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W. Lewis Pamplin, Jr., Director
Steven R. Peterson, Research Chief

DEVELOPMENT OF LYNX POPULATION ESTIMATION TECHNIQUES

By
Robert O. Stephenson

Progress Report
Federal Aid in Wildlife Restoration
Project W-22-2, Job 7.12R

(Printed May 1984)

PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperator: None

Project No.: W-22-2 Project Title: Furbearer Research

Job No.: 7.12R Job Title: Development of Lynx Population Estimation Techniques

Period Covered: 1 July 1982 through 30 June 1983

SUMMARY

Potential techniques for estimating lynx (*Lynx canadensis*) population status were investigated in a 56 mi^2 study area in the upper Tanana valley. A 15-mi survey route was traveled daily from 14 October to 16 December 1982 and again from 10 February to 17 March 1983, during which time lynx tracks were recorded and traps were maintained in an effort to capture and radio-collar lynx.

During October-December, the number of lynx crossings on the 15-mi survey route averaged 0.24/mi/day and increased from 1.07/mi 7 days after a snowfall to 15.18/mi 64 days after snow. The rate of track accumulation declined during midwinter; during February and March, no lynx trails crossed the survey route. Both small and large changes in the rate of track accumulation appeared to reflect changes in the number and activity of lynx during a period when snowshoe hare (*Lepus americanus*) numbers were low and declining.

Four lynx (2 males, 2 females) were radio-collared and monitored for a total of 84 lynx-days. Individual lynx were monitored from 6 to 49 days before being taken by trappers. The average distance between successive daily relocations ranged from 1.3 to 2.0 mi for the 4 lynx. Both male lynx dispersed from the study area, moving from 3.5 to 5.5 mi between daily relocations. The movements and distribution of radio-collared lynx, and the movements of other lynx as indicated by tracks, showed that lynx ranges overlapped considerably in time and space; the lynx population was highly unstable coincident with a food shortage and declined drastically during midwinter.

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 light, from the air as well. The distinguishing characteristics of lynx tracks in various snow conditions are described and recommended procedures for track counts are presented.

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

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BACKGROUND

Basic to the successful management of wild animals harvested by man is a knowledge of population size. Without this, the importance of human harvest cannot be evaluated, and meaningful regulations cannot be formulated. In Alaska, and elsewhere 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, during the last decade, a marked rise in lynx pelt value has heightened trapping of lynx. Because the lynx, along with the marten (*Martes americana*), stands apart from many furbearers in the relative ease with which it can be caught, there is a strong concern among trappers and wildlife biologists alike that, at least in populated areas, 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; O'Connor, In Press).

Although reliable estimates of lynx numbers have been determined in a few relatively small areas through intensive fieldwork (Iurgenson 1955, Brand et al. 1976, Parker et al. 1983), still to be developed is even a rudimentary method of determining lynx population status that is both rapid and economical enough to aid research and management over large areas. The lack of adequate population data and the resultant inability to evaluate the effects of harvest remain significant problems.

During its 1st year, 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.

There are presently no census methods for bobcats (Felis rufus) or lynx (McCord and Cardoza 1982), and techniques that would provide even a simple index to population status have not been developed. In efforts to measure trends in Wisconsin bobcat populations, Klepinger et al. (1979) found that harvest declines corresponded to declines noted in track counts on road transects. Zezulak (1981) found that in northern California the capture/trap-night method was a good indicator of bobcat population trend, while scent stations were ineffective because bobcats were not greatly attracted to the scent. However, in Florida, Conner et al. (1983) found that scent station indices accurately reflected trends in a bobcat population, although scent station visitation rates (19%) were low compared to those for gray foxes (Urocyon cinereoargenteus) (48%).

Although scent station indices could conceivably be applied in Alaska, track counts appear to be more promising since they are less time consuming, can be used throughout the winter, and because both aerial and ground transects may be employed. Karpowitz and Flinders (1979) reported some progress in using track counts following snowfall to monitor bobcat populations and observed track crossings of 0.15/mi/day on a 27.9 mi transect in their Utah study area. The feasibility of bobcat track counts has also been studied in Wisconsin (Klepinger et al. 1979).

This progress report deals primarily with major findings pertaining to the development of techniques for monitoring lynx population status. Data on lynx food habits, activity, and nutritional and reproductive condition are being analyzed and will be presented in a future report.

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 actual population density and productivity of a lynx population.

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

STUDY AREA

The primary study area was located 10 mi south of Tok, Alaska in the Tok River valley (Fig. 1). Intensive fieldwork occurred in a 56 mi^2 area extending from the mouth of Clearwater Creek on the south to Eagle Trail on the north and included the 3-4 mi wide Tok River valley floor and adjacent hillsides with elevation ranging from 1,800 to 3,000 ft. The area is vegetated by spruce (*Picea* sp.) and mixed spruce-aspen (*Populus tremuloides*) forest with a scattering of willow (*Salix* sp.) and alder (*Alnus* sp.) thickets. Additional information was obtained from trappers in the upper Tanana valley and the Fortymile and Ladue River drainages.

METHODS

Efforts to capture and radio-mark lynx and to monitor track occurrence were carried out between 14 October and 16 December 1982 and again between 10 February and 17 March 1983. During these periods a 15-mi route was traveled daily by truck and snow-machine 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. 1½ coil-spring leg-hold traps with padded jaws (Woodstream Corp., Lititz, Pa.). Trapped lynx were immobilized with ketamine hydrochloride (Parke, Davis, and Co., Detroit, Mich.), acepromazine (Ayerst Laboratories, Inc., New York, N.Y.), and atropine sulfate (Med-Tech, Inc., St. Joseph, Mo.) at dosages of approximately 5 mg/lb, 0.25 mg/lb, and 0.025 mg/lb, respectively. Drugs were administered with a pole syringe; radio collars (Telonics Inc., Mesa, Ariz.) were attached; and lynx were weighed, measured, and released.

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 Inc., Mesa, Ariz.). Aerial relocations were obtained with Piper PA-18 aircraft using dual 3-element Yagi antennae.

The activity patterns of radio-marked lynx 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 Inc. The activity monitor was stationary at a site 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.

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 was monitored by cruising the highway and the "hillside road" (Fig. 1) at speeds of 3-10 mi per hour, 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 30-50 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.

RESULTS AND DISCUSSION

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.

Trails of individual lynx were followed for several miles during fieldwork. These observations, as well as those of various trappers, showed that lynx deviate from their normal gait, a walk, only rarely and usually to briefly pursue prey. I estimated that lynx traveled at a walk over 90% of the time. This enhances reliable identification of tracks from both air and ground because the track pattern is consistent compared to canids, which regularly change gaits while traveling.

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 about 3.5 to 4.5 inches, while the distance between successive prints ranges from 12 to 28 inches with a straddle (distance between the outside edges of prints made by the right and left feet) of between 6 and 9 inches. In new, soft snow, lynx tracks may be

6 to 8 inches deep, but in older and slightly crusted snow, they rarely sink more than 4 inches. 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 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 8-10 inches. 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 yards. This is in contrast with other animals, especially canids, which often travel in a more direct fashion. Lynx travel most directly through openings but, even then, leave an easily identifiable trail.

There are some possibilities for confusion with 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. The track made by a running lynx is in some respects 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.

Sightability of Lynx Tracks

During ground transects, lynx tracks intersecting trails are readily detectable under most conditions if the speed of travel is varied according to the nature of the trailside or roadside. Where vegetation is dense or a clear area of at least a few feet is not present along the transect, the speed of travel must be reduced. If snowmachine trails have not been traveled since a previous snowfall, however, the trail itself makes tracks highly visible. Although I did not attempt to quantify the sightability of lynx tracks during ground transects, my impression from extensive fieldwork and from conversations with trappers is that sightability is high except in unusual circumstances.

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, signs of lynx activity were noted in this area; by the morning of 23 February, 27 lynx trails intersected the west side of the highway along a 5.5-mi segment. The roadside in this area is cleared of mature trees for a distance of 30-50 ft, although dense saplings occur within a few feet of the road in some areas. This area was aerially surveyed at midday on 22 February with a PA-18 aircraft at a speed of 80 mph and an altitude of 300-400 ft actual ground level with direct but low intensity light. During a single pass along the west side of the road, the pilot and observer 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 are trails. Lynx are not attracted to open areas to the same extent as foxes, coyotes, and wolves (_Canis lupus_), but they regularly cross small openings. Because lynx habitat in Interior Alaska is diverse with a mixture of open and semi-open plant communities, the chances of not detecting lynx during track surveys are small.

During winter 1982-83, snowshoe hares declined to a low level in the vicinity of Tok. 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. During a peak in hare numbers, the sightability of lynx tracks, particularly during aerial surveys, could be significantly reduced.

Track Frequency as an Index to Lynx Population Status

The occurrence of lynx tracks along ground or aerial survey routes during winter appears to offer the only practical index to lynx numbers. Track frequency data will become more meaningful as they are accumulated from areas where relative or absolute lynx numbers are known.

Fig. 2 shows the cumulative number of tracks/mile crossing the 15-mi route surveyed on the ground in the Tok River study area during a 64-day period from 13 October to 16 December 1982. This figure shows the number of track crossings that would have existed in the absence of snowfall after a 6-in snowfall on 13 October. Although several additional snowfalls occurred, as indicated by asterisks, they were ignored for the purposes of illustration. 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.

The frequency of tracks increased from 1.07/mi on day 7 to 15.18/mi on day 64 (Fig. 2). Although the rate of track accumulation was fairly steady, averaging 0.24/crossings/mi/day, some of the subtle changes may be significant. The absence of new tracks on day 18 and again on day 21 was correlated with marked changes in weather: a sudden drop in temperature from -10 F to -30 F in the 1st case, and rain, sleet, and snow in the 2nd. Temperatures dropped from +15 F to -25 F on day 34 and -50 F on day 37, perhaps accounting for the low occurrence of lynx tracks during this period. These conditions appeared to temporarily slow 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 probably reflects increased lynx activity. During this period, lynx in the vicinity of Tok 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 (Picea glauca)-aspen mixed forest on the flats south and west of Tok. This increase in activity presaged a marked decline in activity during midwinter. This decline is shown in Fig. 2 beginning about day 58. Although observations during midwinter are limited, the available information suggests lynx activity lessened, both in the study area and in the upper Tanana valley in general. Intensive fieldwork was resumed on 10 February 1983. During 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 1 provides track occurrence information contributed by various trappers and obtained in 2 aerial surveys. Two trapper reports were obtained in November, and the remaining 3 reports and 3 aerial surveys represented 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 is apparent that by February 1983 lynx tracks were rare in the general area. Some lynx persisted in localized areas, however, as indicated by the occurrence of over 3 tracks/mi on an 8 mi long section of a survey route on the Little Tok River (Table 1). 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 9.1 tracks/mi in the Little Tok area, compared to 2.1 tracks/mi in the Tok River study area 10 mi to the north.

Relating Lynx Track Frequency to Population Density

As mentioned earlier, the usefulness of track frequency data will increase as values are obtained from areas where relative or absolute lynx numbers are known. In the Tok River study area, the relative abundance of lynx could be estimated with a high degree of reliability because of Dan Grangaard's familiarity with the area. However, the number of lynx in the area was less well known.

Mr. Grangaard, who has trapped in the area since 1966 and assisted in this study during October and early November, observed that during early winter 1982-83 lynx numbers were relatively high. However, numbers may have been somewhat greater during population highs in 1965 and 1972. The study area's 1982-83 population was also high compared to most of the surrounding area. About 17 lynx were trapped in the area during the 1981-82 trapping season.

I made weekly estimates of lynx numbers based on tracks. Direction of travel in relation to the survey route and other tracks, group size (in the case of female lynx with kittens), locations of radio-collared lynx, and to some extent, track size, were used to distinguish individual lynx. Nine weekly estimates of the minimum number of lynx present on the study area during early winter were as follows: 8, 8, 9, 9, 10, 9, 14, 19, and 9. The highest estimates coincide with the period when movement of lynx through the area apparently increased. Assuming these lynx were residents of the 56 mi^2 study area would suggest that density in October-November ranged from 1 lynx per 3 to 7 mi^2. Because the higher density was temporary and probably resulted from immigration, I think the density of 1 lynx per 7 mi^2 more closely reflects the size of the resident population, although it is probably a minimum. In the same area, during February and March 1983, minimum population estimates ranged from 0 to 1 lynx.

The density observed in October-November 1982 is similar to those previously reported from areas where lynx populations were at relatively high levels. Brand et al. (1976) observed densities of 1 lynx per 5.2 and 4.4 mi^2 during successive highs in a 50 mi^2 study area in Alberta, and 1 lynx per 19.3 mi^2 during a low. Iurgenson (1955) reported that lynx density ranged from 1 lynx per 6.9 to 22.7 mi^2 in Russia. On Cape Breton Island, Nova Scotia, Parker et al. (1983) estimated a density of 1 lynx per 1.9 mi^2 during a high. Reported densities for bobcats range from 1 per 0.3 to 7.7 mi^2 (McCord and Cardoza 1982).

Unfortunately, track frequency data are not available from any of the studies in which lynx numbers were estimated (G. Parker, pers. commun. and L. Keith, pers. commun.). However, Klepinger et al. (1979) reported track counts from 3 areas in northern Wisconsin where density was estimated to range from 1 bobcat per 5-10 mi^2. Counts were conducted during 3 winters along road transects 19 to 42 mi long, and occurred 1 night after a snowfall ending by 1800. Each transect was counted on more than 1 occasion during each winter. The number of bobcat tracks/100 mi ranged from 0 to 7.9, or 0 to 0.08 tracks/mi. The highest value compares to 0.07 and 0.20 lynx tracks/mi observed on the 1st and 2nd days after snow, respectively, in the present study. In the Wisconsin study, a decline in tracks in 1 area corresponded with 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, Wis. Dep. of Nat. Resour., per. 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 (about 0.34 tracks/10 mi). Although such counts appear to be of limited usefulness in measuring bobcat population status, they are thought to more accurately index fisher (Martes pennanti) and coyote populations. Karpowitz and Flinders (1979) report that bobcat track crossings of a 27.9 mi transect in Utah averaged 0.15/mi/day. By comparison, lynx track crossings averaged 0.24/mi/day in the Tok River study area between 13 October and 16 December 1982.

Track frequency is used routinely by trappers to assess the abundance and distribution of furbearers. Two experienced individuals in Tok thought that 3 to 5 tracks/mi over long stretches of trail indicated a high population. Higher concentrations of tracks sometimes occur in limited areas. Although trappers could not specify an exact time interval for this value, they were referring generally to a period 3 to 10 days after snow. Additional comments and examples will be solicited from trappers in the future.

The track frequency values in Fig. 2 and Table 1 represent a beginning in developing a practical technique for estimating the relative abundance of lynx. Based on the 1st year of field study, I think track counts have promise as a means of determining lynx population status, particularly since the changes in lynx numbers from year to year are often large and can be fairly easily detected. However, this type of data should be evaluated in combination with general knowledge of hare-predator status, the occurrence of kittens in the lynx population, and other information available from trappers and harvest records.

Despite the general effectiveness of track counts, there are certain aspects of lynx behavior that could significantly affect the accuracy of track counts. One is that lynx sometimes follow precisely in an existing lynx trail. Saunders (1963) and Parker et al. (1983) noted that groups of lynx often traveled single file through habitat where prey was scarce but dispersed where prey was more abundant. However, based on my experience with lynx tracks and trails in the Tok River study area, I do not think the potential for error is large. 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 that is not representative of a larger area. For instance, on 2 November a female lynx with at least 2 kittens crossed a 1.5-mi section of highway 8 times, creating a maze of trails. The occurrence of early successional vegetation along roads and trails can concentrate snowshoe hares. This sometimes appears to attract lynx to these areas, especially when hares are scarce in less favorable habitat. Dan Grangaard has observed similar densities of tracks over large areas during years of exceptionally high lynx populations. However, these situations are not common. The potential error that could result from this behavior, or from the occurrence of relatively small "pockets" of abundance, is a problem only if a transect is short. In the course of a normal aerial or ground transect of 10 to 100 mi or more, unusual concentrations of tracks would be obvious and should be considered in interpreting track survey results.

Recommended Procedures for Track Counts

It appears that under certain conditions, track counts can provide a meaningful index to the status of lynx and other furbearer populations. The following points should be considered in designing and conducting 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, along with a study of photographs of tracks 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. The criteria by which tracks are identified from the air are in many respects similar to those used on the ground. Aerial identification is somewhat more difficult, however, because a close examination of individual prints is not possible.

2. Survey routes--The major requirement of survey routes is that they adequately sample habitat while coinciding with terrain and vegetation that allow scrutiny of the surface of the snow. For ground transects, likely routes include established trails, roads, creeks, rivers, ridgetops, seismic lines, and firebreaks. If the situation warrants, existing trails can be lengthened and expanded. Once established, survey routes should be carefully recorded on maps so they can be duplicated.

The length and spacing of transects can vary greatly depending on the purpose of a survey. Obviously, the results from short transects should not be extrapolated to large areas in view of the often high degree of local variation in lynx abundance. Monitoring populations over large areas requires that transects sample all types of potential habitat.

3. Snow conditions--It is essential that snow accumulation and weather conditions be carefully monitored and recorded before and during surveys. Any snowfall sufficient to obscure or differentiate old tracks provides one of the essential conditions for a survey. However, track visibility generally increases as winter progresses and even dense herbaceous cover and low brush are increasingly covered by snow. This most affects aerial tracking. When conditions are less than optimum, the speed of ground surveys can be reduced to accommodate low sightability. Lynx will leave clear tracks in lightly crusted snow but leave no tracks in hard crusts resulting from thaws or drifting. These conditions are generally rare in mid and late winter in Interior Alaska. I think track counts conducted at least 3 days after snow would be most effective. The chances of failing to detect lynx in an area would be greater immediately after a snowfall.

4. 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, and partly diffused light provides good track visibility. Ground surveys can also be accomplished at night with artificial light. Snowmachine and highway vehicle headlights create very 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.

5. Influence of weather on lynx movements--The apparent influence of weather on lynx activity could significantly affect the results of tracks counts. A period of extreme cold or wet weather following a snowfall may reduce the frequency of tracks compared to a period of moderate weather. Weather conditions should be considered in interpreting track counts.

6. Status of lynx and prey populations--The status and trend of populations of lynx and their prey should also be considered in interpreting track counts. During periods of snowshoe hare abundance, the comparability of track counts should be fairly high. However, I suspect that during the latter stages of a snowshoe hare population decline, increased activity and wider ranging habits of lynx could create a relatively high frequency of trails compared to a similar density of lynx in a more stable population. The temporary presence of increased numbers of dispersing lynx could have a similar effect.

Movements of Radio-collared Lynx

The movements of 4 lynx were monitored for 6 to 49 days (total = 84 lynx-days) before being caught by trappers (Table 2). All 4 lynx were captured near the center of the study area within

2 mi of each other. Three were caught within one-quarter mile of each other and 2 (T-1 and T-2) were caught at the same trap site 12 days apart.

The movements of 1 male (T-1) overlapped the areas used by 2 female lynx which, in turn, largely overlapped each other. Male lynx T-4, captured on 30 November, traveled widely, rarely remaining in a local area for more than 2 days. The low and declining hare population undoubtedly created instability in the lynx population as shown by the changes in track occurrence described earlier. This instability is also manifested in the movements of the 2 male lynx. Both left the study area in early December, and T-4 may have been a transient lynx when collared.

The occurrence of tracks also indicated the system of land tenure and social organization that exists among solitary felids with adequate food (T. Bailey, pers. commun.) did not exist. For example, during October and November, tracks of numerous individual lynx and at least 1 female with kittens were seen in the same area used by 3 radio-collared lynx. Observations of tracks in the study area in general also suggested that lynx distribution was not uniform or predictable.

The average distance between successive daily locations ranged from 1.3 to 2.0 mi (range = 0.25 to 3.5 mi) for the 4 lynx, excluding what appeared to be dispersal movements by the 2 males. During dispersal, straightline movements averaged 4 to 5 mi per day.

The shortest distance between lynx bedding sites (cruising radius) has ranged from about 1.0 to 2.6 mi (Saunders 1963, Nellis and Keith 1968). These figures compare well with the 24-hour movements observed in the present study. The daily cruising distance traveled by lynx has ranged from about 3 to 7 mi, and in North American studies, has averaged about 5 mi (Iurgenson 1955, Saunders 1963, Nellis and Keith 1968, Parker et al. 1983). 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.

RECOMMENDATIONS

The results of the 1st year of study indicate that winter track counts are the most feasible method of determining the status of lynx in Alaska. To augment their usefulness, additional track frequency values should be obtained during fieldwork and from interested trappers. Special efforts should be made to monitor track occurrence when lynx numbers are relatively well known from ground and/or radio-tracking studies.

While the track count technique should be refined during future research, other aspects of lynx ecology should also receive attention. Perhaps the most important of these are the following: the role of long-range movements in reestablishing lynx populations; and the effects of trapping on lynx populations during various phases of the cycle, both locally and over large areas.

ACKNOWLEDGMENTS

Many people contributed to the success of this study, and I am especially indebted to Mr. Dan Grangaard of Tok. Dan generously allowed me to use one of his better traplines for the study, provided critically important help and advice during the early stages of fieldwork, and freely shared a wealth of knowledge and ideas about lynx ecology. Tok Area Biologist David Kelleyhouse also offered helpful advice and was good enough to allow part of the Tok office to become a field station for the lynx study. Robin O'Connor provided valuable field assistance during October and November and also contributed many helpful ideas and suggestions. Student intern Chris Meade also assisted in fieldwork.

Various trappers in the Tok area cooperated in various ways, and I thank Terry Carda, Duane and Ray Sanford, David James, Jim Carson, Bill Simmons, John Terwiliger, John Zabielski, and Ron Sakalaska for their contributions.

Statewide Furbearer Biologist Herb Melchior was helpful in obtaining funding for this and other furbearer research and also provided many helpful suggestions. Wayne Regelin deserves thanks for his support and for a critical review of the report. The Alaska Trappers Association played an important role in obtaining funds and supported the work in other ways as well. Al Jones, Norm Phillips, Pete Buist, Ron Long, and Dean Wilson deserve special thanks for their support through the Alaska Trappers Association.

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PREPARED BY:

Robert O. Stephenson
Game Biologist II

SUBMITTED BY:

Wayne L. Regelin
Regional Research Coordinator

APPROVED BY:

W. Lewis Pamplin, Jr./JB
Director, Division of Game

Steven R. Peterson/JB
Research Chief, Division of Game

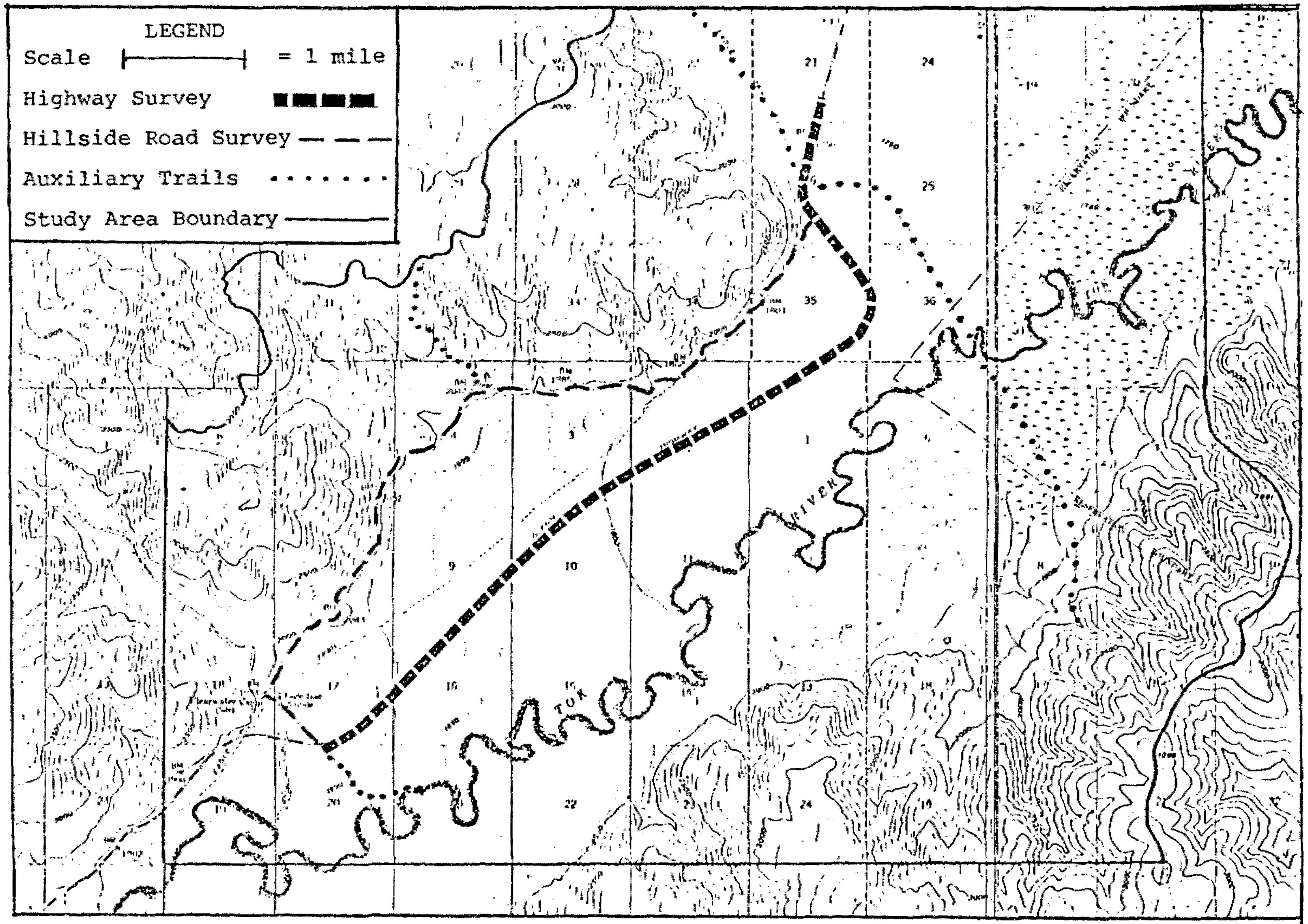

Fig. 1. Map of Tok River lynx study area showing daily track survey routes and auxiliary trails.

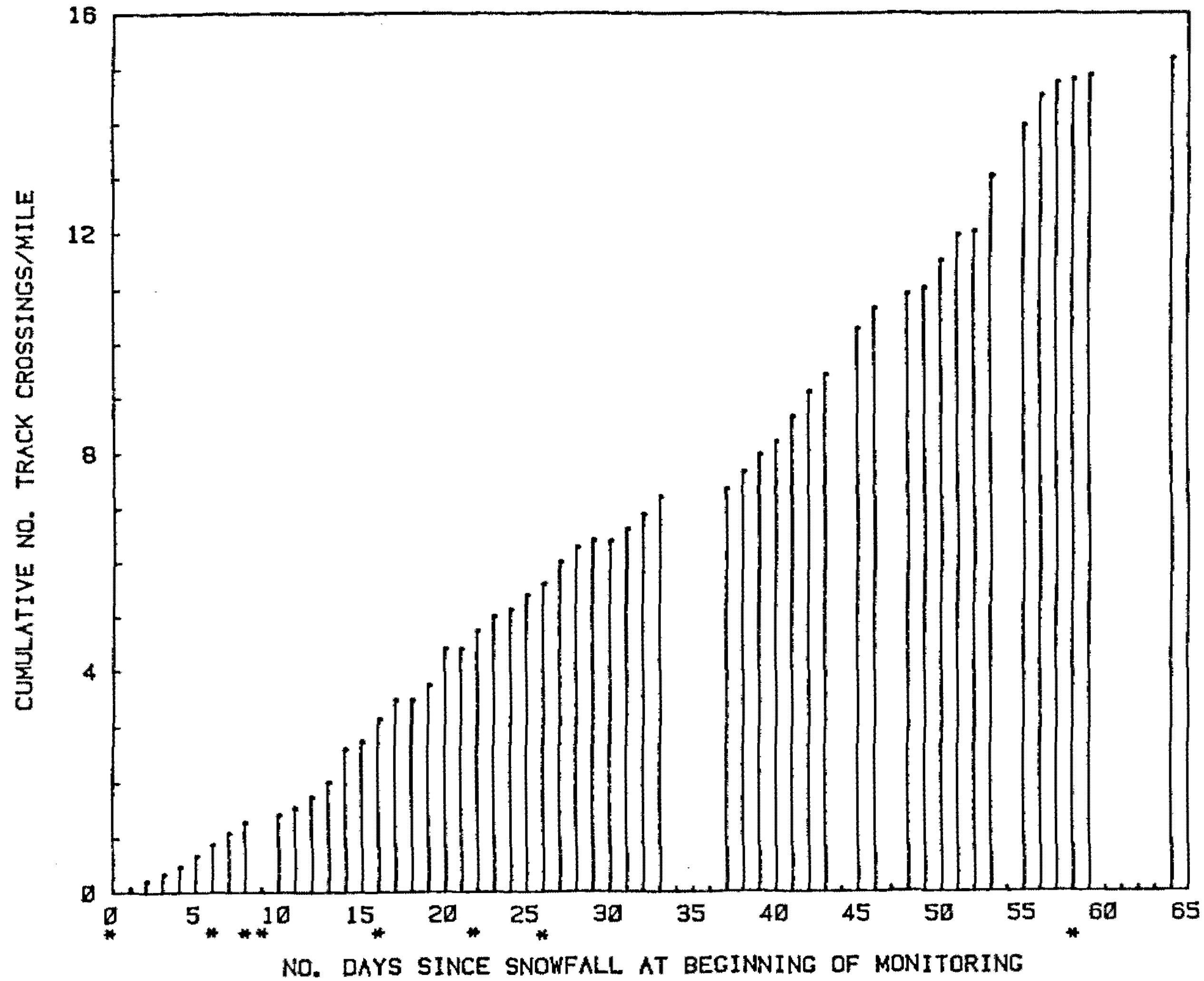

Fig. 2. Cumulative number of lynx trails crossing a 15-mi survey route in the Tok River study area between 13 October (day 0) and 16 December 1982 (day 64). Asterisks (*) indicate snow accumulations of 1 inch or more.

Table 1. 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 (mi)	Day after snow	Number track crossings	Tracks/ mile	Comments
11/7/82	D. Kelleyhouse	7 mi Taylor Highway	5.5	2	3	0.55	
11/10/82	D. Grangaard J. Carson	Ketchumstuk	112	2	30	0.27	
3/2 to 3/7/83	J. Carson F. Entsminger		129	1 to 5	1	<0.01	
3/7 and 3/8/83	B. Simmons	Dennison Fork	35	4-5	0	0	
3/13/83	J. Carson	Riverside	45	3	0	0	
2/17/83	Aerial survey Tok-1	Eagle Trail Clearwater Creek	73	6	1	0.01	2-hr flight under good conditions
2/22/83	Aerial survey Tok-2	Tok River Tetlin Hills	122	10	2	0.02	2-hr flight under good conditions
2/22/83	Aerial survey Tok-2	Little Tok River-Tok River	8	10	25	3.12	Represents a pocket of abundance encountered on Tok-2 survey
		Tok-2 total =	130	10	27	0.21	Represent total values for Tok-2
2/22/83	Aerial survey Tok-3	Tanana River-Robertson River	120	10	2	0.02	2-hr, 27-min survey under good conditions

Table 2. Movements of 4 lynx radio-collared in the Tok River study area, October-December 1982.

Lynx No.	Sex	Estimated age (yr)	Weight (lb)	Date captured	Number days monitored	Area used (mi^2)[a]	Average 24-hr movement (mi)[b]	Comments
T-1	M	2.5	23.0	10/22/82	49	21	1.5 (0.25-3.5) 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	21.5	11/3/82	6	4	1.6 (0.25-2.6) N = 6	Snared on 11/9/82
T-3	F	1.5	15.5	11/27/82	9	4	1.3 (0.6-2.1) 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	18.5	11/30/82	20	56[c]	2.0 (0.4-5.5) 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 captured.