Movements Of Caribou In The Teshekpuk Lake Herd As Determined By Satellite Tracking

1990 - 1993

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1.0 INTRODUCTION

Caribou are a major subsistence resource for residents of the Alaskan North Slope. For example, in Wainwright and Barrow, caribou were second only to marine mammals in total edible weight harvested (Braund *et al.* 1993*a, b*). In both villages, over 50% of the people said that caribou was their largest source of wild meat and over 70% said that caribou was the subsistence meat that they ate most often (Braund *et al.* 1993*a, b*). Caribou are the major subsistence resource for Anaktuvuk Pass (Hall *et al.* 1985) and one of the main subsistence resources for Nuiqsut (Hoffman *et al.* 1988). An advantage of hunting caribou is that they are available much of the year whereas availability of the other major subsistence species is seasonal (Hoffman *et al.* 1988; Braund *et al.* 1993*a, b*).

There are four caribou herds in arctic Alaska; they are (from west to east) the Western Arctic Herd, the Teshekpuk Lake Herd, the Central Arctic Herd and the Porcupine Herd. The Western Arctic Herd, numbering well over 400,000, ranges over 362,600 km^2 of northwestern Alaska, from the North Slope to the Seward Peninsula (Machida 1992). In 1989, 16,649 Teshekpuk Lake caribou were counted by aerial photocensus; their range extends from Wainwright to Nuiqsut (east - west) and from Barrow to the Seward Peninsula (north - south) (Carroll 1992). The Central Arctic Herd numbered approximately 13,000 in 1983 and ranges over approximately 67,300 km^2 from the industrial area near Prudhoe Bay south and southeast to the northern foothills of the Brooks Range (Valkenburg 1992). The Porcupine Herd numbered approximately 178,000 in 1989; its range is approximately 336,700 km^2 of Alaska and Canada (Whitten 1992).

The Teshekpuk Lake Herd was first recognized as a separate herd in the mid-1970s (Davis and Valkenburg 1978), but according to local residents, caribou had been present in the Teshekpuk Lake area year-round for at least the previous forty years (Carroll 1992). Since the Teshekpuk Lake Herd was recognized as an entity, its size has been increasing. Initial estimates from 1978 through 1982 by the Alaska Department of Fish and Game (ADF&G) (Davis and Valkenburg 1979) and the U. S. Bureau of Land Management (BLM) (Reynolds 1982, Silva 1985) were 3,000 to 4,000. In July 1984, the ADF&G and the BLM conducted the first aerial photocensus, enumerating 11,822 caribou (Silva

1985). The increased count in 1984 may well have been due to improved counting methods and better understanding of herd movements and locations as well as actual increase in Teshekpuk Lake caribou numbers (Silva 1985). An ADF&G visual census in July 1985 gave an estimate of 13,406 animals (J. Trent, pers. comm.). The next photocensus - a joint effort among the North Slope Borough (NSB), the ADF&G and the BLM in 1989 - provided a count of 16,649 caribou, a 41% increase (annual mean increase 7.1%) over the 1984 count (Carroll 1992).

Teshekpuk Lake Herd mortality has been difficult to quantify, however some estimates have been made. Based on a subsistence study by Braund and colleagues (1993*a*), radio-tracking data and interviews with hunters, estimated total harvest mortality for 1989-1990 by hunters from Barrow, Nuiqsut and Atqasuk was 808-1,084 (Carroll 1992). An estimated 1,300 caribou from the Teshekpuk Lake, Central Arctic and Western Arctic Herds died in an area of about 14,200 km^2 south of Teshekpuk Lake and between the Ikpikpuk and Colville Rivers during the late winter and spring of 1990; the estimate was based on aerial surveys and interviews (Carroll 1992). Poor body condition appeared to be the prime factor in these deaths (Carroll 1992).

Studies of the Teshekpuk Lake Herd have also included delineation of calving grounds and seasonal movements. The main calving area in 1976 and 1977 was southwest of the lake (Davis and Valkenburg 1979). Subsistence hunters indicated that this area had also been used for calving in the 1930's and late 1940's (Silva 1985). Since 1977, however, calving has concentrated primarily northeast of the lake (Reynolds 1982, Silva 1985, Carroll 1992). Insect relief habitat has been used primarily in July and has been identified from Harrison Bay in the east to Dease Inlet in the west (Reynolds 1982, Silva 1985, our unpublished data). Most caribou aggregate close to the coast for insect relief, but small groups occur in other areas that are relatively windy and cool, such as the Pik Sand Dunes approximately 30 km south of Teshekpuk Lake. The herd was originally thought to winter in the Teshekpuk Lake area (Silva 1985), but initial data from satellite collars in 1990 and 1991 indicated that some Teshekpuk Lake caribou traveled great distances, one as far as the Seward Peninsula (Carroll 1992).

Satellite tracking is a relatively new management tool for tracking caribou locations and movements (Craighead and Craighead 1987, Fancy *et al.* 1988). Until implementation of satellite transmitters, the only means of tracking caribou was by locating VHF radiotransmitters from aircraft. All telemetry data for the Teshekpuk Lake Herd prior to 1990 were collected with VHF radiotransmitters. These VHF transmitters have a longer life (four years versus one to two years for satellite collars) and are quite useful in many research projects such as censusing caribou and determining calving success; however, satellite transmitters are much superior for monitoring caribou movements. Satellite collars have unlimited range so a researcher can get locations regularly and not be affected by such things as weather and aircraft availability. Satellite transmitter data are collected virtually every time the transmitter transmits and a satellite is overhead to receive, regardless of weather or animal location. As a result, far more data are collected from a satellite transmitter.

Management agencies are interested in obtaining more information about the Teshekpuk Lake Herd because of the herd's importance to subsistence hunters and because of its location in areas of potential oil development. The impacts of human developments on caribou have been reviewed from the worldwide perspective (Shideler *et al.* 1986) and with respect to effects of oil and gas development on the Central Arctic Herd (Shideler 1986). In 1987, the NSB, the ADF&G and the BLM began a cooperative effort to collect management-related data on the Teshekpuk Lake Herd. In 1991, the cooperative effort was formalized with a Memorandum of Understanding and Agreement (Appendix A).

One area of study made possible by the joint agency effort was bidaily, seasonal and annual locations and movements. Silva (1985) pointed out that protection of the herd from potential human impacts requires identification of important habitats such as calving areas, insect relief areas and major migration routes. This report addresses movements of Teshekpuk Lake caribou from July 1990 through June 1993.

2.0 GOAL AND OBJECTIVE

The goal of the cooperative study of the Teshekpuk Lake Caribou Herd is to obtain current survey and inventory information which will allow for effective management of the herd. The objective of the satellite telemetry portion of the study is to identify and map the herd's movements throughout the year, specifically to identify wintering areas, migration routes, calving area and other critical habitat.

3.0 METHODS

3.1 Study Area

The study area (Figure 1) encompassed approximately 384,000 km^2 of northwestern Alaska, from Point Barrow (71.5° N) south to the Seward Peninsula (approximately 65° N) and from the Seward Peninsula (approximately 162° W) east to the Yukon Flats (approximately 148° W). The area included the northern coastal plain as well as the Brooks Mountain Range. Teshekpuk Lake is the third largest lake in Alaska and is located in the northernmost part of the study area.

3.2 Telemetry Equipment

Transmission equipment[1] consisting of a satellite transmitter and a conventional VHF radiotransmitter - each with an antenna - was attached to a collar sized to fit an adult female caribou (Figure 2). The satellite transmitter (Model ST-3, 401.650 MHz) was a hermetically sealed unit, 5.8 x 6.9 x 11.1 cm and, as the heaviest component, was positioned under a caribou's neck. The VHF radiotransmitter (Model MOD-500, 151-152 MHz, separated from other radiotransmitters by at least 0.01 MHz) was also hermetically sealed, 3.65 x 5.1 x 7.1 cm, and positioned on one side of the caribou's neck. In 1990 and 1991, the satellite transmitters were programmed to transmit for six hours every day for one month, then six hours every second day for 11 months, then repeat the

[1]Telonics, Inc., Mesa, Arizona.

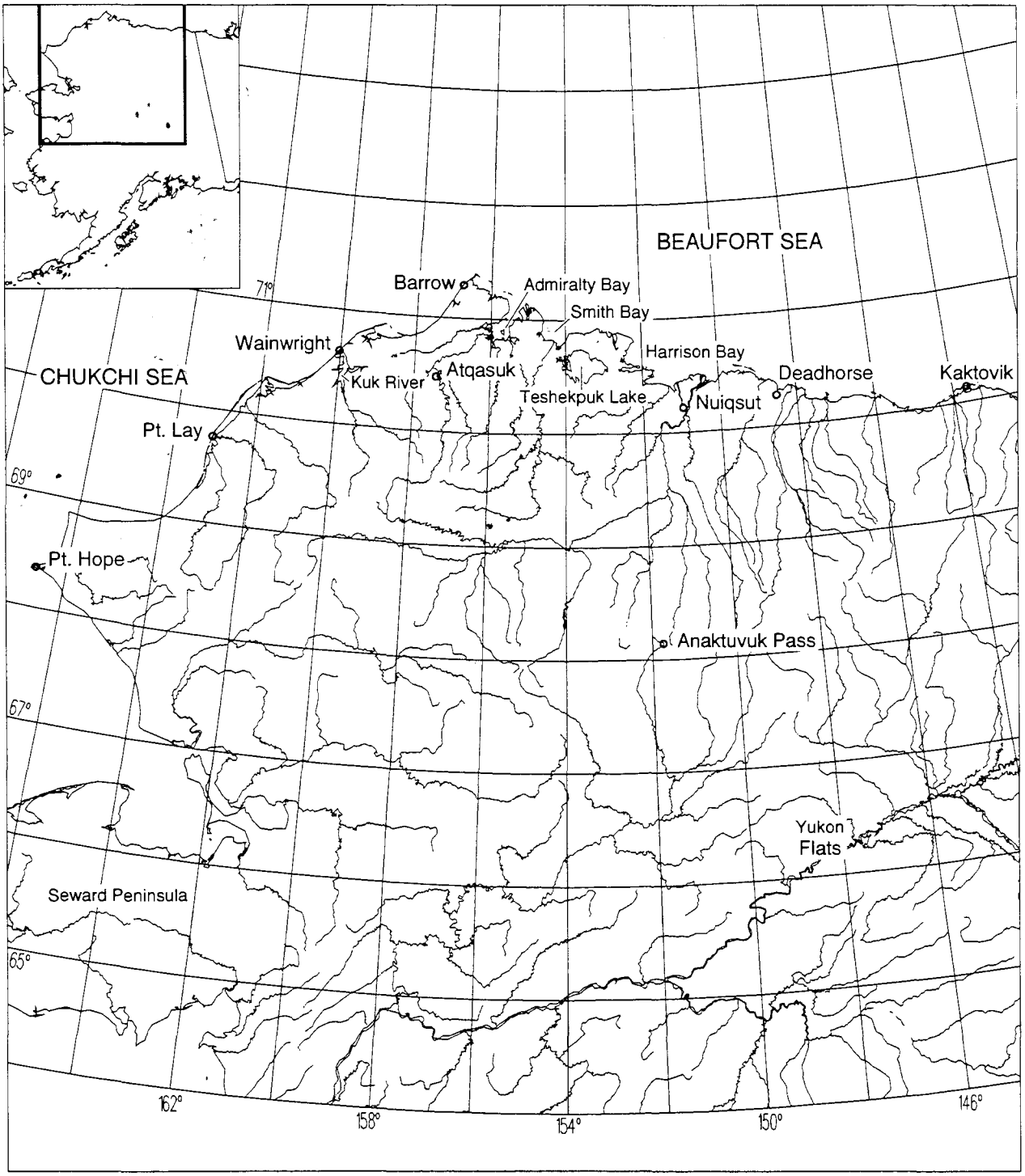

Figure 1. Study area for movements and activity of caribou from the Teshekpuk Lake Herd, July 1990 - June 1993.

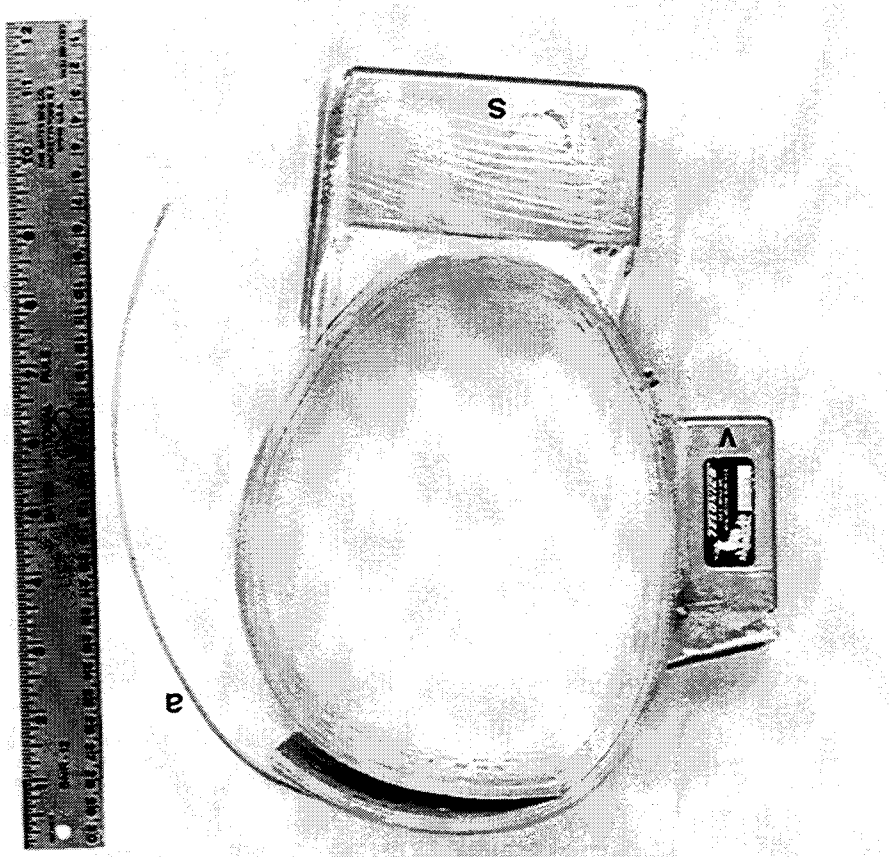

Figure 2. Typical satellite collar used to study movements and activity of caribou from the Teshekpuk Lake Herd, July 1990 - June 1993. VHF antenna (a), satellite transmitter case (s) and VHF radiotransmitter case (v) are visible; satellite antenna is approximately 12 cm long and completely enclosed within the collar.

cycle. In 1992 transmitters were programmed to transmit for six hours every second day year-round. The VHF radiotransmitters transmitted continuously. The antennas were contained between layers of material in the collar although the VHF antenna was too long to be completely contained within the collar (Figure 2). The entire package weighed 1.69 kg. Reception equipment for the VHF transmitters consisted of two three-element Yagi antennas (one attached to each wing of an airplane), cabling and a receiver/scanner unit[2]. Data from satellite transmitters were received and temporarily stored by polar-orbiting satellites, then passed through Command and Acquisition Stations to data processing centers in Landover, Maryland and Toulouse, France. The data were then transferred to the users. (See Fancy *et al.* 1988 for a detailed discussion of satellite data retrieval, processing and transfer.)

3.3 Caribou Collaring

Twelve collars were used. All collars were placed on adult female caribou. The first six were deployed in July 1990, although one was retrieved, refurbished and redeployed in October 1991. The other six were deployed in July 1992. Caribou were captured in 1990 and 1991 by the use of darts containing carfentanil and xylazine, fired from a tranquilizer gun in a helicopter; naloxone and yohimbine were used as antagonists. In 1992 the caribou were captured by net gun from a helicopter and restrained manually for collaring. Collars were adjusted to provide a snug fit that minimized rubbing.

3.4 Data Retrieval and Management

Data collection and retrieval were conducted from July 1990 through June 1993 via the Argos system, a cooperative project of the Centre National d'Études Spatiales in France, the National Oceanic and Atmospheric Administration and the National Aeronotics and Space Administration (Fancy *et al.* 1988). Raw location data were received monthly on diskette[3]. The raw data files were first edited manually to remove incomplete data lines then processed with a

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[2]Either Model TR-2 receiver with Model TS-1 scanner/programmer (Telonics, Inc., Mesa, Arizona) or Model R-4000 receiver/scanner (Advanced Telemetry Systems, Inc., Isanti, Minnesota); antennas and cabling from Telonics, Inc.
[3]Received from Service Argos, Landover, Maryland.

commercial software program[4] to load the location data into a database. It was necessary to manually edit an intermediate location data file to remove lines containing spurious data prior to extraction of data from that file for addition to the database.

3.5 Data Analysis

Once the data were loaded into the database, it was possible to conduct user-specified analyses such as mean daily distances traveled, total distances traveled, ranges and maps of caribou movements. The user could limit data to one or more satellite transmitters and to specific blocks of time prior to each analysis. Range, as used in this report, was the area of the smallest polygon encompassing a specified group of locations. Herd dispersal, as used in this report, was an index of how close or far the instrumented Teshekpuk Lake Herd caribou were from each other. The dispersal index was estimated by calculating range from one location for each satellite-collared caribou on the same day of the month or on days as close together as possible. All locations used for all monthly dispersal estimates were combined to estimate the herd range. Individual wintering locations were identified by the locations in December through March. Approximate wintering entry and exit dates were identified from individual maps of annual movements.

Activity of satellite-collared caribou was measured as percent of active seconds per 24 hours. Raw activity data were received from the collar transmitters as one- to three-digit numbers which, when multiplied by 85, gave the number of active seconds in the previous 24 hours.

[4]GTS-Argos, Geotronics, Bellvue, Colorado.

4.0 RESULTS AND DISCUSSION

4.1 Individual Caribou Movements

Twelve caribou were collared in the Teshekpuk Lake area, the thirteenth near Cape Simpson. Each was tracked until its collar was retrieved as planned, the transmitter failed, or the caribou died (Table 1).

Caribou 1 was collared northeast of Teshekpuk Lake in July 1990 (Figure 3) and data were collected for two years (Table 1). During July 1990, the caribou moved westward to Admiralty Bay, then eastward to south of the Kogru River where she stayed through August and most of September. She then traveled 336 km south, crossing the Brooks Mountain Range near Chandler Lake. She remained in the upper Koyukuk River drainage, south and southeast of Anaktuvuk Pass, from late October 1990 to early May 1991. In early May she began moving northward, crossed the mountains east of Anaktuvuk Pass and was in the general area south of the Kogru River by late May. She was back in the area where she was collared by the end of June. Her movements during the second year (Figure 4) were quite different from those of the first year in that she stayed in the same general area near Teshekpuk Lake all year. Her total distance traveled was only 30% less than the first year, but the area she covered was nearly 90% less (Table 2).

Caribou 2 was collared northeast of Teshekpuk Lake in July 1990 and stayed on the coastal plain into March 1992 when the transmitter failed (Table 1). During the first year (Figure 5), she moved gradually westward, reaching the Admiralty Bay area by mid-September. She then traveled to the Chukchi Sea coast near Peard Bay and wintered between Barrow and Atqasuk. In July 1991 she moved back to the east and wintered in the area south and southeast of Teshekpuk Lake until at least March 1992 (Figure 6). She was sighted northeast of Teshekpuk Lake during calving surveys on 8 June and was recaptured near Cape Simpson on 19 July.

Caribou 3 was collared northeast of Teshekpuk Lake in July 1990 and was tracked until she died in mid-May 1991 (Table 1, Figure 7). Her movements were similar to the first year of Caribou 1. She traveled west to Admiralty Bay,

Table 1. Location data collection dates and reasons data collection stopped for thirteen Teshekpuk Lake caribou with satellite collars.

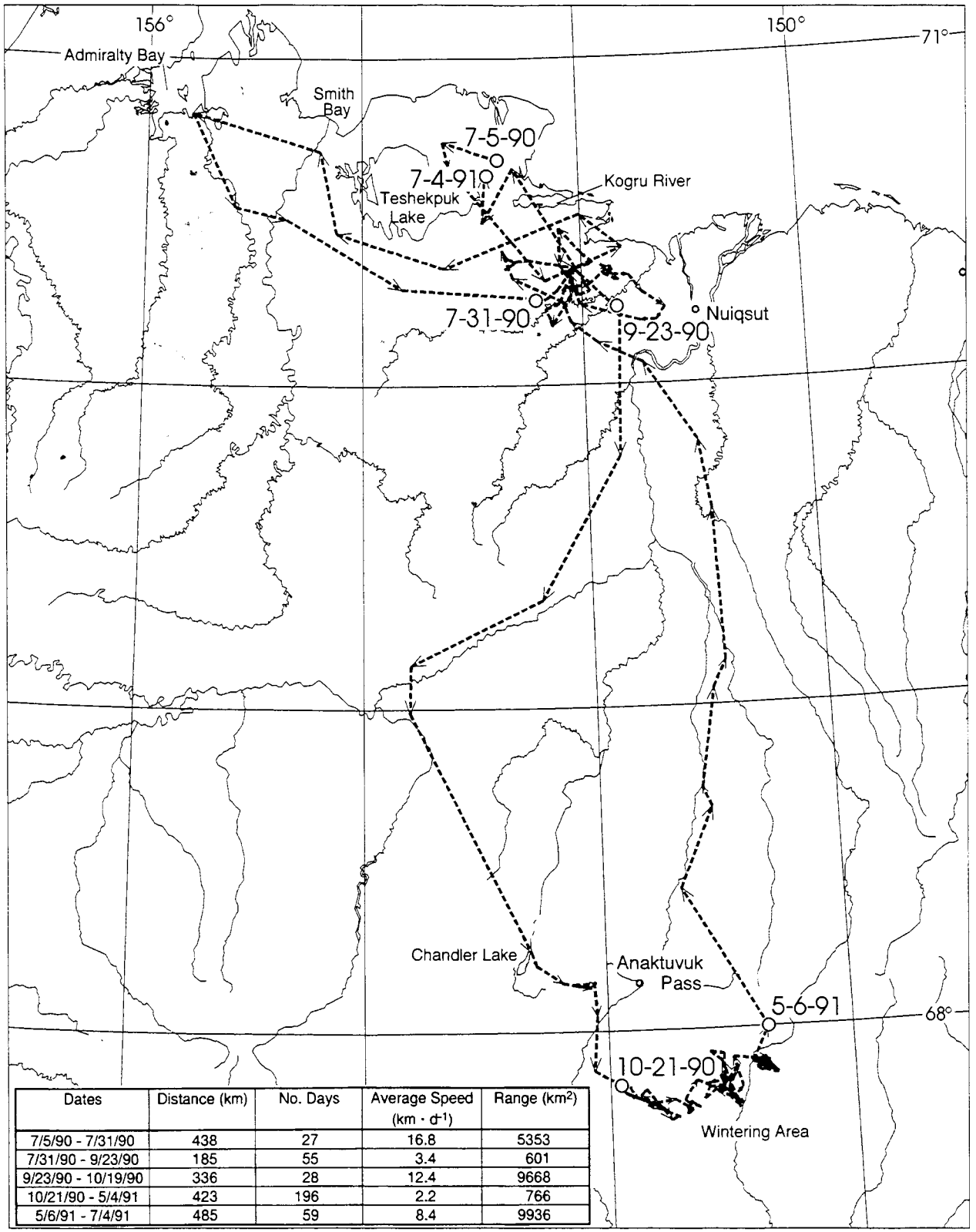
Caribou No.	Date First Data	Date Last Data	Reason Data Stopped
1	5 Jul 90	18 Jul 92	Planned Retrieval
2	5 Jul 90	13 Mar 92	Transmitter Failure
3	5 Jul 90	16 May 91	Mortality
4	5 Jul 90	18 Jul 92	Planned Retrieval
5	5 Jul 90	5 Jun 91	Mortality
6	5 Jul 90	10 Feb 91	Mortality
7	19 Oct 91	11 Jul 92	Planned Retrieval
8	21 Jul 92	23 Jan 93	Mortality
9	21 Jul 92	30 Dec 92	Mortality
10	21 Jul 92	20 Jan 93	Mortality
11	21 Jul 92	23 Jan 93	Mortality
12	21 Jul 92	18 Mar 93	Mortality
13	21 Jul 92	30 Jun 93	Planned Retrieval[1]

[1]Collar retrieved 18 Jul 93.

Table 2. Total annual distances traveled and estimated annual ranges used by five Teshekpuk Lake caribou from July 1990 through June 1993[1].

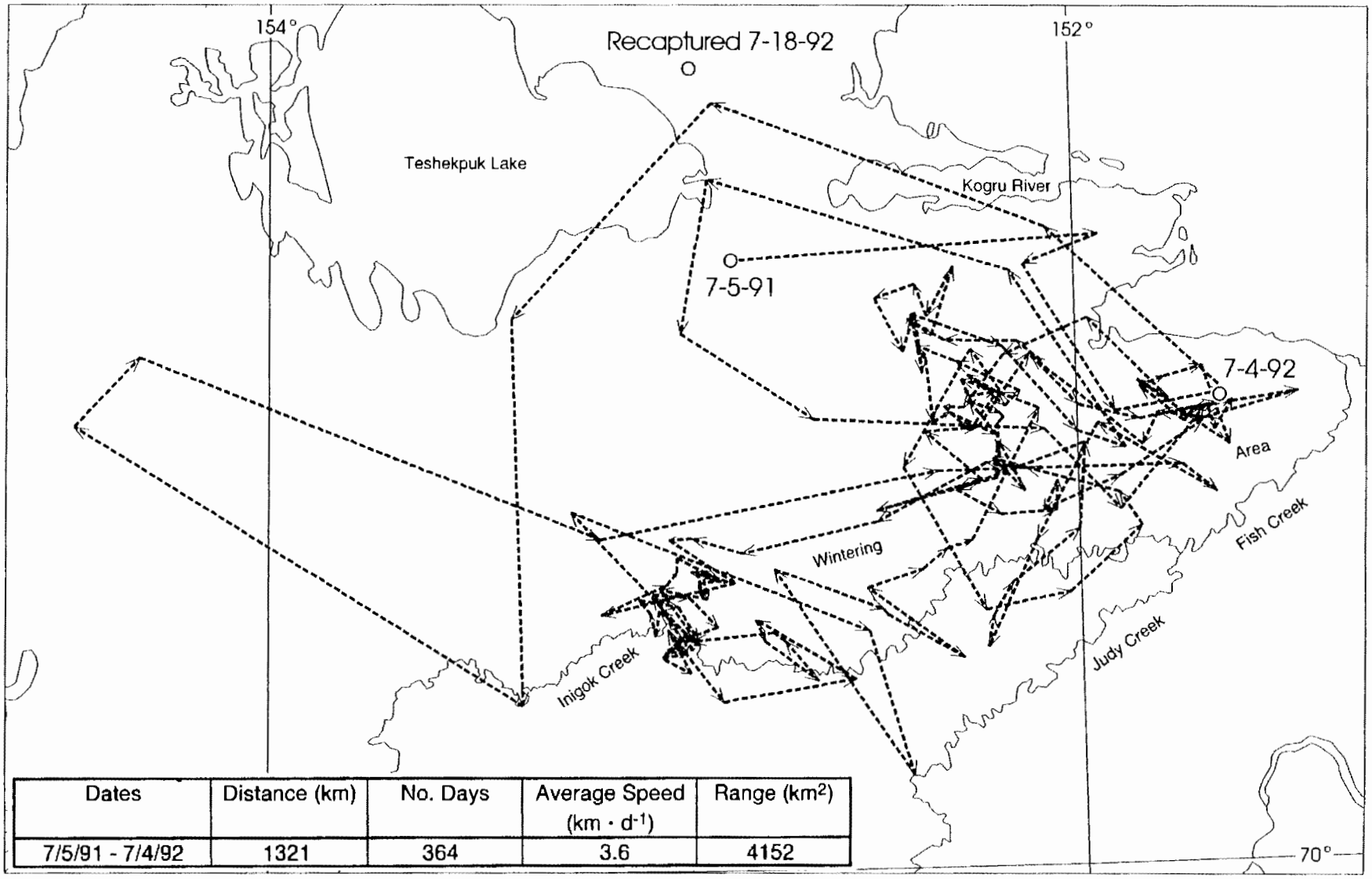
Caribou No.	Dates	Total Distance (km)	Range (km^2)
1	5 Jul 90 - 4 Jul 91	1,878	36,309
	5 Jul 91 - 4 Jul 92	1,321	4,152
2	5 Jul 90 - 4 Jul 91	1,140	9,773
3	5 Jul 90 - 16 May 91	2,033	26,832
4	5 Jul 90 - 4 Jul 91	1,920	22,716
	5 Jul 91 - 4 Jul 92	1,376	5,484
5	5 Jul 90 - 5 Jun 91	3,561	134,345
13	21 Jul 92 - 30 Jun 93	1,376	26,558

[1]Caribou 3 and 5 are included even though they died after 10 and 11 months. No other caribou produced more than 8 months of data.



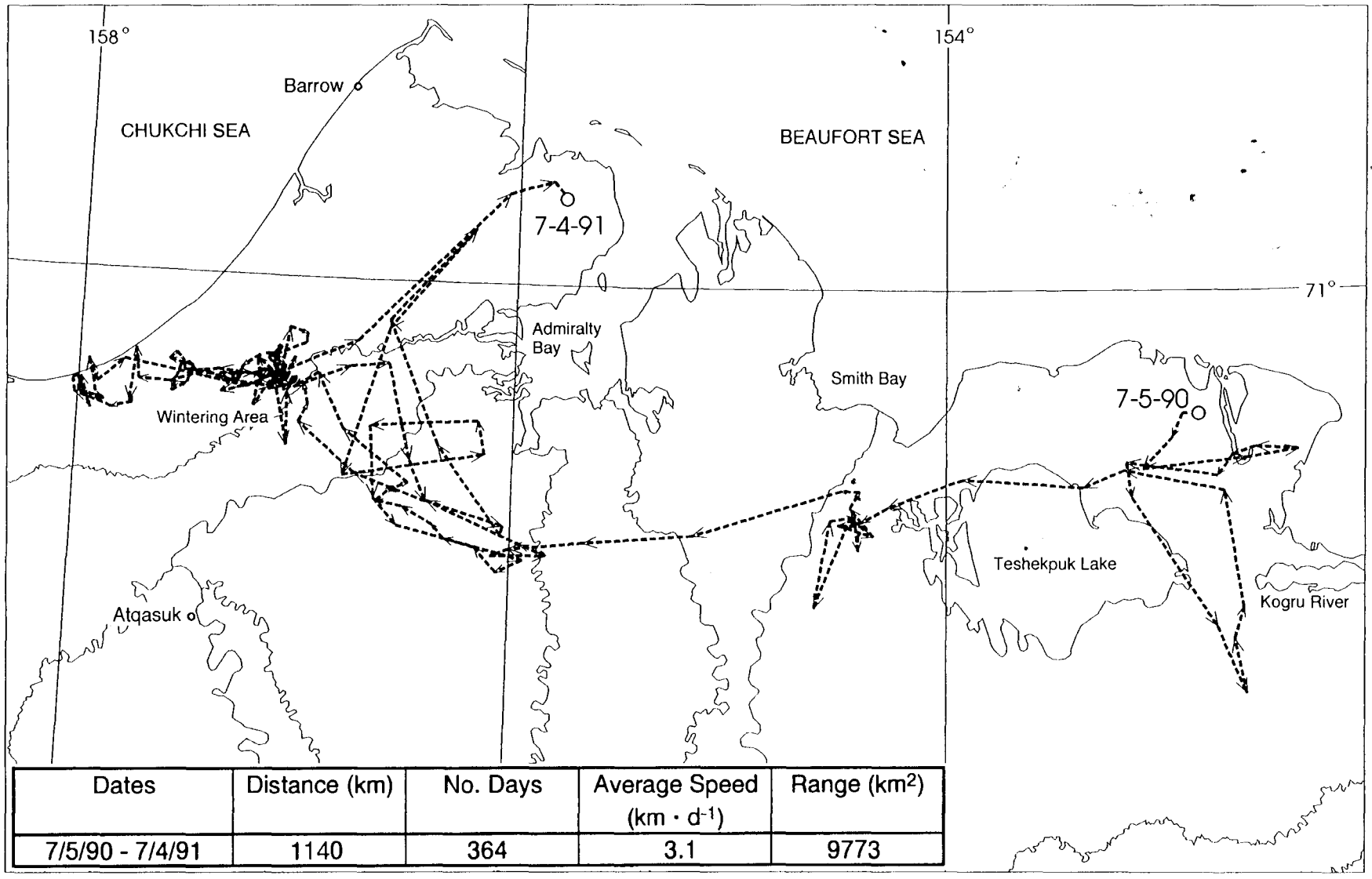
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 7/31/90	438	27	16.8	5353
7/31/90 - 9/23/90	185	55	3.4	601
9/23/90 - 10/19/90	336	28	12.4	9668
10/21/90 - 5/4/91	423	196	2.2	766
5/6/91 - 7/4/91	485	59	8.4	9936

Figure 3. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 1, 5 July 1990 - 4 July 1991 (1 cm = 20 km).



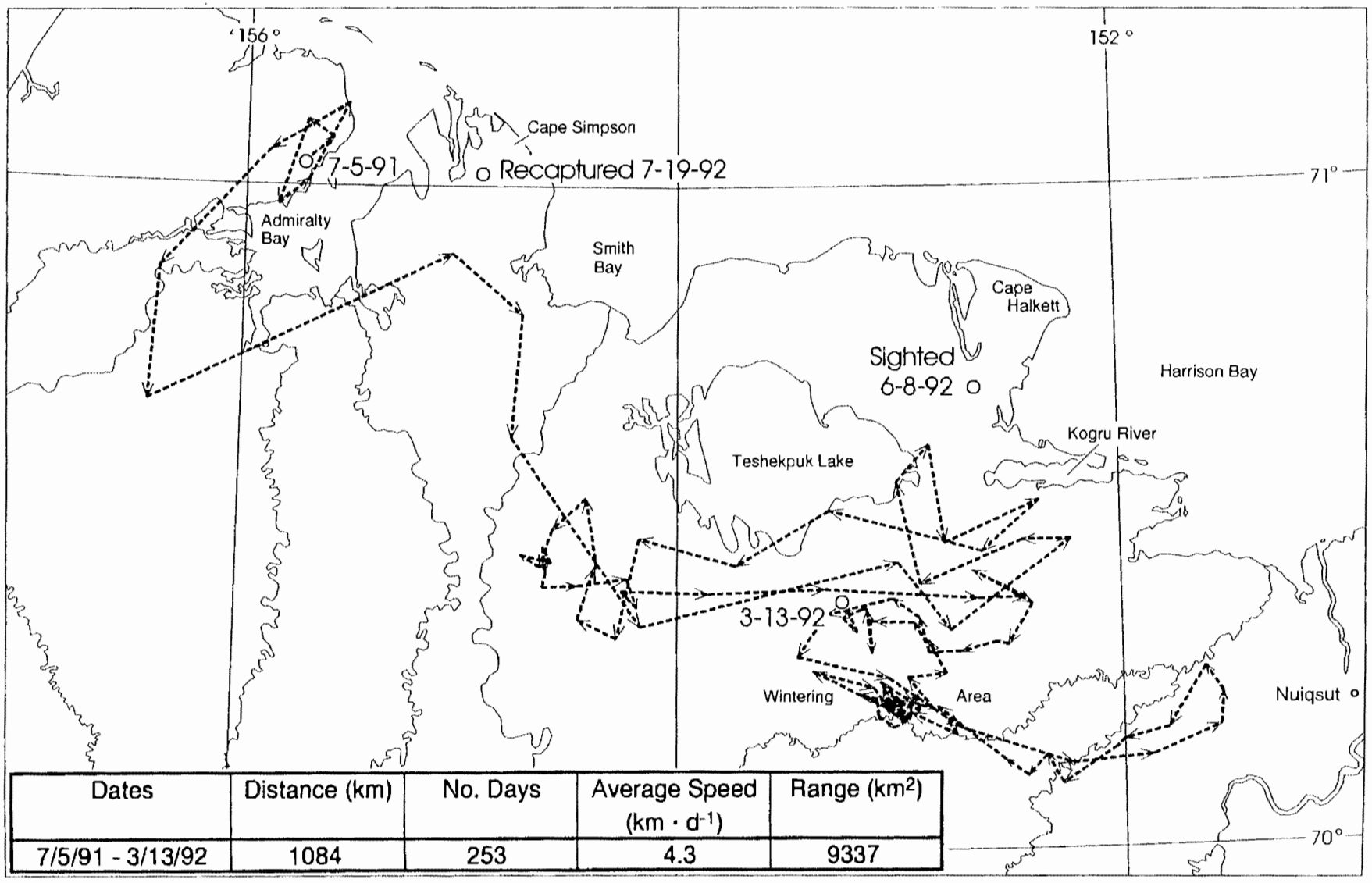
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/91 - 7/4/92	1321	364	3.6	4152

Figure 4. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 1, 5 July 1991 - 4 July 1992 (1 cm = 5.5 km).



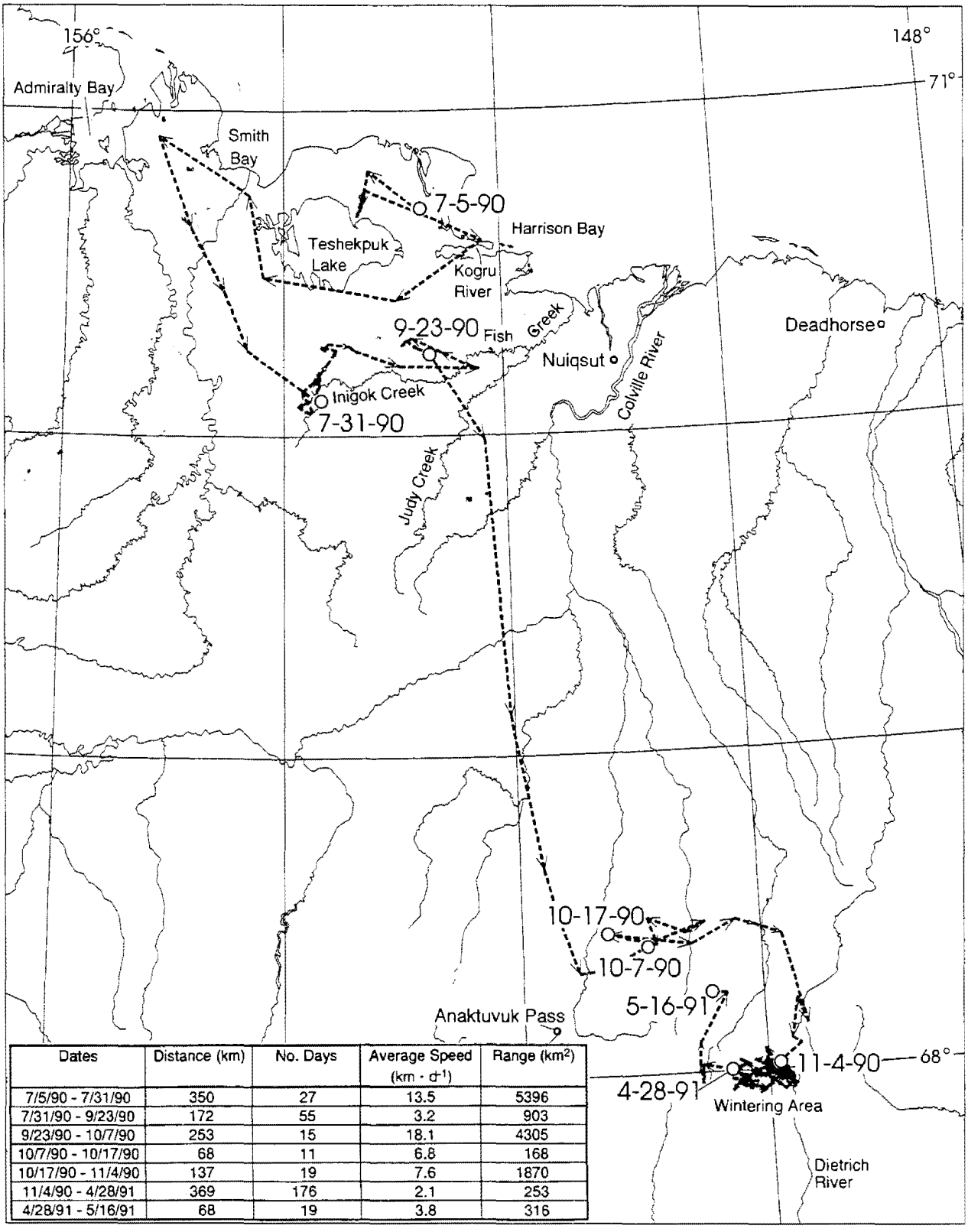
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 7/4/91	1140	364	3.1	9773

Figure 5. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 2, 5 July 1990 - 4 July 1991 (1 cm = 10 km).



Dates	Distance (km)	No. Days	Average Speed ($km \cdot d^{-1}$)	Range (km^2)
7/5/91 - 3/13/92	1084	253	4.3	9337

Figure 6. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 2, 5 July 1991 - 13 March 1992 (1 cm = 10 km).



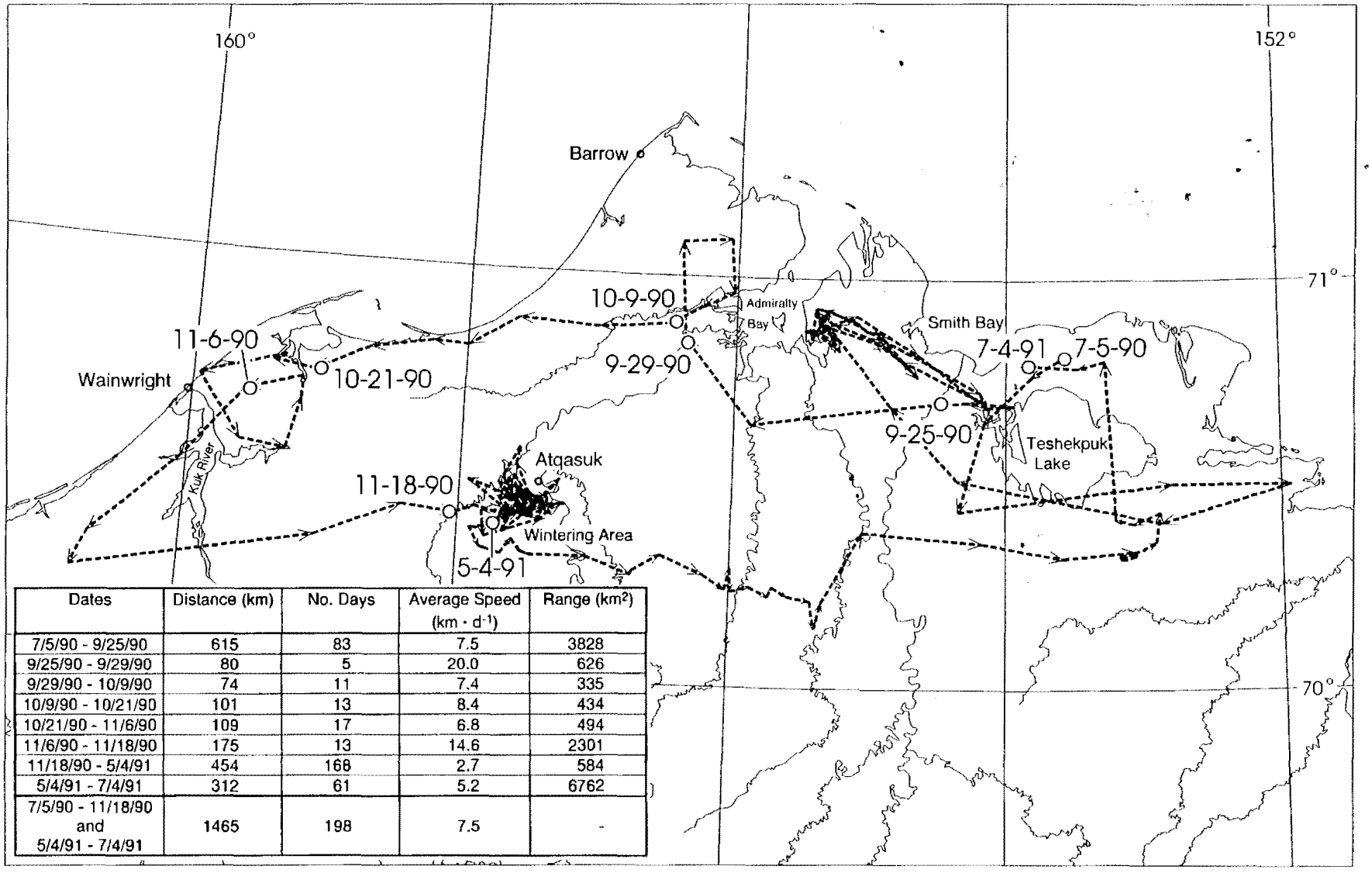
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 7/31/90	350	27	13.5	5396
7/31/90 - 9/23/90	172	55	3.2	903
9/23/90 - 10/7/90	253	15	18.1	4305
10/7/90 - 10/17/90	68	11	6.8	168
10/17/90 - 11/4/90	137	19	7.6	1870
11/4/90 - 4/28/91	369	176	2.1	253
4/28/91 - 5/16/91	68	19	3.8	316

Figure 7. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 3, 5 July 1990 - 16 May 1991 (1 cm = 20 km).

then southeast to Inigok Creek (south of Teshekpuk Lake) by the end of July. She remained along Inigok Creek until late September then traveled south and east, crossing the Brooks Mountain Range east of Anaktuvuk Pass in early November. She remained in a limited area near the continental divide in the headwaters of the Dietrich River from then until late April 1991. Beginning in late April, she traveled west and north until she died in mid-May. Her total distance traveled from collaring until she died exceeded the annual distances of all caribou except Caribou 5 (Table 2).

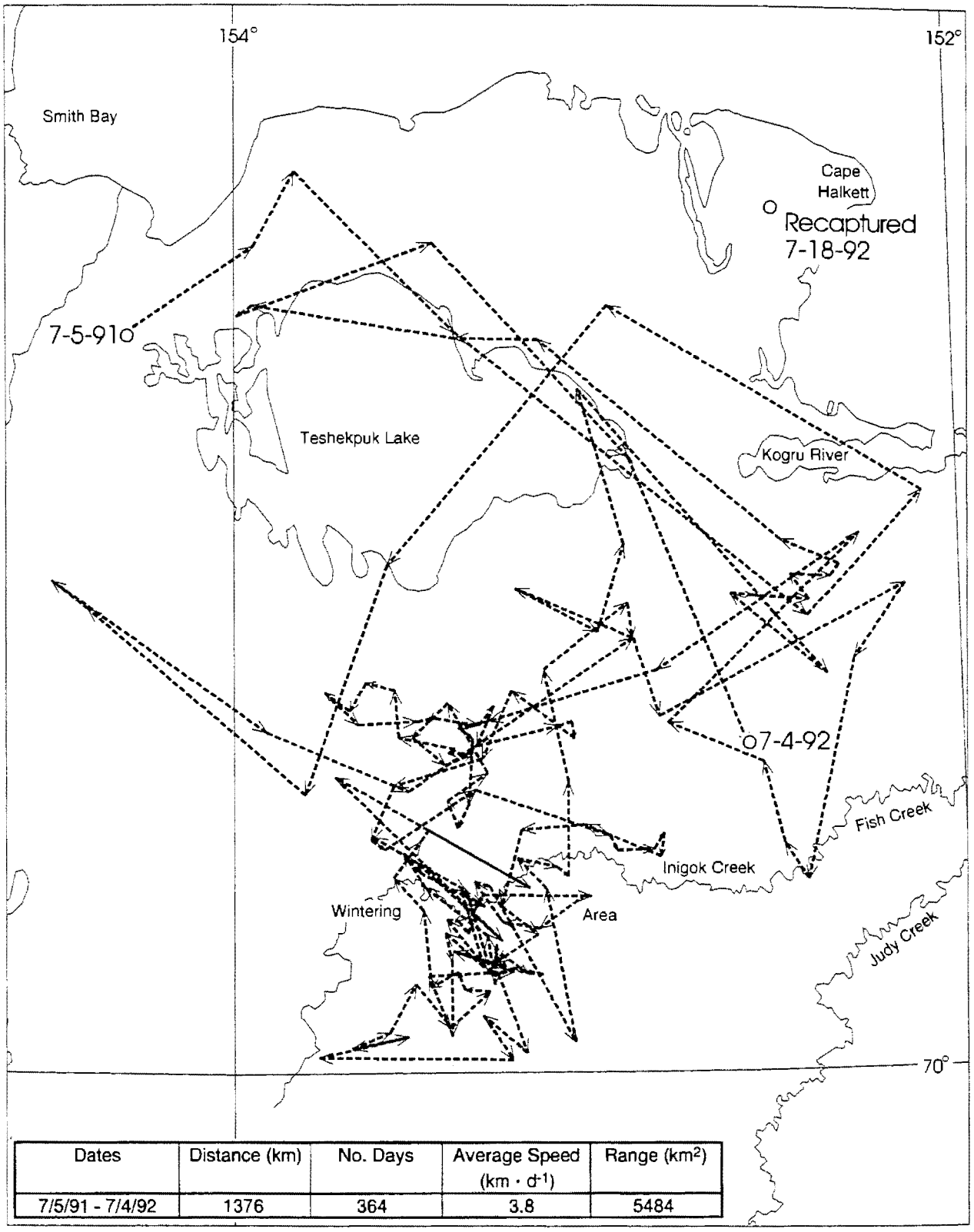
Caribou 4 was collared north of Teshekpuk Lake in July 1990 and was tracked for two years until she was recaptured and the collar removed (Table 1). She spent July through September 1990 east of Admiralty Bay, then traveled west, reaching the Wainwright area in late October (Figure 8). From Wainwright, she moved back to the east, but on a track to the south of her westward track. From mid-November 1990 to early May 1991 she remained in a relatively small area southwest of Atqasuk. In May 1991 she renewed her eastward movements, and by the end of the first year, had traveled to within 10 km of her collaring location. During the second year, Caribou 4 spent most of the winter south of Teshekpuk Lake, near Inigok Creek (Figure 9). In the spring, she moved northeast to the area southeast of Teshekpuk Lake and near the Kogru River. In June 1992, she traveled to the immediate vicinity of her original collaring site, then back to the Kogru River area. She was captured near Cape Halkett about two weeks after the end of her second year. Caribou 4 was similar to caribou 1 in that her second year total distance was only 28% less than the first year distance while the second year range was 76% less (Table 2).

Caribou 5 was collared northeast of Teshekpuk Lake in July 1990 and died in June 1991 (Table 1). She traveled farther and covered a greater range than any other caribou (Table 2). For most of July, she traveled west, then remained south of Admiralty Bay from late July to late September (Figure 10). She traveled generally south southwest from late September to early November, crossed the Brooks Mountain Range 30 - 40 km east of Howard Pass and eventually reached the eastern portion of the Seward Peninsula. She remained there until early April 1991 when she began moving northeast, backtracking much of her previous path. She died in the Brooks Range in early June 1991.



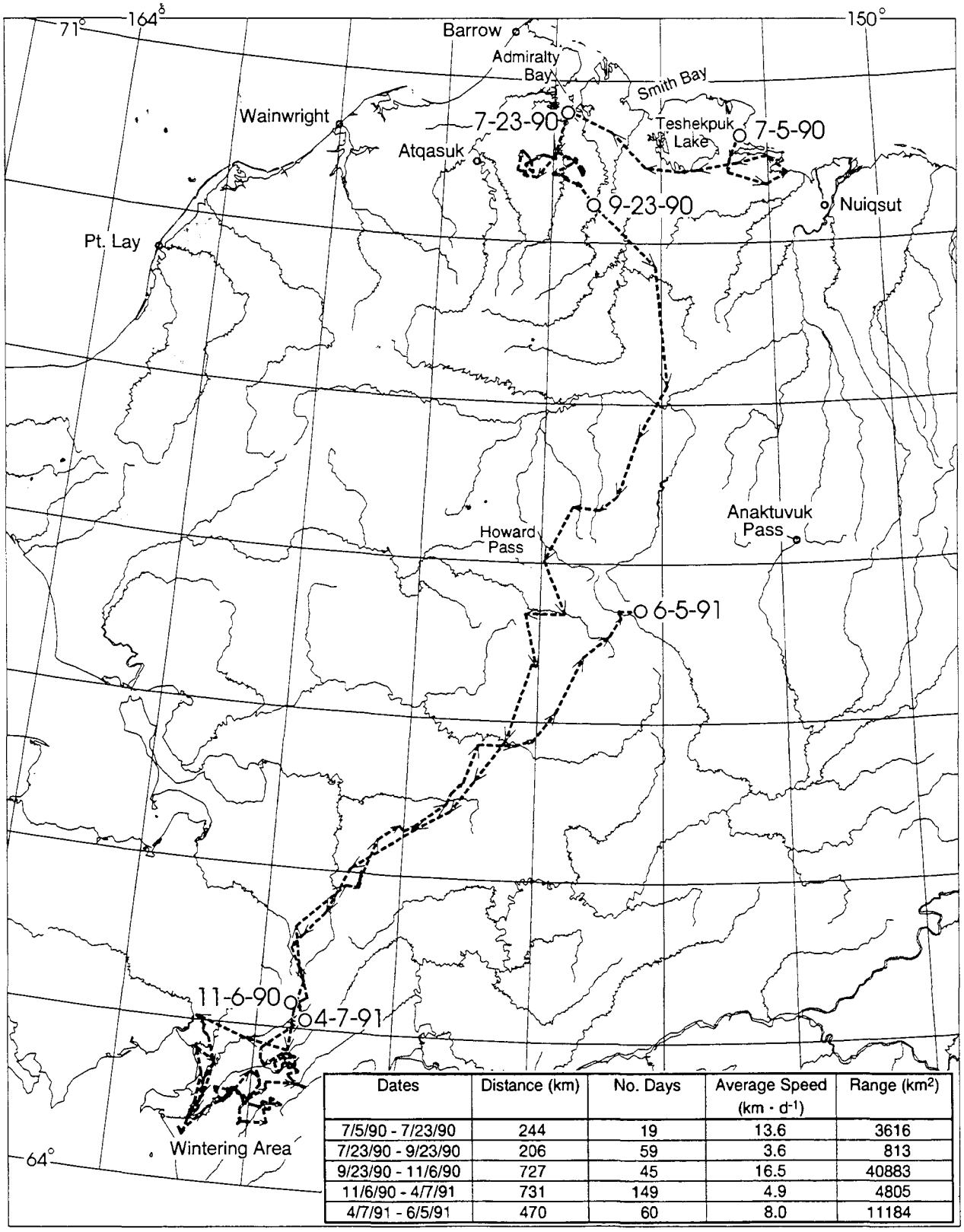
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 9/25/90	615	83	7.5	3828
9/25/90 - 9/29/90	80	5	20.0	626
9/29/90 - 10/9/90	74	11	7.4	335
10/9/90 - 10/21/90	101	13	8.4	434
10/21/90 - 11/6/90	109	17	6.8	494
11/6/90 - 11/18/90	175	13	14.6	2301
11/18/90 - 5/4/91	454	168	2.7	584
5/4/91 - 7/4/91	312	61	5.2	6762
7/5/90 - 11/18/90 and 5/4/91 - 7/4/91	1465	198	7.5	-

Figure 8. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 4, 5 July 1990 - 4 July 1991 (1 cm = 16 km).



Dates	Distance (km)	No. Days	Average Speed ($km \cdot d^{-1}$)	Range (km^2)
7/5/91 - 7/4/92	1376	364	3.8	5484

Figure 9. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 4, 5 July 1991 - 4 July 1992 (1 cm = 6 km).



Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 7/23/90	244	19	13.6	3616
7/23/90 - 9/23/90	206	59	3.6	813
9/23/90 - 11/6/90	727	45	16.5	40883
11/6/90 - 4/7/91	731	149	4.9	4805
4/7/91 - 6/5/91	470	60	8.0	11184

Figure 10. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 5, 5 July 1990 - 5 June 1991 (1 cm = 40 km).

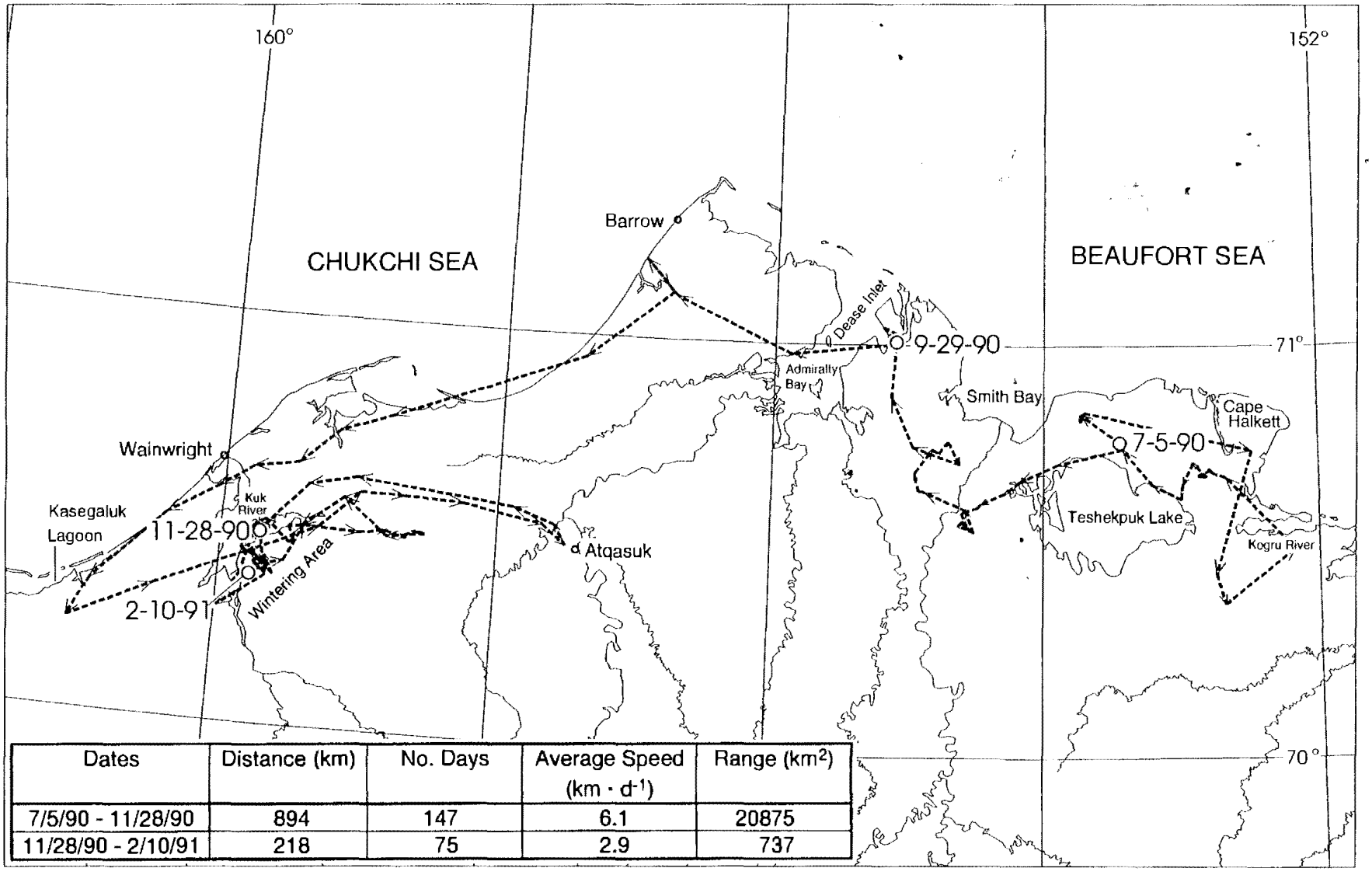
Caribou 6 was collared north of Teshekpuk Lake in July 1990 and died in February 1991 (Table 1). She spent July 1990 north and east of Teshekpuk Lake, then moved west, reaching the east coast of Dease Inlet by the end of September. She traveled to the Chukchi Sea coast near Barrow and followed the coast, reaching the eastern edge of Kasegaluk Lagoon by the end of October (Figure 11). She traveled east to the Atqasuk area, then west to the eastern shore of the Kuk River where she remained from the end of November until her death.

Caribou 7 was collared southeast of Teshekpuk Lake in October 1991 and tracked until the collar was removed in July 1992 (Table 1, Figure 12). She remained in the area east of Teshekpuk Lake, from Cape Halkett on the north to south of the Kogru River. The transmitter functioned sporadically during that time, so we were unable to determine movements with the same level of detail as for other caribou.

Caribou 8 was one of six (caribou 8 - 13) that were collared in July 1992 and one of five (caribou 8 - 12) that died the following winter (Table 1). She was collared north of Teshekpuk Lake and traveled around the western and southern shores of the lake, reaching the area just south of the Kogru River by early August (Figure 13). She remained in that area until her death in late January 1993.

Caribou 9 was collared 1 km south of Cape Simpson in July 1992 and died west of Anaktuvuk Pass at the end of December (Table 1, Figure 14). After being collared, she spent most of August and September in a broad area south of Teshekpuk Lake and Harrison Bay then moved south. She stopped about 150 km west northwest of Anaktuvuk Pass, in the foothills of the Brooks Mountain Range, and remained there from mid-October to early December. She then traveled about 135 km southeast into the mountains, where she died.

Caribou 10 was collared just north of the Kogru River in July 1992 and died southeast of the Kogru River in January 1993 (Table 1, Figure 15). She traveled north to Cape Halkett, then south and east, along the coast of Harrison Bay.



Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/5/90 - 11/28/90	894	147	6.1	20875
11/28/90 - 2/10/91	218	75	2.9	737

Figure 11. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 6, 5 July 1990 - 10 February 1991 (1 cm = 16 km).

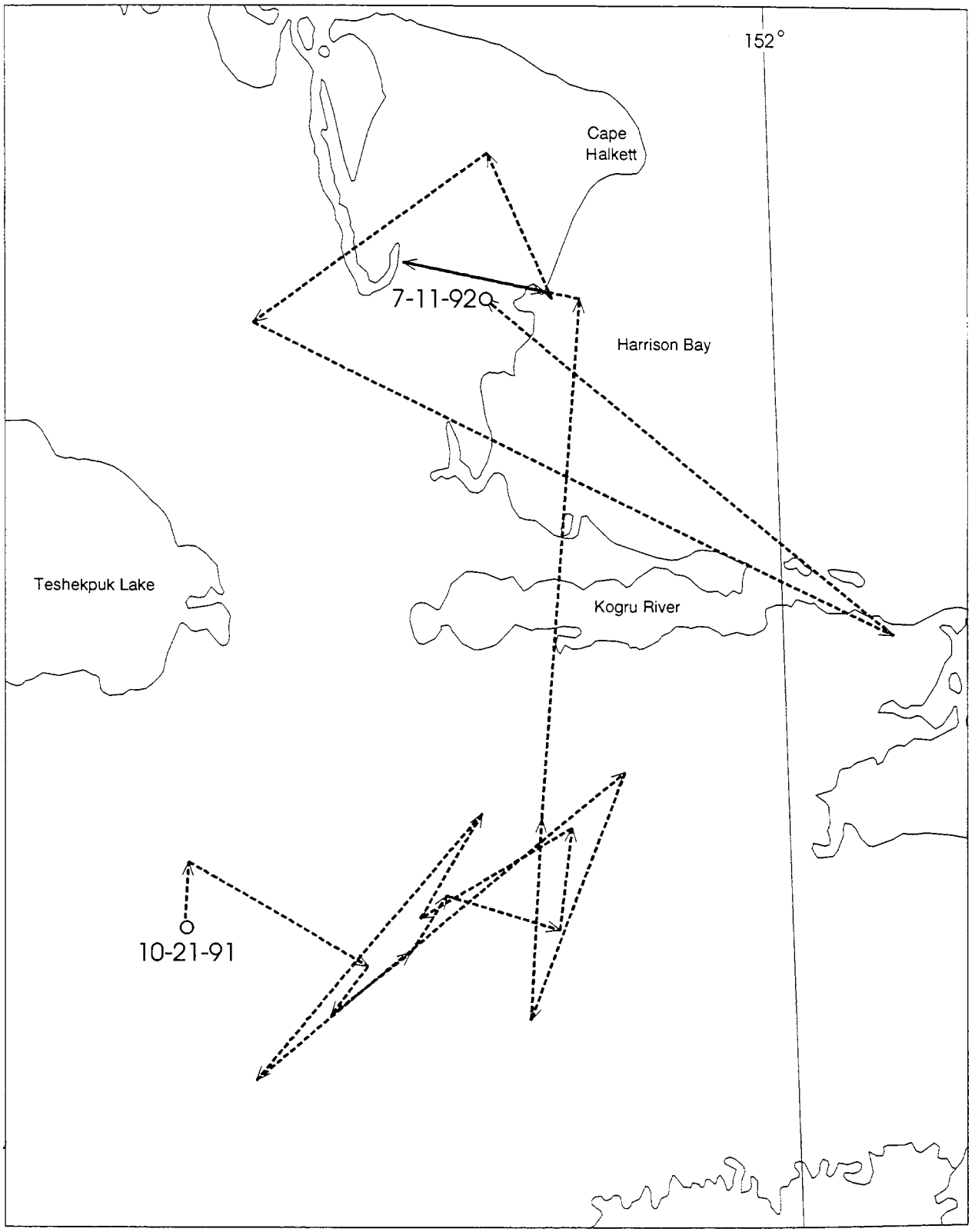
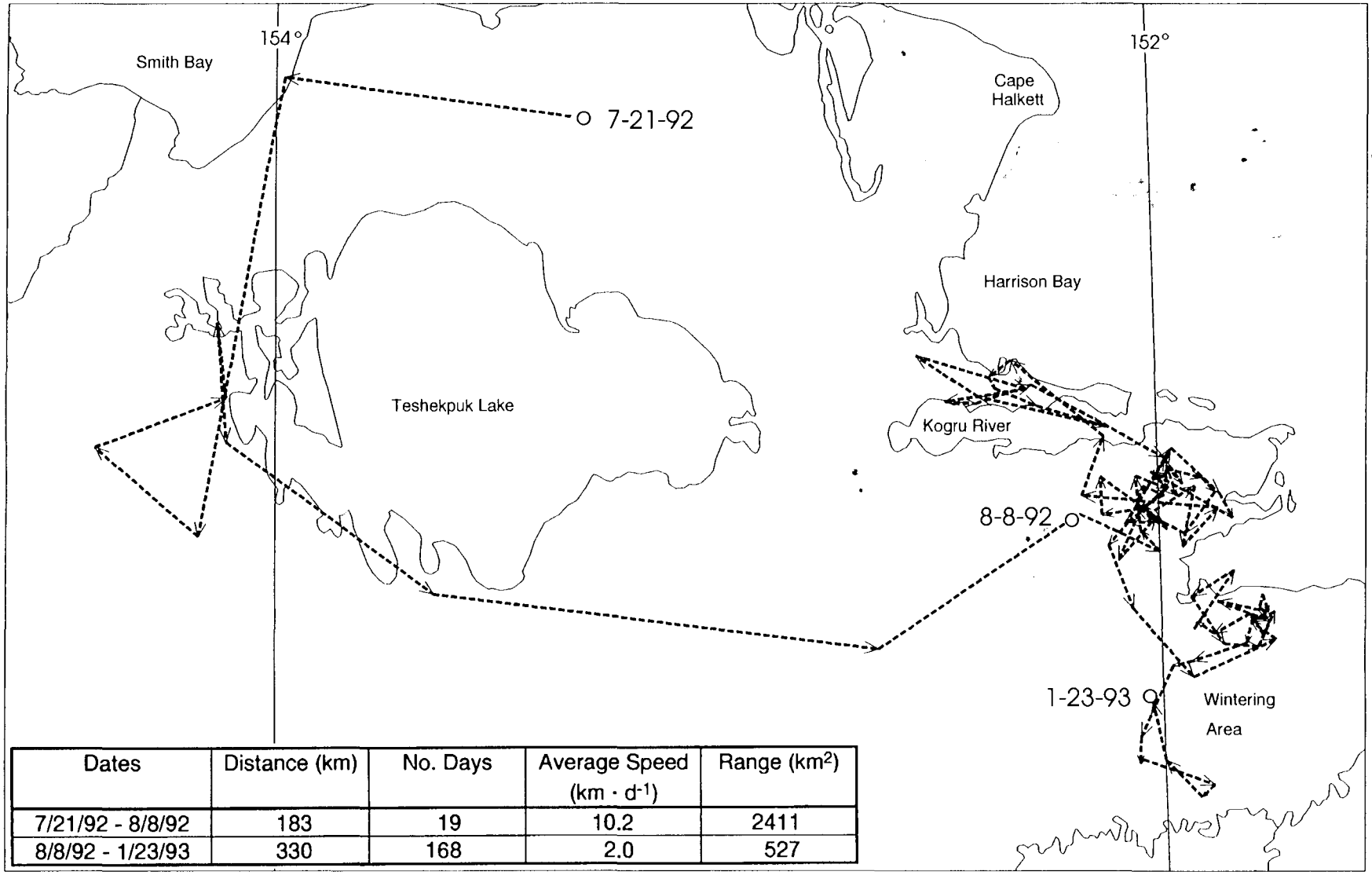
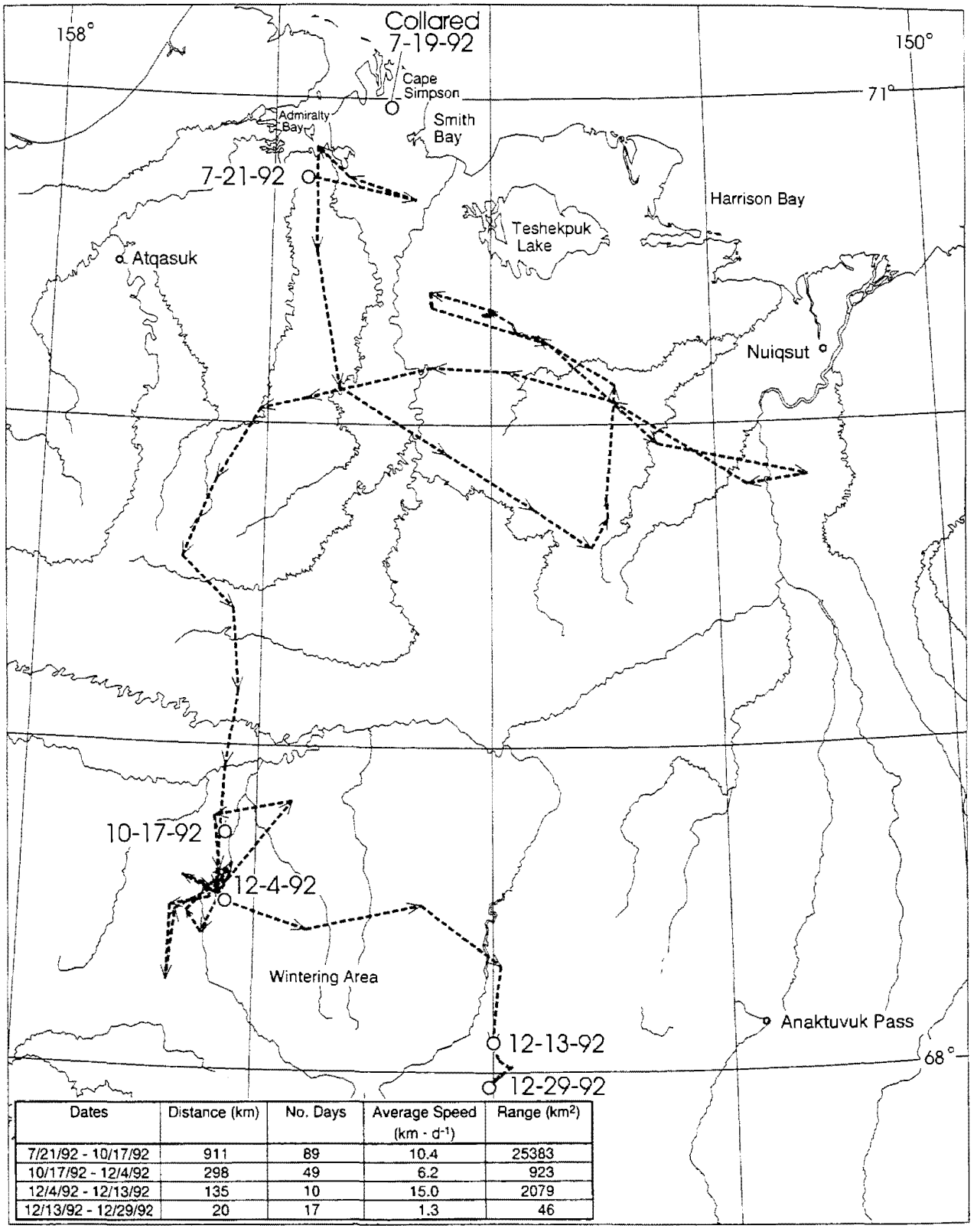


Figure 12. Annotated map showing movements of Teshekpuk Lake caribou 7, 21 October 1991 - 11 July 1992 (1 cm = 3.5 km). Area in this figure lies between 70° N and 71° N. Note that data are sparse due to sporadic functioning of the transmitter.



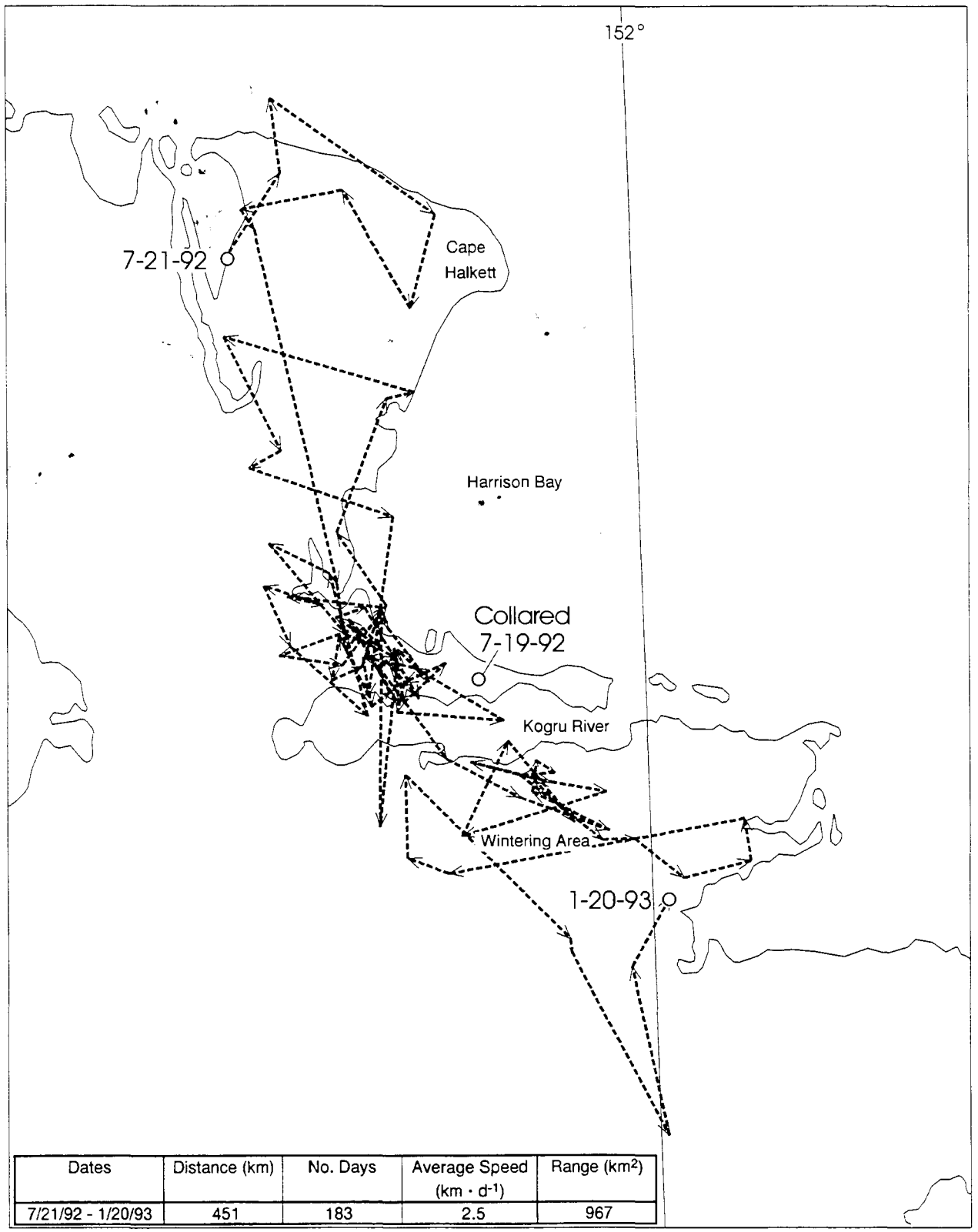
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/21/92 - 8/8/92	183	19	10.2	2411
8/8/92 - 1/23/93	330	168	2.0	527

Figure 13. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 8, 21 July 1992 - 23 January 1993 (1 cm = 5 km). Area in this figure lies between 70° N and 71° N.



Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/21/92 - 10/17/92	911	89	10.4	25383
10/17/92 - 12/4/92	298	49	6.2	923
12/4/92 - 12/13/92	135	10	15.0	2079
12/13/92 - 12/29/92	20	17	1.3	46

Figure 14. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 9, 21 July 1992 - 29 December 1992 (1 cm = 20 km).



Dates	Distance (km)	No. Days	Average Speed ($km \cdot d^{-1}$)	Range (km^2)
7/21/92 - 1/20/93	451	183	2.5	967

Figure 15. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 10, 21 July 1992 - 20 January 1993 (1 cm = 3.5 km). Area in this figure lies between 70° N and 71° N.

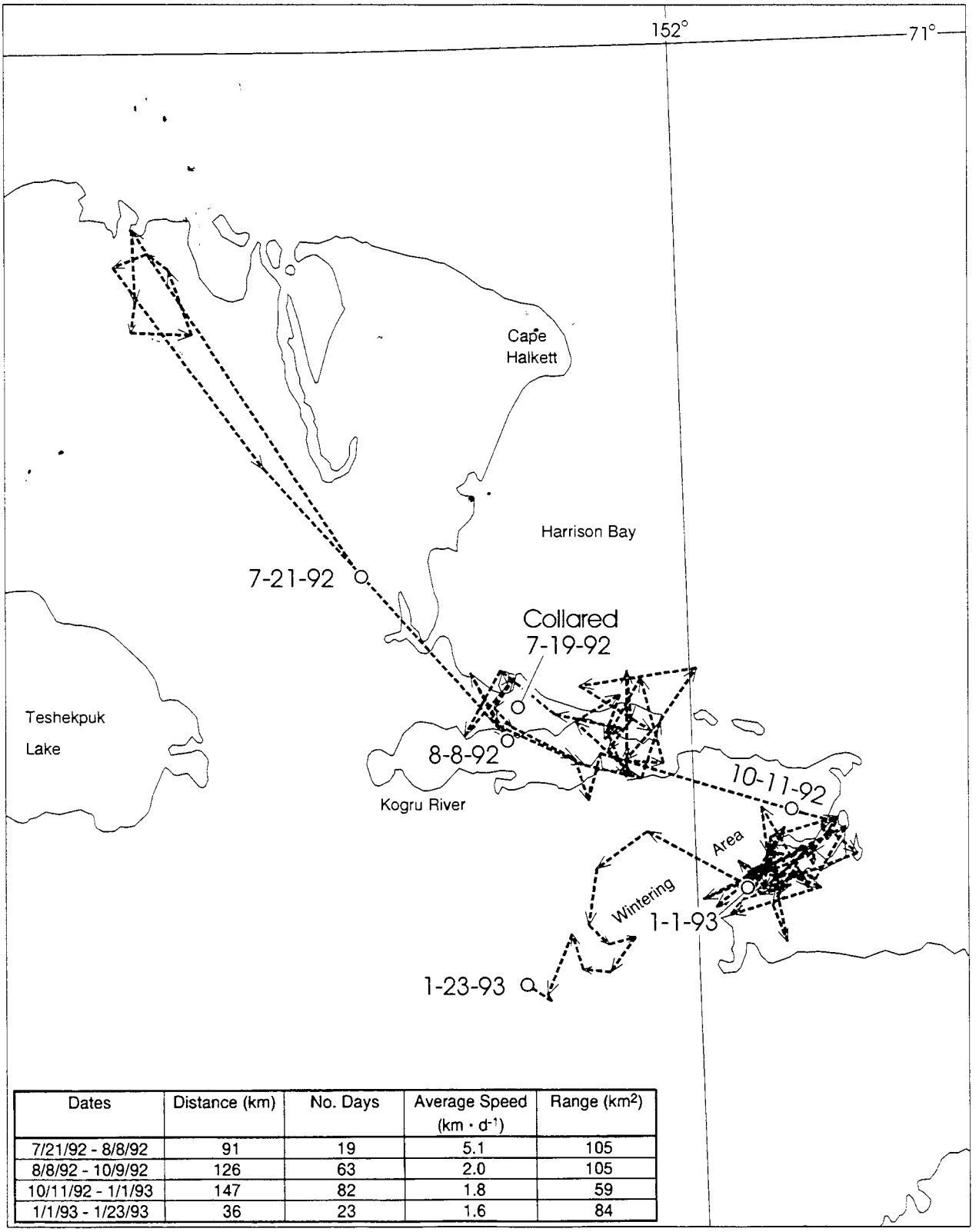
Caribou 11 was collared east of Teshekpuk Lake, just north of the Kogru River, in July 1992 and died south of the Kogru River in January 1993 (Table 1, Figure 16). After collaring she traveled northwest to the coast, then retraced her path southeast past the collaring site near the Kogru River. She remained in the immediate vicinity of the Kogru River from early August to early October, then moved to the coastal area approximately 15 km to the southeast where she remained through December. In early January 1993, she began moving slowly west and south until her death some three weeks later.

Caribou 12 was collared near the mouth of the Kogru River in July 1992 and died a few km to the southeast in March 1993 (Table 1, Figure 17). She traveled west and north along the coast of Harrison Bay, reaching the coastal area near Cape Halkett in late September. She began moving back toward the Kogru River in late October, arriving in the Kogru River area in mid-November. She remained in the Kogru River area until her death.

Caribou 13 was collared east of Teshekpuk Lake, just north of the Kogru River, in July 1992 and was tracked until the collar was removed in July 1993 (Table 1, Figure 18). After collaring, she was in the Cape Halkett area until early August, then moved to the western edge of the Colville River delta where she remained until early September. She moved generally southwest, reaching the foothills of the Brooks Mountain Range in late October, then back to the northeast, at a somewhat slower pace, until mid-December. She remained in the upper Ikpikpuk River area until early May. In early May she continued moving northeast to the Kogru River mouth area. By the end of June 1993 she was near the southern shore of the Kogru River mouth, approximately 10 km from her collaring location. During the time she was tracked (21 July 1992 - 30 June 1993), her total distance traveled approximated the lesser annual distances traveled by other caribou (Table 2).

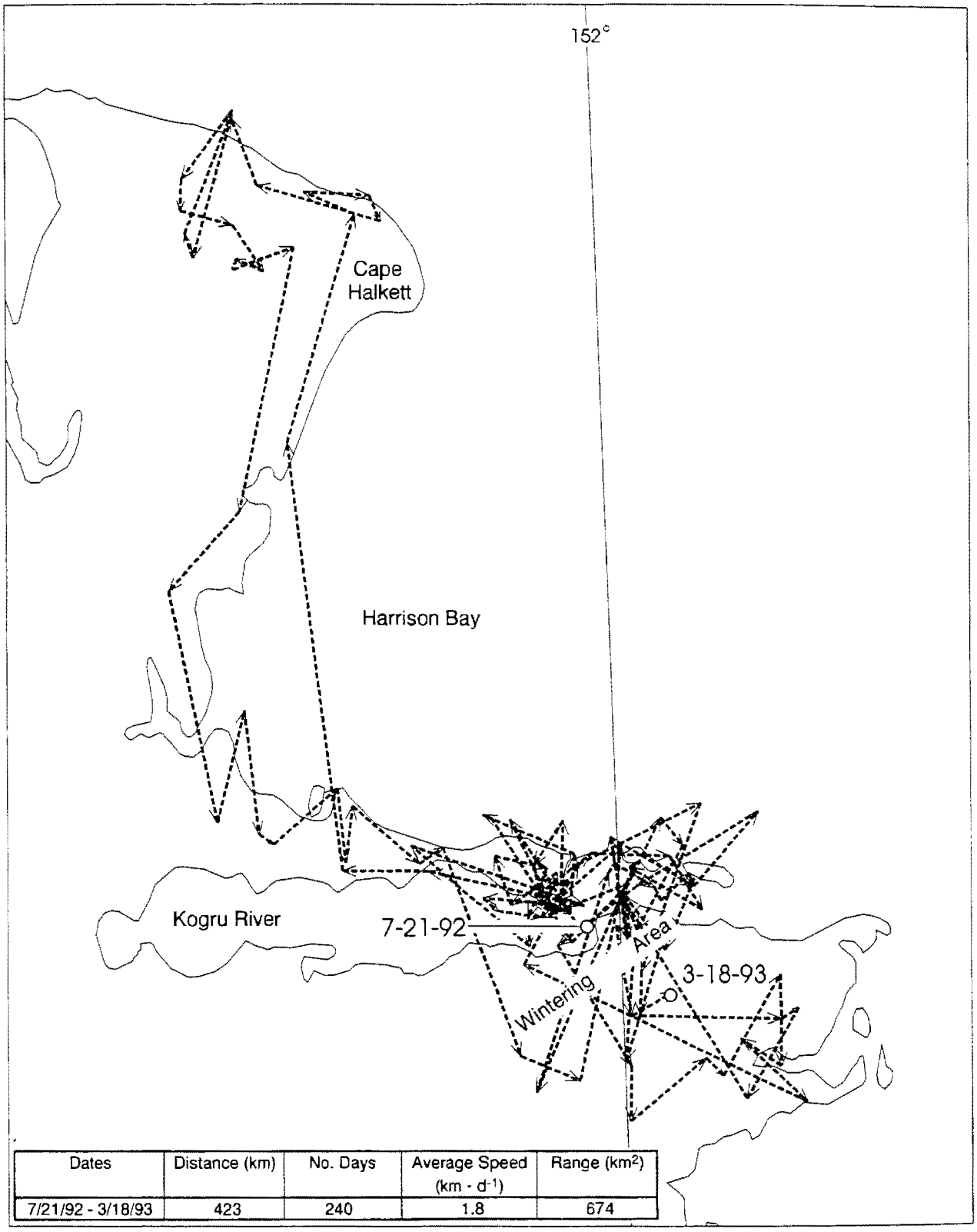
4.2 Monthly and Seasonal Movements

There was considerable variation in distances traveled and area covered among and within years (Figures 19-24, Table 2, monthly data in Appendix B). Monthly distances and ranges were considerably greater in the fall and spring of 1990-91 than in 1991-92. Even those caribou that were collared for all or part of



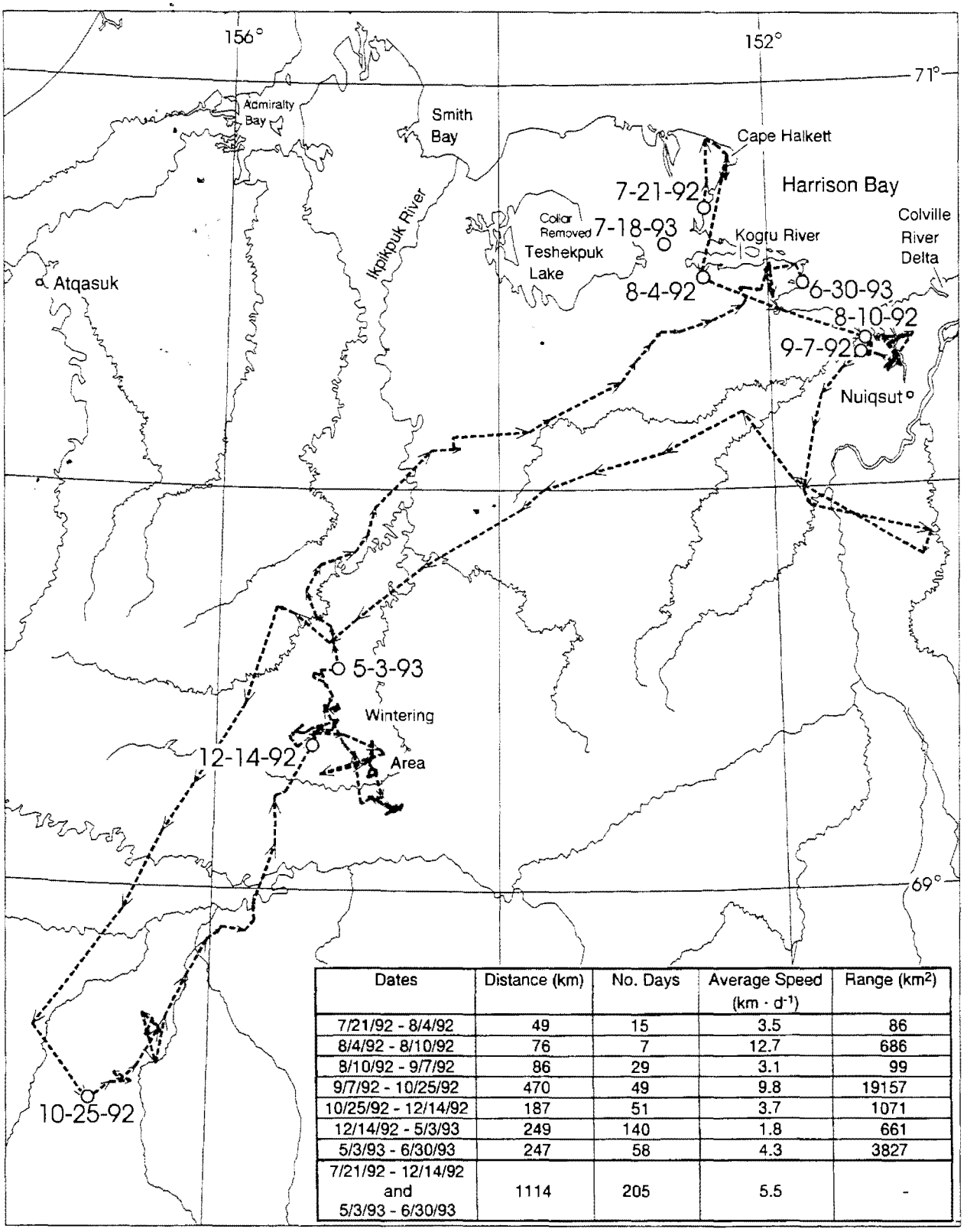
Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/21/92 - 8/8/92	91	19	5.1	105
8/8/92 - 10/9/92	126	63	2.0	105
10/11/92 - 1/1/93	147	82	1.8	59
1/1/93 - 1/23/93	36	23	1.6	84

Figure 16. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 11, 21 July 1992 - 23 January 1993 (1 cm = 4 km).



Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/21/92 - 3/18/93	423	240	1.8	674

Figure 17. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 12, 21 July 1992 - 18 March 1993 (1 cm = 2.5 km). Area in this figure lies between 70° N and 71° N.



Dates	Distance (km)	No. Days	Average Speed (km · d^{-1})	Range (km^2)
7/21/92 - 8/4/92	49	15	3.5	86
8/4/92 - 8/10/92	76	7	12.7	686
8/10/92 - 9/7/92	86	29	3.1	99
9/7/92 - 10/25/92	470	49	9.8	19157
10/25/92 - 12/14/92	187	51	3.7	1071
12/14/92 - 5/3/93	249	140	1.8	661
5/3/93 - 6/30/93	247	58	4.3	3827
7/21/92 - 12/14/92 and 5/3/93 - 6/30/93	1114	205	5.5	-

Figure 18. Annotated map showing movements and movement statistics of Teshekpuk Lake caribou 13, 21 July 1992 - 30 June 1993 (1 cm = 16 km).

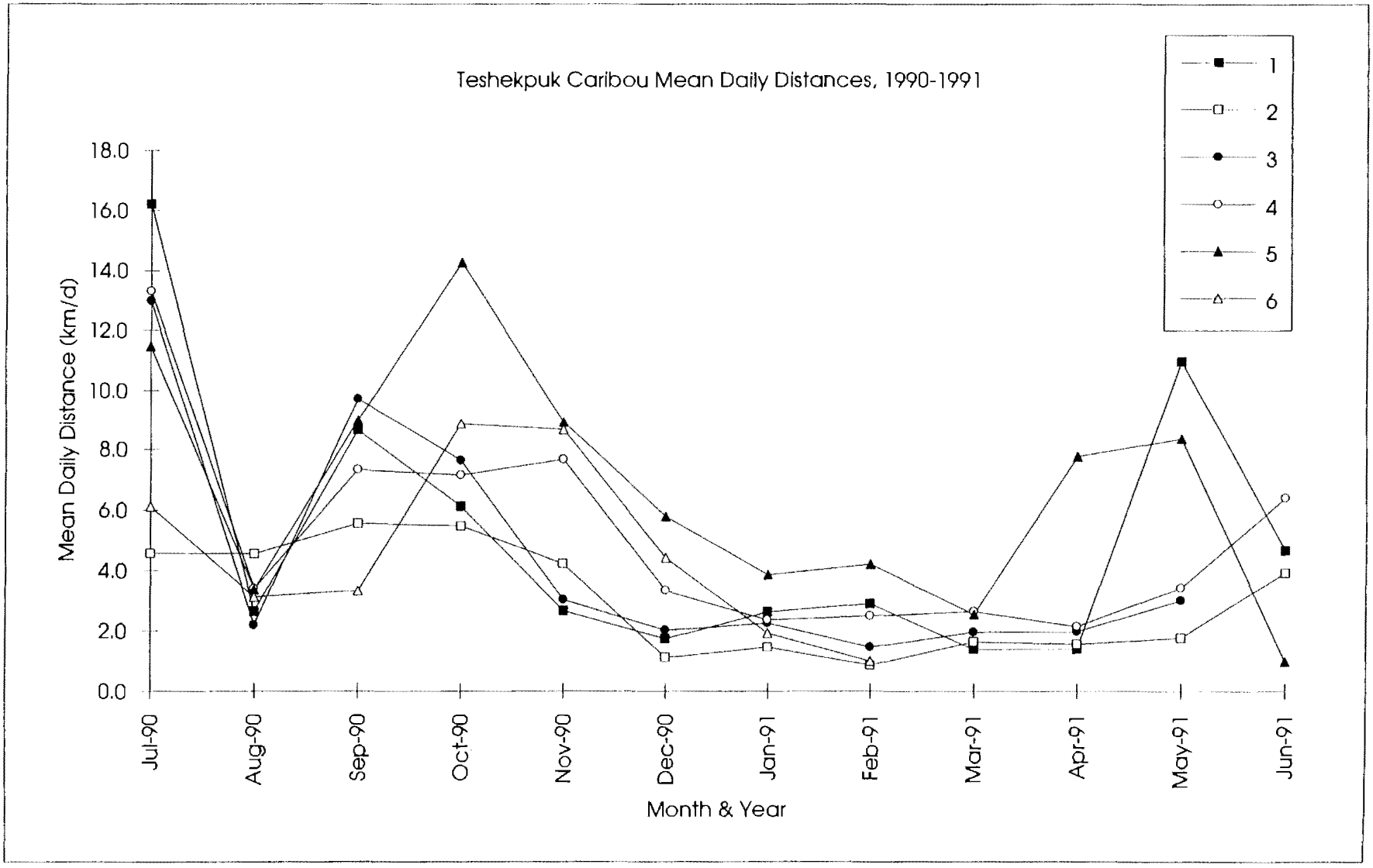


Figure 19. Mean daily distances traveled by six satellite-collared Teshekpuk Lake caribou, July 1990 - June 1991. Note that mean daily distances for July 1990 were calculated only for data collected after collaring (i.e. for 5-31 July). Legend contains caribou identification numbers.

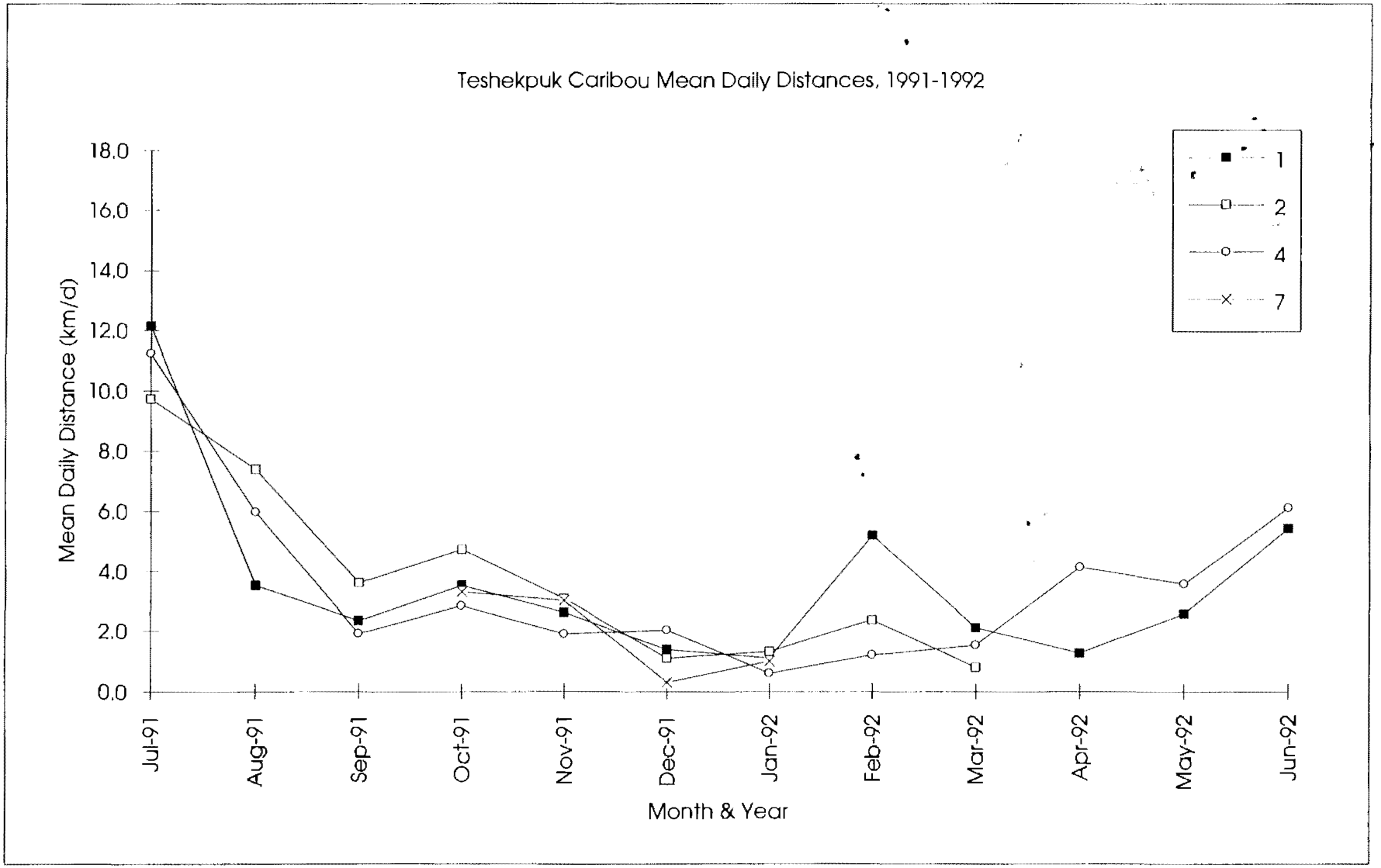


Figure 20. Mean daily distances traveled by four satellite-collared Teshekpuk Lake caribou, July 1991 - June 1992. Legend contains caribou identification numbers.

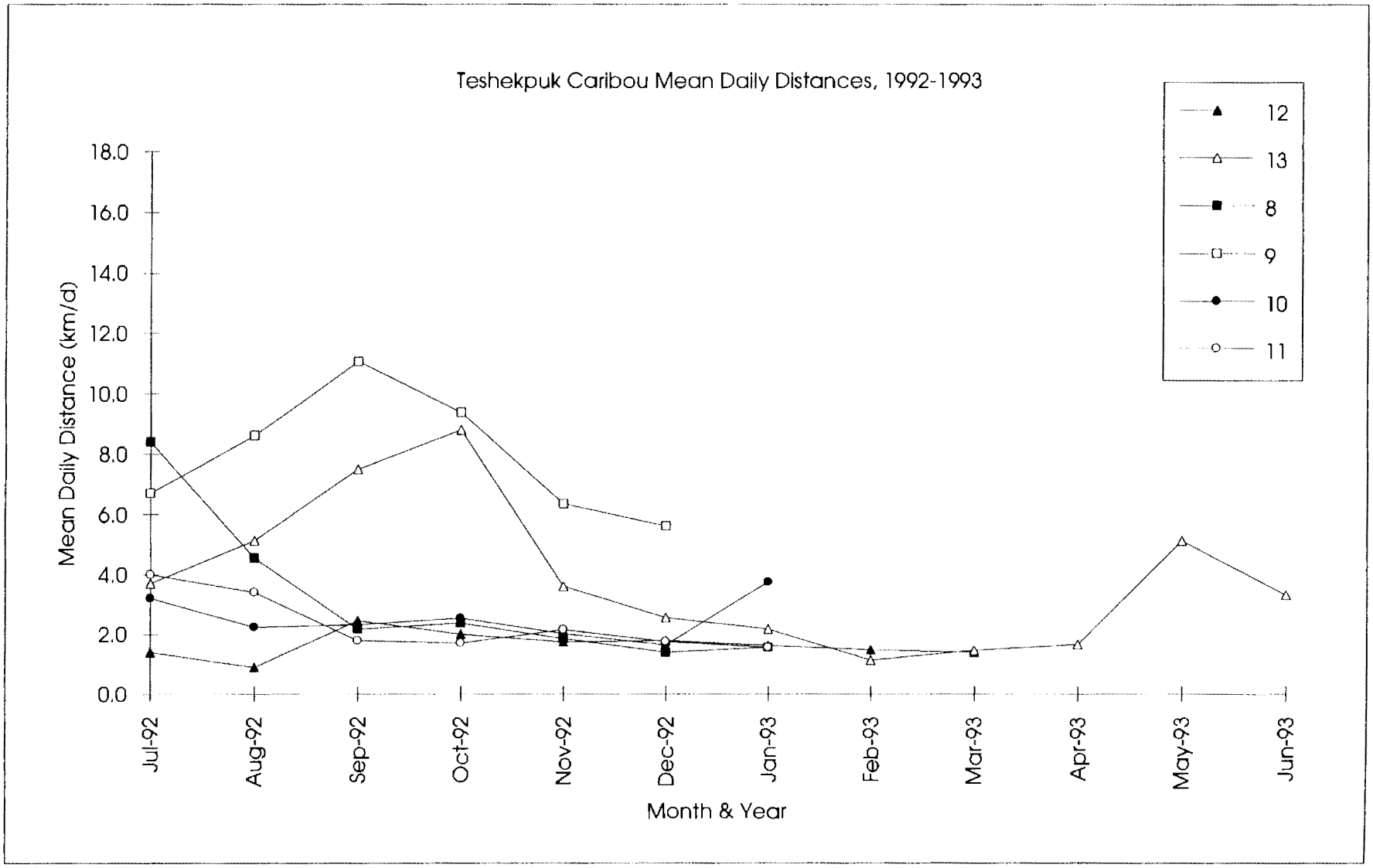


Figure 21. Mean daily distances traveled by six satellite-collared Teshekpuk Lake caribou, July 1992 - June 1993. Note that mean daily distances for July 1992 were calculated only for data collected after collaring (i.e. for 21-31 July). Legend contains caribou identification numbers.

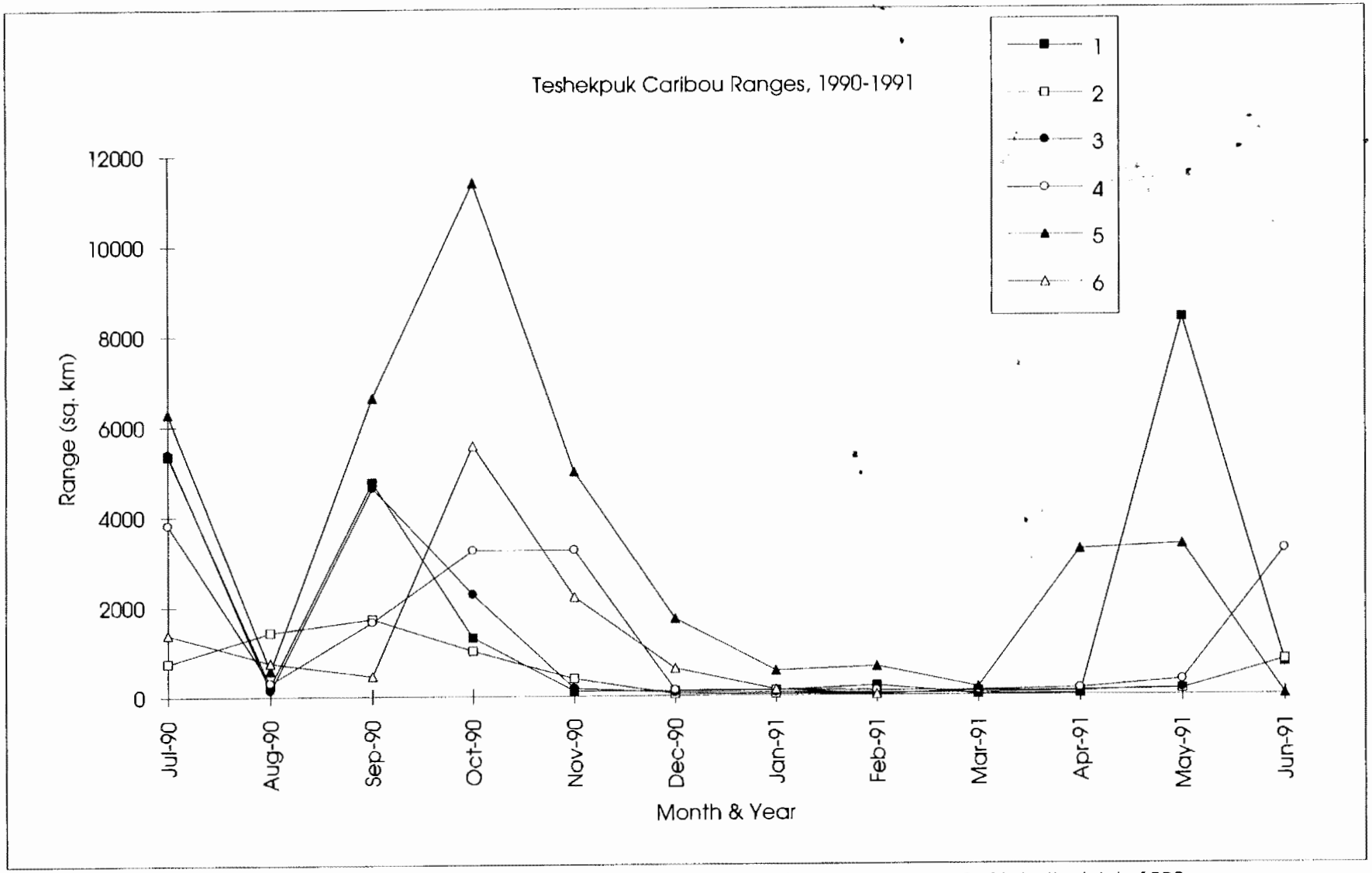


Figure 22. Monthly ranges of six satellite-collared Teshekpuk Lake caribou, July 1990 - June 1991. Note that July 1990 ranges were lower than the true ranges because caribou were collared in early July and data collection did not begin until 5 July. Legend contains caribou identification numbers.

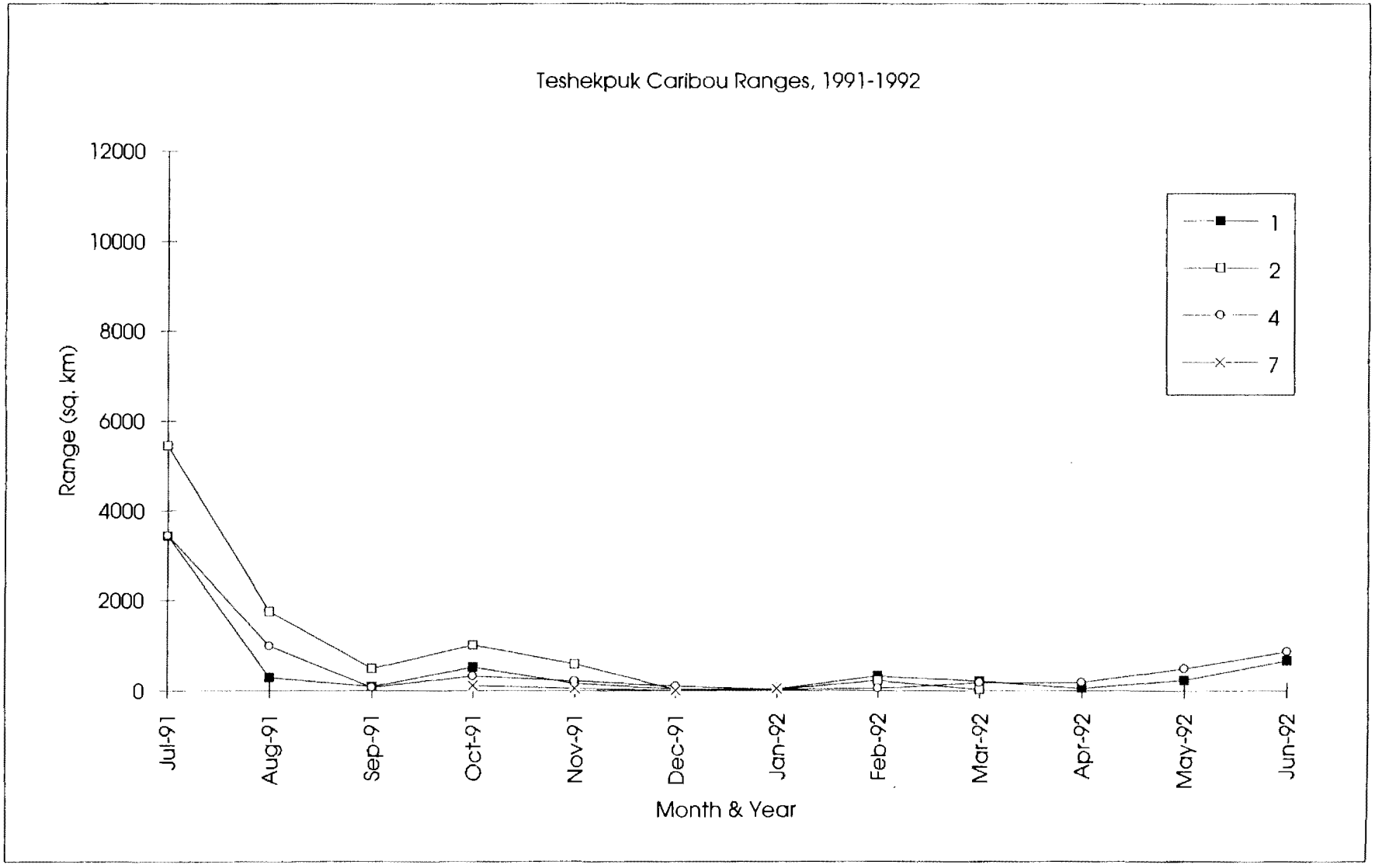


Figure 23. Monthly ranges of four satellite-collared Teshekpuk Lake caribou, July 1991 - June 1992. Legend contains caribou identification numbers.

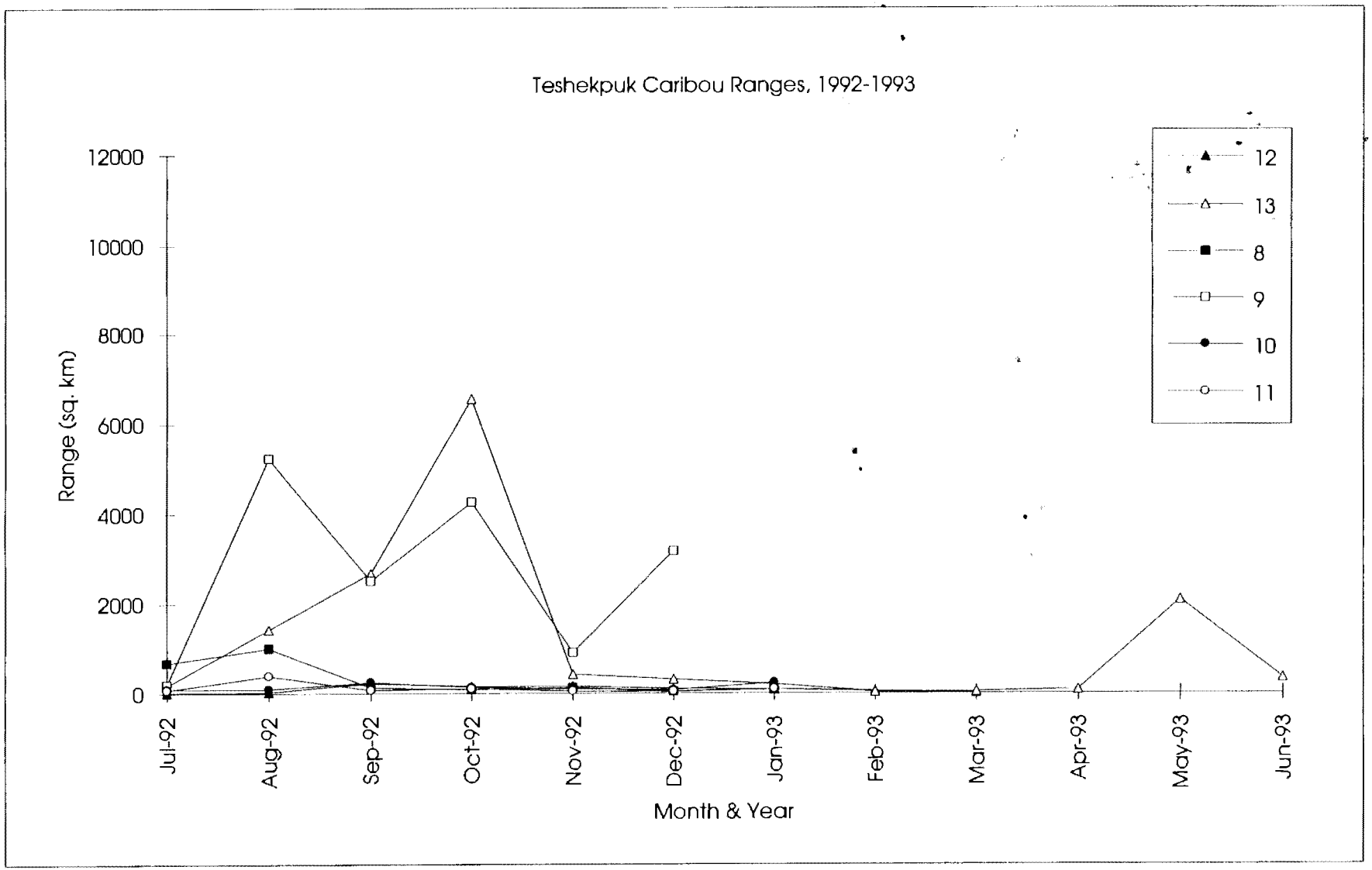


Figure 24. Monthly ranges of six satellite-collared Teshekpuk Lake caribou, July 1992 - June 1993. Note that July 1992 ranges were much lower than the true ranges because caribou were collared in late July and data collection did not begin until 21 July. Legend contains caribou identification numbers.

a second year exhibited different monthly distances and ranges between years. In addition distance traveled and range were generally less in winter (December - March) than in warmer months.

There was variation among caribou but there were also some patterns in distance traveled and area covered. During the first year of the study all of the caribou moved away from Teshekpuk Lake during the fall, traveled relatively long distances and had large ranges. During the second year all of the instrumented animals stayed near Teshekpuk Lake and had smaller ranges and distances traveled. Only in 1992 were there marked within year differences among caribou, when two animals covered large areas and distances while 4 of them had very small ranges and distances traveled.

Like individual distances and ranges, dispersal varied among years (Figure 25, data in Appendix C). During the first year of the study, three of the collared cows dispersed widely from October through May, being distributed over a maximum of nearly 20,000 km^2 in November 1990. This distribution compares to less than 500 km^2 in July of 1990 and 1991. Dispersal of the same caribou during their second year was very different in that, through March 1991 (the extent of the data), dispersal was always less than 1000 km^2. During the third year, five caribou collared in July 1992 had dispersed more in fall and winter than did the three caribou in 1991-1992, but still never approached the dispersal of 1990-1991; the maximum dispersal range for 1992-1993 barely exceeded 4,000 km^2 through January 1993 (the extent of the data).

Three (caribou 1, 4 and 13) of four caribou producing year-long data returned after the first year to within approximately 25 km of their collaring locations; caribou 1 and 4 again returned to the proximity of their collaring locations at or near the end of the second year. These locations were all near Teshekpuk Lake. Caribou 2 was an exception; she was collared northeast of Teshekpuk Lake, but one year later she was near the western shore of Dease Inlet, approximately 125 km from her collaring site. During the second year, she did return to the Teshekpuk Lake area and, although her transmitter failed in March 1992, she was seen near her collaring site during calving surveys on 8 June. Caribou 7 was in the Teshekpuk Lake area in early July, 1992, but, as she was collared in October, 1991, her location in July 1991 is unknown.

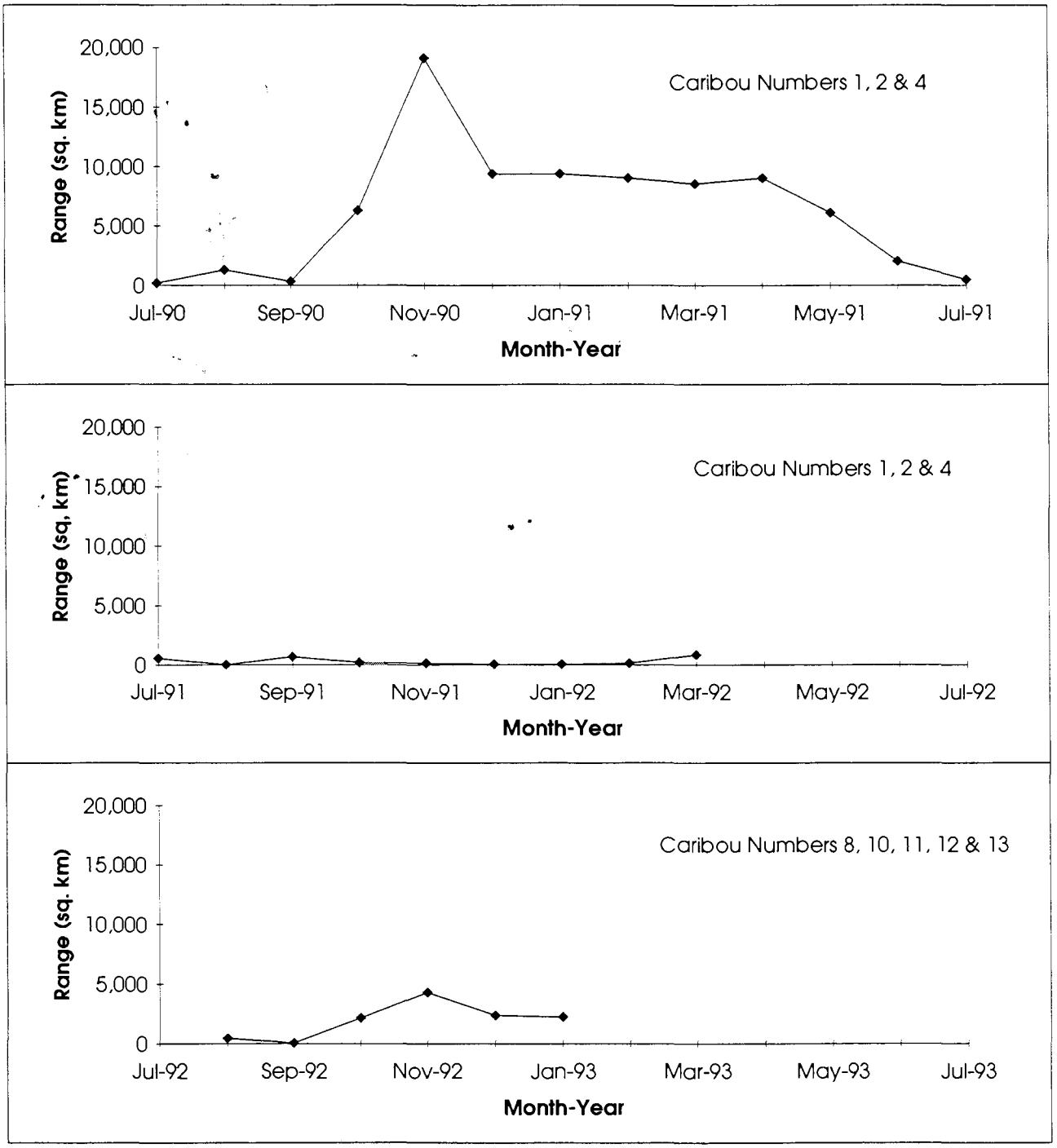


Figure 25. Monthly range of satellite-collared caribou as an index of the Teshekpuk Lake Herd dispersion, 1990 - 1993.

4.3 Calving Areas

During the calving season, satellite-collared caribou (except for caribou 2 in 1991) were distributed from south of Teshekpuk Lake to northeast of the lake (Figure 26). Previous studies have found Teshekpuk Lake caribou in the same general area during calving: south and west of the lake prior to 1978 (Davis and Valkenburg 1979) and, more recently, east, northeast and north of the lake (Davis and Valkenburg 1979, Reynolds 1982, Silva 1985, Carroll 1992). We observed instrumented cows with calves in five of eight instances: caribou 1 in 1991 and 1992, caribou 2 in 1991 (but not in 1992), caribou 4 in 1992 (but not in 1991) and caribou 7 in 1992; caribou 13 had no calf in 1993 (Figure 26).

Caribou 2 calved near Peard Bay in 1991 (Figure 26). Caribou with young calves have been seen each year in the Peard Bay area but their herd affiliation has been unclear. It appears now that at least some of those cows were Teshekpuk Lake caribou using the Peard Bay region as an alternative calving area.

4.4 Wintering Areas

Nine sets of mapped annual movements from seven caribou (caribou 1, 2, 3, 4, 5, 6 and 13) contained discernible locations where the caribou remained in a confined area during winter. We identified these locations as wintering areas. The caribou entered these areas from late October to early December and left between early April and early May. In five instances, caribou began moving from their wintering areas between approximately 28 April and 4 May, and of those, four departed approximately 3 May or 4 May. A sixth caribou departed her wintering area about 5 April. Wintering dates could not be estimated for the other caribou because most remained in a confined area for much of the year and several of those died in mid-winter; in one other case, the data were too sporadic to use.

Wintering locations varied considerably among caribou and among years. The first six collared cows spent their first December in the Barrow-Wainwright-Atqasuk area (three cows), Anaktuvuk Pass area (two cows) and Seward Peninsula area (one cow) (Figure 27). The four caribou producing data into the

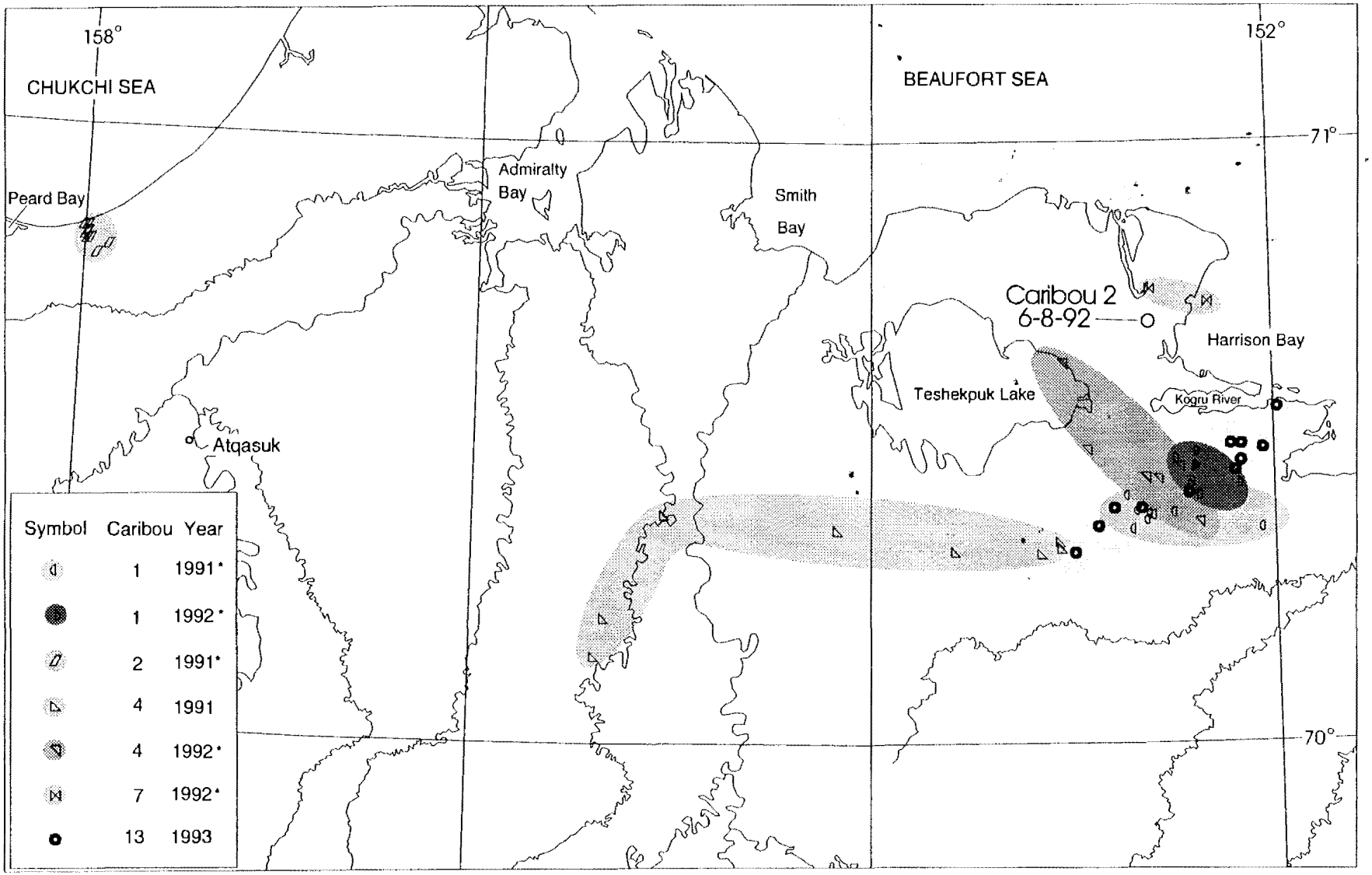


Figure 26. Locations of five Teshekpuk Lake caribou during 1 - 15 June of calving season in 1991, 1992 and 1993 (1 cm = 11 km). All locations were by satellite transmitters except caribou 2 which was located 8 June 1992 by aircraft and VHF radiotransmitter. Asterisk indicates calf present; caribou 2 had no calf when observed 8 June 1992.

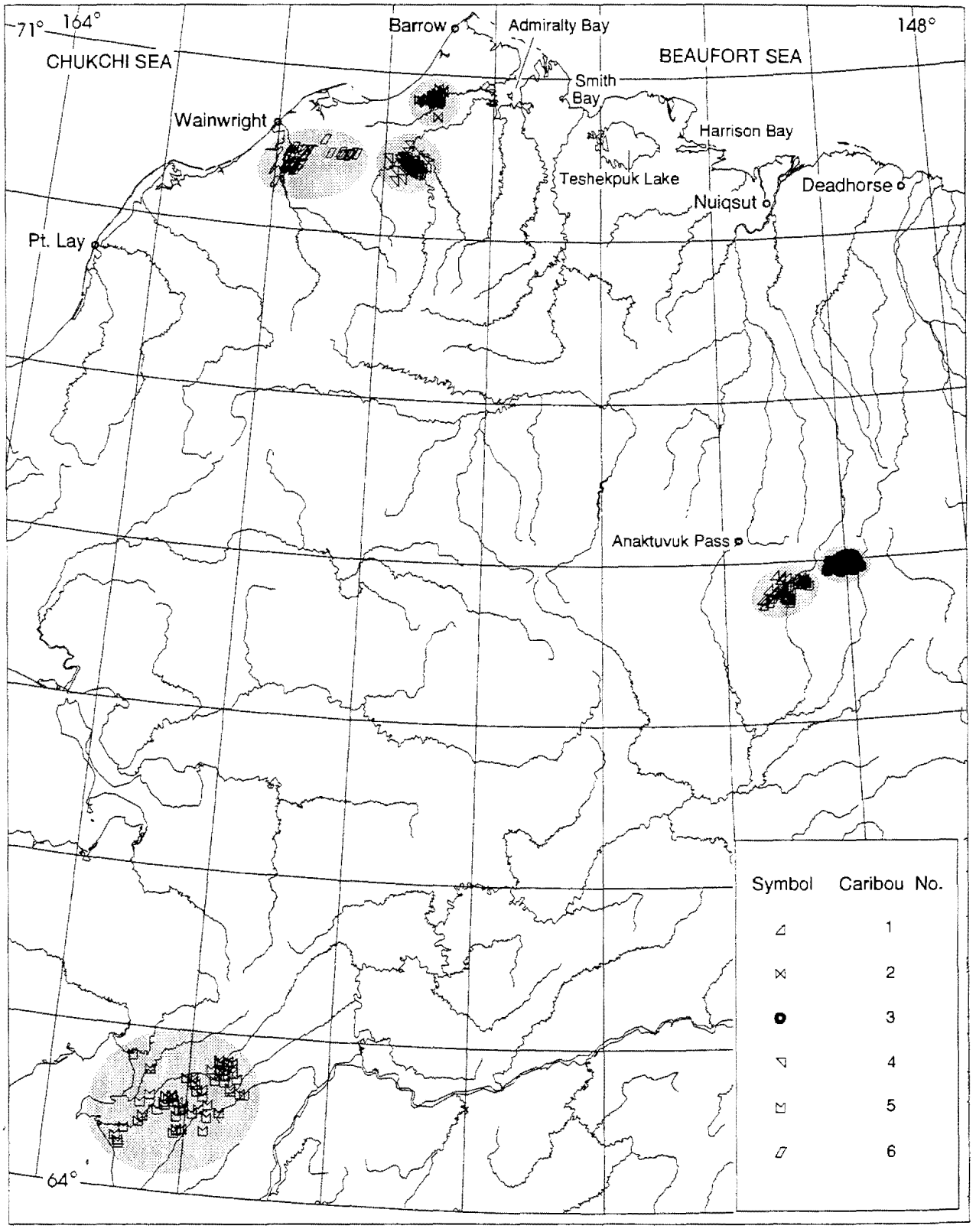


Figure 27. Locations of six satellite-collared caribou, 1 December 1990 - 31 March 1991 (1 cm = 40 km).

second December were all located along Inigok Creek, south of Teshekpuk Lake (Figure 28). The six caribou collared in 1992 were more dispersed during December than were the four from the previous year (Figure 29); four of the six were close together, south and southeast of the Kogru River, while the other two were approximately 200 - 250 km to the south southwest. The four caribou wintering near the Kogru River in 1992-1993 were in the same general area as the four that were tracked during the previous winter.

4.5 Annual Distances Traveled and Areas Covered

Only six caribou produced data for all or virtually all of one or two years (Table 2). Of these, two produced data for two full years. The mean total distance traveled for the six cows (n = 8) was 1,826 $\pm$ 274 (SE) km. By comparison, Fancy *et al.* (1989) found a mean annual distance of 4,355 $\pm$ 150 (SE) km for 10 Porcupine Herd cows and 3,031 $\pm$ 97 (SE) km for 10 Central Arctic Herd cows; the mean distance traveled by the Porcupine cows was significantly greater than that of the Central Arctic cows. Both were considerably greater than the mean for the Teshekpuk Lake cows and exhibited less variability, although one Teshekpuk Lake cow (caribou 5) traveled 3561 km, a distance between the mean annual distances for the Central Arctic and Porcupine cows. These findings were not surprising because previous observations (Davis *et al.* 1978, Reynolds 1982, Silva 1985) have indicated that the Teshekpuk Lake and Central Arctic Herds tended not to migrate extensively.

The annual areas covered by some of the collared Teshekpuk Lake cows - particularly those wintering near the Seward Peninsula or near Anaktuvuk Pass - were greater than indicated in previous reports (Davis *et al.* 1978, Reynolds 1982, Silva 1985). Our findings may simply have been the result of satellite technology and its superior ability to track caribou compared to traditional VHF radiotransmitters. They may also have indicated a true expansion of range due to substantially increased herd sizes and the associated need for more food resources. Fancy *et al.* (1989) attributed the differences in annual distances traveled by the Porcupine and Central Arctic Herds to the differences in herd size, noting that as a herd enlarges, its range increases.

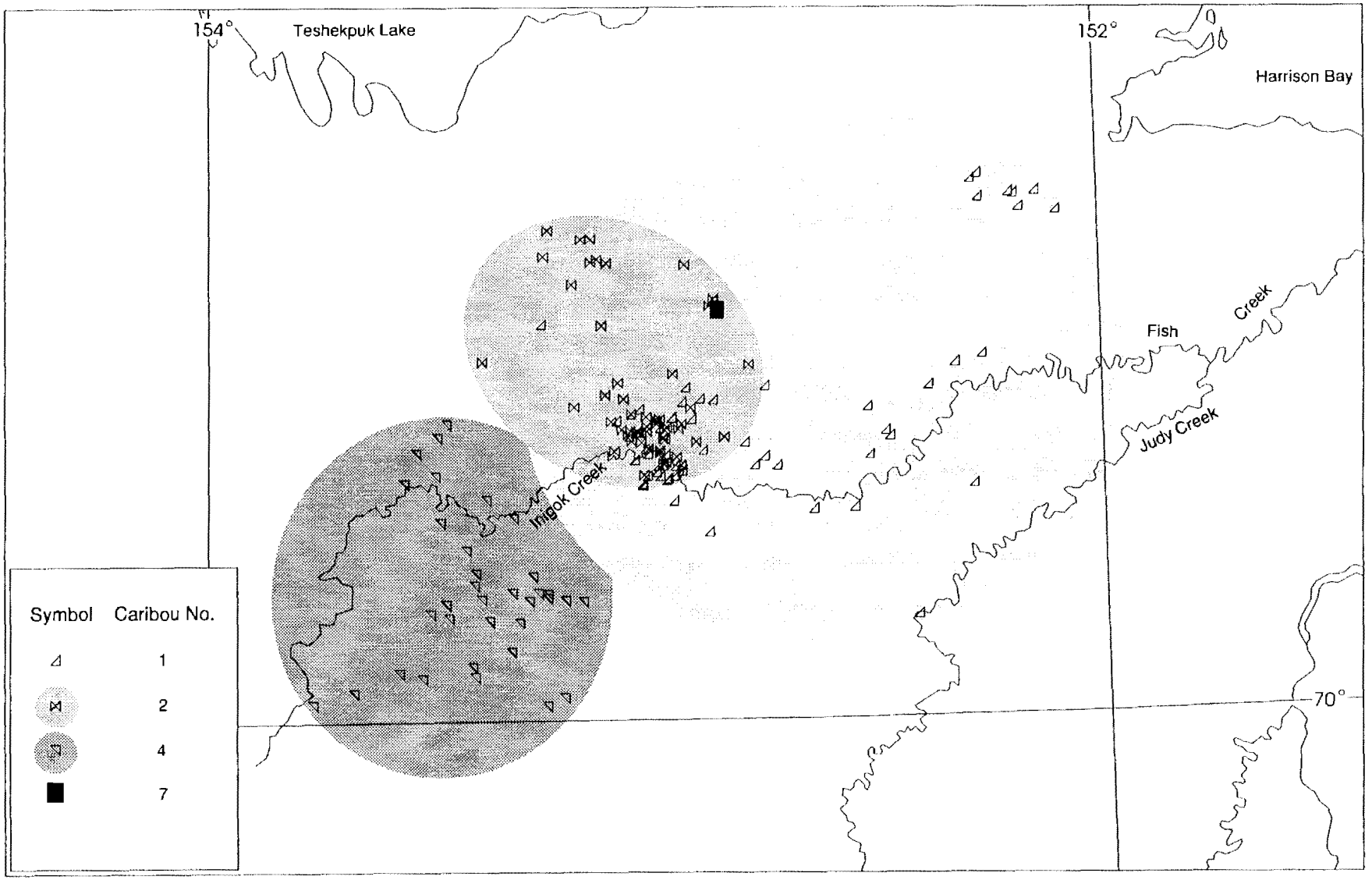


Figure 28. Locations of four satellite-collared Teshekpuk Lake caribou, 1 December 1991 - 31 March 1992 (1 cm = 5 km). Note that there was only one location for caribou 7.

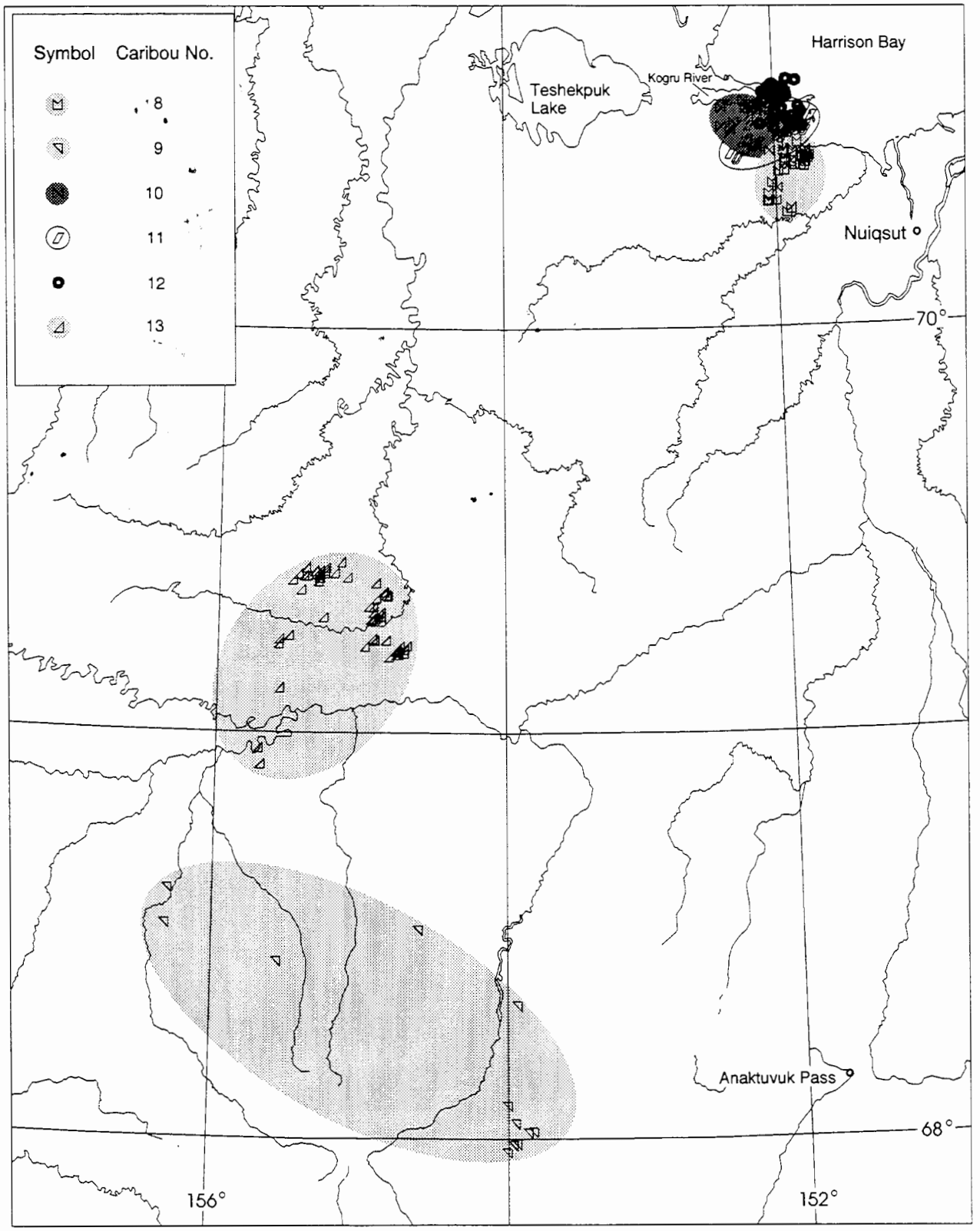


Figure 29. Locations of six satellite-collared Teshekpuk Lake caribou, 1 December 1992 - 31 March 1993 (1 cm = 16 km).

One must consider the possibility that the 1990-1991 movements were so extensive because we had inadvertently collared Western Arctic Herd caribou, but all evidence indicates that the caribou collared in this study were from the Teshekpuk Lake Herd. Western Arctic caribou disperse across the North Slope during the summer and mix with the Teshekpuk Lake Herd; therefore, it would be possible to mistakenly capture a Western Arctic caribou in the Teshekpuk Lake vicinity. However, the caribou were captured near Teshekpuk Lake three weeks after calving, near the Teshekpuk Lake Herd calving grounds. It is unlikely that Western Arctic females with young calves traveled 270 km from their calving grounds during those three weeks. In addition, all of the satellite-collared caribou that survived the 1990-1991 winter and spring returned to the Teshekpuk Lake area and spent the following winter there. More evidence that the satellite-collared caribou were true indicators of 1990-1991 Teshekpuk Lake Herd movements was the detection of five additional Teshekpuk Lake Herd VHF radiocollars south of the Brooks Mountain Range during that winter.

4.6 Activity

Activity patterns varied among caribou and years (Figures 30 - 32) but a few patterns were discernible. The greatest consistency occurred during the second year: activity was greatest in the summers and least in spring and fall, with a secondary activity peak in winter (Figure 31). In most cases for years one (Figure 30) and three (Figure 32), activity was greatest in summer. In a few cases, there were also secondary activity peaks in winter (caribou 6, year one; caribou 11, year three), but most caribou were relatively inactive during those two winters. In a few cases, there were activity peaks of varying degrees in fall and/or spring (caribou 1, 3 and 5 in the first year; caribou 9 and 13 in the third year). These fall/spring activity peaks occurred in caribou that traveled especially long distances - generally south in the fall, north in the spring. Thus, the satellite-collared caribou were active in the summer, sometimes active in the fall and/or spring (if they migrated long distances), were otherwise less active in fall and spring, sometimes had activity increases in winter and sometimes were relatively inactive in winter.

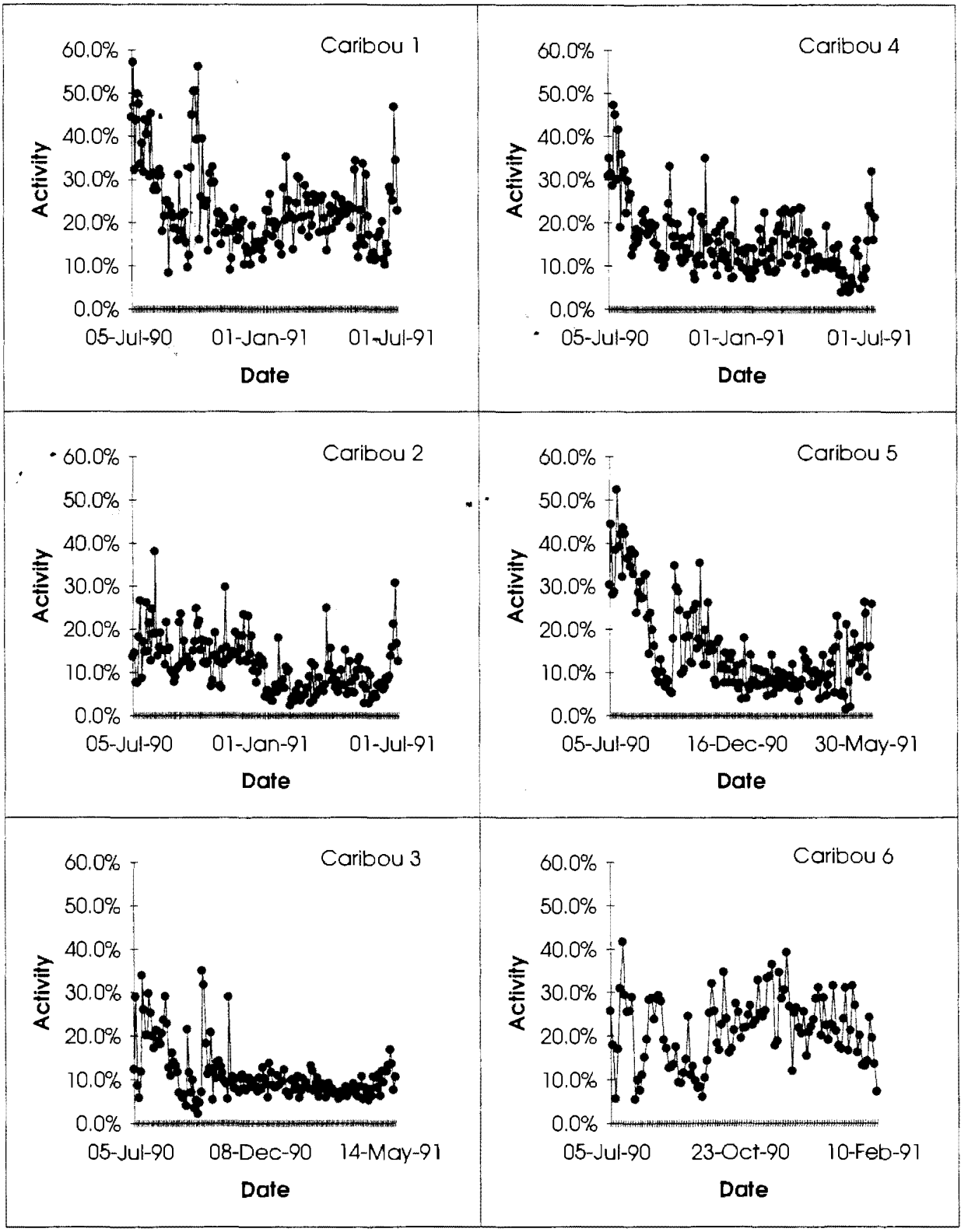


Figure 30. Activity as percent of active seconds per 24 hours for six satellite-collared Teshekpuk Lake caribou, 1990 - 1991.

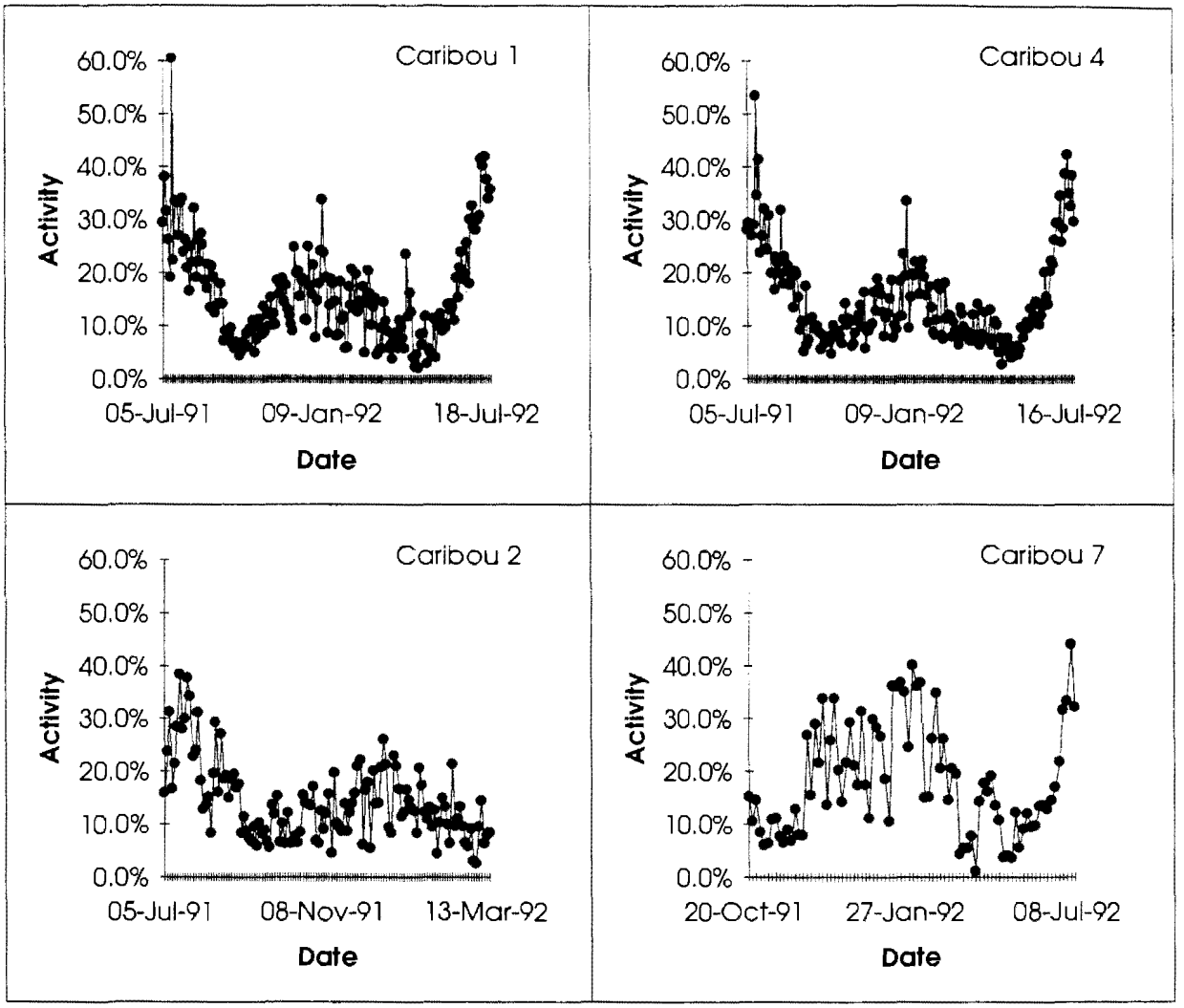


Figure 31. Activity as percent of active seconds per 24 hours for four satellite-collared Teshekpuk Lake caribou, 1991 - 1992.

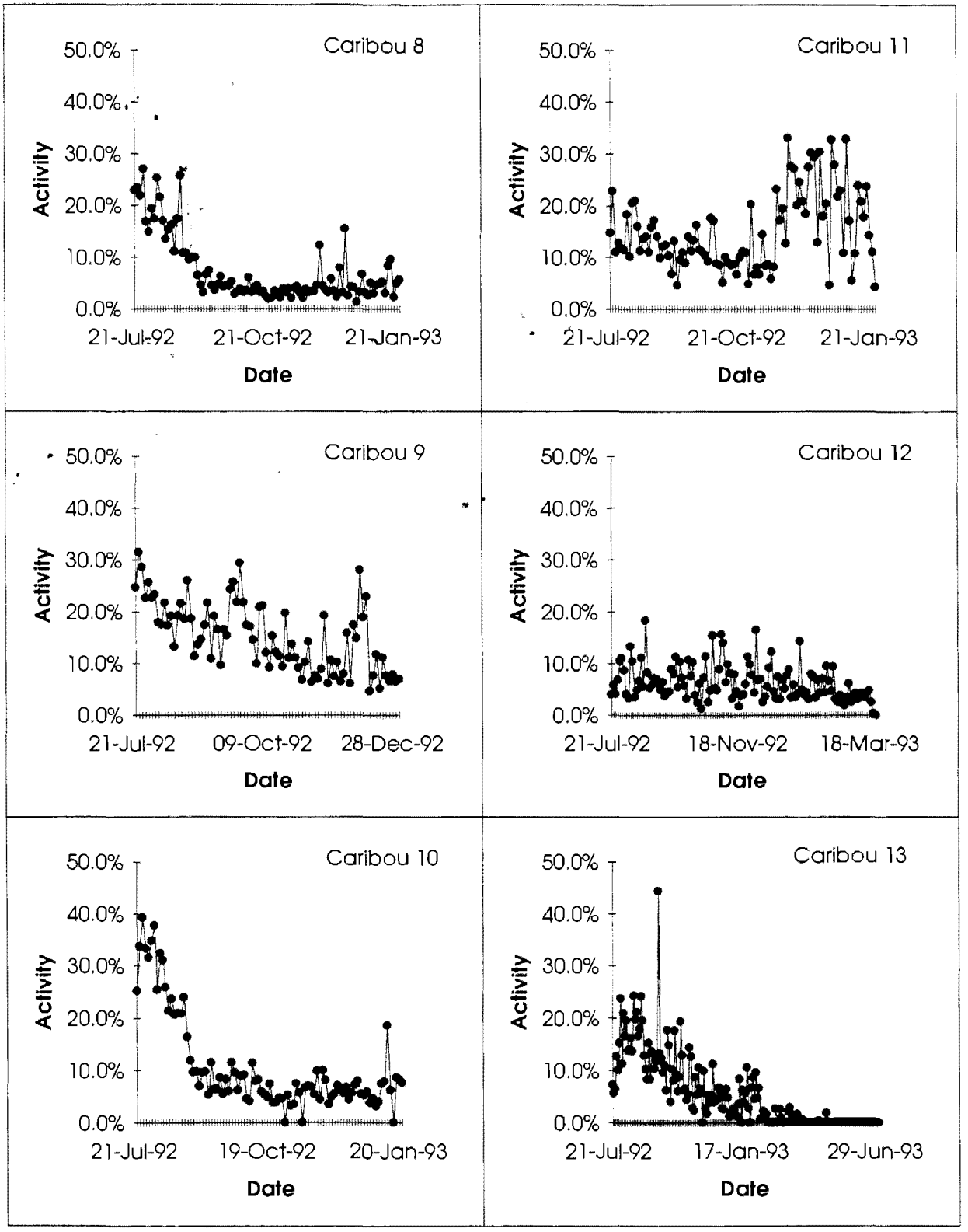


Figure 32. Activity as percent of active seconds per 24 hours for six satellite-collared Teshekpuk Lake caribou, 1992 - 1993.

4.7 Herd Range

The estimated herd range was 219,214 km^2, intermediate between that of the Central Arctic Herd (67,300 km^2) (Valkenburg 1992) and those of the Porcupine (336,700 km^2) (Whitten 1992) and Western Arctic (362,600 km^2) (Machida 1992) Herds. However, this figure more properly represents maximum area used by the Teshekpuk Lake Herd than herd range as calculated for the other herds.

It is difficult to clearly define and compare the Teshekpuk Lake Herd range and to estimate herd density. The area used by the herd can be as large as the 215,600 km^2 estimate for the first year of the study or it can be much smaller as in the second (3,772 km^2) and third (25,597 km^2) years. Two other difficulties in defining the herd range and density are that (1) other arctic caribou herds periodically use the same area, competing for resources and perhaps leading some Teshekpuk Lake caribou beyond their usual wintering areas and (2) much of the Teshekpuk Lake Herd area of use - a greater proportion than for other herds - is covered with water. Accordingly, the only conclusion we can make about the Teshekpuk Lake Herd's range is that it is quite variable and the herd has the potential to use a very large area.

4.8 Mortalities

Mortality rate among satellite-collared caribou was high (Table 1) and much greater than expected. It was greater than for Teshekpuk Lake caribou with VHF radiotransmitters only and greater than for satellite-collared caribou in other parts of Alaska (P. Valkenburg, pers. comm.; K. Whitten, pers. comm.; R. Cameron, pers. comm.). In most cases cause of death could not be determined because the carcasses were scavenged before they could be examined. However, caribou 11 was very thin and appeared to have starved and caribou 8 appeared to have been killed by wolves. Five of the six caribou collared in 1992 died before spring, four between 30 December 1992 and 23 January 1993. Weather had been especially severe before and during the time these caribou were dying: air temperature -40°C and below, wind 25 - 30 $km \cdot hr^{-1}$, snow unusually deep and hard-packed with a dense ice layer approximately in the middle of the snow column. Carcasses of many uncollared caribou were also

found in the area. Apparently the satellite-collared caribou were in an area with such unfavorable conditions that they perished as a result of the severe weather and poor nutrition or were more susceptible to predators. The satellite collars were valuable to managers in that the location and activity data indicated several collared animals had died at similar times and locations. These data alerted us to the possibility that a large number of caribou were dying in that area. We do not know whether the presence of the satellite collars contributed to the study animals' deaths.

5.0 SUMMARY AND CONCLUSIONS

The Teshekpuk Lake Caribou Herd is one of four herds in arctic Alaska and is used as a subsistence resource by area residents. The herd was recognized as an entity in the 1970s. Initial biological studies were conducted by the ADF&G and the BLM; joint studies were later conducted by these agencies and the NSB.

Included in these joint studies was determination of bidaily, seasonal and annual locations and movements, along with activity measurements, through the use of collar-mounted satellite transmitters. Six caribou were collared in July 1990, one in October 1991 and six in July 1992. Twelve were collared in the vicinity of Teshekpuk Lake; one was collared near Cape Simpson. Locations and movements were tracked from July 1990 through June 1993.

Distances traveled, range, and dispersal were at times much more extensive than expected. The herd was once thought to winter in the vicinity of Teshekpuk Lake, but five of the satellite-collared cows wintered from the northern foothills of the Brooks Mountain Range south to the Seward Peninsula area, and three others wintered near the northern Chukchi Sea coast. The others wintered near Teshekpuk Lake as did those that were tracked for a second winter. Despite the variability in wintering areas, the area from east to south of Teshekpuk Lake and within about 50 km of the lake was used by several satellite-collared cows during years two and three of the study. The maximum range, including the most extreme movements was 219,214 km^2.

The amount of movement was highly variable among years. During the first year of the study all of the instrumented animals dispersed widely from Teshekpuk Lake. During the second year all the animals (three of which had dispersed widely the year before) stayed in the vicinity of Teshekpuk Lake. In the third year four stayed near Teshekpuk Lake while two traveled to the foothills of the Brooks Mountain Range. The dispersal index of the herd during December 1990 was 20,000 km^2, but only 500 km^2 in December 1991.

Although movement and migration patterns were quite variable among individual caribou and years, there were areas that all study animals used. Every satellite-collared animal except caribou 9 traveled between Teshekpuk Lake and Harrison Bay at some time during the year. During calving season, most caribou were south to northeast of Teshekpuk Lake, the area southeast of the lake being used most extensively. The most frequently used wintering area was also southeast of the lake. The area southeast and east of Teshekpuk Lake should be considered critical habitat because of its importance to migration routes, calving and wintering. All of the instrumented animals also traveled between Teshekpuk Lake and the Beaufort Sea; other observations (ADF&G unpublished data) have found a general east-to-west summer movement pattern for the herd north of Teshekpuk Lake and that caribou use the area for insect relief. Anything that blocked movements through these areas would disrupt migration patterns, calving and insect relief and could decrease winter survival of Teshekpuk Lake caribou.

Caribou activity was quite variable. The study animals were usually most active in the summer. Some were relatively active in the fall and/or spring (if they migrated long distances), while others were less active at those times. Sometimes activity increased in winter while other times caribou were relatively inactive in winter.

Satellite collars have been a valuable research tool for Teshekpuk Lake Caribou Herd studies. This technology has allowed us to obtain herd movement and activity information that would have been impossible to obtain any other way. Every year that the satellite collars have been on the animals we have learned something new and unexpected. If we are to better understand and

better manage the Teshekpuk Lake Caribou Herd, this study - and the use of satellite collars - should continue.

6.0 ACKNOWLEDGMENTS

We are grateful for the field assistance provided by Harry Brower, Jr., John C. George and Taqulik Opie. The study was funded jointly by the NSB, the ADF&G and the BLM.

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APPENDIX A

MEMORANDUM OF UNDERSTANDING AND AGREEMENT among THE NORTH SLOPE BOROUGH, THE ALASKA DEPARTMENT OF FISH AND GAME and THE U. S. BUREAU OF LAND MANAGEMENT

Relative to: A cooperative management program for the Teshekpuk Caribou Herd.

THIS AGREEMENT, made and entered into by and between the North Slope Borough (herein-after called NSB), the Alaska Department of Fish and Game (herein-after called ADF&G) and the U. S. Bureau of Land Management (herein-after called BLM).

PURPOSE: Obtain current survey and inventory information which will allow for effective management of the Teshekpuk Caribou Herd (TCH).

The NSB, ADF&G and BLM hereby agree as follows:

1. The three agencies recognize that the reasons for studying the TCH include the following:

   a. There are questions as to the degree of mixing, in time and space, between the TCH and the adjoining Western Arctic and Central Arctic herds, i.e. do their ranges overlap?

   b. The long-term trend in TCH population size is unknown.

   c. The sustainable harvest of TCH animals for human subsistence is not clearly defined. Also TCH harvest is not known.

   d. When industrial development encroaches on TCH habitat, defending and preserving TCH habitat and subsistence use will require knowledge of parameters such as TCH distribution, abundance, habitat use, and human subsistence requirements.

   e. Range and critical habitat areas are not clearly defined.

2. The effective management of the TCH requires continued collection of basic information including population size, calf survival rate, mortality and habitat use.

3. In view of the above, the three agencies recognize that a cooperative approach to the study of these animals is an efficient way to resolve uncertainties and to share specialized skills and research costs.

4. In order to obtain the necessary information, the program objectives are:

a. To determine the herd population size every 2 to 3 years through photography and enumeration. The agencies recognize that population enumeration will have to be attempted more frequently than every 2 to 3 years because weather conditions frequently preclude successful photocensusing in any given year.

b. To determine the percentage of calf caribou surviving their first winter through the conduct of a short yearling composition count every spring.

c. To identify and map the herd's movement and distribution throughout the year, using radiotelemetry.

d. To determine the extent of the harvest through development of a harvest-estimating method that is acceptable to hunters as well as to the participating agencies.

e. To develop and improve ways of informing and working with the communities of Atqasuk, Barrow and Nuiqsut regarding Teshekpuk Caribou Herd management.

f. To delineate calving grounds each year.

g. To determine sources of mortality.

5. The NSB Department of Wildlife Management, ADF&G and BLM will share the cost and effort required to collect, analyze and report survey and inventory information on the Teshekpuk Caribou Herd.

6. Funding for the proposed program will come from existing budgets (i.e. there will be no new appropriations).

7. Nothing in this agreement shall be construed as obligating any of the three agencies to expend, or as involving the United States, the State of Alaska or the North Slope Borough in any obligation for future payment of money in excess of appropriations authorized by law and administratively allocated for these purposes.

8. All information obtained under this agreement will be shared equally by the participating agencies.

9. Each agency will receive due credit for products of the proposed program.

NORTH SLOPE BOROUGH

By: _____ Date: 10/9/91
Benjamin P. Nageak
Director, Department of Wildlife Management

By: _____ Date: 10-9-91
Jeslie Kaleak, Sr.
Mayor

STATE OF ALASKA
DEPARTMENT OF FISH AND GAME

By: _____ Date: 1 Nov 91
John W. Coady
Regional Supervisor, Region 5

By: _____ Date: Nov. 1, 1991
David G. Kellyhouse
Director, Division of Wildlife Conservation

U. S. BUREAU OF LAND MANAGEMENT

By: _____ Date: 11-19-91
Dee R. Ritchie
Arctic District Manager

By: _____ Date: 12/14/91
Edward F. Spang
State Director

APPENDIX B. Total distance traveled, mean daily distance traveled and range, by month and year for satellite-collared Teshekpuk Lake caribou, July 1990 - June 1993.

		TOTAL DISTANCE TRAVELED			MEAN DAILY DISTANCE				RANGE	
Month-Year	Caribou #	Dist (km)	#Locs	#Days	Days w/locs	Total #locs	Total #days	Mean Dist per Day (km)	#Points	Area (Sq. km)
Jul-90	1	438	14	27	14	14	27	16.2	14	5353
Aug-90	1	79	16	30	16	16	30	2.6	16	244
Sep-90	1	250	15	29	15	15	29	8.6	15	4752
Oct-90	1	190	16	31	16	16	31	6.1	16	1305
Nov-90	1	77	14	29	14	14	29	2.7	14	107
Dec-90	1	50	15	29	15	15	29	1.7	15	95
Jan-91	1	81	16	31	16	16	31	2.6	16	114
Feb-91	1	78	14	27	14	14	27	2.9	14	211
Mar-91	1	40	15	29	15	15	29	1.4	15	16
Apr-91	1	42	16	30	16	16	30	1.4	16	17
May-91	1	318	15	29	15	15	29	11.0	15	8375
Jun-91	1	135	15	29	15	15	29	4.7	15	711
Jul-91	1	376	16	31	16	16	31	12.1	16	3425
Aug-91	1	106	16	30	16	16	30	3.5	16	287
Sep-91	1	68	15	29	15	15	29	2.3	15	94
Oct-91	1	109	16	31	16	16	31	3.5	16	518
Nov-91	1	75	15	29	15	15	29	2.6	15	151
Dec-91	1	40	15	29	15	15	29	1.4	15	35
Jan-92	1	34	14	31	14	14	31	1.1	14	28
Feb-92	1	140	13	27	13	13	27	5.2	13	326
Mar-92	1	65	14	31	14	14	31	2.1	14	215
Apr-92	1	35	14	28	14	14	28	1.3	14	49
May-92	1	80	15	31	15	15	31	2.6	15	234
Jun-92	1	158	15	29	15	15	29	5.4	15	666
Jul-92	1	158	9	17	9	9	17	9.2	9	2442
Jul-90	2	123	14	27	14	14	27	4.6	14	735
Aug-90	2	136	16	30	16	16	30	4.5	16	1420
Sep-90	2	161	15	29	15	15	29	5.6	15	1718
Oct-90	2	170	16	31	16	16	31	5.5	16	1005
Nov-90	2	122	15	29	15	15	29	4.2	15	389
Dec-90	2	32	15	29	15	15	29	1.1	15	34
Jan-91	2	45	16	31	16	16	31	1.5	16	33
Feb-91	2	23	14	27	14	14	27	0.9	14	13
Mar-91	2	48	15	29	15	15	29	1.6	15	86
Apr-91	2	47	15	30	15	15	30	1.6	15	89
May-91	2	51	15	29	15	15	29	1.8	15	127
Jun-91	2	113	15	29	15	15	29	3.9	15	773
Jul-91	2	302	16	31	16	16	31	9.7	16	5452
Aug-91	2	222	15	30	15	15	30	7.4	15	1742
Sep-91	2	104	15	29	15	15	29	3.6	15	492
Oct-91	2	147	16	31	16	16	31	4.7	16	1006
Nov-91	2	89	15	29	15	15	29	3.1	15	591
Dec-91	2	32	15	29	15	15	29	1.1	15	23
Jan-92	2	40	16	31	16	16	31	1.3	16	23
Feb-92	2	64	14	27	14	14	27	2.4	14	221
Mar-92	2	26	7	31	7	7	31	0.8	7	21
Jul-90	3	350	14	27	14	14	27	13.0	14	5396
Aug-90	3	66	16	30	16	16	30	2.2	16	130
Sep-90	3	281	15	29	15	15	29	9.7	15	4627

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		TOTAL DISTANCE TRAVELED			MEAN DAILY DISTANCE				RANGE	
Month-Year	Caribou #	Dist (km)	#Locs	#Days	Days w/locs	Total #locs	Total #days	Mean Dist per Day (km)	#Points	Area (Sq. km)
Oct-90	3	237	16	31	16	16	31	7.6	16	2261
Nov-90	3	87	14	29	14	14	29	3.0	14	160
Dec-90	3	58	15	29	15	15	29	2.0	15	64
Jan-91	3	70	14	31	14	14	31	2.3	14	66
Feb-91	3	40	12	27	12	12	27	1.5	12	46
Mar-91	3	57	15	29	15	15	29	2.0	15	42
Apr-91	3	59	16	30	16	16	30	2.0	16	80
May-91	3	46	7	15	7	7	15	3.0	7	139
Jul-90	4	359	14	27	14	14	27	13.3	14	3815
Aug-90	4	102	16	30	16	16	30	3.4	16	301
Sep-90	4	213	15	29	15	15	29	7.3	15	1651
Oct-90	4	221	16	31	16	16	31	7.1	16	3234
Nov-90	4	222	13	29	13	13	29	7.7	13	3238
Dec-90	4	96	15	29	15	15	29	3.3	15	120
Jan-91	4	73	14	31	14	14	31	2.4	14	120
Feb-91	4	67	12	27	12	12	27	2.5	12	98
Mar-91	4	76	14	29	14	14	29	2.6	14	96
Apr-91	4	64	16	30	16	16	30	2.1	16	145
May-91	4	99	15	29	15	15	29	3.4	15	332
Jun-91	4	185	15	29	15	15	29	6.4	15	3232
Jul-91	4	348	16	31	16	16	31	11.2	16	3433
Aug-91	4	179	16	30	16	16	30	6.0	16	979
Sep-91	4	55	15	29	15	15	29	1.9	15	71
Oct-91	4	88	16	31	16	16	31	2.8	16	318
Nov-91	4	55	11	29	11	11	29	1.9	11	212
Dec-91	4	58	11	29	11	11	29	2.0	11	102
Jan-92	4	20	7	31	7	7	31	0.6	7	23
Feb-92	4	35	4	27	4	4	27	1.2	4	45
Mar-92	4	47	12	31	12	12	31	1.5	12	171
Apr-92	4	116	15	28	15	15	28	4.1	15	179
May-92	4	110	15	31	15	15	31	3.6	15	482
Jun-92	4	178	15	29	15	15	29	6.1	15	865
Jul-92	4	250	9	17	9	9	17	14.7	9	3219
Jul-90	5	309	16	27	16	16	27	11.4	16	6276
Aug-90	5	101	15	30	15	15	30	3.4	15	588
Sep-90	5	260	15	29	15	15	29	9.0	15	6619
Oct-90	5	442	15	31	15	15	31	14.3	15	11409
Nov-90	5	258	15	29	15	15	29	8.9	15	4978
Dec-90	5	168	15	29	15	15	29	5.8	15	1717
Jan-91	5	119	16	31	16	16	31	3.8	16	554
Feb-91	5	113	14	27	14	14	27	4.2	14	640
Mar-91	5	74	14	29	14	14	29	2.5	14	180
Apr-91	5	233	16	30	16	16	30	7.8	16	3224
May-91	5	242	15	29	15	15	29	8.4	15	3337
Jun-91	5	9	3	5	3	3	5	1.0	3	5
Jul-90	6	165	14	27	14	14	27	6.1	14	1375
Aug-90	6	93	16	30	16	16	30	3.1	16	753
Sep-90	6	97	15	29	15	15	29	3.3	15	454
Oct-90	6	275	15	31	15	15	31	8.9	15	5565
Nov-90	6	251	14	29	14	14	29	8.7	14	2198
Dec-90	6	128	15	29	15	15	29	4.4	15	603
Jan-91	6	60	13	31	13	13	31	1.9	13	127

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		TOTAL DISTANCE TRAVELED			MEAN DAILY DISTANCE				RANGE	
Month-Year	Caribou #	Dist (km)	#Locs	#Days	Days w/locs	Total #locs	Total #days	Mean Dist per Day (km)	#Points	Area (Sq. km)
Feb-91	6	11	5	9	5	5	9	1.0	5	10
Oct-91	7	41	6	12	6	6	12	3.3	6	114
Nov-91	7	31	5	9	5	5	9	3.0	5	45
May-92	7	12	2	31	2	2	31	0.3	2	0
Jun-92	7	30	5	29	5	5	29	1.0	5	42
Jul-92	8	93	6	11	6	6	11	8.4	6	675
Aug-92	8	132	15	29	15	15	29	4.5	15	1001
Sep-92	8	63	15	29	15	15	29	2.2	15	123
Oct-92	8	73	16	31	16	16	31	2.4	16	75
Nov-92	8	54	15	29	15	15	29	1.9	15	125
Dec-92	8	42	15	30	15	15	30	1.4	15	30
Jan-93	8	36	12	23	12	12	23	1.6	12	82
Jul-92	9	75	4	11	4	4	11	6.7	4	190
Aug-92	9	250	11	29	11	11	29	8.6	11	5232
Sep-92	9	320	13	29	13	13	29	11.0	13	2504
Oct-92	9	243	13	26	13	13	26	9.4	13	4266
Nov-92	9	184	11	29	11	11	29	6.3	11	909
Dec-92	9	168	12	30	12	12	30	5.6	12	3174
Jul-92	10	36	6	11	6	6	11	3.2	6	87
Aug-92	10	65	15	29	15	15	29	2.2	15	93
Sep-92	10	67	15	29	15	15	29	2.3	15	238
Oct-92	10	78	16	31	16	16	31	2.5	16	132
Nov-92	10	59	13	29	13	13	29	2.0	13	84
Dec-92	10	49	13	30	13	13	30	1.6	13	64
Jan-93	10	68	9	19	9	9	19	3.8	9	237
Jul-92	11	45	6	11	6	6	11	4.0	6	65
Aug-92	11	99	15	29	15	15	29	3.4	15	389
Sep-92	11	52	15	29	15	15	29	1.8	15	62
Oct-92	11	53	16	31	16	16	31	1.7	16	101
Nov-92	11	63	15	29	15	15	29	2.2	15	48
Dec-92	11	53	15	30	15	15	30	1.8	15	28
Jan-93	11	36	12	23	12	12	23	1.6	12	84
Jul-92	12	16	6	11	6	6	11	1.4	6	7
Aug-92	12	26	14	29	14	14	29	0.9	14	19
Sep-92	12	71	15	29	15	15	29	2.5	15	223
Oct-92	12	62	16	31	16	16	31	2.0	16	153
Nov-92	12	50	14	29	14	14	29	1.7	14	155
Dec-92	12	54	15	30	15	15	30	1.8	15	103
Jan-93	12	49	12	30	12	12	30	1.6	12	81
Feb-93	12	38	14	26	14	14	26	1.5	14	40
Mar-93	12	24	9	17	9	9	17	1.4	9	10
Jul-92	13	48	7	13	7	7	13	3.7	7	169
Aug-92	13	148	15	29	15	15	29	5.1	15	1429
Sep-92	13	217	15	29	15	15	29	7.5	15	2677
Oct-92	13	272	16	31	16	16	31	8.8	16	6554
Nov-92	13	104	15	29	15	15	29	3.6	15	426
Dec-92	13	76	15	30	15	15	30	2.5	15	311
Jan-93	13	65	15	30	15	15	30	2.2	15	198
Feb-93	13	27	12	24	12	12	24	1.1	12	20
Mar-93	13	42	15	29	15	15	29	1.5	15	35
Apr-93	13	50	17	30	17	17	30	1.7	17	73
May-93	13	149	17	29	17	17	29	5.1	17	2092
Jun-93	13	96	19	29	19	19	29	3.3	19	337

APPENDIX C. Monthly indices of Teshekpuk Lake caribou dispersal given as range for three or more caribou or distance between two caribou, July 1990 through June 1993.

	Range (square km)				Distance (km)	Range (square km)		Distance (km)
# Caribou	6	5	4	3	2	6	5	2
Caribou Nos.	1-6	1-5	1-2, 4-5	1, 2, 4	1,4	8-13	8, 10-13	12, 13
Month-Year								
Jul-90	262	250	250	192	34			
Aug-90	7,598	7,552	5,343	1,316	125			
Sep-90	3,894	3,894	2,631	329	129			
Oct-90	31,546	30,614	21,699	6,298	335			
Nov-90	152,479	142,591	119,123	19,122	442			
Dec-90	160,274	134,345	119,801	9,416	394			
Jan-91	167,731	136,975	116,717	9,416	383			
Feb-91	161,131	130,974	117,680	9,039	384			
Mar-91		118,175	111,075	8,557	390			
Apr-91		121,458	114,597	9,057	395			
May-91		76,337	75,040	6,131	361			
Jun-91			30,712	2,050	91			
Jul-91				527	56			
Aug-91				3	14			
Sep-91				660	63			
Oct-91				167	54			
Nov-91				131	22			
Dec-91				18	24			
Jan-92				30	13			
Feb-92				115	28			
Mar-92				832	55			
Apr-92					48			
May-92					46			
Jun-92					7			
Jul-92					14			
Aug-92						2,521	436	16
Sep-92						1,490	60	43
Oct-92						6,561	2,118	144
Nov-92						5,300	4,297	265
Dec-92						7,784	2,374	215
Jan-93							2,210	190
Feb-93								176
Mar-93								185
Apr-93								
May-93								
Jun-93								
Jul-93								