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**Distribution and movements of marked caribou in Ungava, June 1973 to 1974**by T.C. Dauphiné, Jr.,<sup>1</sup> F.W. Anderka,<sup>2</sup> C.A. Drolet,<sup>1</sup> and D.T. McIlveen<sup>1</sup>**Abstract**

Seasonal distribution and movements of marked caribou (*Rangifer tarandus caribou*) in northern Quebec and Labrador were followed between June 1973 and 1974 as part of a 3-year research program being conducted by the Quebec, Newfoundland and Canadian Wildlife Services. Radio transmitters were attached to 24 caribou and visual markers to another 27 at or near the George River in summer and autumn 1973. During the following winter and spring, 25 contacts were made with 17 of the marked individuals, 7 visually and 18 with a radio receiver mounted in an aircraft. In January and February 1974, 10 marked caribou were located in four herds which wintered separately near the Koksoak River, the lower George and Tunulic rivers, the Fraser River, and the Notakwanon River respectively. They had dispersed an average of 198 km (from 55 to 319 km) from their autumn capture sites, and were up to 500 km apart. The position of four females contacted in April indicated that some populations had begun migrating to calving areas. In June, three females were located at a calving area near Hebron Fiord, 160 km north of where they had wintered near the Fraser River. One marked cow was located on another calving area at Vannes Lake, and two other cows were located south of Mistastin Lake; these cows had not been contacted on their winter ranges.

In March 1974, 20 caribou were marked (17 with radio transmitters) near Caniapiscou Lake in north-central Quebec by the Quebec Wildlife Service. Telemetry surveys located all the radio-equipped caribou very near their capture sites in April, but 12 females located in June had moved an average of 66 km (from 26 to 108 km) and were dispersed in the region between Caniapiscou Lake and the Quebec-Labrador border.

On the basis of data presented in this report, and the findings of visual aerial surveys conducted by the Quebec and Newfoundland Wildlife Services, a working model of caribou distribution and movement in Ungava is proposed.

**Introduction**

In 1973 the Quebec Wildlife Service, the Newfoundland Wildlife Service, and the Canadian Wildlife Service began a co-operative 3-year study of caribou in Ungava to obtain information for the formulation of an inter-provincial management plan. Biologists from the three agencies are determining the caribou's numbers, seasonal distribution, migration routes, population dynamics, and economic importance.

Visual aerial surveys were conducted during 1973, in February (Pichette and Beauchemin 1973, Wetmore 1974a), April (Brassard *et al.* 1973, Wetmore 1974a), June (Juniper 1973a, Wetmore 1974a), and October (Juniper 1973c, Wetmore 1974b), and in June 1974 (Juniper, Folinsbee, pers. comm.). The surveys determined the seasonal distribution, approximate numbers, and some migration routes of the caribou. To trace the annual movements of the several populations which inhabit the region, individual caribou were marked (with ear tags, collars, and radio transmitters) and periodically contacted visually or electronically. This report describes the results of the marking program up to July 1974, and analyzes movements of marked caribou in relation to information obtained from visual surveys. It also identifies information required to complete the understanding of each population's distribution and movements.

Aerial surveys conducted at intervals over the past two decades have obtained evidence that some caribou populations in Ungava have recovered from a major decline in the early 20th century and may still be increasing. According to Low (1897), there were originally two major caribou populations within the present study area, an eastern population inhabiting the region between Michikamau Lake and the Atlantic, and a central population inhabiting the area south and west of Ungava Bay. Elton (1942) found support for Low's descriptions in records of traders and explorers as well as evidence that the caribou herds had declined because of overhunting. When the first aerial surveys were made in the mid-1950's, numbers were still very low but believed to be increasing (Banfield and Tener 1958). In late winter of 1958 Bergerud (1967) surveyed northern Labrador and located an estimated 15,000 caribou migrating past Whitegull Lake from wintering grounds on the headwaters of the Naskaupi and Kanairoktok rivers. He located a smaller population on the headwaters of the Ford River. In February 1963, Des Meules and Brassard (1963) located herds containing 40,000 - 60,000 caribou west and northwest of Schefferville, mostly on the upper Caniapiscou River to within 160 km of Ungava Bay. Results of the surveys conducted in the 1950's and 1960's indicated an increase in the number of caribou and in the amount of territory they occupied. Production and survival rates appeared high (Banfield and Tener 1958) and hunter success had improved (Bergerud 1967). But a better understanding of the identity, size, distribution, and biological characteristics of the herds was needed before interprovincial management was feasible.

**Study area**

Boundaries of the study area were set by the southern and western limits of caribou populations that had the potential to migrate across the Quebec-Labrador border (Fig. 1). The

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surveys in 1973 showed that herds occupied a region of approximately 256,000 km<sup>2</sup> north of the 54th parallel and east of the 70th meridian.

Topography within the study area varies from the rugged, 1,500 m peaks of the Torngat Mountains to level sections of the Labrador plateau and the flat coastal plain bordering western Ungava Bay. The plateau, about 600 m above sea level, extends from slightly west of the George River to the Atlantic coast. Deep canyon valleys and fiords dissect the plateau on its eastern and north-western edges. West of the plateau there are many large lakes and wide valleys in a predominantly level landscape occasionally broken by isolated uplands. The Canadian Shield underlies most of the region. Glacial and alluvial landforms are common.

The vegetation may be classified in three broad types or zones described by Hustich (1949), Hare (1950), Rousseau (1952) and Banfield and Tener (1958). The Labrador Taiga (Zone Subarctique) lies south of the 55th parallel. North of that parallel and west of the George River occurs Forest-Tundra (Zone Hemiarctique). Tundra (Zone Arctique) lies east of the George River on the plateau; trees here are restricted to river valleys and occupy less than 5% of the land. Harper (1964) identified two major life zones in the study area, the Hudsonian and Arctic-alpine.

Except along the Atlantic and Ungava coasts, the climate is continental, with cold winters and hot summers (Wilson 1971). Temperatures on the coast are more moderate. Total annual precipitation is highest (800 mm) south of the 55th parallel and along the coast of Labrador. It declines north and west to about 400 mm at Ungava Bay. Mean annual snowfall ranges from less than 200 cm at Ungava Bay to more than 300 cm in southern and coastal areas.

## Methods

### Marking caribou

In June, September, and October 1973, 46 caribou were captured in the water on the George River at or downstream from Indian House Lake (Juniper 1973b, c; Dauphiné 1973); five others were captured with an immobilizing drug administered by a dart gun from a helicopter within 50 km of Indian House Lake (Fig. 1). Juniper (1974) captured 20 additional caribou in nets near Caniapiscu Lake in March 1974 (Fig. 1). Each caribou's sex, age, date of capture and place of capture are given in Tables 1 and 2.

Numbered ear tags, highly visible collars, or both, were placed on all the 71 caribou captured. Forty-one of these, mostly females, were also equipped with miniaturized radio transmitters. Each transmitter broadcast a pulsing signal on a separate frequency. Batteries powering the transmitters had life expectancies of 12 to 24 months. Appendix 1 contains a description of ear tags, collars and transmitters. The identity of each caribou's ear tags and collar is given in Tables 1 and 2.

### Contacting caribou with telemetry

**Equipment and tracking procedure** — A Cessna 340 twin-engined aircraft was used for telemetry surveys because of the large area to be covered. The aircraft was equipped to fly in all weather, had a ceiling of over 6,000 m above sea level, and a cruising range of over 1,700 km.

Two three-element yagi antennas were mounted on the Cessna to receive signals from the transmitters. The antennas were mounted on opposite sides of the fuselage 2 m ahead of the horizontal tail stabilizers and parallel to the wings. Each antenna was directional, producing the loudest signal when pointed at a transmitter. The aircraft's fuselage shielded each antenna from the rear, making it highly selective for signals coming from the side on which it was mounted.

Two radio receivers were carried in the aircraft and connected to the antennas with detachable coaxial cables. The receivers, made by the CWS Bioelectronics Unit, were synthesizer controlled, triple conversion units with 400 channels in 10-KHz increments. The searching procedure began with the operator manually dialing a transmitter's frequency on his receiver. If no signal was heard, the operator then made a brief search within approximately  $\pm 10$  KHz of the designated frequency to detect the signal in case it had wandered slightly. The search for each frequency required approximately 20 sec and was repeated for each transmitter in turn until a signal was heard. When two receivers were in use, the operators started at different places on the list of transmitters to minimize duplication. Each receiver was attached to both antennas while the operators searched for signals; when a signal was received, one antenna was disconnected and the direction of the signal's origin determined as described below.

Before embarking on surveys, the transmitters' broadcast range was determined with the survey aircraft by monitoring signals of new units at various distances and altitudes. Tests were conducted near Ottawa and Schefferville in winter to take into account the effect of temperature (if any). The signals of all new transmitters tested were received at least 32 km away when the aircraft was 3,000 m above ground or higher, and this distance was accepted as the minimum broadcast range of new units. Although identical in construction, some transmitters produced a stronger signal than others. The most powerful transmitters broadcast about 64 km. As the surveys progressed, however, it became apparent that the broadcast range of some transmitters deteriorated over time to 16 km or less. The cause of the deterioration remains unknown because the units in question could not be recovered and examined. It may involve the strength of the antenna; a hunter returned one transmitter with its antenna broken off at the base. Antenna loss would reduce the range of a transmitter to 5 km or less. Not all transmitters were affected by loss of range, however, and some with long service could still be received over distances of 64 km or more.

**Telemetry surveys** — Three telemetry surveys for radio-collared caribou were conducted between January and June 1974. The first was scheduled in January and February when the animals were settled on their winter ranges, the second in April at the beginning of the spring migration, and the third in June when the females were on their calving grounds. Surveys routes are shown in Figures 2, 3, and 4.

The aircraft's speed and the spacing of transects were determined by the number of transmitters sought and their assumed minimum signal range of 32 km. During the January — February survey, when 24 transmitters were sought, approximately 4 min elapsed between successive 20-sec monitorings of each transmitter's frequency. In order to ensure that the aircraft-mounted receivers did not pass a transmitter

**Table 1**

Sex and age of 51 caribou captured at or near Indian House Lake on the George River in June, September, and October, 1973, with dates and locations of capture and identification of markers applied

Date	Location	Sex	Age group*	Collar	Eartag(s)
28/6	56°49', 64°55'	F	Y	18†	—
29/6	57°18', 65°20'	F	A	13†	101
10/9	56°14', 64°44'	F	A	200	200
11/9	56°14', 64°44'	F	A	199	199
11/9	56°14', 64°44'	M	A	449	450
13/9	56°09', 64°45'	M	Y	431	431
13/9	56°09', 64°45'	F	Y	198	198
21/9	56°10', 64°44'	M	A	401	400
22/9	56°09', 64°45'	M	A	432	432
22/9	56°09', 64°45'	M	A	433	433
24/9	56°14', 64°44'	M	A	434	434
24/9	56°14', 64°44'	M	A	436	—
24/9	56°14', 64°45'	M	A	437	437
27/9	56°26', 64°44'	M	A	403	401
27/9	55°57', 64°44'	M	A	351	1, 2
27/9	56°02', 64°44'	F	A	15†	6, 7
27/9	56°02', 64°44'	M	C	67	3
27/9	56°02', 64°44'	F	A	24†	4
27/9	56°02', 64°44'	F	A	19†	5
28/9	56°05', 64°44'	M	A	—	9
28/9	56°05', 64°44'	M	A	354	10
30/9	56°05', 64°44'	M	A	352	8, 11
31/9	56°05', 64°44'	M	A	353	113
4/10	56°03', 64°44'	M	A	363	20, 21
4/10	56°03', 64°44'	F	A	25†	14
4/10	56°03', 64°44'	F	A	1†	16
4/10	56°03', 64°44'	F	C	70	17
4/10	56°03', 64°44'	M	C	69	18, 19
4/10	56°03', 64°44'	M	C	68	15
4/10	56°14', 64°44'	F	A	0†	—
4/10	56°14', 64°44'	F	A	10†	—
4/10	56°14', 64°44'	F	A	20†	—
4/10	56°14', 64°44'	F	A	23†	—
4/10	56°14', 64°44'	—	C	—	194
4/10	56°14', 64°44'	—	C	—	195
4/10	56°14', 64°44'	—	C	—	196
5/10	56°03', 64°44'	F	A	21†	23
5/10	56°03', 64°44'	F	A	7†	24
5/10	56°03', 64°44'	F	A	12†	22
5/10	56°03', 64°44'	F	Y	16†	152

(Cont'd next page)

**Table 1 (cont'd)**  
Sex and age of 51 caribou captured at or near Indian House Lake on the George River in June, September, and October, 1973, with dates and locations of capture and identification of markers applied

Date	Location	Sex	Age group*	Collar	Eartag(s)
5/10	56°03', 64°44'	F	C	71	157, 159
5/10	56°03', 64°44'	M	A	355	25
6/10	56°26', 64°45'	F	A	L†	402
6/10	56°26', 64°45'	F	A	11†	403
11/10	56°24', 64°07'	F	A	H†	151 - 153
11/10	56°25', 64°08'	F	C	4†	—
12/10	56°27', 64°24'	F	A	2†	165, 166
12/10	56°42', 63°57'	F	A	D†	167, 168
17/10	56°43', 64°41'	F	C	17†	—
17/10	56°43', 64°41'	M	C	J†	—
20/10	57°49', 66°20'	M	C	A†	—

\*A, adult; Y, yearling; C, calf.  
†Collars with radio transmitters.

**Table 2**  
Sex and age of 20 caribou captured at or near Caniapiscau Lake in March, 1974, with dates and locations of capture and identification of markers applied (data from Juniper 1974)

Date	Location	Sex	Age group*	Collar	Eartag
11/3	54°26', 69°55'W	F	A	G†	—
11/3	54°26', 69°55'W	F	A	K†	—
11/3	54°26', 69°55'W	M	Y	8†	—
11/3	54°25', 69°55'W	M	C	—	102
17/3	54°12', 69°44'W	F	A	A7†	—
17/3	54°12', 69°44'W	F	A	14†	—
17/3	54°12', 69°44'W	F	A	5†	—
17/3	54°12', 69°44'W	F	A	3†	—
17/3	54°12', 69°44'W	F	A	6†	—
17/3	54°12', 69°44'W	F	A	9†	—
17/3	54°12', 69°44'W	F	A	I†	—
17/3	54°12', 69°44'W	F	A	E†	—
17/3	54°12', 69°44'W	F	A	B†	—
17/3	54°12', 69°44'W	F	A	P†	—
17/3	54°12', 69°44'W	F	A	M†	—
17/3	54°12', 69°44'W	F	Y	C†	—
17/3	54°12', 69°44'W	F	Y	N†	—
17/3	54°12', 69°44'W	F	Y	F†	—
17/3	54°12', 69°44'W	F	A	34†	—
17/3	54°12', 69°44'W	F	Y	32†	—

\*A, adult; Y, yearling; C, calf.  
†Collar with radio transmitter.

without detecting it, we chose a transect spacing of 40.3 km and a ground speed of 260 km/hr. At this spacing and speed, the receivers passed within 22 km of all locations between transects and remained within that distance for at least 4 min. We therefore had ample time to detect transmitters that were broadcasting 32 km or farther. A wider transect spacing of 51.6 km was adopted for the April survey (Fig. 3). In June, however, the spacing was reduced to 16 km over known concentrations of caribou (Fig. 4) as by then it had become apparent that some transmitter signals weakened with age. The aircraft cruised at 4,600 to 5,500 m above sea level during surveys to ensure line-of-sight reception from transmitters in hilly terrain. During each survey, several transmitters were placed in operation at Schefferville and the receiving equipment was tested at the beginning and end of each day's flight.

The position of a radio-equipped caribou was fixed by triangulation once its signal was received. One antenna was disconnected and the aircraft circled while the operators listened for maximum signal strength. When the signal peaked, the antenna's bearing was noted and projected from the aircraft's position on a map. One or more additional bearings were taken from different positions on the same and/or adjacent transects. The intersection of the projected lines indicated the caribou's approximate position.

The additional aircraft required for more frequent surveys and for visual confirmation of telemetry identifications were not available because of budgetary limitations. Therefore it was necessary to make two assumptions when analyzing telemetry results: first, that caribou were alive when contacted (or had not been dead more than several weeks); and second, that transmitter frequencies remained close to their designated values and could not be confused with one another. Two ambiguous signals were received during the surveys, and their identification is described in a later section.

#### Contacting caribou visually

The study team watched for marked caribou during low-level survey flights and attempted to identify any seen. Hunters, pilots, and others were encouraged by notices posted in northern settlements to identify and report any marked caribou seen or shot.

#### Results and discussion

##### Caribou marked at George River and Indian House Lake

**Recovery success** — Between October 1973 and July 1974, 25 contacts were made with the 51 caribou which were marked on or near the George River. Eighteen of the contacts were obtained by telemetry, four by hunters, and three by visual observation. Seventeen different caribou were identified in the contacts, a recovery of 33% of the animals marked.

Of the 24 caribou equipped with radio-collars at George River, 14 were subsequently contacted with telemetry. One animal (collar 7) was contacted on three different surveys and another (collar 4) on two surveys; the other 12 caribou were contacted only once. The number of caribou contacted on each survey was as follows; one in October (at 56°15'N and 64°40'W on October 6), eight in January and February (Fig. 2), three in April (Fig. 3) and six in June (Fig. 4).

Hunters shot and reported the positions of four marked caribou. Two (collars H and D) were radio-equipped cows which had been contacted previously by telemetry. Hunters also saw marked caribou south of the Fraser River during the winter but did not identify them (W. Chalk, pers. comm.). Biologists saw three marked caribou and determined the collar number of one (Wetmore 1974b, Folinsbee, pers. comm.). The dates and locations of these contacts are shown in Figure 5.

**Seasonal distribution** — The seasonal distribution of contacts made with the caribou marked at the George River and Indian House Lake is shown in Figure 6.

In late September and early October 1973 several marked caribou were contacted in the vicinity of Indian House Lake. One cow (collar 13) was located at 56°15'N, 64°40'W, 130 km south of where she had been captured on the George River in June (Table 1). She may have summered on the plateau at the head of the Ford River and then moved south along Indian House Lake. An adult male (collar unidentified), tagged at Indian House Lake between September 11 and October 5, was seen south of the Fraser River on October 12 (Fig. 5) (Wetmore 1974b). Many caribou tagged at the south end of Indian House Lake in autumn moved north immediately afterward. On October 5, six caribou were located by radio-telemetry up to 40 km north or northeast of where they were tagged a few days previously. An adult male (collar unidentified) was seen moving north on the east side of Indian House Lake on October 17 (Fig. 5). In October caribou distribution changed on a day-to-day basis as they migrated to rutting and wintering areas (Wetmore 1974b). For this reason, and because much of the study area was not surveyed, the picture of caribou distribution in autumn remains incomplete.

In January and February 1974 marked caribou were contacted in four main areas: near the Koksoak River, near the lower George and Tunulic rivers, south of the Fraser River (near Nain on the Labrador coast) and in the Notakwanon River area (Fig. 2). In 1972 and 1973 caribou wintered in all of those areas except near the lower George and Tunulic rivers, according to surveys by Wetmore (1972, 1974a) and Pichette and Beauchemin (1973).

Telemetry contacts in April indicated a shift in some wintering populations. A cow (collar 10) located at the head of the Ford River (Fig. 3) may have been part of a general eastward movement across the lower George River from the two wintering areas to the west. We saw heavy trails made by caribou migrating eastward from the Koksoak region and crossing the George River near Helen Falls (58°10'N) during the April survey. Wetmore (1974a) reported a similar shift in April 1973, and Bergerud (1967) found caribou on the upper Ford River in April 1958. Some caribou also remained in the Koksoak valley, however, as one adult female (collar 23) was contacted there in April (Fig. 3).

Wetmore (1972, 1974a) reported that the population wintering south of the Fraser River moved around the Fraser canyon and north toward Hebron Fiord in April 1972 and 1973. The same movement occurred in 1974, as a cow (collar 7) which wintered south of the Fraser (Fig. 2) was contacted in April slightly north of the canyon (Fig. 3).

Another cow (collar H) was killed in early April 1974 (exact date unknown) about 48 km southwest of where she was contacted in January on the Notakwanon River (Figs. 2 and 5). Wetmore (1974a) reported small numbers of caribou on the plateau near the Notakwanon River in February and a concentration of caribou east of Border Beacon in April 1973. The region between Border Beacon and Davis Inlet is probably a traditional wintering area; in 1954–55 and in 1957–58 caribou wintered between Michikamau and Mistastin Lakes (Banfield and Tener 1958, Bergerud 1967).

Des Meules and Brassard (1963) found caribou along the Caniapiscou River to within 160 km of Ungava Bay in the winter of 1962–63; apparently that population has shifted northward, since in the past two winters caribou have occupied the lower Caniapiscou and Koksoak valleys near the Ungava coast. The caribou contacted in the lower George-Tunulic river region near Port-Nouveau-Québec in February 1974 (Figs. 2 and 5) may also have been part of the former western population.

In June 1974, three caribou (collars 4, 7, 15) were located near Hebron Fiord and Okak Bay, one (collar 11) between Vannes and Champdoré Lakes, and two (collars 19 and 20) east of Whitegull Lake and south of Mistastin Lake (Fig. 4). The first two locations are in well-known calving grounds. A large number of caribou calved in the Hebron-Okak region in 1972 and 1973 (Wetmore 1972, 1974a) and they were located and censused there in 1974 by Folinsbee (pers. comm.). Many cows also calved in the Vannes-Tudor-Champdoré Lakes region in 1972 (Wetmore 1972) and 1973 (Juniper 1973a), and cows were located and censused there in 1974 by Juniper (pers. comm.).

In 1973 Wetmore (1974a) found a small calving area near Harp Lake, (55°10'N, 62°00'W) southeast of the location of radio-collared individuals. However, he also found a few females with calves scattered throughout the entire region between Champdoré Lake and the Labrador Coast, and it is possible that the two cows contacted there (collars 19 and 20) were scattered individuals rather than part of a dense concentration. Only part of the Harp Lake calving area was surveyed in June 1974, and it is possible that some radio-equipped caribou were there.

In evaluating data on seasonal distribution, the whereabouts of marked caribou not contacted must be considered. They may have been outside the area surveyed, in which case the data obtained do not describe the complete distribution. Alternatively, they may simply have been missed because of transmitter and receiver malfunction, operator error, or the location of animals in deep valleys and on coastal islands where transmitter signals were shielded by the terrain. The fact that no marked animals were seen or taken by hunters outside the study area supports the view that they remained within the area.

**Migration** — The high cost of telemetry surveys prevented continuous radio-tracking of marked caribou during migration. Determining the location of caribou at different times of the year, however, provided information that could be combined with visual observations to present an indication of migration dates and routes.

The autumn migration of caribou captured on the George River was extensive and diverse (Fig. 7). Marked animals

moved into all quadrants except the southwest. Straight line distances from tagging sites to winter locations ranged from 55 to 319 km and averaged 198 km (Fig. 7). Actual distances travelled by the migrating caribou could, of course, have been considerably longer.

Observations of rutting behaviour suggested that caribou rutted during or at the end of the autumn migration. On October 12 approximately 5,000 caribou were assembled south of the Fraser River, and several thousand more were moving rapidly east to join them (Wetmore 1974b). Breeding had not started. The rut, in that case, apparently occurred where the animals wintered. In contrast, caribou that migrated to winter range on the Koksoak River rutted along the route, possibly between the Whale River and Lac Saffray (57°40'N, 67°10'W) where Wetmore (1974b) observed a large rutting herd on October 20. Similarly, the large herd Wetmore (1974b) observed on October 19 along the east side of the Tunulic River at 57°45'N may have paused to rut slightly south of winter range on the lower George River, or it could have joined the herd which wintered on the Koksoak.

This study has so far not obtained information on the migration route and rutting area of caribou that wintered southeast of Indian House Lake. These caribou may migrate south along the upper George River, in which case their route would be south of that shown in Figure 7. Caribou may also migrate to the east of Indian House Lake, rut with those observed near the Fraser River, and move south in November and December to the separate winter range. However, such a pattern would contradict the concept, suggested by the data, that each wintering population has a separate rutting area.

In late winter, probably in March, some caribou began migrating. Contacts in April with two cows (collars 23 and 10) suggest that some remained on winter range near the Koksoak River while others migrated eastward along the bottom of Ungava Bay, crossing the George River near Helen Falls, and then heading either east or south (Fig. 3). Wetmore (1973a) noted a major influx of caribou into the Ford River region in April 1973, and he observed adult cows moving toward the Hebron calving ground from the west (Wetmore pers. comm.).

There were other examples of late winter population shifts. The caribou wearing collar H was killed in April 1974 about 65 km south of her location in January on the Notakwanon River (Fig. 8). Another cow (collar 7) that had wintered south of the Fraser River moved around its west end and started toward the Hebron calving ground (Fig. 8). Late winter movement similar to those shown by the above data also occurred in 1972 and 1973, according to Wetmore (1972, 1974a).

Two cows (collars 7 and 4) were traced from winter range to calving ground. Both wintered south of the Fraser River and moved to the Hebron calving ground (Fig. 9). Most of the migration occurred in May, judging from No. 7's position in April. These contacts confirm that the Fraser River caribou use the Hebron calving ground, as Wetmore (1972, 1974a) believed. Winter locations of the four other cows contacted in June are not known. The deaths of two cows contacted in winter (collars H and D) was a setback, as they could have provided valuable data if located on their calving grounds.

Collars 11 and 19 were identified from ambiguous signals which could have come from collars 10 and 23 respectively. One of the authors (Anderka) tentatively identified the former pair on the basis of theoretical changes in frequency and pulse which normally occur during the life of a transmitter. If collars 11 and 19 were wrongly identified, it would mean that the cow with collar 10 moved south from its April location on the Ford River (Fig. 3) to Lake Vannes in June (Fig. 4), and the cow with collar 23 moved southeast from its April position on the Koksoak River (Fig. 3) to the Notakwanon River in June (Fig. 4).

#### Caribou marked at Caniapiscou Lake

**Recovery success** — Thirty telemetry contacts were made with the 17 caribou Juniper (Juniper 1974) equipped with transmitters at Caniapiscou Lake in March 1974. All individuals were located in April (Fig. 3) and 12 in June (Fig. 4). **Seasonal distribution** — Caniapiscou caribou were captured in March and relocated in April and in June within 110 km of Caniapiscou Lake (Fig. 10). In April the marked caribou were located within 32 km of both capture sites, and 11 were still very close to the capture site on Caniapiscou Lake. In June, all cows contacted had moved east of their winter range and dispersed over a larger area.

Caribou traditionally winter around Caniapiscou and Delorme Lakes. Des Meules and Brassard (1963) found caribou there in winter 1962–63, as did Pichette and Beauchemin (1973) and Brassard *et al.* (1973) in 1973. Des Meules and Brassard (1963) observed from 40,000 to 60,000 caribou in a continuous herd extending north from Caniapiscou Lake along the Caniapiscou River to Erlandson Lake, 160 km from the Ungava coast. In the winter of 1972–73, however, there was a 160-km gap between a herd of about 3,000 at Caniapiscou Lake and another of about 32,000 on the lower Caniapiscou River near Ungava Bay (Brassard *et al.* 1973). The marking study suggests that the smaller herd remains within 110 km of Caniapiscou Lake, whereas the larger one, which winters in the lower Caniapiscou-Koksoak drainage, migrates far to the southeast to calve, possibly to the Vannes and Champdoré Lakes area (Juniper, pers. comm.) and definitely to Indian House Lake in autumn. It is possible that in 1963 the northern herd spread south along the Caniapiscou River and merged with the herd at Caniapiscou Lake.

Radio-telemetry contacts revealed that cows which wintered in the immediate vicinity of Caniapiscou Lake dispersed to calve in a rectangular area roughly 80 x 130 km which extends southeasterly from Delorme Lake. Juniper (1973a) in 1973 and R. Audet (pers. comm.) in 1974 observed small numbers of calving females dispersed in string-bogs in that region. There were no large concentrations of females similar to calving areas at Vannes Lake and near Hebron Fiord.

Caniapiscou cows probably calve between late May and the middle of June. Des Meules and Simard (1970) reported that pregnant females captured near Lake Opiskotéo (145 km south of Caniapiscou Lake at 53°10'N, 68°10'W) calved between May 25 and June 16.

**Migration routes and timing** — The migration of marked Caniapiscou caribou from winter range to calving ground was a dispersal rather than a unified directional movement (Fig. 10). All 12 individuals located in June had been marked at

the southern (Caniapiscou Lake) capture site; their movements from there ranged from 26 to 108 km and average 66 km. The caribou moved in late April and May. The two cows tagged at the northern capture site (Lake Delorme) may have belonged to a segment of the population that calved outside the area surveyed.

#### Improving efficiency of telemetry surveys

The efficiency of telemetry surveys was affected by knowledge of caribou distribution, age of transmitters, transect spacing, and operator fatigue. Searching for caribou marked at George River was more successful on the first (January–February) and third (June) surveys than the second (April), but all these surveys were considerably less successful than surveys over the smaller Caniapiscou Lake area. To illustrate this, the survey party achieved 33.3% success rate in January and February (8 of 24 found), 15% in April (3 of 20) and 30% in June (6 to 20) in the search for animals equipped at the George River. In theory, the success rate should diminish with time because of transmitter malfunctions and the unreported mortality of radio-equipped animals. The lower success of the April survey was probably caused by the use of wider transects (51.6 instead of 40.3 km or less) and inadequate coverage of the Labrador coast. The improved success in June was due to accurate knowledge about caribou distribution which allowed the narrowing of transects over major concentrations. Knowing the distribution beforehand compensated for any increased transmitter malfunction and mortality of marked caribou.

The high success in locating caribou marked at Caniapiscou Lake (100 and 76% in April and June respectively) was achieved because the transmitters were newer and the animals were closer together. The main survey area is at least 15 times larger than the Caniapiscou Lake area, but the number of radio-equipped caribou was almost the same in each. The drop in success from April to June surveys at Caniapiscou Lake probably resulted from transmitter failure and animal mortality, and possibly from movement outside the survey area.

Survey efficiency should improve if the survey party can learn general caribou distribution from separate visual surveys made just before telemetry surveys, and use closely-spaced transects over caribou concentrations (i.e., 16 to 24 km apart).

#### Conclusions

Considerable information has been accumulated in 1973 and 1974 on the movements and seasonal distribution of Ungava caribou, and it now seems appropriate to propose a working model which can be revised as more data are obtained.

In late summer and early autumn caribou from several populations (or sub-populations) inhabit the upper George River region near Indian House Lake. They separate in late September and October and migrate to four different areas—the Koksoak River, the lower George and Tunulic rivers, the Fraser River, and the Notakwanon River—where they remain until March or April. The herds appear to rut after they separate and therefore may have little or no genetic exchange; their discreteness should be revealed by long-term recovery of marked individuals.

In April and May females from the various winter ranges migrate to three known calving areas. Cows that wintered at



the Fraser River move north and calve near Hebron Fiord and Okak Bay. Thus an approximate description of the annual distribution of that herd is complete; i.e., wintering at the Fraser River, calving near Hebron Fiord, summering on the plateau east of the George River, and migrating by Indian House Lake in autumn. Assuming that no more than three calving areas exist, females from the other winter ranges must calve mainly at Vannes and Champdoré Lakes, south of Mistastin Lake, or both. Females from winter ranges near Ungava Bay have been seen migrating toward both the Vannes – Champdoré Lakes and the Hebron Fiord areas just prior to the calving season, and proximity suggests that females which calve south of Mistastin Lake are from the herd which winters near-by on the Notakwanon River; however, radio-tracking will be required to confirm which herds calve in those areas.

In late June, the cows and calves leave the Vannes Lake and Hebron Fiord calving areas and move to the Ford River drainage on the plateau east of the George River. During this movement they are joined by males and non-breeding females. The mixed herds move slowly south during the summer and are joined at some point by caribou which had calved south of Mistastin Lake. By early September all are in the vicinity of Indian House Lake, where they remain until late September and early October when the rapid migration to winter ranges begins.

The location of marked caribou seen or killed by hunters suggests that the four wintering herds are exposed to roughly equal hunting pressure during the year. In autumn they are hunted on or near the George River by Quebec sport-hunters and in winter by the residents of settlements nearest their respective winter ranges. Mostly adult males are killed in autumn but the winter harvest probably consists of more females than males.

Caribou in the Caniapiscu Lake region are discrete from other populations to the north and east in winter and at calving, and probably have a much smaller annual range. All animals relocated were between Caniapiscu Lake and the Labrador border during the period March to June 1974.

#### Acknowledgements

The two other agencies participating in the cooperative caribou study, the Quebec and Newfoundland Wildlife Services, provided personnel and financial support for the joint effort to capture and mark caribou. Their respective representatives on the study team, I. Juniper and S.P. Wetmore, also made numerous visual aerial surveys and we have drawn freely on information in their unpublished reports in our effort to interpret data on marked caribou. J. Folinsbee, Newfoundland Wildlife Service, provided information on caribou distribution in June 1974. We thank H. Culos of George River Lodge and T. Bennett of Laurentian Air Service for their valuable logistical help. D.R. Flook reviewed the manuscript and G.T. Tessier drew the figures.

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#### APPENDIX I

##### Description of marking devices

**Tags** – Standard metal ear tags designed for cattle and manufactured by the National Band and Tag Co. of Newport, Kentucky, were applied to one or both ears of most captured caribou. Tags were numbered consecutively from 1 to 1,000 and each bore the inscription "ADVISE AVISE: WILDLIFE SERVICE DE LA FAUNE." The tags were coated with orange enamel to increase their visibility.

**Collars** – Bright orange-coloured collars were made of vinyl-covered nylon fabric (trade name "Saflag") from the Safety Flag Co. of America, Pawtucket, Rhode Island. Strips of Saflag were cut so that, after a 2.5 cm hem had been sewn at each end and a 1.2 cm hem in the middle (to prevent curling), the finished collars measured 10.3 x 61.0 cm for females and 10.3 x 81.3 cm for males. A brass grommet with a hole 1.2 cm diameter was placed in the hemmed section at each end. A steel snap fastened the collar around the animal's neck and increased the collar's length by about 2.5 cm. Collars were numbered from 1 to 500 with black Ram Cote paint (Ram Cote Products Inc, Chicago, Illinois). Radio-collars were sewn with a double layer of Saflag to provide a pocket for the radio transmitter and battery.

**Radio transmitters** – The transmitters were designed and built by F.W. Anderka in Ottawa. Each transmitter produced an intermittent signal between 1.5 and 3.3 pps at a frequency between 171.5 and 172.5 MHz. It could be identified by a unique combination of frequency and pulse rate. The radio-collar rode on a caribou with the transmitter unit and 46 cm whip antenna resting dorsally on the animal's neck and the heavier battery pack suspended at its throat.

Each transmitter was a two-stage, oscillator-power amplifier unit with a C-MOS pulsing circuit. It had a power output in the range of 2.0 to 3.0 mW and a duty cycle between 7 and 10%. Half of the transmitters had timing circuits with an LDR (light dependent resistor) to slow the pulse rate at night to one every 5 to 10 sec, thereby reducing power consumption by a factor of 20 to 50. Transmitters with an LDR had an expected life of 20 to 24 months, about twice that of units not so equipped. Mercury batteries of the wound anode type (RM 1450R) with a voltage of 5.4 were used as the power source.

Figure 1  
Map of study area showing approximate limit of telemetry surveys and sites where caribou were captured and marked

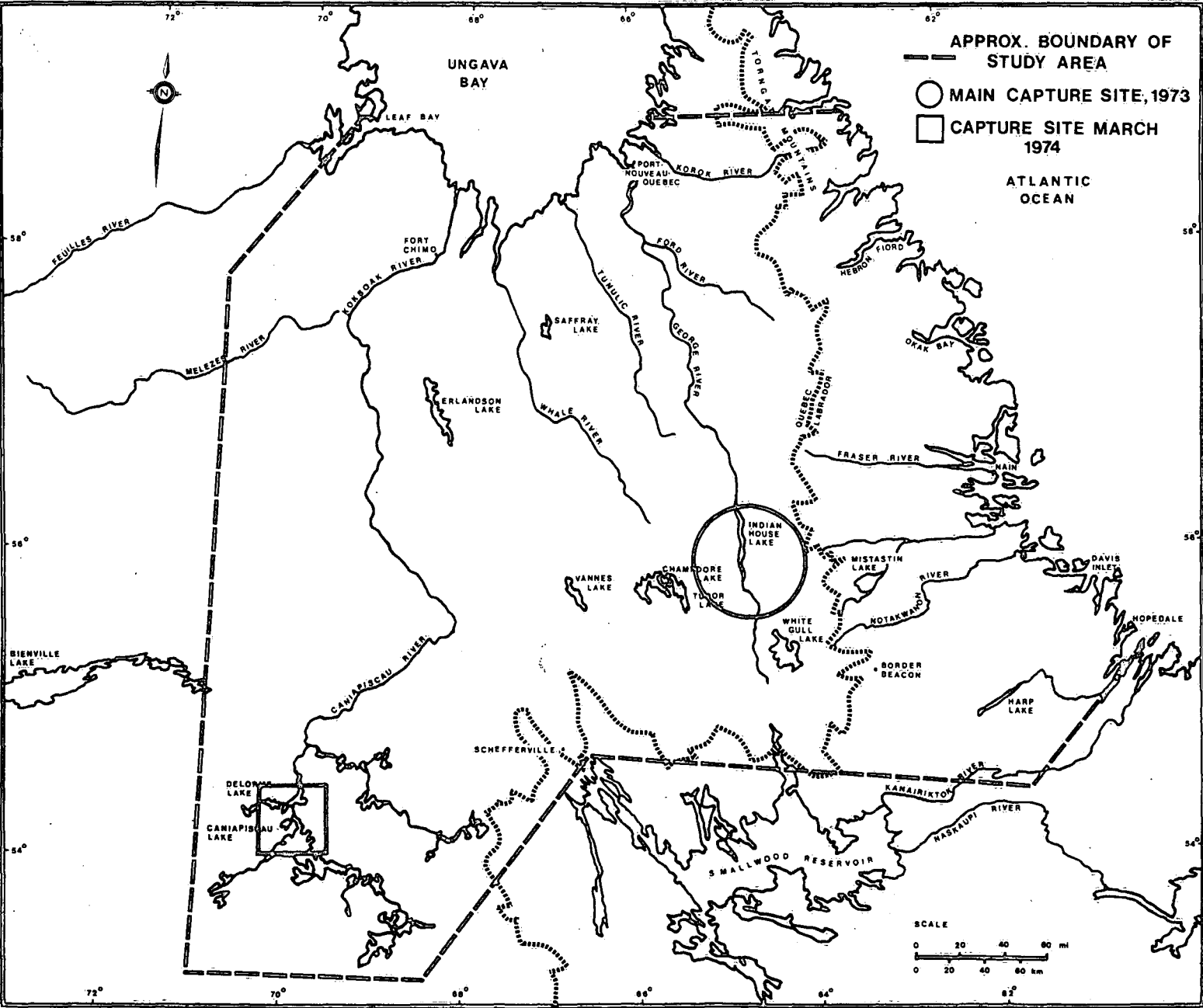


Figure 2  
Aerial transects used for the telemetry survey conducted in January and February 1974. Circles show the collar identification and location of caribou found

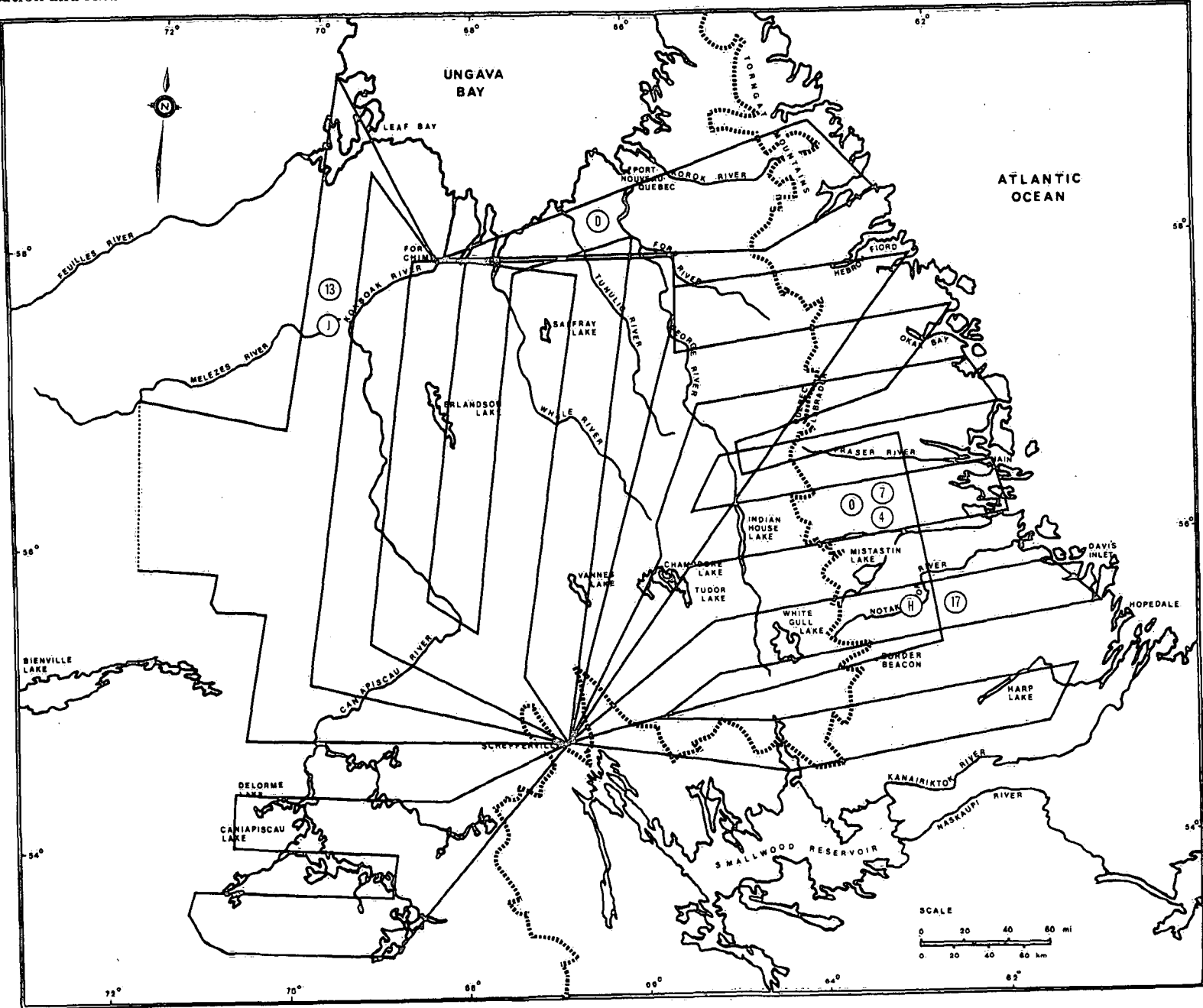


Figure 3  
Aerial transects used for the telemetry survey conducted in April 1974. Circles and rectangle show the collar identification and location of caribou found

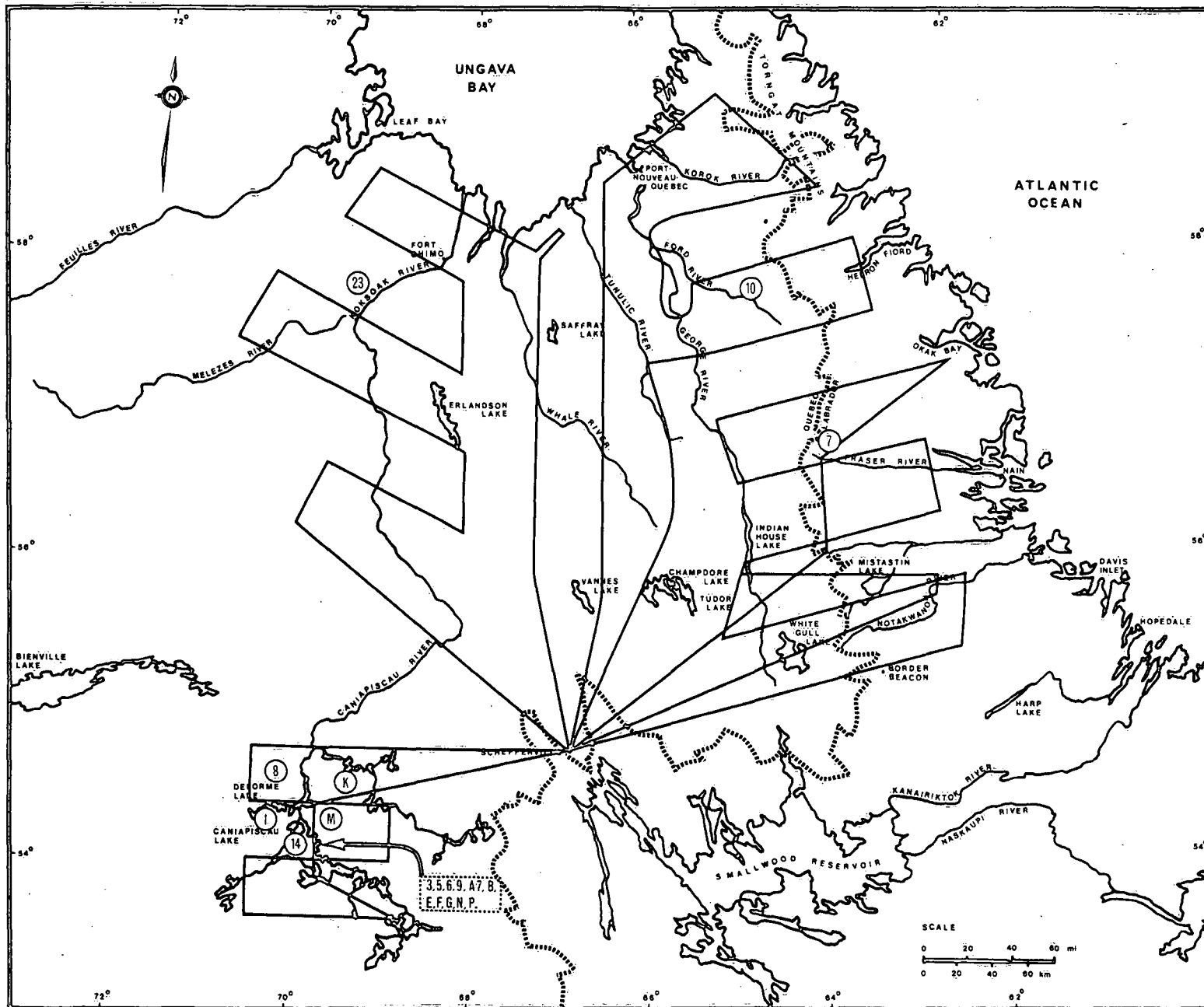


Figure 4  
Aerial transects used for the telemetry survey conducted in June 1974. Circles show the collar identification and location of caribou found

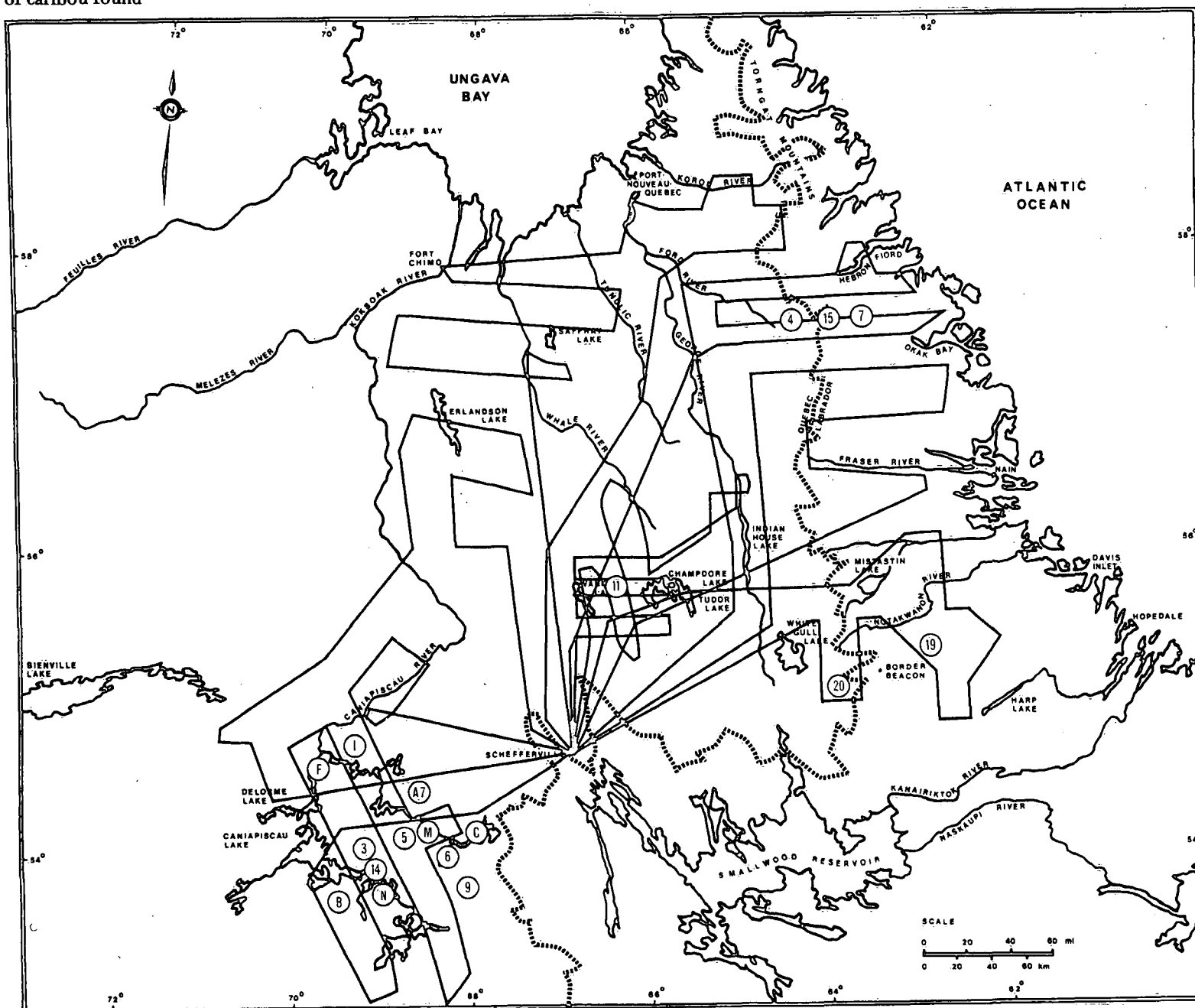


Figure 5  
Location of marked caribou sighted or killed from September 1973 to July 1974. Asterisks denote collars equipped with transmitters

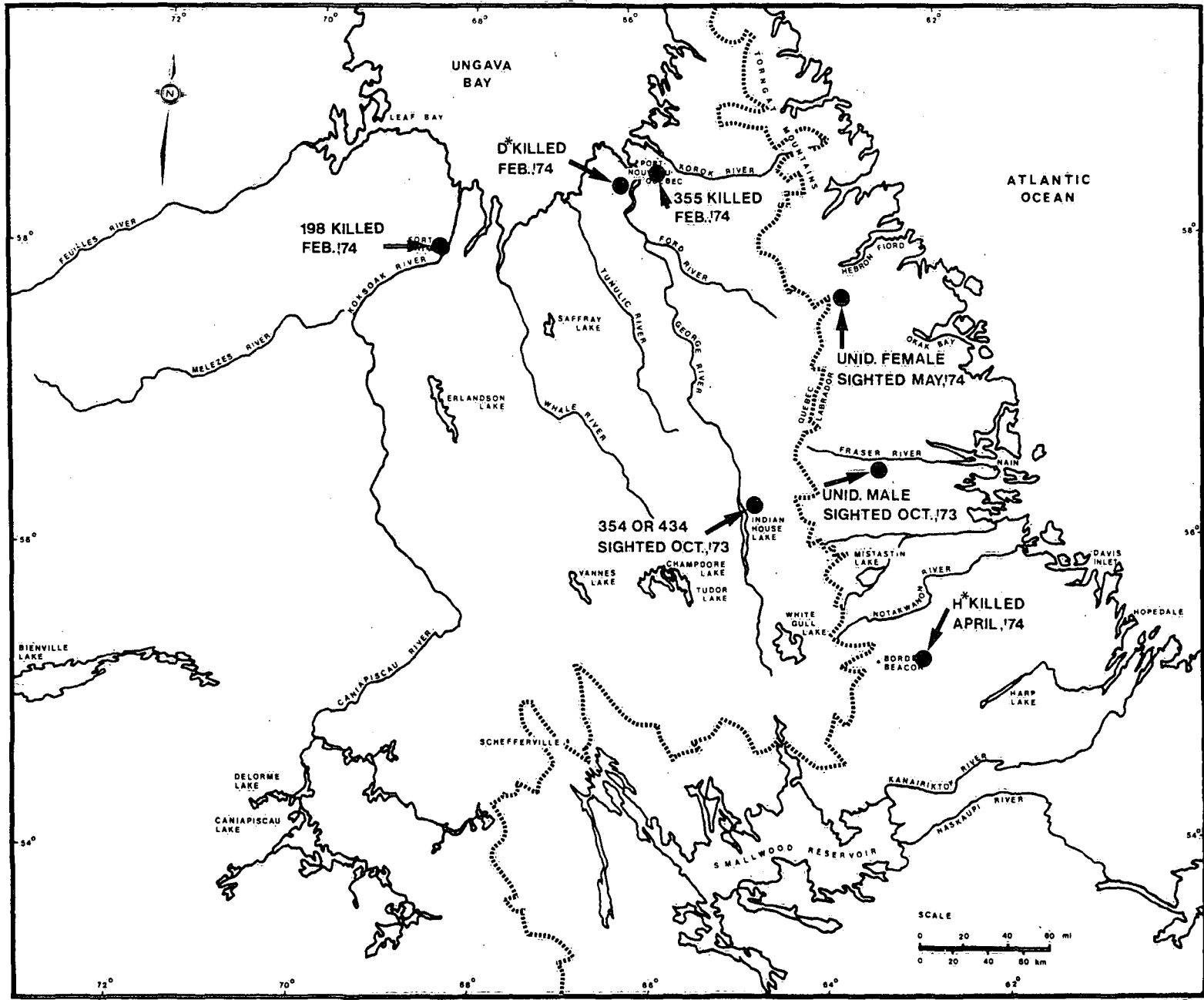
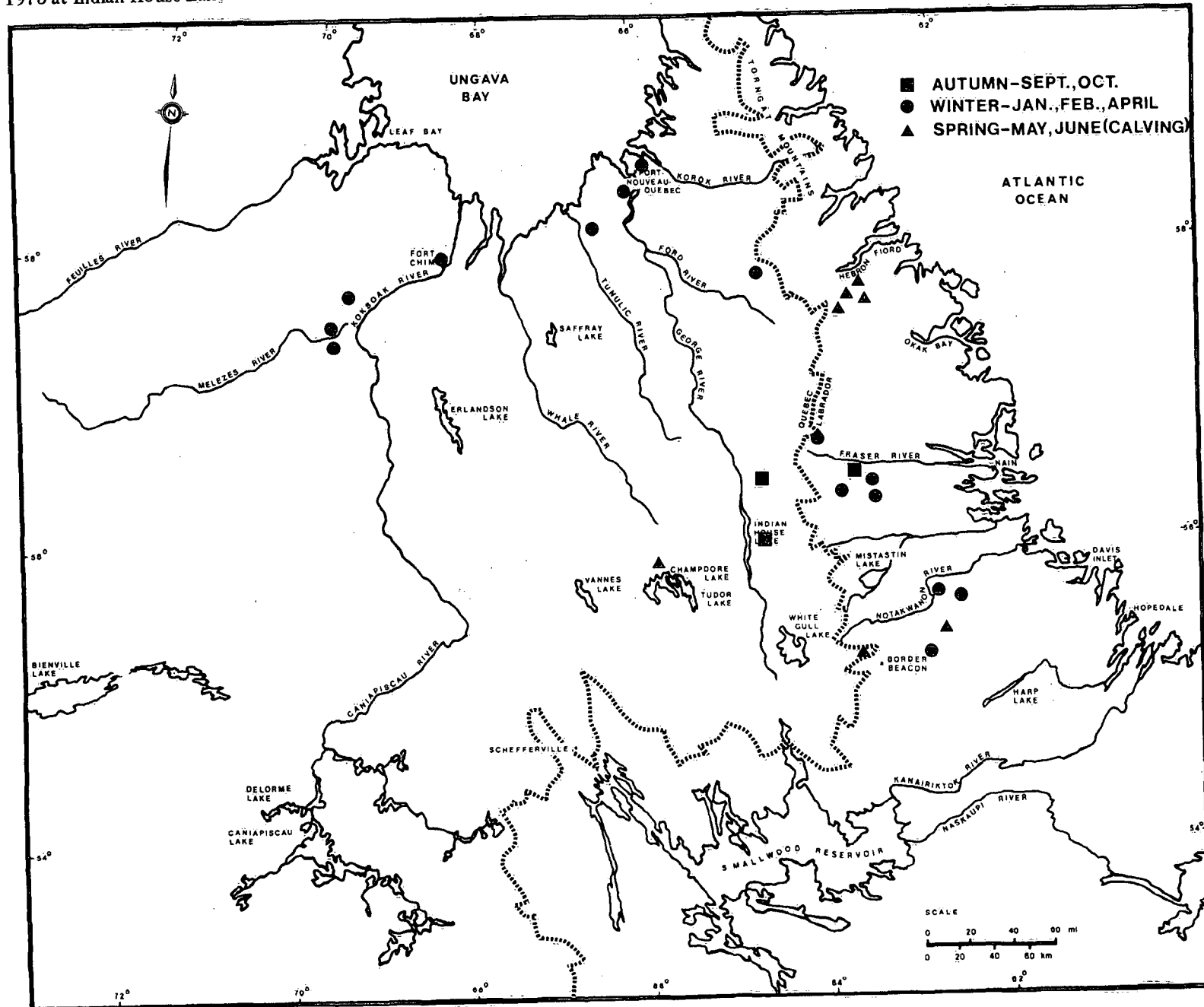
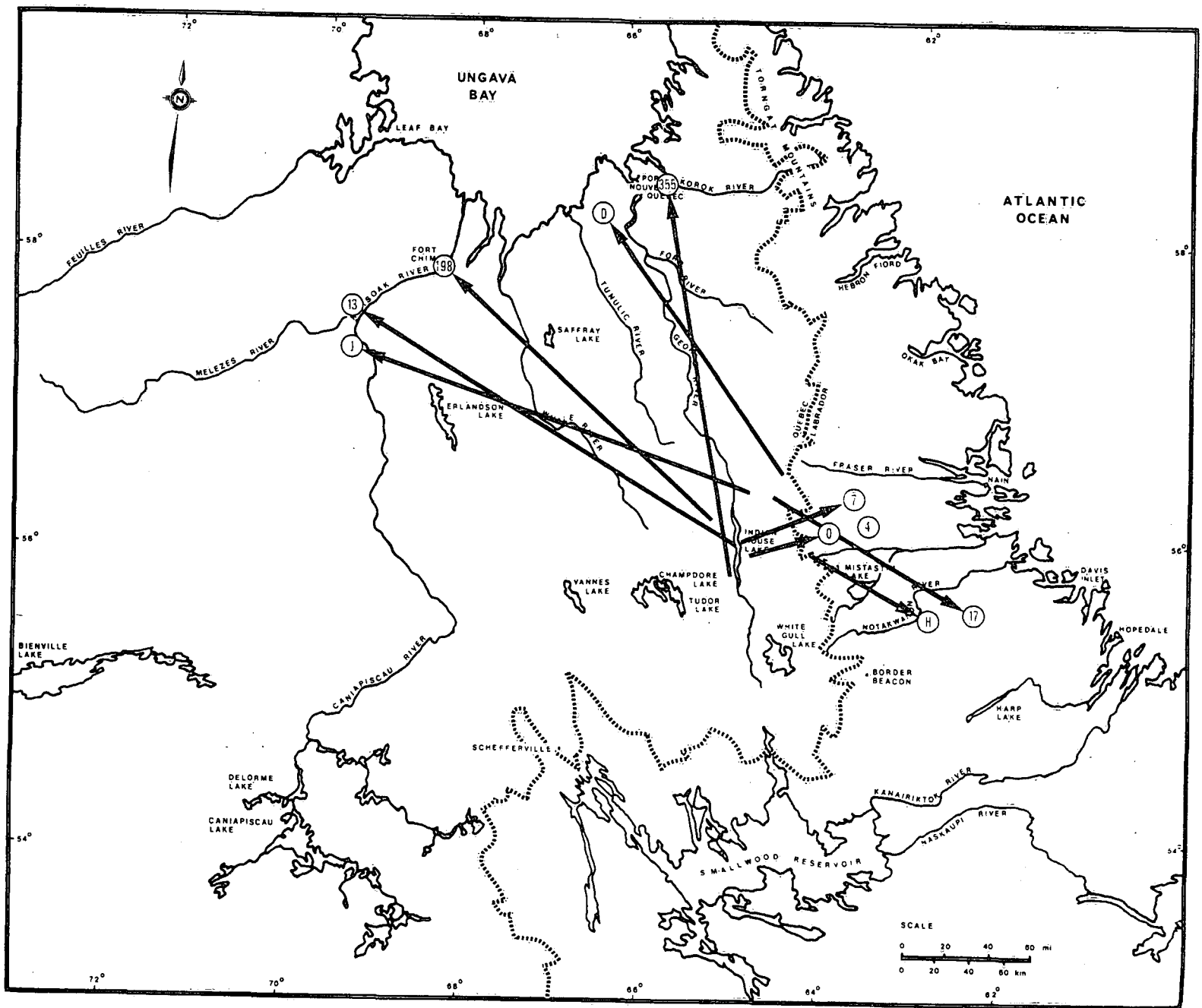


Figure 6  
Distribution of 25 recoveries obtained visually and by telemetry from Sept. 1973 to June 1974 of the caribou marked in 1973 at Indian House Lake





Movement of 10 marked caribou from their capture sites in September and October 1973 to their locations in January and February 1974. The caribou with collar 4 was captured and marked at approximately the same location as the caribou with collar H



**Figure 8**  
Movements of two marked female caribou from their locations in January and February to their locations in April 1974.

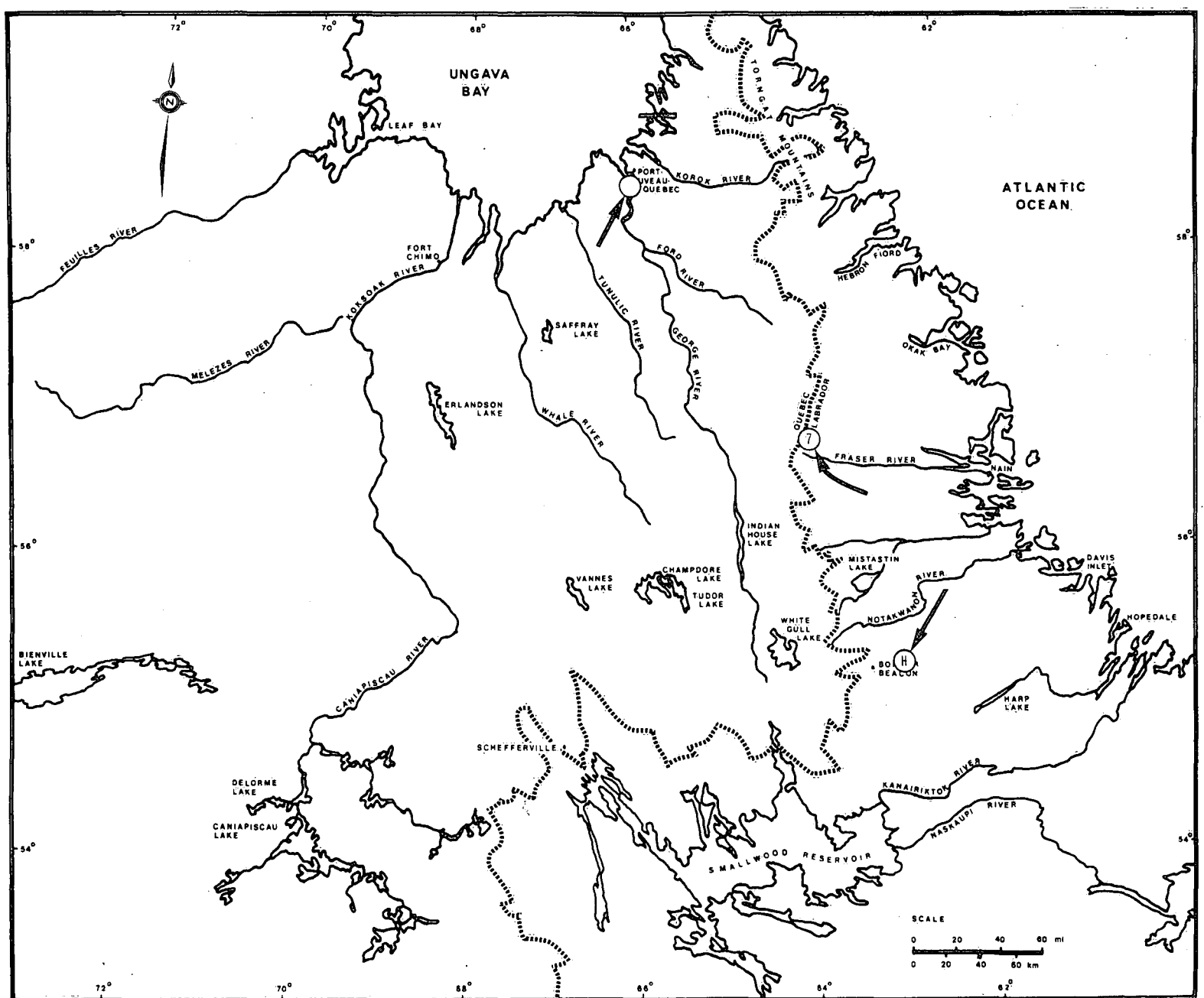


Figure 9  
Movement of a marked female caribou from its location in January (broken line) and another from its location in April to their location in June 1974

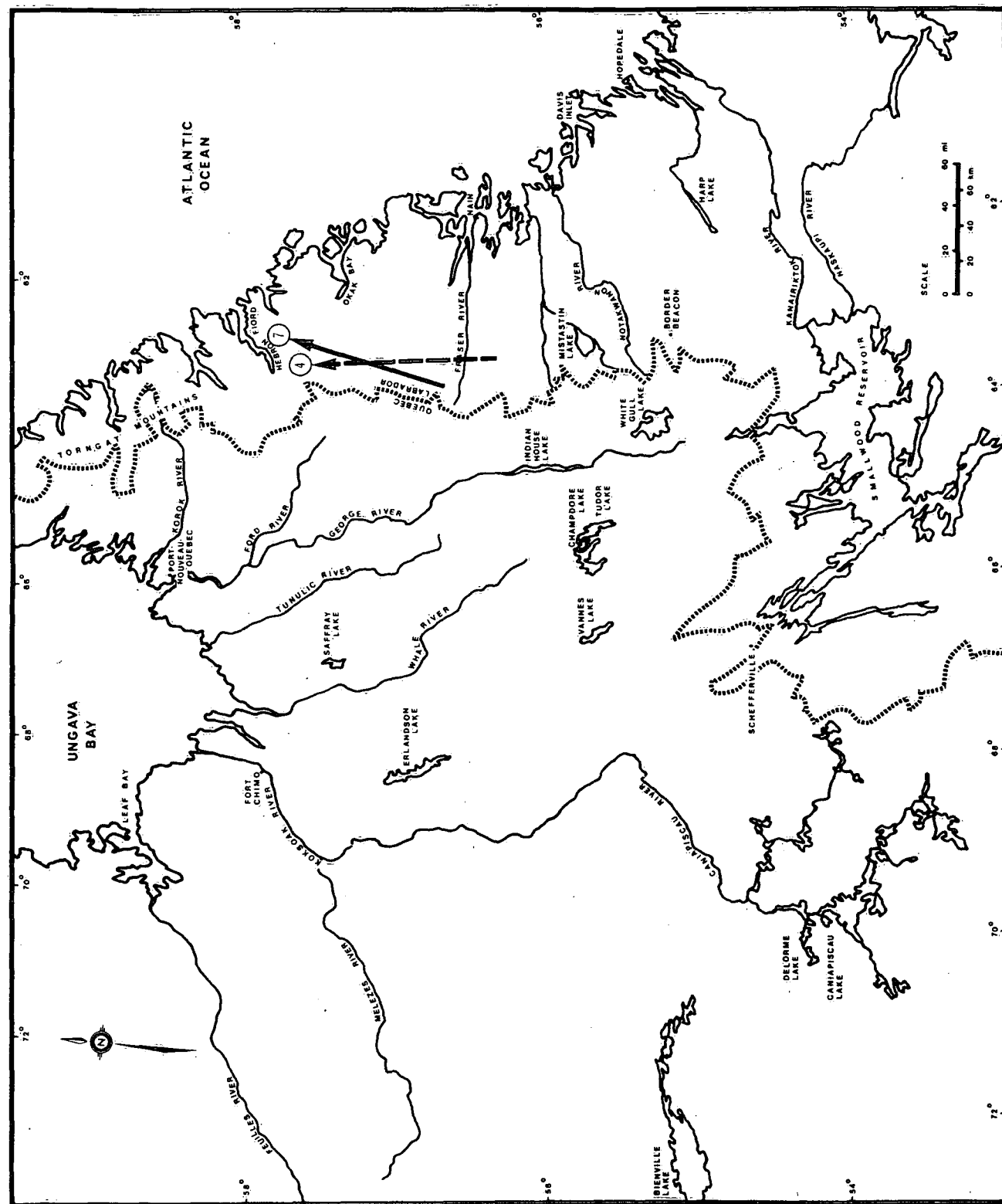
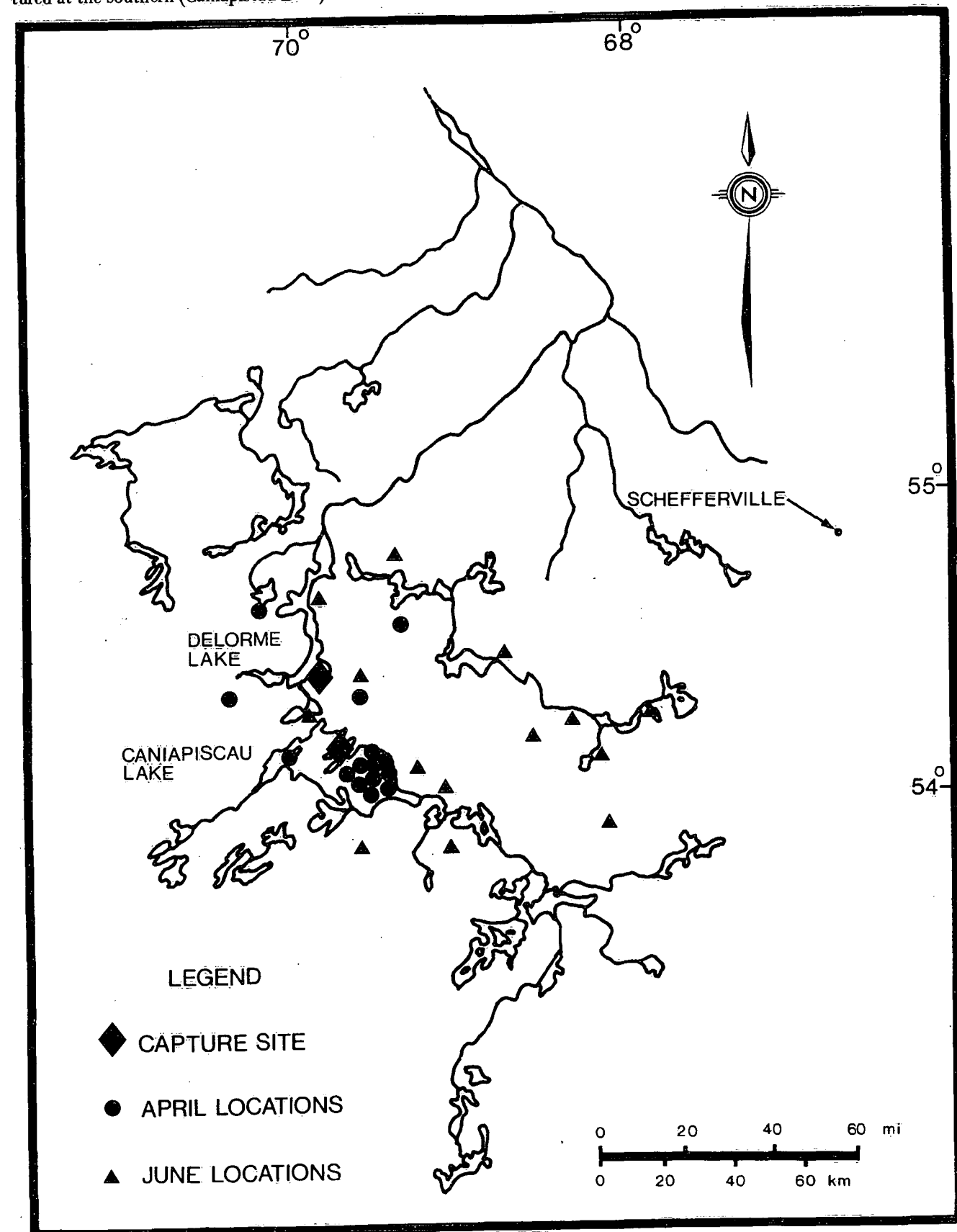


Figure 10  
Distribution of 29 contacts obtained by telemetry in April and June with caribou marked near Caniapiscau Lake in March 1974. The 12 caribou located in June had all been captured at the southern (Caniapiscau Lake) site



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