Alaska Department of Fish and Game
Division of Wildlife Conservation

Federal Aid in Wildlife Restoration
Research Progress Report

FURBEARER TRACK COUNT INDEX

TESTING and DEVELOPMENT

by

Howard N. Golden

Project W-24-1
Study 7.17
December 1993

Alaska Department of Fish and Game
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STATE OF ALASKA
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PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: W. Route, B. Johnson and T. Paragi, T. Doyle, R. Tobey, B. Slough, K. Poole

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SUMMARY

Furbearer management requires reliable population trend information. However, there are few methods available for monitoring furbearer populations that are independent of harvest data, and it is uncertain how accurately harvest data reflect population changes. More direct population data would supplement harvest-related information and improve interpretation of apparent changes in population abundance.

Indices of abundance can be useful in monitoring furbearer populations where actual counts of individual animals are difficult. Winter counts of tracks in snow have been used as indices of distribution and relative abundance, habitat use, and population abundance in a variety of areas. However, the ability of track counts to reliably document population trend has not been shown.

The overall objective of this study is to establish initial track-count procedures to monitor trends in the relative abundance of martens (*Martes americana*), lynx (*Felis lynx*), and snowshoe hares (*Lepus americanus*). Specific objectives are to (1) estimate the variability of track deposition and retention under a variety of conditions, (2) estimate observer track-count biases, (3) evaluate the utility of harvest data in interpreting population trends, and (4) incorporate relevant track-count and population-indexing data from other studies into the development of procedures. Both ground and aerial track counting techniques are being evaluated, as is the utility of harvest data in the interpretation population trends relative to track count data.

Work during this reporting period focused on track counts, trapping, and carcass analysis. Marten, lynx, and snowshoe hare tracks were sampled along a 21-km transect near the Klutina Lake trail on the west side of the Copper River basin in Southcentral Alaska, February and April 1992. The deposition and retention of tracks over time, measured in tracks/km, were compared among vegetation cover classes and between survey periods in the Klutina trail area. Track count data were also examined, through cooperative efforts, in the Wrangell-St. Elias National Park and Preserve, the Koyukuk/Nowitna Refuge Complex, and the Tetlin National Wildlife Refuge in Alaska.

Marten track deposition and retention were highest in moderate and dense forests along the Klutina Lake trail during February 1992; in the dense and closed forests they were highest in April 1992. Track retention there also showed a high degree of linearity. In the Koyukuk/Nowitna Refuge Complex (KNRC), cumulative track-deposition and track-retention rates were highest in the 1985 burn (tall shrub/sapling seral stage) and mature forest. Marten track densities and rates increased between sampling times in both areas.

Cumulative track-deposition and track-retention rates for lynx were highest in the 1966 burn (dense tree seral stage). Cumulative track-deposition rates for lynx in the Tetlin National Wildlife Refuge were variable between sample times, with a high rate of increase in April 1992. Cumulative track-retention for snowshoe hares was highest in the dense and closed forests along the Klutina Lake trail and in the 1966 burn in the KNRC. Track-deposition was approximately an order of magnitude higher in the Wrangell-St. Elias National Park and Preserve than in either the Klutina or KNRC areas.

A sample of over 800 marten carcasses indicated there was a relatively low ratio of juveniles per adult females (37:100) in 1991-92. During that same year, there was also a low proportion of lynx kittens (10%) out of a sample of over 140 carcasses.

Key Words: *Felis lynx*, Interior Alaska, *Lepus americanus*, lynx, marten, *Martes americana*, population index, Southcentral Alaska, snowshoe hare, survey, tracks, winter track counts.

CONTENTS

BACKGROUND

Marten (*Martes americana*) and lynx (*Felis lynx*) are two of the most important furbearers taken by trappers in Alaska. The snowshoe hare (*Lepus americanus*) is an important prey item for both species, with the cyclic oscillations of lynx populations closely tied to those of hares. Management of these species requires reliable population trend information. However, there are few methods available for monitoring their populations that are independent of harvest data, and it is uncertain how accurately harvest data reflect population changes. Harvest statistics are derived from pelt sealing certificates, fur dealer acquisition reports, trapper export reports, trapper questionnaires, and carcass collections.

The collection of more direct population data for furbearers would supplement harvest-related information and improve interpretation of apparent changes in population abundance.

The measure of relative abundance over time is especially appropriate for monitoring furbearer trend except where more rigorous population data are required (Clark and Andrews 1982). Furbearers are some of the most difficult species to monitor because of their secretive, wide-ranging nature, and relatively small body size. When animals cannot actually be counted, some type of animal sign may be used to assess relative abundance if the sign has an approximately linear relationship to animal numbers (Caughley 1977). Winter track counts appear to have the most potential as measurable animal sign in areas with good persistent snow conditions, such as Interior and much of Southcentral Alaska.

Winter track counts, normally expressed as tracks/km/day or tracks/km*day, have been measured along roads, trails, and transects, both ground and aerial, for a variety of furbearers. They have been used to (1) document furbearer distribution and relative abundance across large areas (Hechtel and Follmann 1980; Slough and Jessup 1984; Slough and Slama 1985; Golden 1987, 1988), (2) measure habitat use patterns and preferences (Legendre et al. 1978, Buskirk 1983, Raine 1983, Theberge and Wedeles 1989, Thompson et al. 1989, Koehler 1990), (3) monitor population trends (Slough and Jessup 1984, Slough and Slama 1985, Stephenson 1986, Slough and Ward 1990), and (4) estimate actual abundance (Van Dyke et al. 1986, Schwartz and Becker 1988, Becker 1991).

The advantages of using relative abundance indices based on track counts are that they are (1) independent of harvest data, (2) repeatable, (3) quick and relatively inexpensive, (4) require only a moderate amount of training, and (5) capable of monitoring more than one species at a time. To be useful for monitoring furbearer population trends, winter track counts must do the following:

1. Reflect actual changes in animal abundance (i.e., track density must vary in proportion to animal density).

2. Indicate reliably where a population is in its oscillation.

3. Be accurate enough to guide important management decisions (e.g., ± 10% with 80% confidence intervals).

4. Result in comparable counts among different observers.

5. Be able to sample a variety of habitat types.

The number of animals in an area is a result of production, recruitment, and immigration and the effects of natural mortality, harvest, and dispersal (Fig. 1). The number of tracks deposited in a given time and area is related to the number of animals present (usually unknown) and to the rate that the animals deposit tracks. Rate of track deposition is a function of a number of intrinsic and extrinsic factors; e.g., behavior (breeding and home range/territory maintenance), prey availability and abundance, habitat quality and availability, and weather severity (temperature and snow conditions). The number of tracks present following their deposition is related to the retention of those tracks, which is a function of track overlap, wind, sublimation, and other environmental conditions. Finally, the number of tracks actually observed is related to the number of tracks present at a given time and the sampling scheme used, to the sightability of tracks, and to the observer's abilities.

Track deposition and retention is summarized in the following hypothesis:

> The number of marten, lynx, or snowshoe hare tracks (T) intersecting transects, trails, or roads in an area at a given time (i) is equal to the number of animals (N) present times a function of track deposition (fD) times a function of track retention (fR), i.e.,
>
> $$T_i = N(fD)(fR);$$
>
> where fD includes track overlap by a given animal or another of the same species and the number of days after snowfall (DAS), and fR includes track overlap by animals of a different species (for example, the establishment of trails by hares that overlap other animals or that other animals use as pathways) and the number of DAS.

Instability in track deposition and retention rates may result in nonlinear track accumulation over time. An increase in tracks in an area may mean there are more animals present or that the same animals are more active. Ward and Krebs (1985) found the daily straight-line travel of lynx in southwestern Yukon was inversely related to hare density. It was fairly constant at 2.2-2.7 km/day when hare densities were > 1.0/ha but increased rapidly when hare densities fell below 1.0/ha, rising to 5.5 km/day at 0.2 hares/ha.

Stephenson and Karczmarczyk (1989) reported significant differences in cumulative track-deposition rates of lynx between years in the Wood River area south of Fairbanks. They concluded their T-1 track surveys (of track intersects along trails) should be able to indicate population changes of >50%. However, this may be too imprecise to allow for responsive management decisions, despite Stephenson and Karczmarczyk's (1989) assertion that the population amplitudes of more than 400% reported in the literature for lynx were wide enough for >50% precision to be useful. At this point there are no standard criteria for making a management decision.

Deposition and retention of tracks must be understood and accounted for to determine if track counts are equitable among areas and over time. To illustrate, consider that regression of the same number of tracks along the same transect or set of transects from day 1 through day 10 after snowfall would result in a negative curvilinear relationship (Fig. 2). To use the measurement tracks/km/day, one must assume tracks are being deposited and accumulated at a constant daily rate of 1X, where X = day after snowfall. This assumption may be valid for a short period of time after snowfall but would be problematic as factors limiting track retention increase.

Population-index data on martens, lynx, and snowshoe hares must be collected in a rigorous and consistent manner using reliable techniques. Analysis of the variability of track deposition and retention of those species under different conditions should provide information useful in developing procedures for managers to use in collecting track count data. Harvest-related information on trapper take, effort, and animal-abundance observations and on sex and age ratios through carcass collections should supplement track counts and assist managers in interpreting population status. This approach will not only provide managers with more useful information, it will improve the identification and assessment of other sources of bias in trend data.

It is necessary to evaluate both aerial and ground track-count techniques to determine the capabilities and appropriate uses of each. The advantages of ground transects are that they can be run under less favorable weather, the observer can be more certain of track identification, and they are less expensive. In comparison, aerial transects can sample large areas with diverse habitat, monitor harvested areas as well as refugia, and, as a result, have a greater potential for monitoring populations during lows when there are fewer tracks.

OBJECTIVES

Study Objective:

To establish initial track-count procedures to monitor trends in the relative abundance of marten, lynx, and snowshoe hares.

Job Objectives:

1. To estimate the variability of marten, lynx, and snowshoe hare track deposition and retention measured along aerial and ground transects relative to (a) time since snowfall, (b) vegetation cover, composition, and topography, (c) season, (d) harvest patterns and levels, and (e) snow conditions and temperature.

2. To estimate observer track-count biases, particularly in sightability between aerial and ground counts, among broad classifications of vegetation cover and composition.

3. To evaluate the utility of harvest data in the interpretation of population trends relative to track count data.

4. To incorporate relevant track-count and population-indexing data from the literature and from recent research studies into the trend monitoring procedures being developed.

STUDY AREA

Tracks were counted along a 21-km transect near the Klutina Lake trail approximately 20 km south of Glennallen (Fig. 3). The transect was a seismic line running east to west perpendicular to the Copper River basin in eastern Southcentral Alaska. The Copper River basin separates Game Management Unit (GMU) 13 to the west from GMU 11 to the east, which includes the Wrangell-St. Elias National Park and Preserve. Vegetation along the transect varied from closed canopy cover predominated by white spruce (*Picea glauca*), black spruce (*P. mariana*), birch (*Betula papyrifera*), aspen (*Populus tremuloides*), balsam poplar (*Populus balsamifera*), willow (*Salix spp.*), and alder (*Alnus spp.*). The area is composed largely of mature forest with some small areas burned within the last 15 years.

In February, temperatures in the Klutina area ranged from -26° C to -18° C, cloud cover was scattered to broken, and the wind was calm. Snow consistency was generally dry and lightly packed, and the depth averaged 63 cm along the transect. In April, the temperature hovered around 0° C, skies were generally clear, and wind ranged from calm to 25 kph. Snow consistency became grainy and fairly hard-packed during the April survey. Snow depth, though not measured, was reduced to approximately 30-40 cm along the transect.

METHODS

Track Deposition and Retention

I counted daily deposition of lynx, marten, and snowshoe hare tracks from the ground along the Klutina Lake trail transect using snow machines. Counts were conducted 1-5 days after snowfall (DAS) during 1-5 February 1992 and 1-4 DAS during 5-8 April 1992. The February count period actually began 6 DAS but all tracks were deliberately erased prior to conducting the counts to set the effective DAS back to 1. I counted the number of each species' tracks deposited over each 24-hour period. All of those tracks were erased once they were counted. Daily track deposition was measured along only the north side of the transect.

I measured track retention over all survey days in February and April 1992, along the south side of the Klutina Lake trail transect. Tracks on that side were left intact to determine how well accumulated tracks were retained over time. In February, counts of tracks began 6 DAS because time did not permit erasing those tracks prior to the count period. It was recognized that tracks counted along one side of the transect may not have been deposited by the same animals or at the same rate as tracks on the north side.

The Klutina Lake trail transect was divided into segments based on vegetation cover class (VCC) similar to classifications by Viereck et al. (1992). Cover types were classified into five levels of percent cover: (1) bare = 0 %, (2) light = 1-25%, (3) medium = 26-50%, (4) dense = 51-75%, and (5) closed = 76-100%. Vegetation composition was classified for future reference into conifer, deciduous, and mixed types with major species documented. No analyses of those composition data were made during this reporting period.

I examined differences in track deposition and retention for martens, lynx, and snowshoe hares among sample areas, vegetation types, and time periods in Southcentral and Interior

Alaska. I compared daily means and cumulative rates of increase of track deposition and retention for martens and hares in the Klutina Lake trail, Koyukuk/Nowitna Refuge Complex (KNRC), and Wrangell-St. Elias National Park and Preserve (WRST) areas, and for lynx in the KNRC and Tetlin National Wildlife Refuge (TNWR) areas. Kruskal-Wallis and Mann-Whitney U tests through SYSTAT (Wilkinson 1990) were used to determine statistical significance. Probabilities less than 0.10 were considered significant. Snow depth per VCC and daily temperatures measured along the Klutina Lake trail were not analyzed relative to track counts for this reporting period.

Trapping and Carcass Analysis

Population and harvest data for martens and lynx were examined through harvest records and trapper questionnaires. Carcasses of marten and lynx caught in GMUs 11 and 13 during the 1991-92 trapping season were purchased from trappers and examined for sex and general age class. Teeth and female reproductive tracts were removed from carcasses for examination during the next reporting period. All carcass data were stored in database files for future analysis.

RESULTS AND DISCUSSION

Track Deposition and Retention

Data in this section are presented as preliminary analysis of track-count data from different areas and sample periods. Interpretations of data to assess causal relationships were kept to a minimum. Data from the Klutina Trail area will be analyzed further in conjunction with data collected in that area and other areas in Alaska and Canada during winter 1993-94.

Marten:

Marten track deposition and retention results for the Klutina Lake trail, KNRC, and WRST areas are summarized in Table 1.

Cumulative track-retention rates in the Klutina Lake trail area were significantly different among all VCCs in both February ($\underline{P} = 0.001$) (Fig. 4) and in April ($\underline{P} = 0.003$) (Fig. 5). Mean daily track-retention was highest in moderate and dense VCCs in February (Fig. 4) but in dense and closed VCCs in April (Fig. 5). Along the entire transect, cumulative track-deposition (Fig. 6) and track-retention (Fig. 7) rates increased more rapidly in April than in February. Variability in deposition and retention was also lowest in April but was notably low in both months. Mean daily track-deposition did not differ significantly between February and April ($\underline{P}$ = 0.174), whereas mean daily track-retention was significantly higher in April than in February ($\underline{P}$ = 0.014)·(Fig. 8). The fairly linear rates of track retention shown in Figure 8 reflect the high R^2 values (Table 1).

Marten track deposition and retention data in the KNRC were collected by Johnson and Paragi (1993) in forest communities of three different seral stages (1985 burn, 1966 burn, and mature forest). They counted tracks along trails in each area following similar methods to those I used in the Klutina Lake trail area. Cumulative track-retention rates were highest in the 1985 burn in both 1992 (Fig. 9) and 1993 (Fig. 10) and lowest in the 1966 burn (Fig. 10). However, cumulative track-retention rates for the 1985 burn and the mature forest followed contrary trends and contrasting variability between 1992 and 1993 (Figs. 9 and 10). Mean daily track-deposition was higher in both the 1985 burn and the mature forest in 1993, but mean daily track-retention was higher only in the 1985 burn in 1993 (Figs. 11 and 12). The only significant difference measured among forested areas of three different seral stages and between survey periods in KNRC was that mean daily track-deposition in the mature forest was higher in 1993 than in 1992 ($\underline{P}$ = 0.047).

Marten track deposition and retention data in the WRST were collected along the Kotsina Creek trail following similar methods to those described above (W. Route: pers commun.). Daily track deposition in the mature forest of predominately moderate VCC showed a steady decline between 7 and 11 DAS in 1992 (Fig. 13).

<u>Lynx</u>:

Lynx track deposition and retention results for the KNRC and Tetlin National Wildlife Refuge (TNWR) are summarized in Table 2. In the KNRC area, lynx showed substantial use only of the 1966 burn (Fig. 14), which was consistent with the relatively higher track densities of lynx observed in 25-40-year-old forests in eastern Interior Alaska (Golden 1987). Lynx tracks were counted in TNWR, using similar methods, along a portion of the Stuver Creek trail in 1992 and along its full length in 1993 (T. Doyle: pers. commun.). The area is characterized by mixed forest of moderate to dense cover. Cumulative track-deposition rates in TNWR were variable between February and April 1992 and 1993, with an especially rapid increase between 1 and 8 DAS in April 1992 (Fig. 15). Mean daily track-deposition and track-retention were not significantly different ($\underline{P}$ = 0.122) (Fig. 16), but there was a decline in cumulative track retention after 7 DAS in 1993 (Fig. 17).

Snowshoe Hare:

Snowshoe hare track deposition and retention results for the Klutina Lake trail, KNRC, and WRST areas are summarized in Table 3. Cumulative track-retention rates in the Klutina Lake trail area were significantly different among all VCCs in both February ($\underline{P}$ = 0.001) and April ($\underline{P}$ = 0.021), highest in dense and closed VCCs but low to zero in the light VCC (Figs. 18 and 19). This preference for denser forest communities was also reported for hares in the middle Susitna River basin in Southcentral Alaska (MacCracken et al. 1988). Cumulative track-deposition (Fig. 20) and track-retention (Fig. 21) rates increased for all VCCs more rapidly in February than in April, but variability was remarkably low overall. Mean daily track-deposition along the entire transect was significantly higher in February than in April ($\underline{P}$ = 0.027), whereas mean daily track-retention in both months reflected the high R^2 values overall (Fig. 22). Track deposition and retention in the KNRC were by far the highest in the 1966 burn (Fig. 23), which coincided with lynx track counts. Track deposition was approximately an order of magnitude higher in the WRST area (Fig. 24) than in either the Klutina or KNRC areas.

Trapping and Carcass Analysis

Marten:

Reliable means to determine marten population or harvest levels in GMUs 11 and 13 have been unavailable. There is no requirement for trappers to have marten pelts sealed, and trapper export and furbuyer acquisition data are believed to chronically underestimate harvest. Trappers reported through questionnaires that marten were stable in number after their increase during the mid-1980s which peaked in 1988 (Tobey 1993). The purchase of over 800 marten carcasses from trappers during the 1991-92 trapping season indicated a sizable harvest was possible. However, the purchase of only 39 marten skulls during the 1992-93 trapping season revealed that trapper harvest was variable. In this case, it was attributed mainly to poor pelt prices and, subsequently, low trapper effort (R. Tobey: pers. commun.). Marten harvest in GMUs 11 and 13 in 1991-92 occurred from 10 November through 31 January, with no bag limit.

Percentages and ratios of over 800 marten carcasses collected from trappers in GMUs 11 and 13 during the 1991-92 trapping season are summarized in Table 4. Males:females were just above 150:100. There were 37 juveniles:100 adults and an equal ratio of juveniles:adult females for both GMUs. The proportion of juveniles to adult females in this carcass sample was substantially below the 3:1 ratio that Strickland and Douglas (1987) suggested represents a healthy marten population.

Lynx:

Lynx populations in GMUs 11 and 13 were in their 10-year cyclic low from about 1985 to 1987. They began increasing in 1988 and appeared to have peaked in 1991 or 1992 (Tobey 1993, unpubl. ADF&G data). Trapping was prohibited from 1987 through 1989 due to low lynx numbers. Since the trapping season was reopened in 1990, reported harvests through pelt sealing records for GMU 11 showed a lynx take of 38 in 1990-91, 107 in 1991-92, and 42 in 1992-93. The percent kittens in the harvest declined from 20% to 11% to 5% between seasons. Concurrent harvests in GMU 13 were 110 in 1990-91, 122 in 1991-92, and 125 in 1992-93, with a similar decline in percent kittens from 35% to 14% to 11% between seasons. Lynx harvest in GMUs 11 and 13 in 1991-92 occurred from 15 December through 15 January, with no bag limit.

Analyses of over 140 lynx carcasses from GMUs 11 and 13 during the 1991-92 trapping season are summarized in Table 5. Males:females were nearly equal in GMU 11 but were 150:100 in GMU 13. No kittens were in the GMU 13 sample and they comprised only 10% of the GMU 11 sample. The poor representation of kittens in the sample reflected the 1991-92 pelt sealing data, indicating the lynx population passed through its 10-year peak and was declining to its cyclic low.

PROJECT DIRECTION

The various cooperators and I used similar but non-standardized techniques in 1992-93. We will standardize our approaches as much as possible in 1993-94 by using uniform survey procedures (Appendix B). This study will be terminated on 30 June 1994, 1 year earlier than originally scheduled. Thereafter, the work will be incorporated into an expanded research project devoted to furbearer management technique development beginning 1 July 1994. That effort will lead to the establishment over time of optimal procedures for monitoring and modeling furbearer populations and their management.

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NUMBER OF ANIMALS

Result of:

Production, Recruitment, and Immigration

Natural Mortality, Harvest, and Dispersal

↓

↓

Rate of Track Deposition

Function of:

Behavior

Prey Availability and Abundance

Habitat Quality and Availability

Weather Severity

↓

↓

NUMBER OF TRACKS DEPOSITED

↓

↓

Retention of Tracks

Function of:

Track Overlap, Wind, Sublimation, etc.

↓

↓

NUMBER OF TRACKS VISIBLE

↓

↓

Sampling, Sightability, and Observers

↓

↓

NUMBER OF TRACKS OBSERVED

Figure 1. Relationships between the number of animals present in an area at a given time and the factors influencing the number of tracks deposited and the number actually seen.

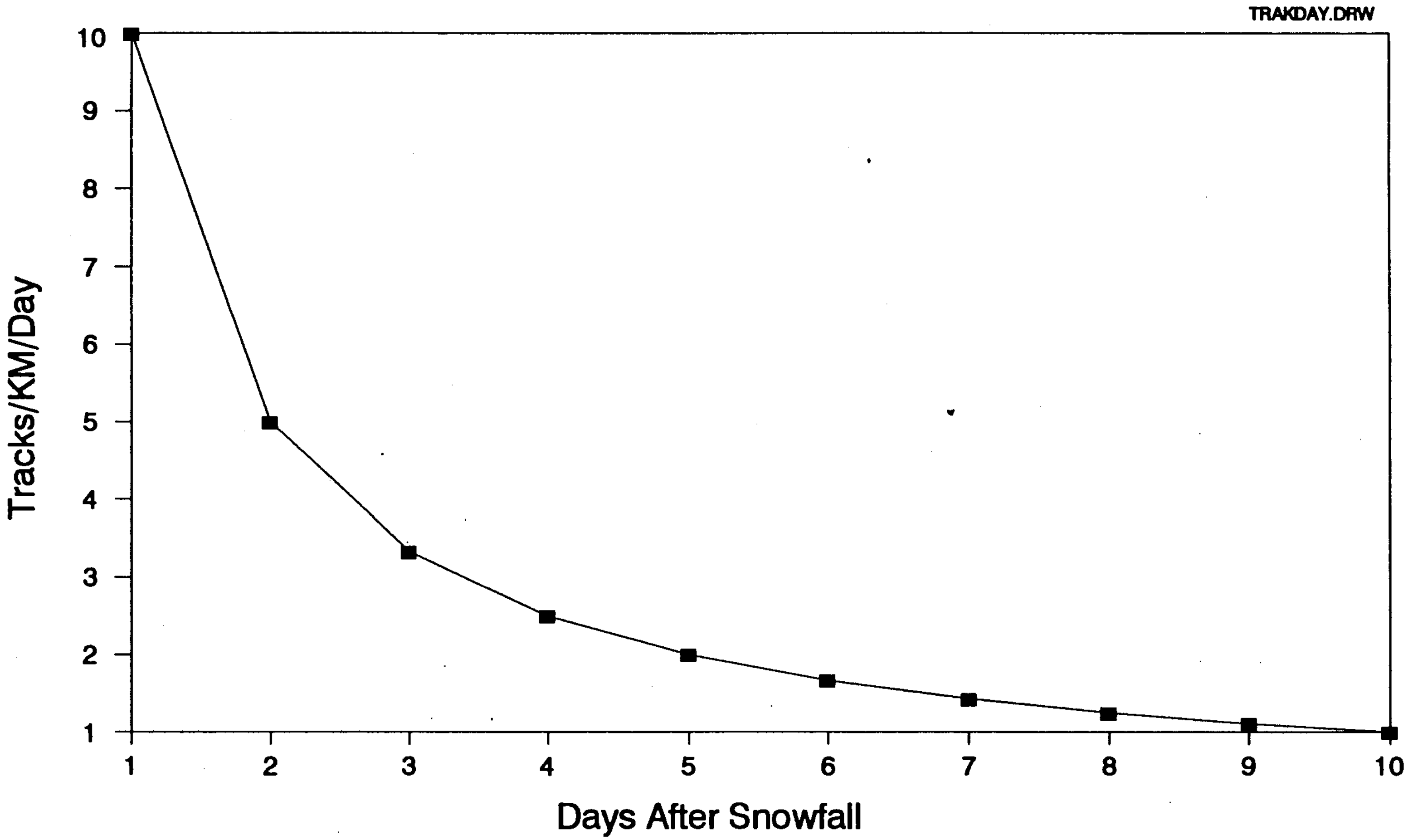

Figure 2. Result of dividing 10 tracks/km observed on 1-10 days after snowfall (DAS) by each DAS.

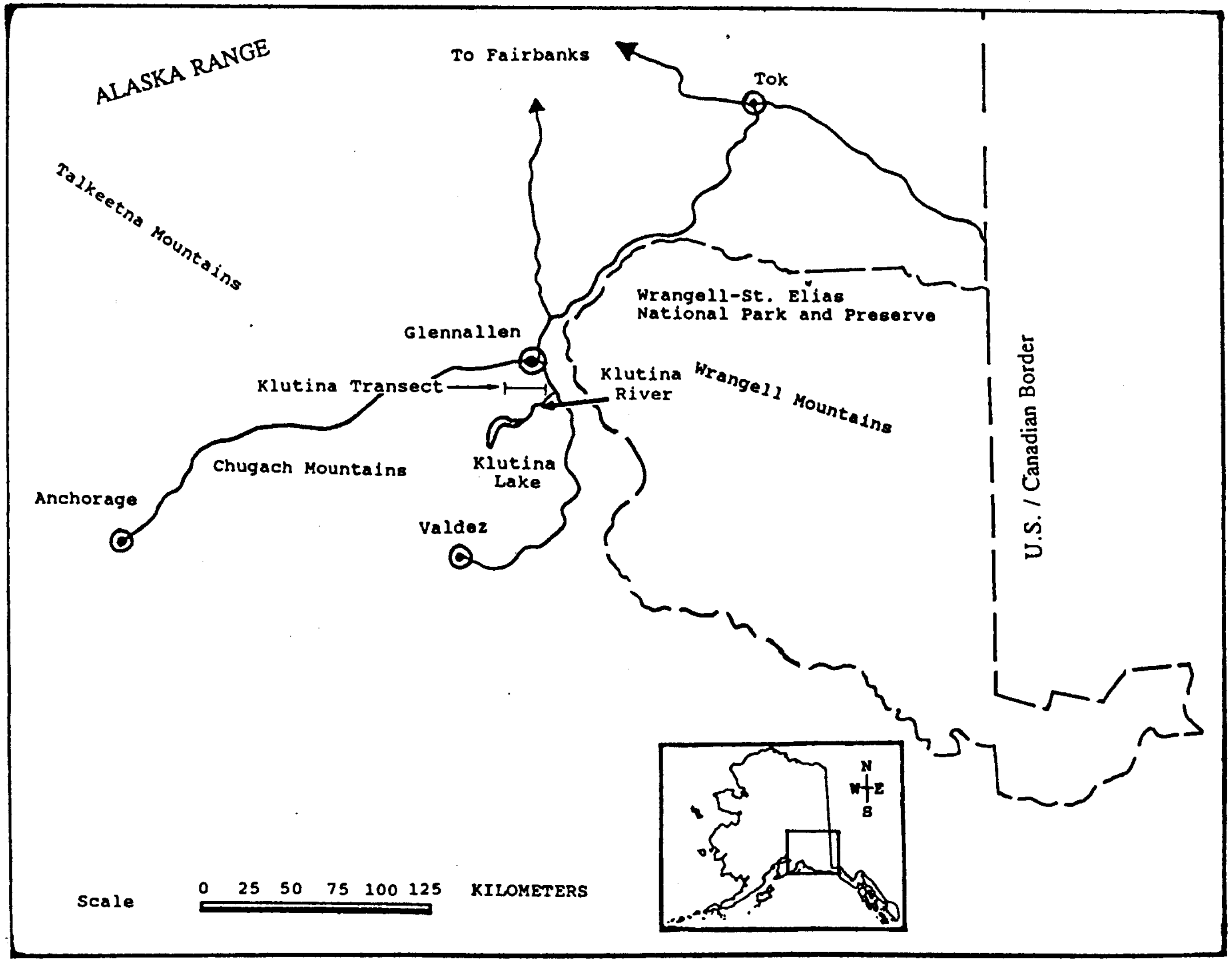

Figure 3. Location of Klutina Lake trail track-transect in the Copper River basin, Alaska.

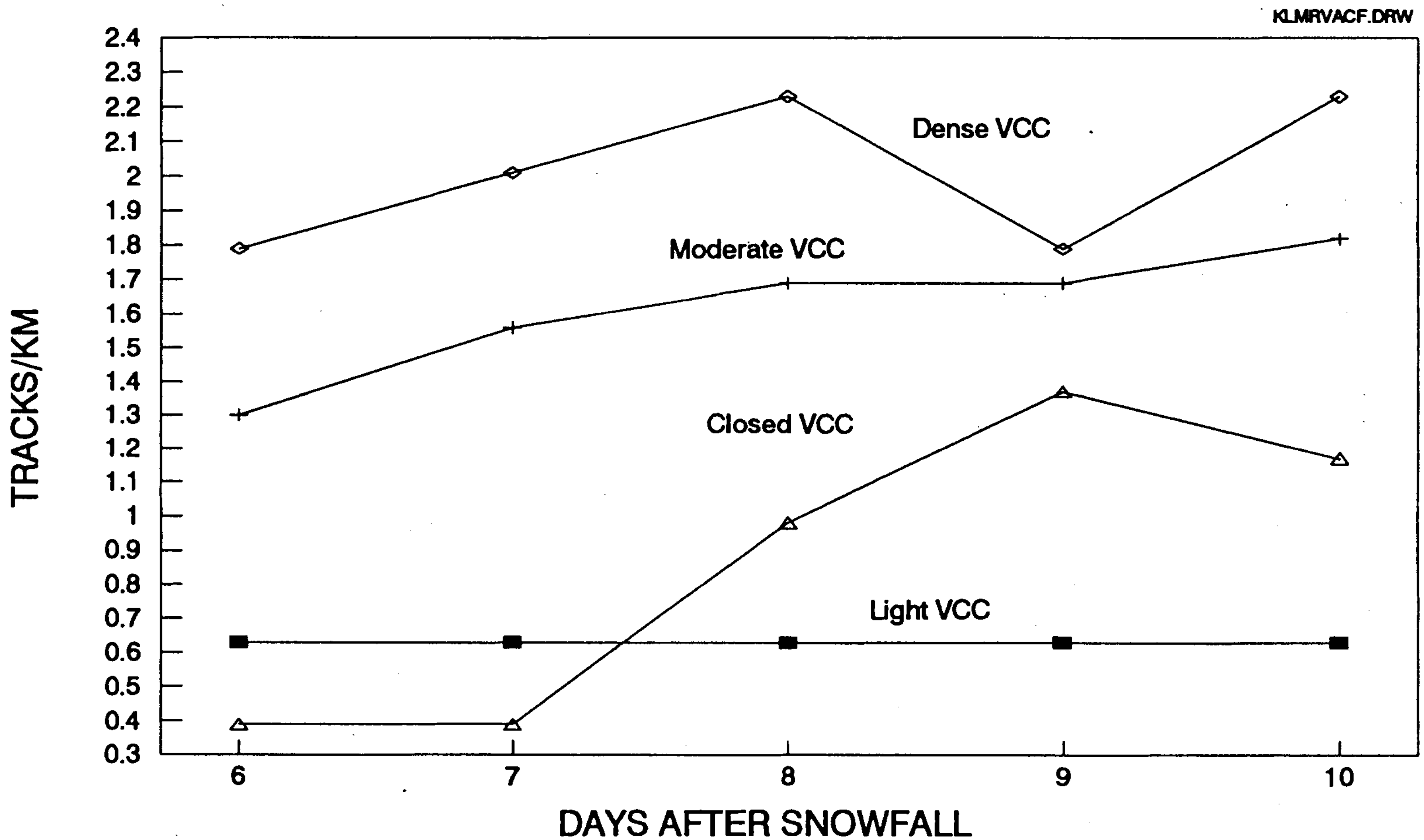

Figure 4. Cumulative retention of marten tracks counted during 1-5 February 1992 among four vegetation cover classes (light = 1-25%, moderate = 26-50%, dense = 51-75%, closed = 76-100%) along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

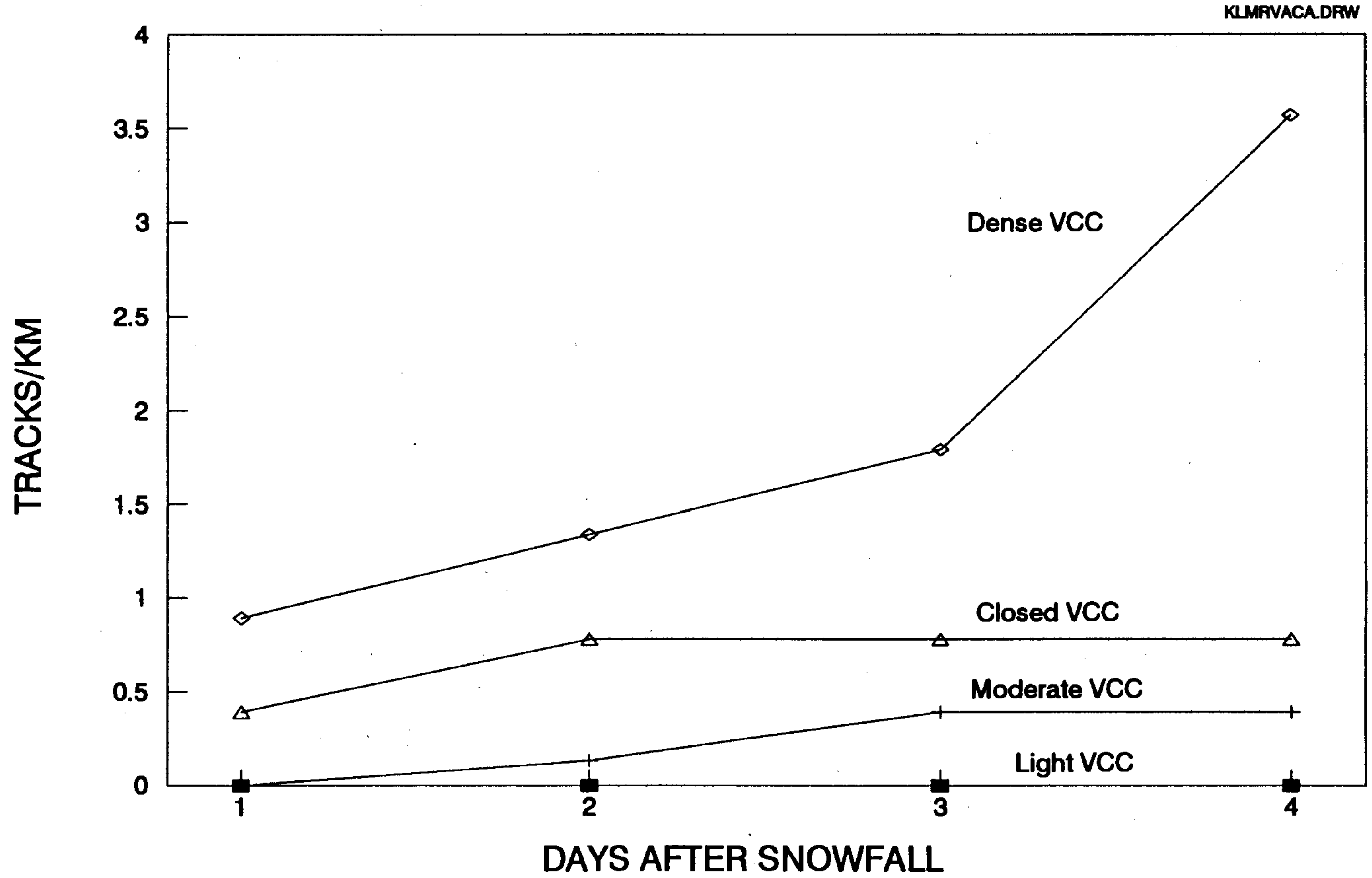

Figure 5. Cumulative retention of marten tracks counted during 5-8 April 1992 among four vegetation cover classes (light = 1-25%, moderate = 26-50%, dense = 51-75%, closed = 76-100%) along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

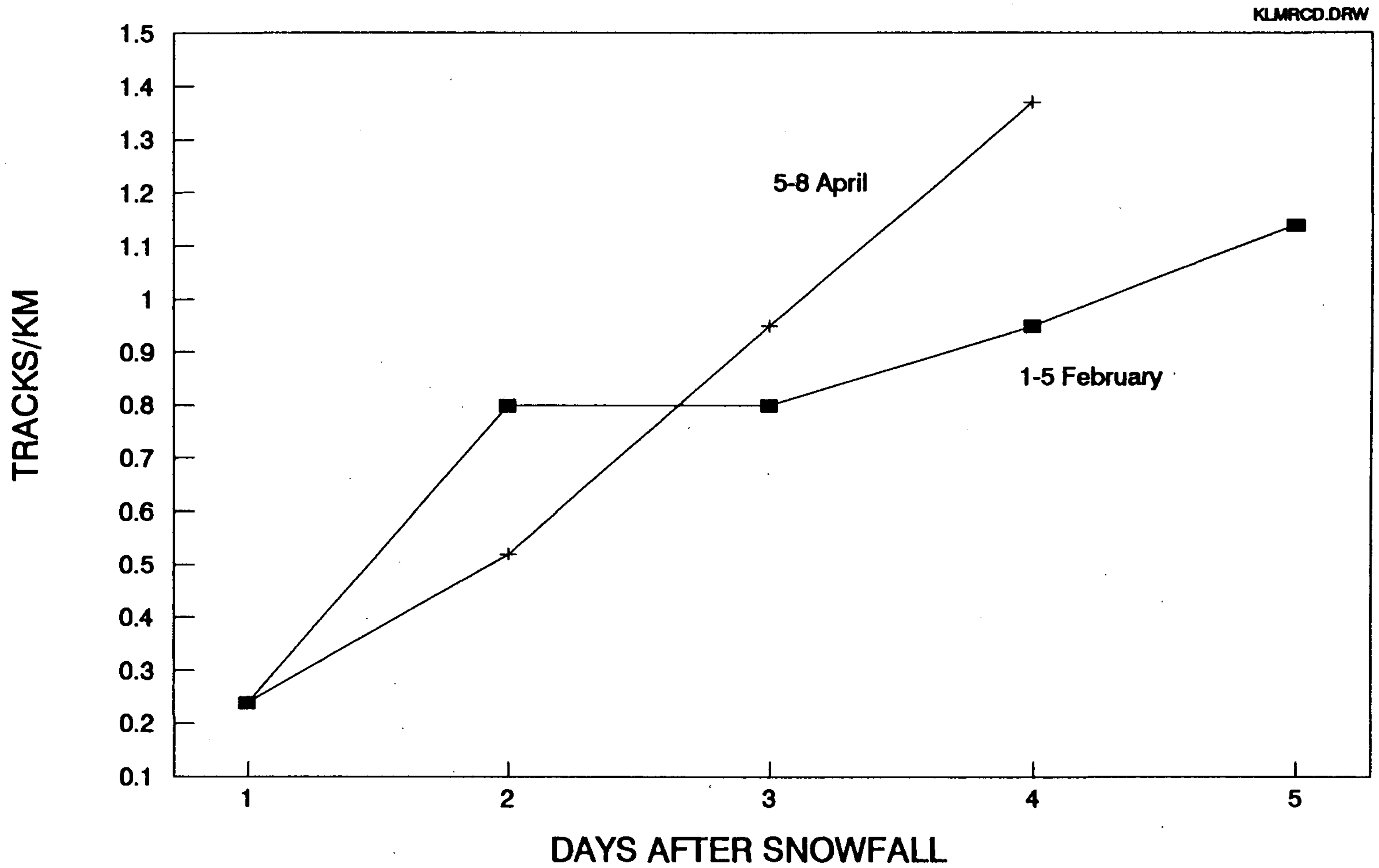

Figure 6. Cumulative deposition of marten tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska. Tracks were erased each day after counting.

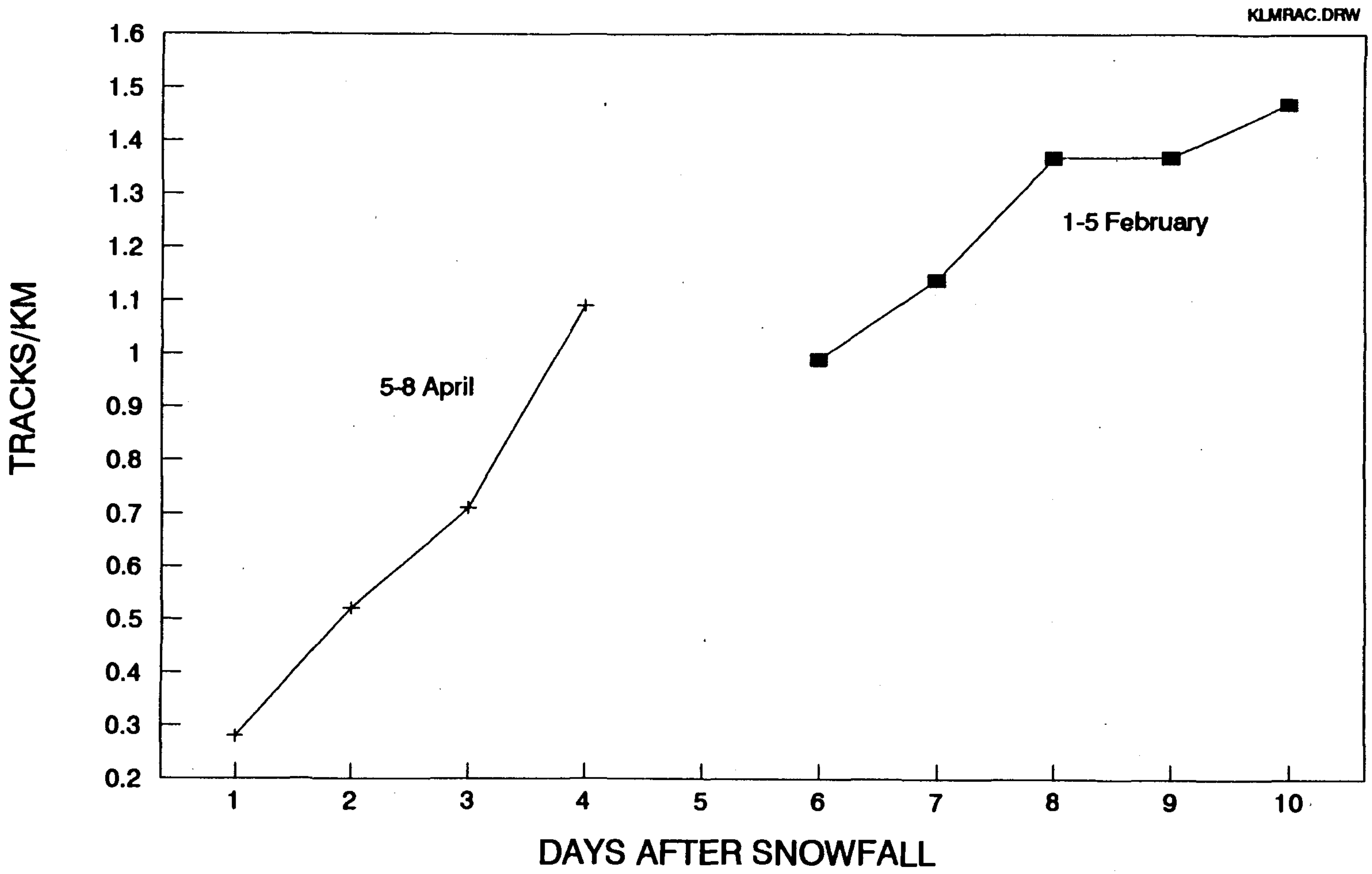

Figure 7. Cumulative retention of marten tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

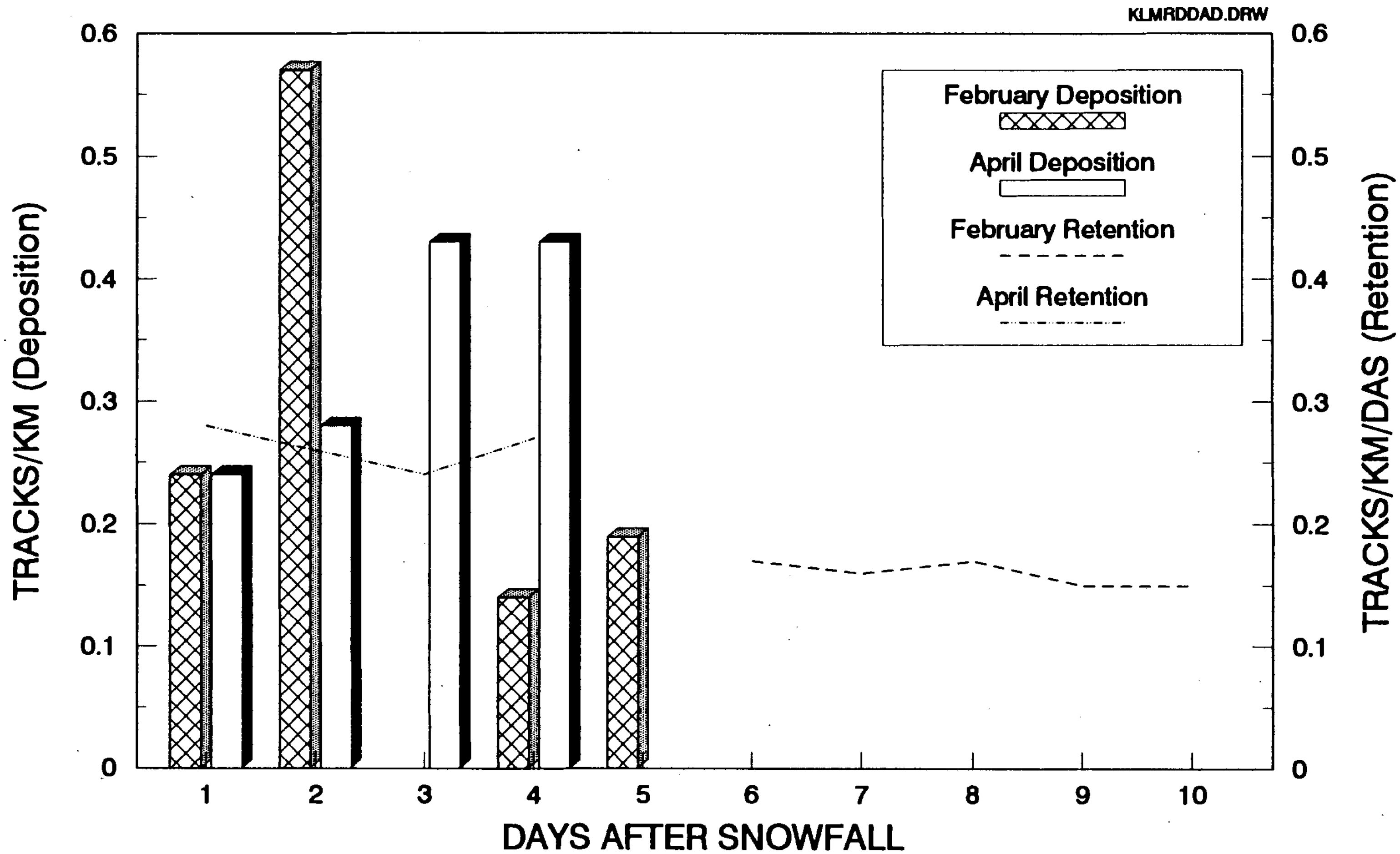

Figure 8. Daily deposition and retention of marten tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska. Tracks for daily deposition counts were erased each day after counting.

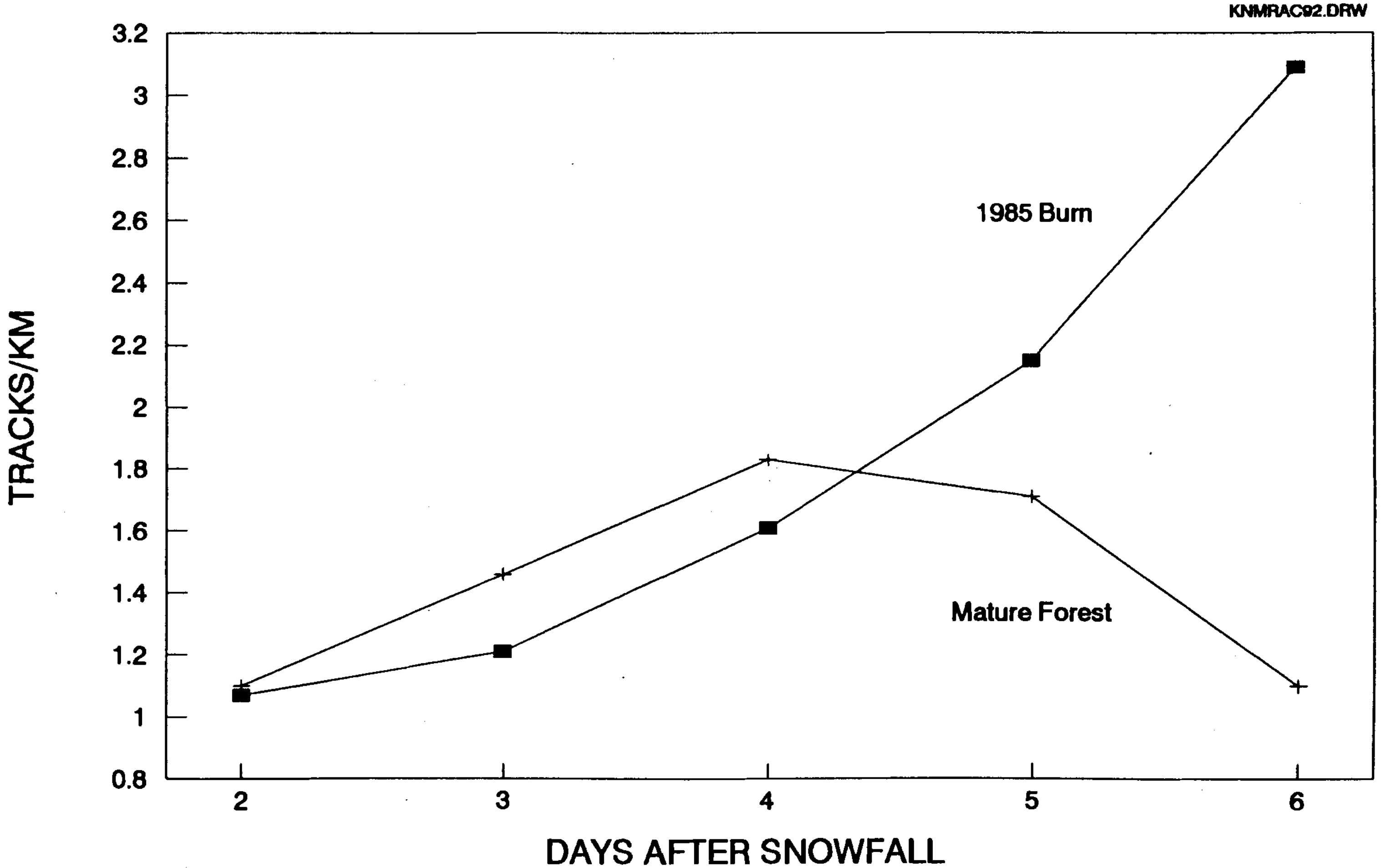

Figure 9. Cumulative retention of marten tracks counted during 1-5 March 1992 in two forest seral stages in the Koyukuk/Nowitna Refuge Complex, Alaska.

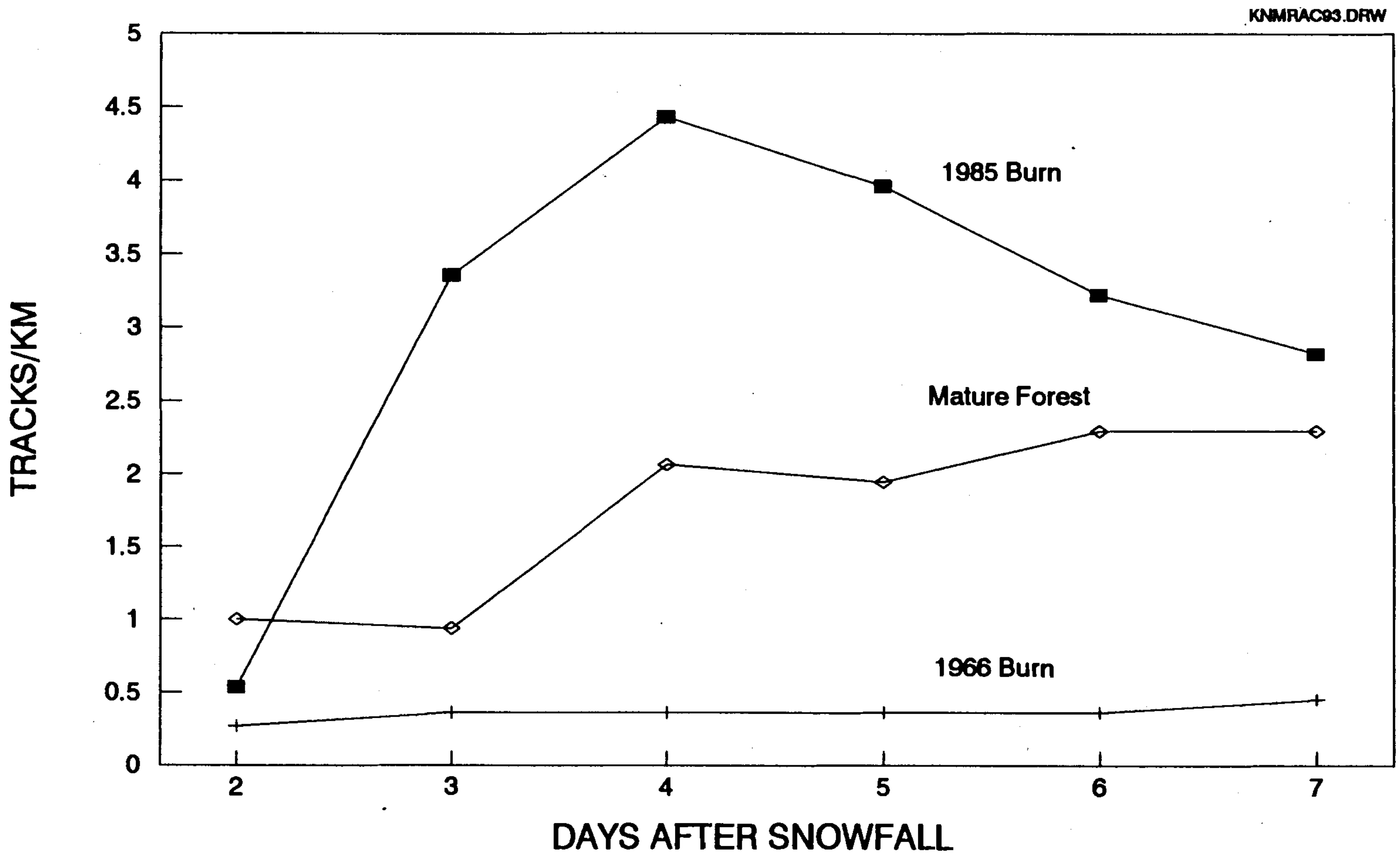

Figure 10. Cumulative retention of marten tracks counted during 9-14 March 1993 in three forest seral stages in the Koyukuk/Nowitna Refuge Complex, Alaska.

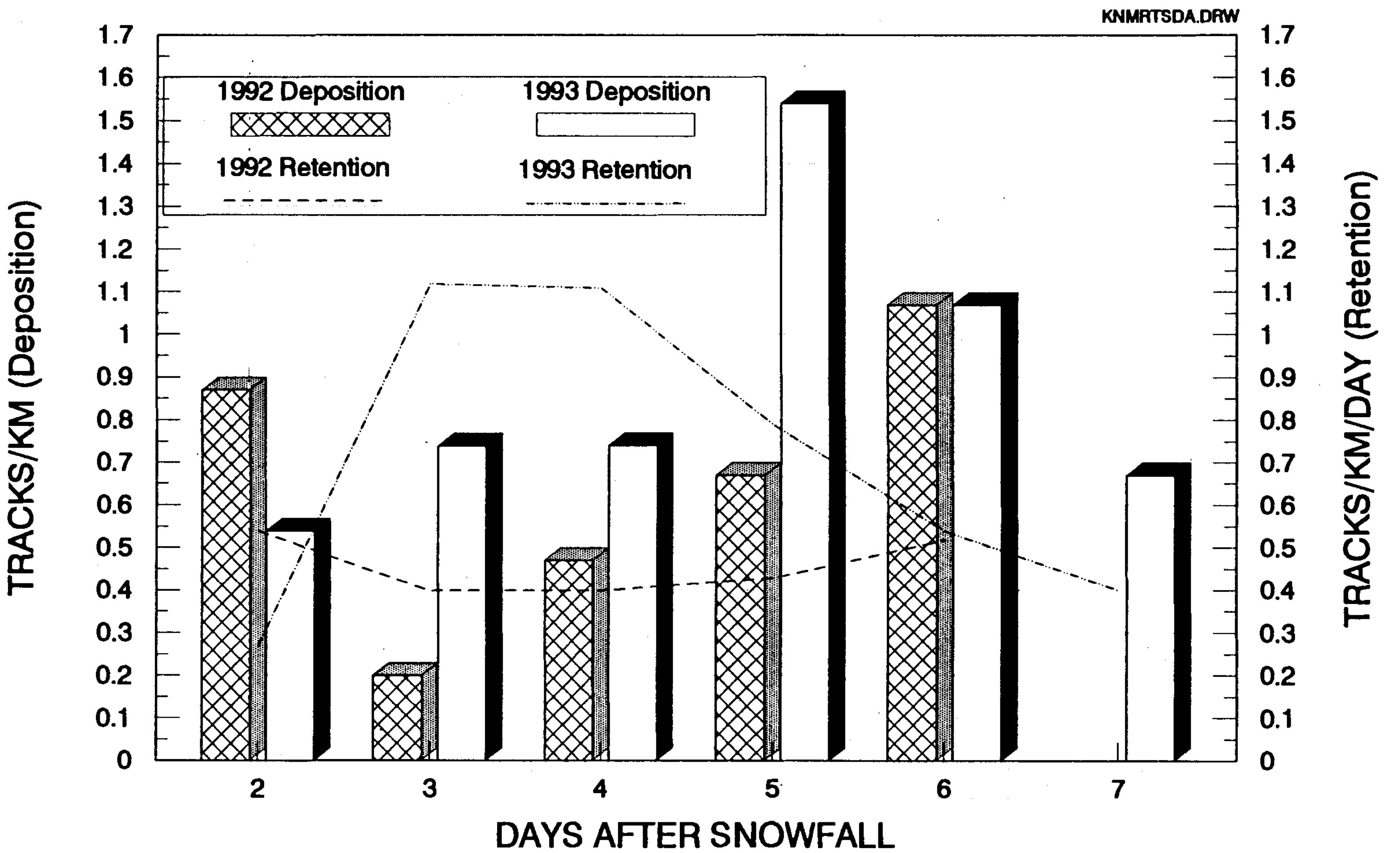

Figure 11. Daily deposition and retention of marten tracks counted during 1-5 March 1992 and 9-14 March 1993 in the 1985 burn (tall shrub/sapling forest) in the Koyukuk/Nowitna Refuge Complex, Alaska.

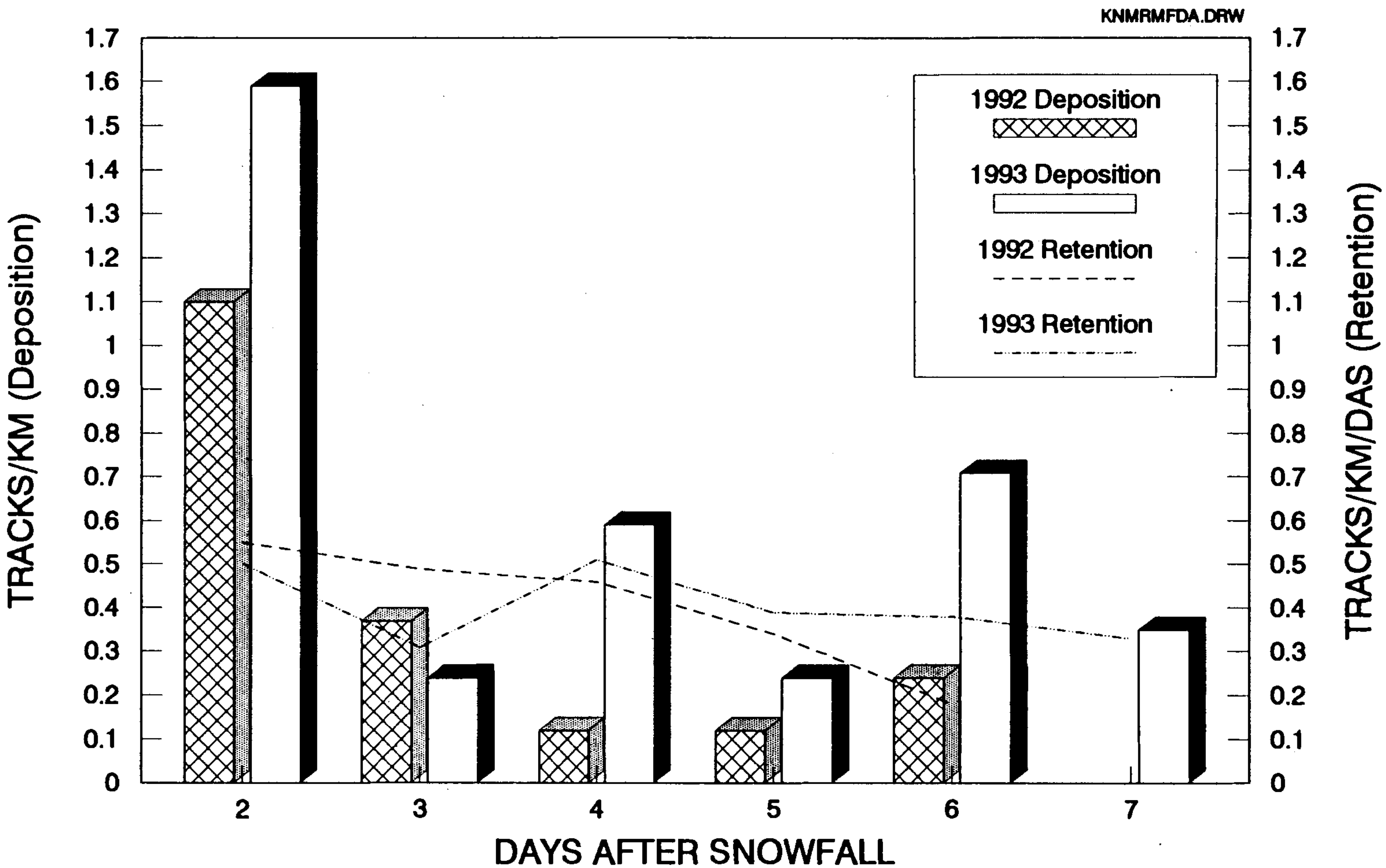

Figure 12. Daily deposition and retention of marten tracks counted during 1-5 March 1992 and 9-14 March 1993 in the mature forest in the Koyukuk/Nowitna Refuge Complex, Alaska.

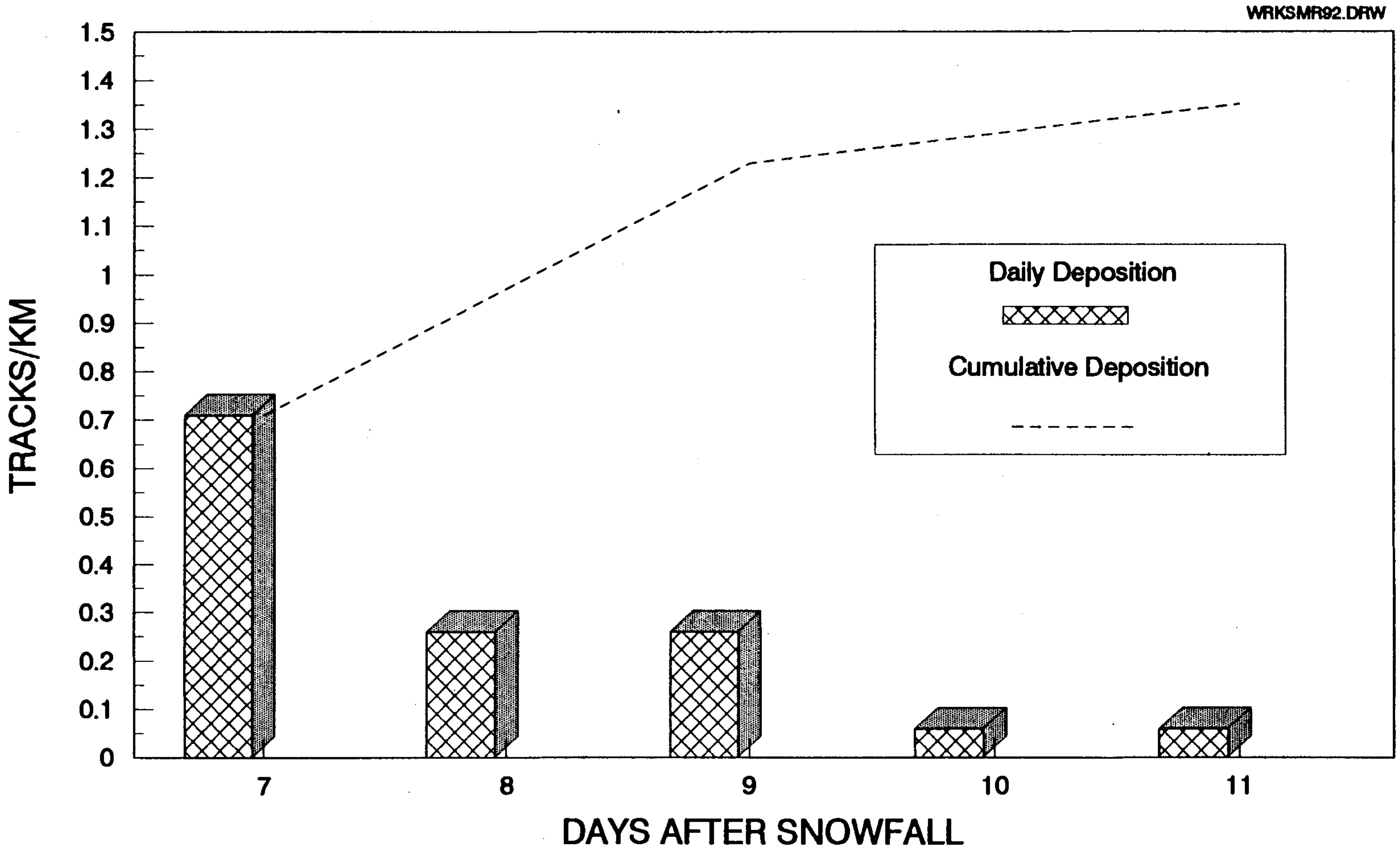

Figure 13. Daily and cumulative deposition of marten tracks counted during 3-7 February 1992 along the 15.5-km Kotsina Lake trail in the Wrangell-St. Elias National Park and Preserve, Alaska.

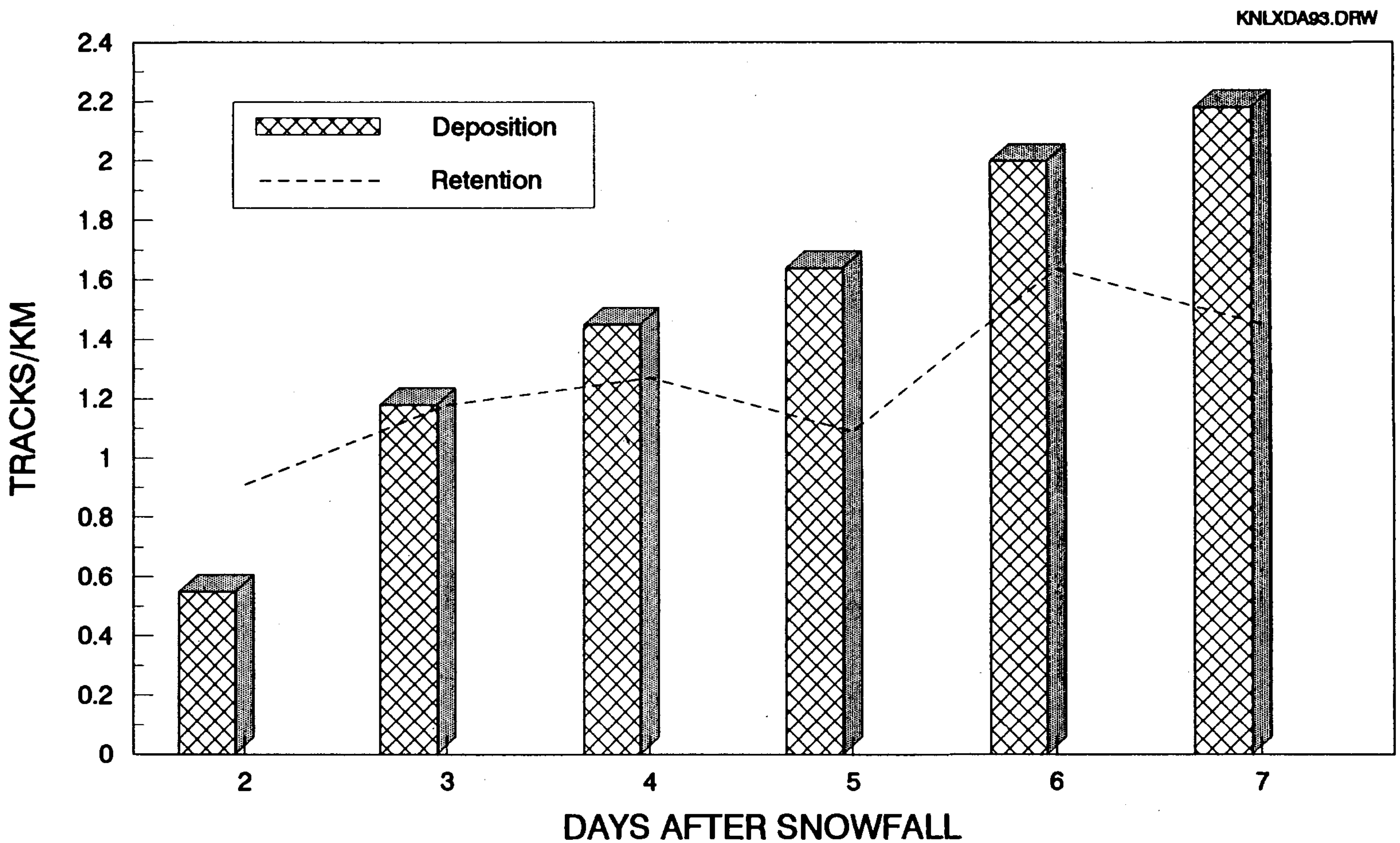

Figure 14. Cumulative deposition and retention of lynx tracks counted during 9-14 March 1993 in the 1966 burn (dense tree forest) in the Koyukuk/Nowitna Refuge Complex, Alaska.

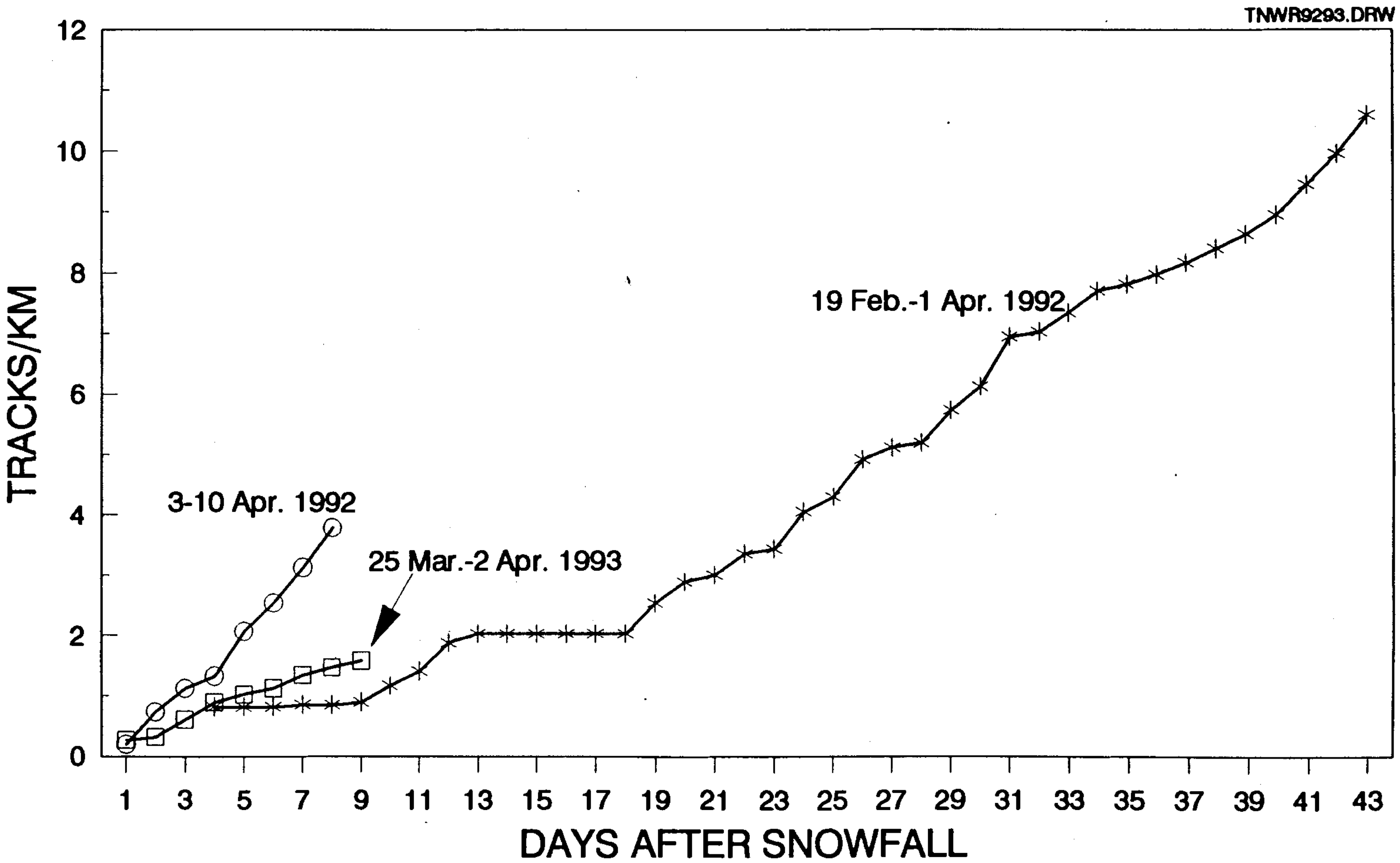

Figure 15. Cumulative deposition of lynx tracks counted during 19 February-10 April 1992 (25.6 km) and 25 March-2 April 1993 (86.4 km) of Stuver Creek trail in Tetlin National Wildlife Refuge, Alaska. Tracks were erased each day after counting.

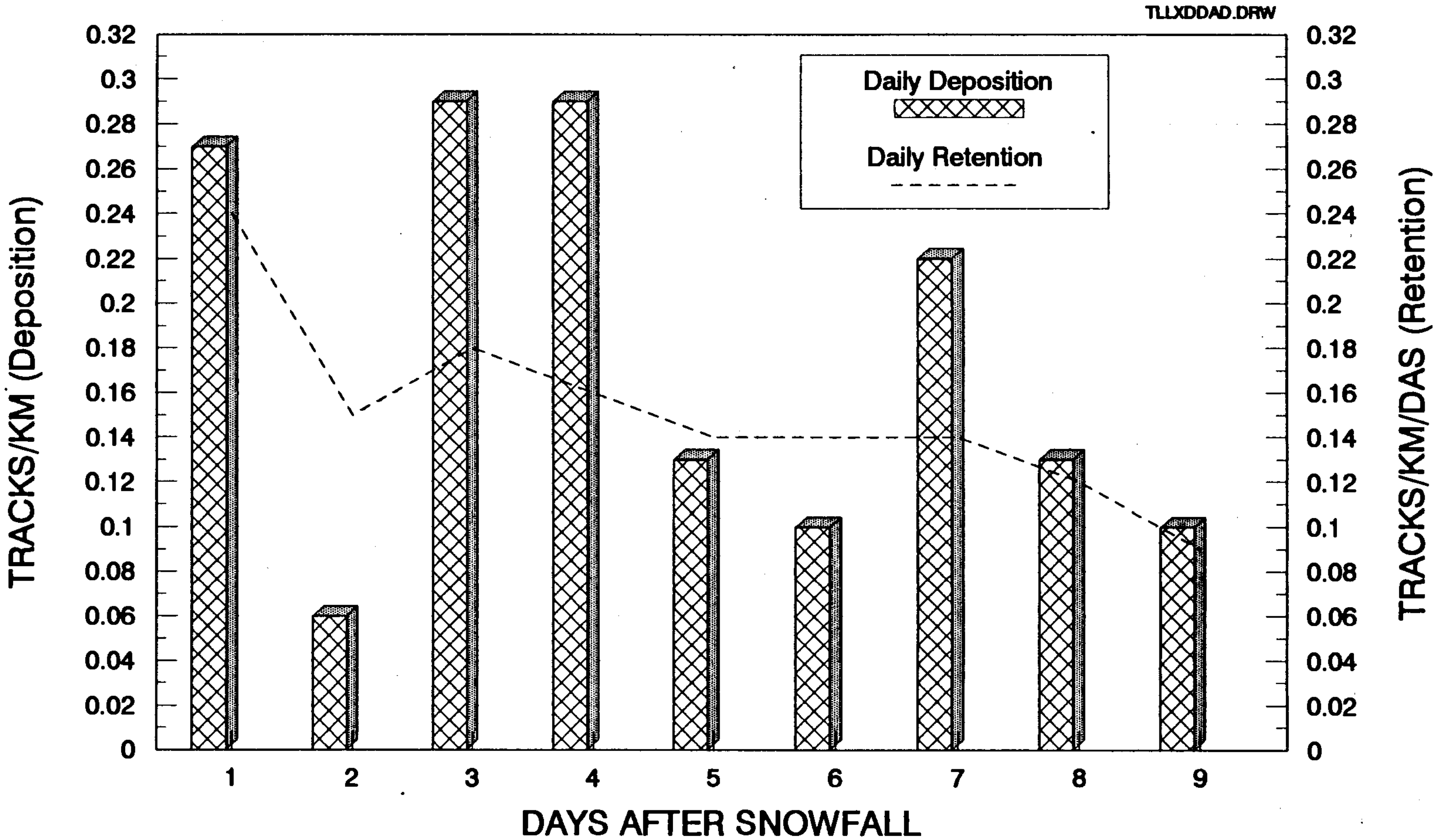

Figure 16. Daily deposition and retention of lynx tracks counted during 25 March-2 April 1993 along an 86.4-km trail in the Tetlin National Wildlife Refuge, Alaska.

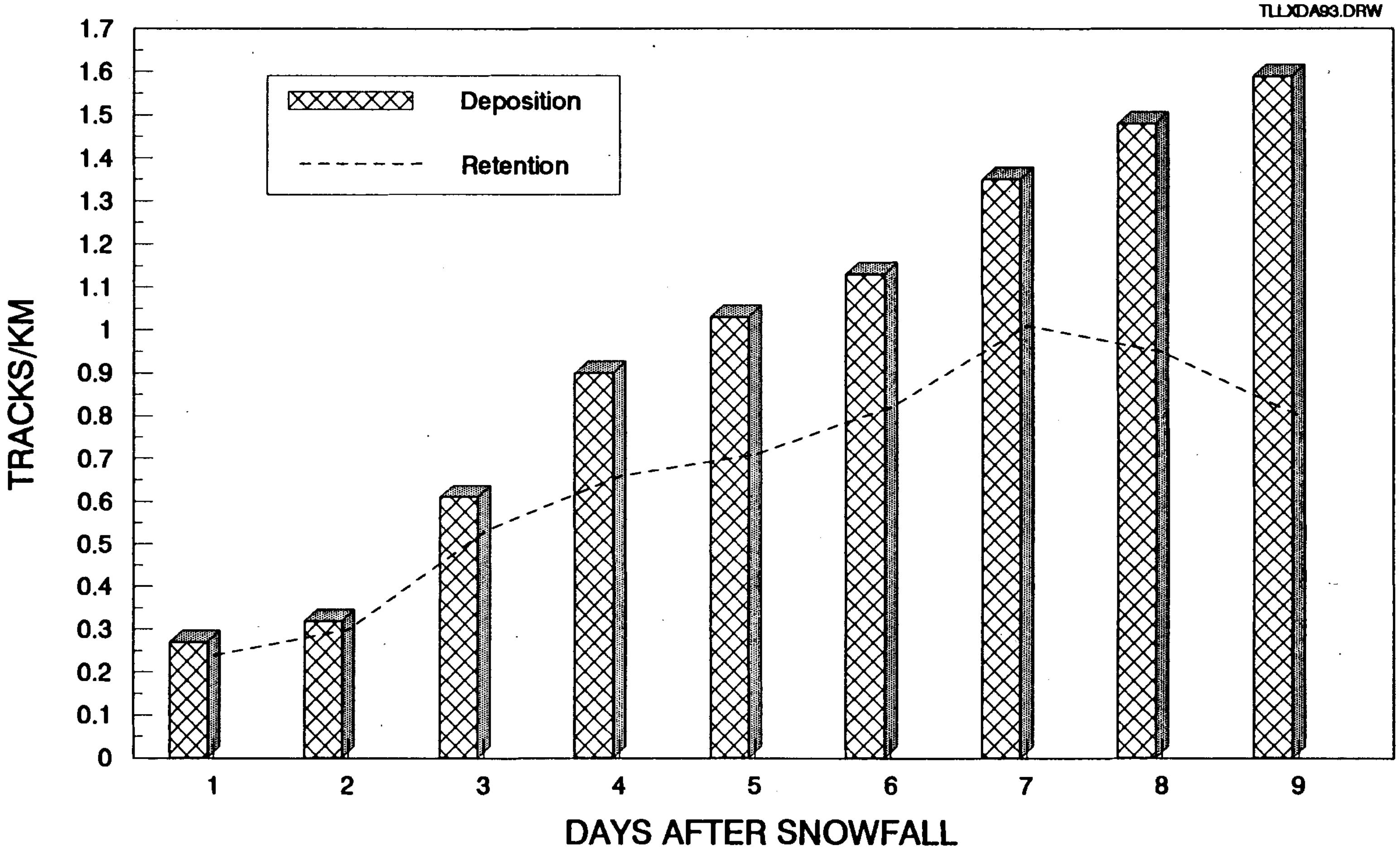

Figure 17. Cumulative deposition and retention of lynx tracks counted during 25 March-2 April 1993 along the 86.4-km Stuver Creek trail in the Tetlin National Wildlife Refuge, Alaska.

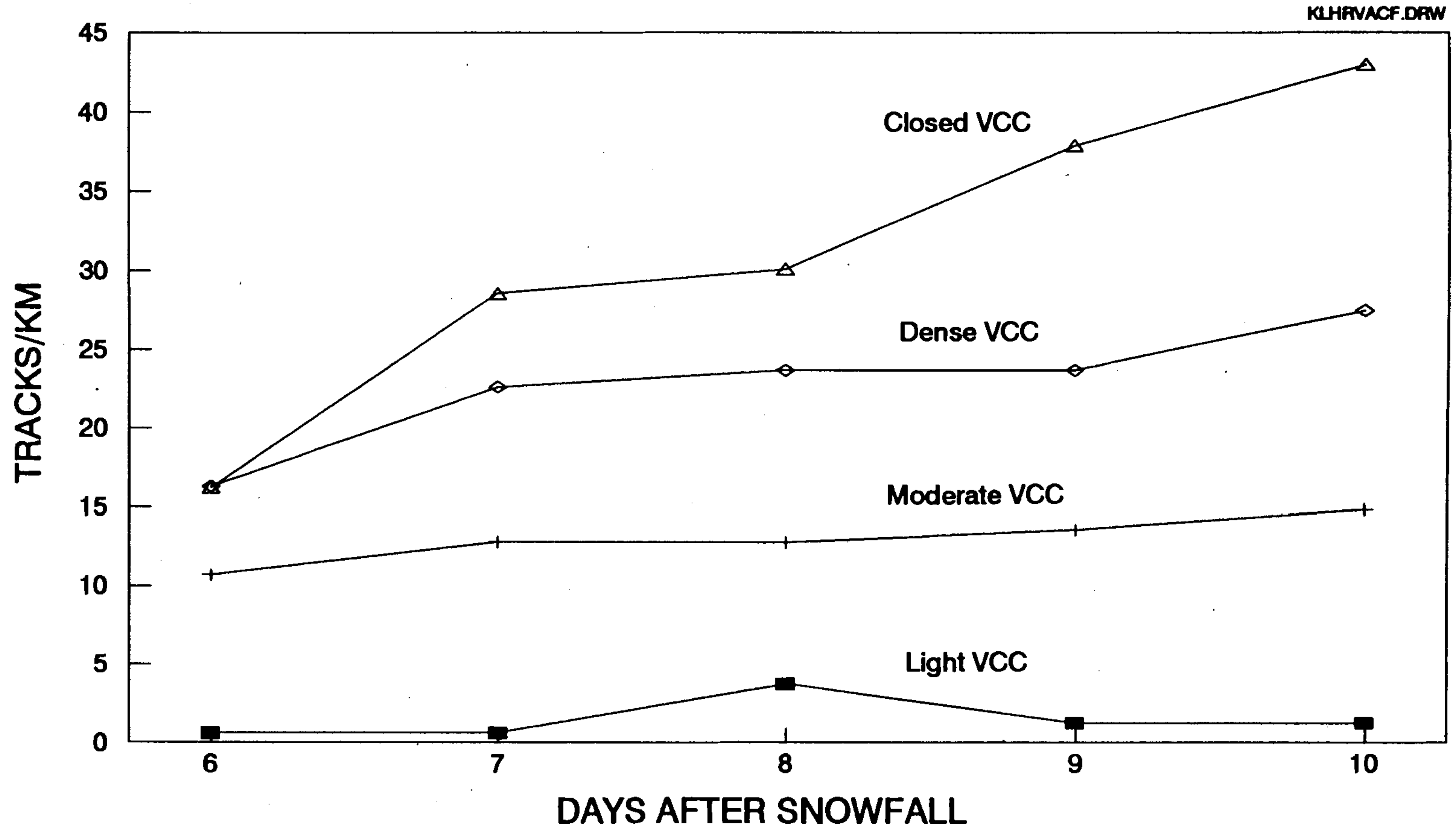

Figure 18. Cumulative retention of snowshoe hare tracks counted during 1-5 February 1992 among four vegetation cover classes (light = 1-25%, moderate = 26-50%, dense = 51-75%, closed = 76-100%) along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

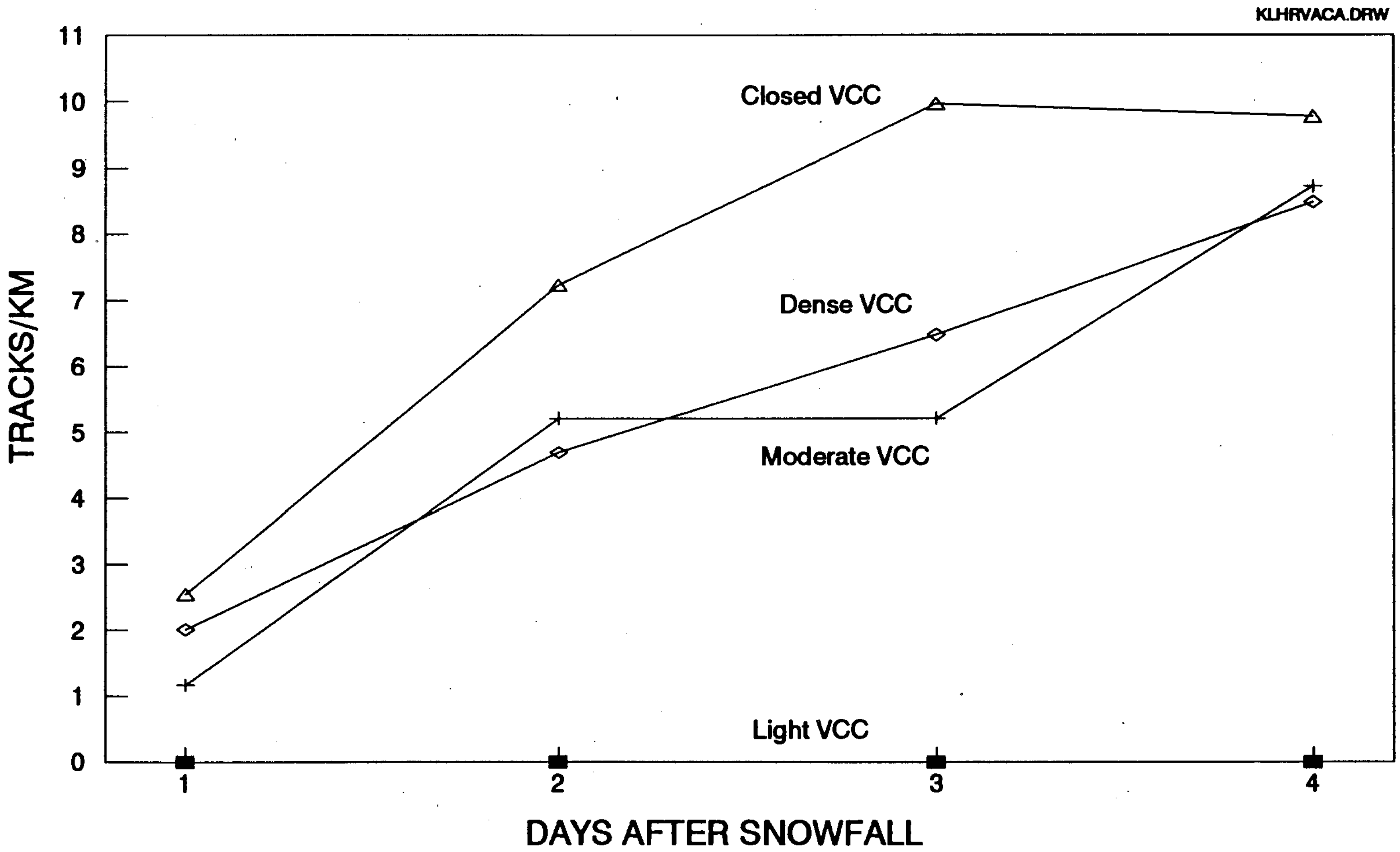

Figure 19. Cumulative retention of snowshoe hare tracks counted during 5-8 April 1992 among four vegetation cover classes (light = 1-25%, moderate = 26-50%, dense = 51-75%, closed = 76-100%) along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

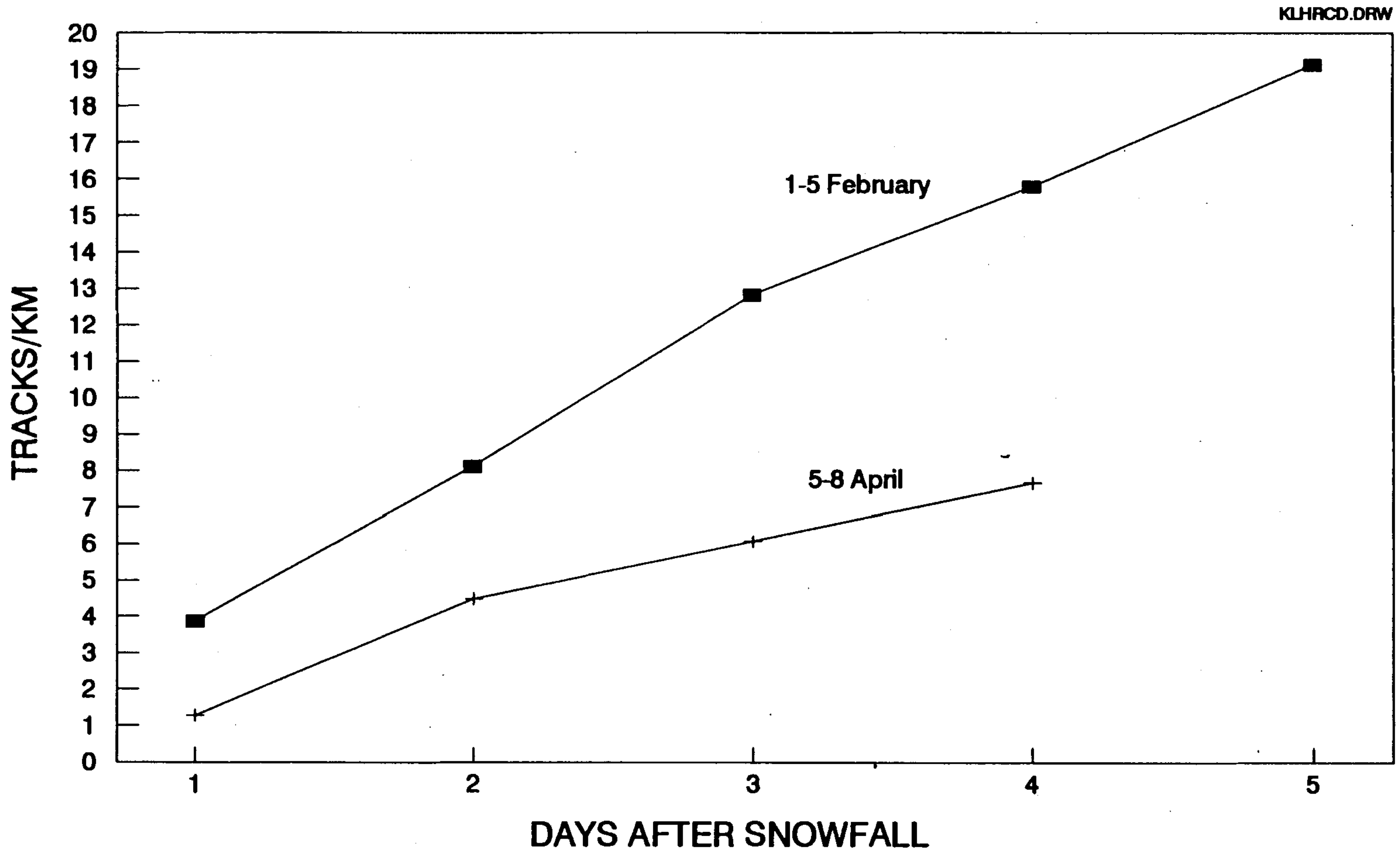

Figure 20. Cumulative deposition of snowshoe hare tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska. Tracks were erased each day after counting.

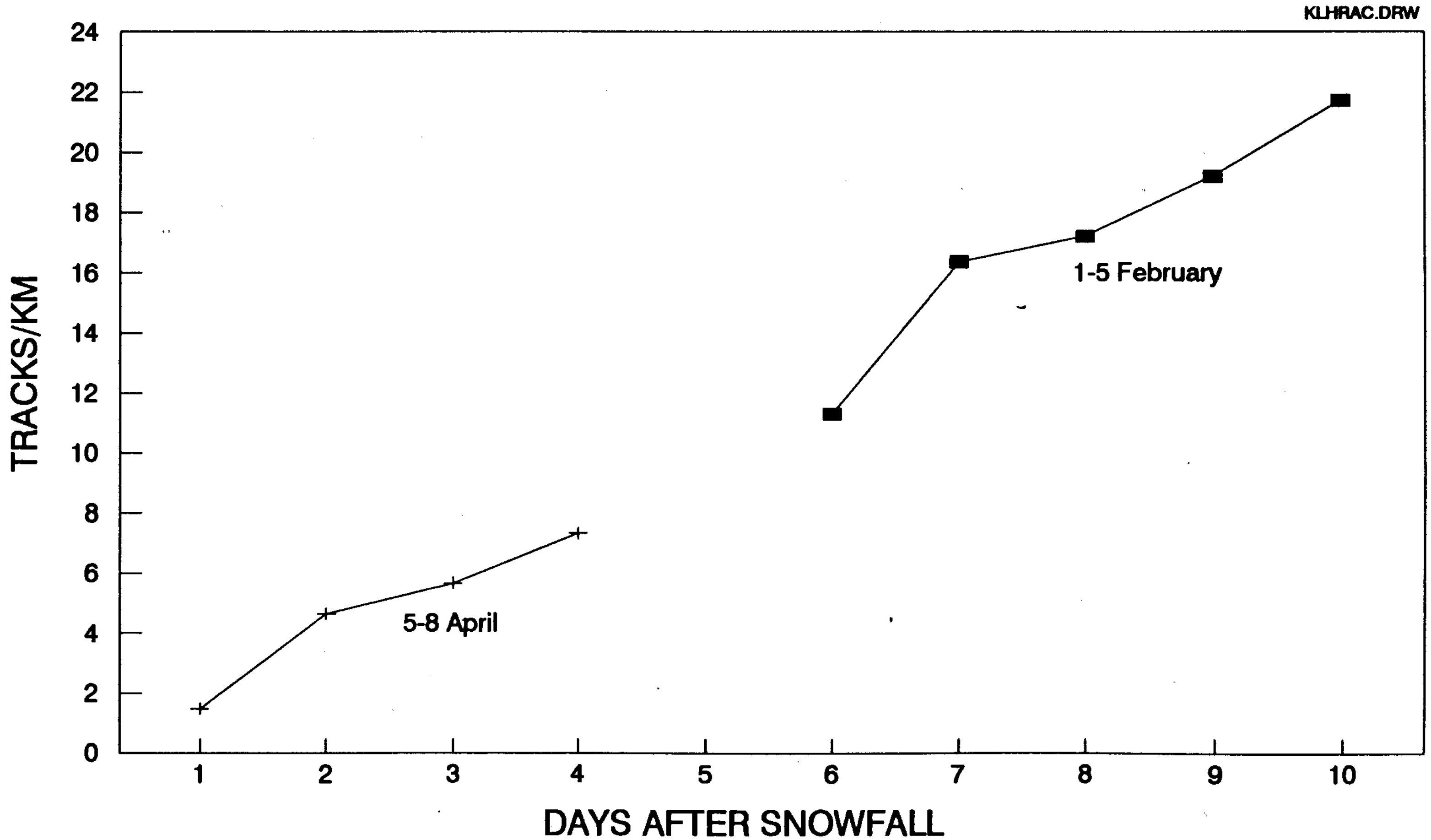

Figure 21. Cumulative retention of snowshoe hare tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska.

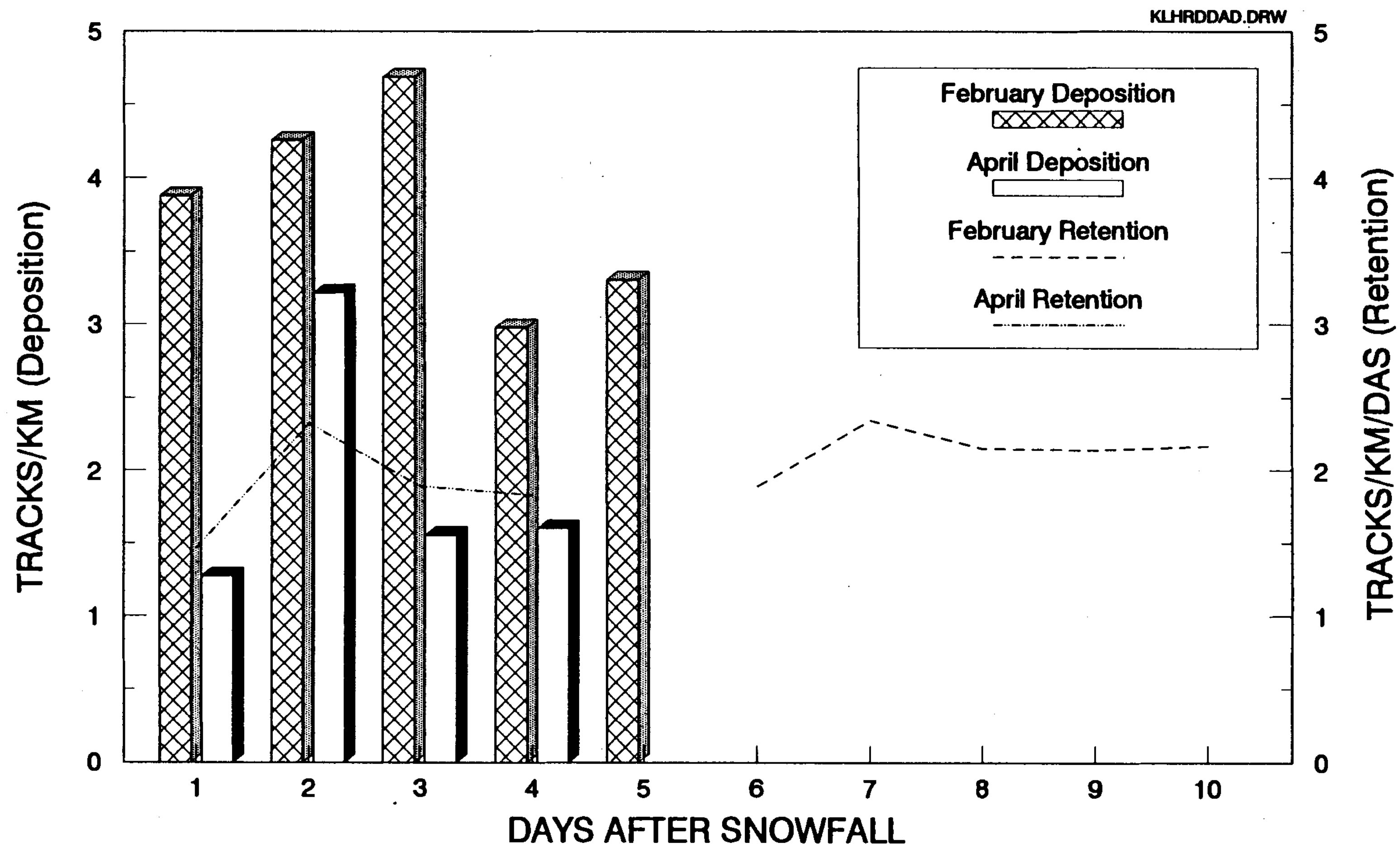

Figure 22. Daily deposition and retention of snowshoe hare tracks counted during 1-5 February and 5-8 April 1992 along the 21-km Klutina Lake trail in the Copper River basin, Alaska. Tracks for daily deposition counts were erased each day after counting.

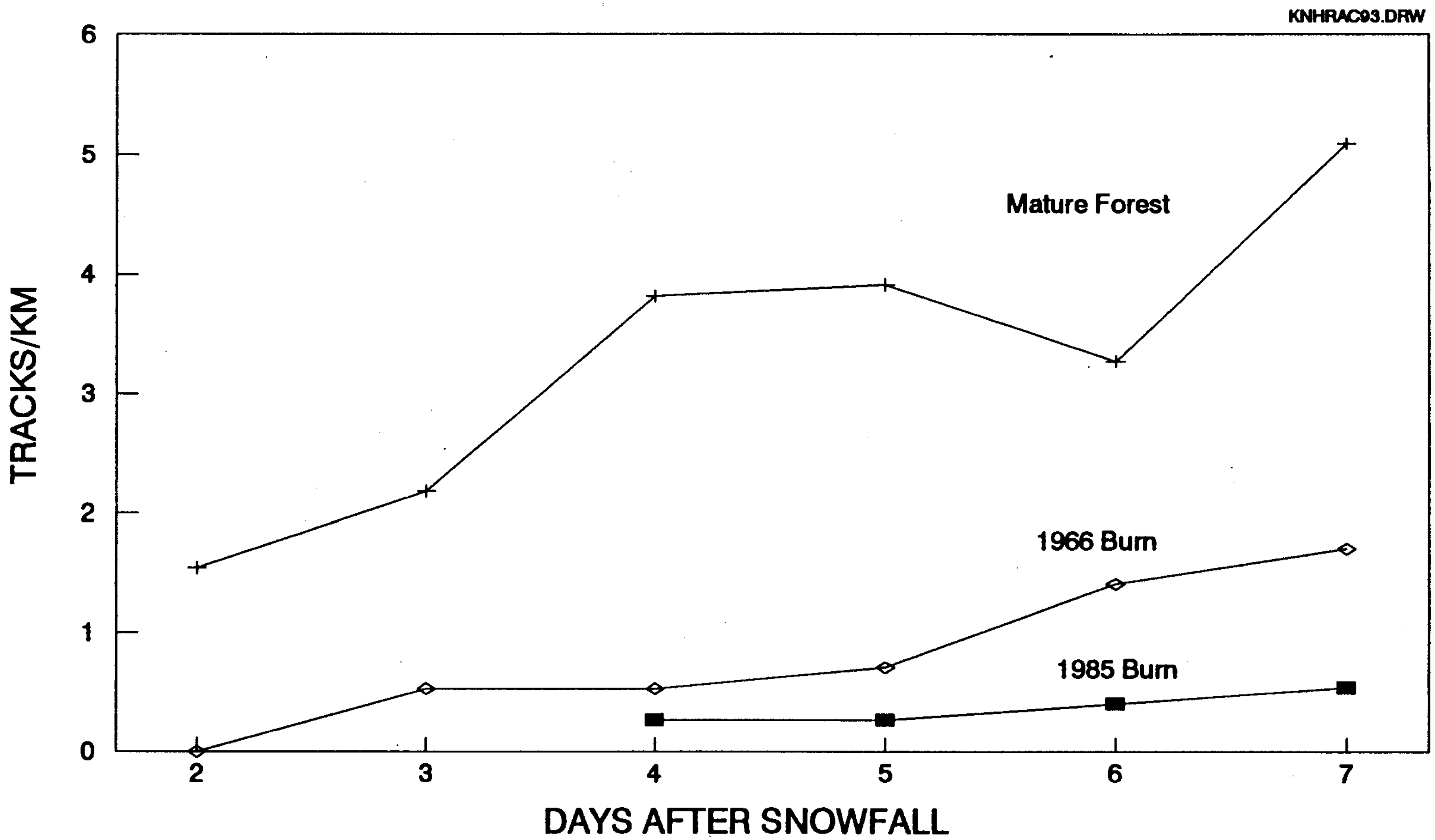

Figure 23. Cumulative retention of snowshoe hare tracks counted during 1-5 March 1993 in three forest seral stages in the Koyukuk/Nowitna Refuge Complex, Alaska.

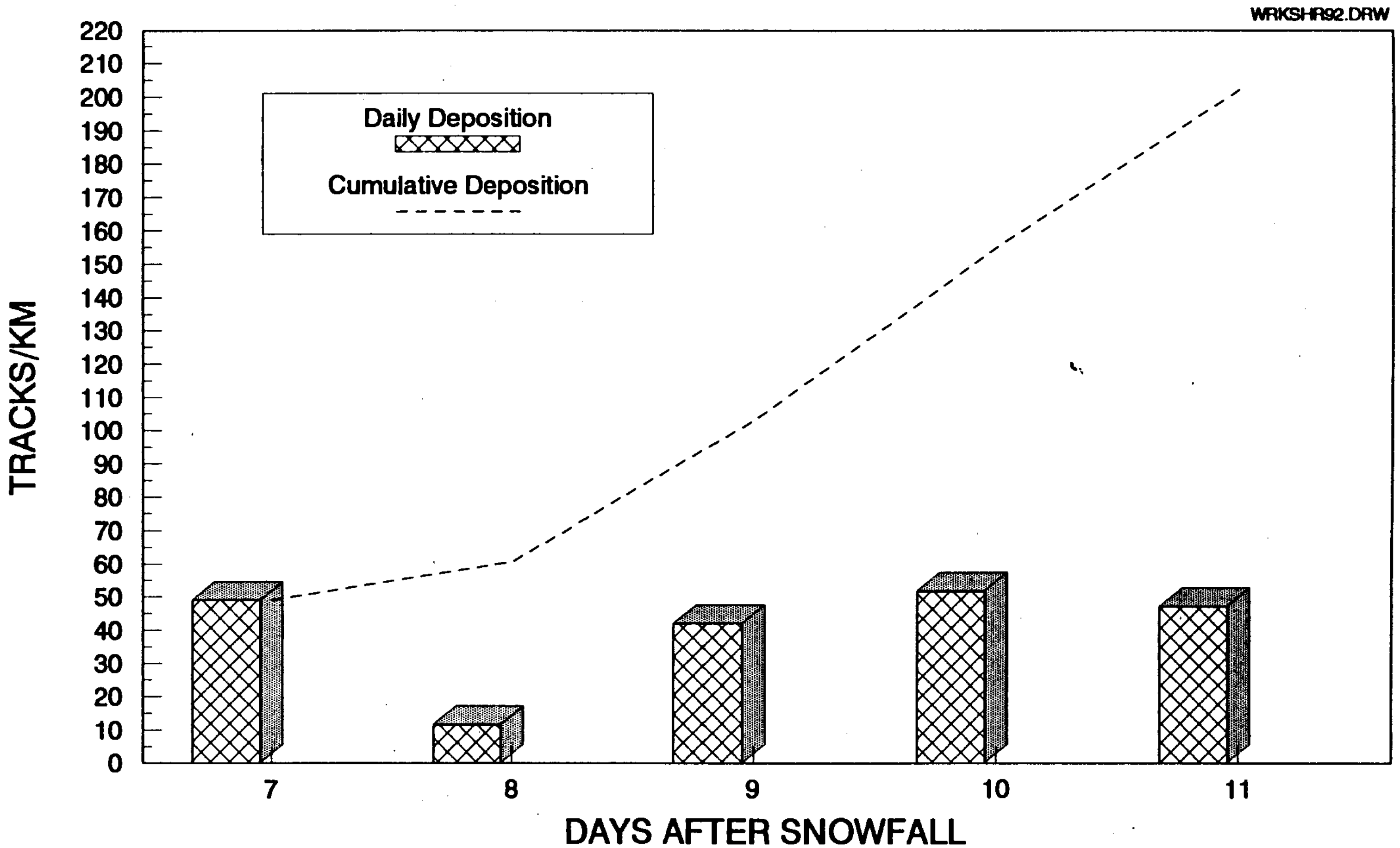

Figure 24. Daily and cumulative deposition of snowshoe hare tracks counted during 3-7 February 1992 along the 15.5-km Kotsina Creek trail in the Wrangell-St. Elias National Park and Preserve, Alaska. Tracks for daily deposition counts were erased each day after counting.

Table 1. Marten track deposition and retention statistics for different sample areas, vegetation types, and time periods in Southcentral and Interior Alaska. Tracks/km were counted in snow along ground transects.

		Trans.	Track Deposition						Track Retention					
		Length		Daily[b]		Cumulative[c]				Daily[d]		Cumulative[e]		
Area & Vegetation	Mo/Yr	(km)	DAS[a]	Mean	(SD)	Rate	(SE)	R^2	DAS	Mean	(SD)	Rate	(SE)	R^2
KLUTINA[f]														
Light VCC	2/92	1.6	1-5	0.00	(0.00)	0.00	(0.00)	0.00	6-10	0.08	(0.01)	0.00	(0.00)	0.00
	4/92	1.6	1-4	0.00	(0.00)	0.00	(0.00)	0.00	1-4	0.00	(0.00)	0.00	(0.00)	0.00
Moderate VCC	2/92	7.7	1-5	0.18	(0.13)	0.14	(0.03)	0.86	6-10	0.20	(0.02)	0.11	(0.02)	0.88
	4/92	7.7	1-4	0.10	(0.11)	0.14	(0.03)	0.90	1-4	0.07	(0.05)	0.14	(0.03)	0.90
Dense VCC	2/92	4.5	1-5	0.40	(0.41)	0.31	(0.11)	0.72	6-10	0.26	(0.04)	0.07	(0.07)	0.22
	4/92	4.5	1-4	0.95	(0.43)	1.05	(0.18)	0.95	1-4	0.76	(0.13)	0.85	(0.23)	0.87
Closed VCC	2/92	5.1	1-5	0.31	(0.26)	0.31	(0.06)	0.89	6-10	0.10	(0.04)	0.25	(0.07)	0.79
	4/92	5.1	1-4	0.44	(0.08)	0.45	(0.03)	0.99	1-4	0.31	(0.08)	0.12	(0.07)	0.60
All VCC	2/92	21.1	1-5	0.23	(0.19)	0.20	(0.05)	0.84	6-10	0.16	(0.01)	0.12	(0.02)	0.91
	4/92	21.1	1-4	0.34	(0.08)	0.38	(0.02)	0.99	1-4	0.26	(0.02)	0.26	(0.03)	0.98
KNRC[g]														
1985 Burn	3/92	14.9	2-6	0.66	(0.30)	0.60	(0.10)	0.93	2-6	0.46	(0.06)	0.50	(0.08)	0.92
	3/93	14.9	2-7	0.88	(0.34)	1.01	(0.06)	0.98	2-7	0.70	(0.33)	0.30	(0.33)	0.17
1966 Burn	3/92	No data												
	3/93	11.0	2-7	0.06	(0.14)	0.00	(0.00)	0.00	2-7	0.09	(0.03)	0.02	(0.01)	0.71
Mature Forest	3/92	8.2	2-6	0.39	(0.37)	0.20	(0.02)	0.96	2-6	0.40	(0.13)	0.02	(0.12)	0.01
	3/93	17.0	2-7	0.62	(0.47)	0.44	(0.03)	0.98	2-7	0.40	(0.08)	0.30	(0.07)	0.80
WRST[h]	2/92	15.5	7-11	0.27	(0.24)	0.16	(0.03)	0.91						

Table 1. Continued.

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[a] Days after snowfall.

[b] Daily deposition of tracks (tracks/km).

[c] Rate of increase and coefficient of determination (R^2) of tracks deposited over all DAS (tracks/km).

[d] Average daily retention of accumulated tracks (tracks/km/DAS).

[e] Rate of increase and coefficient of determination (R^2) of tracks retained over all DAS (tracks/km).

[f] Vegetation in Klutina was primarily coniferous forest that was classified into five vegetation cover classes (VCC): bare = 0%, light = 1-25%, moderate = 26-50%, dense = 51-75%, and closed = 76-100%. No tracks were counted in the bare VCC so that category was not included in this summary. The Klutina area is on the west side of the Copper River valley in Southcentral Alaska, and it contains one small area that was burned in the last 15 years.

[g] Vegetation in Koyukuk/Nowitna Refuge Complex (KNRC) was sampled among forests of three seral stages: 1985 burn = tall shrub/sapling stage, 1966 burn = dense tree stage, and mature forest stage. The 1966 burn was not sampled in 1992. Data for this area were provided by cooperators Johnson and Paragi (1993) and unpublished KNRC records. The refuge is in the western Yukon River basin in Interior Alaska.

[h] The Wrangell-St. Elias National Park and Preserve (WRST) area is on the east side of the Copper River valley in eastern Southcentral Alaska. It is characterized by predominately mixed forest of moderate VCC. These unpublished data were provided by cooperator W. Route of WRST for surveys conducted along the Kotsina Creek trail.

Table 2. Lynx track deposition and retention statistics for different sample areas, vegetation types, and time periods in Southcentral and Interior Alaska. Tracks/km were counted in snow along ground transects.

Area & Vegetation	Mo/Yr	Trans. Length (km)	Track Deposition: DAS[a]	Track Deposition: Daily[b] Mean	Track Deposition: Daily[b] (SD)	Track Deposition: Cumulative[c] Rate	Track Deposition: Cumulative[c] (SE)	Track Deposition: Cumulative[c] R^2	Track Retention: DAS	Track Retention: Daily[d] Mean	Track Retention: Daily[d] (SD)	Track Retention: Cumulative[e] Rate	Track Retention: Cumulative[e] (SE)	Track Retention: Cumulative[e] R^2
KNRC[f]														
1985 Burn	3/93	14.9	2-7	0.07	(0.00)	0.00	(0.00)	0.00	2-7	0.00	(0.00)	0.00	(0.00)	0.00
1966 Burn	3/93	11.0	2-7	0.36	(0.17)	0.31	(0.03)	0.96	2-7	0.31	(0.09)	0.65	(0.11)	0.65
Mature Forest	3/93	17.0	2-7	0.06	(0.00)	0.00	(0.00)	0.00	2-7	0.02	(0.00)	0.00	(0.00)	0.00
TNWR[g]														
Stuver Cr.	2/92	25.6	4-18	0.14	(0.23)	0.12	(0.01)	0.87						
	3/92	25.6	19-43	0.34	(0.20)	0.32	(0.01)	0.99						
	4/92	25.6	1-8	0.47	(0.19)	0.50	(0.02)	0.99						
	3/93	86.4	1-9	0.18	(0.08)	0.17	(0.01)	0.98	1-9	0.15	(0.04)	0.09	(0.01)	0.90

[a] Days after snowfall.
[b] Daily deposition of tracks (tracks/km).
[c] Rate of increase and coefficient of determination (R^2) of tracks deposited over all DAS (tracks/km).
[d] Average daily retention of accumulated tracks (tracks/km/DAS).
[e] Rate of increase and coefficient of determination (R^2) of tracks retained over all DAS (tracks/km).
[f] Vegetation in Koyukuk/Nowitna Refuge Complex (KNRC) was sampled among forests of three seral stages: 1985 burn = tall shrub/sapling stage, 1966 burn = dense tree stage, and mature forest stage. The 1966 burn was not sampled in 1992. Data for this area were provided by Johnson and Paragi (1993) and unpublished KNRC records. The refuge is in the western Yukon River basin in Interior Alaska.
[g] Data were provided by cooperator T. Doyle at the Tetlin National Wildlife Refuge (TNWR) in eastern Interior Alaska near Tok. The Stuver Creek area is characterized by mixed forest of moderate to dense cover.

Table 3. Snowshoe hare track deposition and retention statistics for different sample areas, vegetation types, and time periods in Southcentral and Interior Alaska. Tracks/km were counted in snow along ground transects.

		Trans.	Track Deposition						Track Retention					
		Length		Daily[b]		Cumulative[c]				Daily[d]		Cumulative[e]		
Area & Vegetation	Mo/Yr	(km)	DAS[a]	Mean	(SD)	Rate	(SE)	R^2	DAS	Mean	(SD)	Rate	(SE)	R^2
KLUTINA[f]														
Light VCC	2/92	1.6	1-5	0.13	(0.25)	0.19	(0.06)	0.75	6-10	0.19	(0.14)	0.19	(0.46)	0.05
	4/92	1.6	1-4	0.00	(0.00)	0.00	(0.00)	0.00	1-4	0.00	(0.00)	0.00	(0.00)	0.00
Moderate VCC	2/92	7.7	1-5	2.68	(0.51)	2.51	(0.14)	0.99	6-10	1.64	(0.14)	0.91	(0.17)	0.91
	4/92	7.7	1-4	1.89	(0.97)	2.08	(0.34)	0.95	1-4	1.92	(0.53)	2.27	(0.54)	0.90
Dense VCC	2/92	4.5	1-5	5.13	(1.84)	4.96	(0.61)	0.96	6-10	2.85	(0.21)	2.35	(0.59)	0.84
	4/92	4.5	1-4	2.46	(0.82)	2.66	(0.32)	0.97	1-4	2.16	(0.12)	2.12	(0.13)	0.99
Closed VCC	2/92	5.1	1-5	7.23	(1.12)	7.58	(0.25)	1.00	6-10	3.81	(0.58)	6.29	(0.83)	0.95
	4/92	5.1	1-4	2.93	(1.02)	3.11	(0.38)	0.97	1-4	2.98	(0.50)	2.44	(0.77)	0.83
All VCC	2/92	21.1	1-5	3.83	(0.62)	4.00	(0.00)	0.99	6-10	2.14	(0.15)	2.37	(0.36)	0.94
	4/92	21.1	1-4	1.92	(0.76)	2.07	(0.28)	0.96	1-4	1.88	(0.30)	1.86	(0.31)	0.95
KNRC[g]														
1985 Burn	3/93	14.9	2-7	0.23	(0.03)	0.23	(0.01)	1.00	2-7	0.07	(0.01)	0.09	(0.02)	0.89
1966 Burn	3/93	11.0	2-7	1.14	(0.41)	0.95	(0.06)	0.98	2-7	0.75	(0.12)	0.60	(0.16)	0.78
Mature Forest	3/93	17.0	2-7	0.32	(0.18)	0.35	(0.03)	0.98	2-7	0.15	(0.08)	0.32	(0.05)	0.92
WRST[h]	2/92	15.5	7-11	40.43	(14.73)	40.0	(4.44)	0.96						

[a] Days after snowfall.
[b] Daily deposition of tracks (tracks/km).
[c] Rate of increase and coefficient of determination (R^2) of tracks deposited over all DAS (tracks/km).

Table 3. Continued.

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[d] Average daily retention of accumulated tracks (tracks/km/DAS).

[e] Rate of increase and coefficient of determination (R^2) of tracks retained over all DAS (tracks/km).

[f] Vegetation in Klutina was primarily coniferous forest that was classified into five vegetation cover classes (VCC): bare = 0%, light = 1-25%, moderate = 26-50%, dense = 51-75%, and closed = 76-100%. No tracks were counted in the bare VCC so that category was not included in this summary. The Klutina area is on the west side of the Copper River valley in Southcentral Alaska, and it contains one small area that was burned in the last 15 years.

[g] Vegetation in Koyukuk/Nowitna Refuge Complex (KNRC) was sampled among forests of three seral stages: 1985 burn = tall shrub/sapling stage, 1966 burn = dense tree stage, and mature forest stage. The 1966 burn was not sampled in 1992. Data for this area were provided by cooperators Johnson and Paragi (1993) and unpublished KNRC records. The refuge is in the western Yukon River basin in Interior Alaska.

[h] The Wrangell-St. Elias (WRST) is on the east side of the Copper River valley in eastern Southcentral Alaska. It is characterized by predominately mixed forest of moderate VCC. These unpublished data were provided by cooperator W. Route of WRST for surveys conducted along the Kotsina Creek trail.

Table 4. Percentages and ratios of sex and estimated age of marten carcasses (N) purchased from trappers during the 1991-92 trapping season in Game Management Units (GMU) 11 and 13 in Southcentral Alaska.

	Sex			Age			Sex and Age Class				
GMU	Male	Female	N	Adult	Juv.	N	Adult Male	Adult Female	Juv. Male	Juv. Female	N
11	63	37	359	73	27	356	49	25	14	11	354
	170	: 100		100	: 37		196	: 100	: 57	: 44	
13	62	38	340	73	27	327	47	27	15	11	325
	164	: 100		100	: 37		174	: 100	: 56	: 41	
Total	60	40	843	73	27	825	46	27	14	12	819
	150	: 100		100	: 37		170	: 100	: 52	: 44	

Table 5. Percentages and ratios of sex and estimated age of lynx carcasses (N) purchased from trappers during the 1991-92 trapping season in Game Management Units (GMU) 11 and 13 in Southcentral Alaska.

	Sex			Age			Sex and Age Class				
GMU	Male	Female	N	Adult	Juv.	N	Adult Male	Adult Female	Juv. Male	Juv. Female	N
11	51	49	55	91	9	55	51	40	0	9	55
	104	: 100		100	: 10		128	: 100	: 0	: 22	
13	60	40	10	100	0	10	60	40	0	0	10
	150	: 100		100	: 0		150	: 100	: 0	: 0	
Total	56	44	144	90	10	146	52	38	3	6	143
	127	: 100		100	: 11		137	: 100	: 8	: 16	

APPENDIX A. Investigators in Alaska and Canada who are coordinating their related projects with this study.

1. William Route, Wrangell-St. Elias National Park and Preserve; Development of techniques to monitor furbearer populations in Wrangell-St. Elias National Park and Preserve.

2. Buddy Johnson and Thomas Paragi, Koyukuk-Nowitna Refuge Complex; Relationships of wildfire to lynx and marten populations and habitat in Interior Alaska.

3. Terry Doyle, Tetlin National Wildlife Refuge; Mortality factors, home range characteristics, and habitat preferences of lynx in Game Management Unit 12.

4. Brian Slough, Yukon Department of Renewable Resources; Lynx harvest study.

5. Kim Poole, Northwest Territories Department of Renewable Resources; Lynx research in the NWT.

APPENDIX B. Furbearer track-count index ground-test procedures, 1993-94.

These procedures are designed to enhance the collection of track transect data for marten, lynx, and snowshoe hares in a variety of habitat types; they specifically address the ground portion of Job Objective #1 from the 1993 progress report.

1. Survey Areas

Areas should have easy access by snow machine or snowshoe, and, if possible, they should contain a variety of vegetation cover and composition (VCC) types.

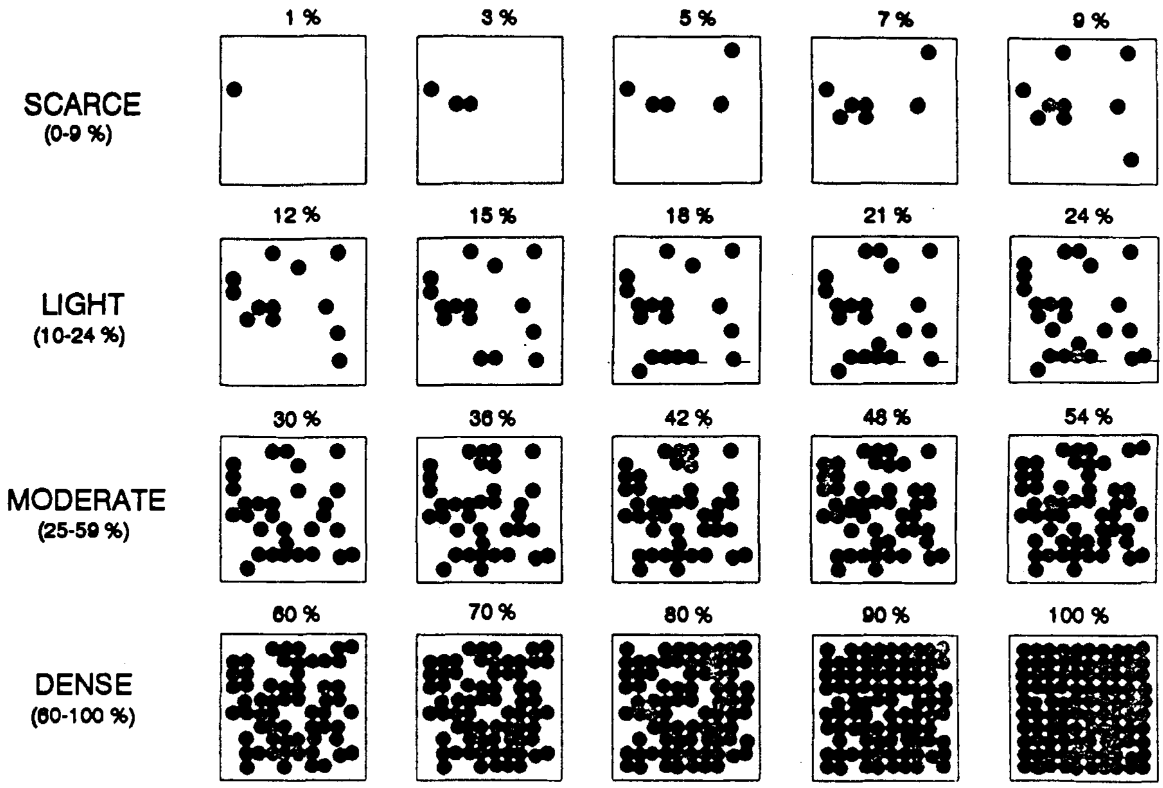
2. Vegetation Cover and Composition

VCCs may be classified using your current study criteria, but you are encouraged to use the criteria below, modified from Viereck et al. (1992). (The Alaska Vegetation Classification. USDA For. Serv. Pac. NW Res. Sta. Gen. Tech. Rep. PNW-GTR-286. Portland, Oregon. 278 pp.). Classifications modified from Viereck, et al. (1992) should be made for trees and tall shrubs in winter, once snow depth is sufficient to cover low shrubs and grasses.

Cover -	SCARCE: 0-9% cover; LIGHT: 10-24% cover; MODERATE: 25-59% cover; and DENSE: 60-100% cover.
Composition -	CONIFER: ≥ 75% needleleaf; DECIDUOUS: ≥ 75% broadleaf; and MIXED: needleleaf or broadleaf = 25-75%; document major species in order of canopy dominance for future analysis.
Example -	M-M-Pima, Bepa, Sasp = Moderate-Mixed-black spruce, birch, willow (spp.).

* Prior to track counts, conduct vegetation classifications from the air after leaf-fall and when there is enough snow to cover small shrubs and grasses. It is necessary to classify VCCs at this time because tracks will be counted in the winter when vegetation will look substantially different than it did during any summertime classifications you may have done. Use the following figure as a guide.

PERCENT VEGETATION COVER CLASSIFICATION SCALE



* Mark each VCC along a transect on a map or aerial photo, and then measure the length of that VCC.

* In general, lump vegetation types less than 0.5 km of a transect's length into one VCC.

* You may want to have someone in an aircraft help you determine where you are when you are marking VCCs on the ground, particularly if you use the Viereck et al (1992) classification scheme.

3. <u>Selection of Transects</u>

* The transects used can vary from one long line that includes many VCCs to several lines with each one or a few lying within different VCCs. Measurements of variability will be improved with the latter but such a configuration may not be possible with your overall study design.

* Minimum transect length should be approximately 1 km for marten and lynx and 100 m for hares.

* Regardless of how many transects are used, you should be able to survey the combined lengths of your transects in 1 day.

4. Track Counts

Timing --

* Attempt to conduct track counts during three periods of 5 to 10 days duration in early, mid, and late winter.

* Begin counts 12-24 hours after snowfall or as soon as possible thereafter. Counting tracks after a fresh snowfall of ≥ 5 cm is best for a clean slate of tracks, but counting with 2-3 cm of new snow may be sufficient as long as tracks deposited before and after the fresh snowfall will not be confused.

* If there has not been a new snowfall for some time or you are unable to count tracks soon after a snowfall, erase all old tracks from both sides of each transect the day before counting tracks.

Track Deposition --

* Count daily deposition of tracks on one side of a transect only.

* Erase each track after it is counted.

* Tally counts within each VCC along a transect or for the entire length of a transect if it is within one VCC.

Track Retention --

* Count cumulative retention of tracks on the opposite side of the transect that deposition was counted. Track retention may be counted simultaneously with deposition counts or on the return trip along the transect.

* Leave all tracks intact after counting for the duration of the count period.

* Count individual hare tracks until they become indistinguishable (3-4+ tracks) and then count them as a trail; keep separate tallies of tracks and trails. If hare

densities are high, it may be necessary to count their tracks along a smaller portion of a transect.

* Continue to count individual tracks until they become too difficult to decipher after degradation by wind, sublimation, or other causes.

* Tally counts within each VCC along a transect or for the entire length of a transect if it is within one VCC.

Additional Measurements --

* Measure snow depth and depth of new tracks for each species every 0.5 km along a transect within a VCC at the beginning and end of each survey period, unless the survey period is ended by a fresh snowfall. If a survey period extends beyond 5 days, try to collect snow measurements every fifth day.

* Record ambient temperature highs and lows and wind speed and duration for each survey day.

5. Compilation of Results and Data Analysis

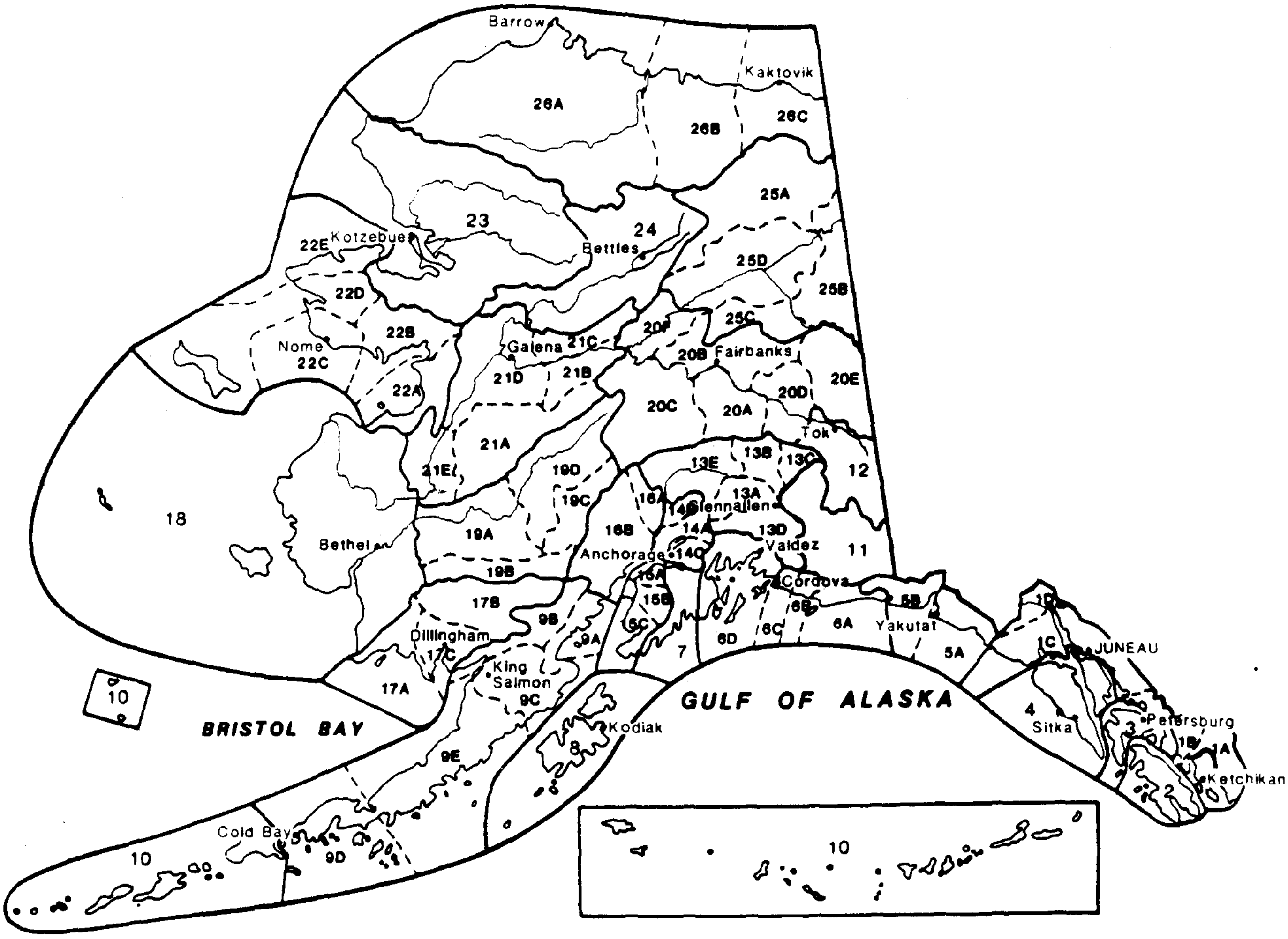
* Sort data by species, transect, VCC, survey period, and observer.

* Send your data on diskette (DOS) and printout to Howard Golden. You can use spreadsheet (LOTUS 2.3) or database (DBASE III or FOXPRO 2.5) files.

* Include comments and additional measurements with the data you send. It would be helpful if you also include raw records, summaries, or finished reports of microtine abundance obtained through snap trapping and hare abundance obtained through pellet count data.

* Also send maps of the survey areas, transects, and VCCs in your study area.

Alaska's Game Management Units



Federal Aid in Wildlife Restoration

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