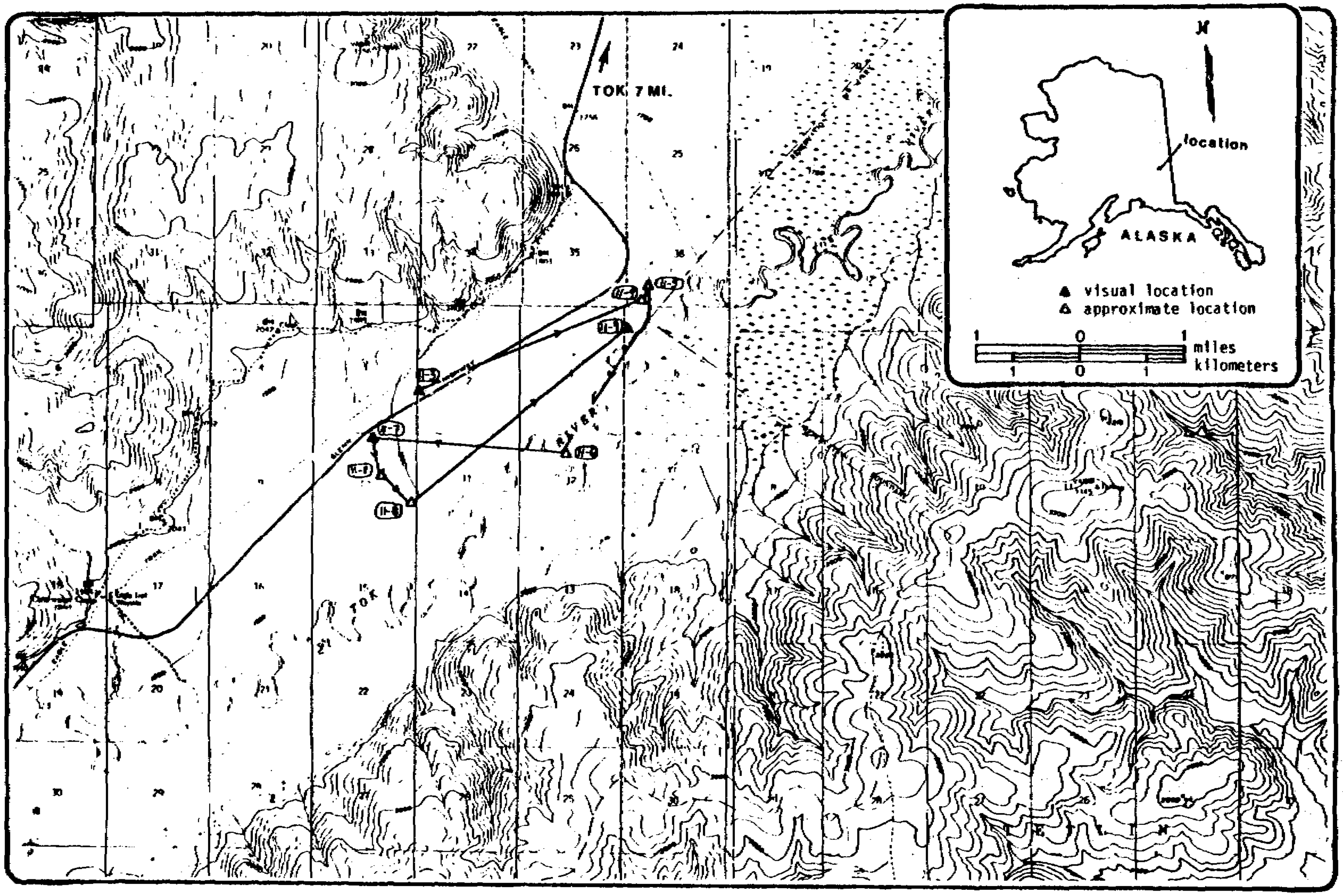


Fig. 4. Locations of radio-collared female lynx T-2 (Granny) near Tok, Alaska, 3-9 November 1982. Month and day for each location are noted.

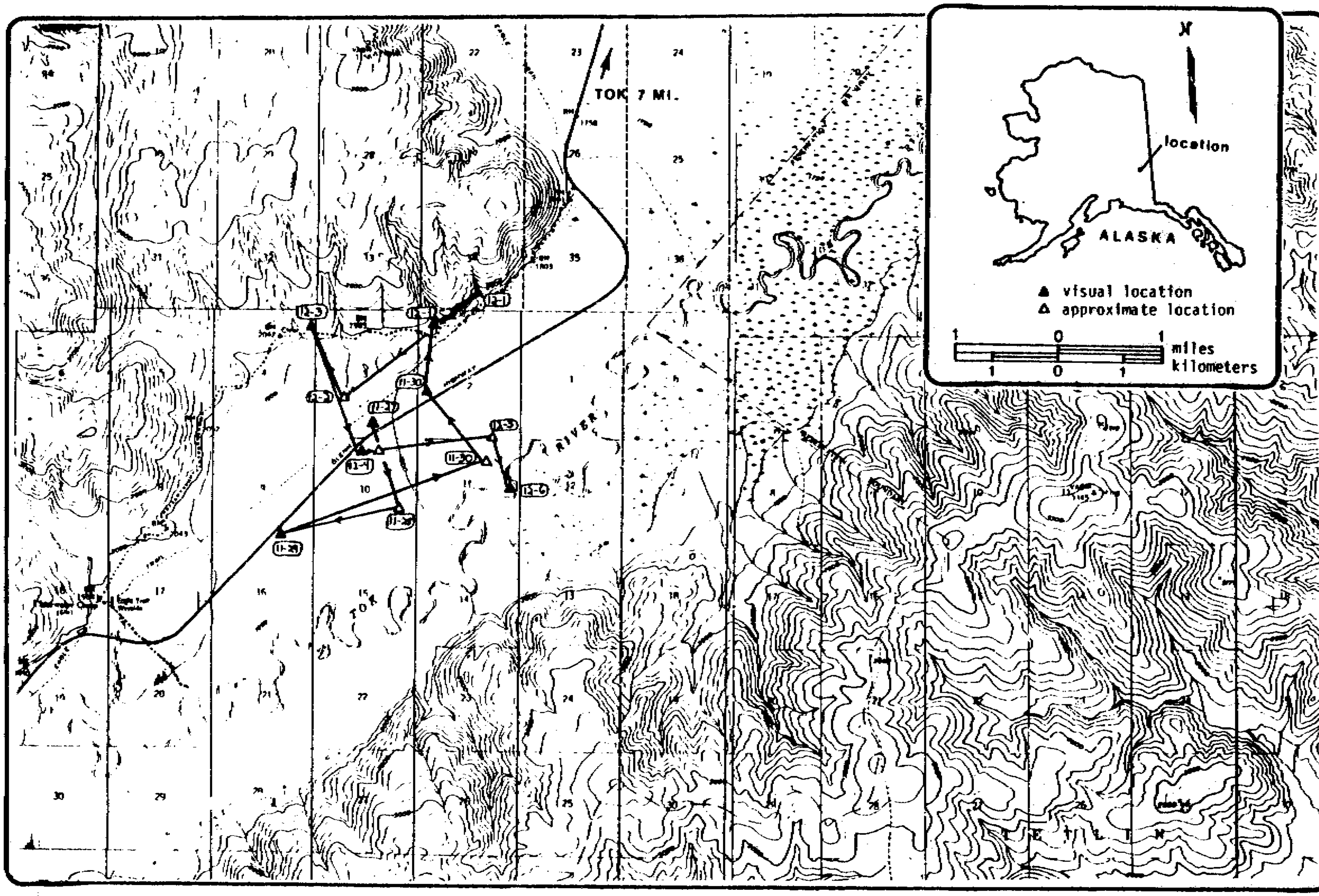


Fig. 5. Locations of female radio-collared lynx T-3 (Ruby) near Tok, Alaska, 27 November-6 December 1982. Month and day are noted for each location.

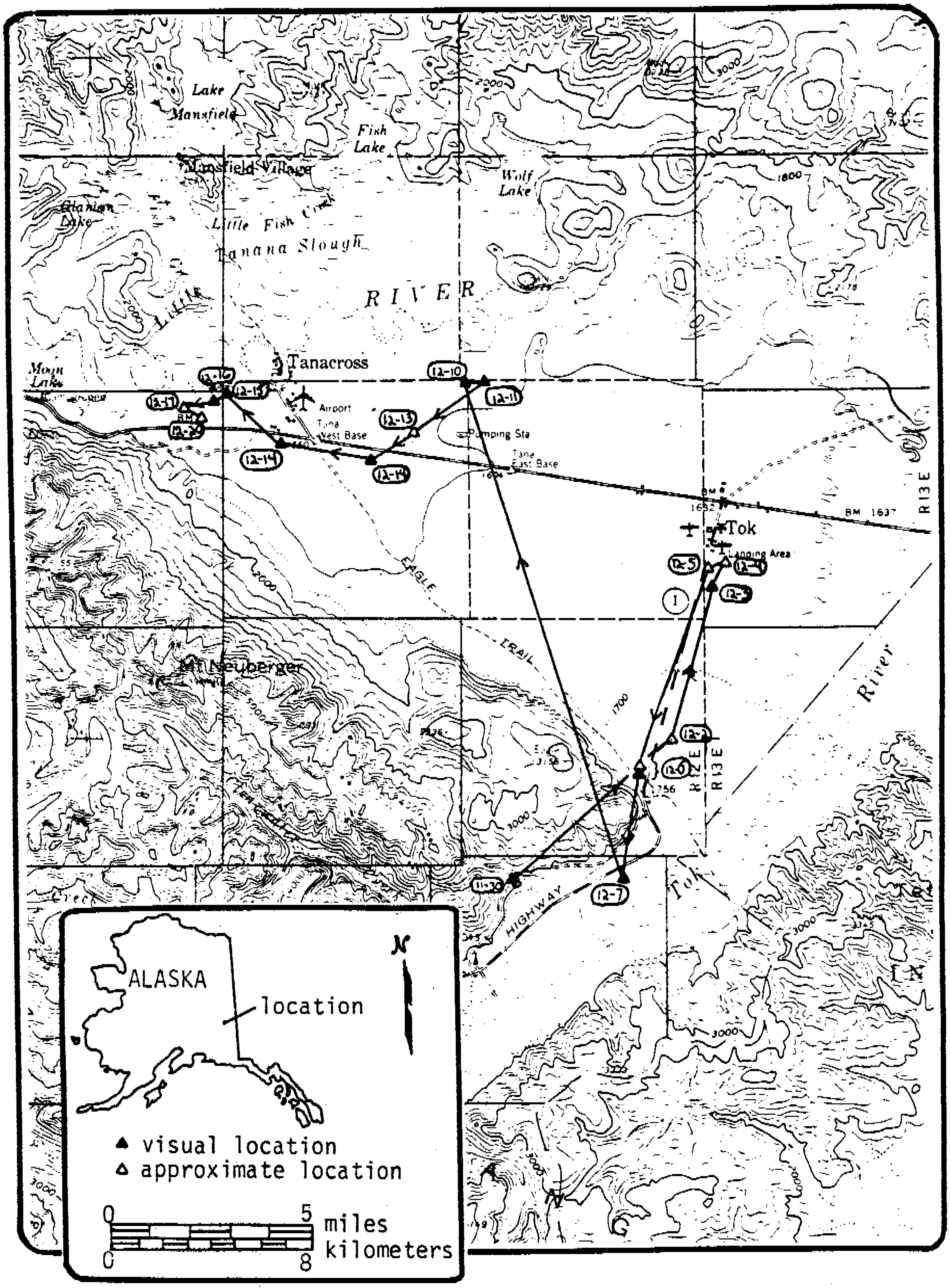


Fig. 6. Locations of radio-collared male lynx T-4 (Garfield) near Tok, Alaska, 30 November-20 December 1982. Month and day are noted for each location.

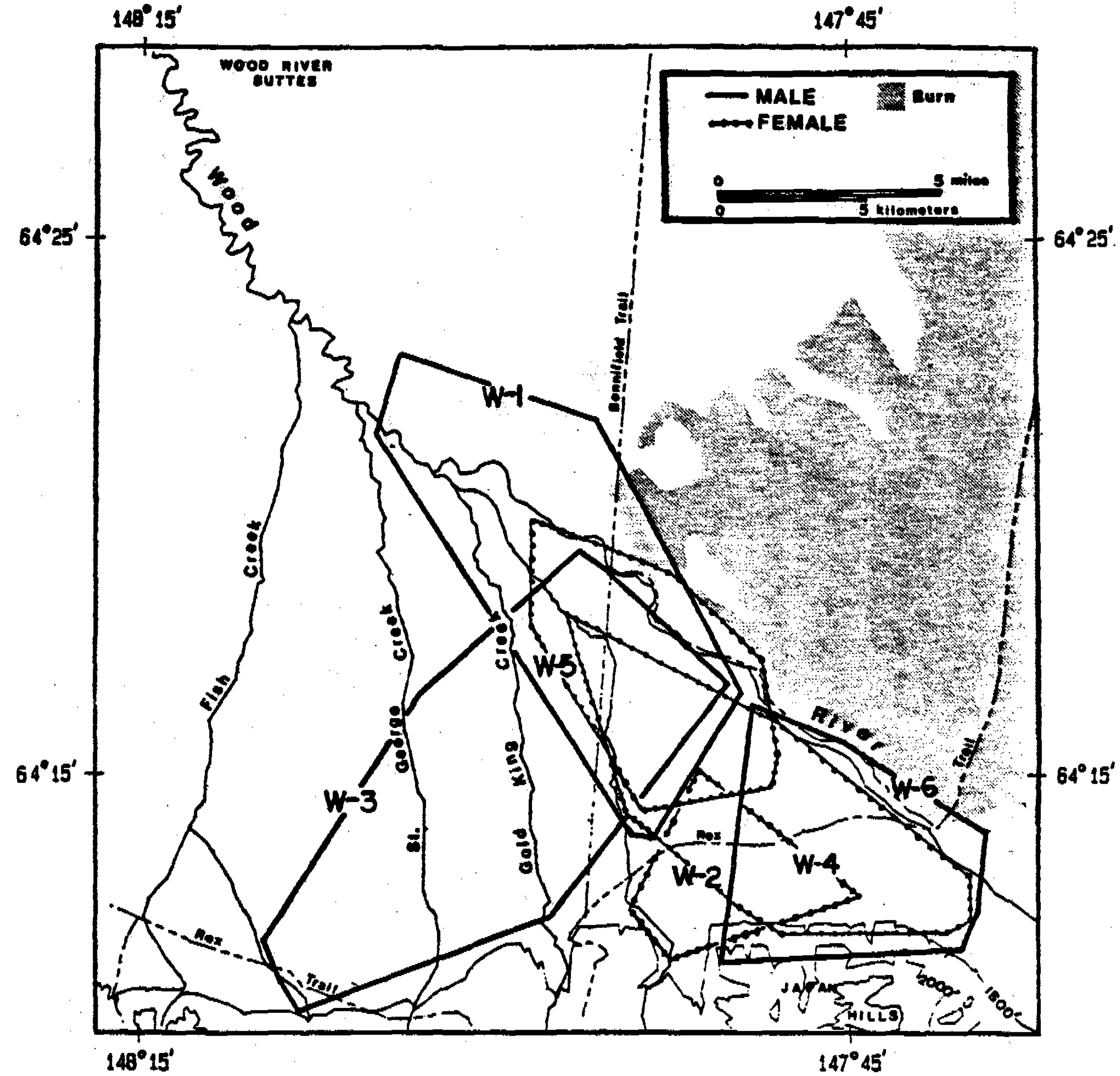


Fig. 7. Home range boundaries for 6 lynx in the Wood River area, based on the innermost 95% of relocations.

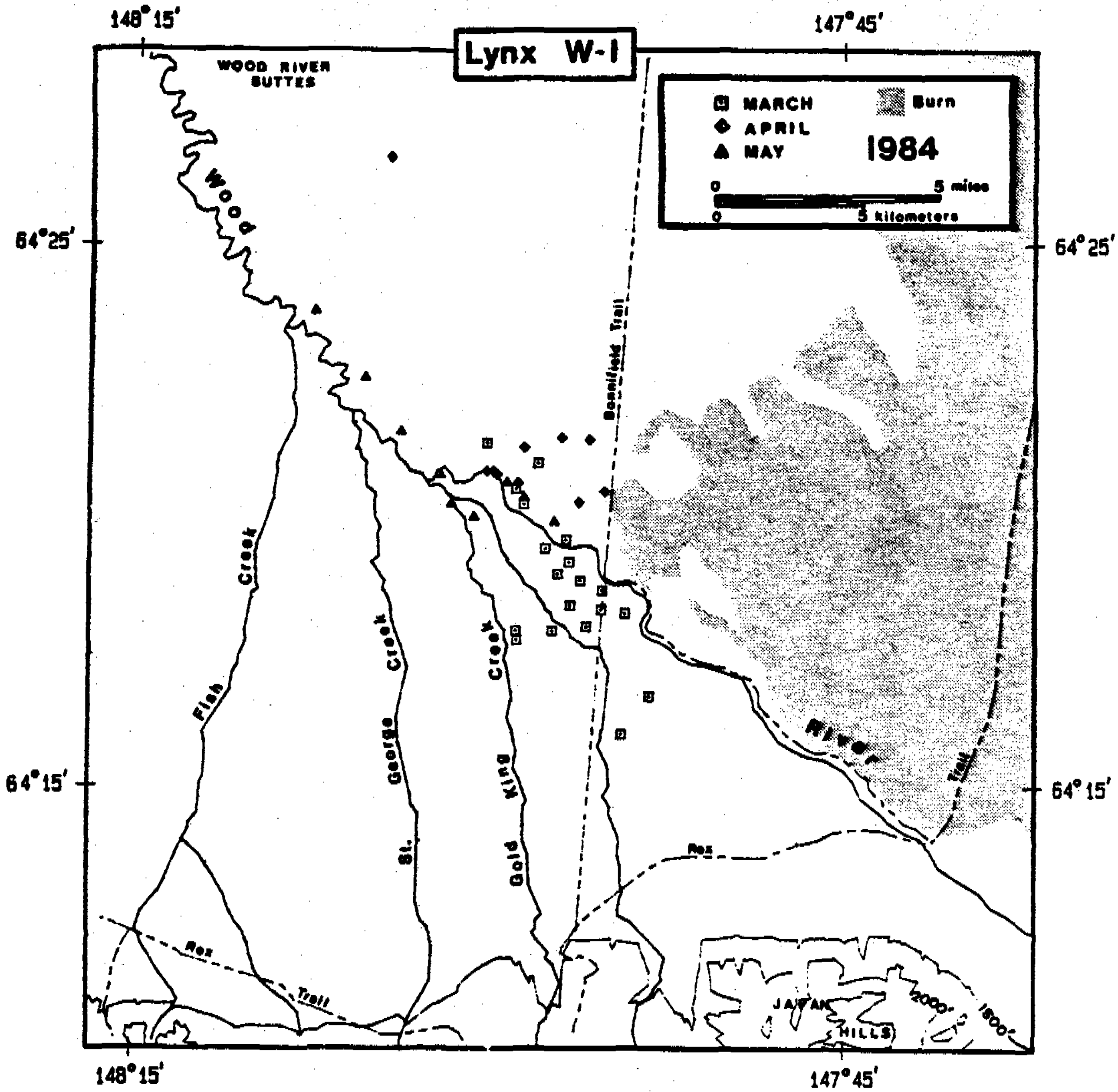


Fig. 8. Relocations of adult male lynx W-1 (Pete), March-May 1984.

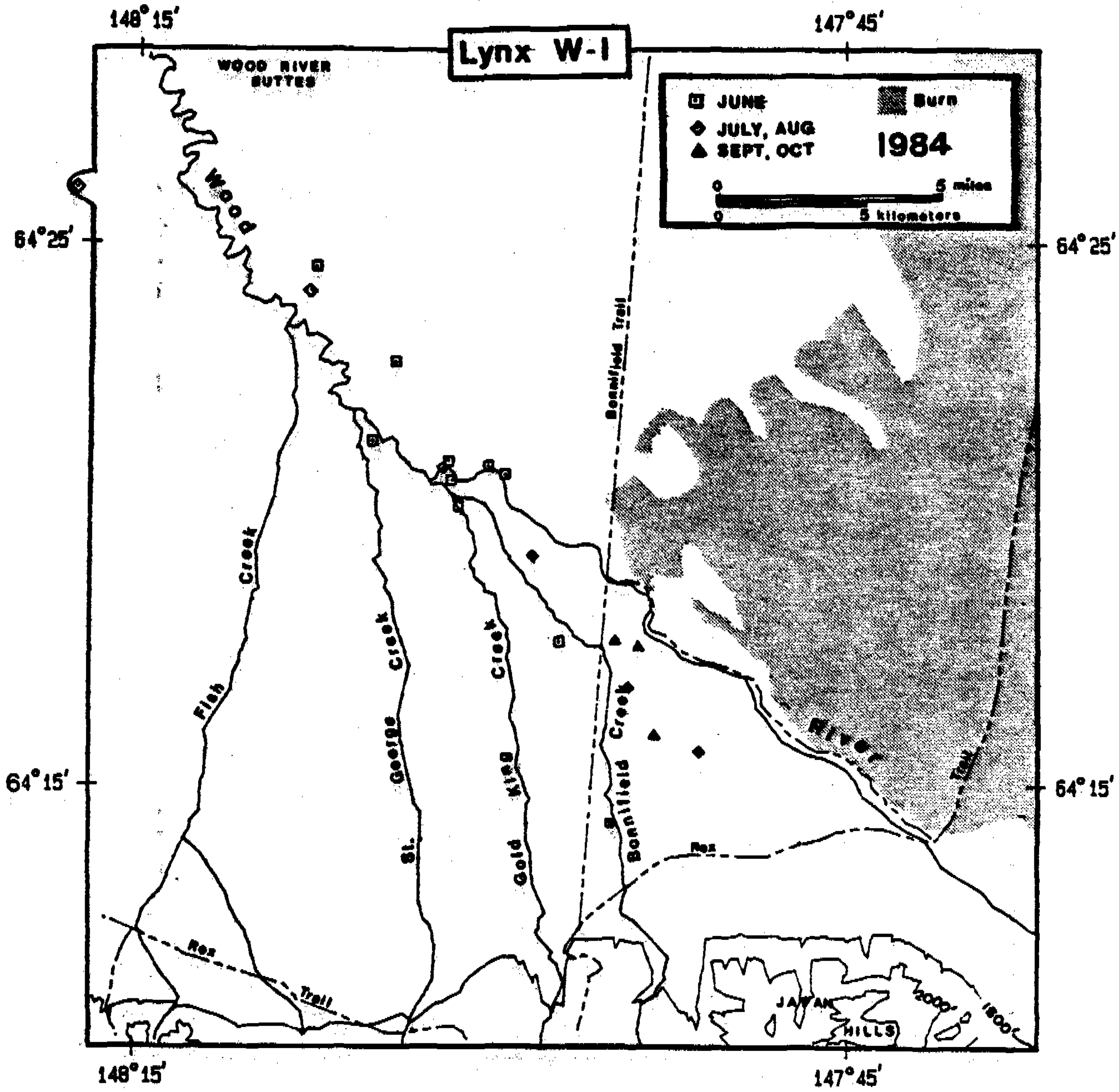


Fig. 9. Relocations of adult male lynx W-1, June-October 1984.

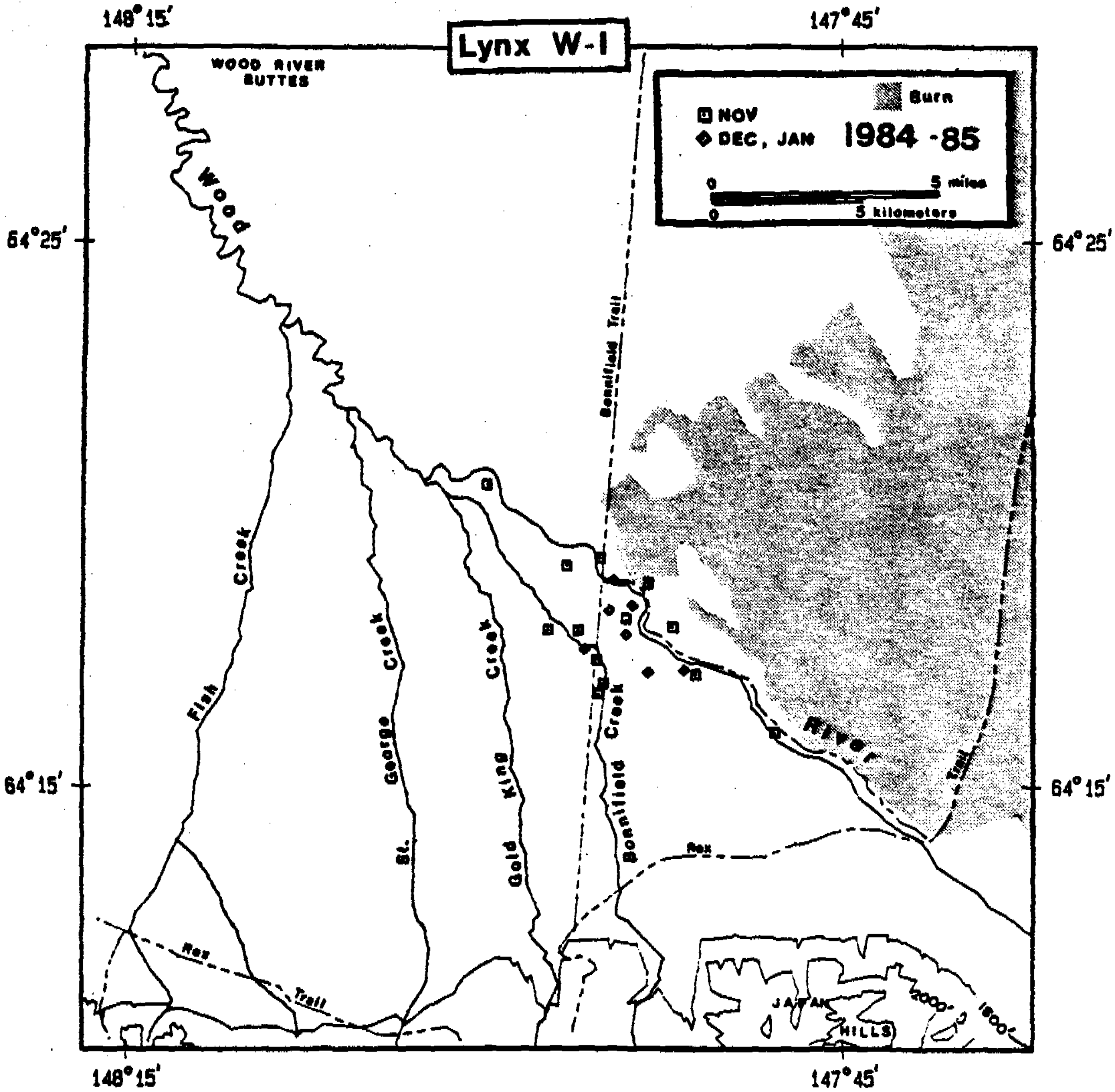


Fig. 10. Relocations of adult male lynx W-1, November 1984-January 1985.

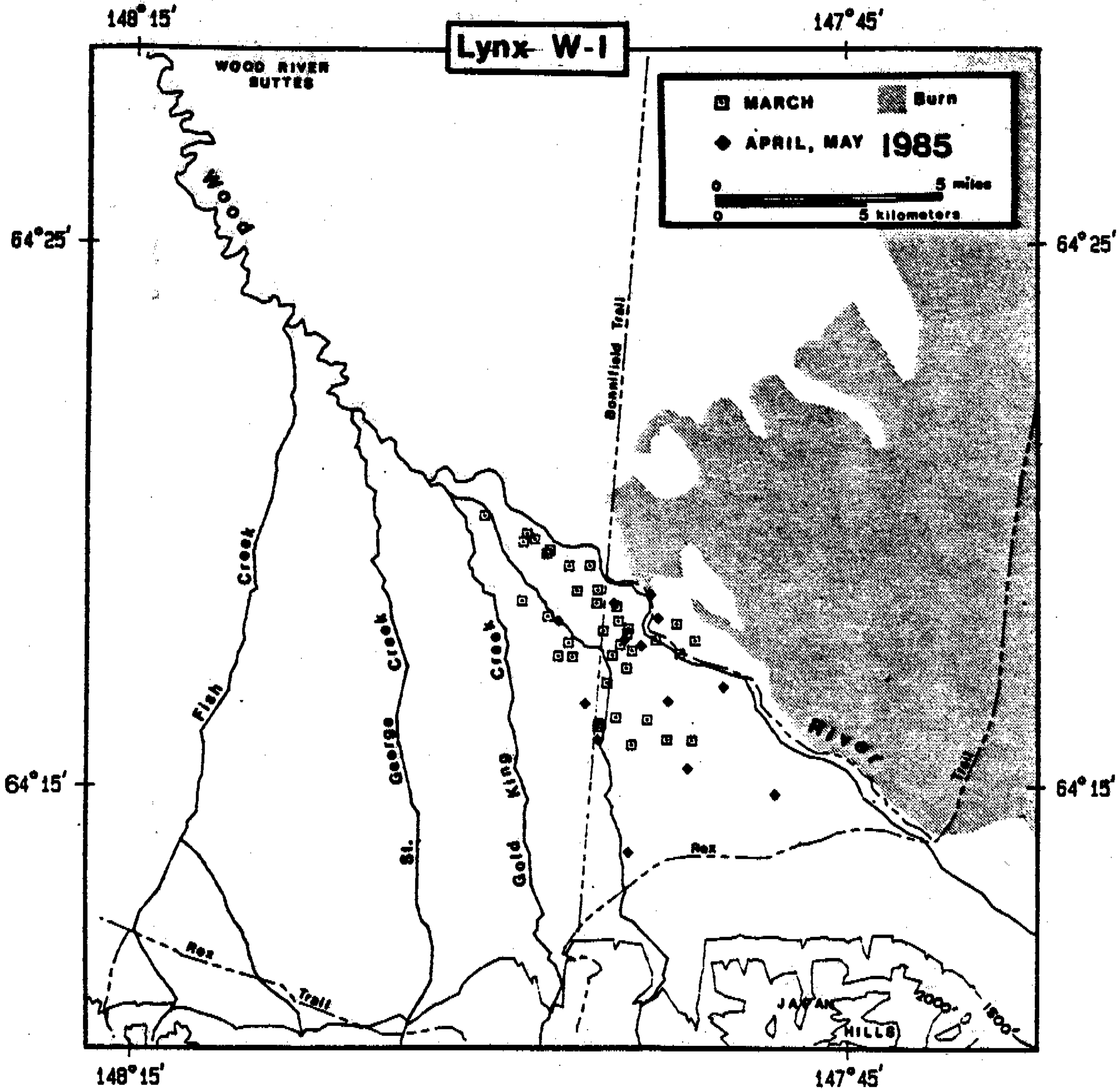


Fig. 11. Relocations of adult male lynx W-1, March-May 1985.

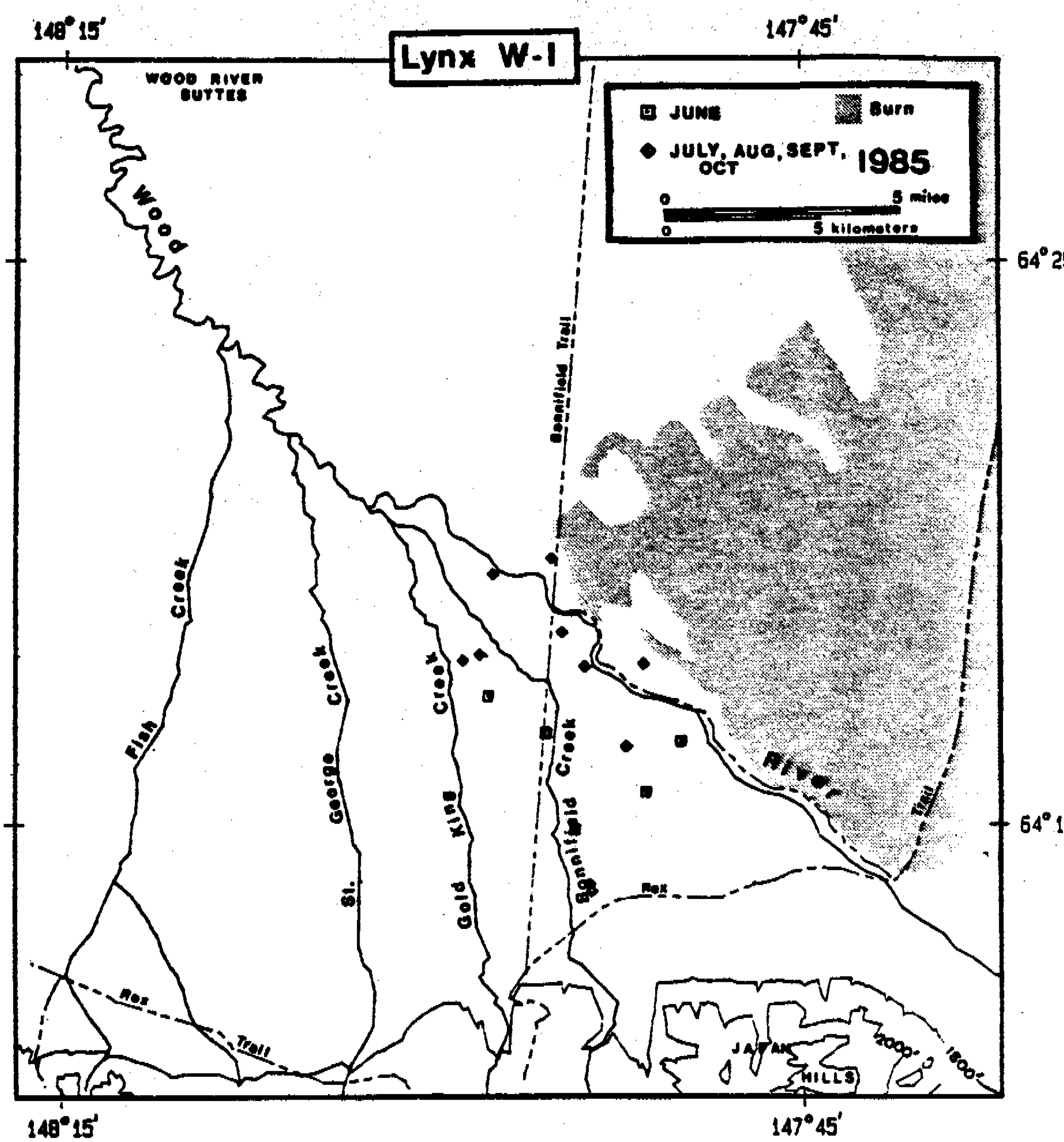


Fig. 12. Relocations of adult male W-1, June-October 1985.

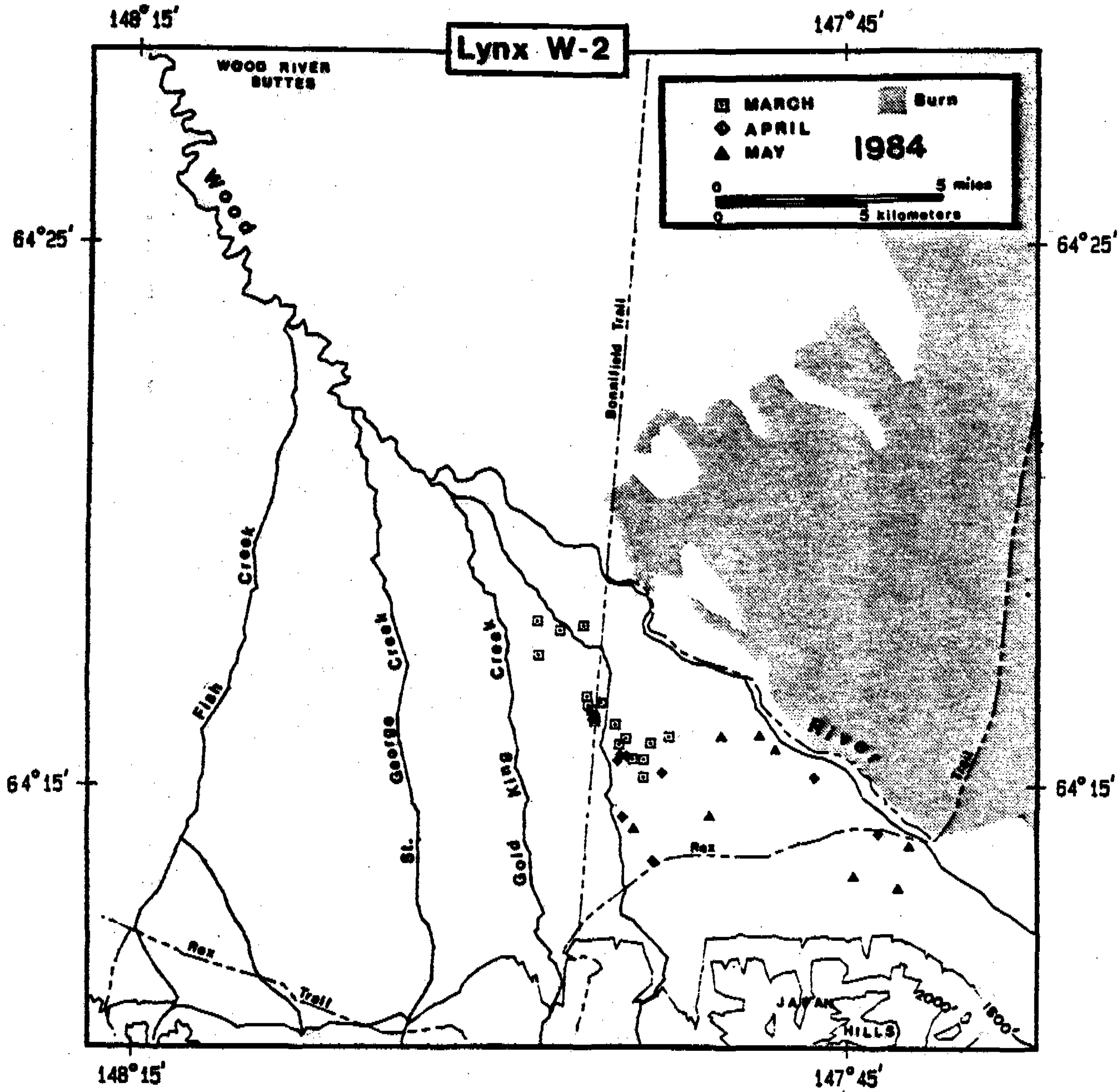


Fig. 13. Relocations for adult female lynx W-2 (Lucy), March-May 1984.

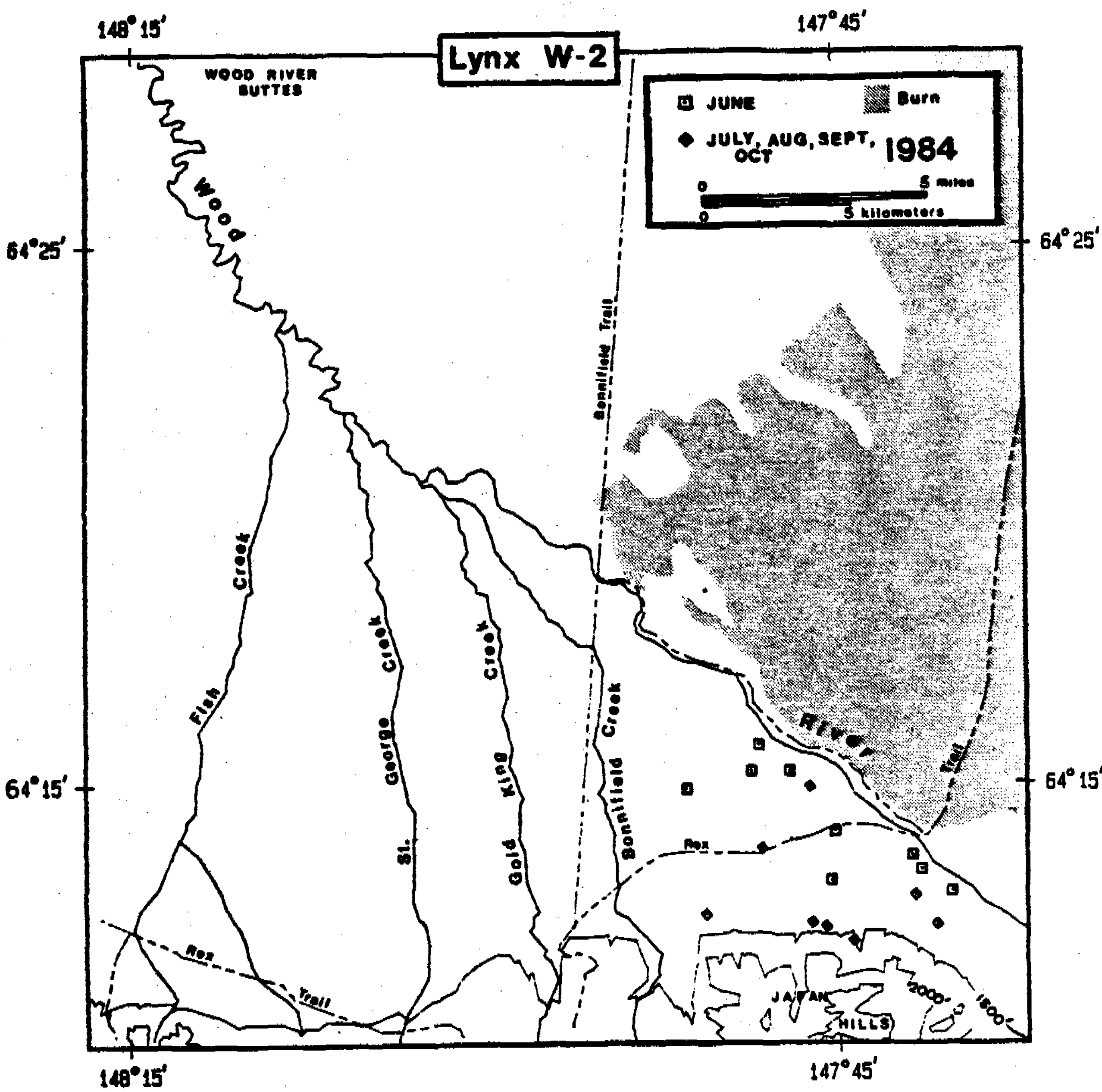


Fig. 14. Relocations of adult female lynx W-2, June-October 1984.

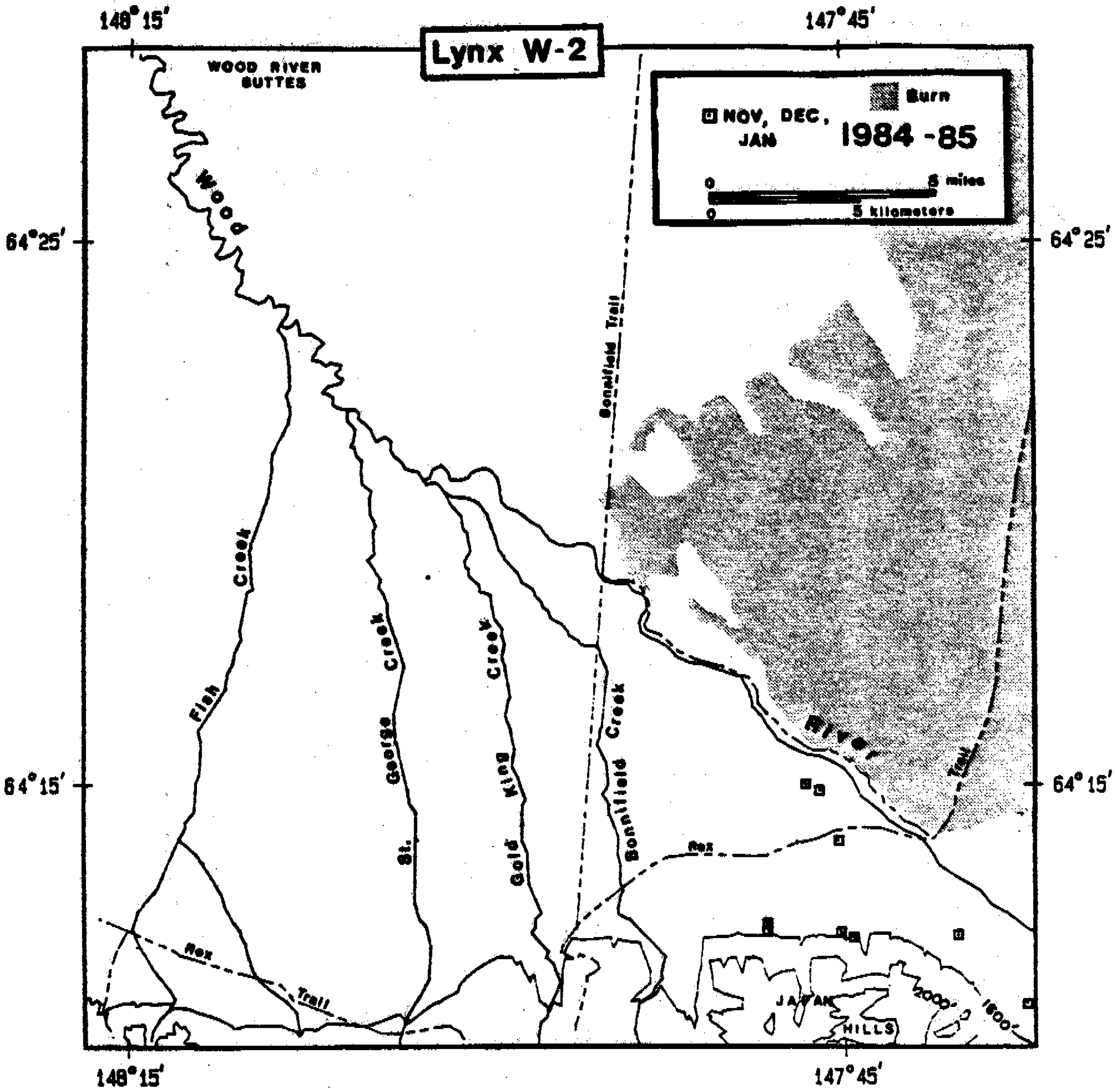


Fig. 15. Relocations of adult female lynx W-2, November 1984-January 1985.

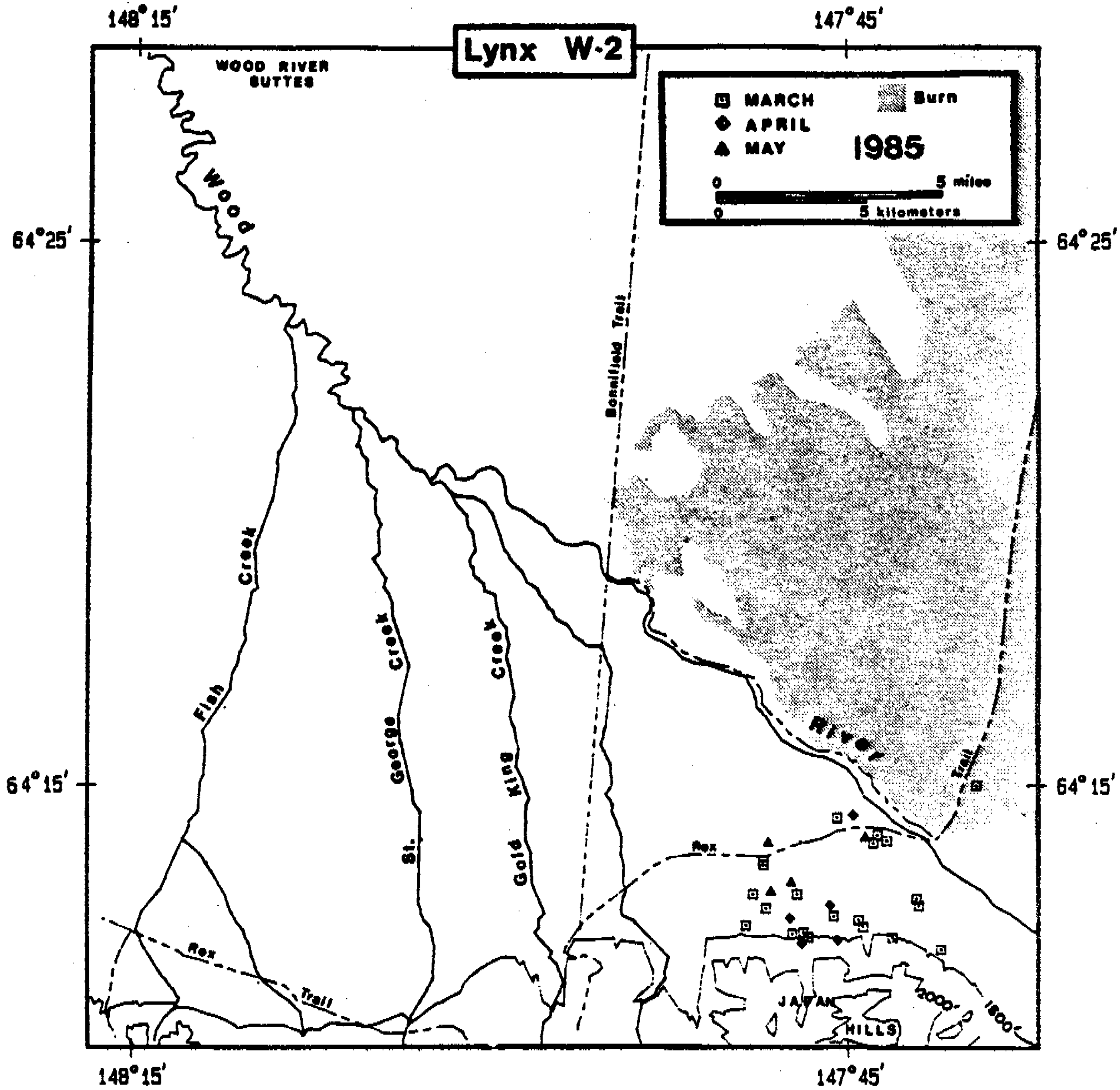


Fig. 16. Relocations of adult female lynx W-2, March-May 1985.

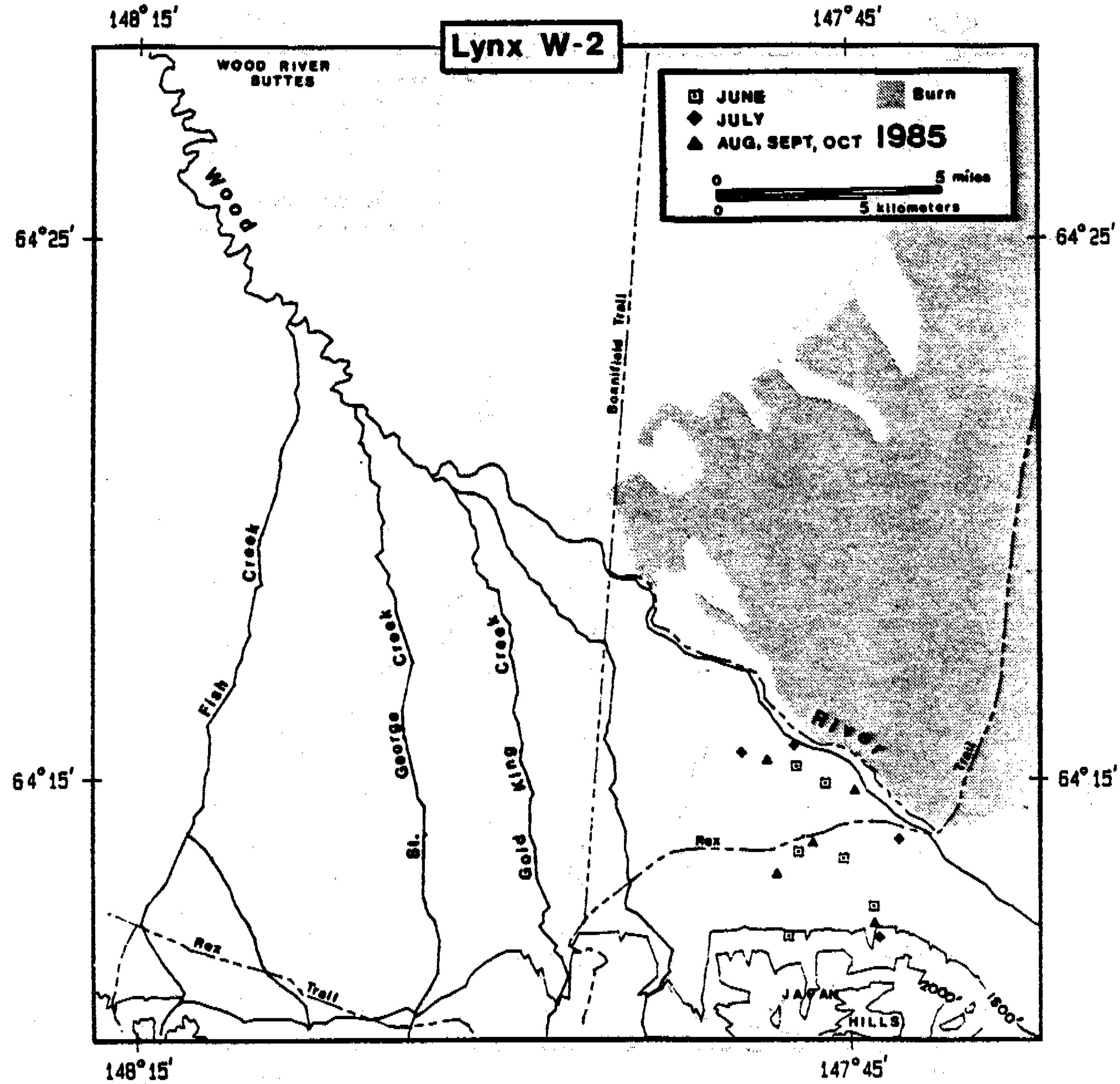


Fig. 17. Relocations of adult female lynx W-2, June-October 1985.

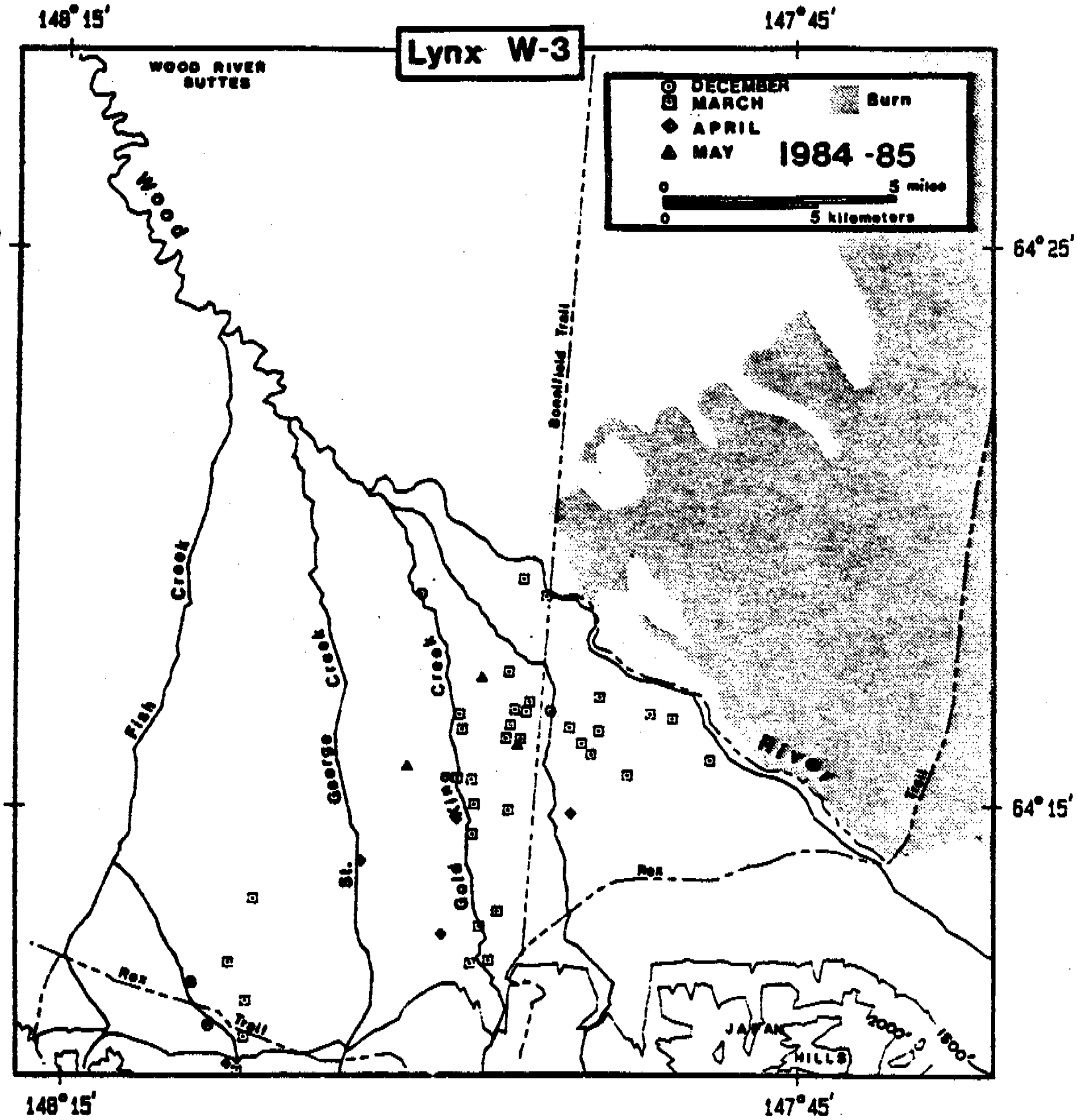


Fig. 18. Relocations of adult male lynx W-3 (Woody), December 1984-May 1985.

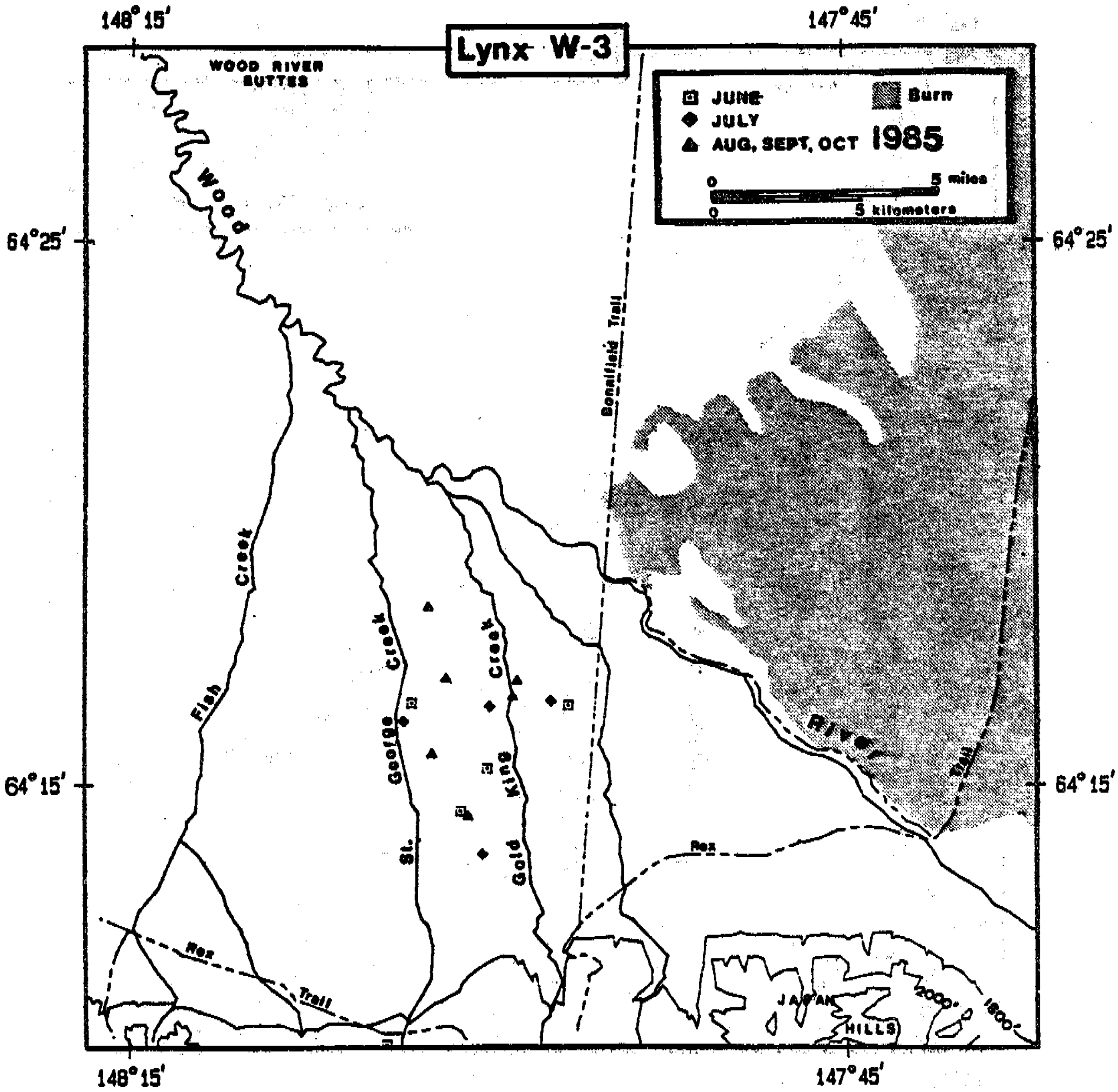


Fig. 19. Relocations of adult male lynx W-3, June-October 1985.

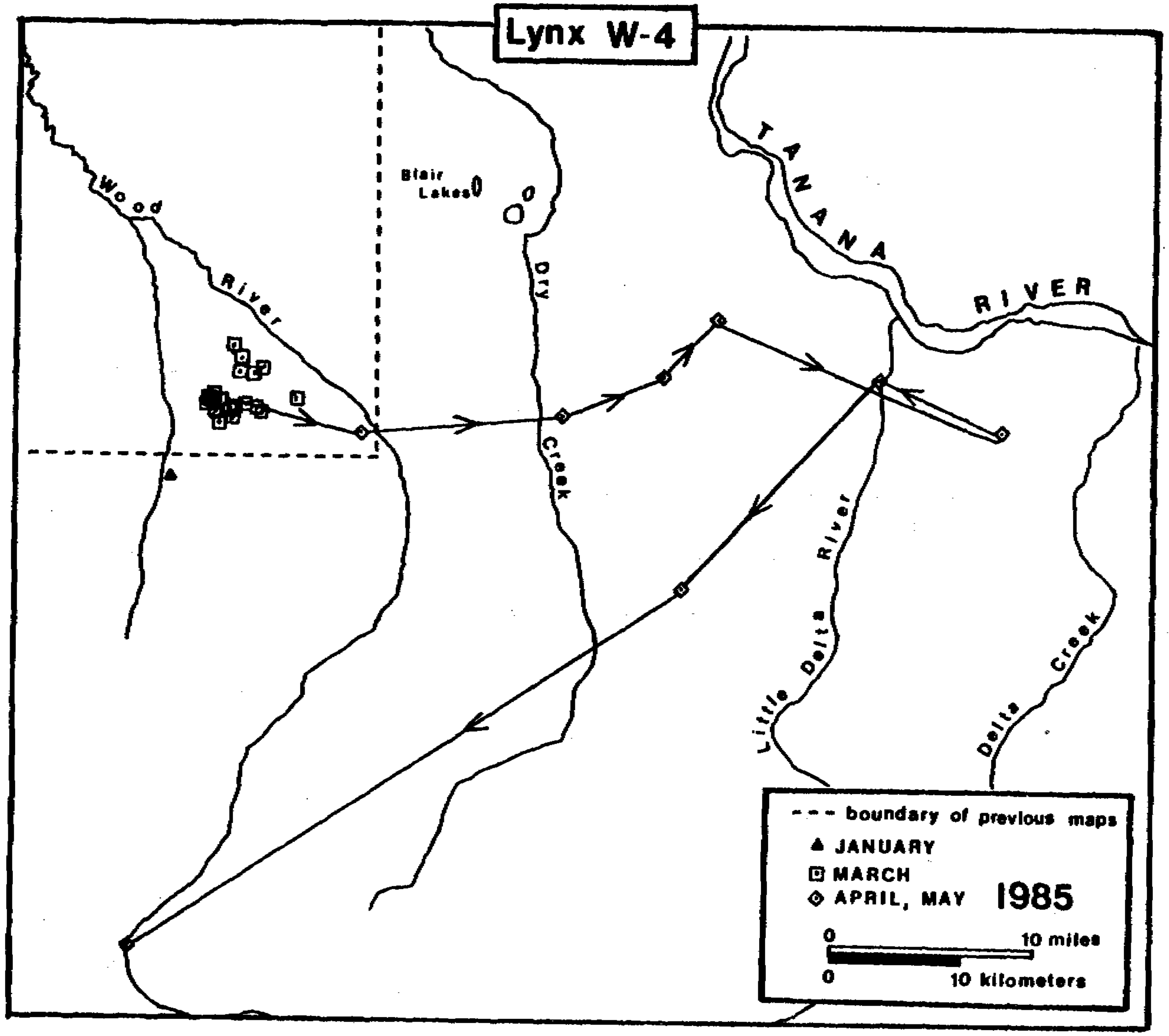


Fig. 20. Relocations of adult female lynx W-4 (Bonny), January-May 1985.

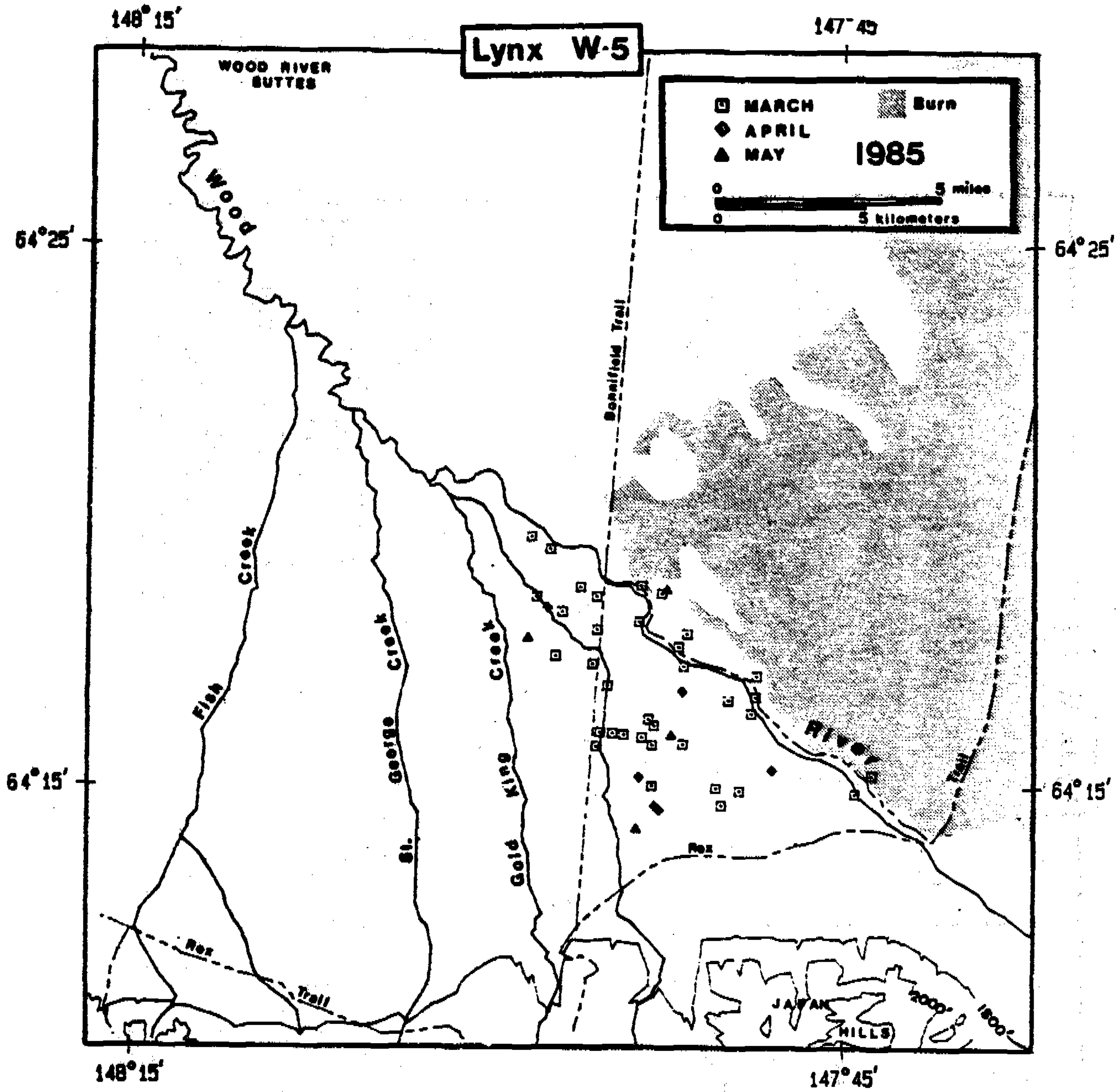


Fig. 21. Relocations of adult female lynx W-5 (Renee), March-May 1985.

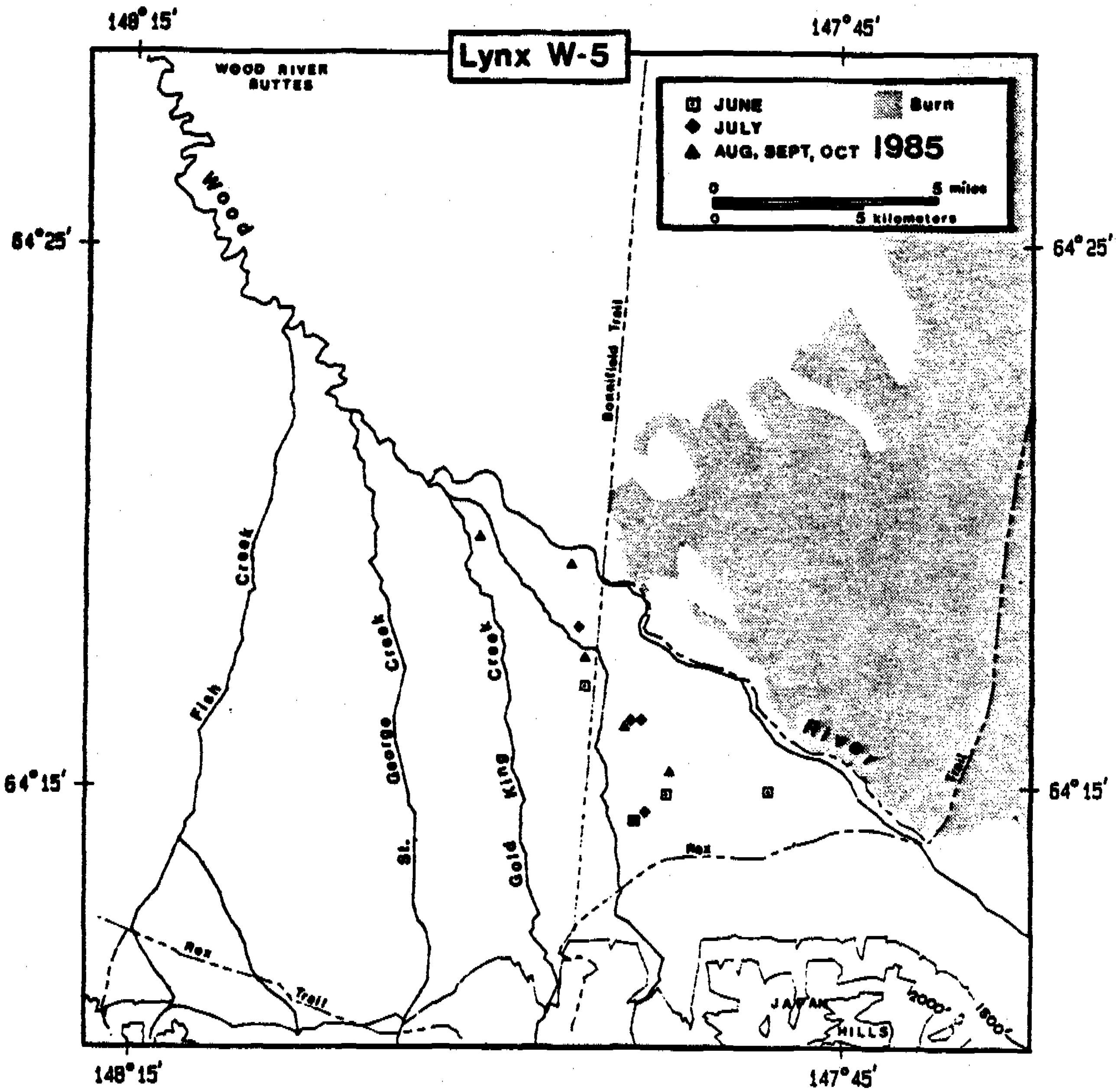


Fig. 22. Relocations of adult female lynx W-5, June-October 1985.

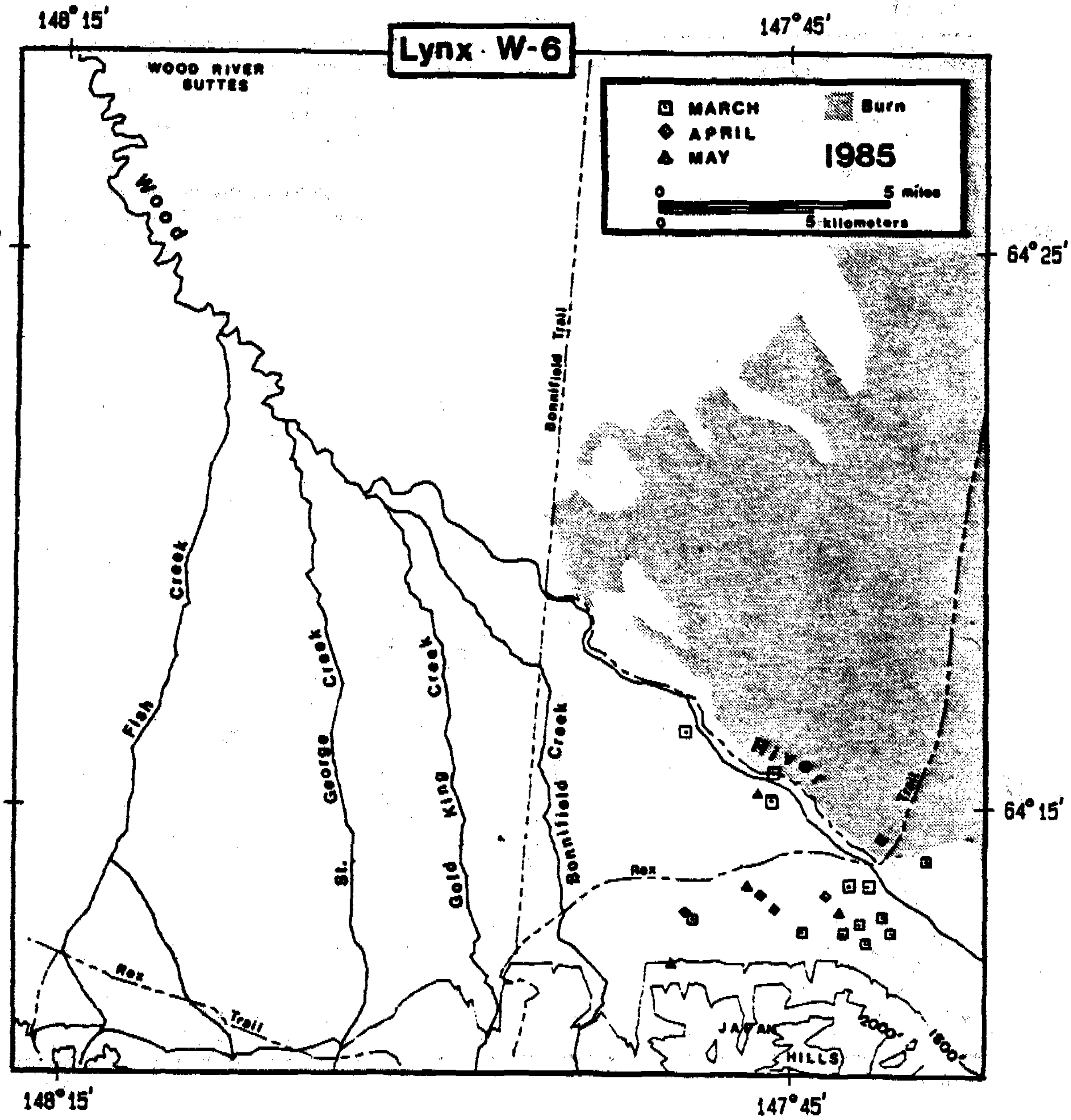


Fig. 23. Relocations of adult male lynx W-6 (Tony), March-May 1985.

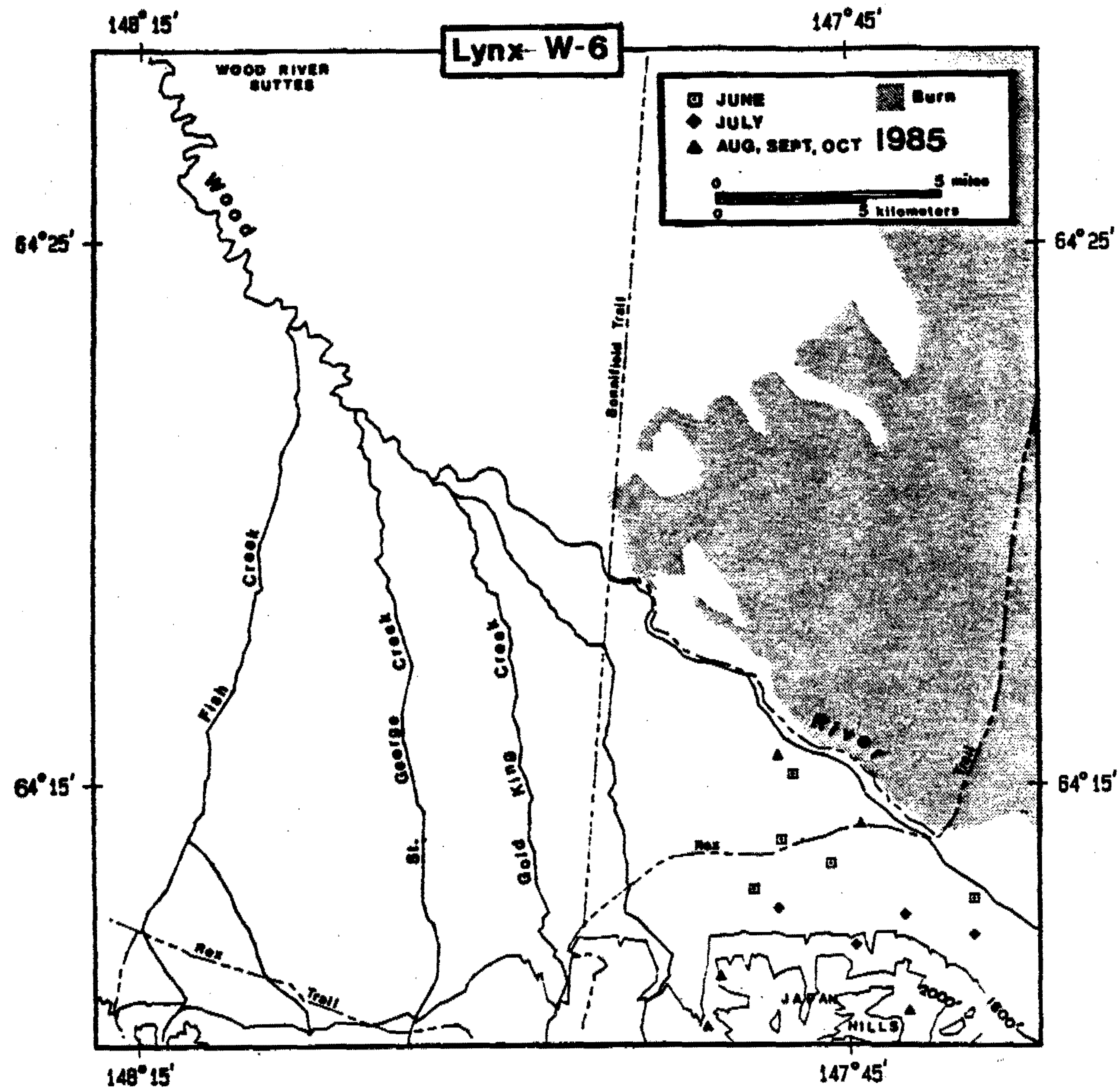


Fig. 24. Relocations of adult male lynx W-6, June-October 1985.

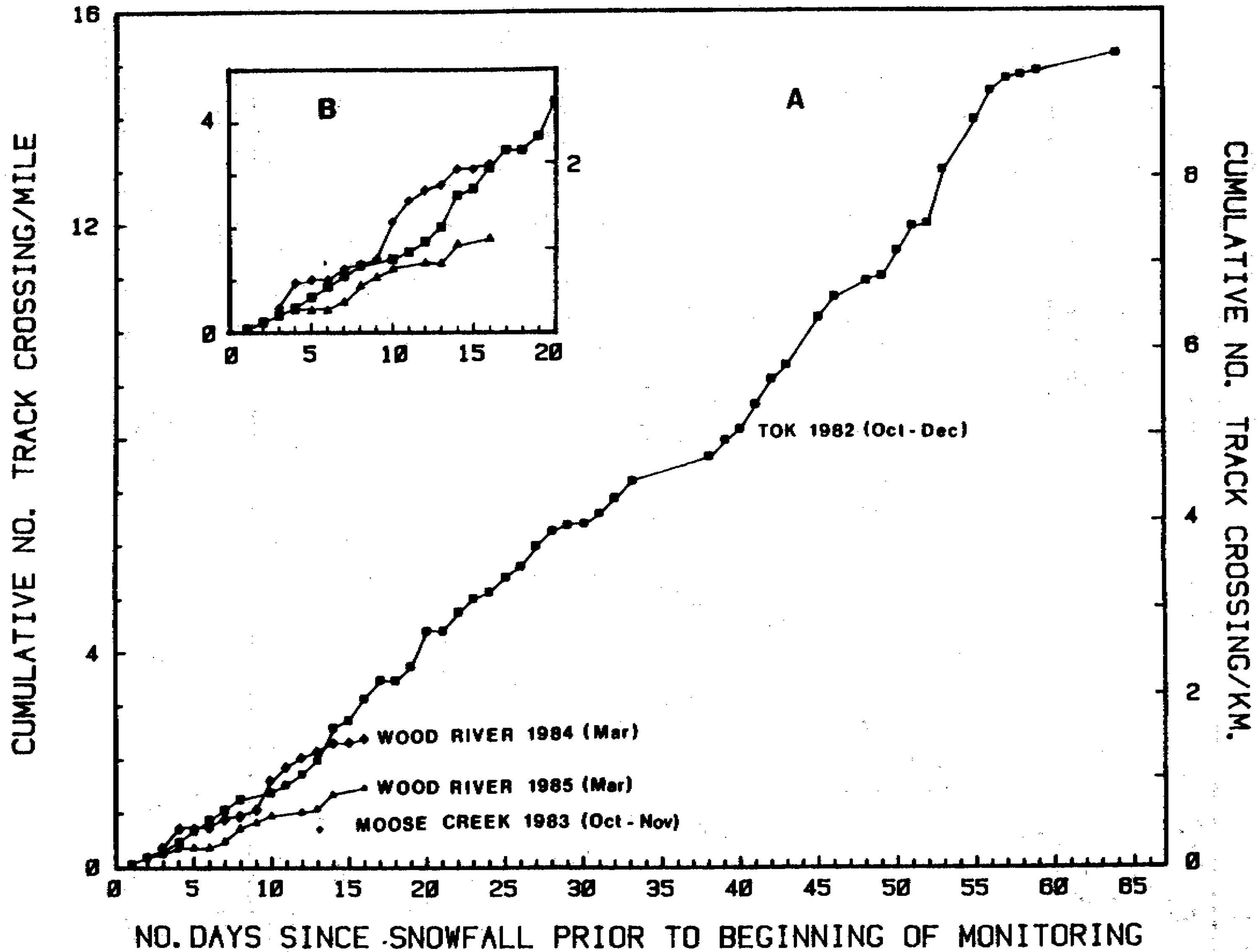


Fig. 25. (A) Cumulative rate of track accumulation along trails in the Tok and Wood River study areas; (B) inset shows first 20 days of Tok data along with revised Wood River data.

Table 1. Capture and location data for 4 lynx radio-collared in the Tok River study area, October-December 1982.

| Lynx No. | Sex | Estimated age (yr) | Weight (kg) | Date captured | Number of days monitored | Area used ($km^2$)[a] | Average 24-hr movement (km)[b] | Comments |
|---|---|---|---|---|---|---|---|---|
| T-1 | M | 2.5 | 10.5 | 10/22/82 | 49 | 54 | 2.4 (0.4-5.6) $n$ = 29 | Dispersed 8.5 mi SE between 12/8/82 and 12/10/82; shot by trapper on 12/10/82, 11 mi SE of capture site |
| T-2 | F | 1.5 | 9.8 | 11/3/82 | 7 | 10 | 2.6 (0.4-4.2) $n$ = 6 | Snared on 11/9/82 |
| T-3 | F | 1.5 | 7.0 | 11/27/82 | 10 | 10 | 2.1 (0.97-3.4) $n$ = 9 | In poor nutritional condition; recaptured 4 times in livetraps and finally caught by a trapper on 12/6/82 |
| T-4 | M | 1.5 | 8.4 | 11/30/82 | 20 | 145[c] | 3.2 (0.6-8.9) $n$ = 13 | Snared on 12/20/82, 14.5 mi NW of capture site |

[a] Excludes apparent dispersal movements.

[b] Average straight-line distance between successive daily locations. Dispersal movements by T-1 and T-4 are excluded.

[c] T-4 traveled widely after capture and may have been dispersing when snared.

Table 2. Capture and location data for 7 lynx radio-collared in the Wood River study area between 13 March 1984 and 1 February 1986.

| Lynx No. | Sex | Estimated age at capture (yr) | Weight (kg) | Date captured | Number of relocations | Months monitored as of 2/1/86 | Home range size ($km^2$) Total | 95% | Comments |
|---|---|---|---|---|---|---|---|---|---|
| W-1 (Pete) | M | 2-3 | 11.1<br>12.0 | 3/14/84<br>3/10/85 | 144 | 22.5 | 210 | 87 | Remained in study area |
| W-2 (Lucy) | F | 2 | 8.2<br>8.9<br>8.0 | 3/16/84<br>3/16/85<br>12/19/85 | 108 | 21.0 | 114 | 70 | Caught in marten trap on 12/15/85; euthanized on 12/19/85 due to injuries |
| W-3 (Woody) | M | 4 | 10.9 | 12/4/84 | 66 | 13.0 | 145 | 119 | Remained in study area |
| W-4 (Bonny) | F | Ad | 9.1 | 1/22/85 | 32 | 4.5 | 47 | -[a] | Dispersed eastward after 4/2/85; no relocations after 5/14/85 |
| W-5 (Renee) | F | 3 | 9.3 | 3/10/85 | 63 | 10.0 | 65 | 52 | Remained in study area |
| W-6 (Tony) | M | 4 | 10.5 | 3/15/85 | 40 | 10.0 | 70 | 57 | Remained in study area |
| W-7 (Noel) | F | 3 | 8.4 | 12/24/85 | 5 | 1.0 | -[a] | -[a] | Caught by trapper 2/17/86 |
| Total | | | | | 453 | 82.0 | $\bar{x}$ = 120.7 | $\bar{x}$ = 76.9 | |

[a] Number of locations does not allow calculation of representative home range.

Table 3. Known trapping harvest of lynx on the Wood River study area, 1969-86.

| Regulatory year | Adult male | Adult female | Male kittens | Female kittens | Unknown sex and age | Total | Comments |
|---|---|---|---|---|---|---|---|
| 1969-70 | -[a] | | | | 102 | 102 | |
| 1970-71 | | | | | 70 | 70 | |
| 1971-72 | | | | | 20-50 | 20-50 | 20 lynx caught in 1 week |
| 1972-73 | | | | | 20-30 | 20-30 | General estimate |
| 1973-74 | | | | | 20-30 | 20-30 | General estimate |
| 1974-75 | | | | | 20-30 | 20-30 | General estimate |
| 1975-76 | | | | | 20-30 | 20-30 | Long trap lines; good lynx year; general estimate |
| 1976-77 | | | | | 20-30 | 20-30 | General estimate |
| 1977-78 | 5 | 3 | 0 | 0 | 0 | 8 | From sealing records |
| 1978-79 | 9 | 8 | 1 | 0 | 0 | 18 | From sealing records |
| 1979-80 | 3 | 3 | 1 | 1 | 0 | 8 | From sealing records |
| 1980-81 | 0 | 0 | 0 | 0 | 0 | 0 | No trapping effort |
| 1981-82 | 2 | 0 | 0 | 1 | 0 | 3 | Light trapping effort |
| 1982-83 | 8 | 9 | 2 | 2 | 1 | 22 | From sealing records |
| 1983-84 | 11 | 6 | 0 | 1 | 0 | 18 | From sealing records |
| 1984-85 | 2 | 1 | 0 | 0 | 1 | 4 | From sealing records |
| 1985-86 | 1 | 4 | 1 | 1 | 0 | 7 | From sealing records |

[a] Sex and age data are not available prior to 1977-78.

Table 4. Estimated lynx population, composition, and mortality in the Wood River study area, during winters 1983-84 and 1984-85.

| Winter | Adult males | Adult females | Adult unknown sex | Total adults | Total kittens | Total number | Estimated mortality rate (%) |
|---|---|---|---|---|---|---|---|
| 1983-84 | | | | | | | |
| Early winter | 7 | 9 | 10 | 26 | 6 | 33 | |
| Known mortality | 4 | 5 | 6 | 15 | 2 | 18 | 54.6 |
| Late winter | 3 | 4 | 4 | 11 | 4 | 15 | |
| 1984-85 | | | | | | | |
| Early winter | 5 | 6 | 2 | 13 | 4 | 17 | |
| Known mortality | 2 | 1 | 0 | 3 | 0 | 3 | 17.7 |
| Late winter | 3 | 5 | 2 | 10 | 4 | 14 | |

Table 5. Estimated lynx population size and density on the Wood River study area during winters 1983-84 and 1984-85.

| Winter | Total adults | Total kittens | Total number | Estimated population density ($km^2$ per lynx) | | |
|---|---|---|---|---|---|---|
| | | | | Area A[a] ($971 km^2$) | Area B[b] ($777 km^2$) | Area C[c] ($570 km^2$) |
| 1983-84 | | | | | | |
| Early winter | 26 | 6 | 33 | 29.5 | 23.6 | 17.4 |
| Known mortality | 15 | 2 | 18 | | | |
| Late winter | 11 | 4 | 15 | 65.0 | 51.8 | 38.1 |
| 1984-85 | | | | | | |
| Early winter | 13 | 4 | 17 | 57.2 | 45.6 | 33.4 |
| Known mortality | 3 | 0 | 3 | | | |
| Late winter | 10 | 4 | 14(10)[d] | 69.4 | 55.4 | 40.7(57.0)[d] |

[a] Includes all habitat within 9.7 km of trails used to gather population data, except that the southern boundary of the area was set at the 300 m elevation (timberline).

[b] Boundaries are as for Area A except that 2 areas where no sign of lynx activity was observed were excluded (part of Blair Lakes Burn and an area south of the Japan Hills).

[c] Includes that portion of Area B within 9.7 km of the trails along which track frequency was monitored and the area known to be used by radio-collared lynx.

[d] Population estimate and density in parentheses exclude a female and 3 kittens which temporarily used only the southern edge of the study area and whose tracks were not observed along the trails used in measuring track occurrence.

Table 6. Lynx track occurrence reported by various trappers and observed during Department aerial surveys in the vicinity of Tok, Alaska, winter 1982-83.

| Date | Source | Area | Transect length (km) | Days after snow | Number track crossings | Tracks/ km | Comments |
|---|---|---|---|---|---|---|---|
| 11/7/82 | D. Kelleyhouse | 11 km Taylor Highway | 9 | 2 | 3 | 0.33 | |
| 11/10/82 | D. Grangaard J. Carson | Ketchumstuk | 180 | 2 | 30 | 0.17 | |
| 3/2-7/83 | J. Carson F. Entsminger | Ketchumstuk | 208 | 1-5 | 1 | <0.01 | |
| 3/7-8/83 | B. Simmons | Dennison Fork | 56 | 4-5 | 0 | 0 | |
| 3/13/83 | J. Carson | Riverside | 72 | 3 | 0 | 0 | |
| 2/17/83 | Aerial survey Tok-1 | Eagle Trail-Clearwater Creek | 118 | 6 | 1 | 0.01 | 2-hr flight under good conditions |
| 2/22/83 | Aerial survey Tok-2 | Tok River-Tetlin Hills | 196 | 10 | 2 | 0.01 | 2-hr flight under good conditions |
| 2/22/83 | Aerial survey Tok-2 | Little Tok River-Tok River | 13 | 10 | 25 | 1.90 | Represents a pocket of abundance encountered in Tok-2 survey |
| | | Tok-2 total = | 210 | 10 | 27 | 0.13 | Represents total values for Tok-2 |
| 2/22/83 | Aerial survey Tok-3 | Tanana River-Robertson River | 193 | 10 | 2 | 0.01 | 2-hr, 27-min survey under good conditions |

Table 7. Track frequency values for the Tok study area in 1982 and Wood River study area in 1984 and 1985.

| | Tok Study Area 1982 | | Wood River Study Area 1984 | | | Wood River Study Area 1985 | | |
|---|---|---|---|---|---|---|---|---|
| Day No. | Cumulative no. crossings (14 Oct-20 Nov) | 24 km cumulative no./km | Cumulative no. crossings (15 Mar-31 Mar) | 40 km cumulative no./km | 30.6 km[a] cumulative no./km | Cumulative no. crossings (8 Mar-23 Mar) | 40 km cumulative no./km | 30.6km[b] cumulative no./km |
| 1 | 1 | 0.04 | 1 | 0.03 | 0.03 | 1 | 0.03 | 0.03 |
| 2 | 3 | 0.13 | 4 | 0.10 | 0.13 | 4 | 0.10 | 0.13 |
| 3 | 5 | 0.16 | 9 | 0.23 | 0.29 | 6 | 0.15 | 0.20 |
| 4 | 7 | 0.21 | 18 | 0.45 | 0.59 | 9 | 0.23 | 0.29 |
| 5 | 10 | 0.42 | 19 | 0.48 | 0.62 | 9 | 0.23 | 0.29 |
| 6 | 13 | 0.54 | 19 | 0.48 | 0.62 | 9 | 0.23 | 0.29 |
| 7 | 16 | 0.67 | 23 | 0.58 | 0.75 | 12 | 0.30 | 0.39 |
| 8 | 19 | 0.79 | 24 | 0.60 | 0.78 | 18 | 0.45 | 0.59 |
| 9 | --[c] | -- | 27 | 0.68 | 0.88 | 21 | 0.53 | 0.69 |
| 10 | 21 | 0.88 | 40 | 1.00 | 1.31 | 24 | 0.60 | 0.78 |
| 11 | 23 | 0.96 | 47 | 1.18 | 1.54 | -- | -- | -- |
| 12 | 26 | 1.08 | 51 | 1.28 | 1.67 | 26 | 0.65 | 0.85 |
| 13 | 30 | 1.25 | 54 | 1.35 | 1.77 | 27 | 0.68 | 0.88 |
| 14 | 39 | 1.63 | 58 | 1.45 | 1.90 | 34 | 0.85 | 1.10 |
| 15 | 41 | 1.71 | 58 | 1.45 | 1.90 | -- | -- | -- |
| 16 | 47 | 1.96 | 60 | 1.50 | 1.96 | 37 | 0.93 | 1.21 |
| 17 | 52 | 2.17 | | | | | | |
| 18 | 52 | 2.17 | | | | | | |
| 19 | 56 | 2.33 | | | | | | |
| 20 | 66 | 2.75 | | | | | | |

[a] 9.4 continuous kilometers with no activity. Deleting this distance alters data as shown.
[b] 9.4 continuous kilometers with only temporary activity. Deleting this distance alters data as shown.
[c] Attempts to collect data were unsuccessful due to weather.

Table 8. Values for mean number of crossings per kilometer per day, standard deviation (SD), and standard error (SE) of various track samples in the Tok and Wood River study areas, 1982, 1984, and 1985.

| Area, year, transect length, interval, and number of days on which tracks were recorded ($\underline{n}$) | $\bar{x}$ no. crossings/km/day | SD ($\bar{x}$) |
|---|---|---|
| Tok, 1982, 24 km, 16 days, $\underline{n}$ = 15 | 0.12 | 0.09 |
| Tok, 1982, 24 km, 20 days, $\underline{n}$ = 19 | 0.14 | 0.11 |
| Wood River, 1984, 40 km, 16 days, $\underline{n}$ = 16 | 0.09 | 0.09 |
| Wood River, 1984, 30.6 km, 16 days, $\underline{n}$ = 16 | 0.12 | 0.11 |
| Wood River, 1985, 40 km, 16 days, $\underline{n}$ = 14 | 0.06 | 0.05 |
| Wood River, 1985, 30.6 km, 16 days, $\underline{n}$ = 14 | 0.07 | 0.06 |

Table 9. Sex and age composition of 65 lynx necropsied from 1982 through 1985 in Interior Alaska.

| Year | Adults | | | Kittens | | Total |
|---|---|---|---|---|---|---|
| | Male | Female | Unknown | Male | Female | |
| 1982-83 | 16 | 27 | 1 | 0 | 0 | 44 |
| 1983-84 | 3 | 4 | 0 | 0 | 2 | 9 |
| 1984-85 | 7 | 5 | 0 | 0 | 0 | 12 |
| Total | 26 | 36 | 1 | 0 | 2 | 65 |

Table 10. Reproductive status of kitten, yearling, and adult female lynx in Interior Alaska, 1982-85.

| Age class | No. specimens | Percent virginal | Percent with C.L.[a] | Percent with R.P.S.[b] |
|---|---|---|---|---|
| Kittens | 2 | 100 | 0 | 0 |
| 1 cementum line (18-22 mo) | 11 | 100 | 0 | 0 |
| 2 cementum lines (30-34 mo) | 10 | 50 | 50 | 20 |
| 3 cementum lines (42-46 mo) | 2 | 0 | 100 | 100 |
| Adult, no cementum age available (1983-84 and 1984-85 specimens) | 7 | 14 | 57 | 71 |

[a] Corpora lutea.

[b] Recent placental scars.

Table 11. Frequency of occurrence of various food remains in stomachs and intestines of lynx examined during the years 1982-85 in Interior Alaska.[a]

| Food item | 1982-83 (n = 42) No. | 1982-83 (n = 42) % | 1983-84 (n = 8) No. | 1983-84 (n = 8) % | 1984-85 (n = 12) No. | 1984-85 (n = 12) % | Total (n = 62) No. | Total (n = 62) % | Total % of digestive tracts containing food |
|---|---|---|---|---|---|---|---|---|---|
| Snowshoe hare | 18 | 43.0 | 4 | 50.0 | 8 | 67.0 | 30 | 48.4 | 68.0 |
| Bird | 3 | 7.1 | 0 | 0 | 1 | 8.3 | 4 | 6.5 | 9.0 |
| Microtine | 4 | 9.5 | 2 | 25.0 | 0 | 0 | 6 | 9.7 | 13.6 |
| Red squirrel | 1 | 2.4 | 0 | 0 | 1 | 8.3 | 2 | 3.2 | 4.6 |
| Caribou | 1 | 2.4 | 0 | 0 | 0 | 0 | 1 | 1.6 | 2.3 |
| Unidentified ungulate | 1 | 2.4 | 0 | 0 | 0 | 0 | 1 | 1.6 | 2.3 |
| Lynx | 1 | 2.4 | 0 | 0 | 0 | 0 | 1 | 1.6 | 2.3 |
| Garbage | 1 | 2.4 | 0 | 0 | 0 | 0 | 1 | 1.6 | 2.3 |
| Vegetation | 0 | 0 | 1 | 12.5 | 0 | 0 | 1 | 1.6 | 2.3 |
| Empty | 13 | 31.0 | 2 | 25.0 | 3 | 25.0 | 18 | 29.0 | |
| Total[b] | 43 | 102.6 | 9 | 112.5 | 13 | 108.6 | 65 | 104.8 | 106.7 |

[a] Some food items may represent trap bait.

[b] Percent totals do not equal 100% and the numbers of food occurrences do not equal the number of specimens because digestive tracts often contain more than 1 item.

Table 12. Frequency of occurrence of various food remains in lynx, fox, and coyote scats collected on the Wood River study area, March 1985-April 1985.

| Food item | Lynx ($n$ = 38) | | Fox ($n$ = 18) | | Coyote ($n$ = 11) | |
|---|---|---|---|---|---|---|
| | No. | (%) | No. | (%) | No. | (%) |
| Snowshoe hare | 33 | 86.8 | 7 | 38.9 | 5 | 45.5 |
| Red squirrel | 5 | 13.2 | 0 | 0 | 0 | 0 |
| Microtine | 0 | 0 | 6 | 33.3 | 1 | 9.1 |
| Moose | 0 | 0 | 4 | 22.2 | 1 | 9.1 |
| Porcupine | 0 | 0 | 2 | 11.1 | 3 | 27.3 |
| Beaver | 1 | 2.6 | 0 | 0 | 0 | 0 |
| Bird | 0 | 0 | 4 | 22.2 | 0 | 0 |
| Totals[a] | 39 | 102.6 | 23 | 127.7 | 10 | 91.0 |

[a] Percent totals do not equal 100% and the numbers of food occurrences do not equal the number of scats because scats often contain more than 1 food item.

Appendix A. Lynx Predation on Red Foxes and Ungulates

During field work in the Tok study area and in conversations with various trappers, I encountered a number of instances of lynx (Lynx canadensis) predation on red foxes (Vulpes vulpes) (Table 1) and ungulates (Table 2).

Six cases of lynx predation on foxes in the Tok area and 2 cases in the Galena area were recorded during winter 1982-83. Five additional reports pertained to previous years, and 2 of these involved multiple cases of predation on foxes during a specific winter or over a period of years. These observations suggest that lynx can fairly easily catch and kill foxes, and are probably aided by moderate or deep snow, which places foxes at a disadvantage due to their greater weight load on track. The cases cited in Table 1 indicate that lynx often capture foxes after relatively short chases of 200 m (180 yd) or less. The large number of cases reported during 1982-83 suggests the frequency of lynx predation on foxes is greatest when snowshoe hares (Lepus americanus) have declined significantly and relatively high lynx populations are left to seek alternative food sources.

Foxes were often eaten by lynx, indicating that hunger was probably a major reason for the predation (Table 1). In only 1 of the individual cases listed was a fox found uneaten, and in this case (see report by T. Carda) the fox had been freshly killed and may have been found before the lynx was able to feed on it. It is conceivable that under these conditions lynx predation can temporarily reduce fox populations. When lynx are abundant, their population density can approach that of foxes, and even a small number of foxes killed by individual lynx could reduce fox numbers. Based on my general observations in the Tok study area and the observations of numerous trappers in the upper Tanana Valley, fox abundance declined drastically during winter 1982-83. J. Huntington reports that a similar phenomenon occurred on the Koyukuk River (Table 1).

A number of trappers have reported that foxes are usually scarce when lynx are abundant in local areas. However, it is difficult to know how much of this is due to the different habitat preferences of the 2 species, foxes preferring more open habitat than lynx, and how much might be caused by avoidance by foxes of areas having high lynx numbers or high mortality of foxes from lynx predation.

Lynx predation on foxes is common in Scandinavia (Haglund 1966, Birkeland and Myrberget 1980), Finland (Pullianen 1981), and central Europe (Lindemann 1956, Hell 1978), but North American records are few. Dufresne (1946) stated that lynx kill red foxes in Alaska and that the remains of foxes consumed by lynx were commonly found when hares were scarce. Seton (1911) described 2 instances in which lynx killed foxes in northern Canada and stated that lynx regularly kill foxes when "...there is soft snow and scarcity of easier prey."

Cases in which lynx killed or attempted to kill caribou (Rangifer tarandus), Dall sheep (Ovis dalli), and mule deer (Odocoileus hemionus) (in the Yukon) are listed in Table 2. Reports of lynx predation on ungulates, as on foxes, appeared to be unusually numerous during winter 1982-83, probably because of the relatively high number of lynx faced with an increasing scarcity of hares. Four caribou killed by lynx during 1982-83 in the Tok area, and 2 killed in previous years, were calves, suggesting some selection by lynx for relatively small caribou. The longest chase recorded occurred near Mentasta Lodge and covered approximately 365 m (400 yd). Even in this case, however, the lynx initially wounded the caribou only 46 m (50 yd) after the attack began. The accounts obtained suggest that lynx usually ambush caribou at close range, with the major wounds being located on the head, neck, and front shoulders. This is similar to the pattern of attack by lynx on caribou calves in Newfoundland described by Bergerud (1971).

In 1 case I was able to backtrack a successful attack on a caribou calf the day after it occurred. This encounter resulted in 1 lynx being killed by another. This incident occurred on 28 November 1982, near Mentasta Lodge on the Tok Cutoff road. Tracks showed that a caribou initially became frightened and ran approximately 46 m (50 yd) without being pursued by the lynx, which continued to stalk along the opposite side of a low ridge parallel to the caribou. The caribou stopped, defecated, and then ran directly away from the lynx, which pursued it around a lake edge and succeeded in wounding it. The caribou bedded down, bleeding, at the lake edge after traveling an additional 91 m (100 yd) and the lynx bedded down approximately 9 m (10 yd) away. The caribou moved only 46 m (50 yd) to a low knoll before again lying down. The lynx walked around the caribou at least twice before attacking it as it ran onto the lake where it was mortally wounded in the neck and began bleeding profusely. After this struggle, the caribou walked approximately 183 m (200 yd) across the lake, with the lynx following, to a narrow channel between islands where it died.

Shortly after the caribou died, the lynx that killed it was apparently killed by another lynx. The kill site, which was located a short distance from the highway, was visited by J. Ainesworth, a local resident, early on the afternoon of 28 November, at which time he found a dead lynx approximately 2 m (2 yd) from the caribou. Although the temperature was approximately -18 C, the lynx was not frozen. I later examined the carcass. The wounds observed, the tracks, extensive areas of torn up snow, and numerous tufts of lynx hair at the site left no doubt that the lynx was killed by another lynx after a struggle near the caribou carcass.

The lynx was a young adult female (cementum age = 3 years) with a calculated live weight of 10.9 kg (24 lb) and abundant deposits of subcutaneous and visceral fat. Wounds included a torn throat (major blood vessels severed and trachea torn), a bite in the middle of the back (broken vertebral spine and broken rib), and a 18-cm (7-in) tear on the abdomen exposing the viscera. The size and spacing of puncture wounds on the neck and back matched those of an adult lynx. The stomach of the lynx contained 330 grams (0.6 lb) of caribou hair, meat, and tracheal cartilage. Because the amount and type of stomach contents matched the portions removed from the caribou, I suspect the female lynx fed briefly on the caribou before another lynx arrived and killed the predator. Although a 2nd lynx may have fed briefly at the kill, it did not appear that it remained in the area for very long. However, the second lynx may have left the area due to human disturbance.

As shown in Table 2, a similar incident, involving an adult male lynx killing a caribou calf, occurred on 7 November 1982 approximately one-half mile east of this location. A trapper who had lived in the area for several years noted that as caribou moved into the area in early November, lynx tracks, as well as those of foxes, coyotes (Canis latrans), and wolves (Canis lupus) became more common, suggesting that due to the scarcity of hares lynx were spending an unusual amount of effort in preying on caribou. The observations of a lynx killing a Dall sheep on the Charley River, attempting to kill a mule deer in the Yukon, and feeding on the remains of a wolf-killed moose (Alces alces) near Tok (D. Grangaard and R. Warbelow, pers. commun.), as well as several cases of lynx predation on red foxes, also suggest that as snowshoe hares became scarce lynx used alternate prey to a larger degree.

There are several previous observations of North American lynx killing ungulates, and the larger European lynx (Lynx lynx) regularly preys on roe deer (Capreolus capreolus) (Haglund 1966, Pullianen 1981). Deer are in some areas a common prey of the bobcat (Lynx rufus) (Fritts and Sealander 1978). Seton (1911) received a report of a lynx killing a young bull caribou, and a Nunamiut Eskimo reported that his father saw a lynx jump from a spruce tree (Picea sp.) onto a small caribou (Gubser 1965). Murie (1935) stated that when hares are scarce, lynx become "a formidable enemy of caribou," and Sheldon (1930) documented 2 cases in which male lynx killed Dall sheep (a yearling ram and a 2-year-old ewe) in what is now Denali National Park. Bergerud (1971) found that lynx were a major cause of caribou calf mortality during summer in

Newfoundland and later showed that lynx predation on caribou calves was greatest when snowshoe hare populations were low (Bergerud 1983). However, Newfoundland caribou generally calve in small areas of open muskeg intermixed with forest, rendering calves more accessible to lynx than in Alaska where most caribou calve on alpine or subalpine tundra. Therefore, the potential for lynx predation on newborn calves is small. However, during years when lynx numbers have not yet declined significantly following declines in snowshoe hares, lynx predation could cause significant losses in areas where caribou frequent wooded habitat during some part of the year.

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Table 1. Cases of lynx predation on red foxes in Interior Alaska, 1930-83. Both successful and unsuccessful attempts are listed.

| Date | Location | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|
| About 1930 | Hog Landing, Koyukuk River | Unk | Unk | Unk | J. Huntington | Reports that after a snowshoe hare population crash, an abundant population of lynx decimated the local fox population. Found several places where lynx had killed and eaten foxes, which rapidly became scarce. |
| 1970's | North of Galena | Unk | Unk | Unk | S. Cleaver | Found where a lynx had killed a fox and cached the remains, after which a wolverine had eaten the rest of the fox. |
| 1960's | Alaska Highway, Northway area | Unk | Unk | | D. James | On 2 occasions a lynx was observed following about 50 m behind a fox. The lynx appeared to be hunting the fox in each case. |
| 1960's and 1970's | Tanana Flats south of Fairbanks | Unk | Unk | Unk | R. Long | Reports finding, at various times, about 12 foxes that had been killed and eaten by lynx after short chases. Notes an inverse correlation between lynx and fox abundance in local areas. |
| 1971-72 | Suslota Creek, Slana area | Unk | Unk | 60% | D. Cramer | Tracks showed the fox had emerged from willows 10 m ahead of lynx traveling on overflow ice. Fox was caught after 20 m chase. |

Table 1. Continued.

| Date | Location | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|
| 3/76 | Ladue River | Unk | Unk | 95% | T. Brigner | Found where lynx had killed and consumed a fox on the river. Snowshoe hares and lynx were abundant at the time. |
| 11/1/82 | East of Tanana River near Tower Bluffs | F | Ad | 0% | T. Carda | Found carcass of freshly killed fox on trail. Tracks showed that lynx had killed fox after a struggle. Carcass showed numerous bite wounds on head and neck and numerous claw marks on shoulders and back. |
| 11/82 | Near Chicken, Taylor Highway | Unk | Unk | 50% | D. Carlson | Found fox recently killed by lynx. Trail of chase was plain in snow. Front half of fox had been eaten. |
| 11/20/82 | Kalutna River, Northway Flats | Unk | Unk | >50% | D. Grangaard R. Warbelow | Tracks showed that large lynx encountered a fox while traveling along lake. Fox ran across lake but was caught and killed after 200 m chase. After a very brief struggle, the lynx carried the fox off the lake before consuming it. |
| 2/15/83 | Upper Ladue River | Unk | Unk | 50% | W. Gramont | Reported finding the half-eaten carcass of a red fox that had been killed by a lynx. |

Table 1. Continued.

| Date | Location | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|
| 12/6/82 | Tok River | Unk | Ad | 90% | This study | Adult male radio-collared lynx seen feeding on a cross fox it had killed. An examination of the site showed the fox had been killed on previous day after chase lasting more than 30 m. Part of the fox had been cached in the snow and then dug out. Remains included a front and hind leg, tail, pelvis, and skull which was buried. |
| 11/82 | Northway Flats | Unk | Unk | Unk | D. James | No details available. Informant was told that residents of Northway had found a fox killed by a lynx. |
| 2/83 | Nikolai Slough, Koyukuk River | Unk | Unk | 99% | K. Dayton | While traveling on river, informant came upon lynx feeding on a freshly killed fox. Upon returning later, the informant found only 16 cm of the fox's tail remaining. |
| 2/83 | Lake south of Galena | Unk | Unk | 90% | J. Demoski | Found scattered remains of fox where it had encountered a lynx at a point on a lake. Lynx caught fox in 2 bounds. |

Table 2. Lynx predation on caribou, sheep, and deer, Interior Alaska, 1800's-1985. Both successful and unsuccessful attempts are listed.

| Date | Location | Species | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|---|
| 1800's | Black River | Caribou | Unk | Unk | | F. Thomas | Informant's great-grandfather once found a large male lynx that had been killed while attacking a caribou. Tracks showed that the lynx had attacked a sleeping caribou. During the ensuing struggle, the lynx was thrown against a tree, breaking its spine. |
| 3/65 or 3/66 | Nabesna Road | Caribou | Unk | Unk | Unk | D. Fredericks | Came upon a large male lynx that had just killed a caribou calf after chasing the caribou across the Nabesna Road. |
| 1/72 | Suslositna Creek, Slana Area | Caribou | Unk | Calf | 2% | J. Ainesworth | Found a caribou calf recently killed by a lynx, which leapt from a leaning spruce as the caribou crossed a pothole. Caribou had been bitten around the head. Lynx left caribou after killing it and never returned. Carcass later visited by a fox and a wolverine. |

Table 2. Continued.

| Date | Location | Species | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|---|
| 1970's | Above Suslota Lake | Caribou (2) | F | Ad | 10% | D. Cramer | Informant found 2 adult cow caribou that had been killed at the same place, but on separate occasions, by an adult male lynx. The lynx had jumped off a bank and in 1 bound reached the caribou. It appeared the 2nd kill was made after the first was frozen. The lynx apparently abandoned both carcasses after they became frozen. |
| 11/7/82 | 1.6 km south of Mentasta Lodge | Caribou | Unk | Calf | Unk | G. Maule | Observed lynx on caribou's back, after which the wounded and nearly dead calf tumbled down steep slope along highway. Calf had been clawed and bitten on the head. Lynx proved to be a large male (est. wt. 12.7 kg). |

Table 2. Continued.

| Date | Location | Species | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|---|
| 11/29/82 | 1 km south of Mentasta Lodge | Caribou | M | Calf | 2% | This study | (See narrative.) Tracks showed clearly how a lynx had killed the calf after a protracted encounter covering about 400 m. A lynx had eaten a few pounds of meat from the throat and lower neck. As described in the narrative, another lynx apparently arrived at the scene after the kill and, in an ensuing struggle, 1 lynx (an adult female) was killed. Caribou femur marrow fat = 56%. |
| 2/15/83 | Upper Ladue River | Caribou | M | Calf | 5% | W. Gramont | Found largely intact carcass of caribou that had been killed by a lynx. The lynx had fed on the throat and part of a shoulder. |

Table 2. Continued.

| Date | Location | Species | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|---|
| 3/10/83 | West Fork Dennison River | Caribou | M | Calf | 60% | D. Grangaard R. Warbelow J. Carson This study | (See narrative.) Large male lynx observed at carcass on 5 occasions between 3/10 and 4/20/83. An inspection on 3/21 showed the lynx had killed the caribou 25 m after first making contact with it. Caribou femur marrow = 77%. Lynx remained at kill for at least 42 days, until 4/21 when ice on river broke up taking the caribou with it. |
| 1/28/85 | Mosquito Fork, Fortymile River | Caribou | Unk | Cow and calf | | D. Grangaard | Tracks showed that a lynx had followed the caribou for at least 1 km. At 1 point the lynx had run about 30 m, chasing the caribou, before again following the caribou at a walk. |
| 12/83 | Charley River | Dall sheep | M | Ad | Unk | W. Rimer | Informant was told that a trapper found a large Dall ram that had been killed by a lynx on the upper Charley River. The lynx, a large male, was trapped at the sheep carcass. |

Table 2. Continued.

| Date | Location | Species | Sex | Age | Approx amt consumed | Informant | Comments |
|---|---|---|---|---|---|---|---|
| 12/7/85 | Riley Creek, Denali National Park | Dall sheep | M | 9 | 1% | J. Birch | Sheep was found soon after it was killed by a lynx. Tracks indicated the lynx had ridden the sheep for at least 30 m before the sheep died. Major wounds were on the dorsal part of the neck behind the head. Sheep femur marrow fat = 69%. |
| 3/3/83 | 48 km west of Whitehorse | Mule deer | Unk | Ad | | R. Hayes | Observed (from aircraft) a lynx pursue a mule deer for about 30 seconds. Deer ran in wide arc and lynx attempted to leap on its back 6 or 7 times but failed and eventually gave up. |