DISTRIBUTION AND ABUNDANCE OF CARIBOU ON SELAWIK NATIONAL WILDLIFE REFUGE, ALASKA 1984-1989

Final Report SNWR 89-5

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Key Words: Caribou, Rangifer tarandus, migration, habitat use, tundra, taiga, fire ecology, Selawik River, Kobuk River, Northwest Alaska, Selawik National Wildlife Refuge

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Abstract: Aerial surveys were conducted on Selawik NWR since 1984 for monitoring caribou distribution and abundance, to assess potential reindeer grazing conflicts, and to evaluate effects of the 1988 Waring Mountains Burn on wintering and migrating caribou. Aerial surveys have shown considerable annual and seasonal variability in caribou distribution and timing of movements. Between 1984 and 1989 Selawik NWR was used intensively by caribou for a few months during spring and fall migration as the herd moved between the Utukok River calving grounds and the Nulato Hills wintering grounds. Three prominent migration routes were identified: (1) from the Noatak River mouth along the north shores of Kobuk Lake and Selawik Lake thence across the western Selawik Flats to the Selawik Hills; (2) from the Squirrel River and Kalarichuk Hills past Kiana to just east or west of Selawik, and thence across the western or central Selawik Flats to the Selawik Hills; and (3) across the Kobuk River near Onion Portage thence parallel to the north-south flowing portion of the Kugarak River, thence across the Kugarak or Rabbit Rivers to cross the Selawik River between Upingivik and Ingruksukruk Creek, thence either east to Purcell Mountains and the upper Selawik River or south to the upper Huslia River. From radio-telemetry two general types of movements were noted for individual caribou during migration: a "leapfrog" from one intensive use area to another, or a steady, gradual, evenly spaced movement. Abundance estimation transects showed that Selawik NWR hosted ~1%-32% of the total Western Arctic Caribou Herd during migration, depending on the month and year. Maximum number estimated was 72,800 in September 1987. Wintering caribou numbers were much less, with a minimum of about 1,000 and a maximum of about 10,000 using the refuge between mid-November and late February. The Hotham Peak area has wintered caribou in all years of the study. The Kuchuk Creek- Kugarak River area and upper Selawik River areas have wintered caribou in three of six years. Transects over the Waring Mountains Burn in 1988-89 showed that September and May caribou densities were similar in the burned and unburned habitats but were more than twice as high along the border between the burn and unburned area. Density was also highest at the burn edge in early June, and was twice as high in the unburned areas adjacent to the burn. In fall 1989 caribou use of the burn and adjacent unburned areas was minimal, with most of the migration occurring 15-25 miles east or west of the burn edge with no wintering on or near the burn.

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Introduction

One of the establishing purposes of Selawik National Wildlife Refuge (NWR) is to "conserve the fish and wildlife populations and habitats in their natural diversity including, but not limited to, the Western Arctic Caribou Herd (including participation in coordinated ecological studies and management of these caribou)..." (Alaska National Interest Lands Conservation Act 1980). The Act also provided for potential reindeer grazing by permit in the southwest corner of the refuge (USFWS 1987). Caribou, and earlier in the century, reindeer, have been primary food sources for the local Inupiat Eskimo population. Caribou conservation and reindeer grazing have been documented as potentially conflicting land uses and may be incompatible (Klein 1980). With the Western Arctic Caribou Herd (WACH) at high population levels in the late 1980's there has been little interest in reindeer grazing; however, with a low caribou population renewed interest in reindeer grazing is anticipated. For these reasons, Selawik NWR has had an active baseline caribou survey and inventory program. Objectives of this report are to summarize and archive caribou distribution and abundance data through fall 1989. Results of a literature review prior to preparation of the refuge caribou inventory plan are presented below as background. Survey results are presented in four separate sections: (1) distribution, (2) abundance, (3) Waring Mountains Burn, and (4) radio-telemetry.

Background

Historically, the Western Arctic Caribou Herd has calved 150-200 miles north of the refuge in the Utukok drainage, and wintered on the refuge and surrounding areas to the northwest, south, and east. Recently, wintering distribution has been highly variable, with extensive wintering north or south of the refuge. The primary use of the refuge has been during migration (Figure 1). The Alaska Department of Fish and Game (ADFG) is responsible for management and monitoring of the herd, but because of the enormous size of the herds' range, relies on assistance from federal agencies, including the U.S. Fish and Wildlife Service (FWS), the National Park Service (NPS) and the Bureau of Land Management (BLM). Monitoring of the herd consists of: (1) a biennial photo census for total population estimation; (2) annual June cow/calf surveys to estimate production; (3) annual March "short yearling" surveys to estimate calf survival; and (4) aerial radio-telemetry/distribution surveys to determine wintering and migration areas. In addition to tracking herd movements, a sample of at least 100 radio-instrumented caribou is a crucial ingredient for accurate and unbiased aerial photo census and production and survival surveys.

Population monitoring of the herd is important because of its significance to the local subsistence economy and the fact that caribou herd sizes are dynamic and have varied considerably in the last century (Lent et al. 1980, Davis et al. 1980, Messier et al. 1988). In 1976 the WACH was

estimated at population low of about 65-75,000 animals (Davis et al. 1980). The situation recently has been healthier. Herd size in June 1988 was estimated at 343,000 (Dau, pers. comm.), up from the estimated 229,000 in June 1986 (James and Larsen, ADFG, 1987). Cow/calf ratios in July 1988 indicated good calf production, at 25% calves, which compared favorably with the 1986 calf estimate of 22%. Short yearling counts in April and May 1989 showed 24% yearlings, which indicated good winter survival (Dau, pers. comm.). Continued good calf production and survival combined with reports of fat caribou shot by hunters in late winter suggest that the herd remains healthy and could continue to increase. Since the herd could be near a peak in its population cycle, monitoring herd demography and health will be important for the next several years. ADFG will continue monitoring population size and will continue jawbone collections to assess herd health. The Selawik NWR staff has been primarily involved with distribution, abundance, and telemetry surveys on and near the refuge. Monitoring distribution and estimating caribou numbers on Selawik NWR was important to determine baseline caribou use levels and to evaluate potential conflicts between caribou and reindeer. A wildfire that burned over 209,000 acres in June and July 1988 along the east end of the Waring Mountains south to the Kugarak River included about 50,000 acres of prime lichen-spruce-birch woodland that had been used by caribou as a wintering area and migration corridor. Efforts were initiated in September 1988 to determine how caribou distribution and abundance was affected by the burn.

Methods

Three separate aerial survey methods were undertaken: (1) distribution surveys; (2) transect surveys; and (3) radio-telemetry surveys. Distribution surveys were often accomplished simultaneously with the latter two surveys, as well as opportunistically during other winter flying (e.g. wolf tracking, moose surveys, village visits, and logistics flights). The latter two types of surveys could not effectively be combined with other work. Description of the methods used are presented separately below.

Distribution survey. This survey was usually a flight over as much of the refuge as possible to map trails and cratering areas. These features were best seen after recent snowfall with clear weather and sunny lighting conditions. The flight usually required five to six hours along a route from Kotzebue to the north side of the Selawik Hills, thence to the upper Selawik River, and return to Kotzebue, usually just south of the Waring Mountains. Exact route, altitude, and flight time varied depending on the primary purpose of the flight. Ideal altitude was about 1000 feet. Higher altitudes prevented counting group numbers, but on clear sunny days, trails and cratered areas with thousands of caribou present were obvious even from 10,000 feet when conducting telemetry flights. Aircraft types used included Super Cub, Arctic Tern, Cessna 185 and 206, and Boeing 737. (On sunny days during major migration, the trails could be seen from the 25-30,000 ft altitude of the Alaska Airlines jet from Kotzebue to Anchorage!). Distribution information was usually gathered monthly beginning with fall migration in September until spring migration in early May. The May, September, and November surveys were usually in conjunction with those respective refuge-wide waterfowl and caribou transects.

Caribou group size was estimated according to 10's, 100's, 1000's, and 10,000's. Trails and cratered areas were marked on a 1:250,000 scale topographic map of the refuge. Particular attention was made to record heavily cratered areas that indicated longer term use, and migration routes showing origin and destination of the particular trail if known. A plastic covered map marked with grease pencil worked well because trail information could be revised easily as the flight proceeded or if the survey was made over a two or three day period. Information was then transferred to the refuge base map. A single fall migration/early winter, and late/winter spring migration distribution map was usually compiled from the monthly maps and included in the refuge annual narrative report.

Refuge abundance estimates. As with the distribution survey, ideal conditions consisted of clear skies, sunshine, 100% snow cover, preferably with some fresh snow. One survey was normally done in mid to late November to ascertain abundance of caribou wintering on the refuge. Additionally, the May and September waterfowl transects were used to provide a population index for those months. The caribou transect survey usually required about eight hours flying time in a Super Cub. Due to diminishing daylight, the survey usually required one day in late October, or two days if performed in November or December.

An array of 18 24-mile long transects with random starting points was established in 1985 (Spindler and Doyle 1986)(Figure 2). The transects were most often flown in a Super Cub at an altitude of 500 feet. A Cessna 185, used occasionally, was found to be satisfactory if slowed to 80 knots (92 mph). The pilot counted all caribou on one side of the aircraft out to 0.25 mile, the observer did the same on the opposite side. Records were tallied in a field notebook. In the May and September waterfowl transects, survey altitude was 100 feet and 12 transects were flown; observations were made out to 0.125 mile each side of the transect and data were recorded using a cassette tape recorder. The waterfowl survey as applied to caribou was less extensive than the November wintering transects, and not directly comparable, but provided a general population index -- (i.e. orders of magnitude: Are there a few hundred, a few thousand or a few ten thousand caribou on the refuge?). Data were entered onto an electronic spreadsheet for tabulation and extrapolations (see Appendix Table 1). Extrapolations were made based on expanding the mean density in caribou/km^2 to a total refuge caribou habitat area estimated by planimeter at 13,557 km^2. The standard deviation associated with the mean density was used to calculate a confidence interval of +/- 80% (Schaeffer et al. 1986).

Waring Mountains Burn. Based on the findings of Cameron et. al. (1985) and Lawhead and Cameron (1987), who tested several survey intensities for caribou population estimation purposes, a transect array with 33% coverage was selected to sample the burn. Six 40-mile long and 1-mile wide transects, subdivided into mile-long subunits, were systematically surveyed over the Waring Mountains 1988 Burn and adjacent unburned areas (Figure 2b). The pilot counted caribou out to 0.5 mile on the left side of the aircraft and the observer did the same on the right side, as well as recorded data. Caribou group sizes and locations were recorded directly on 1:63,360 blue line topographic map copies for accurate data recording and digitizing. The transect grid was flown in a Super Cub aircraft at an altitude of 500 feet

and an airspeed of 90 mph. Each survey required an average of three hours on transect (about 6.5 hours total flying time if done from Kotzebue), and was easily repeatable. Endpoints of the transects were programmed into the aircraft LORAN and used to navigate the transects accurately. Potential exists to directly record caribou numbers and location instantly in the aircraft by interfacing its LORAN receiver with a laptop computer. Use of such a system would allow observers to spend more time observing and less time on orientation, which would result in fewer missed caribou.

Numbers of caribou seen in each transect segment were classified and extrapolated according to the following catagories: burned; unburned; and edge (any transect segment crossing the burn perimeter, or crossing an unburned inclusion). Since each transect segment represented 1 mi^2 of habitat, density and population calculations were simplified. Data from each survey were archived on the original survey maps and as a LOTUS data file. Extrapolation factors for burned, edge, and unburned were determined by digitizing the burn perimeter and unburned inclusions, and then placing one 0.5 mi.-wide buffer zone inside and a similar one outside the perimeter line. The Geographic Information System coverages used to perform these measurements were archived in the USFWS Regional Office, Anchorage (ARC-INFO coverage FIREALL_3U4).

Radio-telemetry. Ideally, telemetry flights were conducted once each in mid fall, mid-winter, and in spring. Timing was usually coordinated by the Kotzebue office of ADFG and involved NPS, BLM, and Selawik NWR personnel to accomplish a range-wide survey with assigned survey areas for each agency. ADFG provided each cooperator with a Data Base (DBase III) printout form showing all functioning collar frequencies and their most recent location. A goal of about 100 functioning collars for the herd was established by ADFG in 1989. Cloud ceilings of at least 5,000 feet were preferred for good tracking range, and 8,000 to 10,000 feet was better. With properly installed antennas, range was often in excess of 50 miles at 8,000 feet. Telemetry surveys were ideally performed on sunny days to help the observer map trails and cratered areas and accomplish a distribution survey as well. Aircraft used included Super Cub, Cessna 206 and Cessna 185. If caribou density was high, the slower Super Cub was preferred.

A Telonics scanner was programmed with all the frequencies before the flight. The pilot navigated and flew from signal to signal while the observer usually operated the scanner and recorded data. The observer also recorded distribution survey information as time and conditions permitted. When close to the signal, it was often most efficient to have the pilot operate the antenna switchbox. Usually "general" locations (e.g. "upper Selawik River, Purcell Mtn.", or "Ekiek Creek") were obtained. Specific locations (e.g. "mouth of Kuchuk Creek, or "4 mi. SW VABM Sand") were desired on and near the Waring Mountains Burn or if a mortality signal was received.

Results

Distribution. Aerial surveys have shown considerable annual and seasonal variability in caribou distribution and movements. During the years of this study Selawik NWR was typically used intensively for a few months during spring and fall migrations as the herd moved between the Utukok

River calving grounds and the Nulato Hills wintering grounds (Figure 1). In some years small groups (500-5,000) have wintered south of Hotham Peak, along the Kugarak River near Kuchuk Creek, and in the headwaters of the Selawik River. Historically, in some years a majority of the herd remained in and north of the Brooks Range to winter, while in other years wintering occurred well south of the refuge with few seen north of the Buckland River plateau. Likewise, in some years, ten's of thousands remained on and near the Kobuk River delta, Selawik Lowlands, Selawik Hills, and Purcell Mountains to winter (Hemming 1971, Shea 1976, Davis and Valkenberg 1985). Detailed descriptions of distribution and movements for the years 1984-1989 follow.

1984. Aerial telemetry surveys were made frequently (almost weekly in March and April) in spring 1984. In February and early March most caribou were located in the Buckland and Shaktoolik River areas. By mid-March northward movement had reached the Selawik Hills (estimated 7,550 caribou) and Derby Creek. On April 5, an estimated 20,000 caribou were in the Selawik Hills (Figure 3) with another 7,000 estimated in the Talik Ridge area and S. Fork of the Buckland River. By mid-April, some caribou had moved north onto the eastern Selawik Flats. On May 1 a majority of the telemetry signals were heard on the eastern Selawik Flats, and by May 19, most were in or near the Waring Mountains or across the Kobuk River. A telemetry flight on November 1, and extrapolations from a random sample of moose survey units flown early to mid-December estimated about 8,500 wintering caribou, mostly on the south side of the Waring Mountains, and along the upper Selawik River (Figure 4, Table 1).

1985. Relatively mild temperatures and below normal snowfall in northwest Alaska from December through April probably contributed to the lack of caribou wintering in the traditional Nulato Hills area. ADFG surveys indicated that substantial numbers of western arctic caribou wintered in and north of the Brooks Range. A radio tracking flight on January 15 yielded only five caribou on or near the refuge, near Shungnak, Kuchuk Creek, and Purcell Mountain. In March, a total of about 3,000 caribou were estimated to have wintered on the refuge in the Kuchuk Creek-Waring Mountains area, with another 3,000 already staging for migration in the Selawik Hills (Figure 5). By mid-April there were estimated to be under 1000 caribou on the refuge: the lackluster spring migration was prolonged by a late spring.

During September and October 1985 the fall migration was spectacular. Early October snow allowed easy documentation of caribou trails. A major portion of the herd migrated across the refuge utilizing three prominent routes: (1) eastward from the Noatak River along the north shores of Kobuk Lake and Selawik Lake thence south to the Selawik Hills and (2) southward from the Squirrel River and Kalarichuk Hills past Kiana to just east of Selawik, and thence south to the Selawik Hills; and (3) south past Ambler and Shungnak across the Kugarak and Selawik Rivers, thence east to Purcell Mountains and the upper Selawik River or south to the upper Huslia River. Routes 1 and 2 above were used mostly in October, while Route 3 was used mostly in September. Peak movement was the second and third week of October (Figure 6). By the last week of October an estimated 12,700 caribou were on the refuge (Table 1), and by mid-November, the number had dropped to about 10,100 (Table 1).

1986. On a January 10 tracking flight there were three telemetry signals received from the Selawik Hills and Rabbit River areas on or near the refuge, and eight signals from south of the refuge. Based on February 14, 20

and March 7 distribution surveys, there were about 2-3,000 caribou wintering in the Hotham Peak-Waring Mountains areas (Figure 7). By March 19 there were 10-20,000 caribou staging in the Selawik Hills and another several thousand in the Continental Divide hills east of the Tagagawik River. The major movement across the Selawik Flats occurred between April 1 and 22, when several routes extended from the Selawik Hills north to cross the Selawik River between Upingivik and the Village of Selawik. Another large group numbering over 10,000 was seen moving north towards Ambler, paralleling the Kugarak River. Tracks indicated that the group had probably crossed the Selawik River near Ingruksukruk Creek. Movement had really slowed by May 7, and by May 13, only scattered small groups were moving north across the refuge.

Fall migration in 1986 was not as spectacular in size nor extent as the previous fall. Migration was protracted from late August into late October, with much of it occurring before substantial snowfall, making documentation difficult. A few thousand were seen moving across the Selawik Flats between Fish River and Kiliovilik Creek, in well spaced bands (Figure 8). By mid-November there were many small groups of a few hundred scattered across the Kobuk River delta, Hotham Peak area, and the south side of the Waring Mountains, apparently wintering. There was also a group of several thousand wintering in the Kiana Hills.

1987. January 26, 27 and February 10 aerial surveys showed several thousand caribou wintering in the Kiana Hills, a few hundred in the Kobuk River delta and Hotham Peak area, and about 500 wintering in the Kuchuk Creek-upper Kugarak River area. On a March 4 survey, the Kobuk delta and Hotham Peak wintering groups were not seen, and the Kuchuk Creek group dropped to under 100. On the same survey about 7,500 caribou were seen staging in the Purcell Mountains, and about 2,300 were seen in the Selawik Hills. By March 17 the Kuchuk Creek group had dwindled to less than 100 animals, but the Selawik Hills staging group grew to at least 10,000. Major migration across the refuge began the second week of April, when 10,000's crossed the Selawik River north of the Purcell Mountains. Groups of several thousand crossed the Selawik River near Upingivik, Ekiek Creek, and Ingruksukruk Creek. The same week over 30,000 caribou were seen moving west between the Sheklukshuk Range and the Kobuk River, just south of Shungnak. Caribou were first seen crossing the Kobuk River near Ambler and Shungnak on April 13. By April 29 most had crossed north of the Kobuk River. Greater numbers of caribou used this easterly route in spring 1987 as compared to the three previous springs (Figure 9). This could have been related to snow cover, since the eastern route had more wind-blown alpine terrain than the western Selawik Flats- Fish River- Kiana route. On April 30, however, a group of 5,000 caribou moved north past Upingivik. By May 5 most northward movement had ceased, except for a group of about 1,000 that passed Upingivik. On a May 22 flight only a few small groups of 20-30 were seen on the east side of the refuge.

Fall migration in the west half of the refuge was a few weeks late, whereas it was a few weeks early on the east half. Large movements had occurred south of Onion portage by mid-September, and by September 17, several thousand had already moved well south of the refuge to the North Fork of the Huslia River. Movements seen on flights September 16-17 included several groups of about 1-3,000 caribou between the Kiana-Fish River route and the east end of the Waring Mountains. A group of 10,000 caribou moving

south from Kiana passed Selawik on September 20, a few miles to the east of the village, and were readily available to hunters. The same week the Onion Portage route had caribou extending from just south of the Kobuk River to the North Fork of the Huslia River (Figure 10). By September 29 about 1,600 caribou were seen in the Hotham Peak area, and about 1,500 were seen on the Onion Portage route crossing the Selawik River near Ingruksukruk Creek. Flights on October 21, November 3 and 6 indicated about 1,000 caribou on the Kobuk River delta, about 700 near Hotham Peak, and several thousand heading south from Kiana. Tracks and/or small groups of 10-100 were seen scattered across the refuge from south of Inland Lake to the Kuchuk Creek-Kugarak River area, and along the upper Selawik River to it's headwaters. A November 20 radio-telemetry survey indicated several thousand caribou had moved into the Kiliovilik and Sheklukshuk Ranges in the northeast corner of the refuge, and had remained there by December 17. ADFG Area Biologist David James thought a reverse migration may have occurred due to mild fall weather.

1988. A January 20, 1988 survey indicated very few caribou wintering on the refuge, only a few groups of a hundred or so in the Purcell Mountains and Lockwood Hills, which was a significant decrease over the several thousand seen in these areas a month prior. A BLM flight on the same day documented large numbers in the Selawik Hills, just south of the refuge boundary, with the remainder on the Buckland River plateau and in the Nulato Hills (Robinson 1988). A few hundred caribou were seen south of Hotham Peak on March 14, in the area that has traditionally wintered caribou. Also on March 14, 10,000's were seen in the Purcell Mountains, Lockwood Hills, and Sheklukshuk Range, and 1000's were in the eastern half of the Selawik Flats, along Ekiek, Keruluk, and Kerchurak Creeks, and the Kugarak River (Figure 11). Spring migration continued gradually through April in the east half of the refuge. Several groups numbering in the 1000's were seen in the upper Selawik River, Purcell Mountains, Kugarak River-Kuchuk Creek, Kerchurak Creek, Ekiek Creek, Kawichiark Creek, and Sheklukshuk Range during March 30-April 2 wolf tracking flights. By early May most of the herd had moved north of the refuge, although a few individuals were seen moving past the Upingivik Field Station until early June.

Fall migration in 1988 was a gradual and steady movement of small groups (<1000 caribou) using several routes between mid-September and mid-November (Figure 12). This was similar to most previous years except for fall 1985, when migration was sudden and more concentrated, utilizing fewer routes. September 20-22 flights showed a few hundred caribou crossing the Waring Mountains east of Kiana, a few thousand moving south near Upingivik and along the upper Kugarak, and a few hundred moving south along Kuchuk Creek. By October 6, groups of about 1,000 moved south near Noorvik and Upingivik, and a group of about 5,000 moved south from near Kiana to just west of Selawik. A group of several hundred crossed the Waring Mountains near the head of Kuchuk Creek. Flights on October 29 and November 1 showed about 1,000 south of Hotham Peak, about 50 on the Tagagawik River moose census area, and several hundred in the eastern Selawik Hills. By November 22 and 23, about 200 caribou were apparently wintering on the Kobuk River delta, about 500 were south of Hotham Peak, 800 were between Inland Lake and the Tagagawik River, and a few hundred to possibly 1,000 were in the upper Selawik River valley. About 3-4,000 were in the northern Selawik Hills, and 10,000's were on the Buckland River plateau south of the refuge.

1989. A majority of the herd wintered well to the south in the Nulato Hills and Buckland plateau. Few caribou remained on the refuge during winter and early spring of 1989: perhaps a few thousand wintered in the western Selawik Hills. A March 3 radio telemetry flight showed only a few dozen caribou in the Lockwood Hills and Purcell Mountains (only two signals) with up to a few thousand in the Western Selawik Hills (five signals). By March 30-31 several thousand caribou were seen slowly moving north near Ekiek, Keruluk, and Ingruksukruk Creeks. A few hundred were seen moving north out of the Selawik Hills and north from Hotham Peak. A mass movement of caribou across the central Selawik Flats occurred in mid April (Figure 13). Flights between April 13 and 19 showed two major northward routes used by ten's of thousands of caribou: (1) from Selawik Hills north crossing the Selawik River near Nillik, thence up the Fish River to the Kiana area; and (2) from Selawik Hills north toward Upingivik thence along Kuchuk Creek toward Onion Portage. A third major route along the upper Kugarak to Onion Portage, usually used in April, was not used until mid-May. Smaller movements of groups of 1000's were noted north of the Purcell Mountains, and near Ekiek, Keruluk and Ingruksukruk Creeks, while several hundred remained on and near Hotham Peak. For the first time in this study, several east-west trail systems were seen paralleling the Selawik and Kugarak Rivers (Figure 13). It was not known whether this pattern was related to the Waring Mountains Burn or the very deep (> 2 m) snow that accumulated on the south side of the Waring and Baird Mountains. In mid-May groups of several thousand caribou were still milling and gradually moving north through the eastern half of the refuge, while 10,000's had just moved north using the upper Kugarak River to Onion Portage route. A few hundred were still in the Hotham Peak area. A June 5 survey showed totals of a few thousand caribou in bull and cow/yearling groups in the northeast quarter of the refuge, however, some reindeer and caribou calves were seen. An ADFG survey June 10-12 showed several thousand caribou and dozens of new calves on the refuge. The late spring breakup, and perhaps a relatively large number of reindeer could have contributed to this calving activity near the refuge.

In the first week of September a few thousand caribou moved south from Onion Portage, crossed the Selawik River near Ingruksukruk and Keruluk Creeks, and continued into the hills east of the upper Tagagawik River (Figure 14). Few other caribou were seen on the refuge in September. By mid-October scattered small groups were seen in the Hockley Hills, Hotham Peak, and Fish River areas, and a few small groups had moved across the Waring Mountains Burn. Several thousand caribou remained north of the Kobuk River near Kiana and Hunt River, probably held there by flowing ice. By the last week of October a group estimated at ten's of thousands moved along the north shore of Kobuk Lake and Kobuk Delta and probably merged on the refuge near Hotham Peak with the many thousands of the Kiana group. This most spectacular movement of autumn 1989 then crossed the Selawik River near it's mouth on October 26 and continued southward to the Selawik Hills by the end of October. Another large movement of many thousands occurred along the north side of the Kobuk River east of Ambler past Shungnak and Kobuk to Mauneluk River the third and fourth week of October. By November 7 the large movements were over: a few small scattered groups were seen along the north side of Selawik Hills; a few hundred near Upingivik; about 1000 in the Pah River Flats and the Zane Hills; and a few 100 south of the Purcell Mountains

near Billy Hawk Creek. On November 30, widely scattered small groups were seen near Fish River and Kuchuk Creek.

Refuge abundance estimates. From 1985 to 1987 one refuge-wide transect survey was conducted each November to estimate early winter caribou abundance on the refuge. Caribou extrapolations for Selawik NWR were also made in conjunction with May and September waterfowl transects and refuge-wide moose censuses in December 1984 and October 1985. Table 1 presents estimates of the number of caribou present on the given day of survey in the month listed and do not represent the total numbers moving through the refuge during the given month. Raw data and calculations were archived in the Lotus spreadsheet "CARIBOU.ALL" (Appendix Table 1).

Table 1. Estimates of caribou numbers using Selawik NWR based on transect (May, Sept., Nov.) and moose plot (Oct. and Dec.) surveys. Figures are thousands (with 80% confidence intervals expressed as a percent of the estimate).

Year	Month				
	May	September	October	November	December
1984		5.3 (78)			48.5 (82)
1985	3.3 (79)	66.6 (50)	12.7 (2)	10.1 (56)	
1986	7.9 (94)	7.4 (67)		6.3 (63)	
1987	6.8 (60)	72.8 (68)		36.3 (62)	
1988	3.3 (60)	23.6 (76)			

Numbers of caribou on the refuge were highly variable according to month and year of survey. In addition to the expected annual and seasonal variation, there was considerable daily variation when the herd was migrating. Because of the high variability, confidence intervals were also high. If more precise estimates are needed in the future, sampling intensity will have to be higher. Sampling intensity for the above estimates was 2.8% for May and September, 3.9% for November, and 15.3% for October 1985. Using estimated herd sizes of 229,000 in 1986, 256,480 in 1987 (a calculated value based on 12% population growth per year), and 343,000 in 1988, the Selawik NWR hosted between 1% and 32% of the total herd, depending on the month and year. The original objective of determining the order of magnitude of caribou abundance on the refuge during migration was attained. Future use of refuge-wide low-intensity transects for caribou estimates is recommended only if the information can be obtained opportunistically with

another survey, such as for waterfowl or moose, or if large numbers of caribou present need to be documented. Surveys of higher intensity are recommended to answer specific questions such as potential conflicts with reindeer grazing or impacts of the Waring Mountains Burn.

Waring Mountains Burn. A high intensity transect sampling procedure was developed to quantify caribou use of this 1988 burn and adjacent unburned areas. Surveys were flown on September 20, 1988, May 3, and June 5, 1989. Surveys were not flown from October 1988 to March 1989, and in fall 1989 because of an absence of caribou on the burn. The September survey was done under ideal fall conditions with good sunlight and no snow. Likewise, the May survey had ideal winter conditions good snow cover and sunlight for sighting tracks and caribou. The June survey was less than ideal. The 10-15% snow cover caused a contrasting background that made caribou difficult to see. Cloudy skies produce the most favorable lighting for such contrasting conditions. Standardization of minimum survey conditions will be required to maintain accuracy and consistency in the future.

In September and May caribou densities were similar in the burned and unburned habitats but were more than twice as high in the edge habitat, the border between the burned and unburned areas (Table 2). In the June survey density was also highest at the edge, but it was twice as high in the unburned area as compared to the burn. The burned area straddles a migration corridor, and the high caribou density observed at the edge could be a result of caribou grouping up at the burn boundary before continuing their migration across or around the fire, or perhaps habitat diversity caused by the proximity of burned and unburned was preferred. Overall caribou density was highest in May, intermediate in June, and lowest in September. There were apparent seasonal differences in habitat use. In September, caribou used the burned area in greater proportion to its occurrence (i.e. proportion of use exceeded proportion of availability), while edge and unburned habitats were used in lower proportions than their occurrence (Table 2). In May and June the unburned habitat was used considerably less by caribou in proportion to its occurrence. The edge habitat was used much more by caribou in proportion to its occurrence, while the burned area was used slightly less than its occurrence in May and considerably less in June (Table 2).

The transect grid across the Waring Mountains Burn was an easily repeatable survey that resulted in population estimates with 80% confidence limits of 19%-35%, depending on month and habitat. These intervals were comparable to those obtained on the North Slope by Cameron et al. (1985) with the same sampling intensity. The method should be useful for continued long-term monitoring of trends in caribou use of the burn area. Because of the daily variability during migration, it is recommended that peak use periods be documented at least weekly with the transect method. General distribution surveys should then suffice for the periods of minimal use.

Qualitative observations made during the transect and distribution surveys can also add to our understanding of short-term effects of the burn on caribou. The September survey showed caribou utilizing unburned islands and green emergent vegetation on wetlands within the burn in about the same number as areas outside the burn. In the May survey snow-free unburned tussock ridges inside and adjacent to the burn attracted large groups of caribou to feed on Eriophorum flower shoots. Trails led from these unburned

Table 2. Extrapolated caribou population estimates for the Waring Mountains Burn and adjacent unburned areas, Selawik National Wildlife Refuge, Alaska, September, 1988, May and June 1989.

Burn Status	Habitat Area (mi^2)	Percent of area	Estimated population			% of total caribou			Caribou per mi2		
			9/22/88	5/3/89	6/5/89	9/22/88	5/3/89	6/5/89	9/22/88	5/3/89	6/5/89
Unburned	325	45.4	1115	13643	2754	35.4	51.1	43.6	3.4	42.0	8.5
Edge	124	17.3	1040	14453	6200	33.0	17.5	42.6	8.4	116.6	50.0
Burned	266	37.3	998	13020	1306	31.6	31.4	13.8	3.8	48.9	4.9
Total	716	100.0	3153	41116	10260	100.0	100.0	100.0	3.9	49.8	11.4

ridges to burned ridges, and perhaps the animals were "decoyed" into these burned areas. In the June survey, the lightly burned areas were visibly greening with new sedge and grass growth that appeared more vigorous than the unburned areas. Most caribou were seen on the southeast corner of the burn and adjacent unburned areas. It is not known whether these June-lingering animals chose to remain in this area to feed rather than migrate, or if they were blocked by the deep mushy and melting snow along the south side of the Waring and Baird Mountains. In June caribou did not appear to be migrating and feeding on the move with brief rests as in the September and May surveys.

Distribution surveys showed little caribou use in the area late in fall 1988, winter, and early in spring 1989, and almost no use in fall 1989. On October 6, 1988 a few hundred caribou were seen migrating across the burn and none were seen on November 1. On November 22 a group of 20 and a single were seen along the southwest corner of the burn. On March 3, 1989 no caribou were seen on the area, but by March 31, several thousand caribou were moving north towards the burn and a group of 500 was seen near the confluence of the Kugarak River and Kuchuk Creek. During April 16-22 ten's of thousands of caribou migrated north across the burn, mostly between Upingivik, mouth of Kuchuk Creek, and Onion Portage. The movement stopped abruptly by the end of April, and did not resume until early May. Use of the burn by groups of several hundred to a few thousand caribou was steady through the remainder of May until mid-June.

Distribution flights in September 1989 showed no use of the burn by caribou. On October 11, a few trails were seen from the south side of Waring Mountains towards Kugarak River, indicating that perhaps a few hundred crossed the burn the previous week. At the same time several hundred to a few thousand moved south in the unburned areas east of the burn. No caribou were seen crossing the burn on October 26, but tracks from a group of about 10 were seen near the mouth of Kuchuk Creek on November 8. Finally, on November 30, a group of about 15 was seen in the unburned area a mile south of the burn near Paniqsigvik, along the Kugarak River.

Lack of caribou in the burn during the winters of 1988-89 may or may not be significant in view of the fact that few caribou wintered north of the Selawik Hills in 1988-89 (Robinson and Spindler 1989) and that the Kugarak River-Kuchuk Creek area has been used inconsistently by caribou (three of the five winters previous to the burn: 1984/1985, 1985/1986, 1986/1987). By comparison, the Hotham Peak area has wintered caribou during parts of the last six winters. Thomas (1989) noted that "caribou freely crossed burns up to 25 km across, but avoided areas mostly burned in the last 50 years. Wide-ranging movements and winter tundra use may be a response to high burn rates combined with high herd numbers." It will be especially important to monitor caribou wintering activities throughout Selawik NWR to determine whether changes in caribou use on the burn represent local changes due to the burn, or correspond with general or widespread trends over the entire refuge or region.

Radio-telemetry. Refuge staff have assisted with these cooperative efforts since 1983. In spring 1984 a major tracking effort (nearly weekly February-May) was undertaken by former refuge manager Kent Hall, to examine extent and rate of migration across the refuge. Data were analyzed in the form of individual movement maps for 25 instrumented caribou. Two general types of movements were noted, a "leapfrog" from one intensive use area to

another (Figure 15), or a gradual, evenly spaced movement (Figure 16). From 1985 to present, radio-telemetry surveys have been undertaken by refuge staff primarily as part of a region-wide coordinated survey, or to obtain prey data for the wolf study. Locations have been entered into the ADFG data base "WAHTEL" (Appendix 2). To date, these data have been used for monitoring general herd distribution, unbiased sampling of cows for calf and short yearling counts, and for the biennial photo census. The enormous task of analyzing individual range-wide caribou movements has not been undertaken by any of the cooperating agencies but such a project could ultimately be accomplished as a funded cooperative study. A list of standardized place names for the herd range would greatly facilitate this effort, and should also be used to record caribou locations in future telemetry surveys. A summary of dates Selawik NWR has conducted radio-telemetry surveys is given in Table 3.

Table 3. Dates Selawik NWR staff have conducted radio-telemetry surveys on and near the refuge.

1983	September 23, October 6, December 1, 14
1984	February 6, 8, 13, March 13, 21-22, April 5, 9, 13, 17, 23 May 1, 5, 14, 18, November 1
1985	January 15, March 25-27, October 24
1986	January 10, March 6, October 31
1987	April 15, November 21
1988	March 16
1989	March 3, March 30, 31, October 4

Recommendations

Distribution surveys should be continued on an opportunistic basis, or about monthly if other flights do not suffice. A November early winter refuge-wide transect survey should be completed if large numbers of fall migrating caribou linger on the refuge and appear that they may winter. The Waring Mountains Burn transects should be continued when caribou are present on the burn since the information is integral to the caribou-fire study. Refuge staff should cooperate with ADFG on radio-telemetry surveys and work toward standardizing location names and analysis of caribou movements.

Acknowledgements

Thanks are due the following individuals who assisted with FWS distribution, transect, and telemetry flights: LeAnne Ayres, Terry Birkenstock, Rachel Brubaker, Beth Behringer, Jim Dau, Terry Doyle, Victor Karmun, Paul Krausman, Kelly Louise, Pamela Nelson, Kate Roney, Bonnie Shaw,

Brad Sworts, Margaret Wilson, and Dennis Witmer. Kent Hall, former Refuge Manager, initiated the study with his keen interest in caribou migration. Helpful comments were received by Jim Dau, Assistant Area Biologist ADFG, and Jerald Stroebele, Refuge Manager. An earlier draft of this report was reviewed by Rachel Brubaker and Dennis Witmer.

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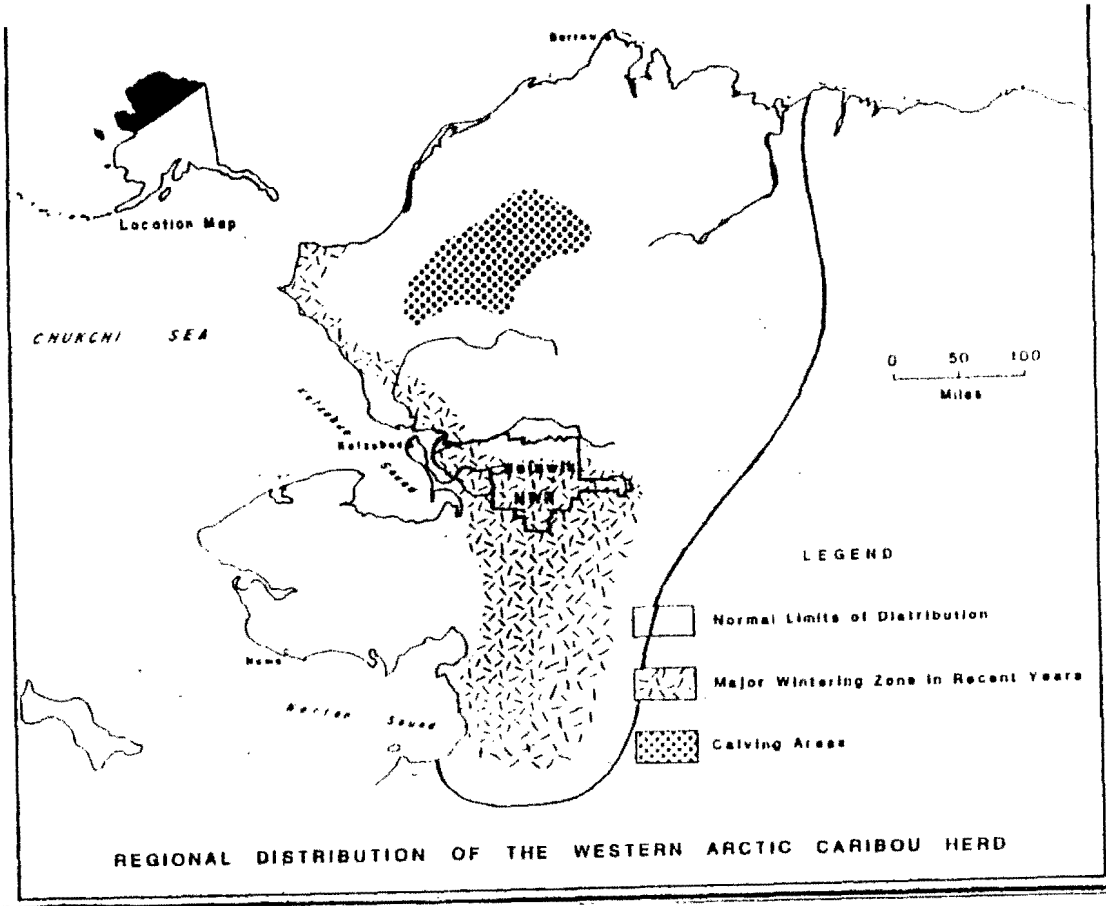


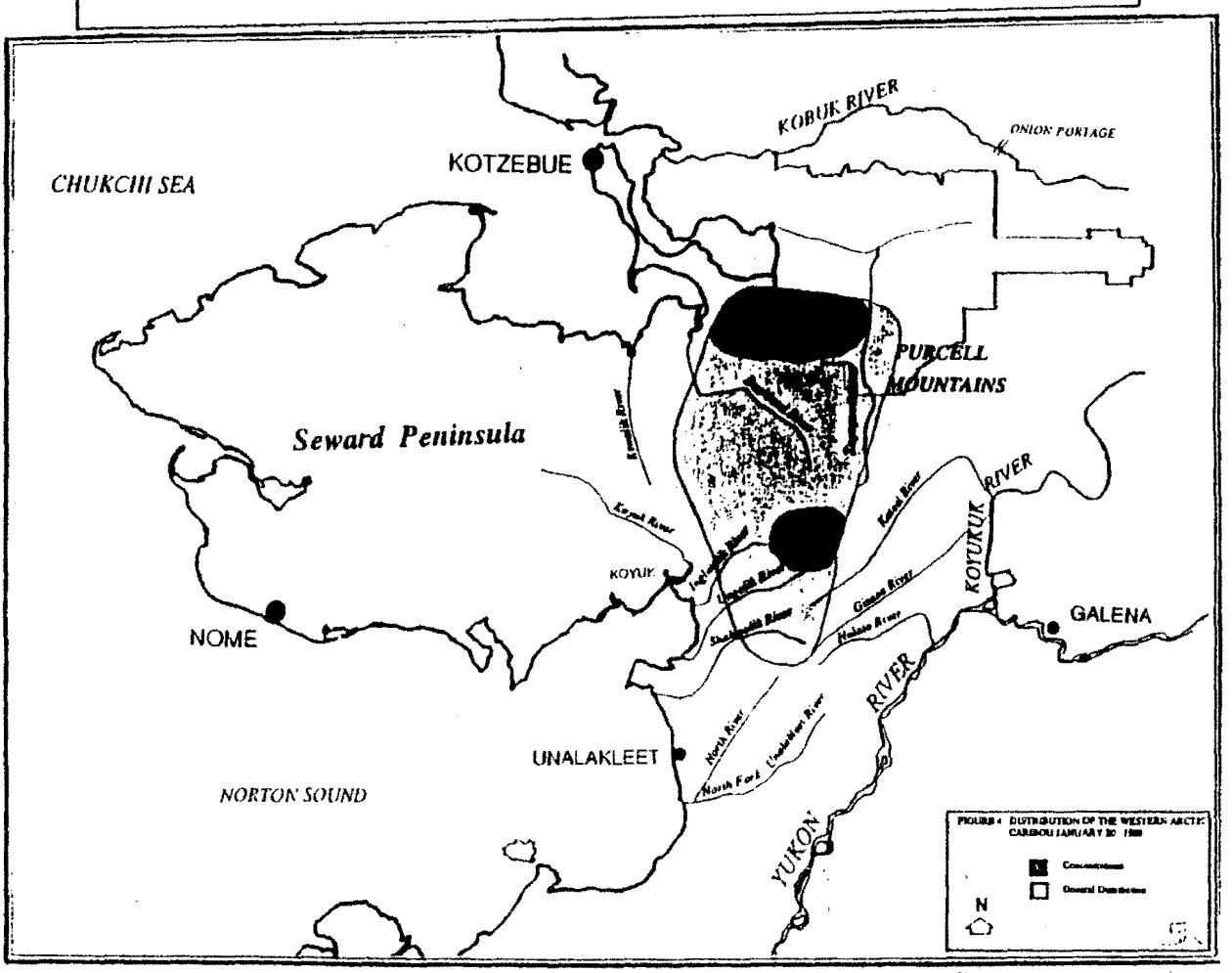


Figure. / General distribution of the Western Arctic Caribou Herd including calving grounds and wintering area (top). Winter distribution in January 1988 (bottom) included the southern boundary of the refuge, especially the Selawik Hills and adjacent areas. This area could be considered for potential reindeer grazing permits by Selawik villagers as mandated by ANILCA. (Bottom figure courtesy Scott Robinson, Bureau of Land Management).

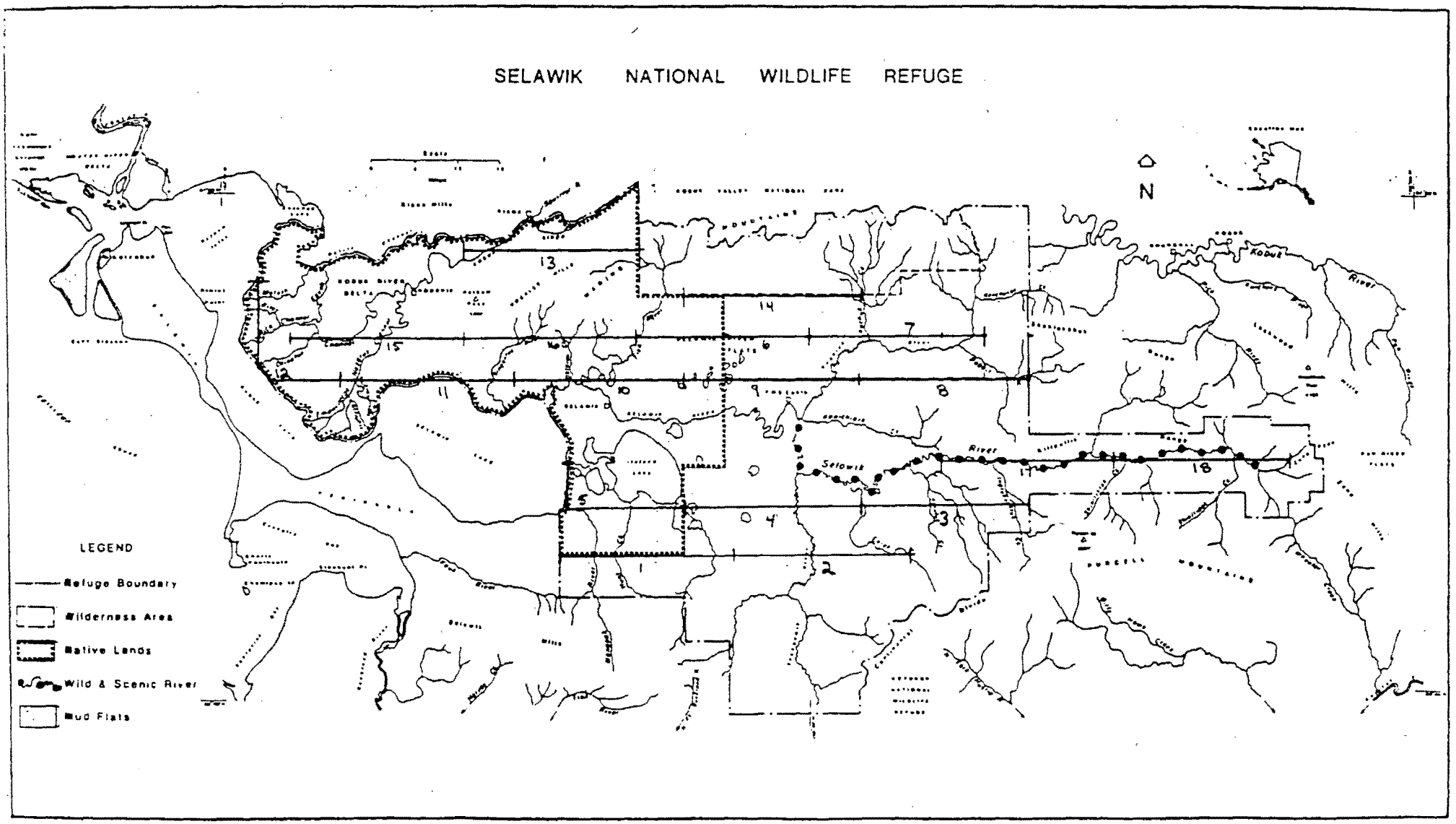


Figure 2. Randomly selected transects used to estimate caribou numbers on Selawik NWR in winter and during migration. Transect segments were 24 miles long and 0.5 mile wide.

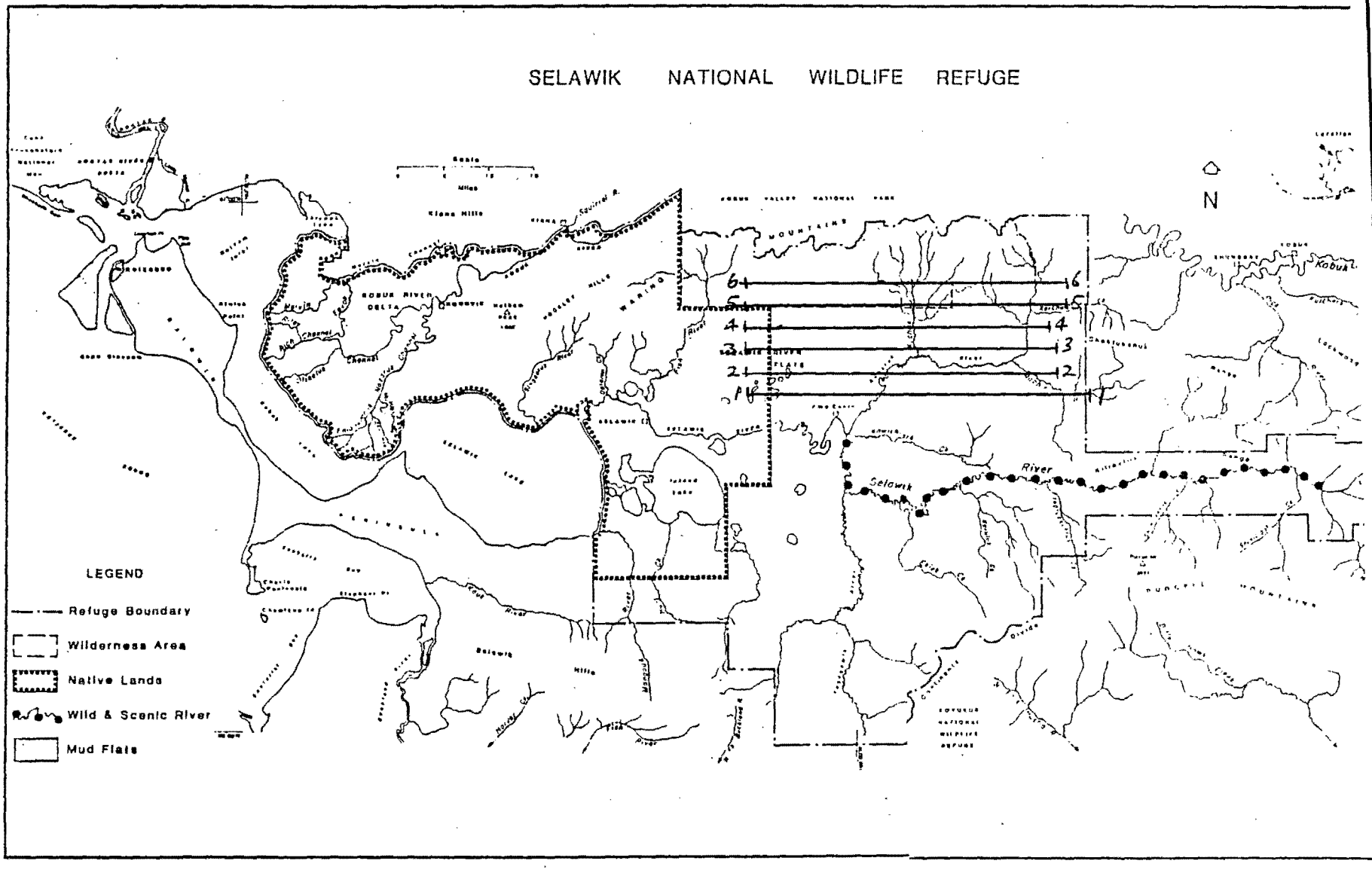


Figure 2b. Transect grid used to sample caribou numbers on the Waring Mountains Burn, Selawik NWR, 1988-1989. Transects were 40 miles long and one mile wide, spaced three miles apart. Each transect was subdivided into one-mile long segments.

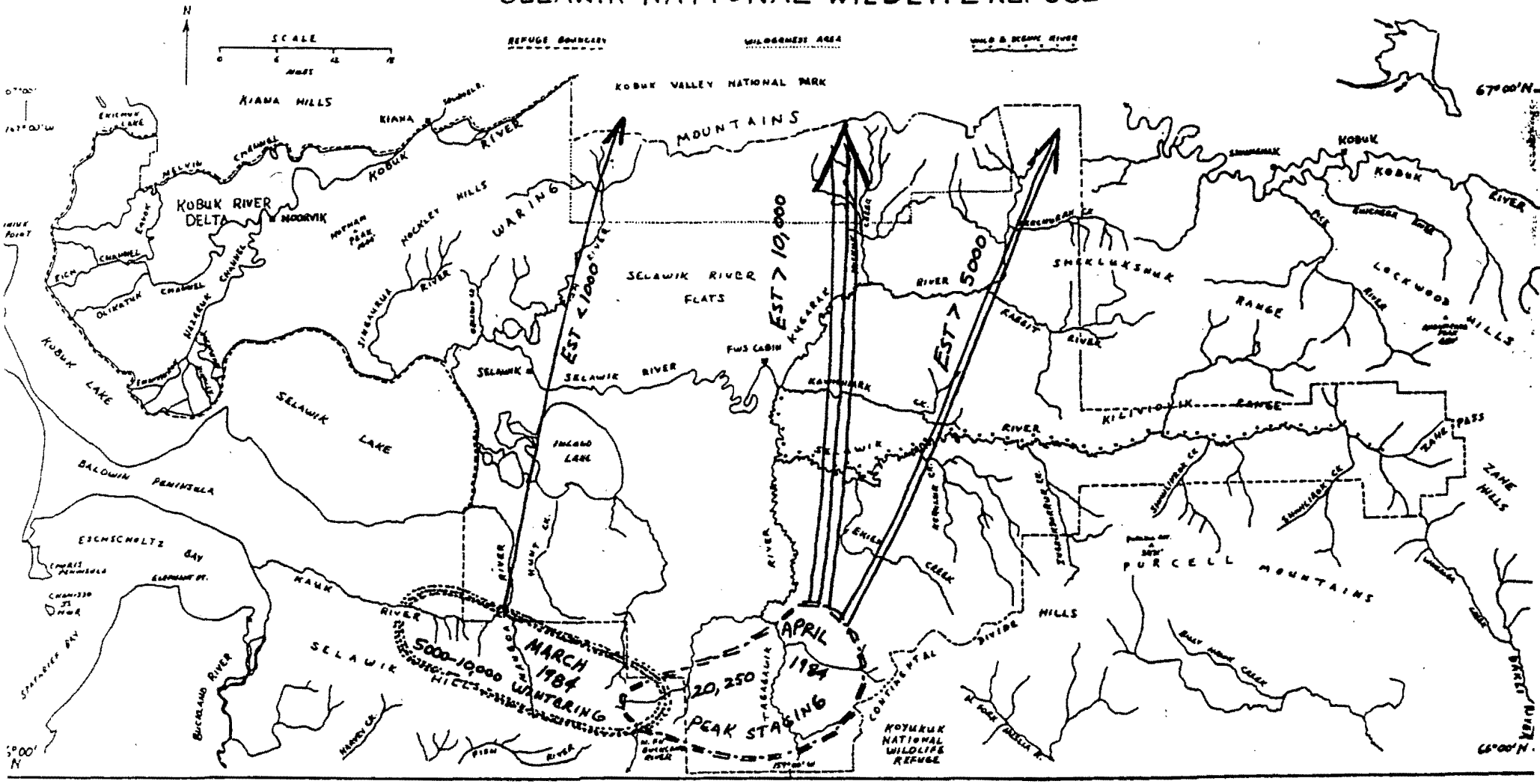


Figure 3. Caribou distribution on Selawik NWR, winter-spring 1984.

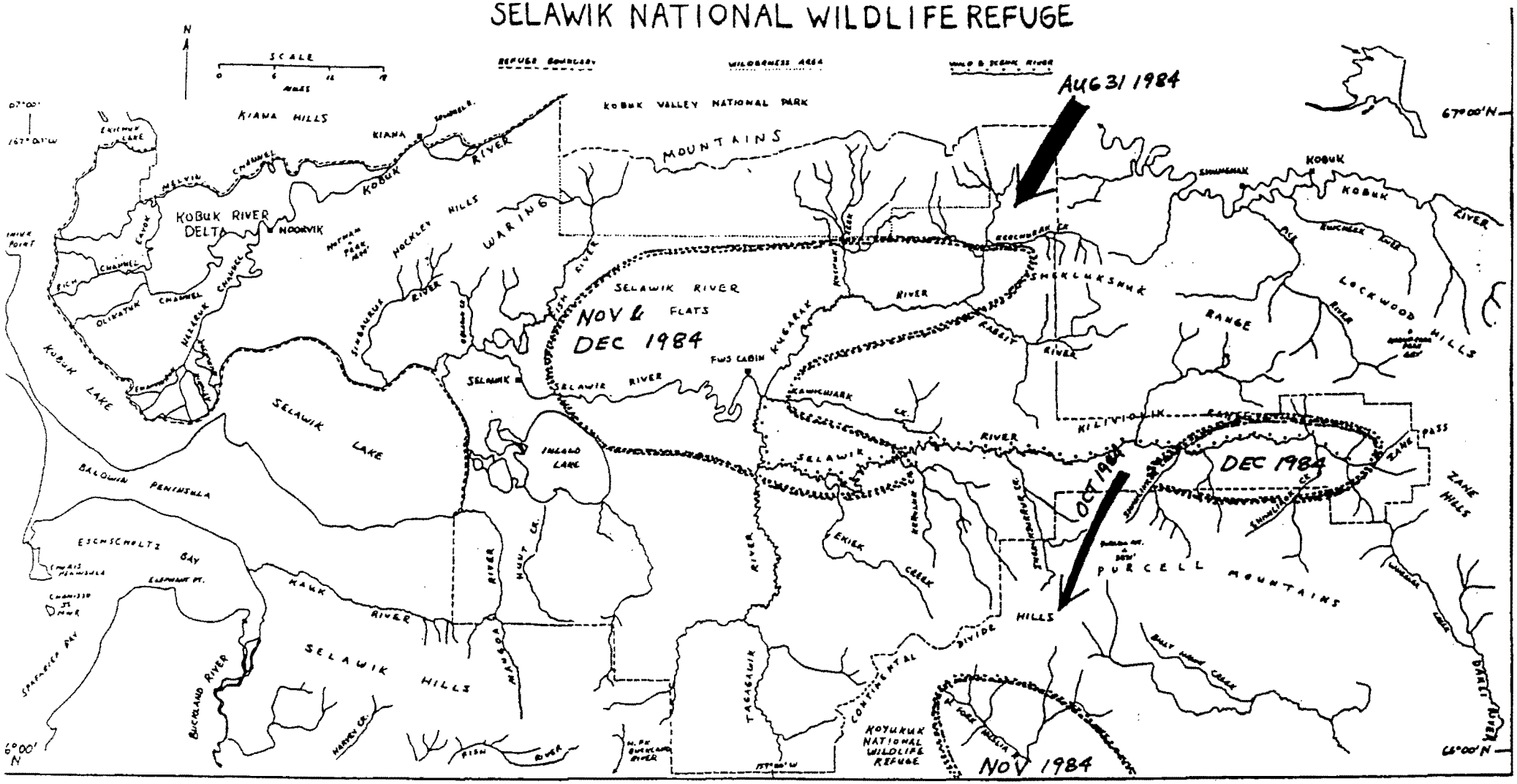


Figure 4. Caribou distribution on Selawik NWR, fall-early winter 1984.

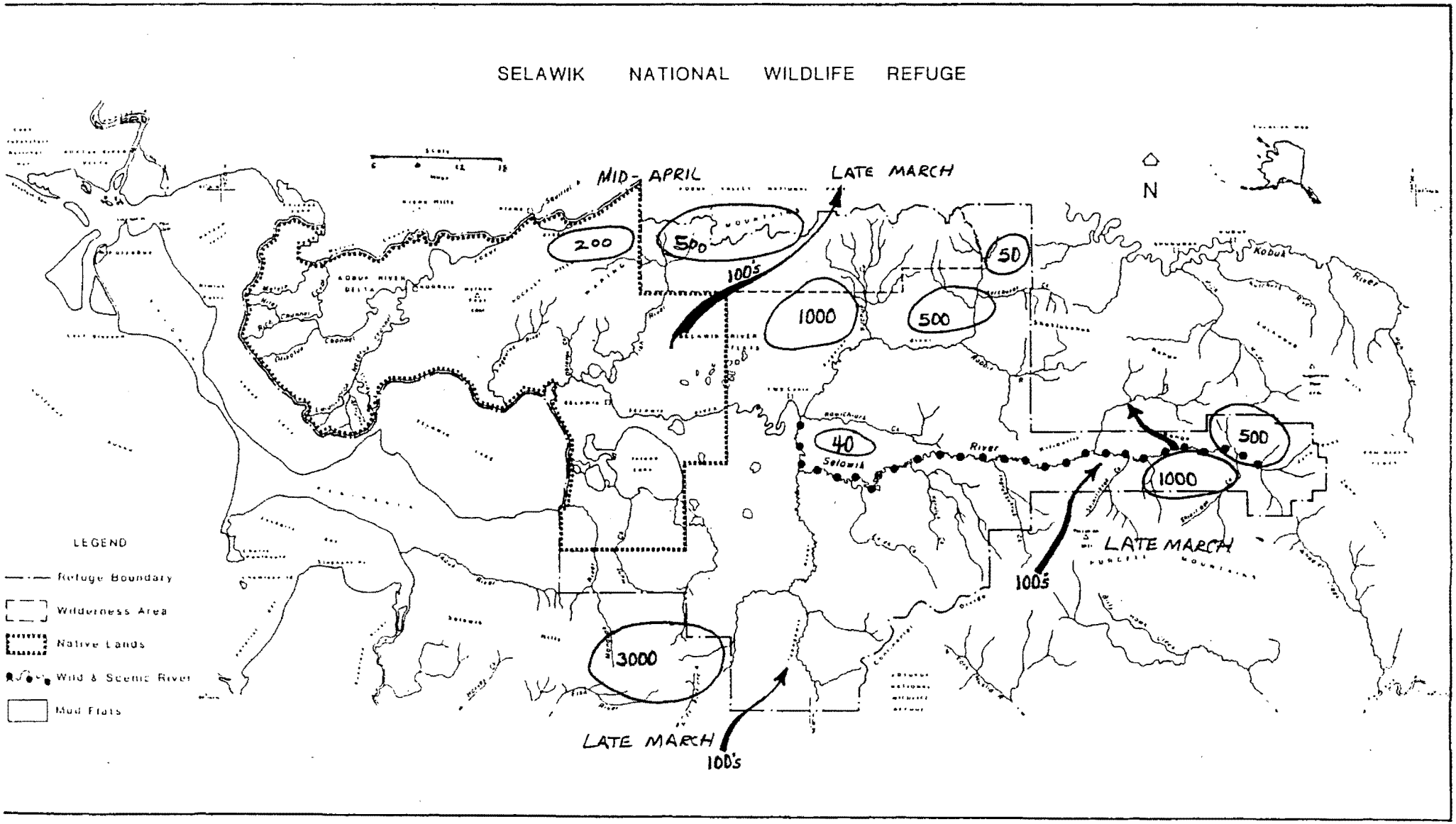


Figure 5. Caribou distribution on Selawik NWR, March 26-27 and April 16-18 1985.

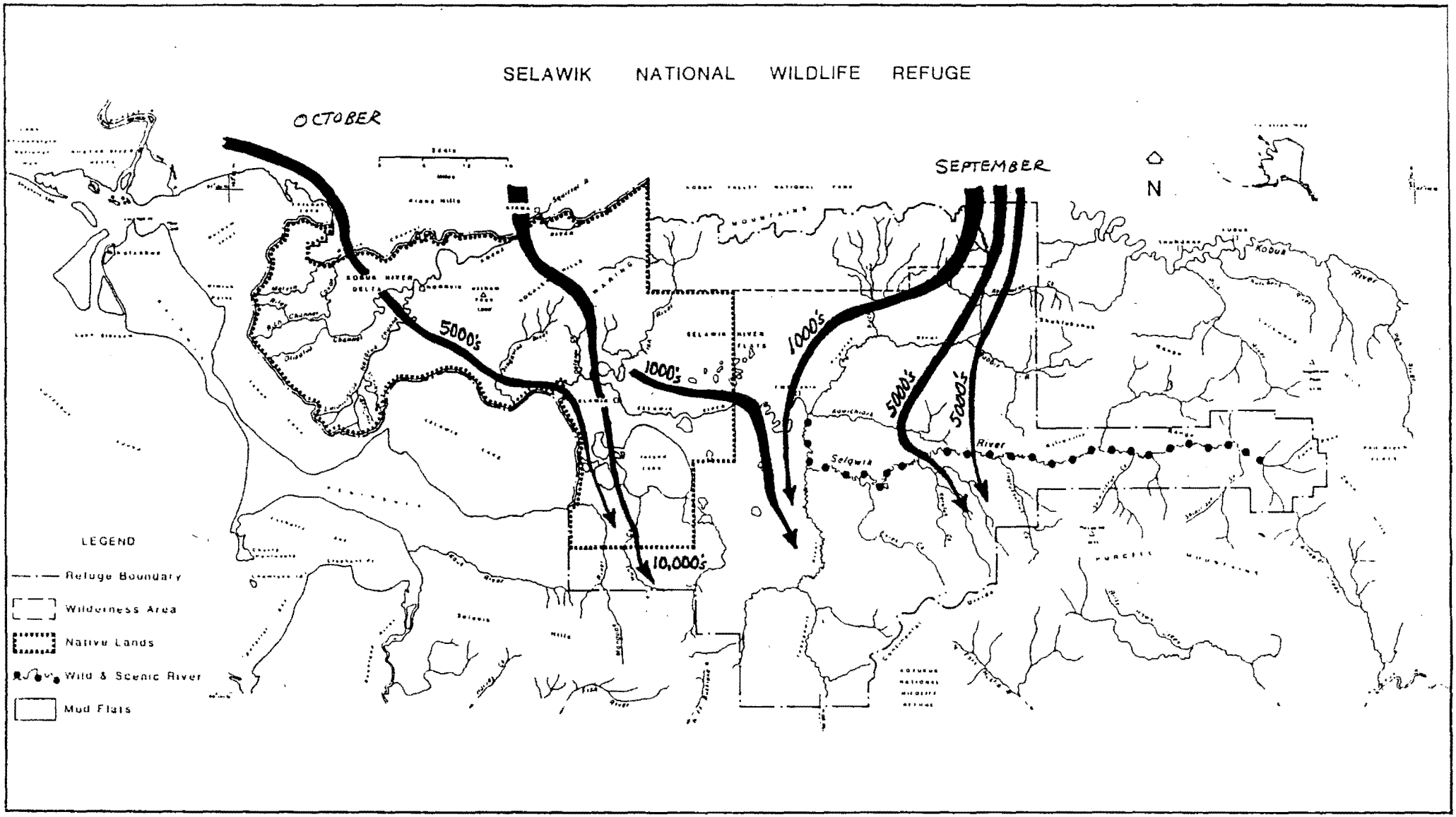


Figure 6. Major migration routes used by caribou crossing Selawik NWR on October 29, 1985. Snow conditions were ideal for mapping and monitoring this spectacular migration.

Figure 7. Caribou distribution on Selawik NWR winter-spring 1986.

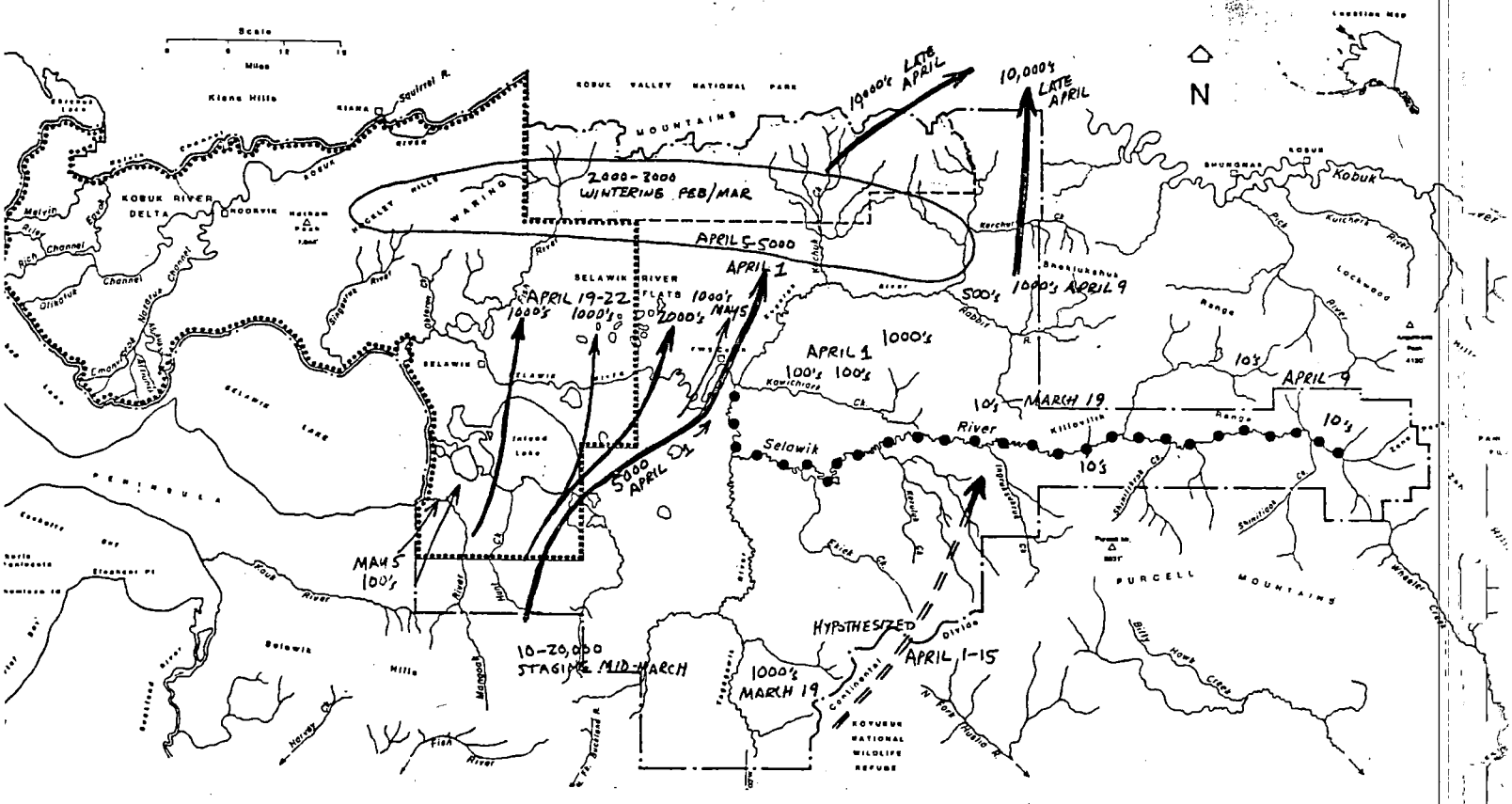


Figure 7. Caribou distribution on Selawik NWR winter-spring 1986.

Figure 8. Caribou distribution on Selawik NWR October 27-31 and November 21, 1986.

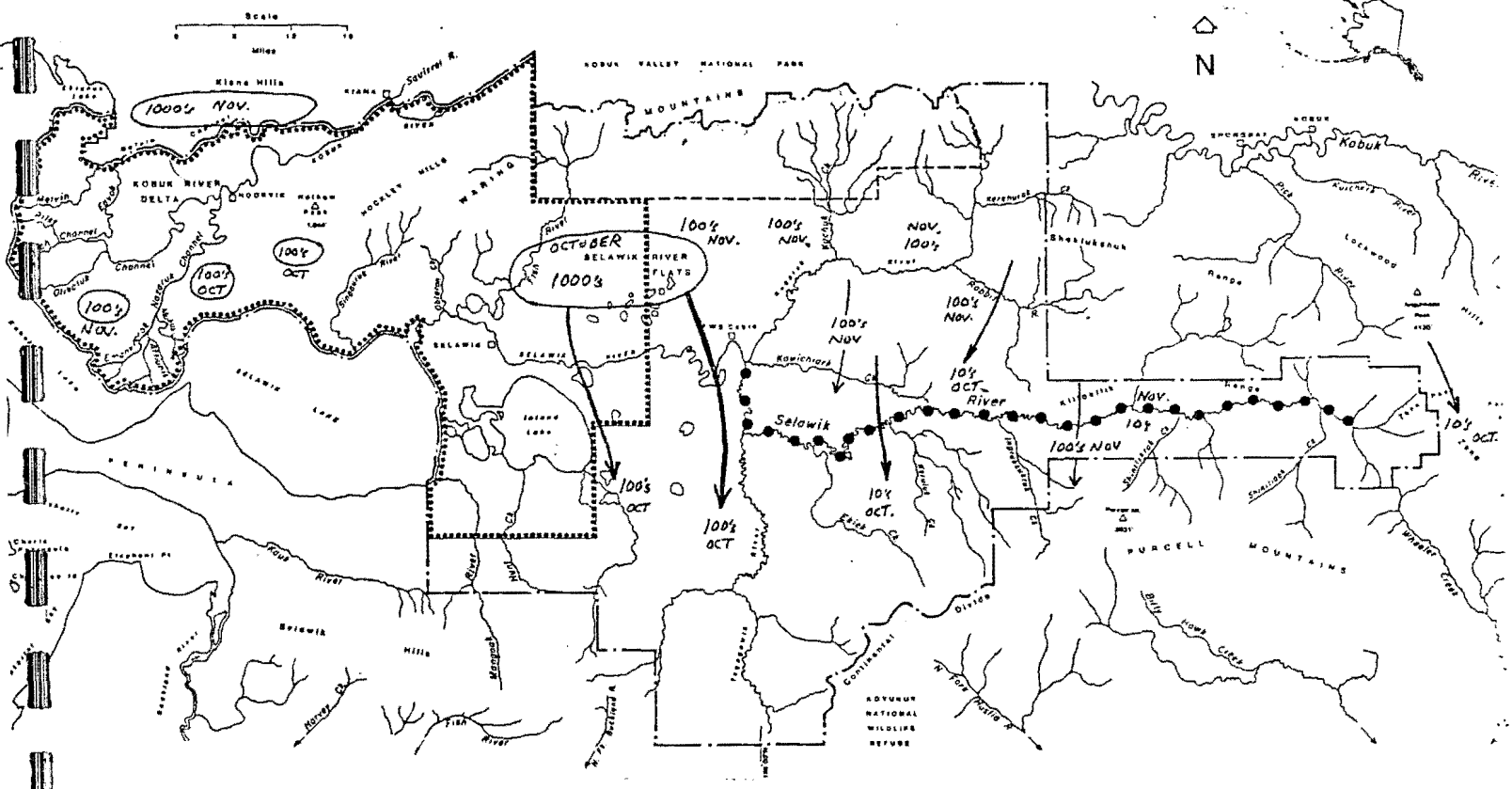
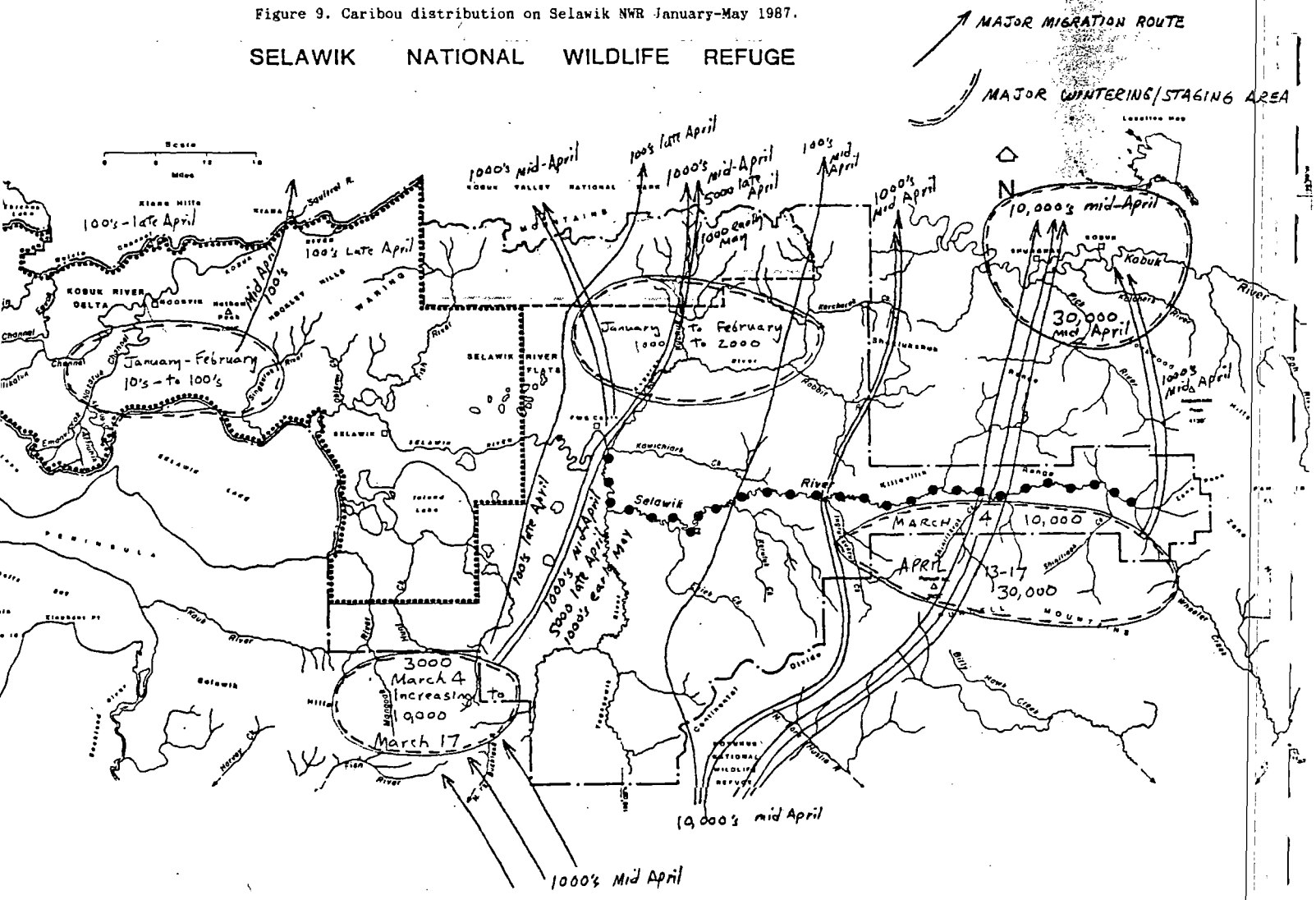


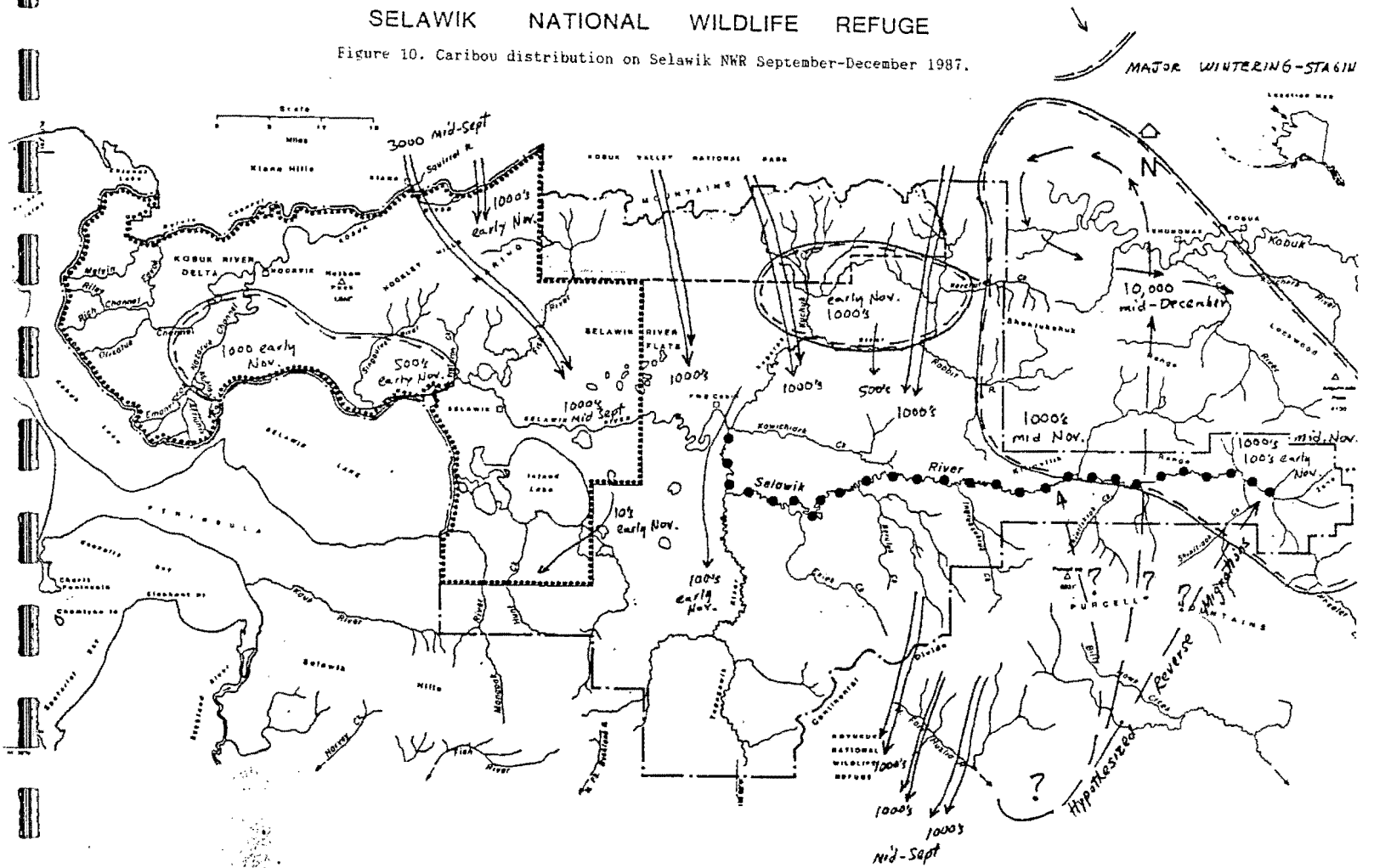
Figure 8. Caribou distribution on Selawik NWR October 27-31 and November 21, 1986.

Figure 9. Caribou distribution on Selawik NWR January-May 1987.



SELAWIK NATIONAL WILDLIFE REFUGE

Figure 10. Caribou distribution on Selawik NWR September-December 1987.



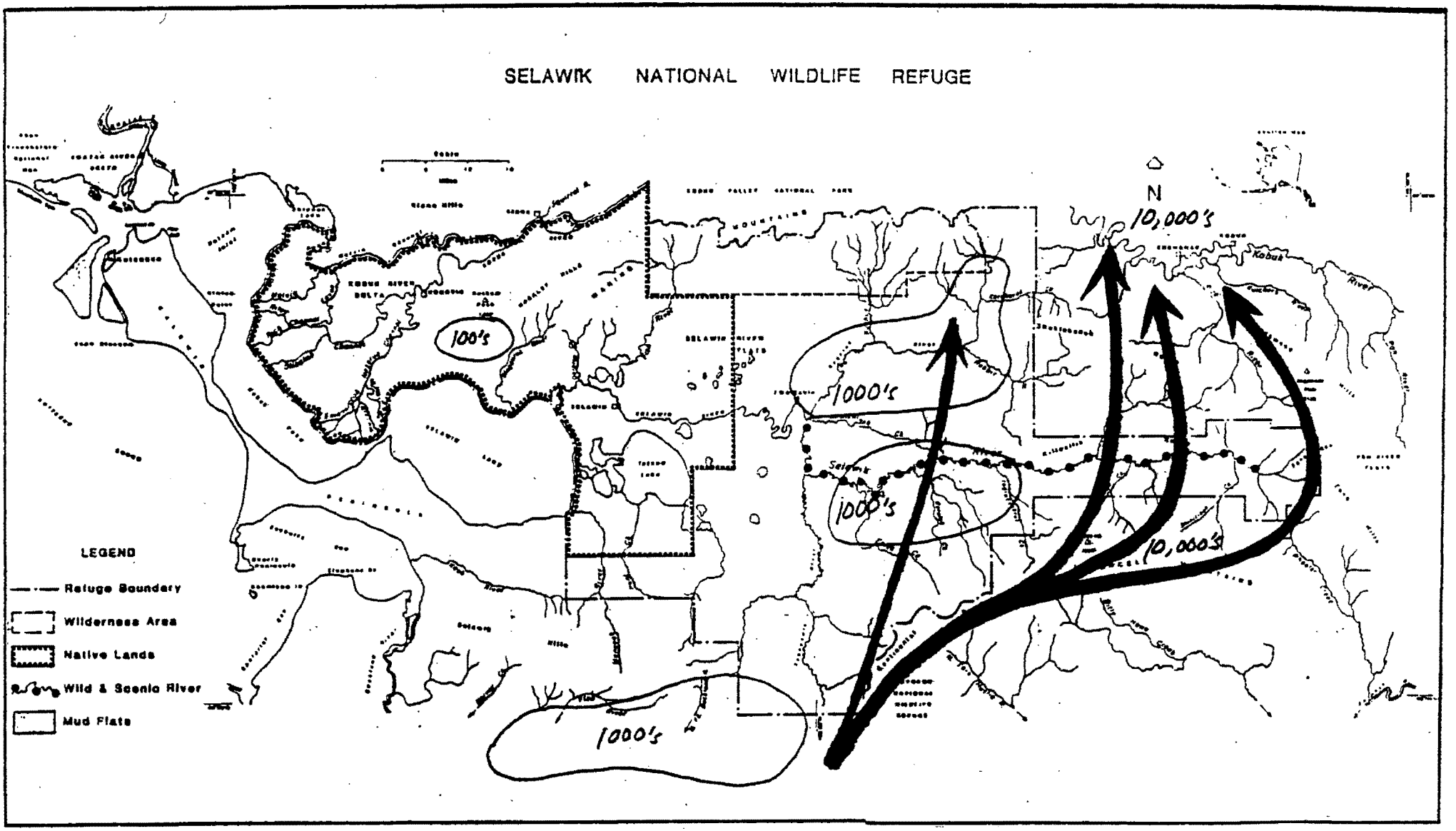


Figure 11. Caribou distribution on Selawik NWR March 14-16, 1988. Significant numbers of caribou were still south of the refuge on the Buckland Plateau and Nulato Hills. Spring migration through April generally followed the same pattern, with heaviest use in the windswept alpine terrain along the upper Selawik River, Purcell Mountains, Kiliovilik Range, Lockwood Hills and Sheklukshuk Range.

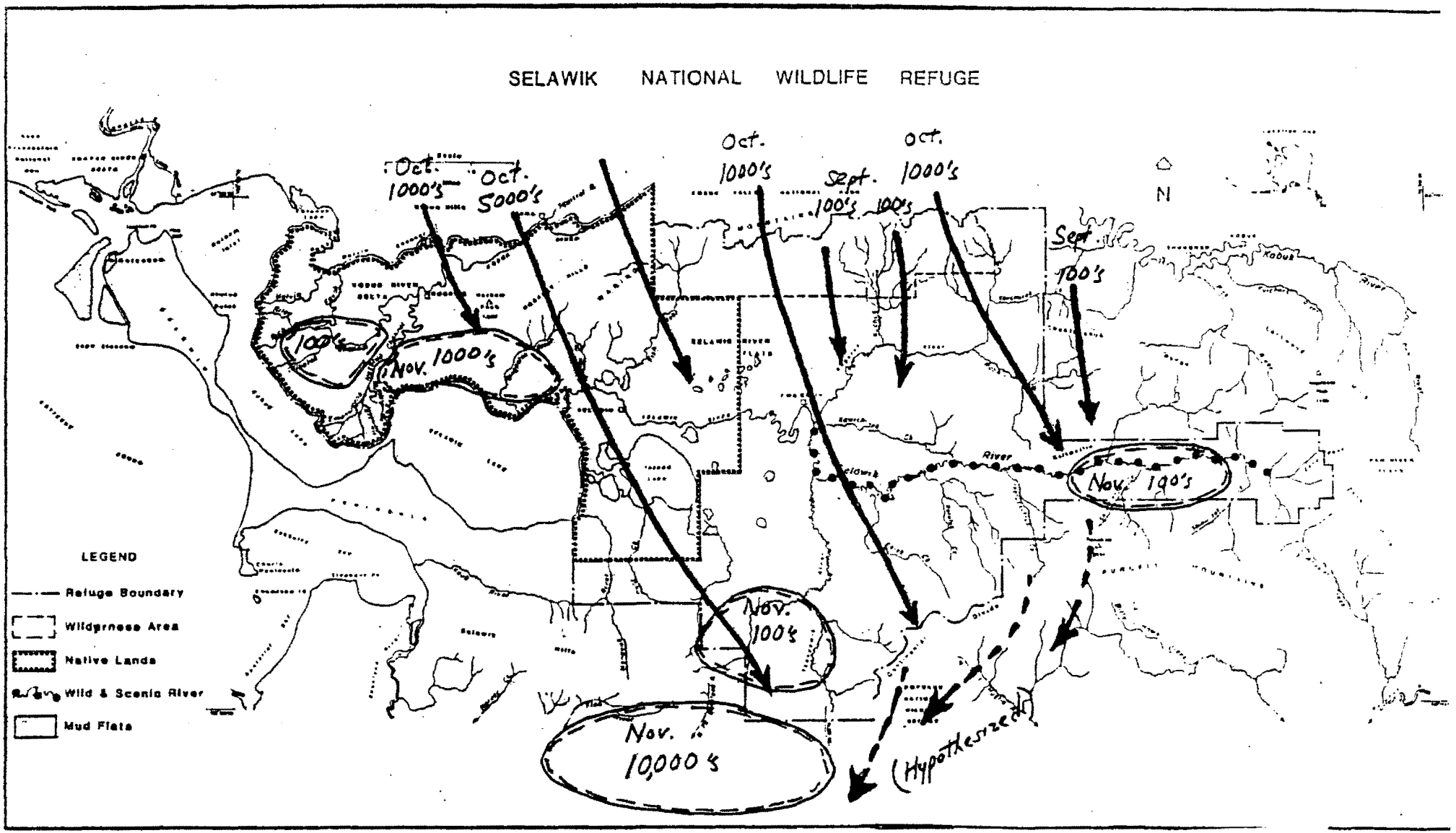


Figure 12. Caribou distribution on Selawik NWR fall-winter 1988, based on surveys September 20, 22, October 6, 29, November 1, 22, and 23, 1988.

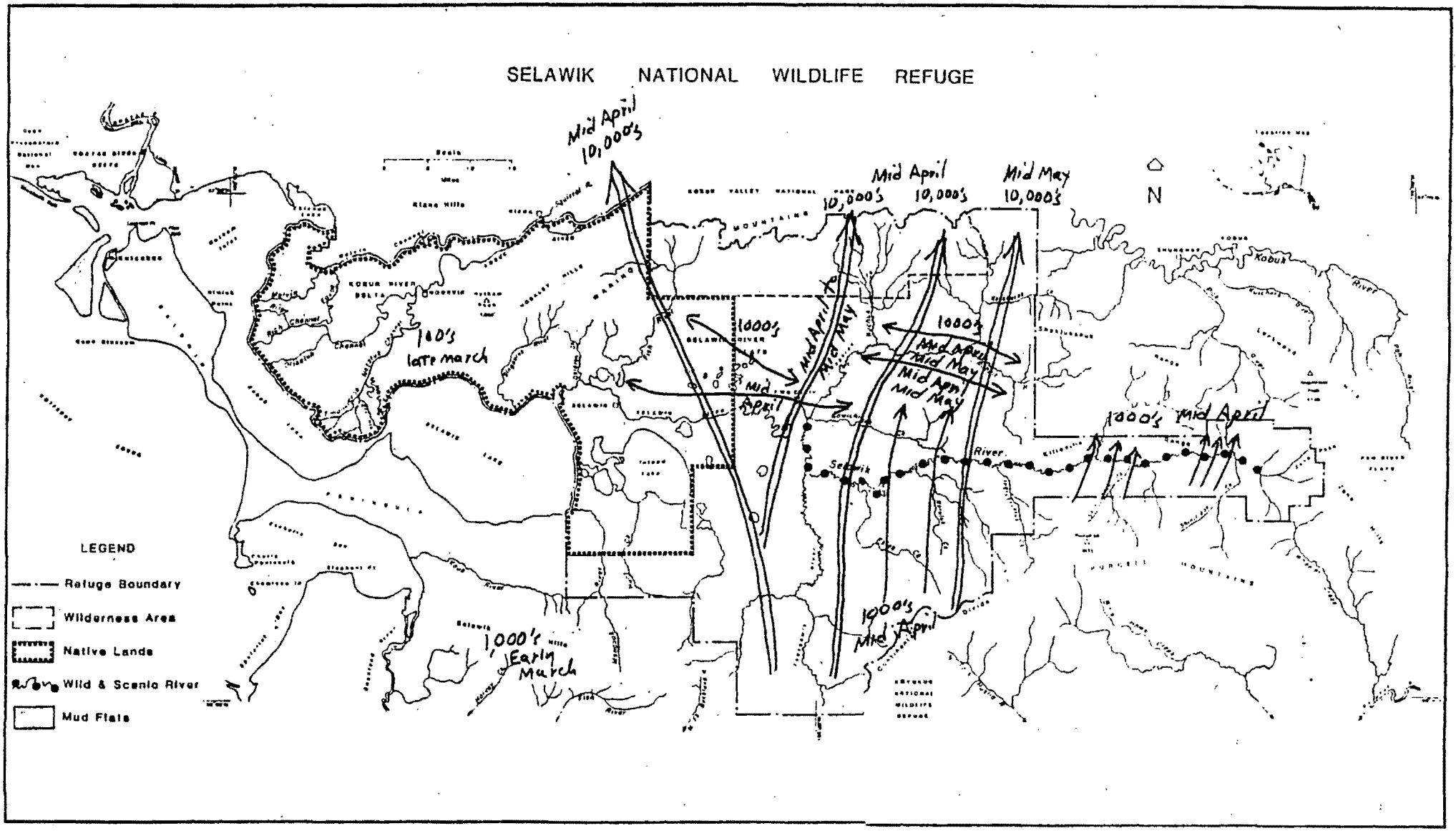


Figure 13. Caribou distribution on Selawik NWR late winter-spring 1989, based on surveys March 6 through May 25.

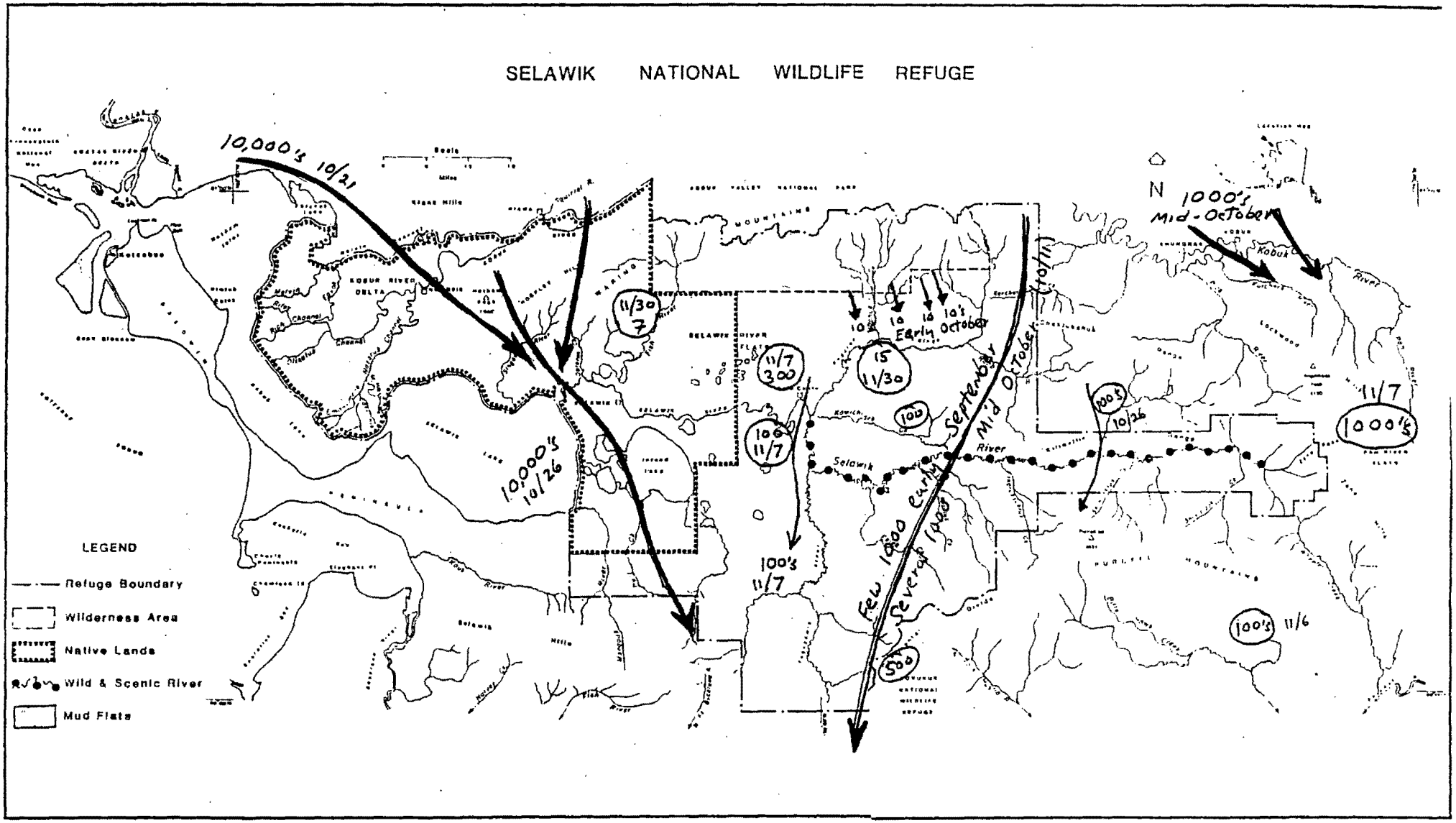


Figure 14. Caribou distribution on Selawik NWR fall/early winter 1989, based on surveys September 1 through November 30.

Figure 15. Radio-instrumented caribou 150.611 showed a "leapfrog" type movement from the Nulato Hills wintering ground to an intensive use area in the Selawik Hills and north across Selawik NWR, February-May 1984.

Figure 16. Radio-instrumented caribou 150.601 showed a steady, gradual movement from the Nulato Hills north across Selawik NWR, February-May, 1981.

APPENDIX 1. RAW DATA AND CALCULATION SPREADSHEET: LOTUS FILE C:\123\CARIBOU.ALL

SUMMARY OF CARIBOU LINE TRANSECT DATA FROM MAY & SEPTEMBER WATERFOWL TRANSECTS AND NOVEMBER CARIBOU TRANSECTS

TRANSECT		9/13-14/84	5/29/85	9/17/85	11/20/85	5/21/86	9/17/86	11/6/86	5/30/87	9/16/87	11/3/87	5/23/88	9/22/88
1		raw	9	116	0	0	0	6	0	0	0	0	1
2		data	8	4	45	0	0	0	1	0	34	0	43
3		missing	0	321	25	162	17	0	0	482	1	20	2
4			56	12	0	15	16	1	30	0	62	0	38
5			0	5	12	24	0	0	84	0	84	4	0
6			0	511	0	0	9	13	12	0	0	10	110
7			19	162	8	11	44	0	37	854	32	40	0
8			0	497	71	2	12	120	23	642	31	16	4
9			0	189	17	4	106	33	1	26	1	0	388
10			0	17	8	0	0	0	0	0	648	0	57
11			0	0	0	0	0	0	0	0	407	0	6
12			0	0	0	0	0	11	0	0	0	0	0
13					0			0			20		
14					0			47			0		
15					0			0			0		
16					38			30			85		
17					18			0			17		
18					176			0			76		
Total			92	1834	418	218	204	261	188	2004	1498	90	649
Mean/transect			7.67	152.83	23.22	18.17	17.00	14.50	15.67	167.00	83.22	7.50	54.08
Std. dev./transect			15.64	184.11	41.69	43.99	29.54	29.00	24.25	294.37	164.76	11.89	105.73
Sampling variance			3770027.	5.2E+08	17599931	29816594	13446288	8516437.	9056624.	1.3E+09	2.7E+08	2178570.	1.7E+08
Estimated popul.		5324	3341	66612	10121	7918	7409	6320	6828	72786	36272	3269	23572
80% Conf. interval		4149	2646	31147	5718	7443	4998	3978	4102	49799	22596	2012	17886

APPENDIX L
501 pages

Western Arctic Herd telemet
(WAHTEL file)

rec#	Freq.	CY	Date	Location Description	LC
2232	0.000		/ /		
11	0.045	79	10/06/82	Selawik Hills	
12	0.045	79	07/02/83	Windy Lake	
13	0.045	79	11/15/83	Between Selawil L. and Kobuk R.	
14	0.045	79	12/01/83	Selawik Hills	
15	0.045	79	05/15/84	Lower Redstone R.	
16	0.045	79	06/04/84	10 mi. SE of Feniak L.	
17	0.045	79	07/02/84	Lower Ipewik R.	
18	0.045	79	07/07/84	SW of Pitmegea R.	
19	0.045	79	11/06/84	Noatak/Anisak Rivers	
20	0.055	79	10/07/82	Mouth of Cutler R.	
21	0.055	79	06/02/83	N. of Carbon Creek	
22	0.055	79	10/20/83	S. of Kobuk R.	
23	0.055	79	10/20/83	Noatak R. mouth	
24	0.055	79	04/09/84	Lower Noatak R.	
25	0.055	79	06/04/84	Igloo Mtn.	
26	0.055	79	07/02/84	Ipewik R.	
27	0.055	79	04/11/85	Near Ambler	
51	0.100	79	07/06/82	Postcalving aggregation	
52	0.100	79	07/02/83	W. of Windy Lake	
53	0.100	79	03/30/84	Chipp R.	
70	0.135	79	07/06/82	Postcalving aggregation	
71	0.135	79	07/02/83	Kukpuk R.	
75	0.150	79	07/06/82	Postcalving aggregation	
76	0.150	79	06/02/83	Carbon Creek	
77	0.150	79	12/08/83	Talik Ridge	
78	0.150	79	03/19/83	Talik Ridge	
79	0.150	79	05/01/84	Ekiek Creek	
80	0.150	79	06/04/84	Carbon Creek area	
81	0.150	79	07/02/84	W. of Windy Lake	
82	0.150	79	07/07/84	Lower Pitmegea R.	
83	0.150	79	11/06/84	Head of Eli R.	
84	0.150	79	06/04/85	Carbon Creek	
85	0.150	79	07/06/85	Iligluruk/Driftwood Creeks	
86	0.150	79	10/17/85	Mid/upper Koyuk R.	
87	0.150	79	10/29/85	Upper Unalakleet R.	
88	0.150	79	11/19/85	Unalakleet R. near Old Woman	
89	0.150	79	01/22/86	Head of Anvik R.	
564	0.150	79	04/08/86	Unalakleet r. 15 mi E. of Unk	
94	0.160	79	07/06/82	Postcalving aggregation	
95	0.160	79	07/02/83	Pitmegea R.	
96	0.160	79	11/15/83	Monument Mtn. (Seward Pen.)	
97	0.160	79	01/06/84	Monument Mtn.	
98	0.160	79	02/13/84	E. of Imuruk Lake	
99	0.160	79	03/19/84	N. of Granite Mtn.	
145	0.200	79	07/06/82	Postcalving aggregation	
146	0.200	79	10/24/83	SW of Teshekpuk Lake	
147	0.200	79	03/29/84	Anaktuvuk Village	
152	0.210	79	07/06/82	Postcalving aggregation	
153	0.210	79	02/02/83	Anaktuvuk R.	

APPENDIX 2

Updated 10-22-86

list record#	FREQ	CAPYEAR	DATE	LOCDESC	LOCCODE	COMMENTS	STATUS
524	0.811	84	10/24/85	S. of Purcell Mtn.		Craighead (Hall-FWS)	y
525	0.831	85	06/06/85	Calving ground		Craighead	y
526	0.831	85	10/24/85	S. of Purcell Mtn.		Craighead (Hall-FWS)	y
527	0.831	85	01/10/86	N. Fork Huslia R.		Craighead (FWS)	y
528	0.860	85	06/06/85	Calving ground		Craighead	n
529	0.860	85	10/12/85	Upper Buckland R.		Craighead	n
530	0.860	85	11/19/85	Upper Inglutalik/Ungalik Rivers		Henry reindeer on same frequency	n
531	0.860	85	01/10/86	Upper Tag. R.		FWS	n
532	0.085	85	03/21/86	Middle Tag River		F&G (James): General	n
533	0.090	85	03/06/86	10 mi NNW of Wrench Lake		FWS (Spindler); Specific; (0.091)	y
534	0.120	85	03/06/86	Headwaters, S. Fork Buckland River		FWS (Spindler); General; (0.121)	n
535	0.135	85	03/21/86	Selawik R., Creek E. of Tag R.		F&G (James); General; major trail	y
536	0.145	85	03/06/86	Selawik Hills		FWS (Spindler); General; (0.146)	y
537	0.155	85	03/06/86	Headwaters, S. Fork Buckland R.		FWS (Spindler); Specific; (0.158)	y
538	0.165	85	03/21/86	E. end of Selawik Hills		F&G (James); General; (0.166)	y
539	0.170	80	03/21/86	Middle Selawik Hills		F&G (James); General; (0.171)	y
540	0.175	80	03/06/86	Headwaters, Inglutalik R.		FWS (Spindler); Specific; (0.176)	y
541	0.180	82	03/06/86	South of Selawik Hills		FWS (Spindler); General; (0.181)	y
542	0.190	85	03/06/86	Upper S. Fork Buckland R.		FWS (Spindler); Specific; (0.192)	y
543	0.200	85	03/06/86	Headwaters, Inglutalik R.		FWS (Spindler); Specific; (0.201)	y
544	0.210	85	03/06/86	10 mi NNW of Wrench Lake		FWS (spindler); Specific	y
545	0.240	85	03/21/86	E. end of Selawik Hills		F&G (James); General	y
546	0.250	85	03/06/86	Headwaters, Inglutalik R.		FWS (Spindler); Specific; (0.251)	y
547	0.260	85	03/21/86	Buckland R., middle Selawik Hills		F&G (James); General	y
548	0.270	81	03/06/86	15 mi SE of Wrench Lake, upper Tag		FWS (Spindler); Specific; Mortality	n
549	0.280	85	03/06/86	Upper Tag R.		FWS (Spindler); Specific; (0.283)	y
550	0.290	81	03/21/86	Middle Selawik Hills, north side		F&G (James); General; MORTALITY	n
551	0.300	85	03/21/86	E. lower Tag R., Mts. W. of Purcell		F&G (James); General	y
552	0.310	85	03/06/86	10 mi NNW of Wrench Lake		FWS (Spindler); Specific; (0.313)	y
553	0.330	85	03/21/86	Lower Buckl. R. or W. Selawik Hills		F&G (James); General; (0.331)	y
554	0.340	85	03/06/86	Headwaters, Inglutalik R.		FWS (Spindler); General	y
555	0.350	85	03/21/86	Mouth Buckl. R. or base Baldw Penn.		F&G (James); General	y
556	0.360	85	03/06/86	South of Selawik Hills		FWS (Spindler); General; (0.362)	y
557	0.370	85	03/21/86	Middle Tag R., E. side		F&G (James); General; Major trail	y
558	0.420	83	03/21/86	W. side of Purcell Mtn.		F&G (James); General; (0.421)	y
559	0.420	83	03/06/86	North Fork Huslia R.,E. Wrench Lake		FWS (Spindler); General	y
560	0.430	83	03/06/86	Middle Tag R.		FWS (Spindler); Specific; (0.431)	y
561	0.490	84	03/06/86	Headwaters, S. Fork of Buckland R.		FWS (Spindler); Specific; (0.491)	y
562	0.541	83	03/06/86	Headwaters, N. Fork Buckland R.		FWS (Spindler); Specific	y
563	0.601	83	03/06/86	Upper S. Fork of Buckland R.		FWS (Spindler); Specific	y
564	0.640	81	03/06/86	10 mi SE Wrench Lake, middle Tag R.		FWS (Spindler); Specific; (0.641)	y
565	0.650	85	03/06/86	Buckland Village		FWS (Spindler); Specific; MORTALITY	n
566	0.680	85	03/06/86	SW of Selawik & Kugarak R. confl.		FWS (Spindler); General; (0.681)	y
567	0.690	85	03/06/86	Middle S. Fork Buckland R.		FWS (Spindler); General; (0.692)	y
568	0.860	85	03/06/86	N. Fork Huslia R.		FWS (Spindler); General; (0.861)	n
569	0.105	85	04/08/86	Granite mtn. 10 mi. N. of site		200 animals,vis. Smith/Nelson	y
570	0.145	85	04/08/86	W. end of Selawik Hills		Gen. Smith/Nelson	y
571	0.150	79	04/08/86	Unalakleet r. 15 mi E. of Unk		Dropped collar? spec. Smith	n
572	0.230	85	04/08/86	Head of Tag. R.		gen. Smith/Nelson	y
573	0.075	81	06/18/86	Colville R; 15 mi. N. of Noluck Lk.		Smith/Larsen; General	y
574	0.085	85	06/18/86	2 mi. N. of Omicon Hill		Smith/Larsen; mortality; Visual	n
575	0.090	85	06/18/86	Utukok R.; 30 mi. SE. of Driftwood		Smith/Larsen; General	y
576	0.105	85	06/18/86	15 mi. N. of Igloo Mtn.		Smith/Larsen; General	y
577	0.120	85	06/19/86	5 mi. S. of Kuk R.		Mortality; Flew low, couldn't see	n
578	0.135	85	06/19/86	Between Utukok R. & Arch. Ridge.		Smith/Larsen; No antlers, w/calf.	y
579	0.145	85	06/20/86	15 mi. W. of Igloo Mtn.		Smith/Larsen; No antlers, w/calf.	y
580	0.155	85	06/18/86	Arch. Ridge; headwaters Avingak R.		Smith/Larsen; General	y
581	0.165	85	06/18/86	Headwaters of Tupikchak Ck.		Smith/Larsen; General	y
582	0.175	80	06/18/86	Utukok R.; 5 mi. SE of Driftwood		Smith/Larsen; No antlers, no calf.	y
583	0.180	82	06/18/86	Colville R.; 20 mi. NW Liberator Lk		Smith/Larsen; General	y
584	0.190	85	06/19/86	5 mi. NE. of Archimedes Ridge.		Smith/Larsen; No antlers, w/calf.	y