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SOUTHCENTRAL MOOSE POPULATION STUDIES

by
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and Julius Reynolds

Volume I
Project Progress Report
Federal Aid in Wildlife Restoration
Project W-17-8, Job 1.16R
and
Final Report
Federal Aid in Wildlife Restoration
Projects W-17-6, W-17-7 and W-17-8, Job 1.12R

(Printed April 1977)

JOB PROGRESS REPORT (RESEARCH)

State: Alaska

Cooperators: Jack C. Didrickson and Donald Cornelius

Project No.: W-17-8 Project Title: Big Game Investigations

Job No.: 1.16R Job Title: Lower Susitna Valley Moose Population Identity Study

Period Covered: December 15, 1975 to June 30, 1976

SUMMARY

Forty-nine adult moose were marked with individually identifiable collars, including 24 radio-collars and 25 visually identifiable collars, in the Peters-Dutch Hills portion of Alaska's Game Management Subunit 16A during November 1975. The radio-collared moose were tracked weekly and a search for visually-collared moose was conducted in conjunction with the radio-tracking. To date, 386 observations of radio-collared moose and 74 observations of visually-collared moose have been obtained. In August 1977 a report on the movement data will be submitted.

CONTENTS

BACKGROUND

Knowledge of moose *(Alces alces)* population identities and seasonal movement patterns is necessary for game management. Alaska game managers are presently formulating management plans and require information of this type to delineate management areas and evaluate the adequacy of present data collections. Winter and summer ranges as well as rutting and calving areas must be recognized in order to identify critical habitats and minimize land use conflicts.

Little information is available on moose populations in Game Management Unit 16. Hunter interest in this area has increased steadily and potentially conflicting land uses have been proposed. The initial phase of this study was directed at one population of moose that has a fall distribution in the Dutch and Peters Hills, a portion of the area designated as Alaska's Game Management Subunit 16A.

Hunter access to this area is limited to a single road system which begins on the Parks Highway and ends between the Peters and Dutch Hills. Aircraft are used infrequently by hunters because there are few landing strips and few lakes for float-equipped planes. Some off-road vehicle use takes place, but closure of recent moose seasons before snow fall has prevented use of snowmachines, which were very popular in the past.

The Alaska Department of Fish and Game has several years' sex-and-age composition counts of moose in the Peters and Dutch Hills area. Bull/cow ratios have fluctuated from 25.5/100 in 1967 to 30.0/100 in 1975. Calf/cow ratios have also fluctuated from a low of 23.6/100 in 1975 to a high of 51.2/100 in 1970. In 1975, 43 moose were taken. The area experiences severe winters and it appears that winter kill does occur, although this has not been well-documented.

The study area includes the Peters Hills, Little Peters Hills and Dutch Hills on the south side of the Alaska Range, 33 km west of Talkeetna and 56 km south of Mt. McKinley. It is bounded on the north and east by the Tokositna River and on the west by the Kahiltna River. To the south lies a vast area of mature birch and white spruce forest interspersed with areas of open muskeg and black spruce stands. The Little Peters Hills, Peters Hills and Dutch Hills are low rolling mountains less than 1500 m in elevation which form the southern foothills of Mt. McKinley. Subalpine areas are comprised of large tracts of alder interspersed with spruce stands and open grasslands. The Tokositna River and Kahiltna River Valleys both are comprised of large tracts of alder mixed with

open meadows, gravel flats and ponds. An old burn is located on the west side of the Little Peters Hills and is dominated by heavily-browsed birch and willow cover, most of which is within reach of browsing moose. The terminal and lateral glacial moraines of the Kahiltna Glacier are dominated by young stands of mixed willow and alder.

OBJECTIVES

To delineate populations and subpopulations of moose on the west side of the lower Susitna Valley and to assess their seasonal movement patterns.

PROCEDURES

Under S&I Job 1.1, 49 moose were captured and marked using helicopter darting techniques between November 13 and 17, 1975 (Appendix I). Initial dosages of 25 mg of Anectine (Succinylcholine chloride) per moose were utilized but drug-associated problems caused this dosage to be reduced to as low as 20 mg for males and 21 mg for females.

An attempt was made to mark each animal with red streamers held in the ear by numbered ear tags. Hair samples for mineral analysis were taken from each animal and an incisor tooth was collected when time permitted. When an incisor was not taken an estimate of the age of the moose was made based on tooth wear.

Twenty-four moose (18 adult females and 6 adult males) were fitted with radio-collars supplied by AVM Instrument Company, Champaign, Illinois. Each collar was equipped with an SB 2 transmitter with an internal whip antenna. These 40km-range transmitters are powered by low temperature lithium batteries with a theoretical life span of 48 months. The transmitter and battery pack were imbedded in dental acrylic with the transmitter enclosed in a hermetically sealed can. The entire unit is waterproof. Each transmitter emits a pulsed signal on frequencies between 150,800 and 151.090 MHZ.

Twenty-five moose (18 adult females and 7 adult males) were fitted with numbered neck collars visually identifiable from the air (Franzmann et. al. 1974).

Antlered moose present a unique problem because the drug utilized has little or no effect on the neck musculature. Initial attempts to place open-ended collars on antlered moose resulted in a loss of time and placed the individual who bolted the collar together in a precarious position. Very large antlers were a particular problem, because the individual could be caught between the swinging antlers and the body of the recumbent animal. After working on a few antlered animals and realizing the drug down-time was too short to permit us to accomplish all of the collections and also to bolt on the collars, we utilized a teflon-coated carpenter's hand saw to remove the antlers. This procedure allowed us to prefabricate the collars and slip them onto the animal easily. Prior removal of the antlers required less time and eliminated the possibility of an accident.

FINDINGS AND DISCUSSION

Surveys and Observations

During the 28-month study from March 1974 through June 1976, 45 surveys were flown by the reporting biologist (Tables 1 and 2). A total of 414 sightings of collared moose were recorded. East of the Copper River, 23 surveys yielded 208 collared moose observations. Twenty-two surveys west of the Copper River yielded 206 observations. Mean percent of collared moose observed during the surveys east and west of the Copper River were: (1) 46.3 percent east; (2) 43.4 percent west.

During the winter of 1974-75 collared moose comprised a substantial portion of the population as indicated by the percentage of moose seen that were collared: 9.3 to 12.4 percent east and 11.4 to 13.5 percent west for the December-through-March period. During the same months the following winter, collared moose comprised only 7.8 to 10.6 percent of the herd east of the Copper River and 7.7 to 7.9 percent west.

Surveys conducted during the winter months of December through March typically yielded samples of over 100 moose per survey including 60 to 90 percent of the collared moose (Table 3). Surveys at other seasons were less efficient.

Interaction

Intermingling of the two collared groups was surprisingly rare. During the 28-month study two bulls and three cows were observed to have crossed the management boundary. The two bulls made their noteworthy movements during the spring months. In May 1974, #20 had moved from the east side to the west side but was killed in August 1974 east of the Copper River during the hunting season. In May 1975, #46 had moved from west to east of the Copper River where it remained until taken by a hunter in August 1975. Another male, #23, moved approximately 15 miles immediately after being collared, but this movement may have resulted from handling stress.

Probably the most significant movements were made by females collared west of the Copper River. Females #34 and #45 utilized the lower Copper River islands during the spring and summer of 1974, while female #33 was observed on Long Island several times the same summer. The summer range of these three females is in the "eastern" management area. All three females returned to the west side prior to hunting season.

No collared moose were observed utilizing the lower Copper River islands during summer 1975 or spring 1976.

Following the termination of the collared moose study in June 1976, two noteworthy observations were made of moose tagged on the west side; #38, a female with twins, was seen in August 1976 on a lower Copper River island and #41, also a female, was observed in February 1977 east of the Copper River in the Martin River Valley. The movement of #41 from west to east was significant in that it represented the first collared moose to winter in the management area opposite that in

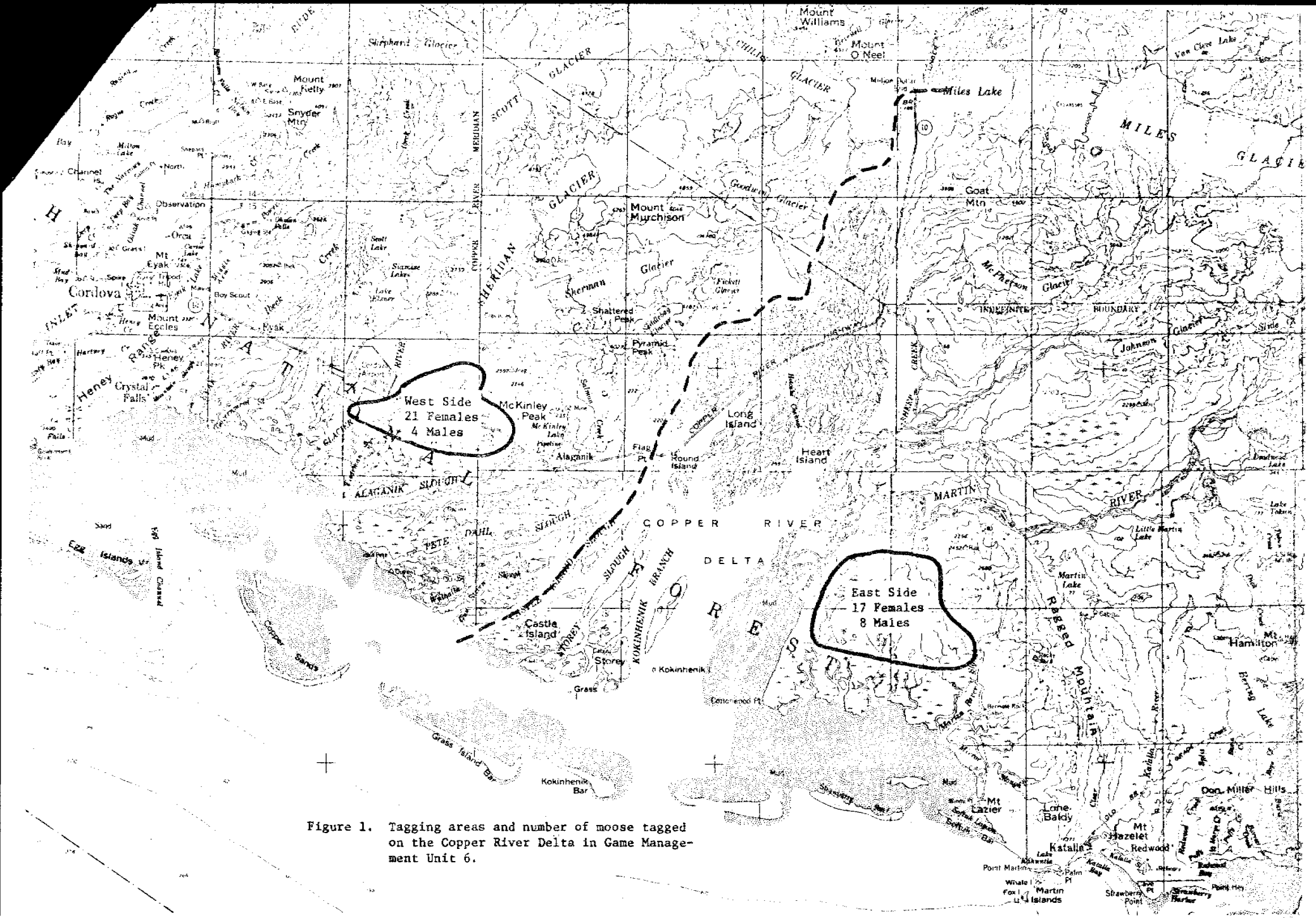


Figure 1. Tagging areas and number of moose tagged on the Copper River Delta in Game Management Unit 6.

which it was collared. It was also the first observation of a collared cow to actually cross the Copper River.

Based on the above observations, it is obvious that: (1) the lower Copper River islands are part of the western herd's normal summer range (it should be noted that no moose collared east of the Copper River were seen on these islands) and (2) an occasional moose will move from one side of the Copper River to another but such movements are insignificant from a management viewpoint.

Individual Movements

Individual observation records are found in Appendix I. Most sightings were made during the winter and spring months when counting conditions were optimal, i.e., maximum snow and minimum foliage. Females appeared to be more traditional in using the same area year after year than males.

East of the Copper River, collared moose exhibited three basic movement patterns during the 28-month study (Fig. 2). One segment of the herd moved north, from the winter range, across the Martin River to utilize the eastern side of the Copper River, Sheep Creek and Pleasant Valley. A second segment moved north and then west, circling around the northern end of Ragged Mountain to utilize the upper two-thirds of the Martin River Valley. A third segment of the herd remained on the winter range throughout the year.

West of the Copper River, collared moose displayed similar movements (Fig. 2). One segment moved west from their winter range to utilize the Scott Glacier drainage; a second segment remained in the Alaganik Slough wintering area; and the third segment migrated eastward to utilize the western side of the Copper River and the lower Copper River islands. The majority of collared moose moved into the latter area.

Moose collared in March 1974 on their winter range consistantly returned to the same winter range the following two winters. Individual moose displayed the same movement pattern annually, which is consistant with movement patterns of Interior moose (Coady 1976).

Movement of moose, both east and west of the Copper River, is confined to the flatlands. They do not display an altitudinal movement, probably because the delta is fringed with steep mountains forested with spruce and hemlock. No food source is present on the higher elevations.

Seasonal Movements

Seasonal movements of the collared animals are shown in Appendix II by calendar month and year. Movement on the Copper River Delta was closely related to climatic conditions, primarily snow depth. Moose that migrated off the winter range tended to remain off until motivated by wind or deep snow to return. In the late fall, moose along the western side of the Copper River may retreat from cold Copper River winds with little snow on the ground.

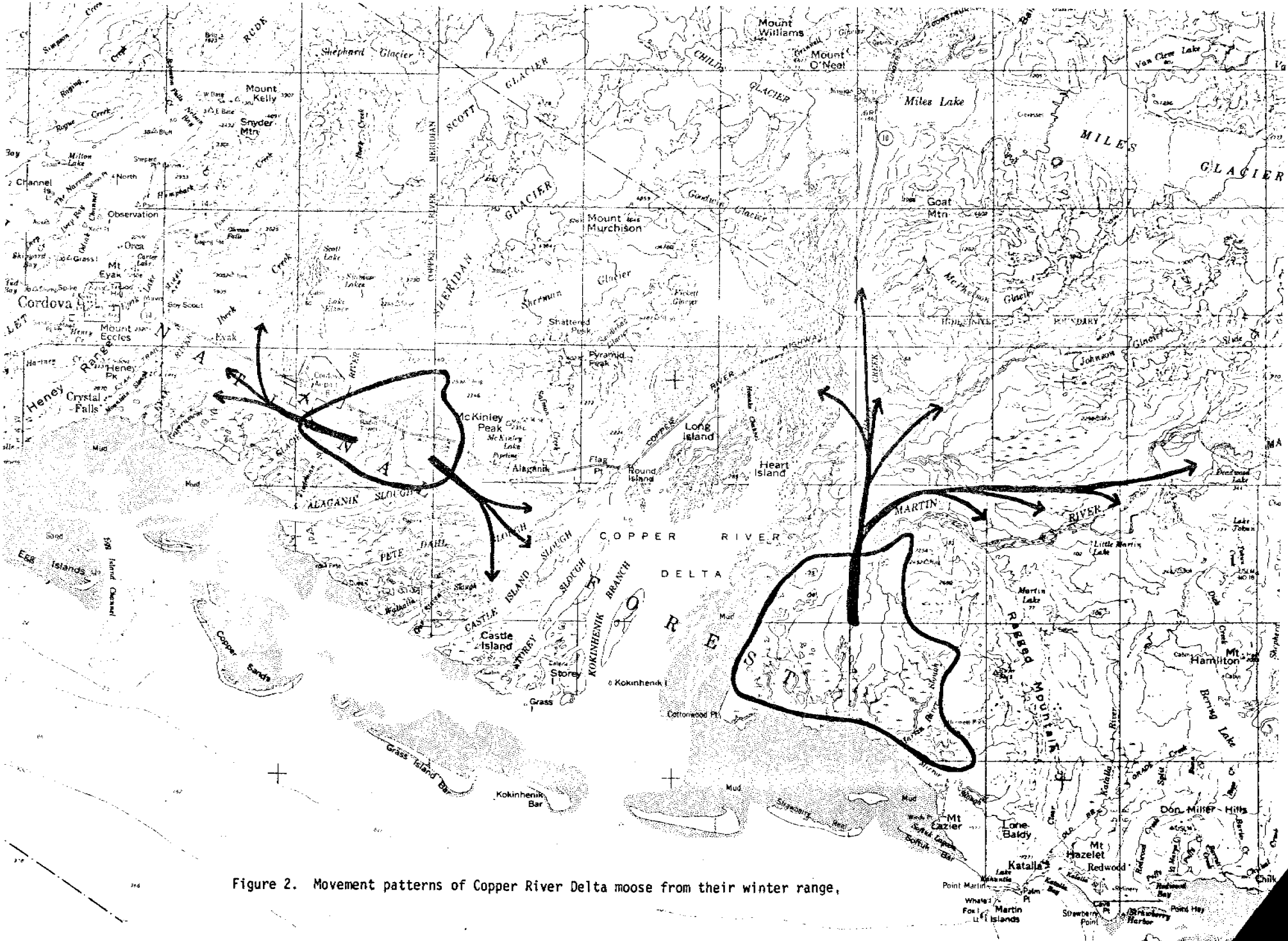


Figure 2. Movement patterns of Copper River Delta moose from their winter range.

An observation not obvious in the distribution data is that east of the Copper River, the deeper the snow the closer to saltwater the collared moose winter; whereas, west of the Copper River, the deeper the snow the farther inland they retreat. Warm coastal (SE) winds minimize snow depth on the eastern side of the delta near saltwater. In contrast, winds funneling out of the Interior (Gulkana Basin) primarily flow down the western side of the Copper River. The cold Copper River wind causes more snow to accumulate on the outer delta. In the spring, as the Interior warms up, the Copper River winds diminish. Coastal rain clouds "pile up" along the Chugach Mountains and deposit precipitation near the mountains. Thus, snow on the inland portion of the west side melts earlier than does snow on the seaward portion or the Martin River Valley.

Seasonal movements during this 28-month study may be summarized as follows:

January, February, and March--Moose were on their winter range. Highest concentrations on the winter range normally occur in March.

April--Moose were starting to disperse west of the Copper River. East of the Copper River the animals were still confined to their winter range.

May--Moose were well dispersed west of the Copper River and just beginning to disperse off the winter range east of the Copper River.

June--Moose were scattered throughout their summer range west of the Copper River. Snow may have retarded full utilization of the summer range east of the Copper River.

July through November--Moose were on summer ranges. Animals were scattered and hard to locate because of dense foliage.

December--Moose had retreated from the Copper River on the west side because of wind and snow conditions. East of the Copper River, the moose had not been forced onto the winter range by snow but appeared to have moved away from the Copper River.

The coastal climate influencing the Copper River Delta is highly variable and has a direct effect upon seasonal movements. A record snowfall during the winter of 1971-72 restricted moose west of the Copper River to their winter range until early June. In contrast, during the winter of 1976-77, the ground was nearly snowfree. Moose observed in February 1977 were scattered throughout most of their summer range. Results of this March 1974-through-June 1976 study of moose movements are fairly typical of an "average" year.

Calving Areas

Calving areas on the Copper River Delta were determined for the years 1974, 1975, and 1976 (Appendix III). Each year during late-May

to mid-June surveys were flown and the location of every cow with a newborn calf was recorded. The majority of cow-calf observations were not of collared animals. Judging from the three years of data, calving is well dispersed throughout the delta in the willow-alder zone. No distinct "calving grounds" exist.

Mortality

Mortality of collared moose on the Copper River Delta is listed in Table 4. Moose that were neck collared (March 1974) but never seen in 1975 or 1976 were considered dead. The high proportion of collared moose observed during winter months and the high frequency of individual sightings indicate some form of mortality, most likely natural.

Mortality of collared moose during this 28-month study was estimated to be 30 percent (15 of 50). Discounting collared moose #22, which probably died of drug effects, mortality incurred during 1974 (March through December was estimated at 16.3 percent (8 or 49) and for 1975 14.6 percent (6 of 41). It appears that annual mortality of adult moose on the Copper River Delta is probably 15-20 percent in a normal year.

East of the Copper River mortality was estimated to be 36.0 percent (9 of 25) for the study period. Known mortality consisted of four animals taken by hunters and one killed by drowning. One animal (#22) was never seen after being collared and is suspected to have died from drug effects. Three were "missing" and suspected dead from natural causes. Illegal shooting is not a problem east of the Copper River because the area is roadless most of the year.

West of the Copper River the estimated mortality was 24.0 percent: three moose taken by hunters, two shot illegally, and one "missing".

The environment east of the Copper River is more harsh than that west of the Copper River, which may account for the greater number of missing collared animals on the eastern side.

Predation by brown bears and wolves was known to have occurred during the study period but no collared moose were known to have succumbed to a predator. Brown bear predation on new born calves and winter-weakened adults is common each spring on both sides of the Copper River. Wolves do not normally inhabit the western side of the delta and are not numerous east of the Copper River. Wolf predation on moose was noted along the headwaters of the Martin River during the winter months when most of the eastern herd was on its winter range. Predation was not a significant mortality factor during this study.

Calf mortality during the study was minor (Appendix I). In contrast to Interior moose populations (Coady 1976), survival through the summer and winter was excellent, indicating good range and low predation rates.

Appendix I. Numerical designation and sex of moose in Game Management Unit 16 fitted with visual-collars or radio-collars.

Radio-Collared Moose		Visually-Collared Moose	
Numerical Designation	Sex	Numerical Designation	Sex
5527	M	1	F
5528	M	2	F
5529	M	3	F
5530	M	4	F
5531	F	5	F
5532	F	6	F
5533	F	7	F
5534	F	8	F
5535	F	9	F
5536	F	10	F
5537	F	11	F
5538	F	12	F
5539	M	13	F
5540	M	14	F
5541	F	15	F
5542	F	16	F
5543	F	17	F
5544	F	21	F
5545	F	76	M
5546	F	77	M
5547	F	80	M
5548	F	82	M
5588	F	83	M
5589	F	84	M
		85	M

Appendix I. (cont.) Individual Observation Records.

No.	Sex	Area	Observations[1/]	Remarks
14	F	East	1974 - 3/27, 4/26, 10/8[1] 1975 - 3/25[1] 1976 - 2/16[2], 3/12[2], 5/21, 6/2	
15	F	East	1974 - 10/8, 11/6, 12/26 1975 - 3/25, 4/24 1976 - 2/16, 3/12[1], 5/21, 6/2	
17	F	East	1974 - 3/27, 11/6, 12/26 1975 - 1/27, 3/25, 4/24, 5/31, 12/9 1976 - 2/16, 3/12, 6/2	
20	M	East	1974 - 3/27, 4/26, 5/28	5/28/74 west of C.R 8/20/74 shot east of C.R. by hunter.
21	M	East	1974 - 3/27, 5/22, 8/24, 11/6, 12/26 1975 - 1/27, 3/25, 4/24, 5/31, 8/26	10/20/75 shot by hunter.
22	M	East	1974 - not seen 1975 - not seen 1976 - not seen	Probably died after being drugged.
23	M	East	1974 - 3/27, 4/26, 10/8, 11/6, 12/26 1975 - 5/31	8/21/75 shot by hunter.
24	M	East	1974 - 3/27, 11/6 1975 - 1/27, 3/25, 12/9 1976 - 2/16, 3/12, 6/2	
25	F	East	1974 - 3/27, 7/17, 12/26[1] 1975 - 1/27[1], 3/25[1], 4/24[1], 10/16[1], 12/9[1] 1976 - 3/12[1], 5/21[1], 6/2	
26	M	East	1974 - 3/27, 4/26, 5/22, 11/6, 12/26 1975 - 1/27, 3/25, 4/24, 5/31, 8/26, 10/16 1976 - 3/12, 5/21	
27	M	east	1974 - 3/27 1975 - not seen 1976 - not seen	Probably dead.
28	F	East	1974 - 3/27, 4/26, 6/27, 10/8, 11/6 1975 - 1/27, 3/25, 8/26, 12/9 1976 - 2/16, 3/12, 5/21	

1/ Subscript number beside date denotes number of calves with female.

Appendix 1. Individual Observation Records.

No.	Sex	Area	Observations[1/]	Remarks
1	F	East	1974 - 3/27, 4/26, 5/22, 12/26 1975 - 3/25, 4/24 1976 - not seen	
2	F	East	1974 - 3/27, 5/22, 12/26 1975 - 1/27, 3/25, 4/24, 12/9 1976 - 6/2	
3	F	East	1974 - 3/27, 8/24[1], 12/26[2] 1975 - 1/27[2], 3/25[2] 1976 - not seen	Only 1 calf seen in Aug.
4	F	East	1974 - 3/27, 4/26, 12, 26 1975 - 1/27, 3/25, 5/31, 8/26	11/25/75 drowned in Martin R.
5	F	East	1974 - 3/27, 4/26, 6/7 1975 - 1/27, 3/25, 5/31[2]	8/21/75 shot by hunter.
7	F	East	1974 - 3/27, 4/26, 5/22, 6/7[2], 6/10[2], 6/27[2], 10/8[2], 11/6[2], 12/26[2] 1975 - 1/27[2], 4/24[2], 5/31[2], 12/9 1976 - not seen	
8	F	East	1974 - 6/12[2], 10/8[1], 11/6[1], 12/26[1] 1975 - 1/27[1], 3/25[1], 5/31, 10/16 1976 - not seen	Lost one calf.
10	F	East	1974 - 3/27, 5/22, 12/26 1975 - 1/27, 3/25, 12/9 1976 - 2/16, 3/12, 6/2[2]	
11	F	East	1974 - 3/27, 4/26, 5/22, 10/8, 11/6, 12/26 1975 - 1/27, 2/28, 3/25, 4/24, 12/9[1] 1976 - 3/12[1], 5/21[1]	
12	F	East	1974 - 4/26, 5/22 1975 - not seen 1976 - not seen	Probably dead.
13	F	East	1974 - 3/27, 4/26, 6/10[1], 12/26[1] 1975 - 3/25[1] 1976 - 2/16, 3/12, 6/2[2]	

1/ Subscript number beside date denotes number of calves with female.

Appendix I. (cont.) Individual Observation Records.

No.	Sex	Area	Observations[1/]	Remarks
40	F	West	1974 - 3/26, 6/26, 11/7, 12/20 1975 - 1/29, 3/3, 4/28, 5/28, 6/6 8/25, 9/22, 10/24 1976 - 2/18	
41	F	West	1974 - 3/26, 4/25 1975 - 1/29, 3/3, 4/28 1976 - 2/18[1]	(2/28/77 East of CR/Martin R. valley.)
42	F	West	1974 - 3/26, 4/25, 5/28, 12/20 1975 - 1/29, 4/28 1976 - 2/18	
43	F	West	1974 - 4/25, 6/26, 11/7, 12/20 1975 - 1/29, 3/3, 4/28, 8/25[2], 10/24[2] 1976 - 2/18[2]	
44	F	West	1974 - 3/26, 4/25, 5/22, 12/20 1975 - 1/29, 3/3, 5/28, 6/6, 8/25, 12/10 1976 - 2/18	
45	F	West	1974 - 4/25, 6/12, 6/26, 7/18, 12/20[2] 1975 - 1/29[2], 3/3, 4/28, 8/25[1], 12/10[1] 1976 - 2/18[1]	On lower Copper R. Is. 6/74
46	M	West	1974 - 3/27, 4/25, 11/7, 12/20 1975 - 1/29, 3/3, 4/28, 5/31, 8/26	E. of CR 5/31 until shot by hunter 8/29/75
47	M	West	1974 - 4/25, 5/28, 6/10, 6/26, 7/18,	9/10/74 shot by hunter.
48	M	West	1974 - 4/25, 6/11, 12/20 1975 - 1/29, 3/3, 6/12 1976 - 5/17	W/o antlers 12/20/74
49	M	West	1974 - 3/26, 5/28, 6/11, 6/26, 8/23, 9/27, 12/20 1975 - 1/29, 4/28, 5/28, 6/6, 9/22 1976 - 2/18, 5/17	With 1 antler 12/20/74
50	F	West	1974 - 5/28, 6/11, 7/18, 12/20 1975 - 1/29, 3/3, 6/6, 8/25	9/14/75 shot illegally.

1/ Subscript number beside date denotes number of calves with female.

Appendix I. (cont.) Individual Observation Records.

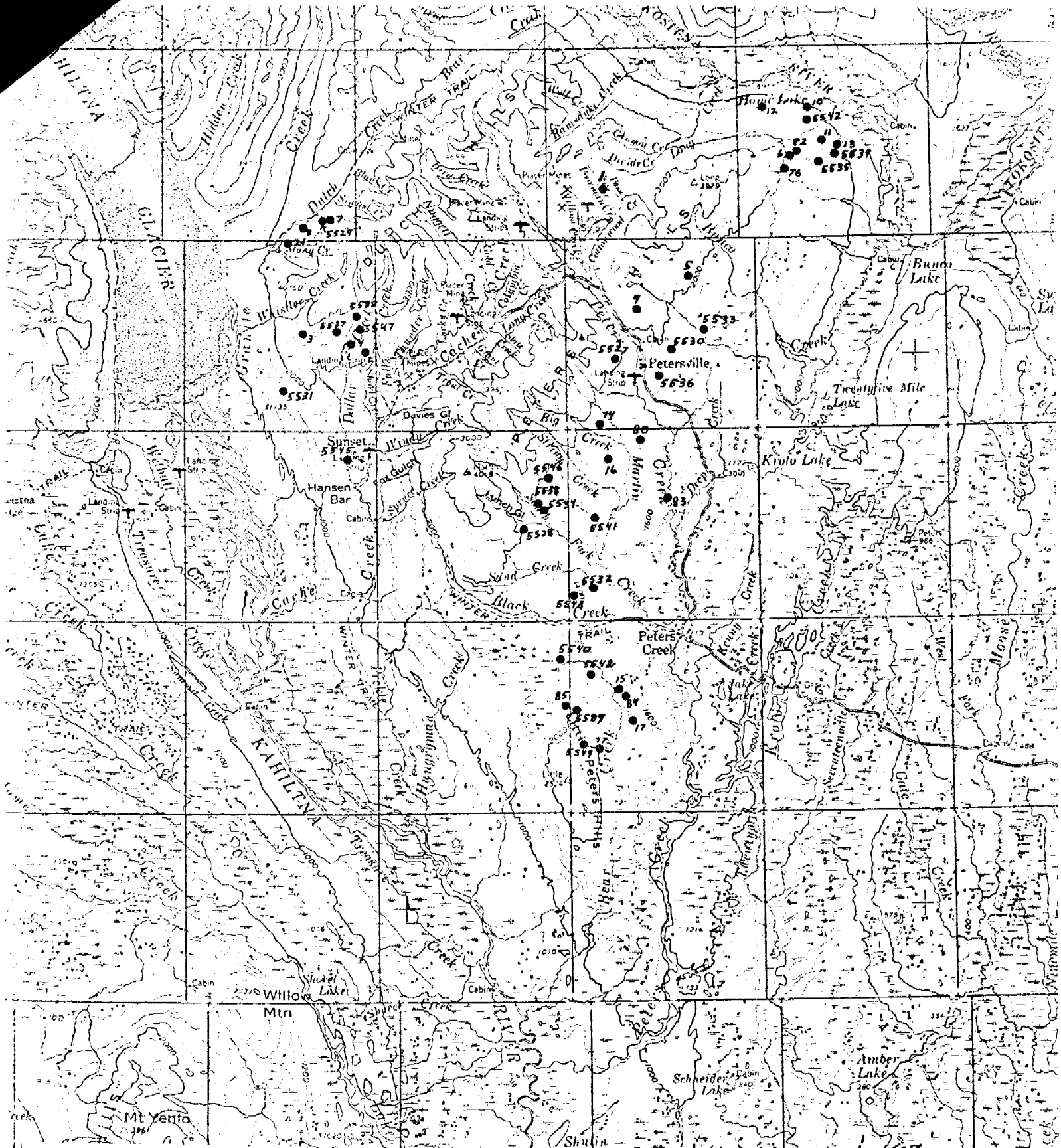
No.	Sex	Area	Observations[1/]	Remarks
29	M	East	1974 - 3/27, 12/26 1975 - 3/25 1976 - not seen	Probably dead.
30	F	East	1974 - 3/27, 4/26 1975 - not seen 1976 - not seen	Probably dead.
31	F	West	1974 - 3/26, 6/11, 11/7, 12/20 1975 - 4/28, 6/6, $12/10^{1}$ 1976 - 2/18	
32	F	West	1974 - 4/26, 5/28, 8/23	9/13/74 shot by hunter.
33	F	West	1974 - 3/27, 5/22, 6/7, 6/10 7/18, 12/20 1975 - 1/29, 3/3, $10/24^{2}$, $12/10^{2}$ 1976 - $2/18^{2}$	On Long Island in June and July of 1974.
34	F	West	1974 - 3/26, 4/25, 6/12, 8/28, 12/20 1975 - 1/29, 3/3, $8/25^{2}$, $10/24^{1}$, $12/10^{2}$ 1976 - 2/18	On lower CR Is. in June and August of 1974. Missed 1 calf 10/75.
35	F	West	1974 - 6/11, 7/18, 11/7, 12/20 1975 - 1/29, 3/3, 4/28, $6/6^{2}$, $9/22^{2}$, $12/10^{2}$ 1976 - not seen	
36	F	West	1974 - 8/29, 11/7 1975 - 5/28 1976 - not seen	(9/10/76 shot by hunter.)
37	F	West	1974 - not seen	12/17/74 shot illegally.
38	F	West	1974 - 4/25, 5/28, 6/11, 7/18, 8/23, 11/7, 12/20 1975 - 1/29, 3/3, $8/25^{1}$, $12/10^{1}$ 1976 - $2/18^{1}$, 5/17	(8/22/76 #38/twins on lower Copper River island.)
39	F	West	1974 - 4/26, 6/11, 6/26 1975 - 1/29, 3/3, 6/6, 9/22, 12/10 1976 - 2/18	

1/ Subscript number beside date denotes number of calves with female.

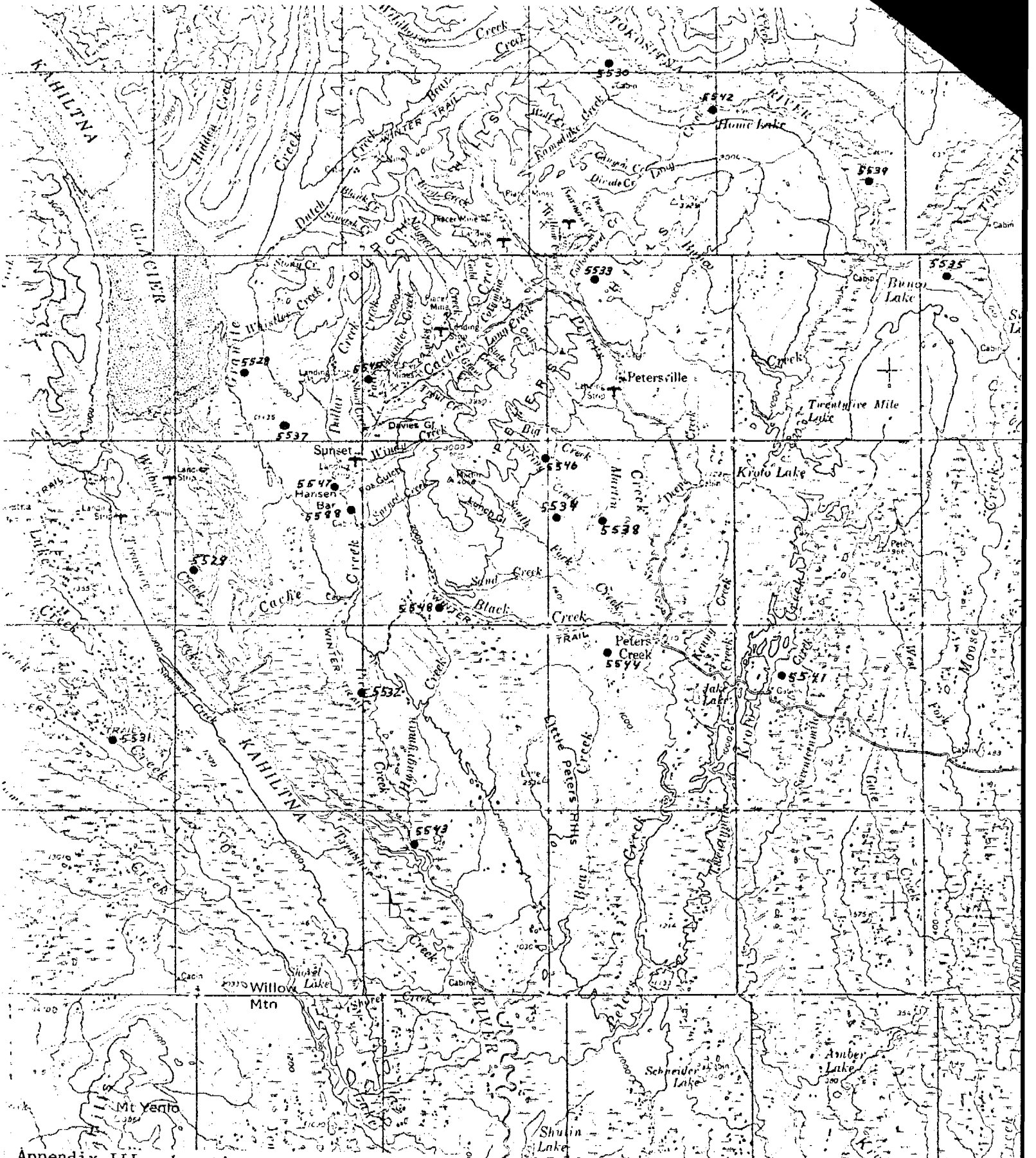
Appendix I. (cont.) Individual Observation Records.

No.	Sex	Area	Observations[1/]	Remarks
51	F	West	1974 - 6/26, 7/18, 8/23, 12/20 1975 - 1/29, 5/28, 6/6[2] 1976 - not seen	
52	F	West	1974 - 3/27, 4/25 1975 - not seen 1976 - not seen	Probably dead.
53	F	West	1974 - 3/26, 4/25, 11/7, 12/20 1975 - 1/29, 3/3, 8/25, 12/10[1] 1976 - 2/18[1], 5/17[1]	
54	F	West	1974 - 6/11, 6/26, 7/18, 8/24, 12/20 1975 - 1/29, 3/3, 6/6[2], 12/10[1] 1976 - 2/18[1], 5/17[1]	Lost one calf.
55	F	West	1974 - 7/18, 12/20 1975 - 1/29, 3/3, 4/28, 8/25[1], 12/10[1] 1976 - 2/18[1]	

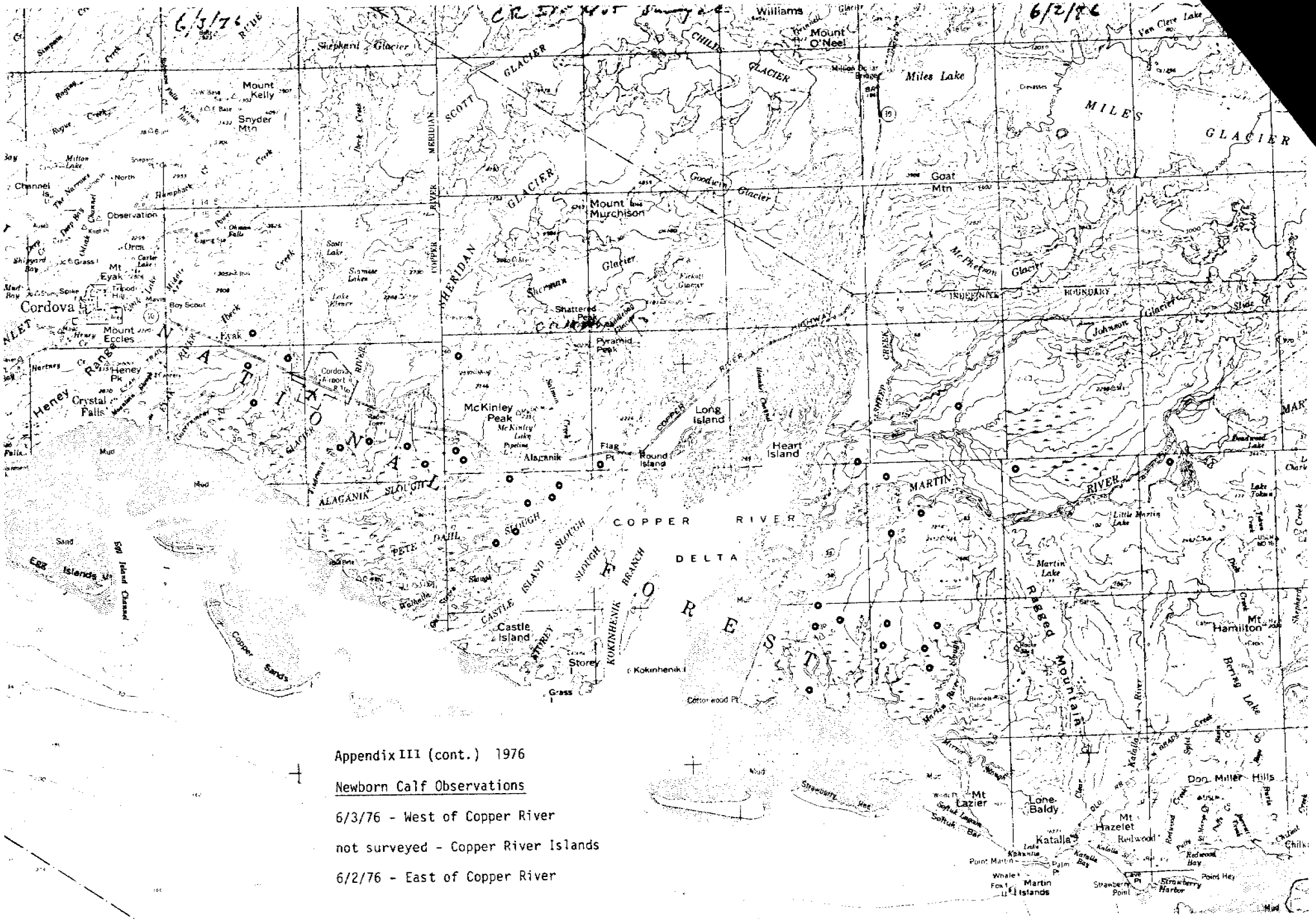
1/ Subscript number beside date denotes number of calves with female.



Appendix II. Locations of moose in Game Management Unit 16 when collared November 13-17, 1975. Four digit numbers represent locations of radio collared moose. One and two digit numbers represent locations of visual-collared moose.



Appendix III. Locations of moose in Game Management Unit 16 during peak of calving, June 3, 1976. Four digit numbers represent locations of radio-collared moose.



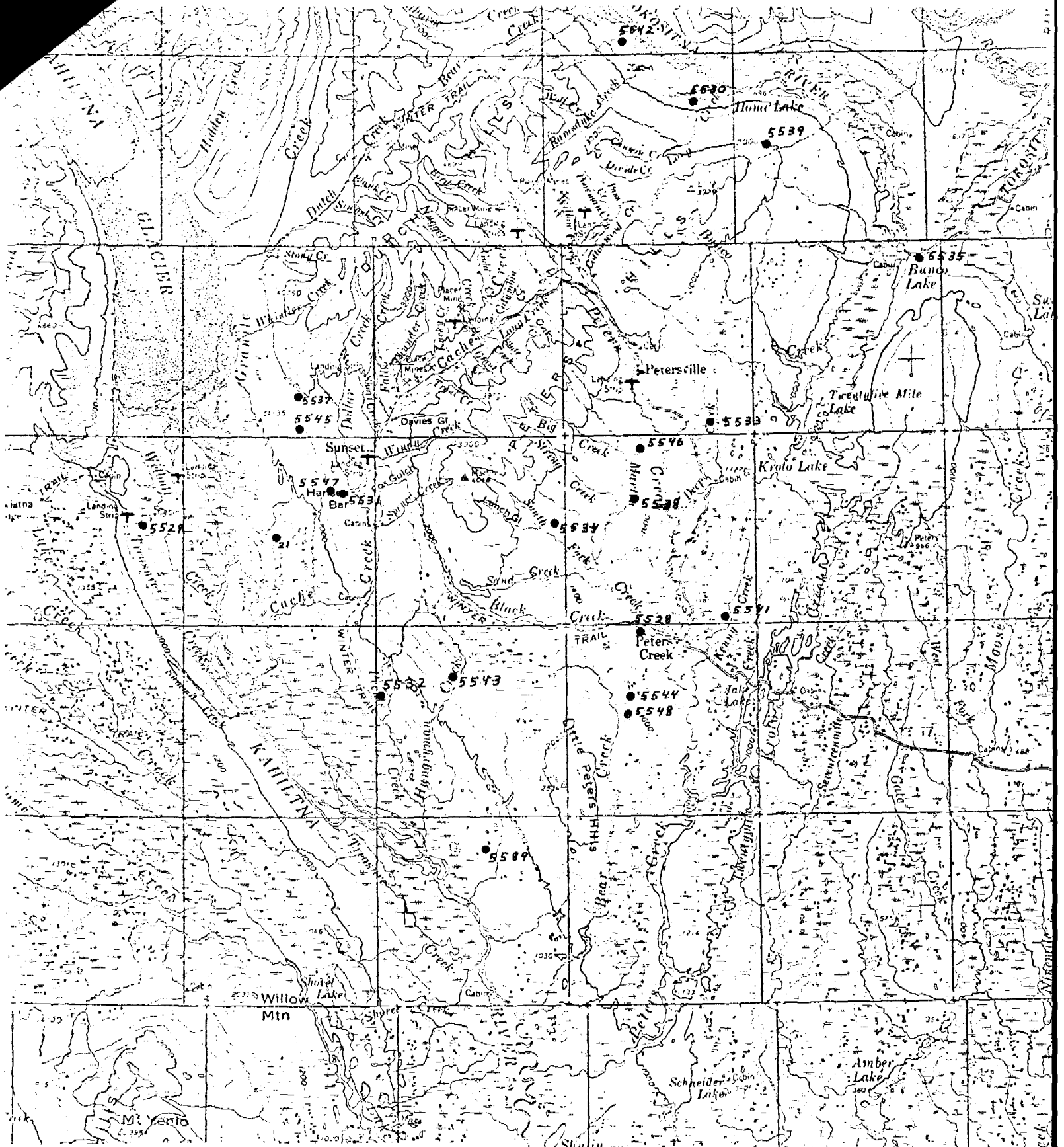
Appendix III (cont.) 1976

Newborn Calf Observations

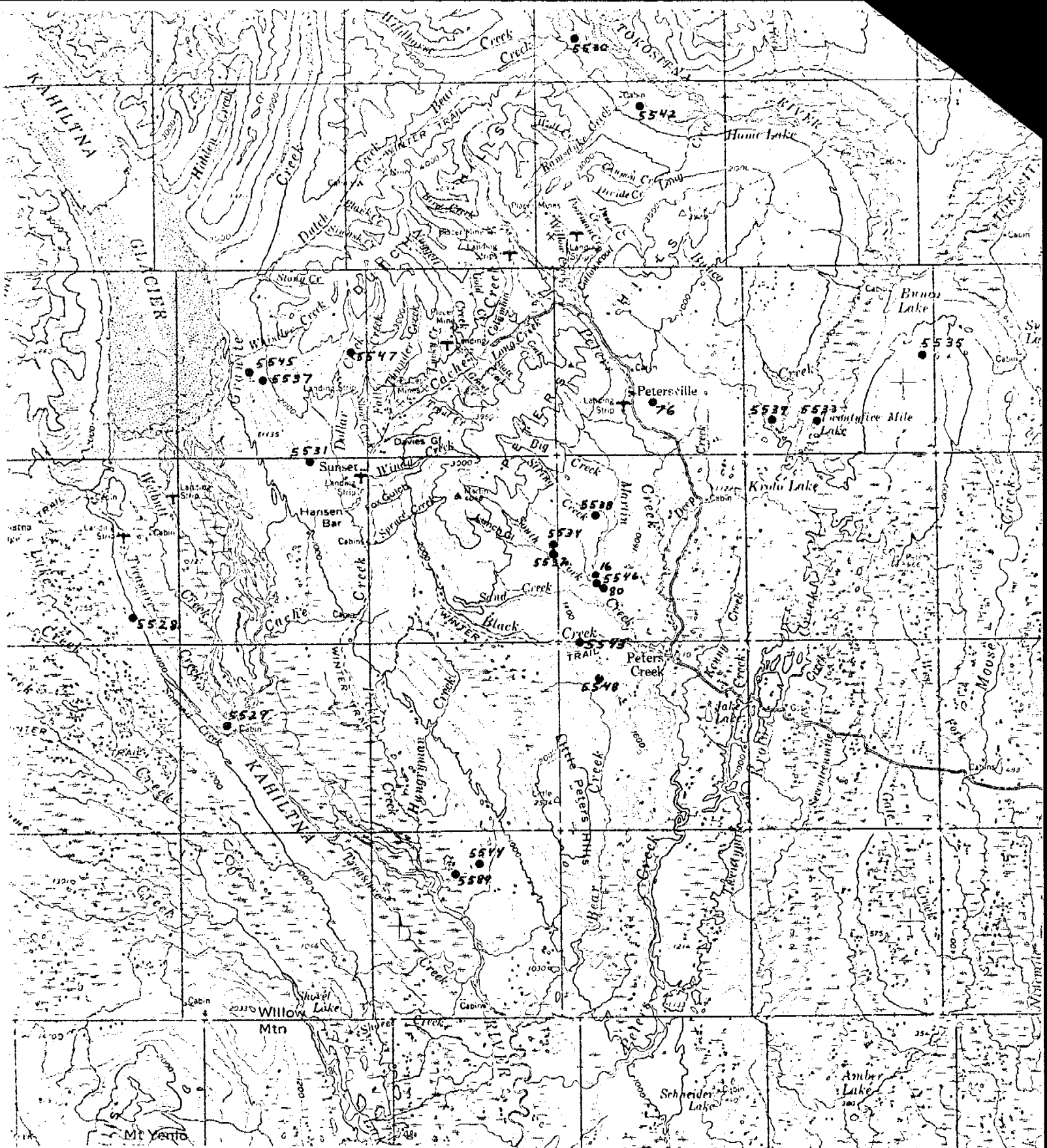
6/3/76 - West of Copper River

not surveyed - Copper River Islands

6/2/76 - East of Copper River



Appendix IV. Locations of moose in Game Management Unit 16 during mid-summer, July 14-23, 1976. Four digit numbers represent locations of radio-collared moose. One and two digit numbers represent locations of visual-collared moose.



Appendix V. Locations of moose in Game Management Unit 16 during breeding season, September 14 through October 13, 1976. Four digit numbers represent locations of radio-collared moose. One and two digit numbers represent locations of visual-collared moose.

FINAL REPORT (RESEARCH)

State: Alaska

Cooperators: Julius Reynolds

Project Nos.: W-17-6, W-17-7 and W-17-8

Project Title: Big Game Investigations

Job No.: 1.12R

Job Title: Copper River Delta Moose Population Identity Study

Period Covered: March 8, 1974 to June 30, 1976

SUMMARY

This is a final report on 50 moose (38 females and 12 males) that were neck-collared in Game Management Unit 6, the Copper River Delta. Twenty-five moose were individually marked in each of the two major wintering areas to identify populations, key habitat areas and seasonal movements.

Forty-five surveys, 23 east and 22 west of the Copper River, were flown during the 28-month study. Four hundred fourteen sightings were recorded. Surveys flown December through March yielded over 100 moose per survey; 60-90 percent of the collared animals were observed.

Movement from one side of the Copper to the other was minimal. Movement by month is shown. Observations of cows with newborn calves are shown for three years.

Mortality during the study was estimated at 30 percent. Humans accounted for most of the mortality.

Management implications are discussed.

CONTENTS

BACKGROUND

Moose (*Alces alces*) are not native to the Copper River Delta. The present population is the result of introductions made by the Izaak Walton League of America (Cordova Chapter) in cooperation with the Alaska Game Commission. During the 1950's (1949-1959) 6 male and 14 female calves were released along the Copper River Highway, west of the Copper River (Sheets 1960, Robards 1954). The transplant was an immediate success with a rapid increase in numbers of animals and expansion of the area utilized (Robards 1954).

By 1960 the herd was of sufficient size to allow a limited harvest of 25 bulls. Annual harvests have since been held on the Copper River Delta each year with the exception of 1961. Regulations separating the east and west sides of the delta were enacted in 1968 to distribute the harvest and hunting pressure. Utilization of the female segment of the population commenced west of the Copper River in 1968 and east in 1969.

Present management goals provide for a post-season population of 175-200 west and 150-175 east of the Copper River. Regulations governing the harvest are established in the spring after herd size, composition, winter survival and calf production have been determined.

The Copper River Delta moose herd lends itself to intensive management because of its restricted range, its popularity as a hunting ground, and the generally cooperative attitude of the public. Additional knowledge of population indentities and seasonal movements, however, is needed to properly manage this resource and to protect its critical habitat.

The Copper River Delta lies at the east side of Prince William Sound and is bounded by the Chugach Mountains on the north and the Gulf of Alaska on the south. This entire area is a flat, glacial plain of deposited silt, gradually sloping up from sea level. The Delta is a mosaic of freshwater ponds, lakes and marshes dissected by silty glacial streams and intertidal sloughs. Its seaward portion is vegetated by sedges and small forb-shrub communities. Slightly higher elevations further inland are dominated by an alder-willow association with scattered

stands of cottonwood and spruce. The steep mountainous fringe is heavily timbered with spruce and hemlock. Moose use the willow-alder zone almost exclusively.

The climate of the Copper River Delta is typical of coastal Alaska with heavy precipitation and cool temperatures. Average annual precipitation is 92.5 inches and the temperature averages 38.2° F with a range during 1974 of -13° to 79° (Nt. Oceanic and Atmospheric Admin. 1974). Snow depth varies with the winter, from almost nonexistant to the maximum of 261 inches, recorded during the winter of 1971-72.

Roughly 80 percent of the Delta (330,000 acres) is managed under a cooperative agreement, entitled "Copper Delta Management Area," by the United States Forest Service, Alaska Department of Fish and Game and Alaska Department of Natural Resources. The purpose of the agreement is to preserve the habitat in its present quality and condition for wildlife (U.S. Forest Service 1967).

OBJECTIVE

To identify populations and key habitat areas and to learn seasonal movement patterns of moose on the Copper River Delta.

PROCEDURES

Fifty moose (38 females and 12 males) were captured on the Copper River Delta on March 5, 8 and 9, 1974 utilizing 22-24 mg. of Anectine (Succinylcholine chloride) in projected syringes shot from helicopters. Wydase (hyaluronidase) was added to speed reaction time of the immobilizing agent. One mortality occured during tagging when the drug was accidentally injected introvenously.

Twenty-five moose were tagged in each of the two major wintering areas (Fig. 1). Separate color-coded and numbered neck collars (Franzmann and Arneson 1974) were used because each wintering area was suspected to support a distinct moose population. East of the Copper River, white canvas collars with red numbers were used to mark 17 females and eight males, whereas yellow canvas collars with blue numbers were placed on 21 females and four males west of the Copper River. No calves were collared and yearlings were avoided. Numbered metal ear-tags were placed in each ear and a 3-inch x 9-inch strip of flourescent flagging, red denoting males and yellow denoting females, was attached to one ear with an ear tag.

Monthly surveys were flown on each side of the Copper River to monitor movements of collared animals. Time and weather permitting, the same areas were flown each month with the same Department biologist, aircraft (PA 18 Supercub) and pilot. Normally the west bank of the Copper River and Castle Island Slough formed the boundary between the two survey areas but some overlap did occur.

Collared moose were located on reconnaisance flights made approximately once a week using either a PA-18 or a PA-11 aircraft equipped with a Hy-Gain directional antenna.

A 100 microampere meter is an integral part of the receiver and a remote 100 microampere meter is situated above the instrument panel in view of the pilot. The arrangement allows the pilot to find the area in which the radio-collared moose is located in the most expeditious manner.

Moose not observed during one week were the first to be searched for the following week. On occasion, inclement weather conditions prevented flights for an entire week. Whenever possible, moose were visually located, and their locations were plotted on 1:63,360 USGS maps. Searches were conducted for visually-collared and radio-collared moose concurrently.

In addition, locations of visually-collared moose observed during a moose sex-and-age composition survey on December 2, 1975, were also plotted.

FINDINGS

Attempts to observe moose movements on the Kenai Peninsula resulted in 200 observations of 185 visually-collared moose over a 21-month period (LeResche 1970). The proportion of radio-collared (386 observations of 24 moose) to visually-collared moose observations (74 observations of 21 moose) in this study is greater than four-to-one. Use of a radio signal to bring the biologist into the immediate area of the radio-collared moose greatly increases the opportunity to sight the animal. In a large number of individual sightings of visually-collared moose, the animals were seen only because they were in association with radio-collared moose. It is extremely difficult, and at times impossible, to see a radio-collared adult moose even though its general location is known. In the summer, high grass and dense alder patches combine to form an effective barrier to sighting the animal from the air. If a visually-collared moose were in such a patch of alder, it could not be noted or seen. The radio receiver, however, is accurate enough to locate the radio-collared moose within 200 yards, regardless of whether or not the animal can be seen; a definite location can thus be made.

Because a number of the visually-collared moose were collared in the same area and within the same small pods as moose that were radio-collared (Appendix II), the gregarious animals are often found together at a later date. Often the visually-collared moose move a similar direction and distance as the radio-collared moose; thus the chances of sighting the visually-collared moose were much increased. Had visual collars been placed on all of the moose, it is doubtful that the total number of observations made would be any greater than the observations made on the 25 visually-collared moose, because the association with radio-collared moose would have been lost.

For example, only three of the visually-collared moose were seen between April 19 and June 30. This is believed to be due to emerging

vegetative complexes which effectively prevented aerial observers from locating animals. During the same period, however, 155 observations of radio-collared moose were made, illustrating the greater usefulness of radio-collars.

The longest movements recorded to this point in the study were made by female moose just prior to calving (Appendix III). Although the reasons for these long movements are unknown at this time, the previous winter was not harsh and this may have had an effect on the condition of the female moose, allowing greater mobility.

Midsummer sightings of radio-collared moose revealed that they tended to remain in low areas after moving from higher altitudes prior to winter (Appendix IV).

Bull moose movements during the rut (Appendix V) were not as extensive as expected. Most bulls moved altitudinally to lower riparian habitat and moved within smaller areas than calving females.

The following is a chronological listing of radioed moose locations and other significant observations.

November 13-17, 1975: 24 moose were radio-collared, and 25 moose were visually-collared. One bull and six cows were killed as a result of drug vagaries. No animals were killed in self-defense. An additional 28 moose were darted and failed to go down after receiving the drug.

November 13, 1975 to June 30, 1976: 386 observations of 24 radio-collared moose and 74 observations of 21 visually-collared moose were made.

November 19: male #5527 lost his collar. The collar was subsequently retrieved. Female #5544 was not noted to have rejoined her calf after collaring. Female #5547 was not noted to have rejoined twin calves after collaring.

November 28: signal from female #5589 was lost. Interference on frequency of female #5538 prevented location of that moose.

December 2: 10 of 25 visual-collars were located during sex and age composition counts in Peters-Dutch Hills count area.

January 23, 1976: female #5538 was located. Position of antenna was moved forward on the wing strut, and this eliminated interference on that frequency.

February 2: male #5540 lost his collar. Collar was subsequently retrieved. Female #5589 was located. Variance in location of signal when utilizing channel selector on receiver had exceeded expectations, and the signal was lost.

March 5: the last date that female #5589 was observed to have her calf.

March 11: visually-collared female #11 was observed in an area heavily-covered by wolf tracks. Calf of cow was not located in the same area where cow and calf had been located six days earlier.

April 27: female #5536 was found dead. She had been largely consumed by wolves and a wolverine and had apparently died shortly after last sighting on April 7. Exact cause of death was not determined, and the calf was not located. The collar was subsequently retrieved.

May 27: seven females were observed with newborn calves, three with twins and four with single calves.

June 3: six additional females were observed with newborn calves--one pair of twins and five single calves.

June 10: female #5588 was not observed, but a female brown bear with two yearling cubs was observed at location of transmitter signal.

June 15: brown bear cub was observed on remains of female #5588, and collar was observed near bear. No sign of #5588's calf was seen because of dense foliage. Female #5532 was seen without one of two newborn calves. Female #5543 was seen without her calf. Female #5545 was seen without both of her calves.

June 30: female #5588's collar was retrieved. Examination of long bones indicated that she was not debilitated. No sign of her calf was found. Female #5588 had been consumed by brown bear.

In general, collared moose in the tagging area moved out of the upland areas in December to winter in a few key areas: on the lateral and terminal moraines of the east side of the Kahiltna Glacier below Dutch Creek, on the west side of the Little Peters Hills, on the Bunco Creek flats, and along Cache Creek. Smaller numbers of moose wintered in other areas such as the Tokositna Flats, Peters Creek and upper Bunco Creek. In May, moose began dispersing throughout the area and became widespread. Immediately prior to calving many of the females made their longest movements observed to date. Movement data will be analyzed and covered extensively in a subsequent report.

Three of seven females which had eight calves when collared kept three calves until the 1976 calving season. Observations indicate that the visually-collared moose were more successful in keeping their calves through winter, but difficulties in maintaining continuity in observations of individual visually-collared moose, particularly after mid-April, preclude making any definite statements.

Thirteen of the 17 radioed females alive at the time of the 1976 calving season produced 17 calves. Four females were never observed with calves, but it is unknown whether they bore and lost calves between observations. Individual habitat preferences and large movements immediately prior to the calving season suggest that two of the females might have produced calves which were never seen. By July 1, seven of the 17 calves were no longer seen. Difficulties in observing moose in dense alder or under birch canopies preclude making any positive statements regarding newborn calf mortality at this time.

In summary, two of the 24 radio-collared moose (both males) lost their collars within three months after being collared; one female was probably killed by wolves; and one female was probably killed by a brown bear. At this time 20 radio-collars are still in operation on moose, three radio-collars are in Fish and Game offices, and one radio collar remains in the field to be picked up at a later date.

ACKNOWLEDGEMENTS

Appreciation is extended to Department of Fish and Game personnel David Lorring, Ken Taylor, and Dave Harkness, for assisting in the moose-collaring project. Helicopter pilot Vern Lofstedt is to be commended for his efforts in making the project a success.

LITERATURE CITED

Franzmann, A.W., P.D. Arneson, R.E. LeResche and J.L. Davis. 1974. Developing and testing of new techniques for moose management. Alaska Dept. of Fish and Game P.R. Proj. Final Rep. 54pp. Miltilith.

LeResche, R.E. 1970. Moose report. Ann. Proj. W-17-2, Vol. XI, Alaska Dept. of Fish and Game. 13pp.

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Management Implications

Movement data collected during this March 1974-through-June 1976 study indicate that the two major wintering areas on the Copper River Delta are utilized by essentially separate moose populations. Some interaction between the two herds exists but it is insignificant for management purposes. The Copper River is not a physical barrier between the two moose herds. Moose migrating east toward the Copper River from their wintering grounds find ample food and cover along the west shore and lower Copper River islands. They are not inclined to cross the 5-plus miles of flat riverbed with little or no vegetation. Similarly, the moose east of the Copper River move inland (N and NW) with the vegetation rather than cross the broad, barren Copper River near their winter grounds. The Long Island area is the only route across the Copper which offers food and cover. This route is probably used by the occasional migratory animal. The numerous islands adjacent to Long Island are fairly dry, lacking the succulent aquatics that moose prefer in the spring and summer. Such conditions further retard the migration of moose between areas.

The present management boundary along the western shore of the Copper River and Castle Island Slough should be modified to include the lower Copper River islands in the western management area. These islands are part of the spring and summer range of the western herd. Only moose collared west of the Copper River were observed on the islands during this study.

Survey data gathered on a monthly basis indicate that the sizes of the two herds can best be determined in January, February or March, when maximum snow depth has concentrated them on their winter ranges. Sex-and-age composition counts should be conducted the first half of December. At this time the animals begin to concentrate on the winter range, foliage is at a minimum, and sex can still be determined by presence or absence of antlers. Calf survival can be determined fairly easily in late April or early May, just prior to dispersal from the winter range. Success in determining newborn calf-cow ratios is dependent upon leaf emergence in the spring. Parturition surveys should be flown in early June, just prior to the time that the willow and alder canopy obstructs aerial observations.

The willow-alder zone across the Copper River Delta is the key habitat utilized by moose, particularly during the spring and summer. The entire zone is important to calf production and rearing. No separate, distinct calving area exists. The most critical habitat is the two wintering areas (Fig. 3).

The mortality data obtained during this study indicate that the legal and illegal take of moose on the Delta is a significant mortality factor. Human use of the western herd is its primary regulating factor at present. An extimated 75 percent of the adult mortality west of the Copper River is caused by humans; east of the Copper River, humans account for 50 percent of the mortality.

It should be noted that by the end of the 28-month study the neck collars had deteriorated considerably. The canvas collars worked

well for 2 years, were becoming marginal at 2.5 years, and were unusable for individual identification after 3 years. No adverse effects on the moose were noted from either the neck collar or metal ear tags. Colors of ear flagging and neck collars were still recognizable at the termination of the study.

LITERATURE CITED

Coady, John W. 1976. Interior Moose and Moose Disease Studies. Alaska Dept. of Fish and Game, P-R Proj. Rep., W-17-6 thru W-17-8. 22pp. multilith.

Franzmann, A.W. and P.D. Arneson. 1974. Development and Testing of New Techniques for Moose Management. Alaska Dept. of Fish and Game, P-R Proj. Rep., W-17-2 through W-17-6. 54 pp. multilith.

National Oceanic and Atmospheric Administration. 1974. Climatological Data, U.S. Dept. of Commerce, Annual Summary 1974, Vol. 60, No. 13.

Robards, Frederick C. 1954. Annual Report: Game, Fur and Game Fish, Cordova, AK.

Sheets, Arthur M. Jr. 1960. Moose Report. Alaska Dept. of Fish and Game, P-R Proj. W-6-R-2. 179pp. multilith.

U.S. Forest Service. 1967. Copper Delta Game Mgmt. Plan, Chugach National Forest.

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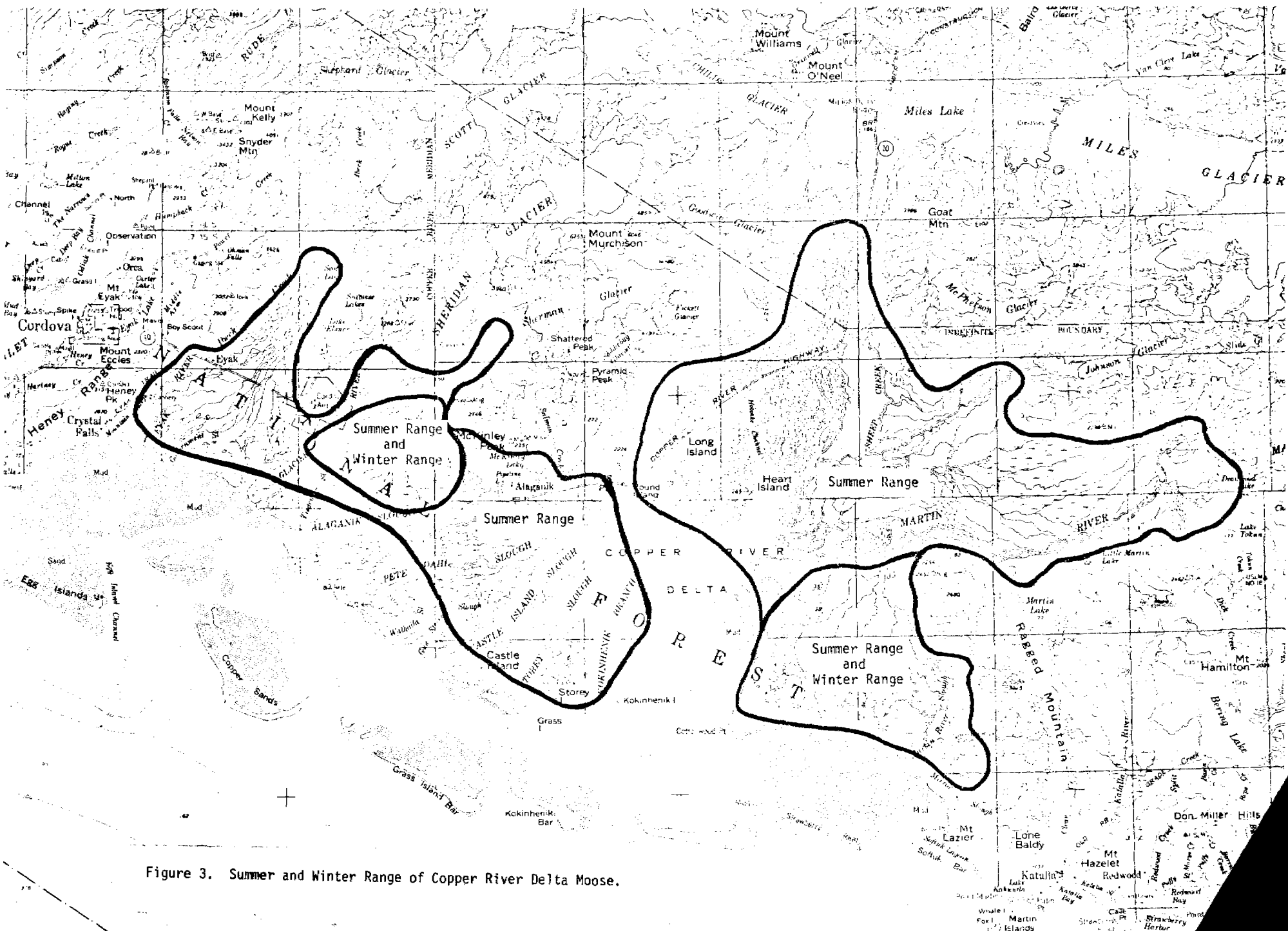


Figure 3. Summer and Winter Range of Copper River Delta Moose.

Table 1. Collared Moose Survey Data, East of Copper River.

Survey Date	Number Collared Moose Seen	Number Collared Moose Present[1/]	Total Moose Observed	Percent of Observed Moose Collared	Percent Collared Moose Seen
3/27/74	21	24	123	17.1	87.5
4/26/74	13	23	82	15.9	56.5
5/22/74	8	22	59	13.6	36.4
6/10/74	2+1[4/]	21	38	5.3	9.5
6/12/74[2/]	1+3[4/]	21	32	3.1	4.8
6/27/74	2	21	27	7.4	9.5
7/17/74[3/]	1	21	6	16.7	4.8
10/8/74	7	20	67	10.4	35.0
11/6/74	10	20	108	9.3	50.0
12/26/74	16	20	136	11.8	80.0
1/27/75	14	20	137	10.2	70.0
2/28/75	14	20	151	9.3	70.0
3/25/75	18	20	145	12.4	90.0
4/24/75	9	20	100	9.0	45.0
5/31/75	8+1[4/]	20	93	8.6	40.0
6/12/75	0	20	7	0.0	0.0
8/26/75	5+1[4/]	18	67	9.0	27.8
10/18/75	3	18	60	5.0	16.7
12/9/75	11	16	113	9.7	68.8
2/16/76	10	16	129	7.8	62.5
3/12/76	14	16	132	10.6	87.5
5/21/76	6	16	90	6.7	37.5
6/2/76	9	16	84	10.7	56.3
TOTAL	208	449			46.3

1/ Estimated number of collared moose present east of the Copper River.

2/ Copper River Islands only.

3/ "Random Survey" - surveyed timbered fringe area.

4/ First number denotes a moose collared east of the Copper River, second number denotes a moose collared west of the Copper River.

Table 2. Collared Moose Survey Data, East of Copper River.

Survey Date	Number Collared Moose Seen	Number Collared Moose Present[1/]	Total Moose Observed	Percent of Observed Moose Collared	Percent Collared Moose Seen
3/26/74	8	25	--	--	32.0
4/25/74	12	25	74	16.2	48.0
5/28/74	6+1[2/]	24	88	6.8	25.0
6/11/74	8	24	84	9.5	33.3
6/26/74	8	24	54	14.8	33.3
7/18/74	8	24	83	9.6	33.3
8/23/74	4	24	64	6.3	16.7
9/27/74	10	22	75	13.3	45.5
11/7/74	8	22	107	7.5	36.4
12/20/74	18	21	158	11.4	85.7
1/29/75	19	21	141	13.5	90.5
3/3/75	16	21	131	12.2	76.2
4/28/75	10	21	76	13.2	47.6
5/28/75	5	21	53	9.4	23.8
6/6/75	9	21	92	9.8	42.9
8/25/75	9	21	97	9.3	42.9
9/22/75	4	19	87	4.6	21.1
10/24/75	4	19	75	5.3	21.1
12/10/75	11	19	143	7.7	57.9
2/18/76	15	19	191	7.9	79.0
5/17/76	6	19	85	7.1	31.6
6/3/76	7	19	119	5.9	36.8
TOTAL	206	475			43.4

1/ Estimated number of collared moose present west of the Copper River.

2/ 7 collared moose seen: 6 collared west and 1 collared east.

Table 3. Collared Moose Survey Data, by Month.

Survey Date	Total Moose Observed	Percent of Collared Moose Seen
1/27/75	137	70.0
1/29/75	141	90.5
2/16/76	129	62.5
2/18/76	191	79.0
2/28/75	151	70.0
3/3/75	131	76.2
3/12/76	132	87.5
3/25/75	145	90.0
3/26/74	--	32.0
3/27/74	123	87.5
4/24/75	100	45.0
4/25/74	74	48.0
4/26/74	82	56.5
4/28/75	76	47.6
5/17/76	85	31.6
5/21/76	90	37.5
5/22/74	59	36.4
5/28/74	88	25.0
5/28/75	53	23.8
5/31/75	93	40.0
6/2/76	84	56.3
6/3/76	119	36.8
6/6/75	92	42.9
6/10/74	38	9.5
6/11/74	84	33.3
6/12/75	7	0.0
6/26/74	54	33.3
6/27/74	27	9.5
7/18/74	83	33.3
8/23/74	64	16.7
8/25/75	97	42.9
8/26/75	67	27.8
9/22/75	87	21.1
9/27/74	75	45.5

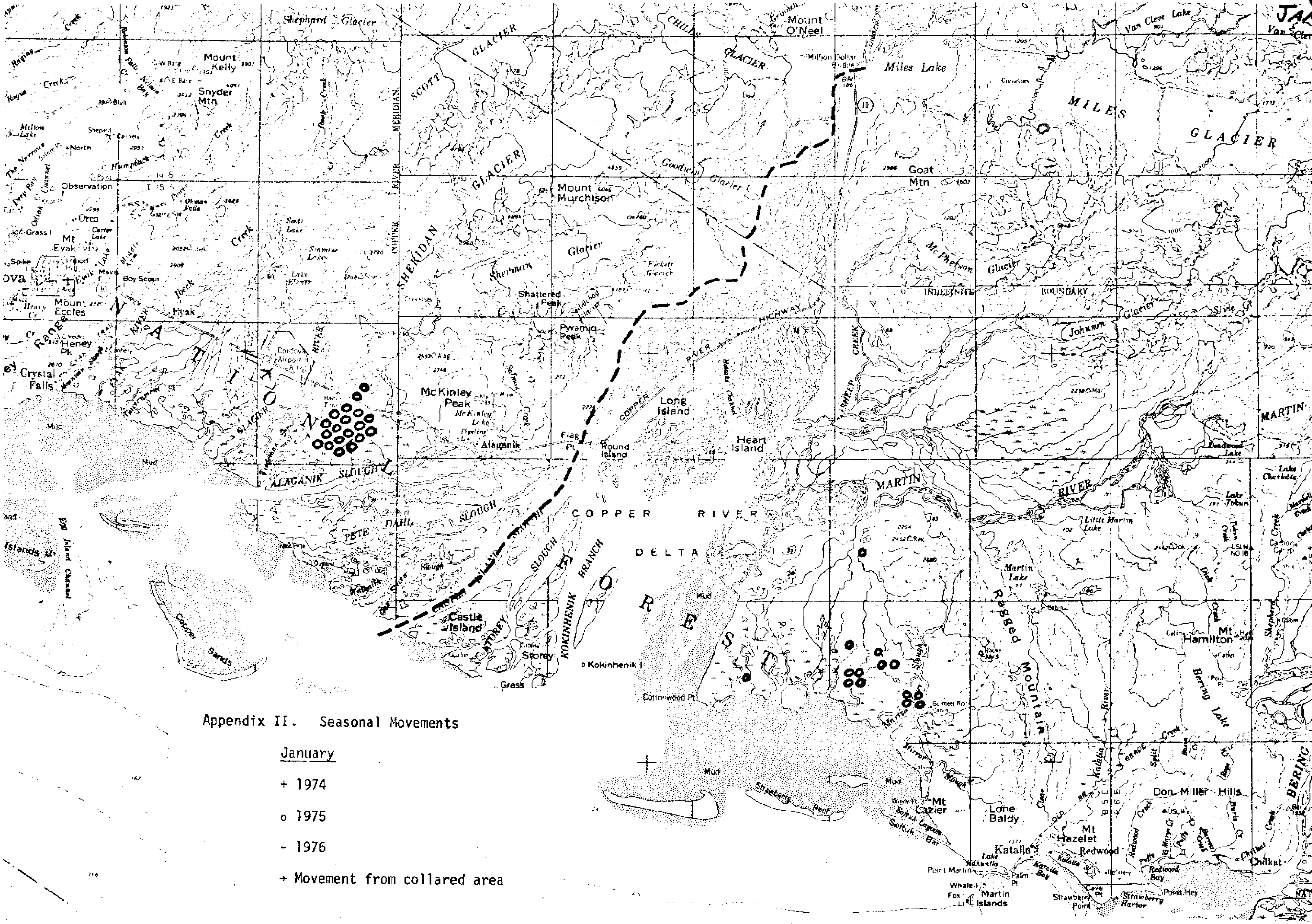
Table 3. (cont.) Collared Moose Survey Data, by Month.

Survey Date	Total Moose Observed	Percent of Collared Moose Seen
10/8/74	67	35.0
10/18/75	60	16.7
10/24/75	75	21.1
11/6/74	108	50.0
11/7/74	107	36.4
12/9/75	113	68.8
12/10/75	143	57.9
12/20/74	158	85.7
12/26/74	136	80.0

Table 4. Mortality of Collared Moose.[1]

No.	Area	Sex	Date	Remarks
4	East	Female	11/25/75	Drowned in Martin River.
5	East	Female	8/21/75	Shot by hunter.
12	East	Female	5/22/74	Last seen--presumed dead.
20	East	Male	8/20/74	Shot by hunter.
21	East	Male	10/20/75	Shot by hunter.
22	East	Male		Never seen--probably died of drug effects.
23	East	Male	8/21/75	Shot by hunter.
27	East	Male	3/27/74	Last seen--presumed dead.
30	East	Female	4/26/74	Last seen--presumed dead.
32	West	Female	9/13/74	Shot by hunter.
37	West	Female	12/17/74	Shot illegally.
46	West	Male	8/29/75	Shot by hunter east of Copper River.
47	West	Male	9/10/74	Shot by hunter.
50	West	Female	9/14/74	Shot illegally.
52	West	Female	4/25/74	Last seen--presumed dead.

1/ Collared moose not observed in 1975 or 1976 are considered as dead.



Appendix II. Seasonal Movements

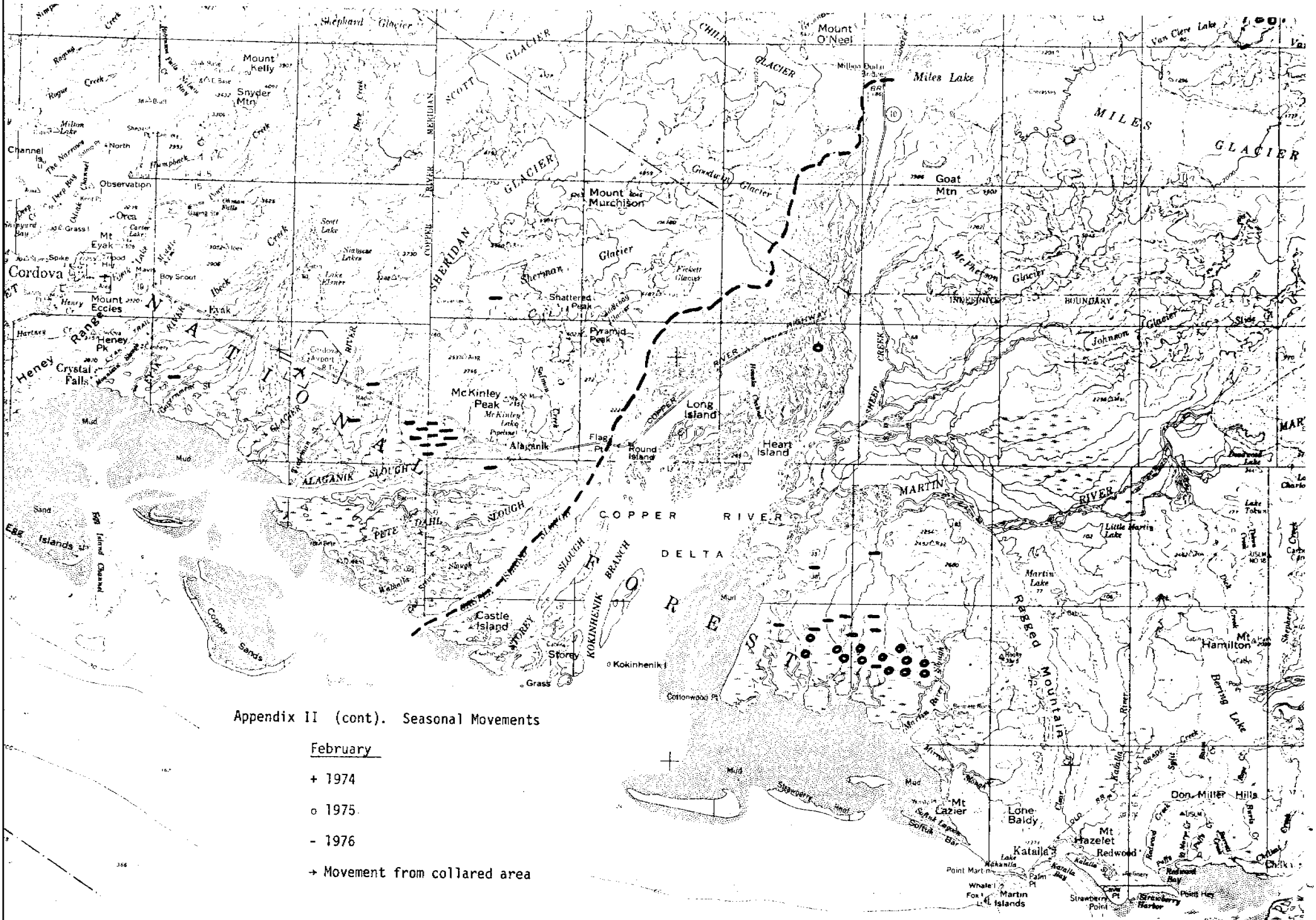
January

\+ 1974

o 1975

\- 1976

→ Movement from collared area



Appendix II (cont). Seasonal Movements

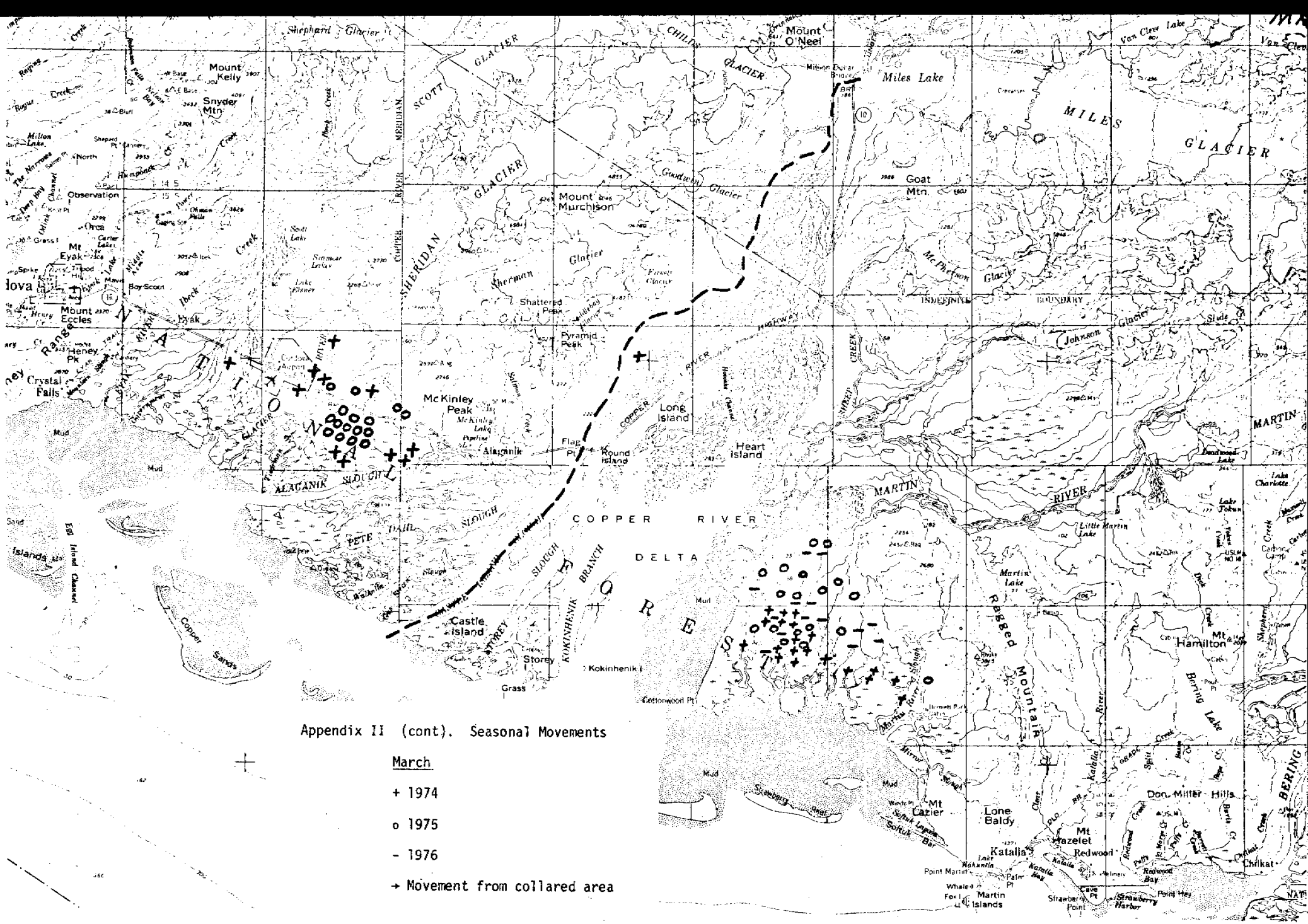
February

\+ 1974

o 1975

\- 1976

→ Movement from collared area



Appendix II (cont). Seasonal Movements

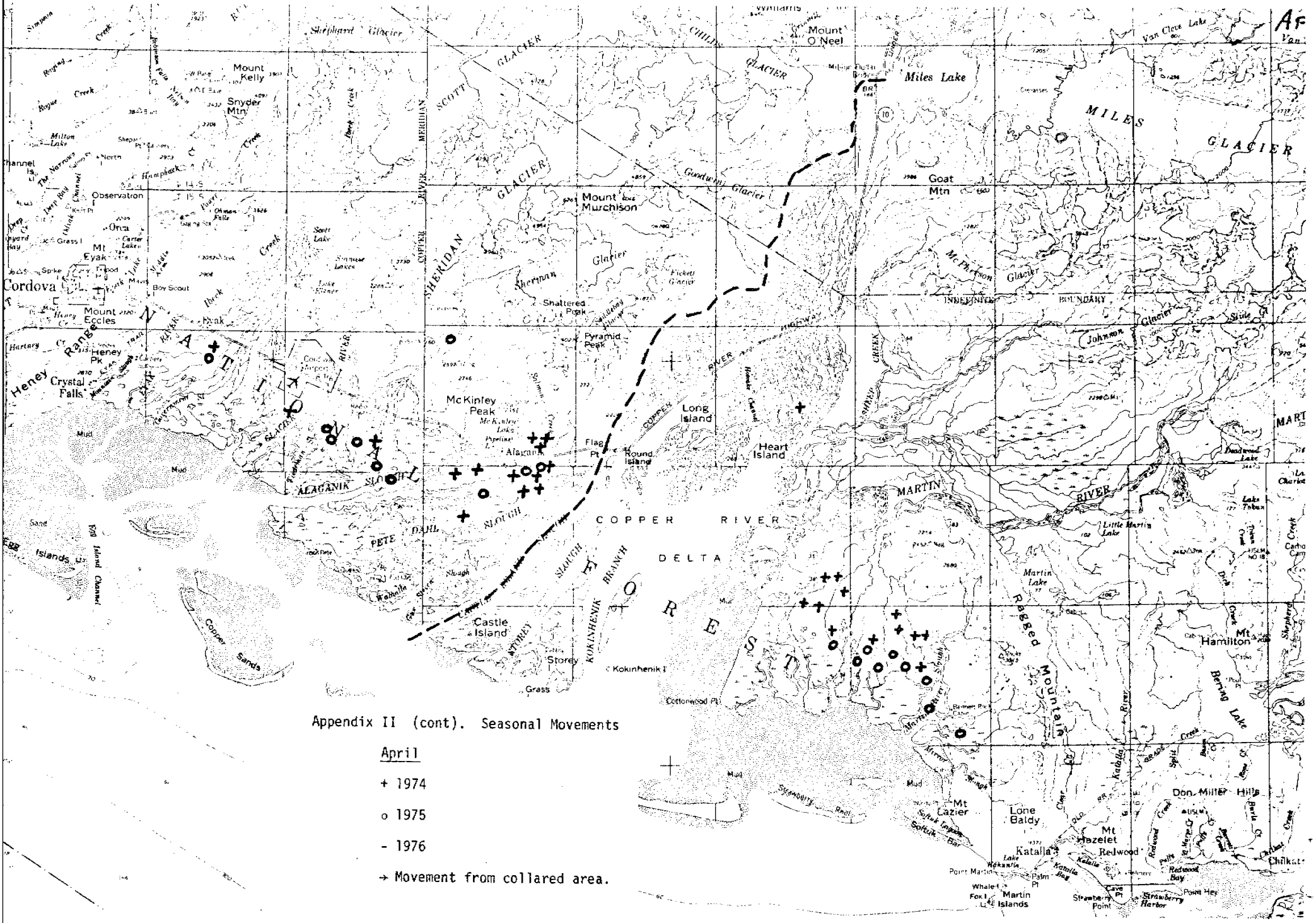
March

\+ 1974

o 1975

\- 1976

→ Movement from collared area



Appendix II (cont). Seasonal Movements

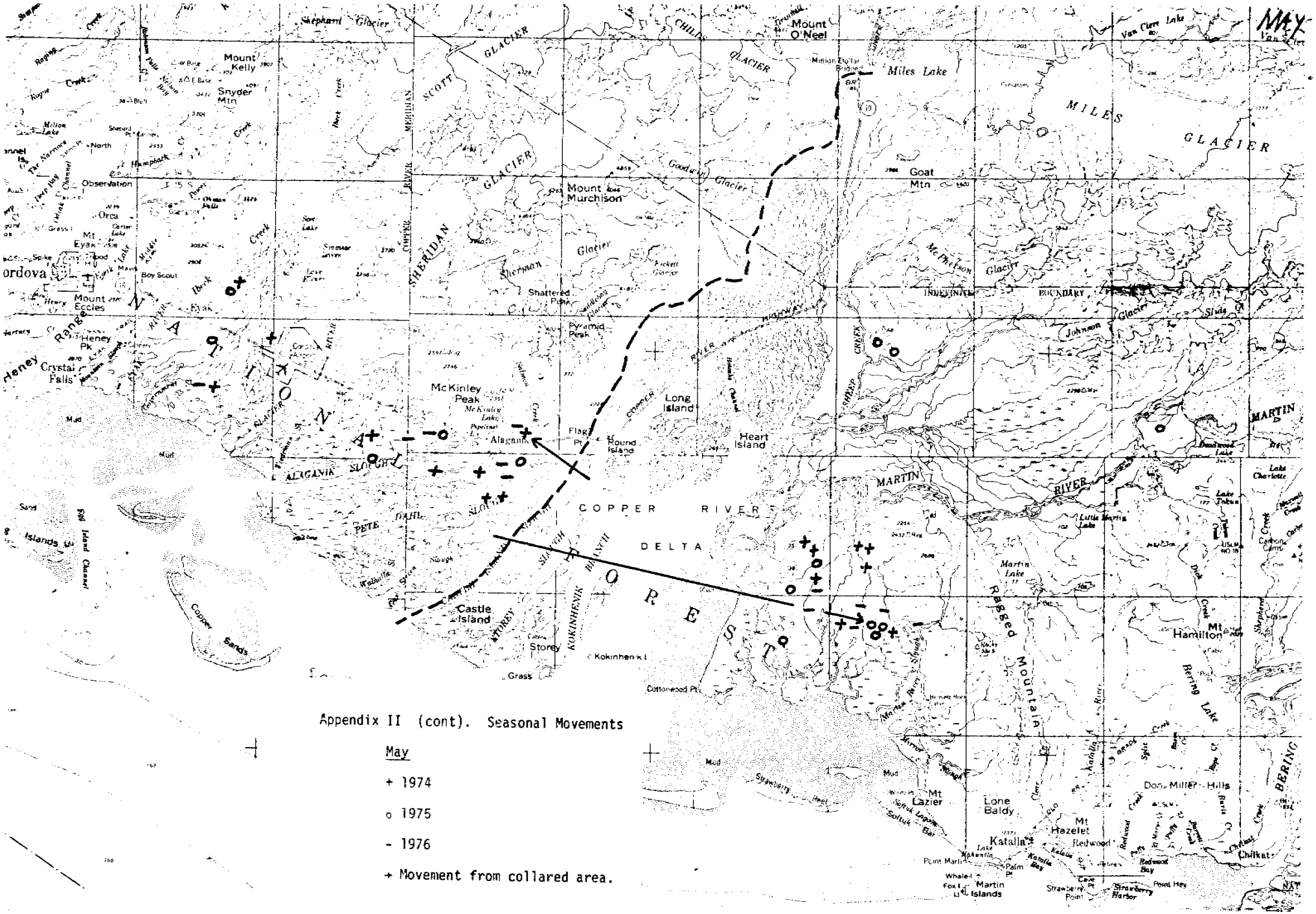
April

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

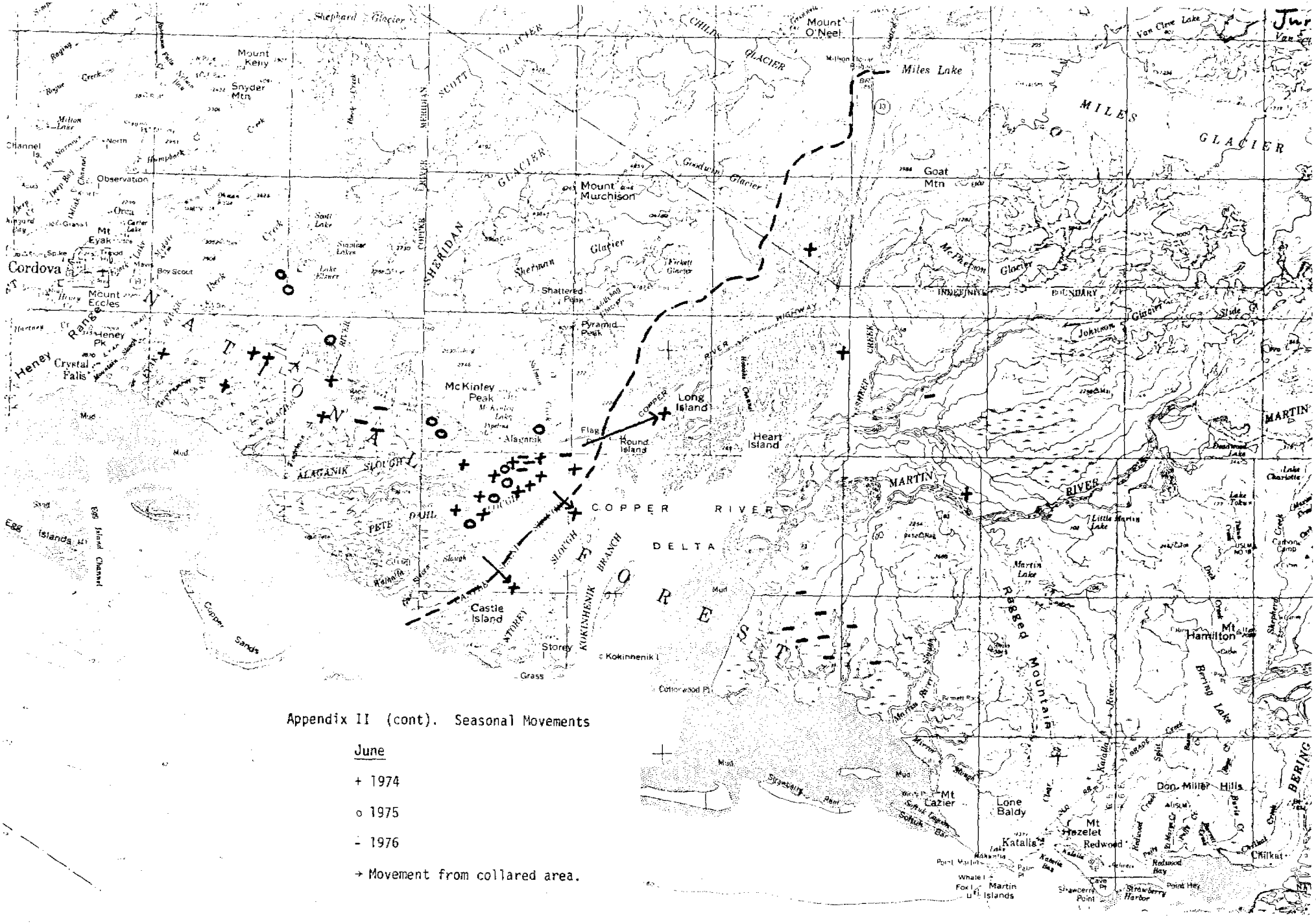
May

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

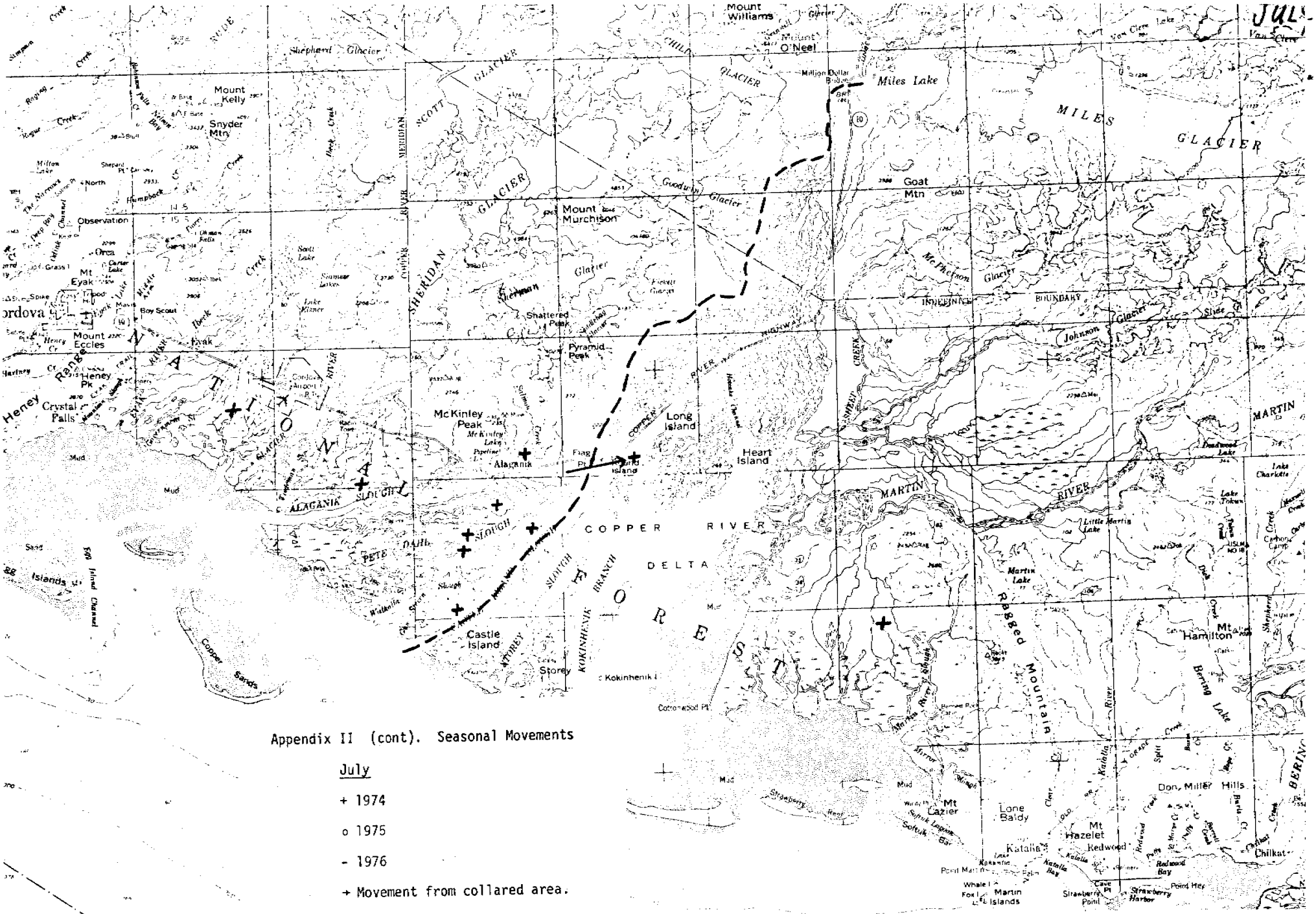
June

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

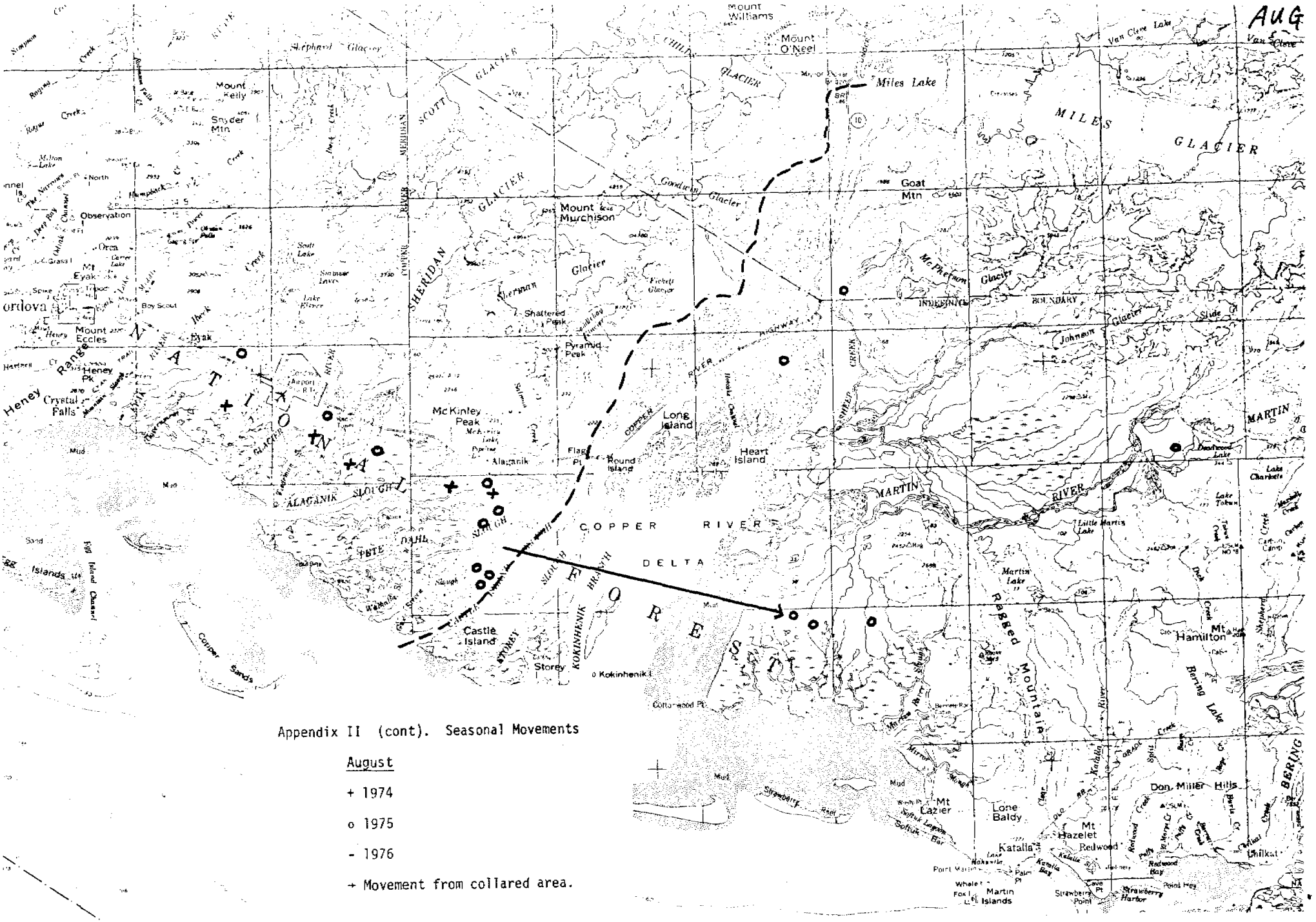
July

+ 1974

o 1975

- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

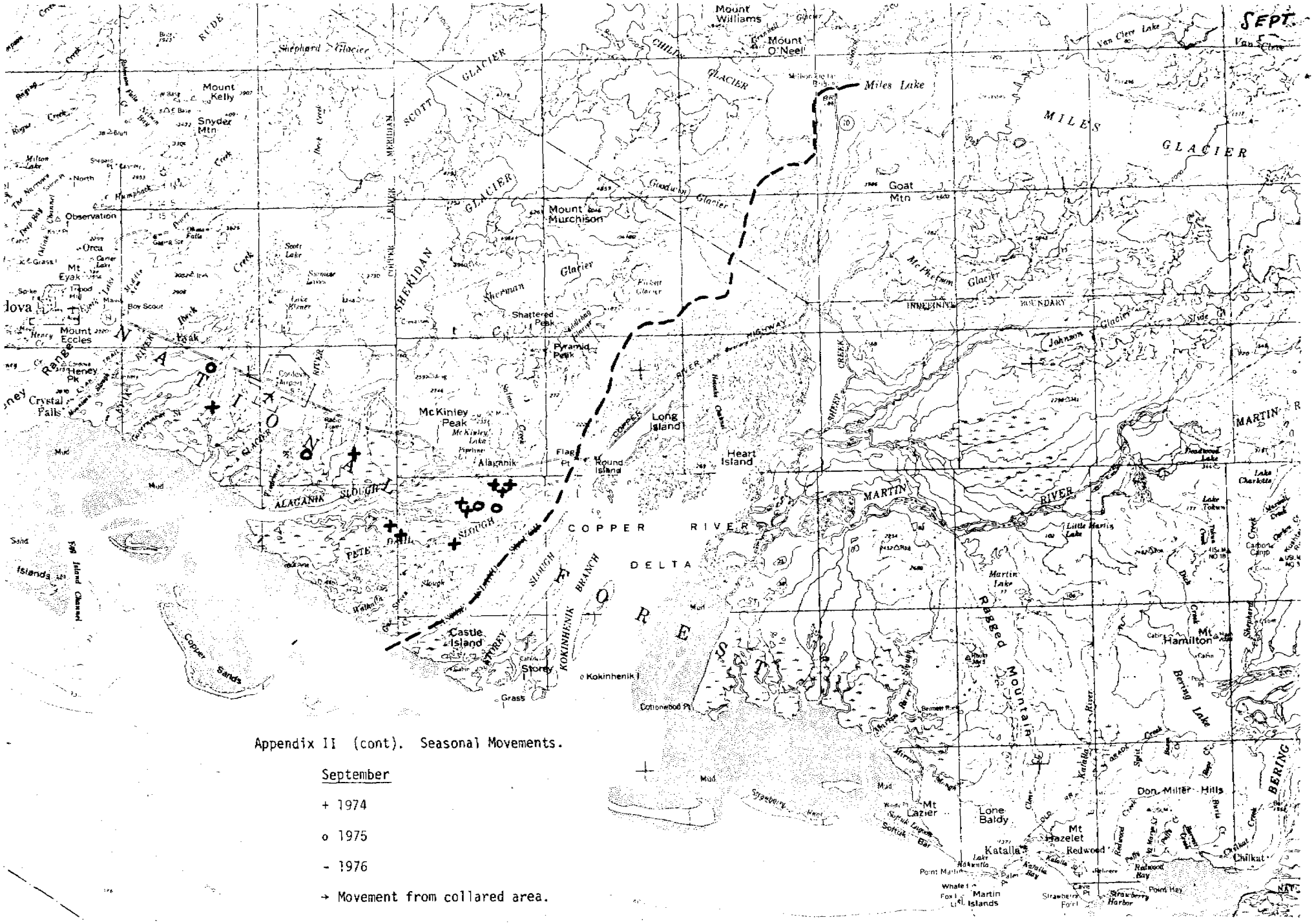
August

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements.

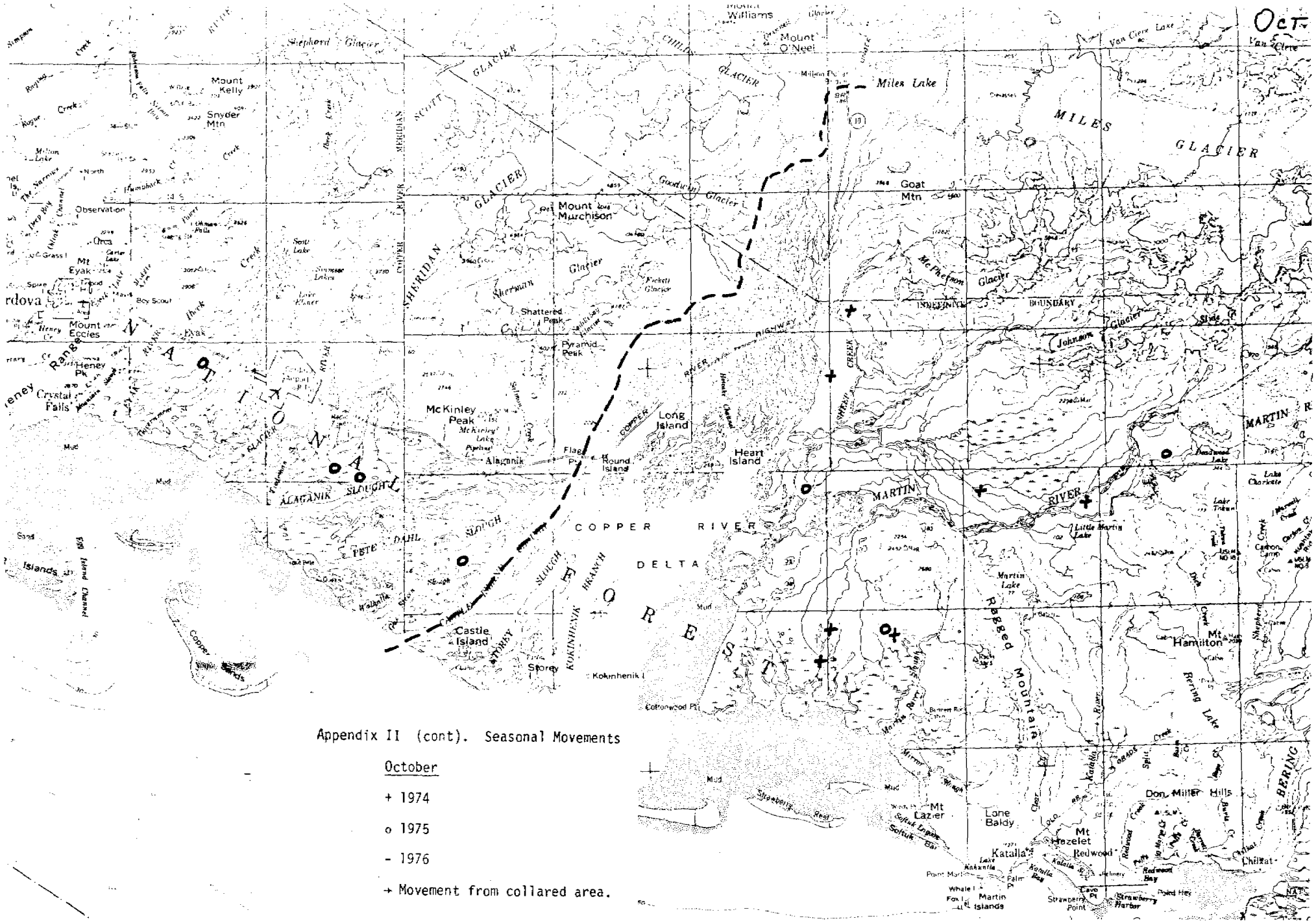
September

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

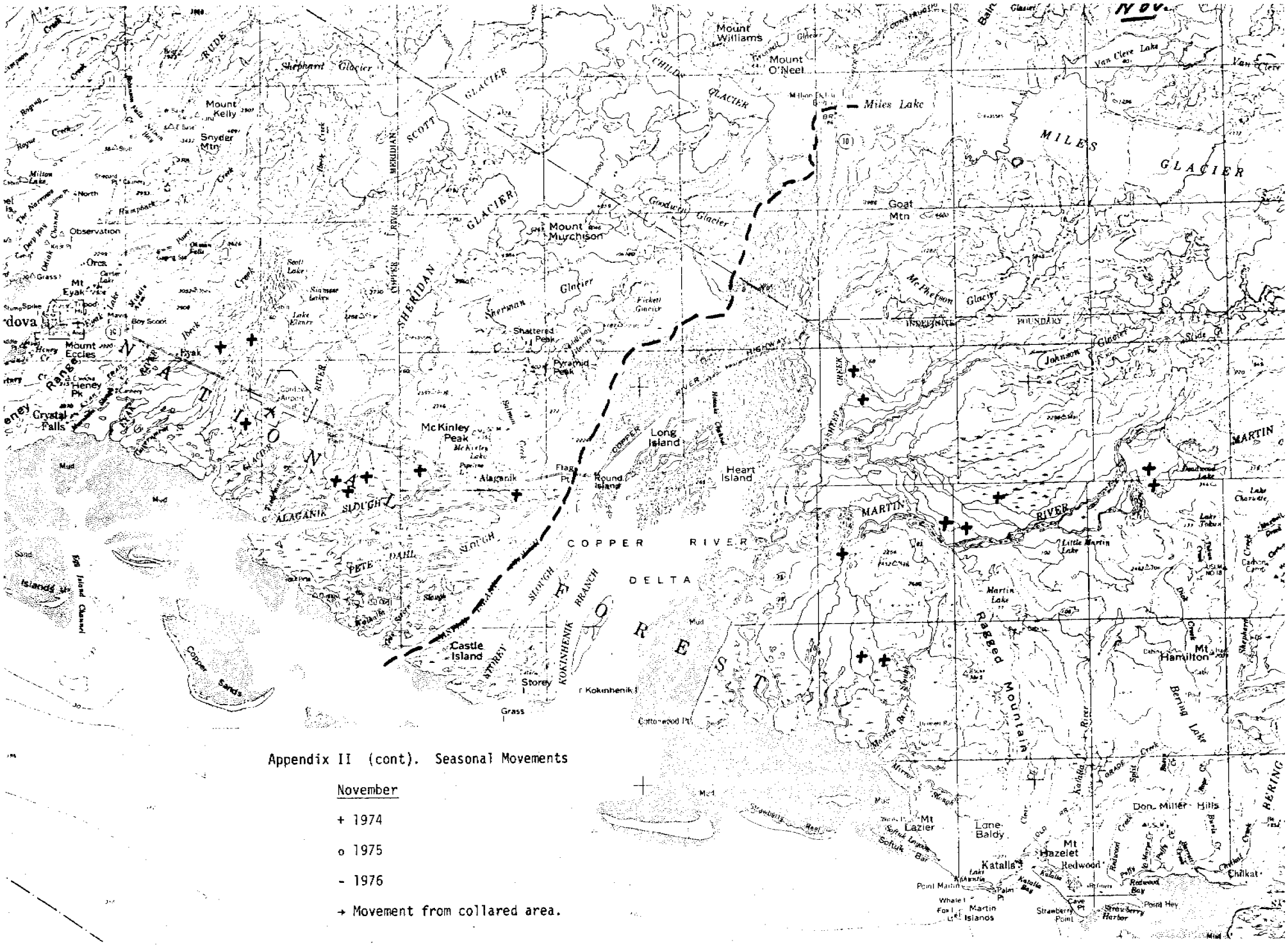
October

\+ 1974

o 1975

\- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

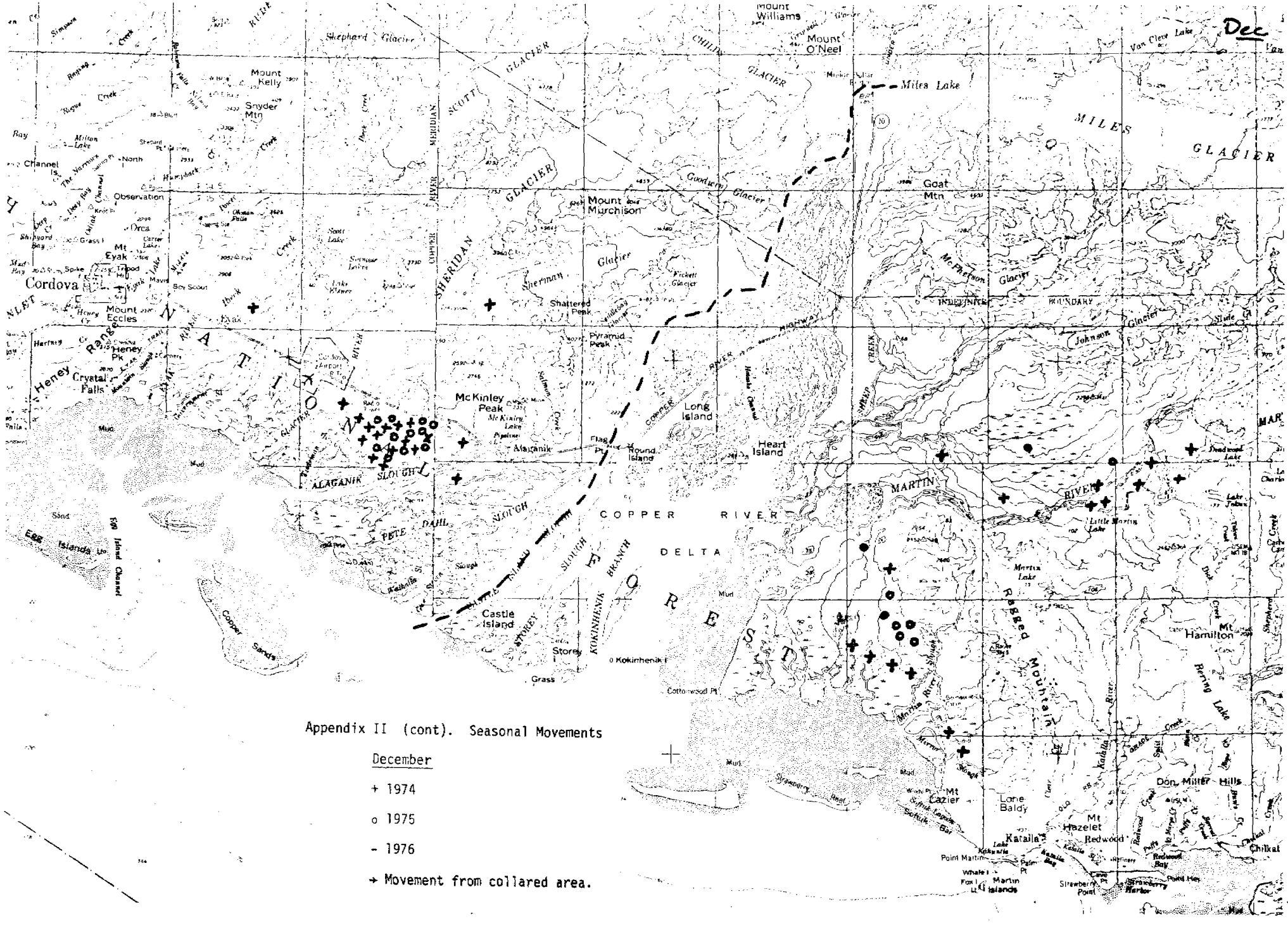
November

+ 1974

o 1975

- 1976

→ Movement from collared area.



Appendix II (cont). Seasonal Movements

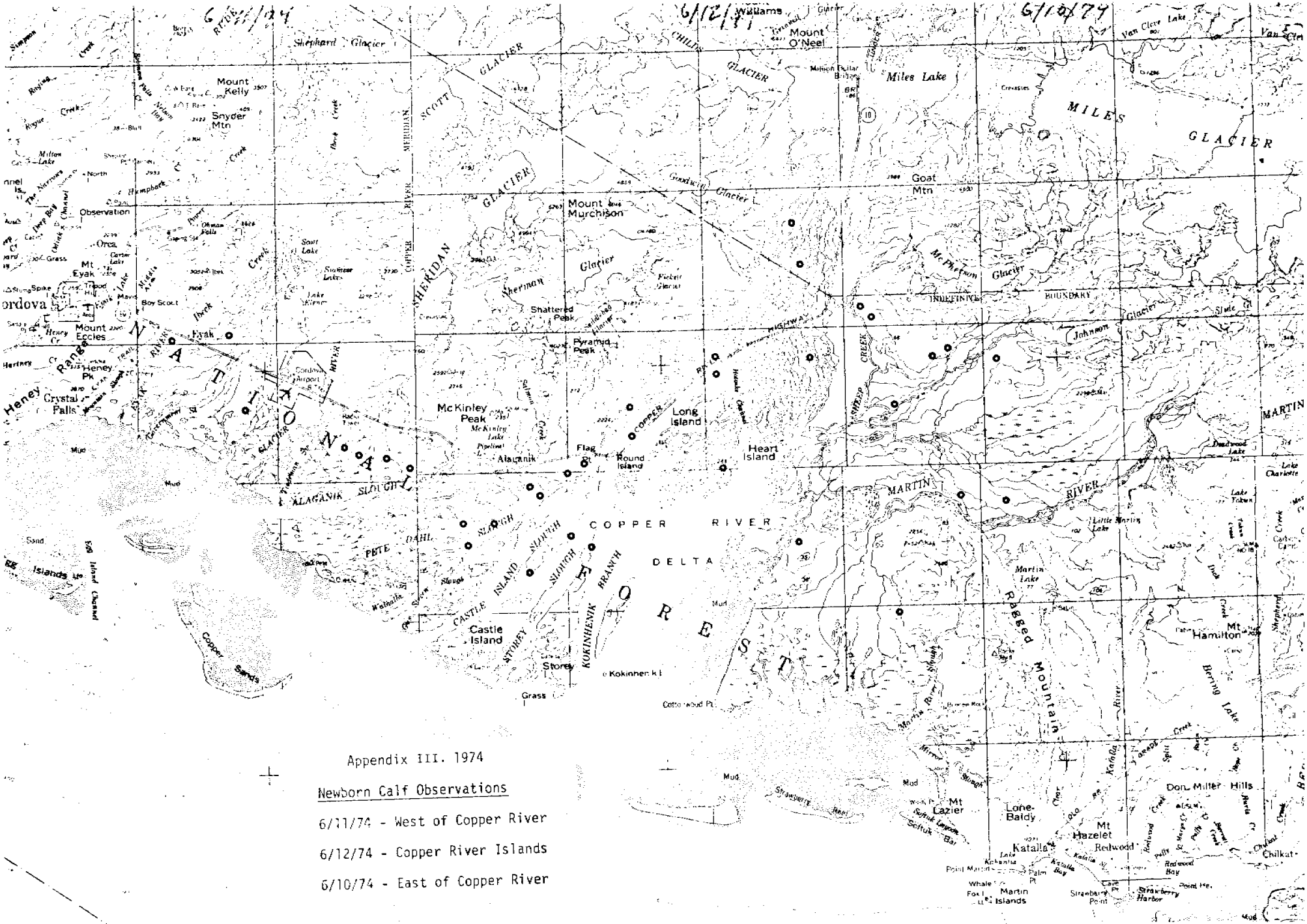
December

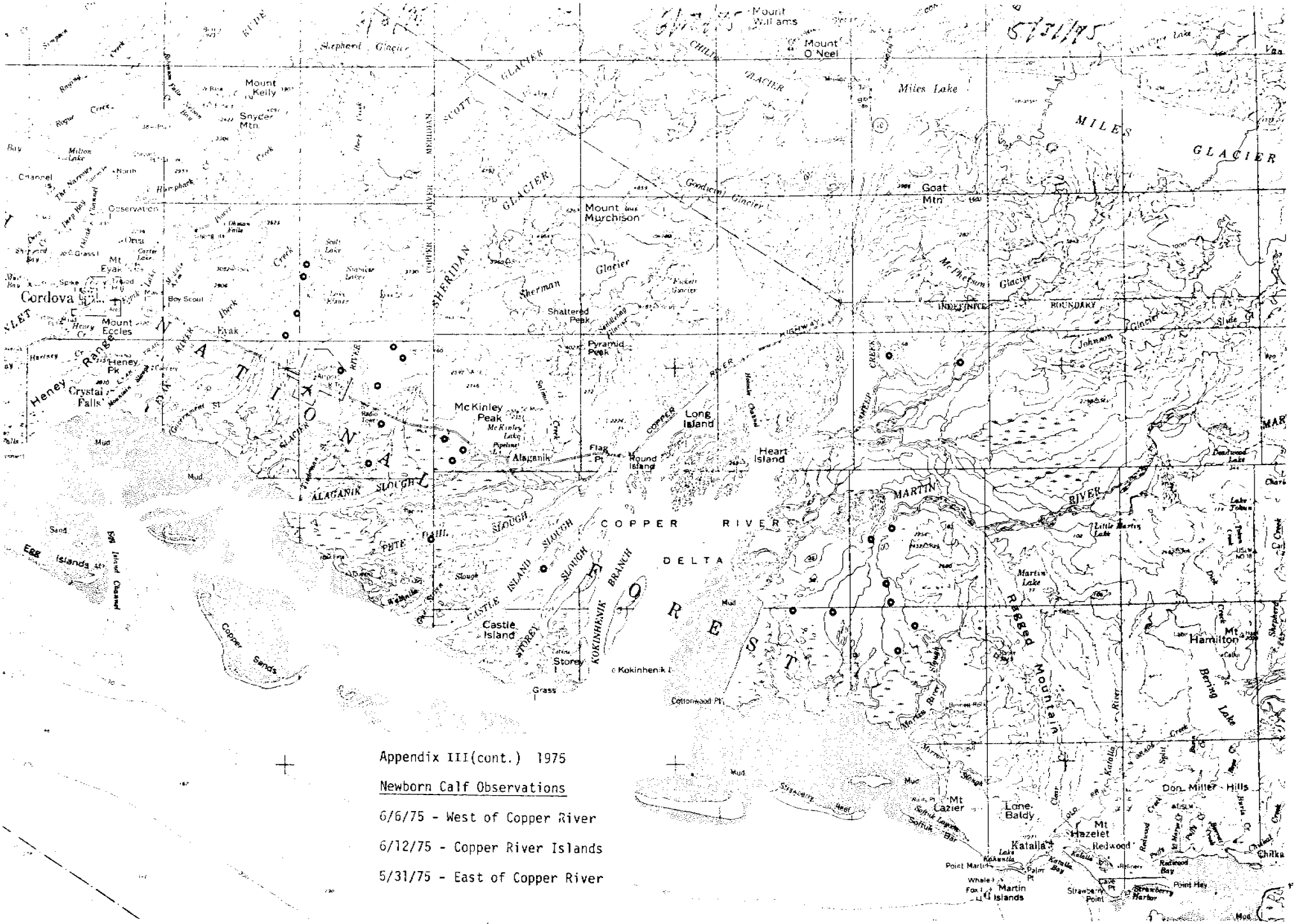
+ 1974

o 1975

- 1976

→ Movement from collared area.


6/11/74
6/12/74
6/10/74
Shepard Glacier
Mount Kelly
Snyder Mtn
Observation
Orca
Mt Eyak
Mount Eccles
Eyak
Heney Range
Heney Pk
Crystal Falls
NATIVE
Mount O'Neel
Miles Lake
MILES GLACIER
Goat Mtn
Mount Murchison
Shattered Peak
Pyramid Peak
McKinley Peak
Alaganik
Flag Pt
Round Island
Long Island
Heart Island
COPPER RIVER DELTA
Castle Island
Storey
Kokinhenik
Grass
Copper Sands
Martin River
Ragged Mountain
Mt Hamilton
Mt Lazier
Lone Baldy
Mt Hazelet
Redwood
Katalla
Don Miller Hills
Chilkat
Martin Islands
Strawberry Point
Strawberry Harbor
Appendix III. 1974
Newborn Calf Observations
6/11/74 - West of Copper River
6/12/74 - Copper River Islands
6/10/74 - East of Copper River



Appendix III(cont.) 1975

Newborn Calf Observations

6/6/75 - West of Copper River

6/12/75 - Copper River Islands

5/31/75 - East of Copper River