HOME RANGE USE, SOCIAL STRUCTURE, AND HABITAT SELECTION OF THE WESTERN ARCTIC CARIBOU HERD

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by

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Contractor:	Alaska Department of Fish and Game
Principal Investigators:	James L. Davis and Patrick Valkenburg
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PREFACE

In 1978, relating to Alaska lands legislation, Congress appropriated $100,000 to the U.S. National Park Service (NPS) for caribou research in northwestern Alaska. NPS administrators reasoned that the research monies would be most efficiently used for operating costs and not permanent personnel salary. Other considerations were that the research be germane to administration of NPS lands in northwestern Alaska and increase understanding of basic caribou ecology.

The Alaska Department of Fish and Game (ADF&G) was awarded the contract to conduct this research over a 3-year period. This final report summarizes findings of the study. Several conclusions from the study are tentative; more definite answers would require additional study. Nevertheless, we do not believe that any conclusions will be contradicted through further study.

This research was designed to be complementary to a concurrent study initiated by ADF&G to analyze natural mortality in the Western Arctic Caribou Herd (WAH) (Davis and Valkenburg 1979a, 1980). The ADF&G study was part of a major continuing project initiated in 1975 on the WAH. In 1981 an additional complementary study was initiated by ADF&G and the U.S. Bureau of Land Management (BLM). Caribou collared for all studies increased the total sample size for each study without detracting from the objectives of any. The latter projects are continuing, and much of the data will apply to NPS contract study objectives. Subsequent reports containing summaries of findings will be sent to the NPS, and acknowledgment of support from the NPS will appear in each.

SUMMARY

During 1978-81, 38 male and 55 female caribou (Rangifer tarandus) were successfully radio-collared in the range of the WAH and monitored on a year-round basis for 322 and 736 collar-months, respectively. Males were relocated 83 times and females 279 times. Collared males died or shed collars more frequently than females. As of 31 December 1981, radio collars were functioning on a maximum of 19 males and 53 females.

By relocating collared caribou for 2 or more years, we found that the only movement patterns of collared individuals included the following: (1) females returned each May to the traditional WAH calving area on the North Slope; (2) both sexes used the foothills near the calving grounds in May and June; and (3) both sexes returned to the arctic coastal plain in summer. Use of a particular winter range during successive winters by an individual was not predictable. In addition, the number of caribou using a particular winter range varied greatly between years, although the most important wintering areas consistently included the Selawik and Buckland River drainages, the arctic coastal plain, and the central Brooks Range.

Findings from this study and concurrent complementary studies have helped identify discrete caribou herds within the greater range of the WAH. The Teshekpuk Herd and Central Arctic Herd clearly exist as discrete entities which reside year-round on the North Slope in the northeast corner of the WAH's range. Seven of 15 females and all males collared in the Price and Oumalik River drainages in April 1981 remained in this vicinity through summer 1981. This may indicate a widely scattered distribution of the Teshekpuk Herd among other possibilities. The Ray Mountains Herd exists in the southeastern portion of the WAH's range, and the Andreafsky Herd is distributed near the southwestern extent of the WAH's range. However, within northwestern Alaska, no discrete herd inhabits NPS lands year-round. This implies that the caribou which seasonally use NPS lands in northwestern Alaska can be maintained only through cooperation between private landowners, the State of Alaska, and various Federal agencies.

Because of the current and historic seasonal distribution patterns of the region's caribou, policies for managing NPS lands in northwestern Alaska will generally have substantial effect on important direct mortality factors to caribou. These policies will affect the caribou population by controlling hunting, both for subsistence and sport, and predation through protective regulations for major predator species. NPS policies will have less impact on welfare factors such as habitat because critical seasonal habitats extend well beyond or occur totally outside of NPS lands.

We investigated the existence of strong social bonds between individuals by radio-collaring 2 to 4 caribou in each of 17 groups (38 individuals). Although 125 resightings were made of these 38 individuals, we did not document any persistent, nonrandom associations between individuals. Our present data and observations support the hypothesis that the basic

units of caribou social structure are either "temporary, tenuous associations of individuals" (Lent 1965) or "open, social units" (Bergerud 1974).

The most unexpected aspect of habitat selection by the WAH, and the one possibly having greatest habitat management implications, was that spruce (Picea spp.) forest habitat was rarely used even in winter. Instead, open tundra plateaus, tussock communities, and windblown ridgetops were favored. Food habits of caribou wintering on the arctic coastal plain apparently differed substantially from those of caribou wintering in the Selawik Hills and south of the Brooks Range. For instance, caribou feces collected on the arctic coastal plain in late winter contained about 40-50 percent less lichen fragments and 4 times more shrub fragments (primarily Vaccinium) than similar samples collected south of the Brooks Range.

Review and assessment of effects of fire on the WAH suggest to us that wildfires had little or no effect on the WAH's decline between 1970 and 1976. The WAH apparently uses tundra wintering habitats more than tree-dominated winter habitats. Consequently, emphasizing research on tundra fire ecology rather than taiga fire ecology should be more relevant to managing the WAH.

CONTENTS

BACKGROUND

Concern for conservation and management of caribou in Alaska increased steadily during the 1970's. This interest resulted from rapidly increasing exploration and development in the North coincident with heightened environmental awareness and recent major declines in some Alaskan caribou herds (Klein and White 1978). Major herds that declined include the WAH, Delta, Fortymile, McKinley, and the Nelchina. Between 1970 and 1977, Alaska's caribou population declined by 42 percent to 55 percent (Davis 1978).

Because the WAH was the largest herd in North America and its decline was numerically most dramatic, the population dynamics and management of the herd have been the focus of public and scientific attention. The herd declined from 240,000 in 1970 to >75,000 in 1976 (Davis and Valkenburg 1978). Since then, major changes in management and favorable environmental conditions have allowed the herd to increase at an apparent mean annual rate of 14 percent (Davis et al. 1980) to approximately 160,000-170,000 in 1981.

Studies addressing aspects of the biology of the WAH were initiated in 1975 and 1976, but results are just beginning to be published. These include population studies by ADF&G (Davis 1978; Davis and Valkenburg 1978, 1979a, 1979b, 1980, 1981; Davis et al. 1979, 1980) and caribou habitat and population modeling studies by the Cooperative Wildlife Research Unit, University of Alaska (Doerr 1979, 1980; Doerr and

Dieterich 1979; Klein 1980; Kuropat and Bryant 1980; Wright 1980). Additional relevant studies include physiological and nutritional studies of reindeer and caribou by the Institute of Arctic Biology, University of Alaska, and several socio-economic studies of the WAH by other organizations. Current management strategy for the herd is based on the results of these studies. Although these studies contributed to a better understanding of caribou in northwestern Alaska, important questions relating to social structure and traditional movements of the WAH were not addressed. These factors may influence the susceptibility of caribou to hunting, range deterioration, and predation. Improved understanding is necessary to make intelligent management decisions.

A caribou herd is generally defined as that group of caribou which shares a common calving area (Skoog 1968). Use of a communal calving ground is commonly considered the only social characteristic shared by most animals in a herd, and it is assumed that no persistent social units are formed. Further, caribou are not assumed to be faithful to particular seasonal ranges, or if fidelity does exist, it occurs only for the entire herd and not for units of the herd. Therefore, management programs have considered all caribou in a herd equally susceptible to hunting by assigning only 1 season and bag limit throughout the range of the herd even though hunting is localized. These concepts have important management implications and need to be tested.

All caribou management programs are based on our poorly understood concept of basic caribou social structure, described by Lent (1965) as a "temporary tenuous association(s) of individuals," and by Bergerud (1974) as "open social units." Lent (1965) defined a group as "...an aggregation of individuals separated by some distance from other aggregations and showing some weak coordination of activities, traveling together, or resting and feeding together." However, social ethologists, such as McBride (1971), argued that groups are "...not simple congregations of anonymous animals, but are formed and maintained by affiliative behavior."

Distinction between the definitions of the term "group" by Lent and McBride may be semantic, although recent evidence suggests that caribou may indeed be organized into groups as defined by McBride. In the Kaminuriak Caribou Herd in Canada, Parker (1972), Miller (1974), and Miller et al. (1975) observed persistent associations between adult animals which they believed were nonrandom and the result of social attachment. These investigators observed radio-collared and visual-collared caribou and found that: 1) certain animals were repeatedly seen together on the same day, 2) certain animals were usually in the same groups, and 3) animals returned to the same groups after being separated for hours or days (Miller et al. 1975). They suggested that the basic caribou social unit, usually less than 10 animals, is the winter "band" or group. They believe the 2 main categories of winter bands are adult bull bands consisting of males 3 years old and older, and the cow-juvenile bands consisting primarily of cow-calf pairs and loosely associated subadults (Miller 1974). This model of caribou

social structure includes social tolerance and social facilitation which are implicit in the discussion by Lent (1965) and Bergerud (1974), but further implies that a tendency to form social bonds exists between adults.

In Alaska several social group phenomena were recognized in the Fortymile Caribou Herd which may have important management implications (Davis et al. 1978). It is well documented that, while major portions of the herd consistently calve, winter, and migrate in specific locations, portions of the herd or "peripheral animals" consistently use different areas for each of these activities. It is unknown if these peripheral animals are the same individuals each year.

OBJECTIVES

To determine seasonal home range use, social structure, and habitat selection of the WAH.

PROCEDURES

Of the 93 caribou radio-collared during this study (Table 1), 21 were collared while swimming across the Kobuk River, and 72 were darted using Cap-Chur equipment and/or netted with a shoulder-held net gun (.308 caliber, Mountain Helicopters, Greymouth, New Zealand). A riverboat was used to capture the swimming caribou, and a helicopter was used for darting and netting operations. Attempts to capture caribou with tangle nets (Miller et al. 1971) were unsuccessful, primarily because caribou were only present in areas lacking deep snow and thick cover. Descriptions of radio collars and collaring procedures were detailed by Davis and Valkenburg (1979a). Locations and month and year of collaring are presented in Fig. 1. For each relocation, the date and location were plotted on a detailed map of northwest Alaska. The data for all radio-collared caribou relocated 3 or more times are presented in Appendix A.

Radio-tracking was accomplished from 3 aircraft: Cessna 185, Bellanca Scout, and Piper Super Cub. Each plane was equipped with paired 2-, 3-, or 4-element Yagi antennas. Range of signal reception varied from 10 mi (16 km) to 100 mi (160 km) and seemed to depend on aircraft type, antenna type, terrain, elevation of the tracking aircraft, and perhaps weather. We obtained the greatest range with a Cessna 185 equipped with 3-element Yagi antennas in relatively warm weather (0° C) from an altitude of 10,000 ft (3,000 m) above ground. We made no systematic attempt to determine the best combination of antennas and aircraft, but the Cessna 185 seemed to function better than the 2 fabric-covered aircraft with similar antennas. However, the Bellanca Scout was our preferred radio-tracking aircraft because of its relative speed, maneuverability, rate of climb, comfort, and short field performance. We flew about 525 hours on the project from October 1979 through December 1981 (Table 2).

Table 1. Radio-collared caribou captured from the Western Arctic Herd and the Teshekpuk Herd, April 1979 through July 1981.

Collar frequency	Collar number[a]	Permanent accession number	age[b]/ sex	Location of capture	Date of capture	Comments
150.005	81	102,262	Ad/M	Tinayguk R.	4/80	
150.015	62	102,220	Yg/M	Ambler R.	10/79	Killed by bear 9/80
150.020	69	101,999	Yg/M	Kevuk Cr	4/79	Missing since 7/79
150.022	82	102,264	Ad/M	Tinayguk R.	4/80	
150.025	64	101,998	Ad/M	Kevuk Cr.	4/79	Shed collar 11/79
150.030	32	102,203	Yg/M	Ambler R.	9/79	
150.035	31	102,269	Ad/F	Anaktuvuk	4/80	Had calf 6/81
150.040	60	102,263	Ad/M	Tinayguk R.	4/80	
150.045	34	102,004	Ad/F	Hunt R.	5/79	Had calf 6/79, 6/80
150.050	63	102,003	Yg/M	Hunt R.	5/79	Shed collar 5/79
150.055	61	102,206	Ad/F	Ambler R.	9/79	Had calf 6/80, 6/81
150.060	78	102,204	Yg/M	Ambler R.	9/79	Shed collar 9/79
150.065	68	102,001	Yg/M	Selawik H.	5/79	
150.070	39	102,279	Ad/F	Chandler R.	4/80	Had calf 6/81
150.075	55	102,393	Ad/F	Oumalik R.	4/81	
150.080	54	102,352	Ad/F	Selawik H.	3/81	Had calf 6/81
150.085	73	102,202	Yg/M	Ambler R.	9/79	Missing since 9/79
150.090	77	102,205	Yg/M	Ambler R.	9/79	Probably shed collar 4/80
150.095	74	102,207	Yg/M	Ambler R.	9/79	Shed collar 3/80
150.100	37	102,209	Ad/F	Ambler R.	9/79	Had calf 6/80, 6/81
150.105	76	102,201	Yg/M	Ambler R.	9/79	Killed by wolves 12/79 picked up 12/80
150.115	2	102,218	Yg/M	Ambler R.	10/79	Killed by hunter 10/79 picked up 10/79
150.115	new2	102,273	Yg/F	Chandler R.	4/80	Had calf 6/81
150.120	1	102,006	Ad/F	Driftwood	5/79	Had calf 6/80, 6/81
150.125	66	102,213	Ad/M	Ambler R.	9/79	Killed by hunter 3/80
150.130	75	102,210	Ad/M	Ambler R.	9/79	Shed collar 4/80
150.135	36	102,208	Ad/F	Ambler R.	9/79	Had calf 6/80, 6/81
150.145	3	102,274	Ad/F	Chandler R.	4/80	Had calf 6/80, died giving birth 6/81
150.150	9	102,005	Ad/F	Driftwood	5/79	Had calf 6/79, 6/80, 6/81
150.155	71	102,215	Ad/M	Ambler R.	9/79	Shed collar 11/79
150.160	6	102,216	Yg/M	Ambler R.	10/79	
150.165	89	102,394	Ad/M	Oumalik R.	4/81	
150.170	30	102,268	Ad/F	Anaktuvuk	4/80	Had calf 6/80, 6/81
150.175	10	102,276	Ad/F	Chandler R.	4/80	Had calf 6/80, no calf 6/81
150.190	33	102,007	Ad/F	Driftwood	5/79	Had calf 6/79, 6/81
150.195	67	102,000	Yg/M	Kevuk Cr.	4/79	
150.200	0	102,217	Ad/F	Ambler R.	10/79	Had calf 6/80
150.210	38	102,211	Ad/F	Ambler R.	9/79	
150.215	5	102,275	Ad/F	Chandler R.	4/80	Had calf 6/80, 6/81
150.220	65	102,214	Ad/M	Ambler R.	9/79	Missing since 9/79
150.225	79	102,221	Ad/M	Ambler R.	10/79	Shed collar 1/80
150.225	new79	102,260	Ad/M	Tinayguk R.	4/80	Shed collar 3/81

Table 1. Continued

Collar frequency	Collar number[a]	Permanent accession number	age[b]/ sex	Location of capture	Date of capture	Comments
150.230	35	102,277	Ad/F	Chandler R.	4/80	Had calf 6/80, 6/81
150.235	11	102,266	Ad/F	Anaktuvuk	4/80	Had calf, 6/80, 6/81
150.240	4	102,219	Ad/F	Ambler R.	10/79	Shed collar 3/80
150.245	72	102,212	Ad/M	Ambler R.	9/79	Shed collar 11/80
150.245	new72	102,278	Ad/M	Ambler R.	9/79	Died, unknown cause 4/80
150.260	24	102,358	Ad/F	Selawik H.	3/81	Had calf 6/81
150.270	25	102,378	Ad/F	Price R.	4/81	Had calf 6/81
150.280	26	102,351	Ad/F	Selawik H.	3/81	Died from disease 8/81
150.290	27	102,359	Ad/F	Selawik H.	3/81	Had calf 6/81
150.350	99	102,379	Ad/M	Price R.	4/81	
150.370	19	102,380	Ad/F	Price R.	4/81	No calf 6/81
150.380	13	102,381	Ad/F	Price R.	4/81	
150.390	28	102,382	1yr/F	Price R.	4/81	
150.400	29	102,383	Ad/F	Price R.	4/81	Had calf 6/81
150.410	40	102,384	Ad/F	Price R.	4/81	Had calf 6/81
150.440	43	102,385	Ad/F	Price R.	4/81	No calf 6/81
150.450	44	102,386	Ad/F	Price R.	4/81	No calf 6/81
150.460	45	102,356	Ad/F	Selawik H.	3/81	Had calf 6/81
150.470	46	102,355	Ad/F	Selawik H.	3/81	Had calf 6/81
150.480	57	102,395	Ad/F	Oumalik R.	4/81	Had calf 6/81
150.520	58	102,387	Ad/F	Price R.	4/81	Had calf 6/81
150.530	59	102,353	Ad/F	Selawik H.	3/81	
150.540	91	102,396	Ad/M	Oumalik R.	4/81	
150.550	96	102,397	Ad/M	Oumalik R.	4/81	
150.560	98	102,354	Ad/F	Selawik H.	3/81	No calf 6/81
150.570	17	102,388	Yg/M	Price R.	4/81	
150.620	14	102,389	Ad/F	Price R.	4/81	Had calf 6/81
150.630	15	102,390	Ad/F	Price R.	4/81	Had calf 6/81
150.640	12	102,391	Ad/F	Price R.	4/81	Had calf 6/81
150.650	16	102,392	Ad/F	Price R.	4/81	Had calf 6/81
150.670	18	102,398	Ad/F	Oumalik R.	4/81	No calf 6/81
151.605	30	102,407	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.610	31	102,408	Ad/F	Teshekpuk L.	5/81	
151.620	32	102,409	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.625	33	102,410	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.630	34	102,428	Ad/F	Teshekpuk L.	7/81	No calf 6/81
151.635	35	102,400	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.640	36	102,401	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.650	37	102,402	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.660	38	102,403	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.680	39	102,404	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.690	40	102,405	Ad/F	Teshekpuk L.	5/81	
151.710	41	102,406	Ad/F	Teshekpuk L.	5/81	Had calf 6/81
151.720	70	102,420	Ad/M	Teshekpuk L.	7/81	
151.730	71	102,421	Ad/M	Teshekpuk L.	7/81	
151.740	72	102,422	Ad/M	Teshekpuk L.	7/81	
151.750	73	102,423	Ad/M	Teshekpuk L.	7/81	

Table 1. Continued

Collar frequency	Collar number[a]	Permanent accession number	age[b]/ sex	Location of capture	Date of capture	Comments
151.760	74	102,424	Ad/M	Teshekpuk L.	7/81	
151.770	75	102,425	Ad/M	Teshekpuk L.	7/81	Killed by hunter 8/81
151.780	76	102,426	Ad/M	Teshekpuk L.	7/81	
151.790	77	102,427	Ad/M	Teshekpuk L.	7/81	
Handled but not collared:						
Ear tags 12523,12524		102,261	Yg/M	Tinayguk R.	4/80	
Visual collar only:						
---	80	102,222	Ad/M	Ambler R.	10/79	

[a]All collars are yellow with black numbers. In addition, Teshekpuk Lake collars have red plastic panels between the black numbers.

[b]Yg denotes caribou estimated as 1, 2, or 3 years old; Ad, those older than 3 years.

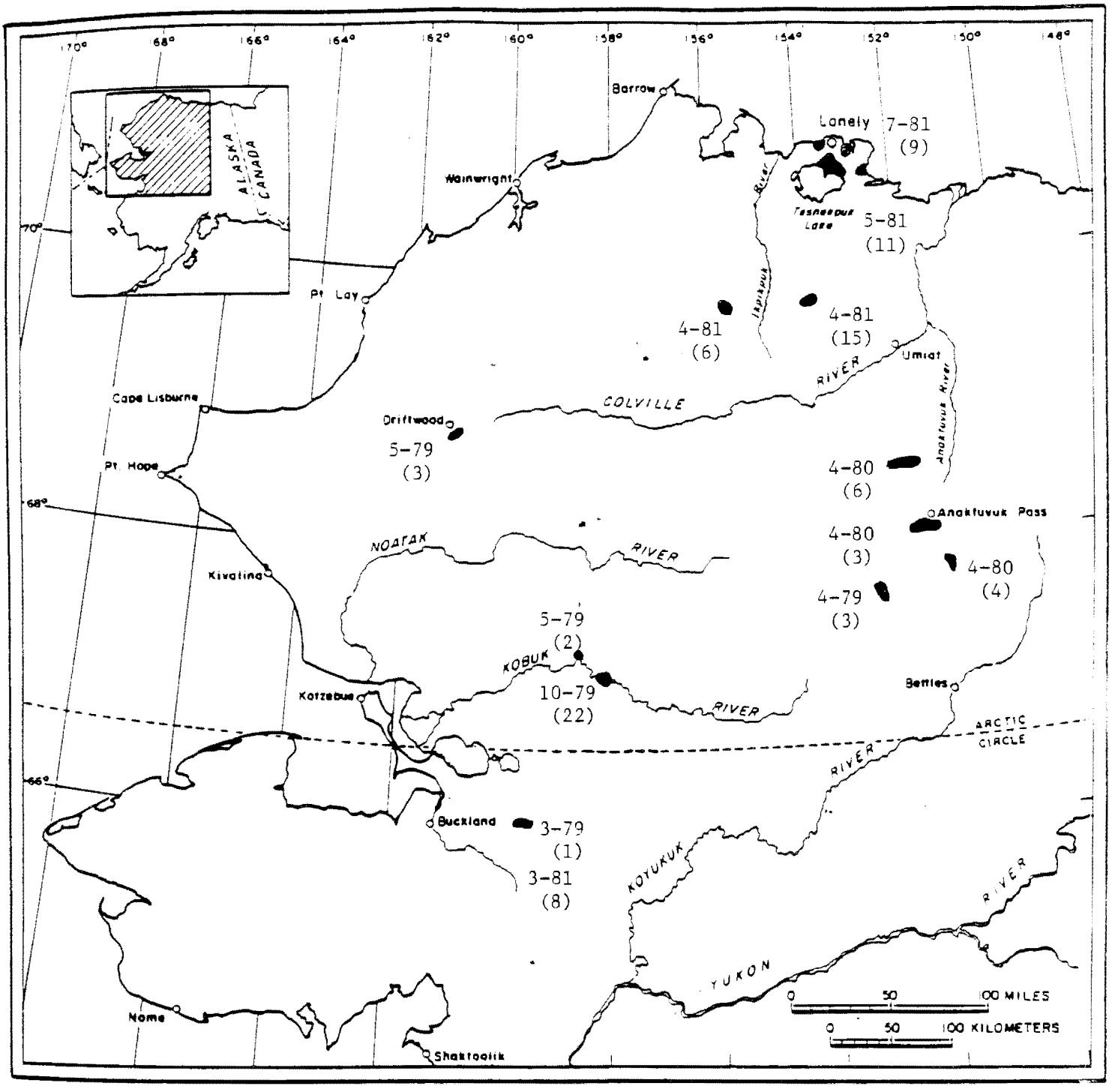

Fig. 1. Collaring date, location, and number collared (n), Western Arctic Herd, April 1979-July 1981.

Table 2. Summary of flights conducted for radio-tracking and collaring caribou in northwest Alaska, 1 October 1979 through 31 December 1981.

Year	Month	Hours Flown				Total # flights	Total # hours flown
		Bellanca Scout	Cessna 185	Super Cub	Helicopter		
1979	October		25			1	25
	November						0
	December						0
1980	January	5	11	6		5	22
	February	2	7			3	9
	March	15	2			3	17
	April	40	8	35	30	15	113
	May			6		2	6
	June	5		16		9	21
	July	20				4	20
	August			8		1	8
	September		15			2	15
	October		2			1	2
	November		19	12	20	3	51
	December					0	0
1981	January	12				1	12
	February					0	0
	March	18	21	12	20	8	71
	April	35			12	6	47
	May					0	0
	June		20			6	20
	July		6			1	6
	August		23			3	23
	September						0
	October		35			8	35
	November		2				2
	December						0
TOTALS		152	196	95	82	82	525

Caribou movements, social structure, and habitat selection were studied through visual reconnaissance during radio-tracking missions. Winter food habits were investigated by analyzing feces collected on winter ranges. Analyses were conducted at the Composition Analysis Laboratory, Colorado State University and based on 100 fields per sample (100X). Means were calculated from 5 subsamples of 20 fields per sample. Each sample contained 25 fecal pellets from 25 different, fresh defecations. Field data collection forms are included in Appendix B. Field notes are available from ADF&G files, Fairbanks.

RESULTS AND DISCUSSION

From May 1979 to July 1981, we radio-collared 38 male and 55 female caribou in the WAH on 12 different occasions (Fig. 1). Radio-collared males were monitored for 322 collar-months and relocated 83 times; females were monitored for 736 collar-months and relocated 279 times (Table 3). Collared males died or shed collars much more frequently than collared females. Causes of death and implications to the population dynamics of the herd were discussed in Davis and Valkenburg (1981).

As of December 1981, radio collars were functioning on a maximum of 19 males and 52 females. These collars are capable of transmitting approximately 808 more collar-months for males and 1,388 for females, assuming a 40-month transmitter life.

Seasonal Home Range Use

Investigation of home range use of the WAH was 3-fold. First, major seasonal range use patterns and movements were delineated through general aerial reconnaissance and by mapping relocations of individual radio-collared caribou (Appendix A). Second, fidelity to winter range was investigated by relocating individual caribou during subsequent winters (Table 4). Third, caribou were radio-collared in several different portions of the herd's range (Fig. 1) to investigate the possible existence and extent of distinct herds within the WAH's range.

Davis and Valkenburg (1978) reviewed and summarized the movement and distribution information for the WAH through 1977. The following discussion of movements and distribution pertains only to the current study period. For a proper perspective of current movements and distribution, past data should be reviewed.

Consistent use of the upper Ketik and middle Utukok River drainages occurred annually during the calving season, late May through mid-June. Female caribou moved rapidly to the calving grounds primarily in April and May, and calving peaked there from 2 to 5 June during 1979-1981. Males, particularly adult males, generally lagged behind during spring migration and did not occur on the calving ground in substantial numbers.

Table 3. Status of 93 radio-collared caribou in the Western Arctic Herd, 31 December 1981.

Status	Young[a]		Adult		Total
	Male	Female	Male	Female	
Radio functioning	1	1	18	51	71
Killed by hunters	1	0	2	0	3
Probably killed by wolves	1	0	0	0	1
Probably killed by brown bears	1	0	0	0	1
Died, cause unknown	0	0	1	0	1
Died from disease	0	0	0	1	1
Died giving birth	0	0	0	1	1
Shed collar	4	0	6	1	11
Missing[b]	2	0	1	0	3
Total	10	1	28	54	93

[a] Young refers to caribou about 1, 2, or 3 years old.

[b] Caribou were considered missing if they were not located for over 1 year.

Table 4. Winter range locations of radio-collared Western Arctic Herd caribou relocated during 2 or more winters.

Collar no.[1]	Age[2]/Sex	Winter Range 1978-79	1979-80	1980-81	Expected 1981-82 (based on Oct. and Nov. 1981 observations)	Major change
2BKY	Ad/F		Central Brooks Range	Arctic coastal plain		yes
5BKY	Ad/F		Central Brooks Range	Buckland R.	Selawik-Buckland R.	yes
6BKY	Yg/M		Selawik R.	Buckland R.	Selawik-Buckland R.	no
9BKY	Ad/F		Kobuk, Selawik R.	Buckland R.		no
10BKY	Ad/F		Central Brooks Range	Buckland R.		yes
11BKY	Ad/F		Central Brooks Range	Buckland R.		yes
14BKY	Ad/F			Arctic coastal plain	Central Brooks Range	yes
15BKY	Ad/F			Arctic coastal plain	Central Brooks Range	yes
30BKY	Ad/F		Central Brooks Range	Kobuk, Selawik R.		yes
32BKY	Yg/M		Buckland R.	Buckland R.	Buckland R.	no
33BKY	Ad/F		Central Brooks Range	Buckland R.	Selawik-Buckland R.	yes
34BKY	Ad/F	Kobuk, Selawik R.	Buckland R.	Kobuk, Selawik R.	Central Brooks Range	yes
35BKY	Ad/F		Central Brooks Range	Buckland R.		yes
36BKY	Ad/F		Buckland R.	Buckland R.		no
37BKY	Ad/F		Selawik R.	Buckland R.		no
38BKY	Ad/F		Selawik-Buckland R.	Buckland R.	Western Brooks Range	yes
39BKY	Ad/F		Central Brooks Range	Buckland R.		yes
43BKY	Ad/F			Arctic coastal plain	Central Brooks Range	yes
44BKY	Ad/F			Arctic coastal plain	Central Brooks Range	yes
46BKY	Ad/F			Arctic coastal plain	Central Brooks Range	yes
59BKY	Ad/F			Buckland R.	Buckland R.	no
60BKY	Ad/M		Central Brooks Range	Selawik-Buckland R.	Central Brooks Range	yes
61BKY	Ad/F		Selawik R.	Selawik-Buckland R.	Buckland R.	no
64BKY	Ad/M	Central Brooks Range	Arctic coastal plain			yes

Table 4. Continued

Collar No.[1]	Age[2]/Sex	Winter Range 1978-79	1979-80	1980-81	Expected 1981-82 (based on Oct. and Nov. 1981 observations)	Major change
67BKY	Ad/M		Central Brooks Range	Selawik-Buckland R.		yes
68BKY	Yg/M	Selawik R.	Central Brooks Range	Kobuk, Selawik R.	Kobuk, Selawik R.	yes
78BKY	Yg/M	Kobuk	Kobuk			no
81BKY	Ad/M		Central Brooks Range	Buckland R.		yes
82BKY	Yg/M		Central Brooks Range	Selawik-Buckland R.	Selawik-Buckland R.	yes
99BKY	Ad/M			Arctic coastal plain	Arctic coastal plain	no

[1] All collars are yellow with black numbers.

[2] Age when collared: Yg denotes estimated age of 1, 2, or 3 years; Ad, older than 3 years.

Following calving, the caribou consistently formed large post-calving aggregations in the western DeLong Mountains, particularly in the northern drainages and foothills. In August, the WAH dispersed over the entire coastal plain and northern foothills of the Brooks Range from the coast on the west to about the Anaktuvuk and Colville Rivers on the east. Movement to the various wintering ranges occurred primarily in September and October.

Winter Range Fidelity

In contrast to the consistent annual use of specified ranges in spring and summer, the number of caribou using a particular wintering range varied substantially between years. In addition, 21 of 30 of the collared caribou for which at least 2 winters' observations are available changed their use of winter range between years (Table 4). However, none of the collared caribou changed winter ranges during a particular winter. In fact, most collared caribou moved less than 50 miles between relocations during a particular winter (Appendix A).

Three important wintering areas were identified: the Selawik-Buckland area, the arctic coastal plain, and the central Brooks Range. However, in all years a relatively small proportion of the herd (perhaps 10% or less) wintered in other widely scattered locations. In winter 1978-79, most of the herd wintered in the Selawik-Buckland area and the arctic coastal plain (equally distributed between the 2 areas). Several thousand wintered in the central Brooks Range. During winter 1979-80, the herd was almost equally dispersed between the 3 areas. In winter 1980-81, most of the herd wintered south of the Kobuk River primarily in the Buckland River drainage, but as far south as the Shaktoolik River drainage. The Shaktoolik drainage was used particularly by bulls. In addition, 5,000 or more caribou wintered in the central Brooks Range along the Nigu River and around Etivluk Lake, and 10,000 to 20,000 or more caribou wintered on the arctic coastal plain. Results of reconnaissance flights and radio-tracking in early winter 1981 suggest that a majority of the herd will winter on the arctic coastal plain and in the central Brooks Range. If these indications are correct, the winter use of the central Brooks Range during 1981-82 will be the greatest since the early 1970's. Increasing herd size may partially explain the increased use of this area. Use of the Selawick-Buckland area appears to be the lightest since prior to 1975.

Timing of movements across the Kobuk River, and to a lesser extent across the Noatak River, influences the accessibility of caribou to hunters living in the region. Caribou usually begin crossing the Noatak River southward in mid-August and the Kobuk River in late August, with highest numbers crossing from mid-September through early October. Most autumn crossings of the Kobuk River occur in the vicinity of Onion Portage after most caribou cross the Baird Mountains through the Hunt River and Miluet Creek drainages. Smaller numbers cross the Baird Mountains through the Squirrel and Redstone River drainages and arrive at the Kobuk River near the mouths of the Squirrel and Ambler Rivers. Spring movements northward to the calving ground usually begin about 20 March; large numbers of caribou continue to cross in early to mid-April.

Major spring crossings also occur in the vicinity east and west of Ambler, and migration routes generally continue up the Hunt and Redstone River valleys into the Cutler River drainage and finally into the Anisak River valley and across the DeLong Mountains.

Herd Identities of Caribou in the Western Arctic Herd's Range

The range (i.e., distribution) of the WAH has been variously delimited in the past several decades by Lent (1964), Skoog (1968), Hemming (1971), Davis and Valkenburg (1978), and Davis (1978, 1980). Lent (1964) described the herd's range as occupying about 85,000 mi^2 lying mostly north of the Arctic Circle. Skoog (1968) and Hemming (1971) delineated the herd's range on distribution maps over an area encompassing about 140,000 mi^2. Davis et al. (1980) described the herd's distribution as roughly including the area west of the Trans-Alaska Pipeline (TAP) and north of the Yukon River. Limited movements south of the Yukon River and east of the TAP occurred in the early and mid-1970's.

More intensive study of caribou in northwestern Alaska since 1974 has verified the existence of several discrete herds, or groups of caribou sharing common calving grounds (Skoog 1968), within the greater range of the WAH. Davis and Valkenburg (1978) concluded that at least 2 small semi-migratory or nonmigratory herds, the Teshekpuk Herd and the Central Arctic Herd (CAH), existed within the range of the WAH; limited evidence also suggested the existence of an Andreafsky Herd and Ray Mountains Herd. Identity of the CAH has been well defined by Cameron and Whitten (1979), and the population has increased from 5,000-6,000 in 1975 to about 9,000 in 1981 (Cameron and Whitten, pers. commun.). Herd identity of the Teshekpuk Herd has been less well-defined, although ADF&G (unpubl. data, Fairbanks files) has documented calving annually since 1975. The population has been variously estimated at 500 (Davis 1978), several hundred to 4,000 (Davis et al. 1978), and 3,000-4,000 (Davis 1980).

Findings from this study and other continuing studies will help refine the identity of the Teshekpuk Herd. Seven of 15 females and all 6 males collared in the Price and Oumalik River drainages in April 1981 remained in this vicinity through summer 1981. This lack of movement may indicate a protracted distribution of the Teshekpuk Herd, among other possibilities. However, more relocations are needed during spring and calving in 1982 before conclusions are warranted.

Calving was verified in each of 3 years when surveys were conducted in the range of the Ray Mountains Herd, and the population was estimated to number about 200 (Davis 1978, 1980).

Calving has never been documented in the range of the Andreafsky Herd, but the herd's existence is unquestionable. Recent observations suggest that the herd's range does not overlap the WAH's.

Caribou Use of NPS Lands in Northwest Alaska

NPS lands within the range of the WAH include Cape Krusenstern National Monument, Gates of the Arctic National Park and Preserve, Kobuk Valley National Park, and Noatak National Preserve (Fig. 2). Additionally, movements of the WAH may rarely extend into the Bering Land Bridge National Preserve.

Many WAH caribou migrate through Cape Krusenstern National Monument in years when a major segment of the herd uses a coastal route to southern winter ranges. Major use of the coastal route last occurred in early fall 1975 and involved about 60,000 caribou. In winter 1975-76 up to 10,000 caribou wintered in the Mulgrave Hills and Kivalina River drainage. In most years several hundred to several thousand caribou winter in the Mulgrave Hills within Cape Krusenstern National Monument. Caribou are relatively scarce in the area during other seasons.

WAH use of the western portion of Gates of the Arctic National Park and Preserve has occurred in recent years in August and September, particularly in the Noatak River drainage. In addition, early winter use of the Killik, Chandler, Anaktuvuk, Itkillik, North Fork of the Koyukuk, Tinayguk, John, and Alatna River drainages within the Gates of the Arctic National Park and Preserve was documented in November 1981.

The Kobuk Valley National Park includes the Hunt River drainage which for many years has been the primary migration route for caribou that travel to and from the Selawik-Buckland wintering range. In addition, small numbers of caribou usually winter along the Kobuk River within the Kobuk Valley National Park. Autumn crossings of the Kobuk River usually occur from late August through October, with the first large numbers usually crossing after about mid-September. Hunting in the Park is concentrated during this period and occurs along the Kobuk River, particularly around Onion Portage. Spring crossings of the Kobuk River occur primarily in March and April, with large numbers of pregnant cows crossing in early April. Caribou also predictably move through the northwest corner of Kobuk Valley National Park in late August and September, particularly in the upper Salmon River. However, many of these caribou move west and southwest into the Squirrel River drainage immediately prior to their southward migration to the Selawik-Buckland wintering area. The Squirrel River drainage west of the Park and the Redstone River drainage, east of the Park, are presently secondary migration routes to and from the Selawik-Buckland wintering range.

WAH use of the Noatak National Preserve occurs during northward spring migrations to the calving ground and often during and immediately prior to the autumn rutting season. Spring migrations through the Noatak National Preserve occur in April and May primarily in the Cutler and Anisak River drainages. This route is followed earlier by females than by males, and females move in larger aggregations than males. In general, males tend to be more scattered throughout the Preserve than females. During spring, large numbers of males often travel west along the north or south slopes of the Brooks Range prior to moving north to join the females and calves. Large WAH post-calving aggregations form

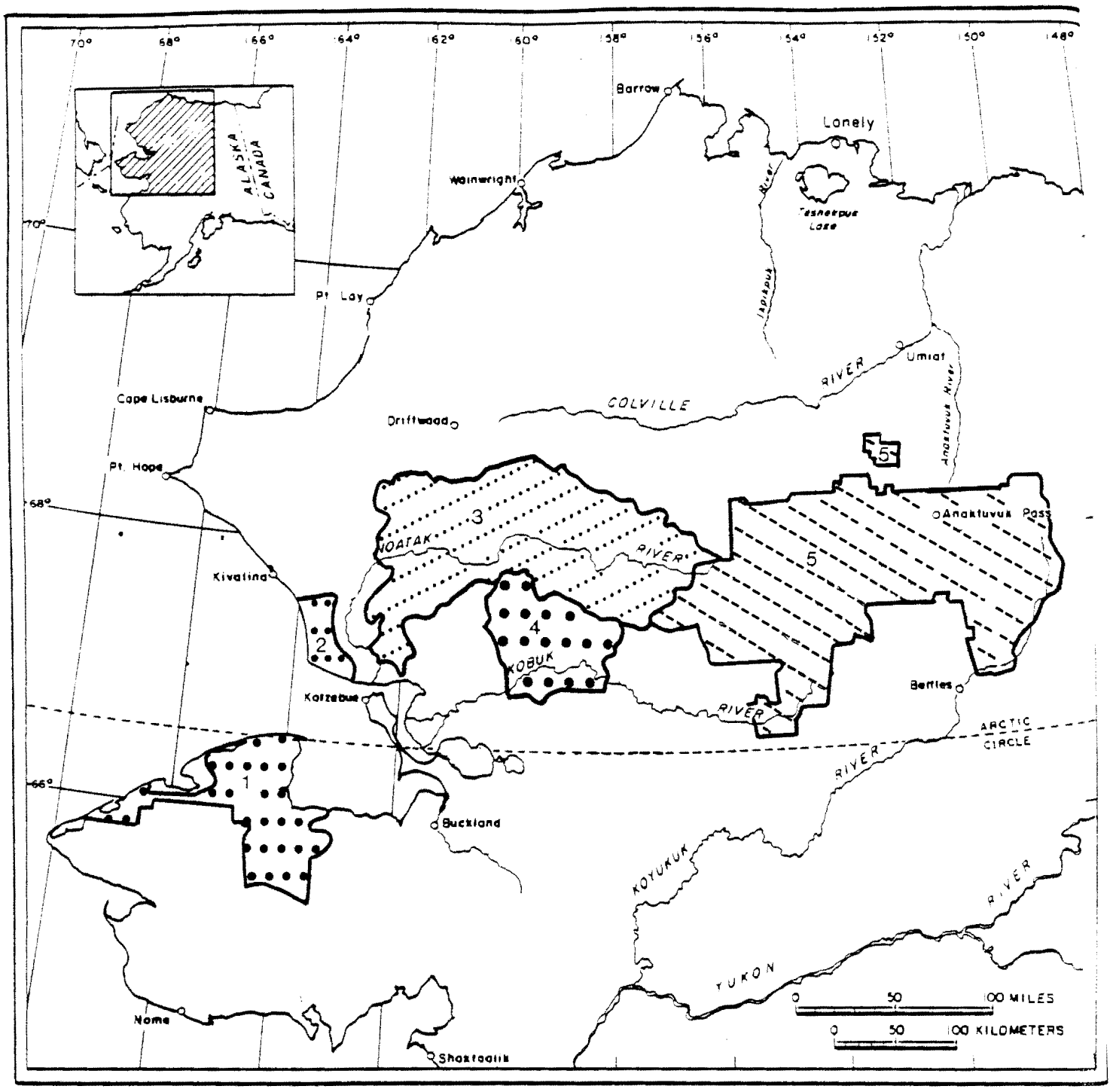

Fig. 2. Location of National Park Service lands in northwestern Alaska. 1) Bering Land Bridge National Preserve; 2) Cape Krusenstern National Monument; 3) Noatak National Preserve; 4) Kobuk Valley National Park; 5) Gates of the Arctic National Park and Preserve.

in July on the northern slopes of the Brooks Range and often enter the northern fringes of the Preserve. Most of the herd stays north of the Brooks Range during "August dispersal" and in September; however, at this time thousands of caribou are usually spread throughout the Noatak River drainage, within the boundaries of the Noatak National Preserve. Relatively few caribou normally winter within the Preserve, although in recent years a few thousand caribou have wintered along the northeast border of the Preserve, particularly near Etivluk Lake and the Nigu River.

Currently, the WAH does not range onto Bering Land Bridge National Preserve. However, caribou historically used the area (Skoog 1968) and probably will in the future unless prevented through conflicts with the reindeer industry. In November 1981, about 2,000 WAH caribou were present in the Kiwalik River drainage on the eastern edge of the Preserve, making reindeer/caribou conflicts imminent. Policies implemented by NPS, other agencies, and private landowners will determine how this issue is resolved.

Social Structure

Miller (1974) hypothesized that the basic caribou social unit is "the winter band," usually consisting of a group of less than 10 animals which maintain cohesiveness throughout winter. Further, he suggested that "the primary function of post-calving aggregations is socialization, which provides favorable situations for the regrouping of previous winter bands." To test the hypothesis that group constancy exists among caribou of the WAH, we radio-collared and monitored 2 to 4 caribou from each of 17 winter groups. Group constancy was defined as the tendency for a particular group of individuals to remain together (Knight 1970). Radio-collars in 14 of these 17 groups (38 individuals) functioned long enough to determine whether a strong bond existed between collared group members (Table 5). A total of 125 resightings was made of these 38 individuals; 33 were made in winter (November to April). In only 2 of these 125 relocations did we find any evidence of group constancy. However, in both instances, the association between the collared animals could have occurred by chance, as thousands of caribou were in the immediate vicinity of those resighted. One of these relocations was made in late March in a group of about 15,000 which contained 2 caribou out of 4 originally collared from a winter group. The other relocation was made on the core calving ground in late May where tens of thousands of caribou were present, and this relocation occurred only 1 month after collaring.

Thus, at present, our data do not reveal that group constancy occurs among caribou of the WAH. To accept the hypothesis that these associations exist, we would need to see at least 2 identifiable caribou in a small group (less than 15 animals) on 2 or more occasions several months apart. We have not seen such associations in any of our collaring and tracking activities in the WAH, Central Arctic, or Delta Caribou Herds (unpubl. data, ADF&G files, Fairbanks). The lack of group constancy precludes the need for management plans directed toward manipulation of discrete groups.

Table 5. Resightings of caribou collared together in the WAH, 1979-81.

Group number	Location and date collared	Collar no. and age/sex	Total number of resightings (winter resightings)[a]	Status of collar[b]
1	Ambler River	4 (Yg/M)	2 (1)	NF
	10/2/79	62 (Ad/F)	2 (1)	NF
2	Ambler River	61 (Ad/F)	3 (3)	F
	9/29/79	74 (Yg/M)	1 (1)	NF
3	Ambler River	77 (Yg/M)	1 (1)	NF
	9/28/79	78 (Yg/M)	2 (2)	NF
4	Ambler River	36 (Ad/F)	20 (7)	F
	9/29/79	37 (Ad/F)	12 (4)	F
		38 (Ad/F)	16 (3)	F
		75 (Ad/M)	0 (0)	NF
5	Ambler River	0 (Ad/F)	10 (2)	F
	9/29/79	2 (Yg/M)	0 (0)	NF
		6 (Yg/M)	9 (6)	F
6	Kevuk Creek	67 (Yg/M)	0 (0)	F
	4/19/79	69 (Yg/M)	2 (0)	NF
7	Tinayguk River	79 (Ad/M)	0 (0)	NF
	4/17/79	82 (Ad/M)	4 (2)	F
8	Selawik Hills	45 (Ad/F)	4 (0)	F
	3/27/81	46 (Ad/F)	2 (0)	F
		59 (Ad/F)	1 (0)	F
9	Price River	17 (Yg/M)	2 (0)	F
	4/25/81	25 (Ad/F)	2 (0)	F
		28 (Calf/F)	1 (0)	F
10	Price River	19 (Ad/F)	1 (0)	F
	4/25/81	29 (Ad/F)	1 (0)	F
		99 (Ad/M)	1 (0)	F
11	Price River	13 (Ad/F)	1 (0)	F
	4/25/81	14 (Ad/F)	3 (0)	F
		44 (Ad/F)	2 (0)	F
		58 (Ad/F)	3 (0)	F
12	Price River	16 (Ad/F)	4 (0)	F
	4/25/81	40 (Ad/F)	1 (0)	F
		43 (Ad/F)	2 (0)	F

Table 5. Continued

Group number	Location and date collared	Collar no. and age/sex	Total number of resightings (winter resightings)[a]	Status of collar[b]
13	Price River 4/25/81	12 (Ad/F)	2 (0)	F
		15 (Ad/F)	2 (0)	F
14	Oumalik River 4/26/81	18 (Ad/F)	4 (0)	F
		57 (Ad/F)	1 (0)	F
		89 (Ad/M)	1 (0)	F

[a] Figures include only the number of resightings when at least two of the collars in a group were known to be functioning. Number of resightings made in winter (November to April) is given in parentheses.

[b] "NF" denotes a nonfunctioning radio collar; "F," a functioning collar. Any collar located since March 1981 was considered a functioning collar.

A more general view of social structure in the WAH is attainable through analysis of seasonal variations in group size (Table 6). Extremely large groups (greater than 5,000 caribou) are most often observed during the post-calving migration and, to a lesser extent, in mid- to late-winter and during the fall and spring migrations. In August WAH caribou disperse widely into small groups. A predominance of small groups also occurs in a less pronounced manner from September through November, although large groups do occur during fall migration and during calving.

Data from collared caribou indicate that large post-calving aggregations are not well defined and are constantly changing in size and composition. In July 1980, 1 large aggregation dispersed, probably due to weather and an associated decrease in insect harassment, and then re-formed a few days later. The re-formed aggregation contained different collared animals than the initial aggregation, and some of the radio-collared caribou present in the initial aggregation were in other, smaller aggregations up to 80 km (50 mi) away. This reshuffling also evidently occurs in winter groups, as 2 collared caribou were never observed together in the same group on successive relocations during different winter months.

The sex and age structure in groups of WAH caribou changes substantially during the year. Adult females, particularly pregnant females, lead the spring migration to the calving ground, and adult males and yearlings follow in separate groups. Often 50 or more yearlings can be seen in a single group during the spring migration. In June variable numbers of barren females, yearlings, and young males may be on or near the calving grounds. Intermingling of adult bulls and adult females rarely occurs during the calving season or early post-calving period. Yearlings may join either cow-calf groups or adult male groups during the post-calving period. In autumn adult bulls and females intermingle, but young bulls are often found in separate groups. In winter the only apparent segregation in the herd is the separation of some adult bulls from the remainder of the age-sex classes. For instance, some bulls made extensive migrations to the extreme southern limits of the wintering range, the Ungalik and Shaktoolik River drainages.

Habitat Selection

Three aspects of habitat use by the WAH were investigated: (1) habitat selected by radio-collared caribou (Table 7), (2) assessment of winter food habits through fecal analysis (Tables 8 and 9), and (3) the influence of tundra and forest fires (Fig. 3) on the herd's recent population dynamics.

Our most intriguing finding about WAH habitat selection was that spruce-dominated habitat was rarely utilized by the WAH during this study (Table 7), even though many caribou wintered south of the treeline. Only during autumn and spring migrations across the Kobuk River did we find large numbers of WAH caribou in forested habitat. Limited use of spruce habitat also occurred in the upper Huslia, Selawik, and Buckland River drainages.

Table 6. Seasonal variation in the size of groups containing radio-collared caribou, Western Arctic Herd, 1979-1981.

Group size:	1-50	51-300	301-1000	1001-5000	>5000
Season:	Number of groups				
Calving (late May to mid-June)	68	9	5	1	0
Post-calving (late June to late July)	2	3	2	2	15
August dispersal (August)	22	5	1	0	0
Autumn migration and rut (Sept. to late Oct.)	14	7	1	0	0
Early winter (Nov. to mid-Dec.)	12	5	2	0	0
Mid-winter (late Dec. to late Jan.)	15	11	1	4	4
Late winter (Feb. to mid-March)	12	6	1	0	7
Spring Migration (late March to mid-May)	5	4	0	1	2

Table 7. Habitat types in which radio-collared WAH caribou were located from 1979 to 1981.

Habitat type	Number of sightings during the month							Total sightings (%)
	May	June	July	Aug.	Sept.	Oct.	Nov.-Apr.	
Eriophorum tussock-shrub tundra	14	34	13	24	12	7	45	149 (61)
Dryas ridgetop	1	1	2	3	1	1	31	40 (16)
Birch/willow (*Betula*/*Salix*) hillside				3	1		9	13 (5)
Shrub tundra						2	6	8 (1)
Riparian willow (*Salix*)		2	3	1		1	3	10 (4)
Sedge/grass meadow		5				2		7 (3)
Alpine sedge			2		1		5	8 (3)
Spruce woodland					2	4	2	8 (3)
Other							2	2 (1)
Total number of sightings (%)	15 (6)	42 (17)	20 (8)	31 (13)	17 (7)	17 (7)	103 (42)	245

Table 8. Average percentages (± s.d.) of plant fragments in fecal samples collected on caribou wintering areas north of the Brooks Range, Western Arctic Herd, 1981.

Collection location:	Percent relative density of plant fragments						
	Price R.		Judy Creek		Lonely		Mean ± s.d.
Collection dates 1981:	4/24	4/25	4/26	5/2	5/2	5/2	
Plant Species:							
Forbs							
Artemisia		1±2					
Cerastium					1±2		
Lupinus							
Saxifraga				8±6	2±2	1±2	2±3
Stellaria		1±2	4±2		7±8		2±3
Total:	0	2	4	8	10	1	4±4
Graminoids							
Carex	6±7	2±3	4±4		2±2		2±2
Eriophorum	7±5	8±3	5±4	11±7	5±4	11±7	8±3
Luzula	1±1						
Poa	2±2	1±1	3±3	8±11	17±7	13±3	7±7
Total:	16	11	12	19	24	24	18±6
Lichens							
Cetraria	13±8	12±7	8±5	4±4	10±2	6±4	9±3
Cladonia	19±6	16±4	32±7	4±2	4±3	10±7	14±11
Peltigera	1±1	3±2	3±2	8±7			3±3
Stereocaulon	3±4		1±2	2±4		8±5	2±3
Total:	36	31	44	18	14	24	28±11
Mosses							
Selaginella	7±4	7±6	8±7	3±3	4±4	3±2	5±2
Other	2±2	4±5	7±6	3±2	1±2		3±2
Total:	9	11	15	6	5	3	8±4
Shrubs							
Dryas	4±3	3±3		4±2		1±2	2±2
Ledum	7±5	7±11	3±2				3±2
Salix	3±4	6±5		18±7	19±8	15±9	10±8
Vaccinium	25±16	29±15	23±14	27±12	29±9	31±8	27±3
Total:	39	45	26	49	48	47	42±9

Table 9. Average percentages (± s.d.) of discerned plant fragments in fecal samples collected on caribou wintering areas south of the Brooks Range, Western Arctic Herd, 1981.

Collection location:	Percent relative density of plant fragments					
	Selawik Hills			Kollioksak Lake		Mean ± s.d.
Collection dates 1981:	3/24	3/25	3/26	4/21	4/21	
Plant Species						
Forbs						
Equisetum	1±2					
Saxifraga				10±8	6±4	3±5
Stellaria				4±3		
Total:	1	0	0	4	6	4±6
Graminoids						
Carex	3±3	2±3	7±1	1±2	4±4	3±2
Eriophorum	16±6	11±6	4±2	3±5	3±2	7±6
Festuca		1±2				
Luzula				1±2		
Poa			1±2	3±3	7±5	2±3
Total:	19	14	12	8	14	13±4
Lichens						
Cetraria	13±5	23±5	19±9	23±11	24±8	20±5
Cladonia	42±12	45±11	53±8	38±9	31±7	42±8
Peltigera	1±2	2±2	2±3			1±1
Stereocaulon	7±4	5±3	5±2		9±2	5±3
Thamnolia	1±1					
Total:	64	75	79	61	64	69±8
Mosses						
Selaginella	6±2	2±3	2±2		1±2	2±2
Other	2±2		1±1			1±1
Total:	8	2	3	0	1	3±3
Shrubs						
Dryas	1±2					
Ledum	1±2	1±2			3±2	1±1
Salix	1±2	1±2	3±3	5±2	5±2	3±2
Vaccinium	6±7	6±3	3±4	11±4	8±4	7±3
Total:	9	8	6	16	16	11±5

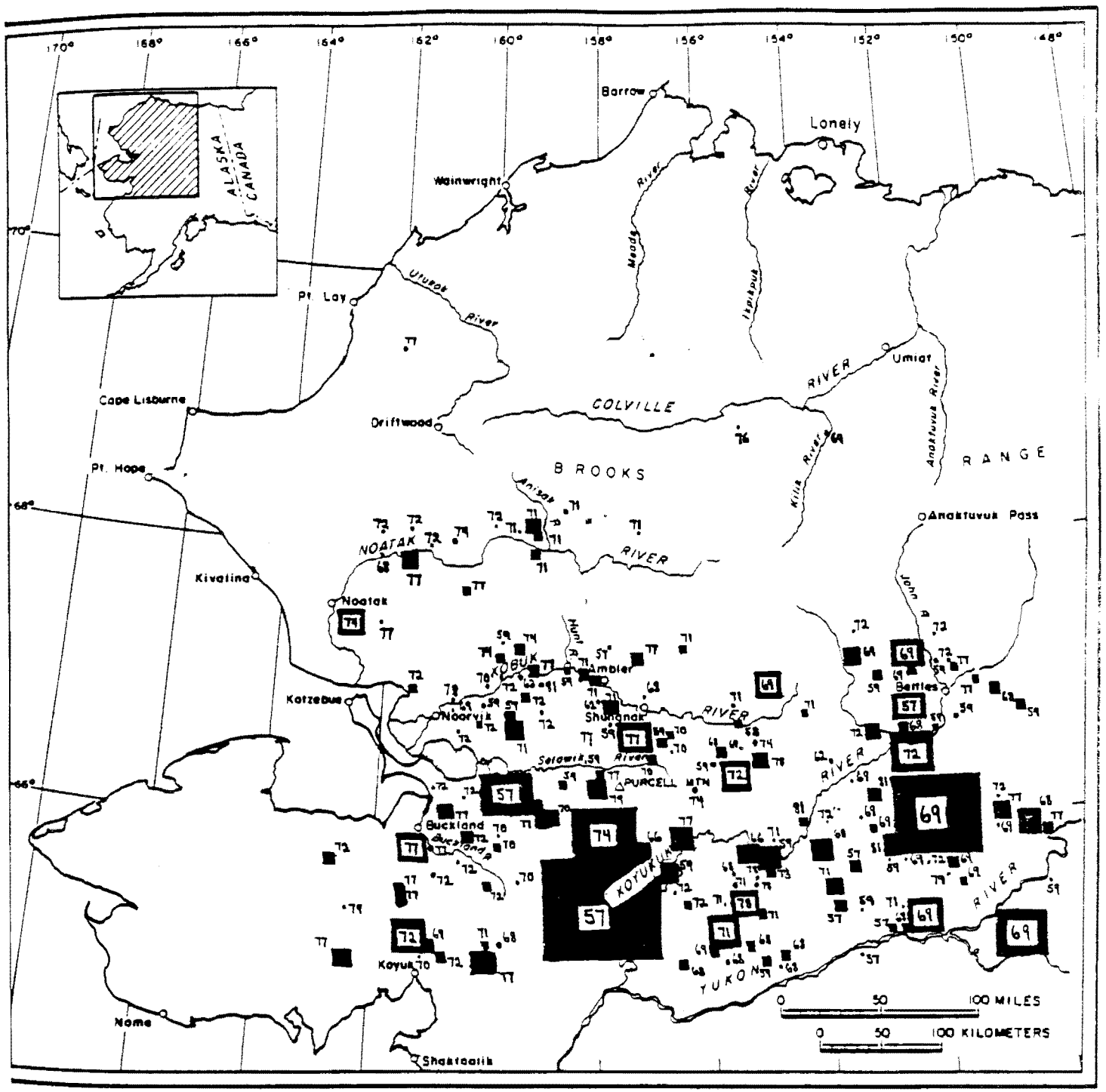

Fig. 3. Year and location of fires that burned more than 1,000 acres (400 ha) in the range of the WAH, 1957-1981.

Prior to the mid-1970's, a principal WAH wintering range was the forested middle-Koyukuk River drainage and Kanuti Flats (Hemming 1971, Moser et al. 1979). Since 1977 few caribou have used the lichen-rich woodlands of the Koyukuk drainage. Instead, open tundra plateaus, tussock communities, and windblown ridgetops have been favored. However, early winter data from 1981 suggests that renewed use of the upper Koyukuk River drainage may occur.

Winter Food Habits

Winter food habits of caribou on the arctic coastal plain (Table 8) apparently differed greatly from those wintering south of the Brooks Range (Table 9). For example, caribou feces collected on the arctic coastal plain in late winter contained mostly fragments of shrubs (42%) and lichens (30%) with smaller proportions of graminoids (18%), mosses (8%), and forbs (4%). In contrast, similar samples collected south of the Brooks Range contained large proportions of lichen fragments (averaging 68%) with small proportions of graminoids (13%), shrubs (11%), mosses (3%), and forbs (2%). Vaccinium and, to a lesser extent, Salix were the major genera of shrubs in the samples. Cladonia and Cetraria were the major lichen genera identified, although significantly fewer Cladonia fragments and more Peltigera and Stereocaulon fragments were found in samples collected north of the Brooks Range. Eriophorum, Poa, and Carex were the major graminoid genera identified. Previously, through cursory observations of rumen samples, it appeared that sedges were possibly the most important winter food of caribou wintering on the arctic coastal plain (Davis and Valkenburg 1978).

Availability of green vegetation in early spring is particularly important to the nutritional regime of caribou (Skoog 1968). In 1979, migrating caribou began feeding on flowering heads of Eriophorum sedge as early as 10 May in the Brooks Range and its northern foothills. However, Eriophorum flowering heads were not available until about 20 May in 1980. Generally, caribou selected Eriophorum flowering shoots almost exclusively until willow (Salix) and dwarf birch (Betula nana) leaves emerged in late May in the foothills of the Brooks Range. On the calving area, caribou did not generally obtain new leaves until early June. Salix leaves and the leaves and flowers of a variety of forbs are the primary foods of caribou in summer. Kuropat and Bryant (1980) presented detailed information on summer food habits of WAH caribou.

Fire/WAH/Range Relationships

In-depth study of fire/caribou relationships is beyond the scope of this report. However, because of the potential impact of fire on the WAH and the continuing conjecture about how the WAH's recent population dynamics might have been influenced by fires we have analyzed the data and literature most pertinent to the WAH.

Background on fire and caribou habitat relationships is available in recent comprehensive reviews by Kelsall et al. (1977), Davis et al. (1978), Davis and Franzmann (1979), and Viereck and Schandelmeier (1980).

To date, there has been much literature review, discussion, and conjecture about fire/caribou relationships, but relevant hypotheses have not been explicitly stated and tested through research. Viereck and Schandelmeier (1980) appropriately commented that review of any controversial subject will not produce any new information, nor will it solve the controversy which can only be resolved through additional research.

We quantified WAH use of fire-affected habitat by determining how frequently radio-collared caribou were located within the perimeter of recent fires. However, most winter observations of caribou were made on tundra covered by snow which made determination of the site's recent burn history very difficult. Viereck and Schandelmeier (1980) commented that this problem is characteristic of burned tundra, even when snow-free.

We rarely observed WAH caribou using spruce-dominated habitat during the study, even though many caribou wintered well south of treeline. It has generally been assumed that the WAH is primarily a taiga-wintering herd (Hemming 1971, Klein 1979) similar to the Canadian barren-ground caribou.

Recognizing the importance of tundra as winter range has major implications in considering WAH/habitat relationships, particularly regarding the impact of fires. It is generally assumed that barren-ground caribou are taiga-wintering animals or by omission that tundra winter ranges are not affected detrimentally by fire. Since as early as 1863, numerous authors (See Davis and Franzmann for review) believed that taiga fires were detrimental to caribou. More recently, recommendations from a recent Alaskan caribou population ecology symposium (Klein and White 1978) called for studies of the effects of fires on summer range and spruce/lichen wintering range for reindeer and caribou. Wildfire impact on tundra winter range was not considered because its prevalence was not recognized.

We believe that knowledge of ecological effects of fire on tundra ranges is lagging many years behind that for taiga.

Viereck and Schandelmeier (1980) summarized the situation as follows:

> Interest in fire effects in tundra vegetation has developed relatively recently. As a consequence, little information is available from Alaska and much of it is short term, from studies of the 1977 fires. In Alaska information on fire effects comes primarily from a man-caused fire in a study site in alpine tussock tundra on the Elliott Highway and from recent studies of the Seward Peninsula fires and the Kokolik fire of 1977.
>
> In Canada information on the effects of fire on tundra has come from the Inuvik fire of 1968, which burned in a treeline area where tundra was interspersed with forested areas. It is often difficult to separate data obtained in tundra sites from data from forested sites....

> In most cases, all signs of the fire have disappeared by 6 to 8 years. In areas with abundant lichen cover, however, recovery may take much longer.

To help assess the effect of fire on the WAH, we compiled the available fire history from within the herd's range. We calculated the portion of the herd's winter range that has been burned (Table 10). We compared the distribution of fires (Fig. 3) to the seasonal distribution of caribou (Appendix A) and the distribution of NPS lands in northwestern Alaska (Fig. 2).

We considered the entire range of the WAH as winter range because caribou have wintered throughout the entire area. Skoog (1968) pointed out that in contrast to most ungulates, caribou can use all habitat types in winter and actually are more dispersed in winter than at any other season.

For the 25 years from 1957 to 1981, 7 percent (2,913,398 ha) of the herd's 41,500,000 ha winter range burned. The mean annual burning rate was 0.28 percent of the winter range. This contrasts to Miller's 1956-72 data (1980) which showed that wildfires annually burned an average of 0.7 percent of the taiga winter range in Saskatchewan and 0.2 percent in Manitoba (1956-67). Miller believed that at this rate, or even Scotter's (1964) 1.0 percent annual rate, forage would not limit a caribou population. Bunnell et al. (1975) predicted from a computer simulation model that increasing the annual burning rate to 5 percent annually would have little impact on barren-ground caribou populations.

The principal contact WAH caribou have with fire-affected habitat is during winter in the southwestern portion of the range (Fig. 3, Appendix A). Further, of the NPS lands in northwestern Alaska, only Kobuk National Park is in the area where most burns have occurred (Figs. 2, 3); even so, the Park is north of the most heavily used WAH winter range. (The Bering Land Bridge National Preserve is excluded in this discussion because it lies west of the WAH's current distribution.)

In any case, the concepts that wildfire is detrimental to caribou and that a direct cause-and-effect relationship exists between burning of caribou habitat and declines of caribou have not been substantiated (Davis and Franzmann 1979). Two long-term studies of caribou life history concluded that range destruction (e.g., wildfires) was not a major factor in the decline of caribou in the early 1900's in Newfoundland and Alaska (Skoog 1968, Bergerud 1971a, 1971b, 1972, and 1974).

Miller (1976, 1980) conducted the most recent intensive investigation of the effect of fire on caribou and taiga winter ranges and concluded: "In particular forest fires are beneficial in that they increase the heterogeneity of the plant cover and favor the growth of some lichens which occur in early successional stages. There is a plentiful supply of forage in the area despite caribou use and fires. Snow cover rather than scarcity of forage limits the capacity of the taiga to support caribou."

Table 10. Fire history for the Western Arctic Herd's range, 1957-1981, from BLM Fire Reports.

Year	No. of fires > 1,000 acres	Total acreage burned
1957	10	1,631,480
1958	1	1,500
1959	21	205,370
1960	1	37,800
1961	0	0
1962	3	7,860
1963	1	5,100
1964	0	0
1965	0	0
1966	3	89,150
1967	0	0
1968	19	287,690
1969	21	1,837,283
1970	12	99,690
1971	24	392,680
1972	35	670,490
1973	1	18,500
1974	8	547,200
1975	0	0
1976	1	2,000
1977	28	1,280,740
1978	4	10,260
1979	2	3,100
1980	0	0
1981	4	68,200
Total	199	7,196,093

Davis et al. (1978) and Davis and Franzmann (1979) evaluated the role of wildfires in declines of Alaska's caribou in the early 1900's and the 1970's. Their conclusions paralleled Skoog's, Bergerud's, and Miller's.

More recently, and specifically in reference to the recent decline and subsequent growth of the WAH, Davis et al. (1980) discussed the role of possible forage deficiencies which could result from wildfires:

> In 1975, when a dramatic decline of the WAH was first documented, we hypothesized that human exploitation and predation were greatly exceeding recruitment to the herd. Opposing views were that: 1) no decline had occurred; 2) the decline was attributable to emigration, primarily to the Porcupine Herd; 3) the herd was experiencing a "normal" cyclic decline (or some other occult phenomenon), and further that predation and subsistence hunters had no, or only beneficial, effects; and 4) any decline was due to forage deficiencies, and that, if anything, more hunting and predation were necessary to facilitate range recovery.
>
> For those who believe in a cause-and-effect world, the logical prediction to follow our original hypothesis was that the herd would increase if human harvest and predation were eliminated or adequately reduced. An opposing occultist prediction was that the population trend would continue in a given direction regardless of extrinsic changes. Available data strongly suggest that the herd has increased coincident to reduced mortality due to humans and wolves. Obviously some minimum level of yearling recruitment is essential for herd growth even under conditions of no exploitation by humans or predators. If, however, increased yearling recruitment occurs simultaneously to reduced exploitation, and herd growth (r) becomes positive, it is a coincidence difficult to explain using any of the alternative arguments. Further, it seems improbable that forage conditions could deteriorate and recover rapidly enough to account for the drastic short-term decline and subsequent recovery, particularly if herd growth is sustained for several years. We acknowledge that extrinsic factors such as weather must be considered, but the fall and rise of this herd correlates so closely to the level of exploitation that logic argues that exploitation must be the causative force in this situation.

Since the above was written, the herd has continued to increase to 160,000-170,000 caribou in 1981, and calf production and survival have remained very high. This is further evidence that forage was not the/a limiting factor during the decline.

Although qualitative observations of caribou/fire relationships are of limited value in improving our understanding of this complex subject, it may be instructive to contrast our observations with observations made by others for different herds. In Canada, Banfield (1954) and Kelsall (1968) reported that caribou movements were deflected by large, recent burns; in contrast, Miller (1980) observed caribou moving through such areas. We have also observed caribou utilizing large, recent burns to

feed and rest both during daily wanderings and seasonal migrations. West of Ambler and north of the Kobuk River, we have observed caribou traversing a burned area annually since 1976. The burn occurred in the early 1970's and contains much standing and down fire-killed timber. We have observed the same pattern in other areas. During April 1977 in the upper Kobuk River drainage, we observed numerous groups of caribou that were bedded or moving through areas burned the preceding summer. Many of these caribou had charcoal discoloring on their rumps. During fall 1977, caribou were aggregated and feeding in the same burned areas, presumably selecting the robust green Carex and Eriophorum growth. Similarly, in the range of the Delta Herd southeast of Fairbanks we observed radio-collared caribou feeding and, in several instances, calving in tussock areas burned 1 or 2 years previously.

CONCLUSIONS

1. The only predictable movement of individual WAH caribou has been the return of cows each May to the traditional North Slope calving ground. Fidelity to particular wintering range by individuals was not predictable and usually changed annually. In addition, the number of caribou using a particular wintering range varied greatly between years. However, during this study the most heavily used wintering areas were the Selawik and Buckland River drainages, the arctic coastal plain north of 70°N latitude, and the central Brooks Range.

2. Discrete caribou herds including the Central Arctic Herd, the Ray Mountains Herd, and the Teshekpuk Herd (and perhaps a Price River/Omalik River Herd) exist within the greater range of the WAH. However, no discrete herd or portion of the WAH inhabits NPS lands year-round. This implies that maintenance of caribou seasonally present on NPS lands in northwestern Alaska can only be accomplished through multi-agency and multi-landowner cooperation and understanding of requirements for maintaining the region's caribou.

3. Our present data support the hypothesis that the basic units of caribou social structure are "temporary, tenuous associations of individuals" or "open, social units." An opposing hypothesis is that the basic caribou social unit is the winter band. These groups, usually less than 10 animals, are characterized by persistent, nonrandom associations between adult animals resulting from social attachment. We found no evidence for existence of such winter bands in the WAH.

4. Existing caribou management programs which have considered all caribou in a herd as being equally susceptible to hunting by assigning only 1 season and bag limit throughout the range of the herd, even though hunting is localized, is consistent with biological realities (albeit social and political realities may at times contraindicate such a regulatory scheme).

5. In recent years the WAH's most heavily used wintering areas have included the Selawik and Buckland River drainages, the arctic coastal plain north of 70°N latitude, and the central Brooks Range. Calving has continued on the traditional North Slope calving area.

6. Caribou winter food habits on the arctic coastal plain differed substantially from those in the Selawik Hills and south of the Brooks Range. For instance, feces collected on the arctic coastal plain in late winter contained 40-50 percent less lichen fragments and 4 times more shrub fragments (primarily Vaccinium) than similar samples collected south of the Brooks Range.

7. The WAH, unlike barren-ground caribou in Canada, rarely utilized taiga-dominated habitat even in winter. Instead, open tundra plateaus, tussock communities, and windblown ridgetops above treeline were favored.

8. Research on the effects of wildfires on the ecology of the WAH should focus on impacts of fires on tundra and not taiga vegetation.

9. At least in recent years, the impact of fires on the availability of winter range has not played a significant role in WAH population dynamics. Only 0.28 percent of the WAH's potential winter range has burned annually in the past 25 years with little effect on availability of winter forage. Similarly, recent computer simulation modeling in Canada (Bunnell et al. 1975) predicted that an annual burning rate of 5 percent (almost 18 times greater than calculated for the WAH) of the winter range would have little impact on barren-ground caribou populations. It is improbable that forage conditions could deteriorate and recover rapidly enough to account for the drastic short-term decline and subsequent recovery of the WAH, particularly when it increased 120 percent from 1976 to 1981 and productivity and survival have remained extremely high.

10. Because no discrete caribou herd inhabits NPS lands year-round in northwestern Alaska, the caribou which seasonally use NPS lands can be maintained only through cooperation between private landowners, the State of Alaska, and various Federal agencies. NPS regulations that provide habitat protection for some areas of important seasonal use by the WAH cannot, alone, ensure that the WAH is maintained in a healthy or natural condition. On the other hand, NPS regulations which affect subsistence hunting, sport hunting, and predator populations may play an important role in regulating WAH numbers throughout the range of the herd.

RECOMMENDATIONS

1. Despite the much improved understanding of the WAH's biology since 1975, much controversy and need for study continues. NPS should initiate or support ecological research of the WAH and its habitat to the fullest extent possible.

2. NPS should consider the conclusions of this report in formulating policies and programs that involve caribou and caribou habitat on NPS lands in northwestern Alaska.

3. In formulating policies or priorities specifically regarding wildfires, the recommendations in Viereck and Schandelmeier (1980) should be considered. In addition, we emphasize that tundra fire ecology is probably more relevant to the WAH than taiga fire ecology.

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LITERATURE CITED

Banfield, A. W. F. 1954. Preliminary investigation of the barren-ground caribou. Part I. Former and present distribution, migration, and status. Part II. Life history, ecology and utilization. Can. Wildl. Serv., Wildl. Manage. Bull. Ser. 1, No. 10A and B. 79pp. and 112pp.

Bergerud, A. T. 1971a. Abundance of forage on the winter range of Newfoundland caribou. Can. Field-Nat. 85:39-52.

_____. 1971b. The population dynamics of Newfoundland caribou. Wildl. Monogr. 25. 55pp.

_____. 1972. Food habits of Newfoundland caribou. J. Wildl. Manage. 36(3):913-923.

_____. 1974a. The role of the environment in the aggregation, movement, and disturbance behavior of caribou. Pages 552-584 in V. Geist and F. Walther, eds. The behaviuor of ungulates and its relation to management. Int. Union Conserv. Nat. Publ. New Ser. No. 24. Morges, Switzerland.

_____. 1974b. Decline of caribou in North America following settlement. J. Wildl. Manage. 38(4):757-770.

Bunnell, F., D. C. Dauphine, R. Hilborn, D. R. Miller, F. L. Miller, E. H. McEwan, G. R. Parker, R. Peterman, G. W. Scotter, and C. J. Walters. 1975. Preliminary report on computer simulation of barren-ground caribou management. Pages 189-193 in J. R. Luick, P. C. Lent, D. R. Klein, and R. G. White, eds. Proc. First Int. Reindeer and Caribou Symp., Univ. Alaska, Fairbanks.

Cameron, R. D., and K. R. Whitten. 1979. Seasonal movements and sexual segregation of caribou determined by aerial survey. J. Wildl. Manage. 43(3):626-633.

Davis, J. L. 1978. History and current status of Alaska caribou herds. Pages 1-8 in D. R. Klein and R. G. White, eds. Parameters of caribou populations in Alaska. Proc. Symp. and Workshop, Biol. Pap., Univ. Alaska, Fairbanks, Spec. Rep. No. 3.

_____. 1980. Status of Rangifer in the U.S.A. Pages 793-797 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

_____, and A. W. Franzmann. 1979. Fire-moose-caribou interrelationships: a review and assessment. Proc. North Am. Moose Conf. Workshop. 15:80-118. Lakehead Univ., Thunder Bay, Ontario, Canada.

_____, R. Shideler, and R. E. LeResche. 1978. Range reconnaissance--Fortymile Caribou Herd. Alaska Dept. Fish and Game, Juneau. Fed. Aid. in Wildl. Restoration, Proj. W-17-6, W-17-7, Job 3.16R. 43pp.

_____, and P. Valkenburg. 1978. Western Arctic caribou studies. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. W-17-8 and W-17-9. Juneau. 95pp.

_____, and _____. 1979a. Natural mortality of Western Arctic caribou. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. W-17-11. Juneau. 8pp.

_____, and _____. 1979b. Caribou distribution, population characteristics, mortality, and responses to disturbance in northwest Alaska. Pages 13-15 in U.S. Dept. Int. Natl. Petroleum Reserve in Alaska Field Study 3(105c). Anchorage.

_____, and _____. 1981. Natural mortality of Western Arctic caribou. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. Proj. W-17-11. Juneau. 19pp.

_____, _____, and S. J. Harbo, Jr. 1979. Refinement of the aerial photo-direct count-extrapolation caribou census technique. Alaska Dept. Fish and Game, Fed. Aid Wildl. Rest. W-17-11. Juneau. 23pp.

_____, _____, and H. V. Reynolds. 1980. Population dynamics of Alaska's Western Arctic Caribou Herd. Pages 595-604 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

Doerr, J. 1979. Population analysis and modeling of the Western Arctic Caribou Herd with comparisons to other Alaska Rangifer populations. M.S. Thesis, Univ. Alaska, Fairbanks. 341pp.

_____. 1980. Modeling the population decline of two Alaskan caribou herds. Pages 611-623 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

_____, and R. A. Dieterich. 1979. Mandibular lesions in the Western Arctic Caribou Herd of Alaska. J. Wildl. Dis. 15:309-318.

Hemming, J. E. 1971. The distribution and movement patterns of caribou in Alaska. Alaska Dept. Fish and Game Tech. Bull. No. 1. Juneau. 60pp.

Kelsall, J. P. 1968. The migratory barren-ground caribou of Canada. Can. Wildl. Serv. Monogr. 3. 340pp.

_____, E. S. Telfer, and T. D. Wright. 1977. The effects of fire on the ecology of the boreal forest, with particular reference to the Canadian north: a review and selected bibliography. Can. Wildl. Serv. Occas. Pap. No. 32. 58pp.

Klein, D. R. 1979. Wildfire, lichens and caribou. (Abstract) in Klein, D. R. 1980. A study of the range interrelationships of the Western Arctic Caribou Herd--an abstract and synthesis of completion reports. Alaska Coop. Wildl. Res. Unit, Fairbanks. 32pp.

_____. 1980. A study of the range interrelationships of the Western Arctic Caribou Herd--an abstract and synthesis of completion reports. Alaska Coop. Wildl. Res. Unit, Fairbanks. 32pp.

_____, and R. G. White, eds. 1978. Parameters of caribou population ecology in Alaska. Proc. Symp. and Workshop, Biol. Pap., Univ. Alaska, Fairbanks, Spec. Rep. No. 3. 49pp.

Knight, R. K. 1970. The Sun River elk herd. Wildl. Monogr. 23. 66pp.

Kuropat, P., and J. P. Bryant. 1980. Foraging behavior of cow caribou on the Utukok calving grounds in northwestern Alaska. Pages 64-70 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

Lent, P. C. 1964. Calving and related social behavior in the barren-ground caribou. Univ. Alberta, Edmonton, Canada. Ph.D. Thesis. 220pp.

_____. 1965. Rutting behavior in a barren-ground caribou population. Anim. Behav. 13:259-264.

McBride, G. 1971. Theories of animal spacing: the role of flight, fight, and social distance. Pages 53-68 in A. Esser, ed. Behavior and environment: the use of space by animals and men. Plenum Press, New York.

Melchior, H., ed. 1976. Biological survey of the proposed Kobuk Valley National Monument. Alaska Coop. Park Studies Unit, Biol. and Resour. Manage. Prog. Univ. Alaska, Fairbanks. 215pp.

Miller, D. R. 1976. Wildfire and caribou on the taiga ecosystem of northcentral Canada. Ph.D. Thesis. Univ. Idaho, Moscow. 131pp.

_____. 1980. Wildfire effects on barren-ground caribou wintering on the taiga of northcentral Canada: A reassessment. Pages 84-98 in E. Reimers, E. Gaare and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norway, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim.

Miller, F.L. 1974. Biology of the Kaminuriak population of barren-ground caribou. Part 2: Dentition as an indicator of age and sex; composition and socialization of the population. Can. Wildl. Serv. Rep. Ser. No. 31. Queen's Printer, Ottawa. 88pp.

_____, D. F. Behrend, and G. D. Tessier. 1971. Live capture of barren-ground caribou and tangle nets. Trans. Northeast Sect. Wildl. Soc. 28:83-90.

_____, A. C. Vithayasai, and R. McClure. 1975. Distribution, movements, and socialization of barren-ground caribou radio-tracked on their calving and post-calving areas. Pages 423-435 in J. R. Luick, P. C. Lent, D. R. Klein, and R. G. White, eds. First Int. Reindeer/Caribou Symp., Univ. Alaska, Fairbanks.

Moser, T. J., T. H. Nash, III and J. W. Thomson. 1979. Lichens of Anaktuvuk Pass, Alaska with emphasis on the impact of caribou grazing. Bryologist 82(3):393-408.

Scotter, G. W. 1964. Effects of forest fires on the winter range of barren-ground caribou in northern Saskatchewan. Can. Wildl. Serv. Wildl. Manage. Bull., Series 1(18):1-111.

Skoog, R. O. 1968. Ecology of the caribou in Alaska. Ph.D. Thesis. Univ. Calif., Berkeley. 720pp.

Viereck, L. A., and L. A. Schandelmeier. 1980. Effects of fire in Alaska and adjacent Canada--a literature review. USDI. BLM-Alaska Tech. Rep. 6, Anchorage. 124pp.

Wright, J. M. 1980. Spring and summer vegetation preferences of semi-domestic reindeer on the northwest Seward Peninsula. Pages 167-173 in E. Reimers, E. Gaare, and S. Skjenneberg, eds. Proc. 2nd Int. Reindeer/Caribou Symp., Røros, Norwary, 1979. Direktoratet for vilt og ferskvannsfisk, Trondheim. 799pp.

APPENDIX A

Locations of radio-collared Western Arctic Herd caribou located 3 or more times, April 1979-December 1981 (ordered by collar number).

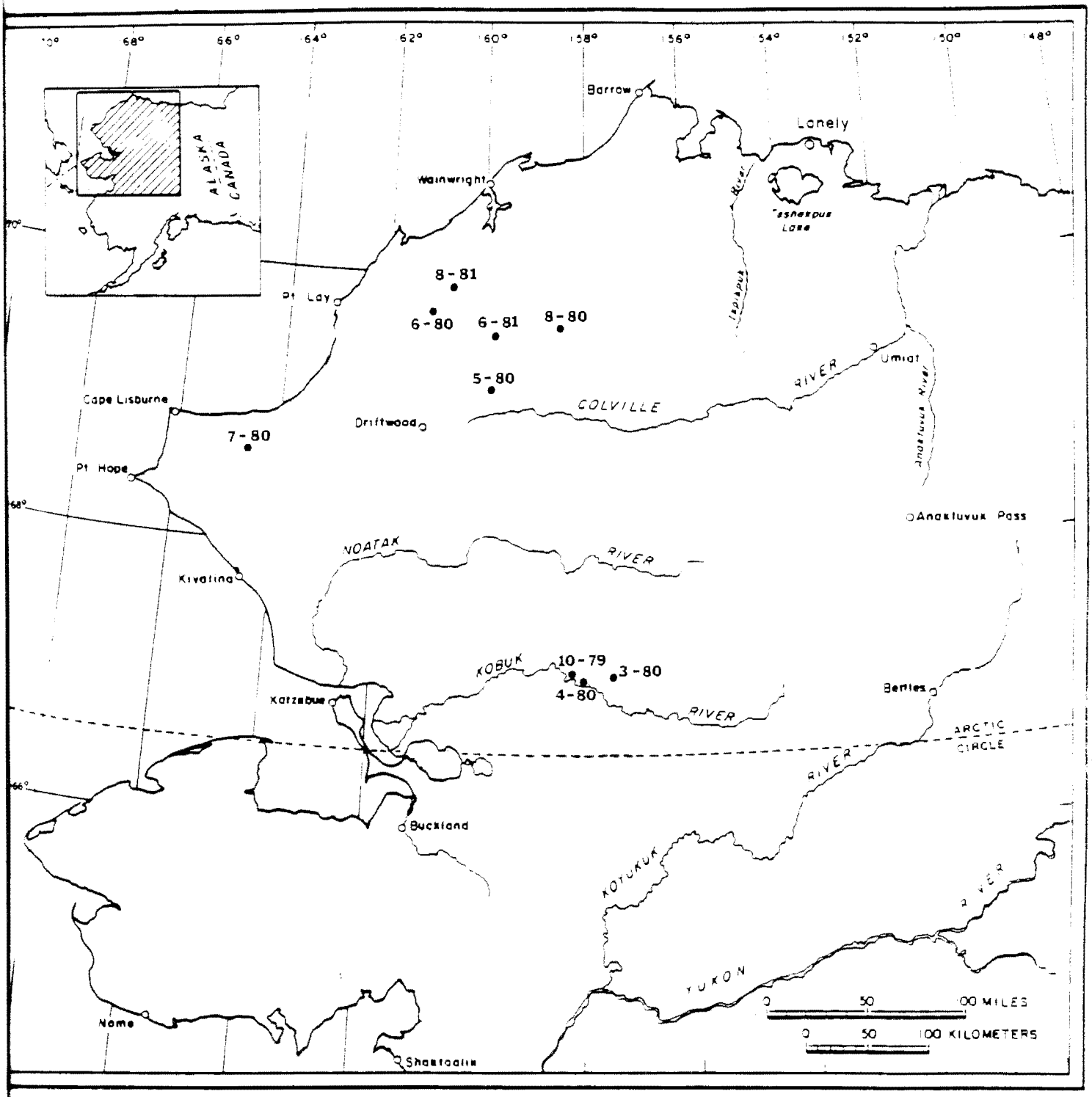


Fig. A-1. Relocations (month-year) of adult female caribou #0, radio-collared near Ambler, 1 October 1979.

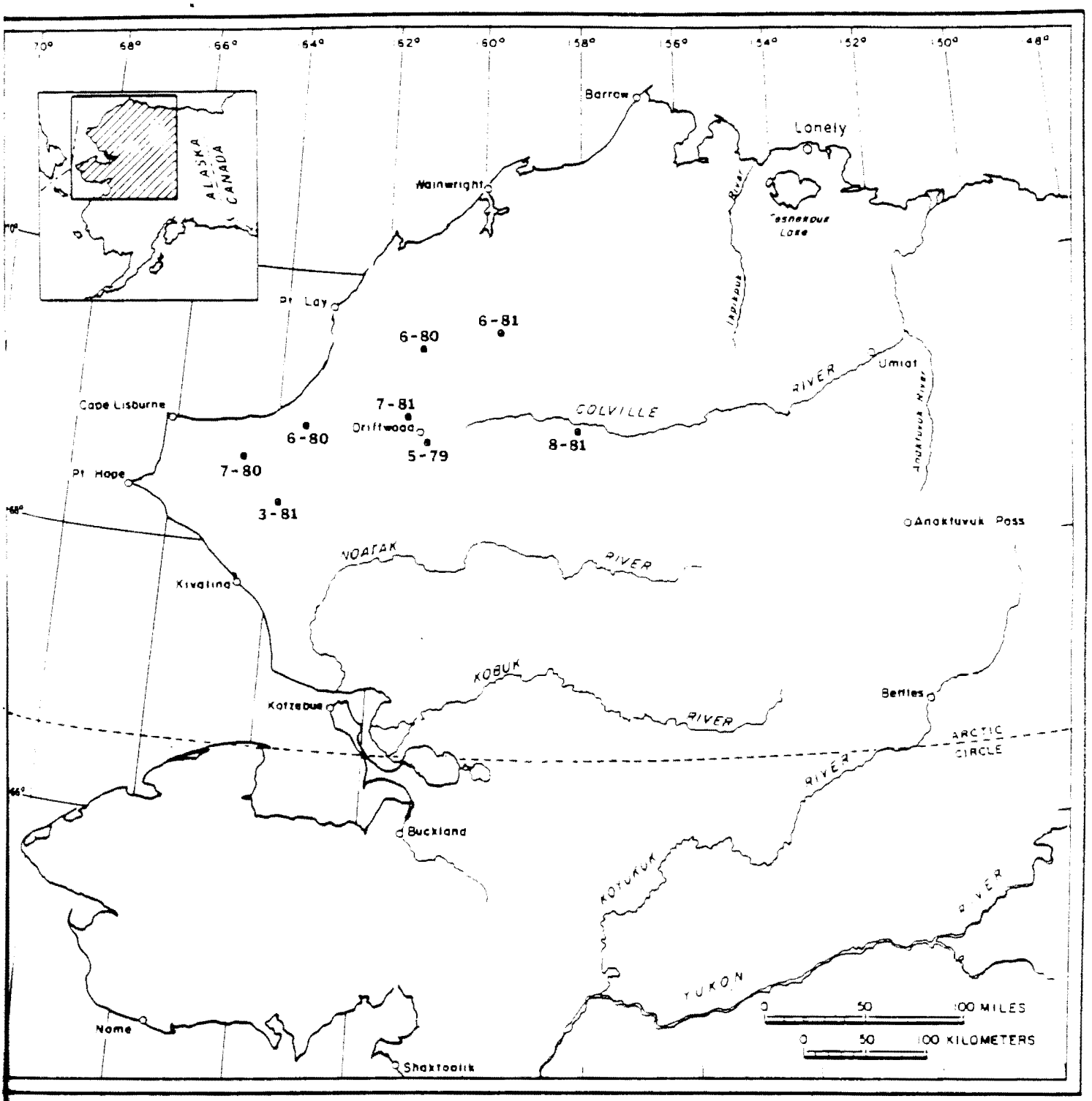


Fig. A-2. Relocations (month-year) of adult female caribou #1, radio-collared near Driftwood, 9 May 1979.

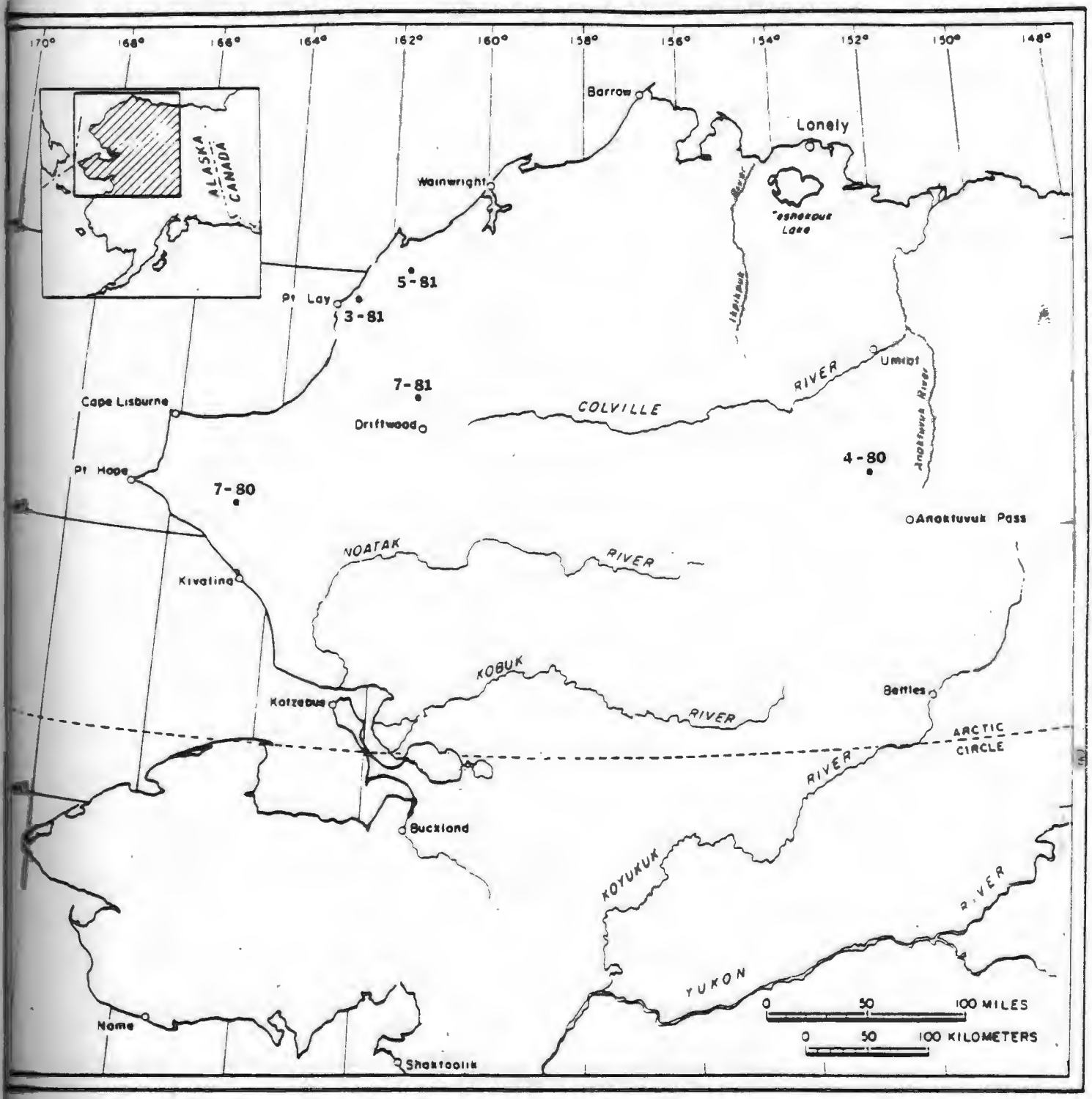


Fig. A-3. Relocations (month-year) of female caribou #2, radio-collared as a 2- or 3-year-old near the Chandler River, 23 April 1980.

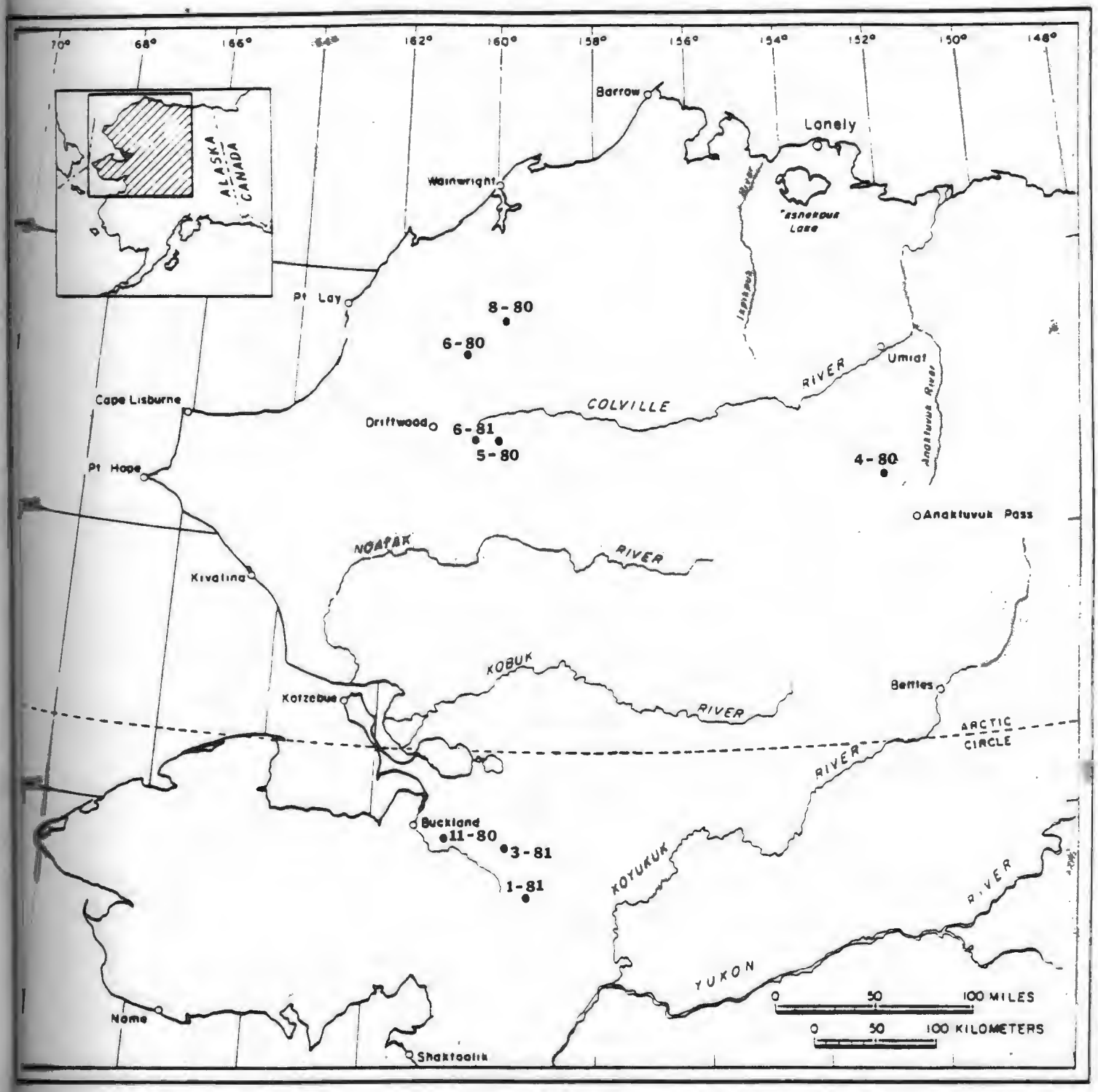


Fig. A-4. Relocations (month-year) of adult female caribou #3, radio-collared near the Chandler River, 23 April 1980.

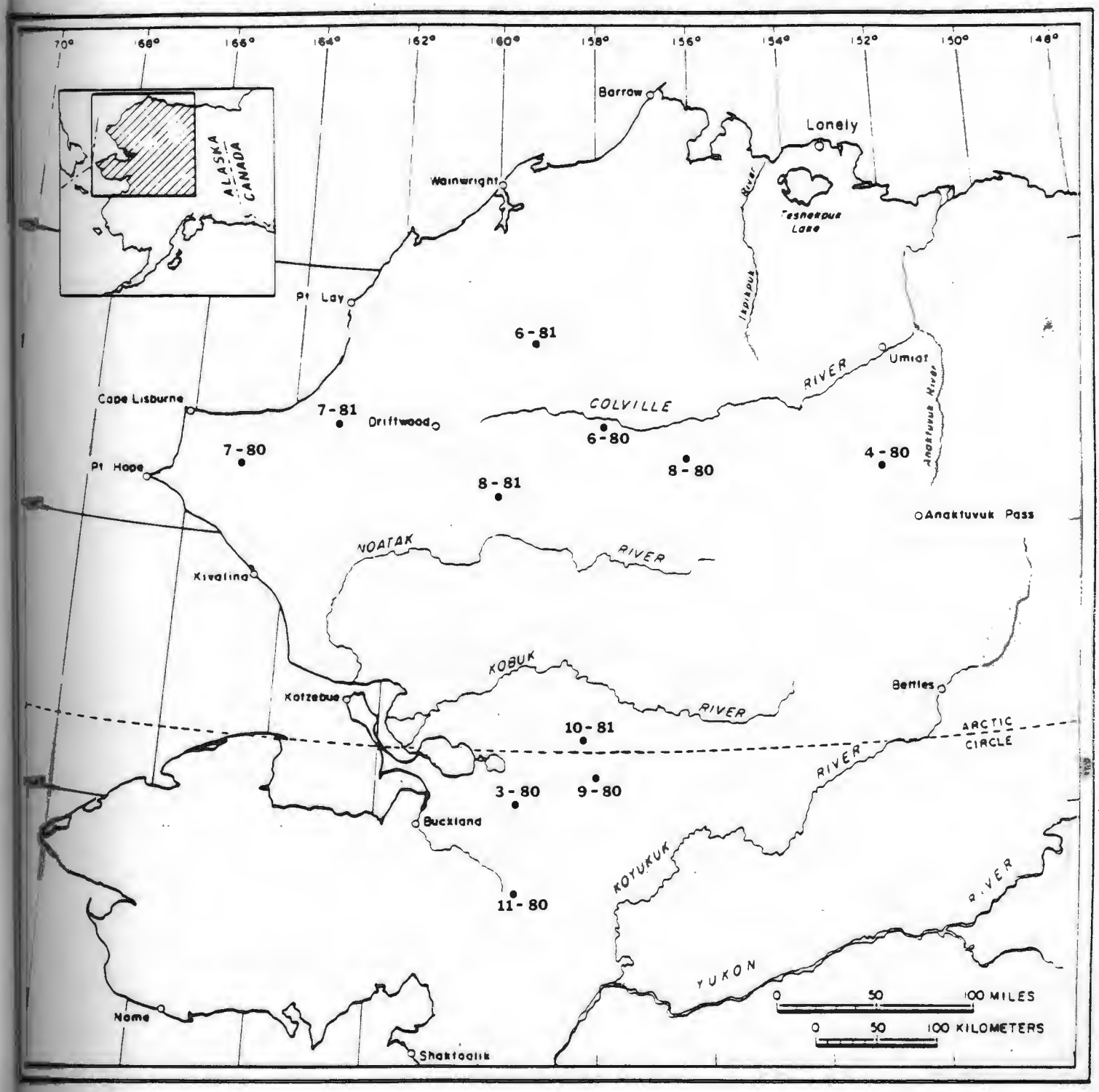


Fig. A-5. Relocations (month-year) of adult female caribou #5, radio-collared near the Chandler River, 23 April 1980.

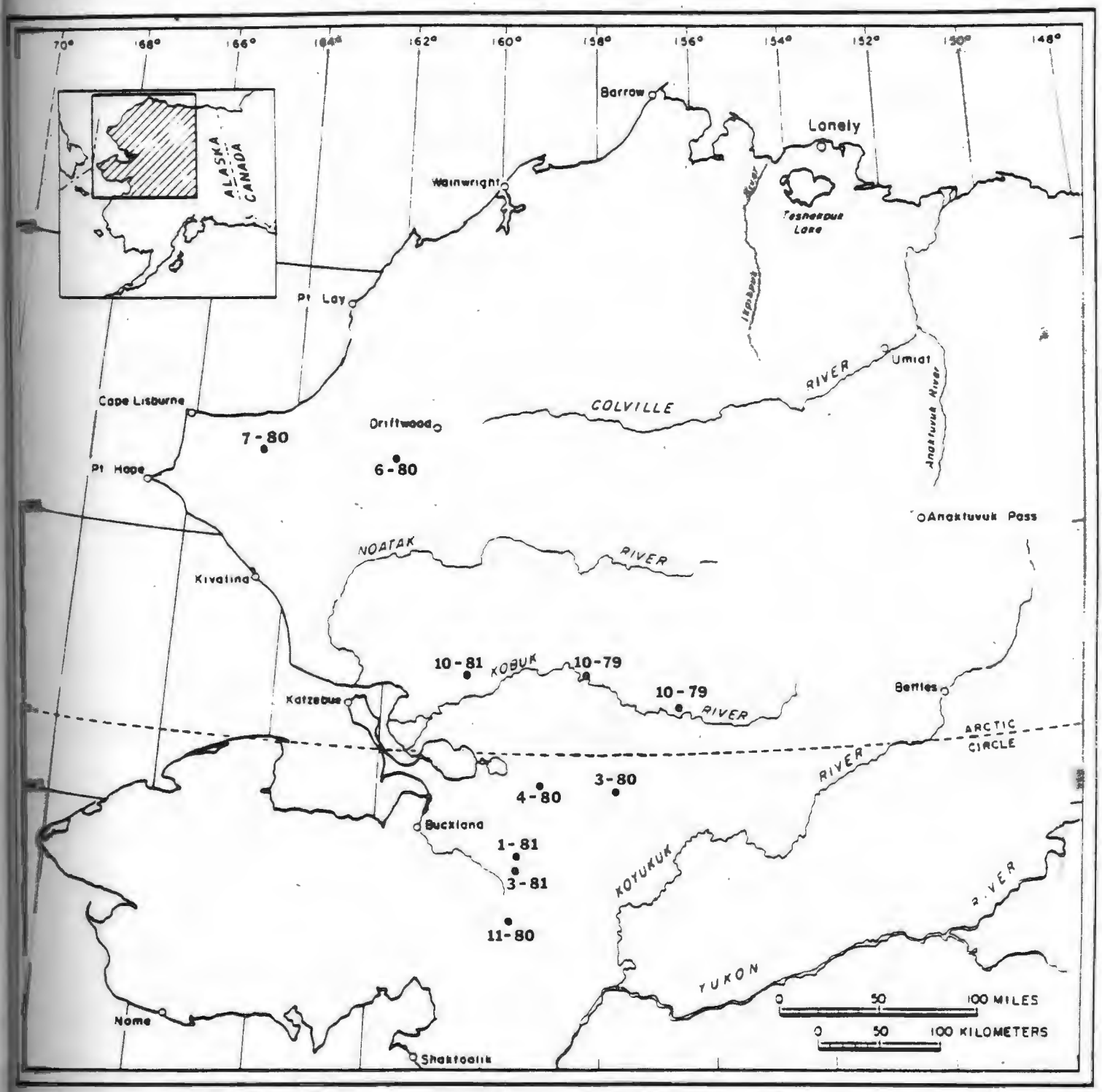


Fig. A-6. Relocations (month-year) of male caribou #6, radio-collared as a 2- or 3-year-old near Ambler, 1 October 1979.

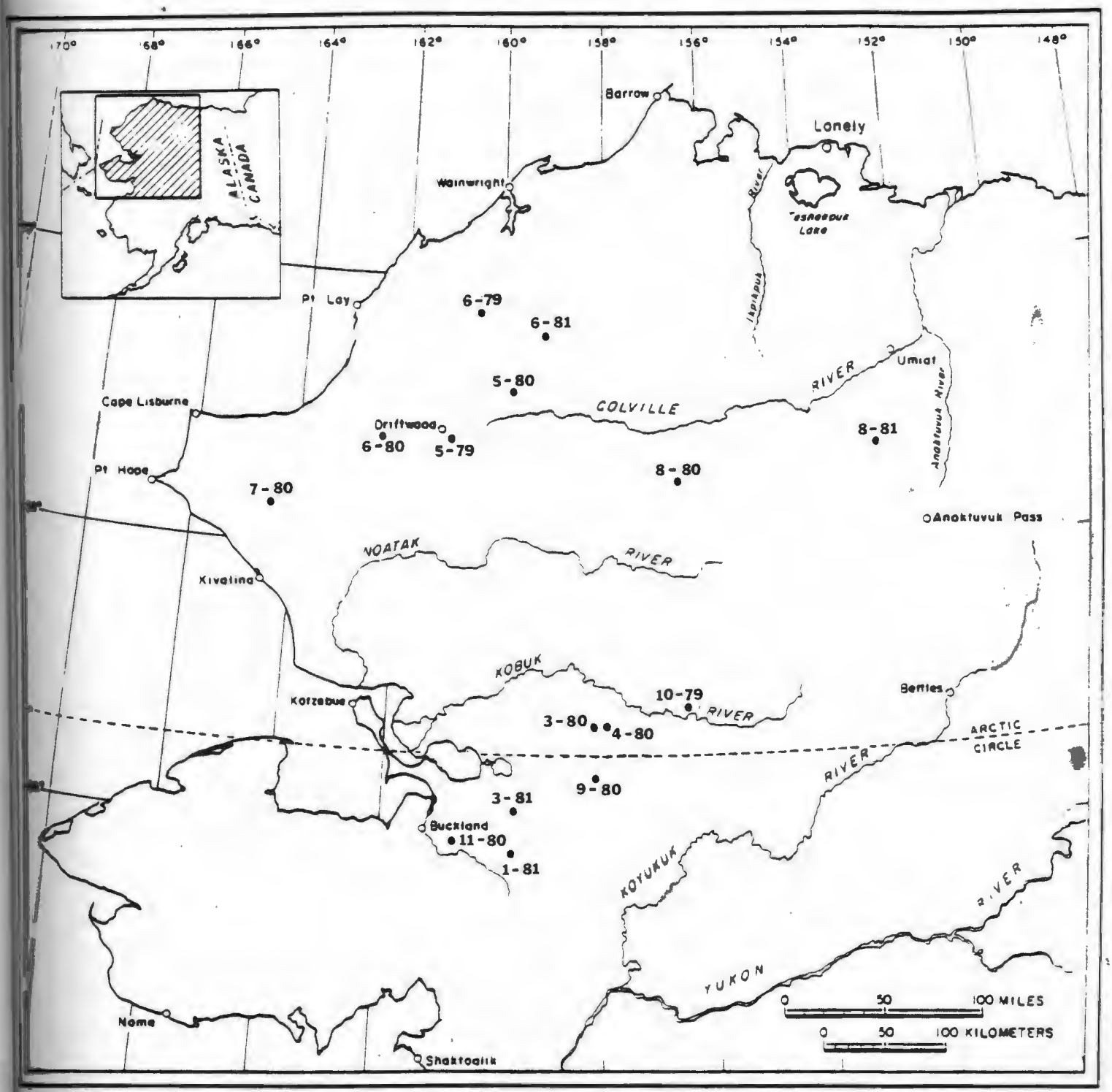


Fig. A-7. Relocations (month-year) of adult female caribou #9, radio-collared near Driftwood, 9 May 1979.

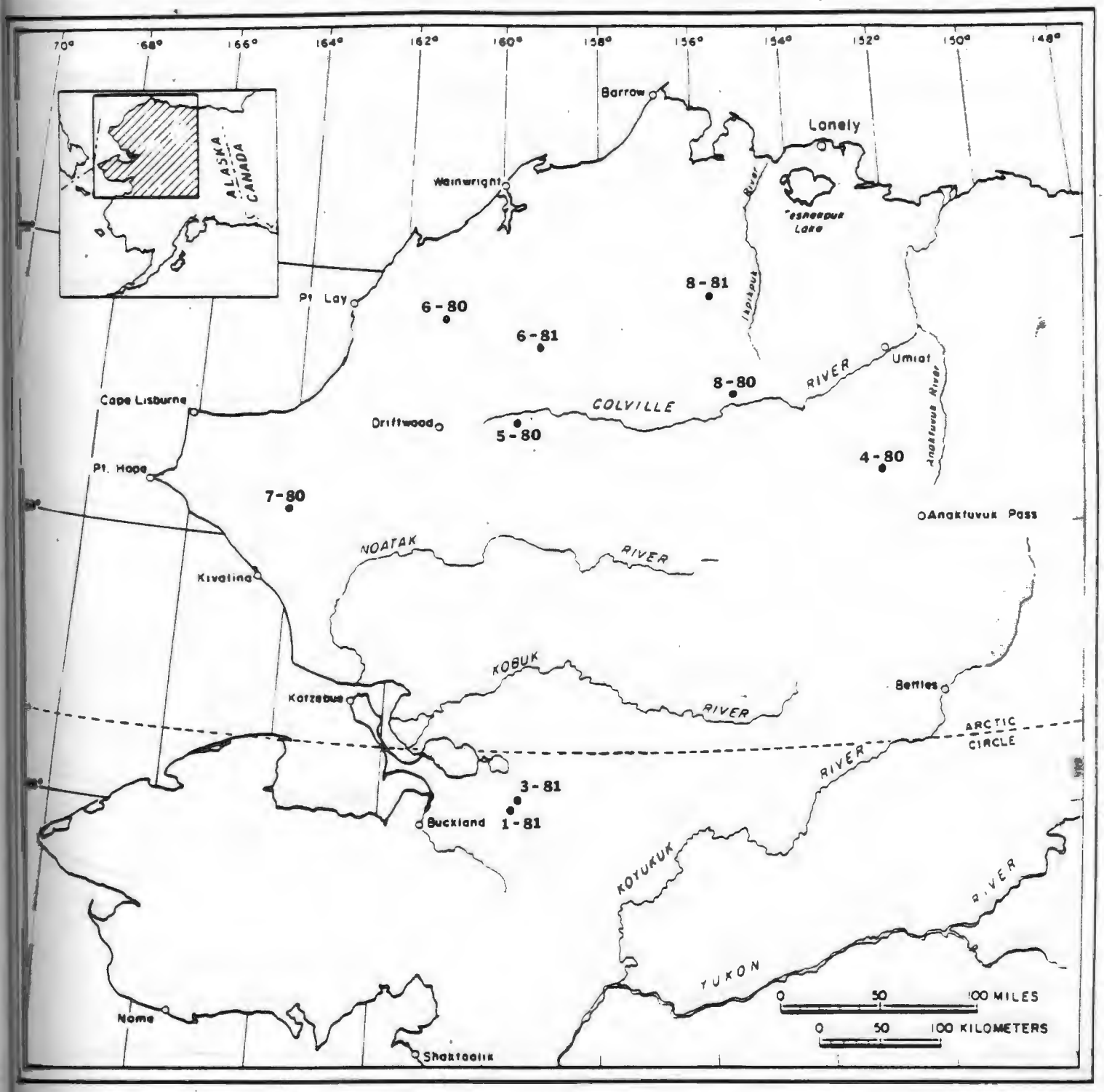


Fig. A-8. Relocations (month-year) of adult female caribou #10, radio-collared near the Chandler River, 23 April 1980.

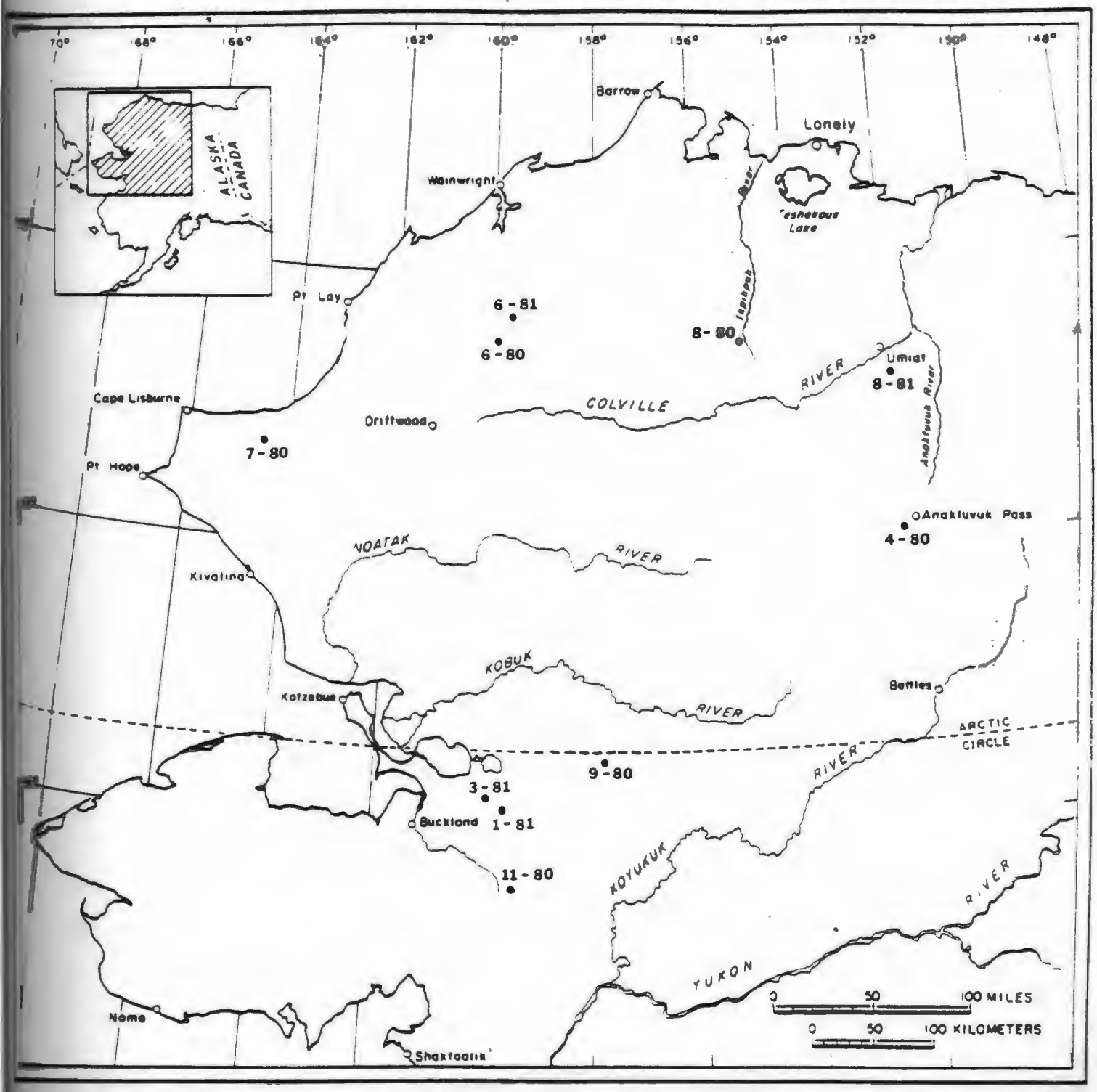


Fig. A-9. Relocations (month-year) of adult female caribou #11, radio-collared near Anaktuvuk Pass, 18 April 1980.

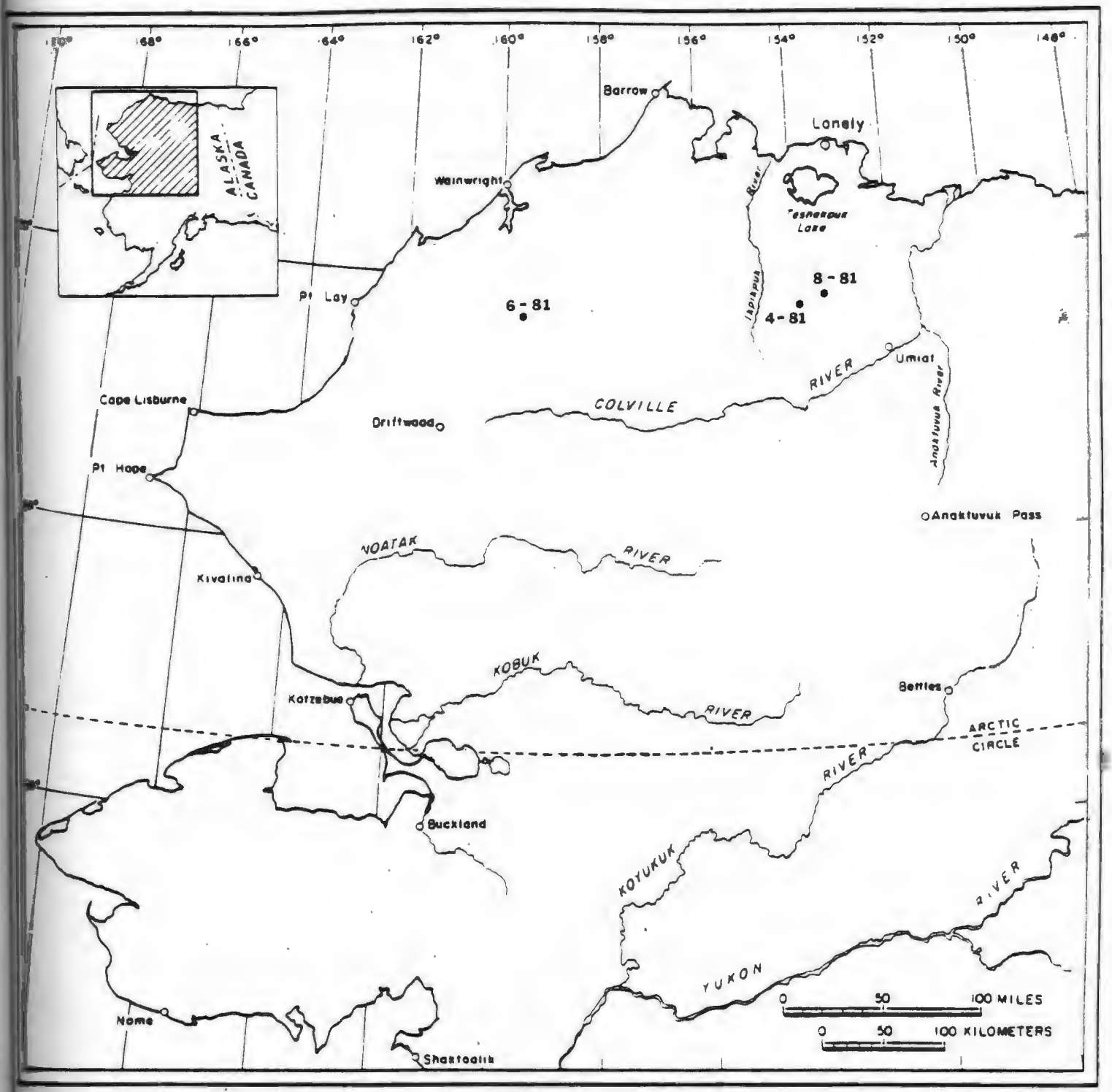


Fig. A-10. Relocations (month-year) of adult female caribou #12, radio-collared near the Price River, 25 April 1981.

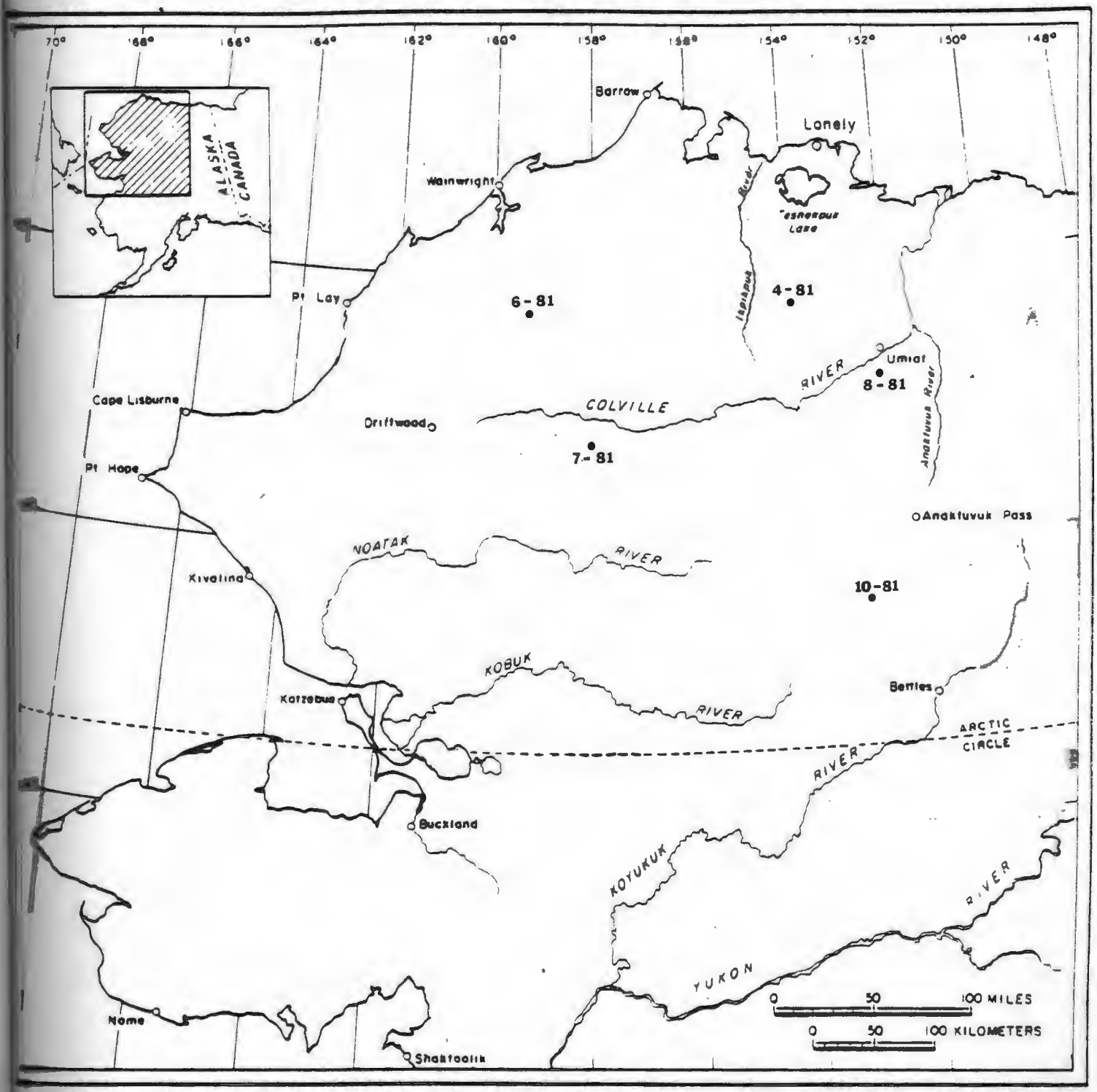


Fig. A-11. Relocations (month-year) of adult female caribou #14, radio-collared near the Price River, 25 April 1981.

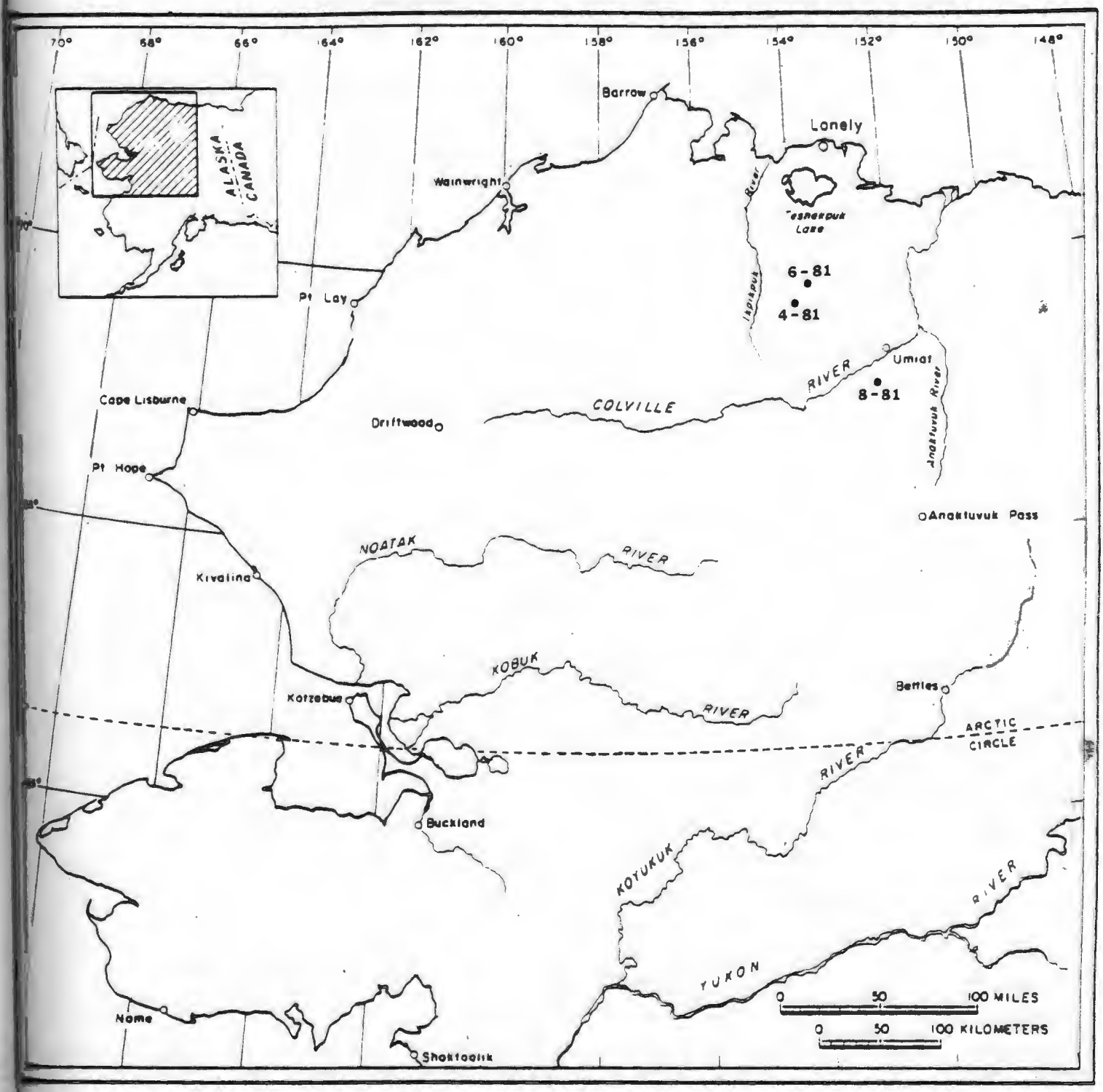
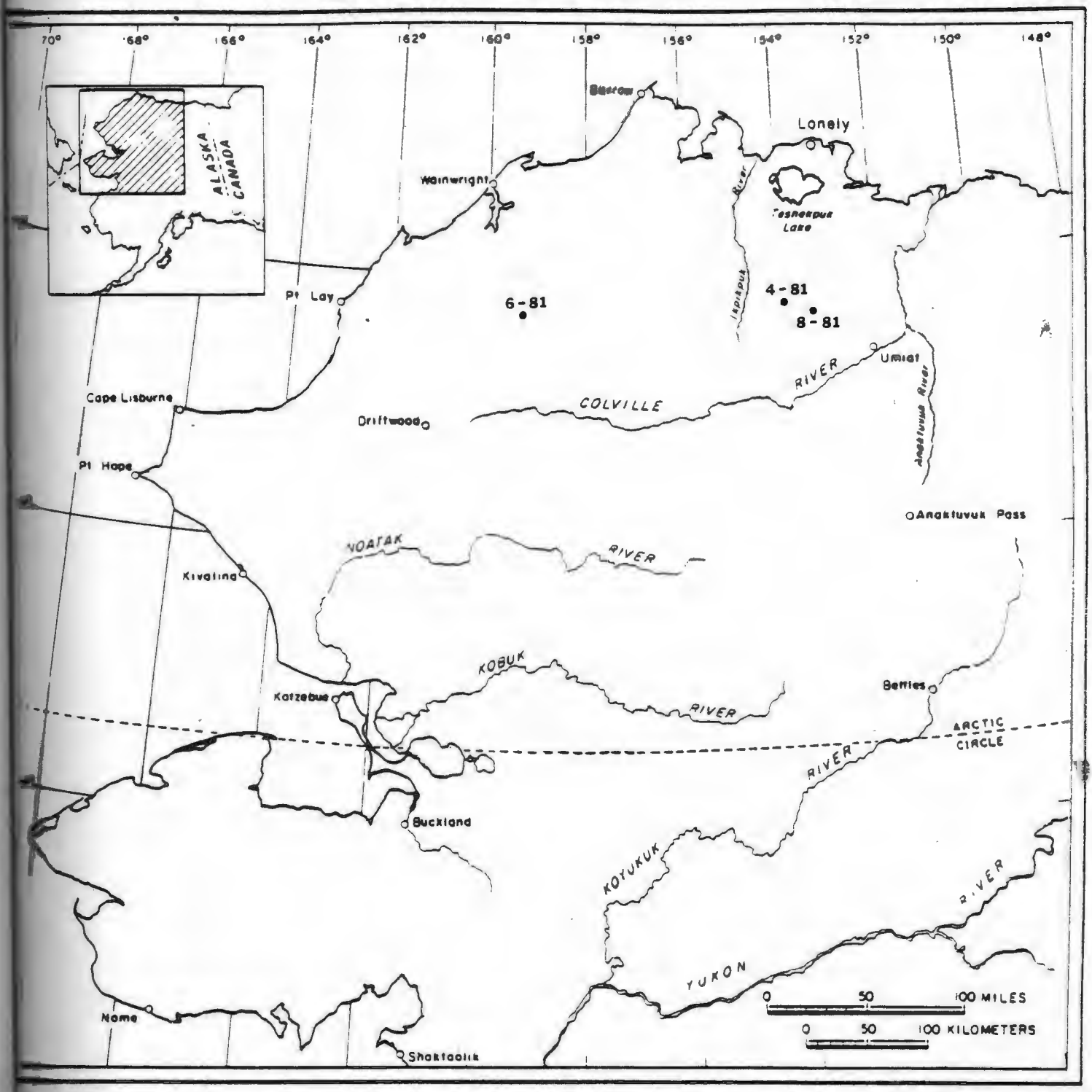
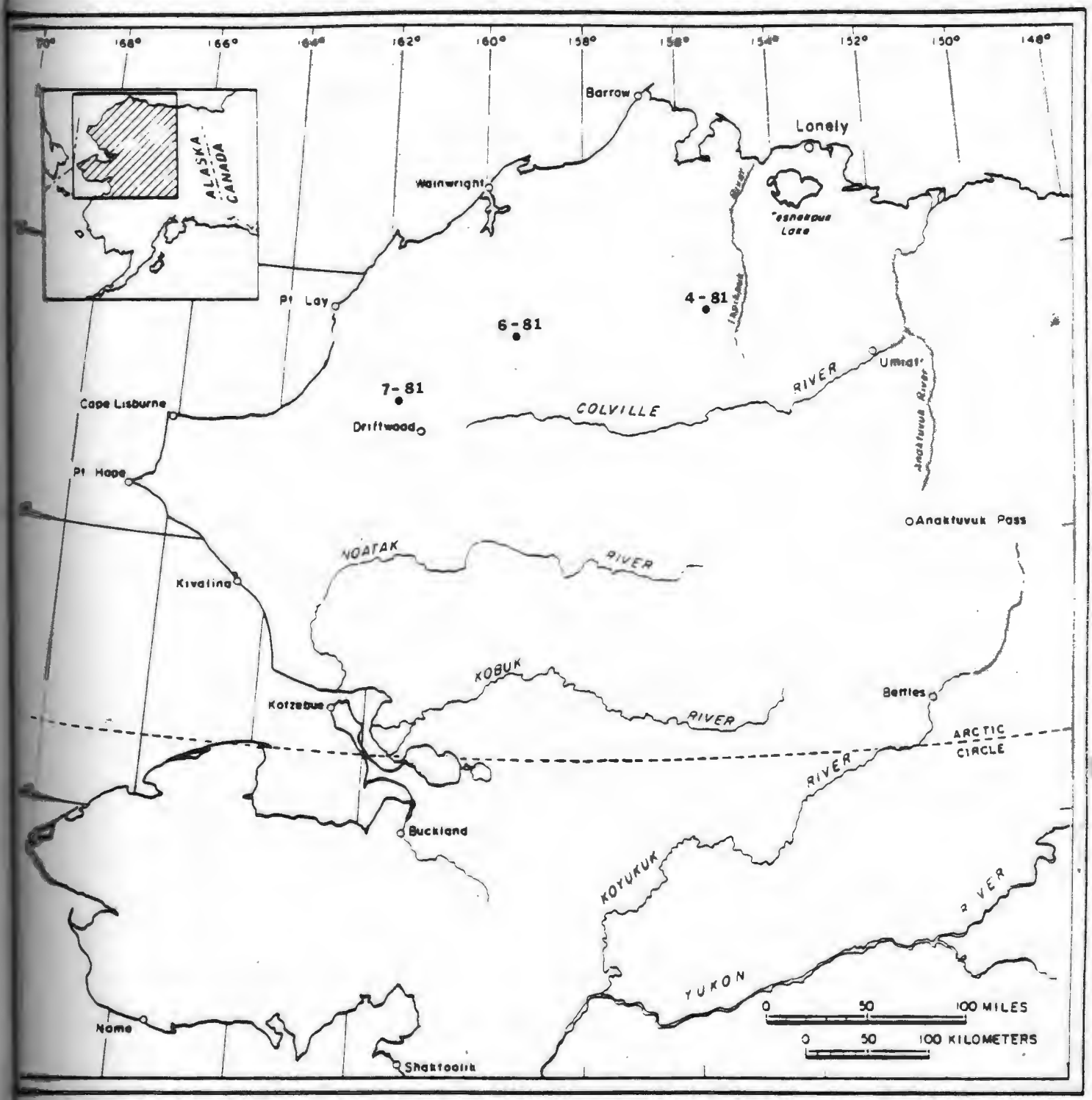


Fig. A-12. Relocations (month-year) of adult female caribou #15, radio-collared near the Price River, 25 April 1981.

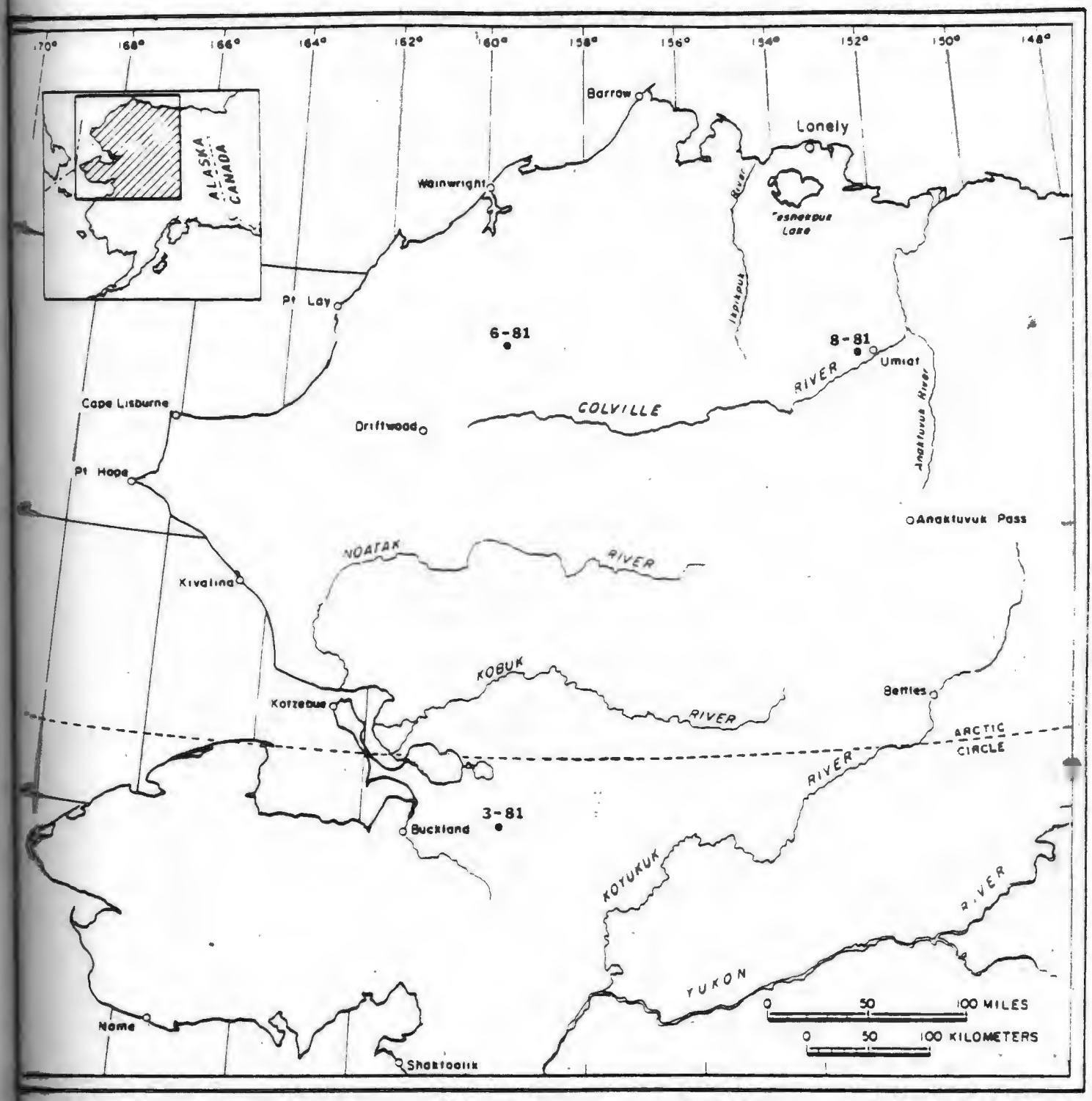


. A-13. Relocations (month-year) of adult female caribou #16, radio-collared near the Price River, 25 April 1981.

Fig. A-14. Relocations (month-year) of male caribou #17, radio-collared as a 2- or 3-year-old near the Price River, 25 April 1981.



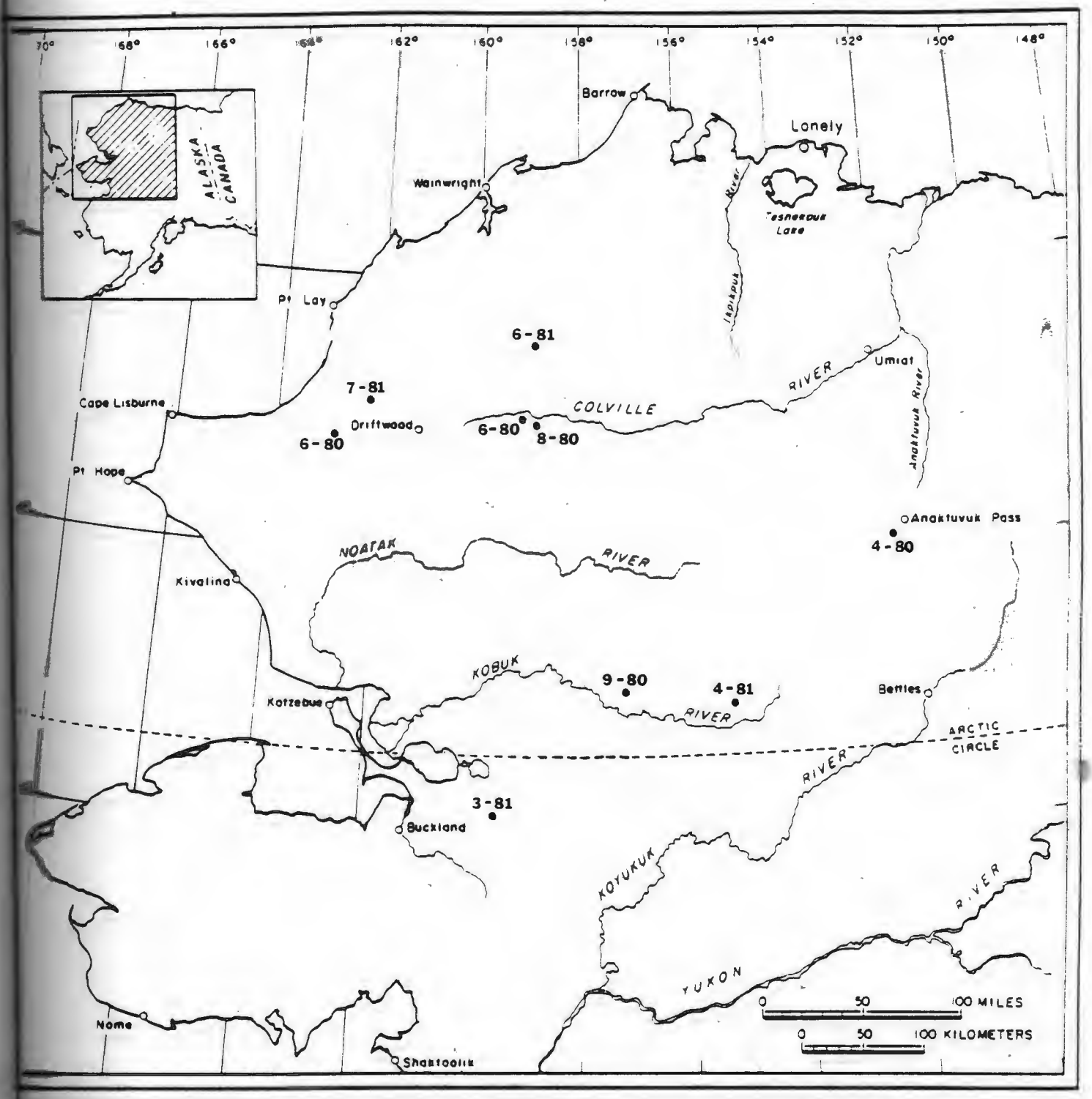
A-15. Relocations (month-year) of adult female caribou #18, radio-collared near the Oumalik River, 26 April 1981.



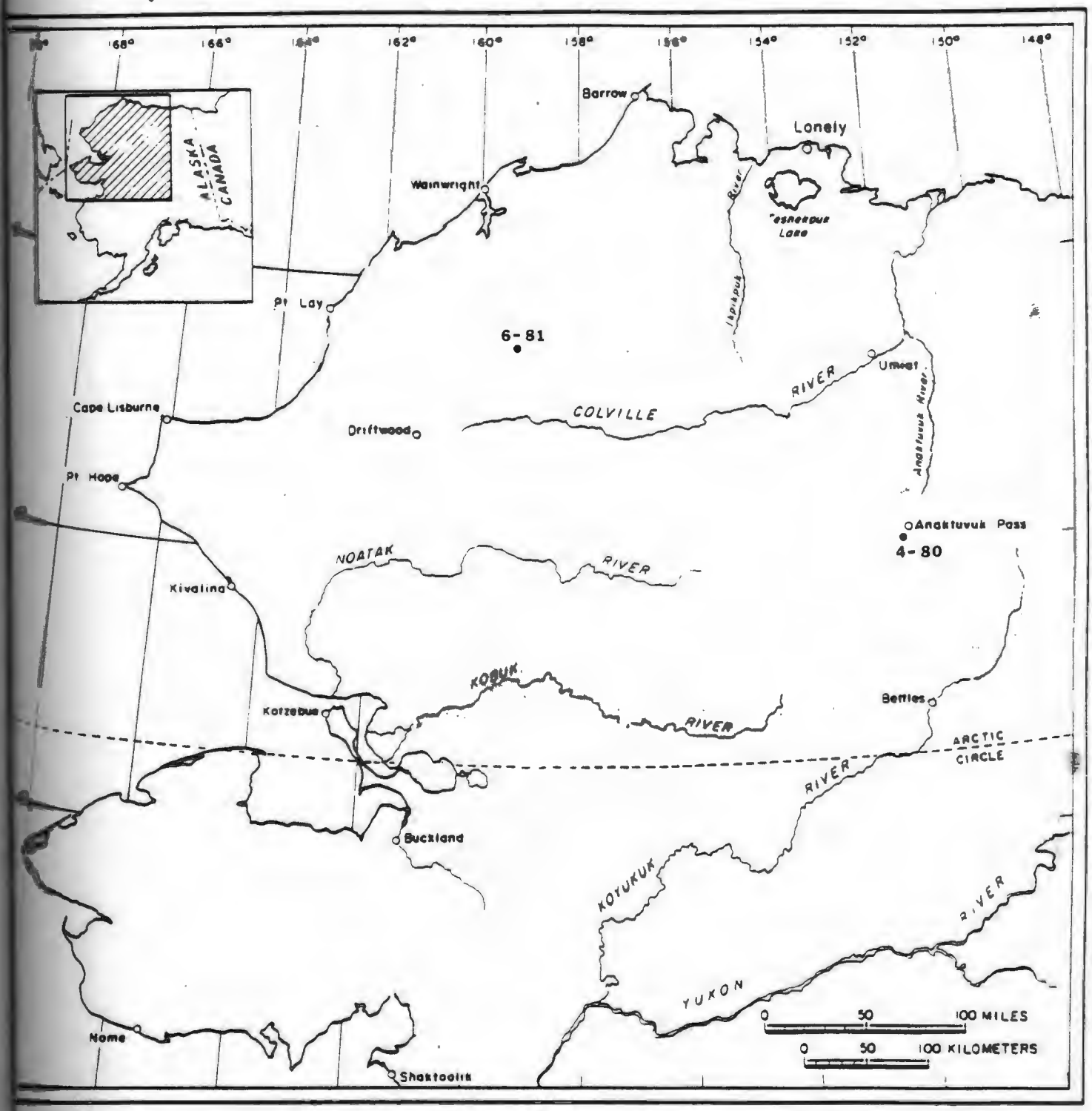
A-16. Relocations (month-year) of adult female caribou #24, radio-collared in the Selawik Hills, 27 March 1981.

A-17. Relocations (month-year) of adult female caribou #25, radio-collared near the Price River, 25 April 1981.

Fig. A-18. Relocations (month-year) of adult female caribou #27, radio-collared in the Selawik Hills, 27 March 1981.

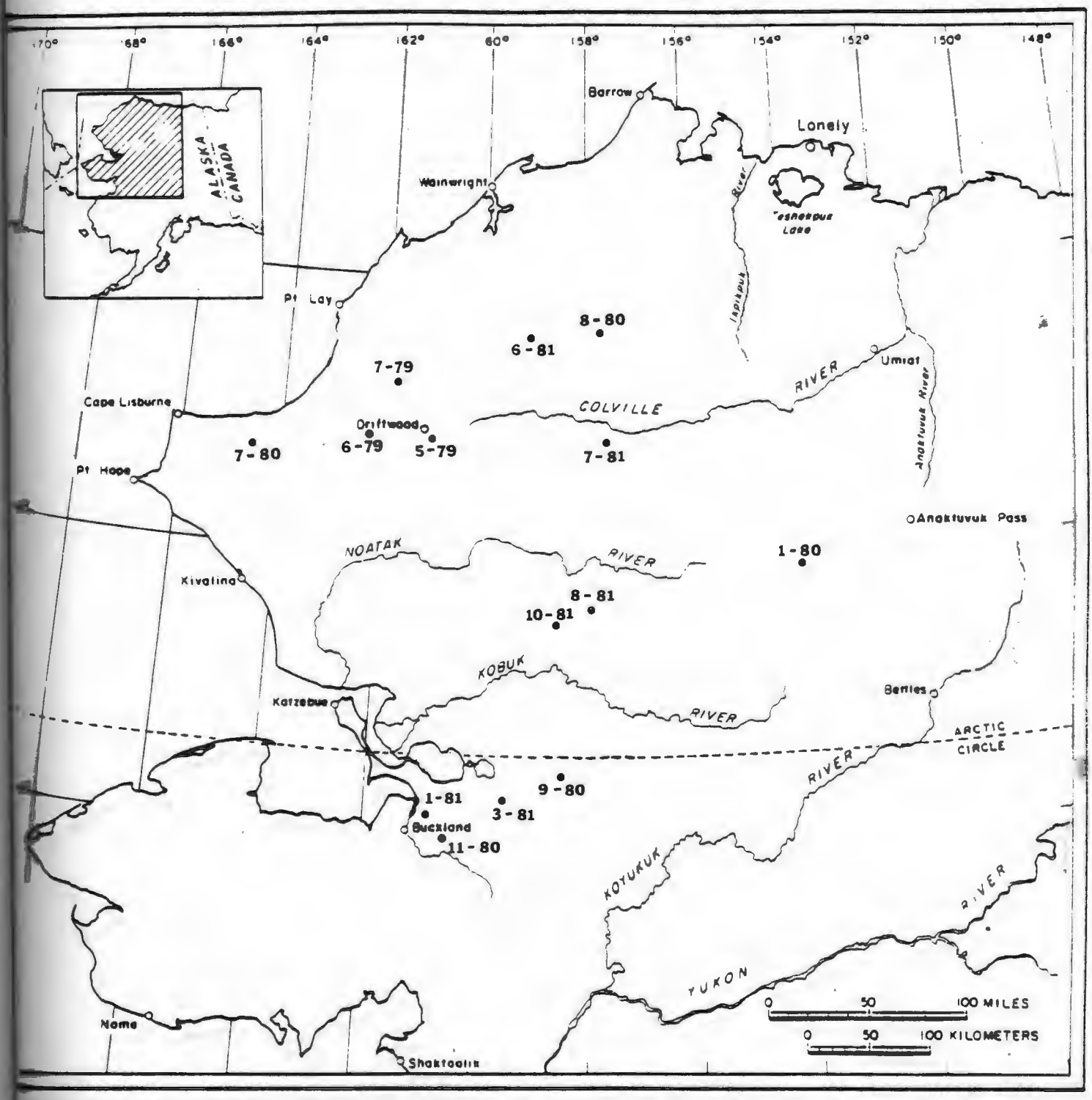


A-19. Relocations (month-year) of adult female caribou #30, radio-collared near Anaktuvuk Pass, 18 April 1980.



A-20. Relocations (month-year) of adult female caribou #31, radio-collared near Anaktuvuk Pass, 18 April 1980.

. A-21. Relocations (month-year) of male caribou #32, radio-collared as a 2- or 3-year-old near Ambler, 28 September 1978.



A-22. Relocations (month-year) of adult female caribou #33, radio-collared near Driftwood, 9 May 1979.

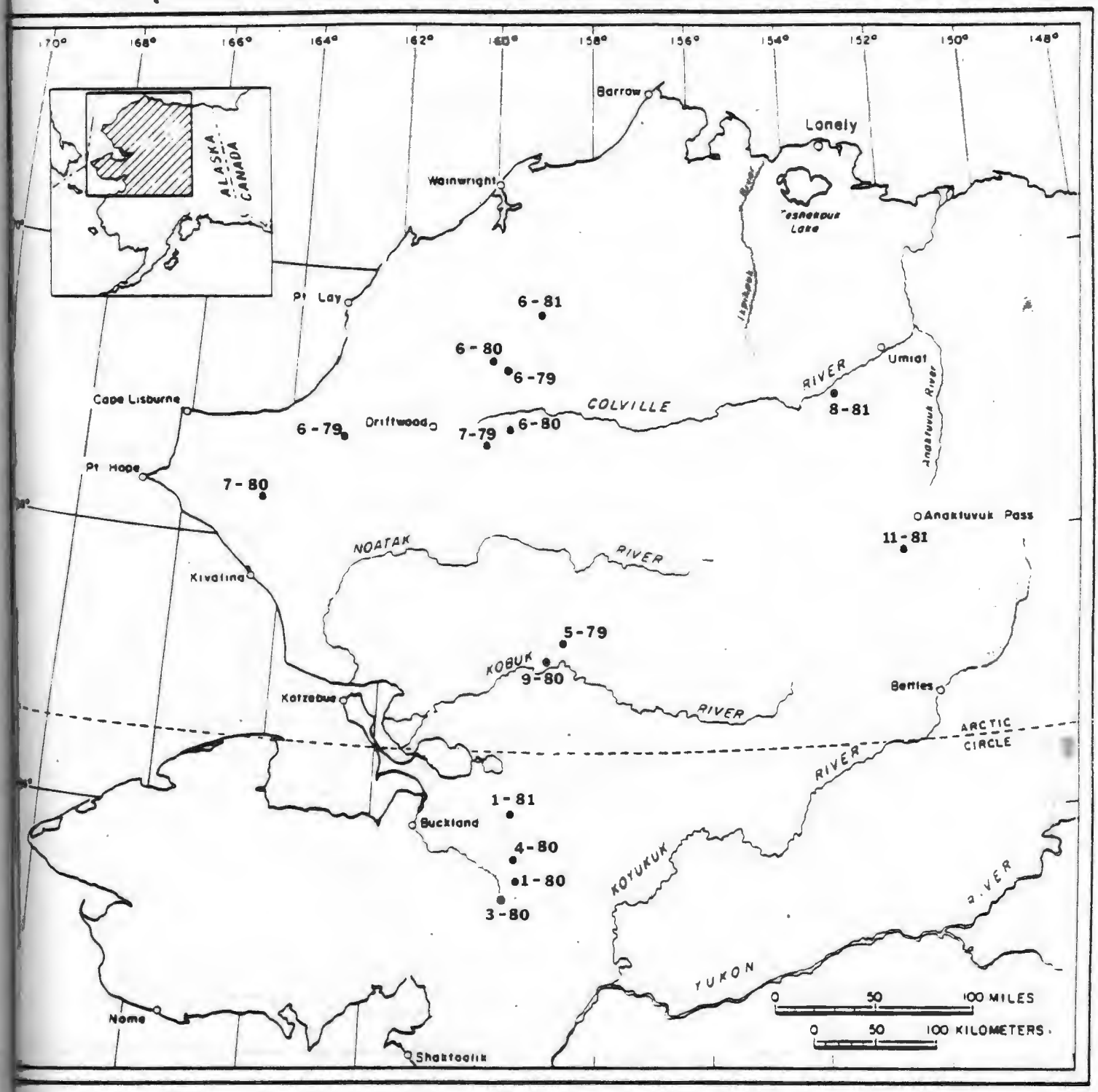


Fig. A-23. Relocations (month-year) of adult female caribou #34, radio-collared near the Hunt River, 2 May 1979.

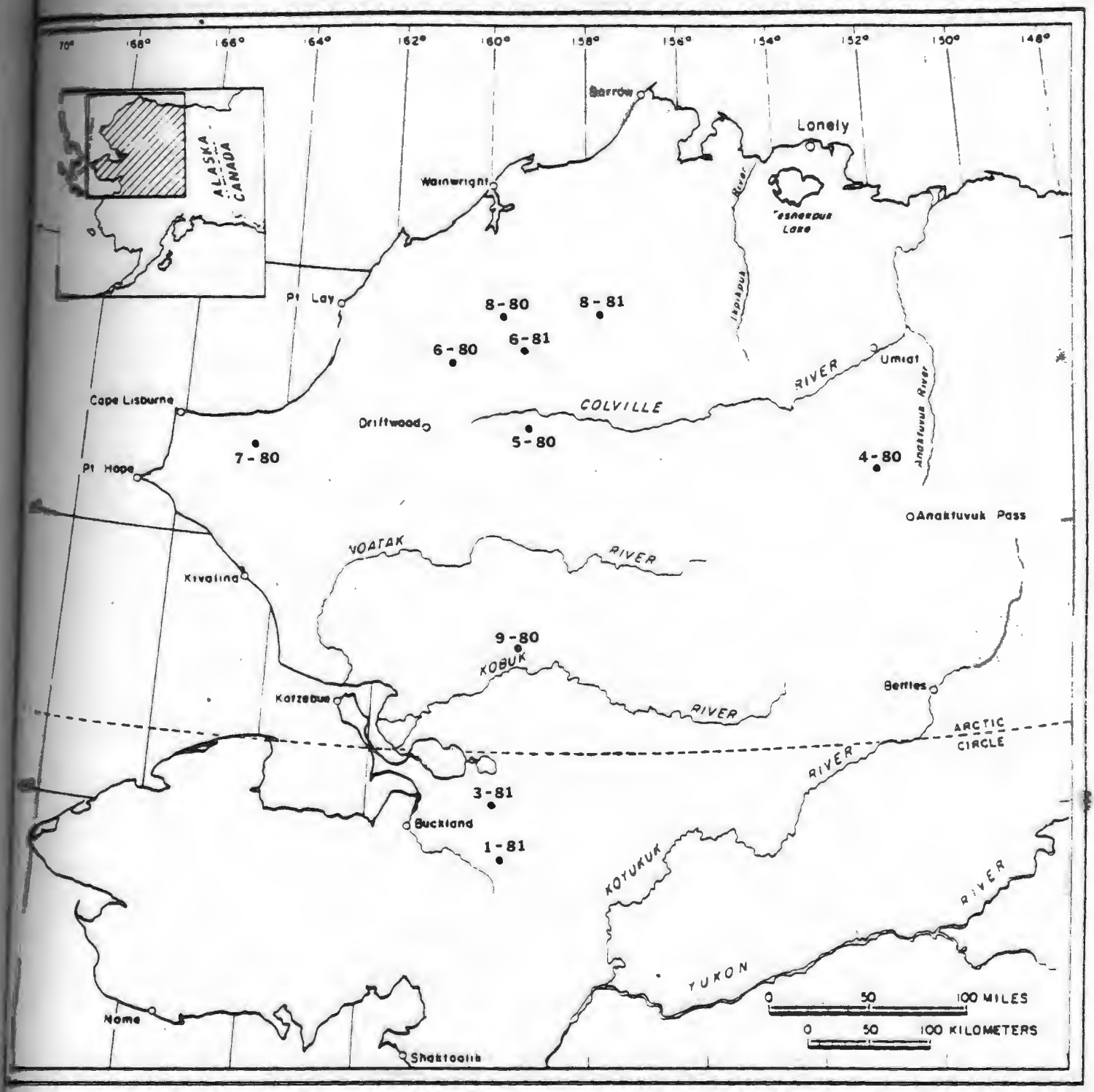
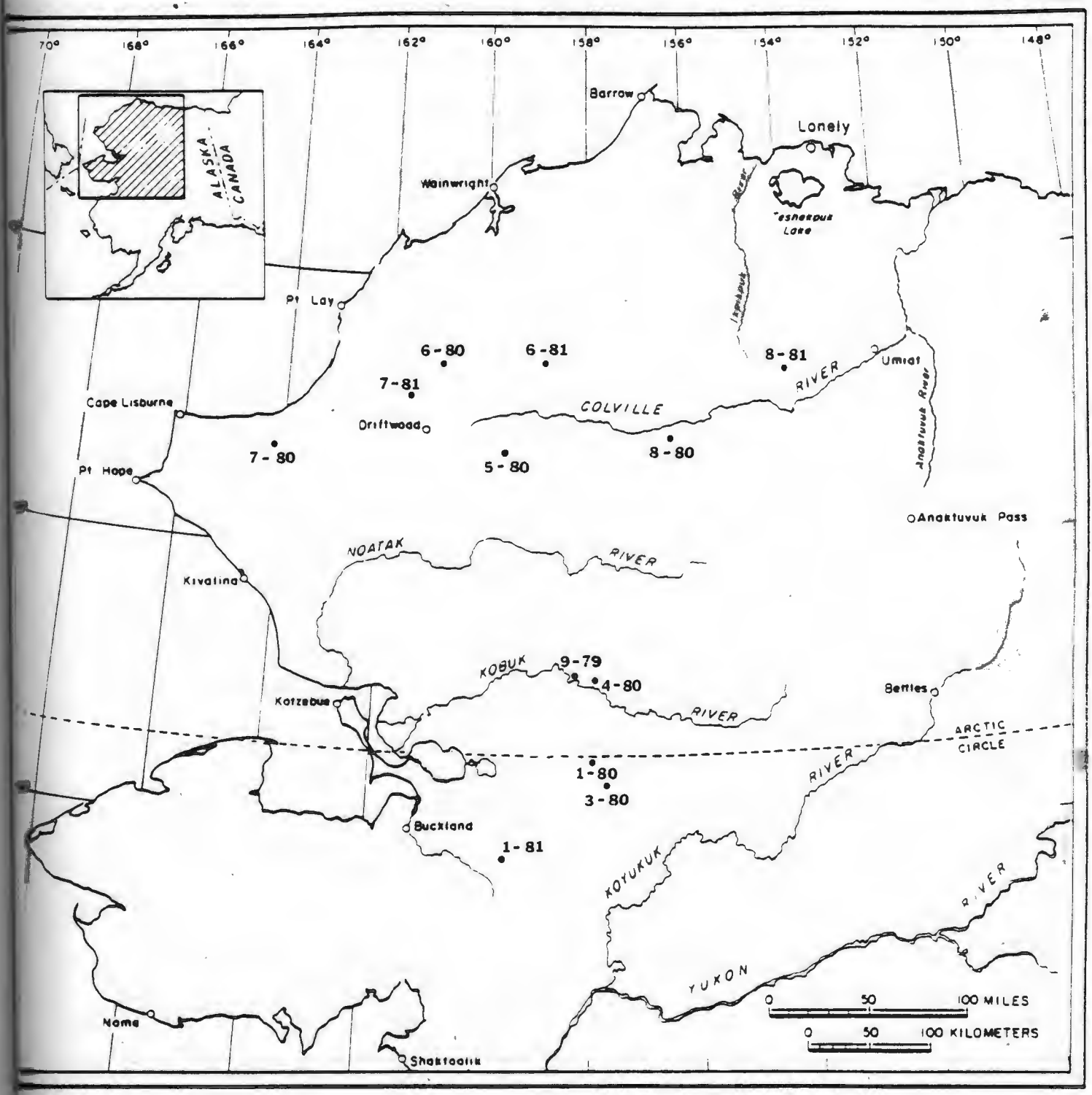
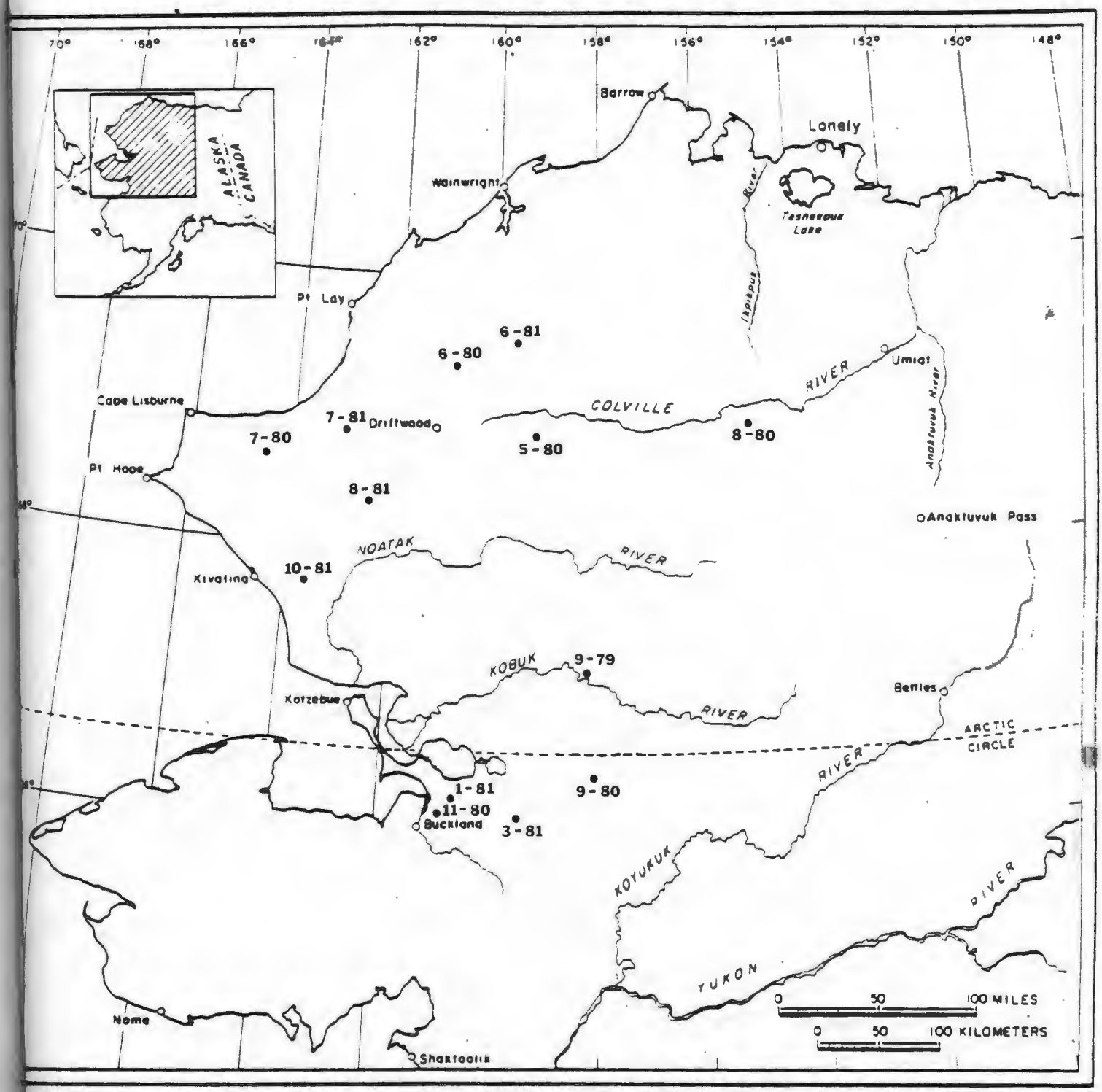


Fig. A-24. Relocations (month-year) of adult female caribou #35, radio-collared near the Chandler River, 23 April 1980.

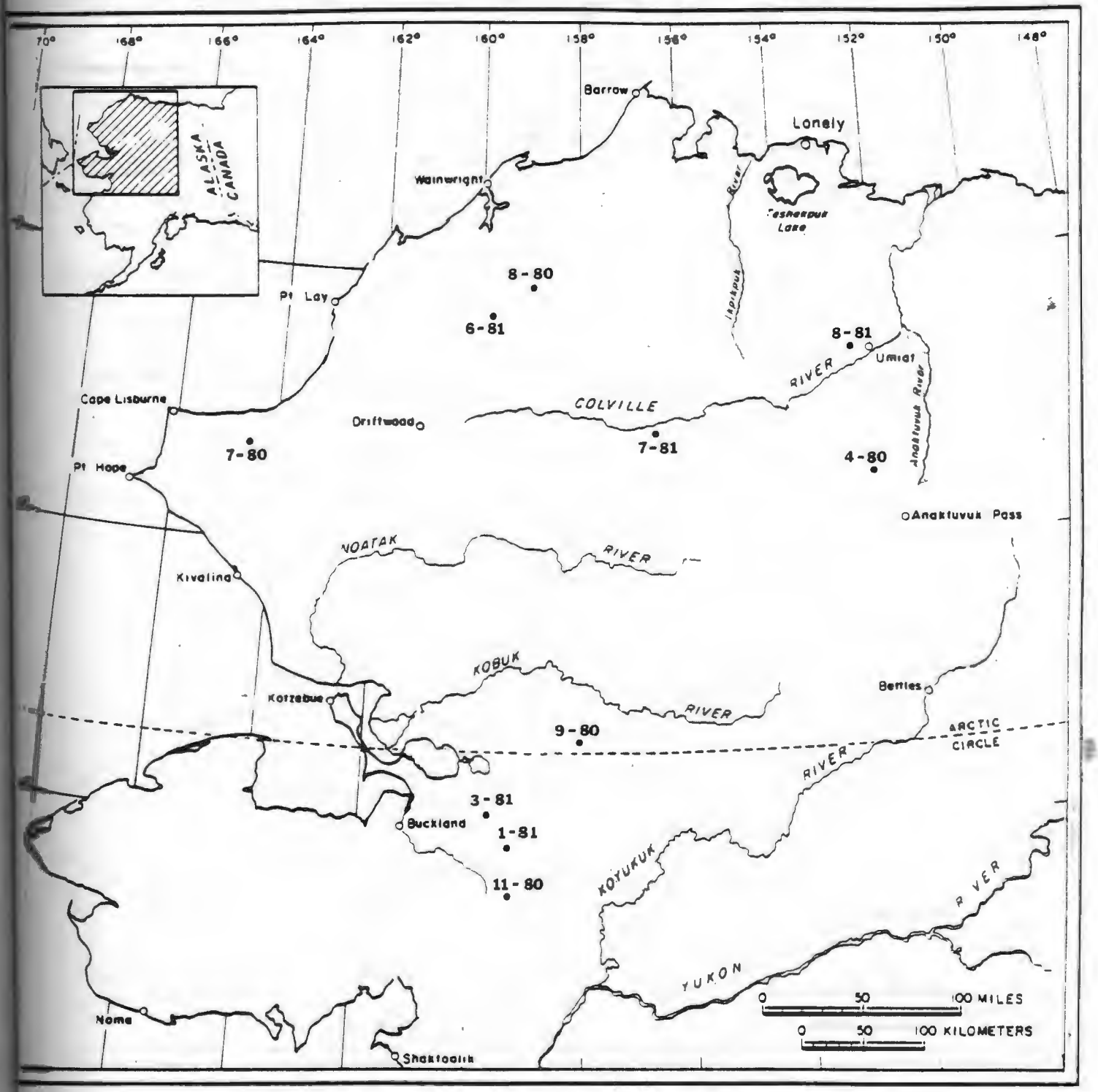
A-25. Relocations (month-year) of adult female caribou #36, radio-collared near Ambler, 29 September 1979.



A-26. Relocations (month-year) of adult female caribou #37, radio-collared near Ambler, 29 September 1979.



g. A-27. Relocations (month-year) of adult female caribou #38, radio-collared near Ambler, 29 September 1979.



A-28. Relocations (month-year) of adult female caribou #39, radio-collared near the Chandler River, 23 April 1980.

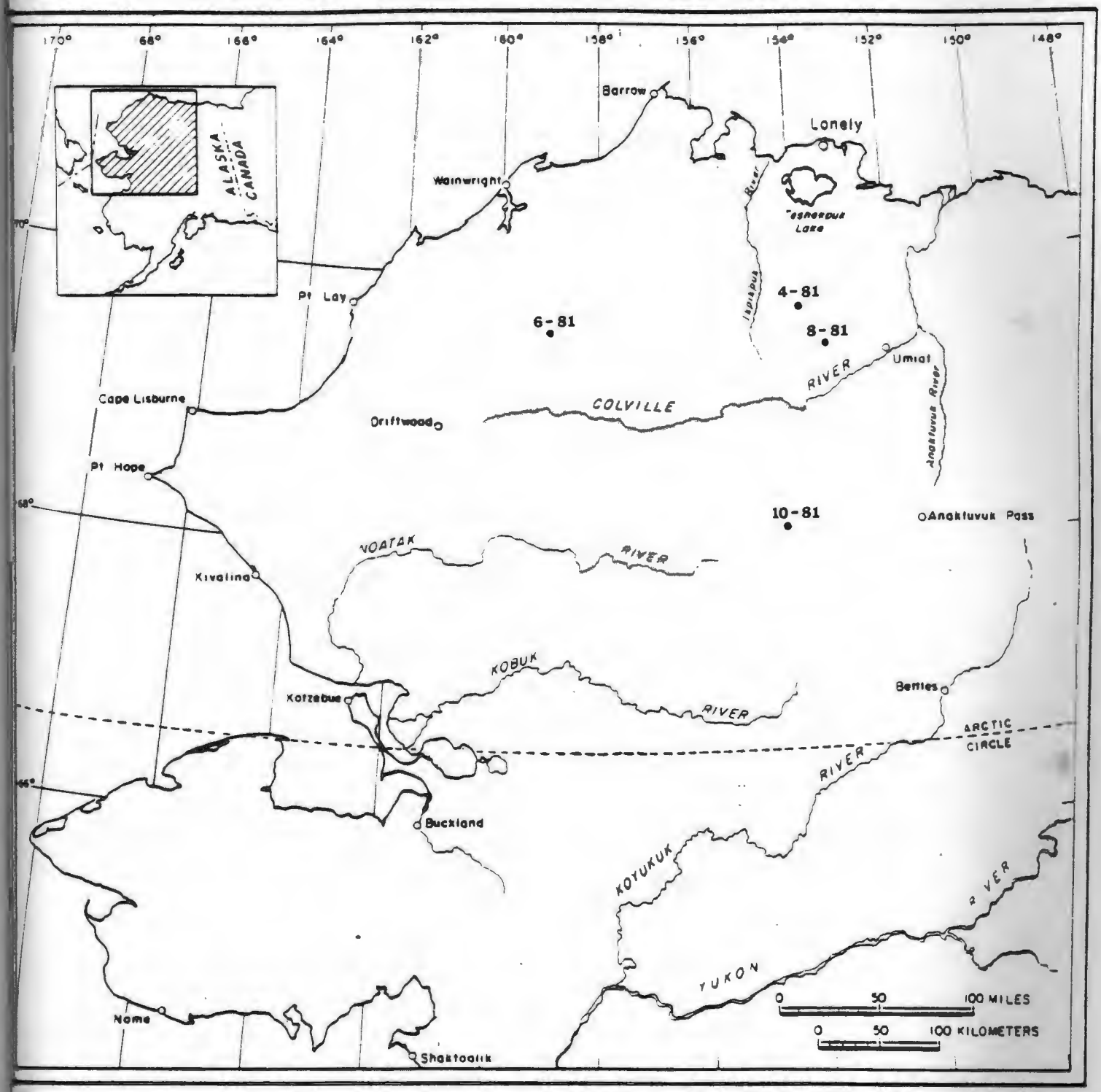


Fig. A-29. Relocations (month-year) of adult female caribou #43, radio-collared near the Price River, 25 April 1981.

Fig. A-30. Relocations (month-year) of adult female caribou #44, radio-collared near the Price River, 25 April 1981.

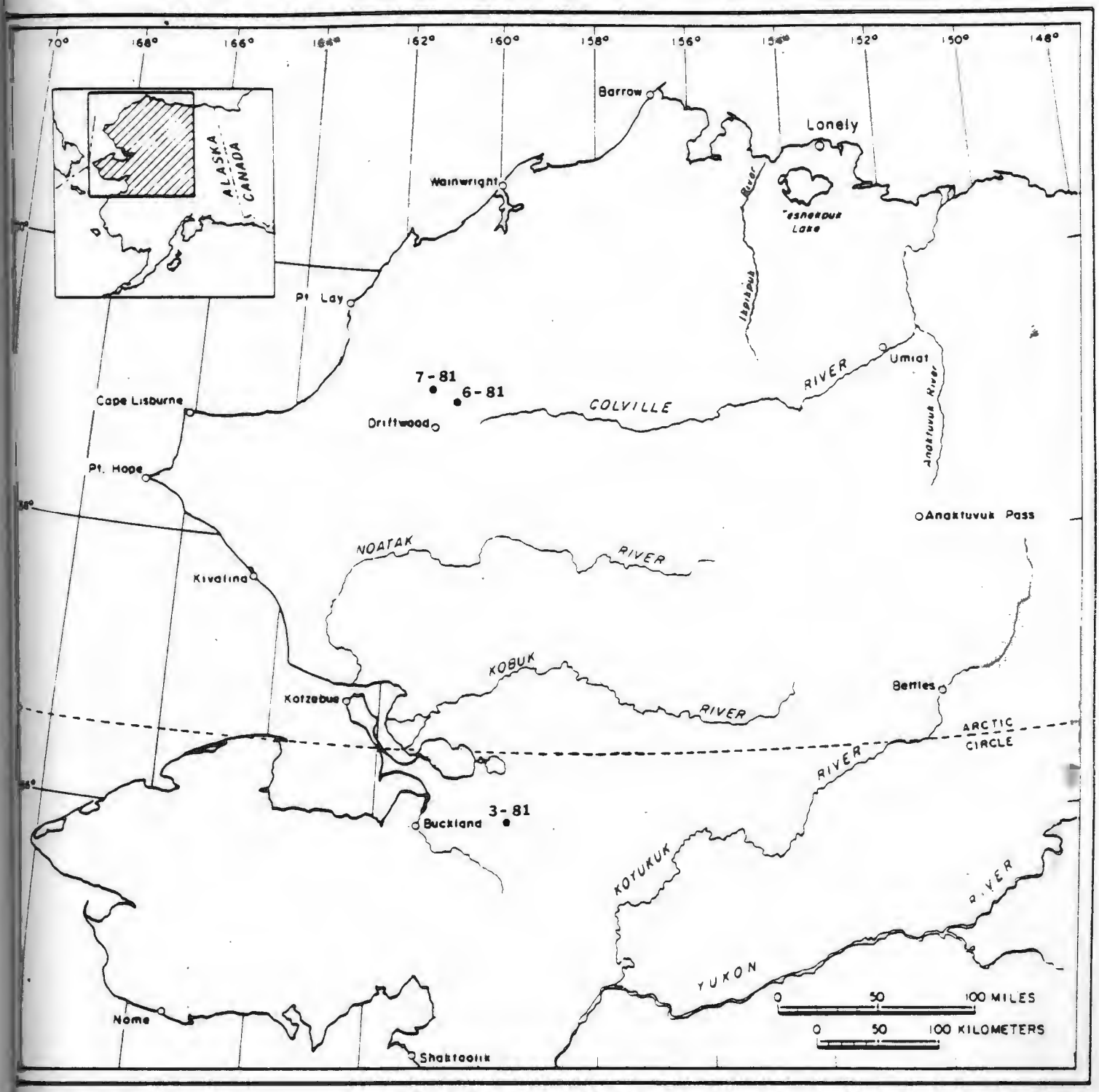


Fig. A-31. Relocations (month-year) of adult female caribou #45, radio-collared in the Selawik Hills, 26 March 1981.

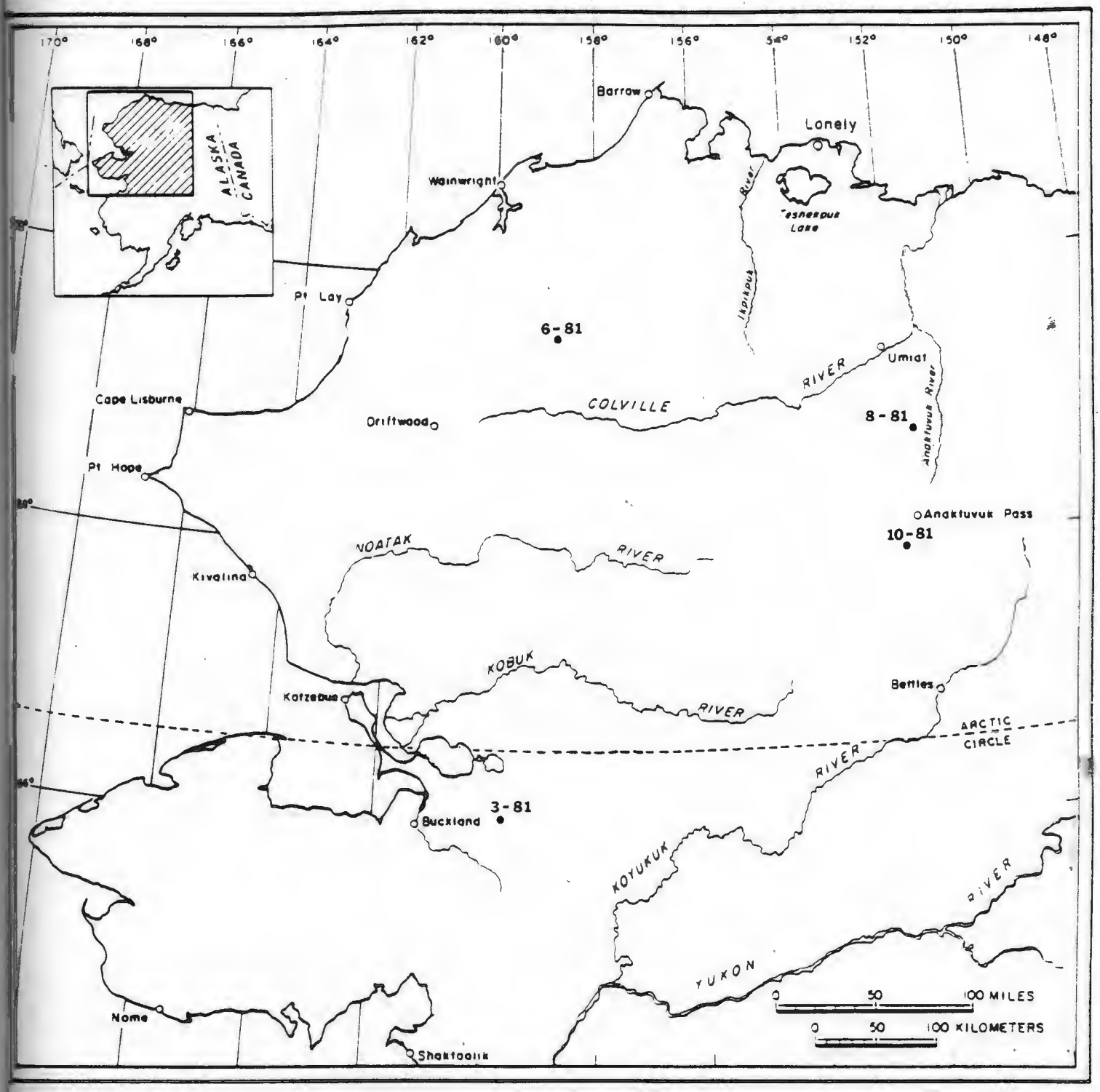


Fig. A-32. Relocations (month-year) of adult female caribou #46, radio-collared in the Selawik Hills, 26 March 1981.

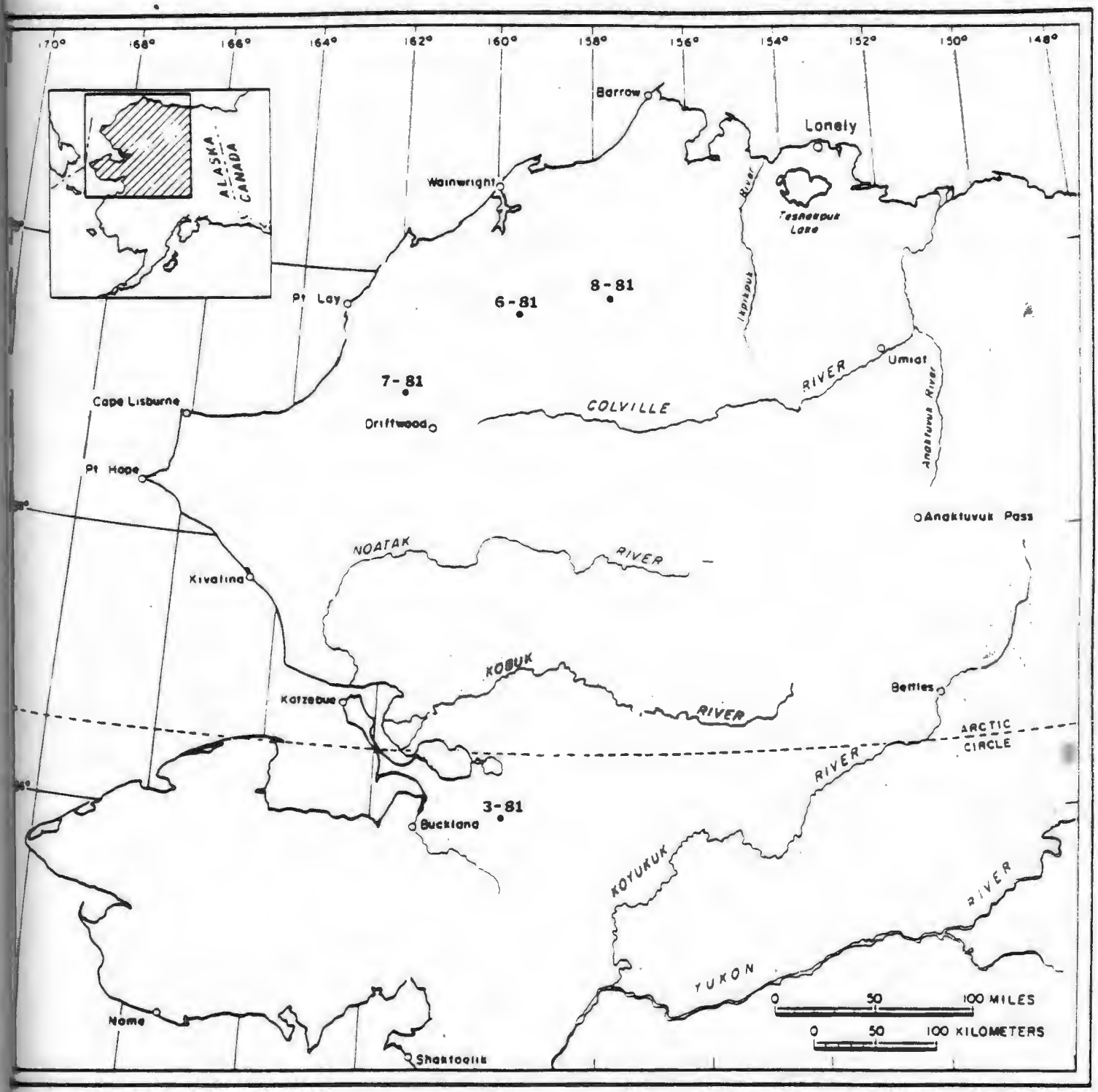


Fig. A-33. Relocations (month-year) of adult female caribou #54, radio-collared in the Selawik Hills, 27 March 1981.

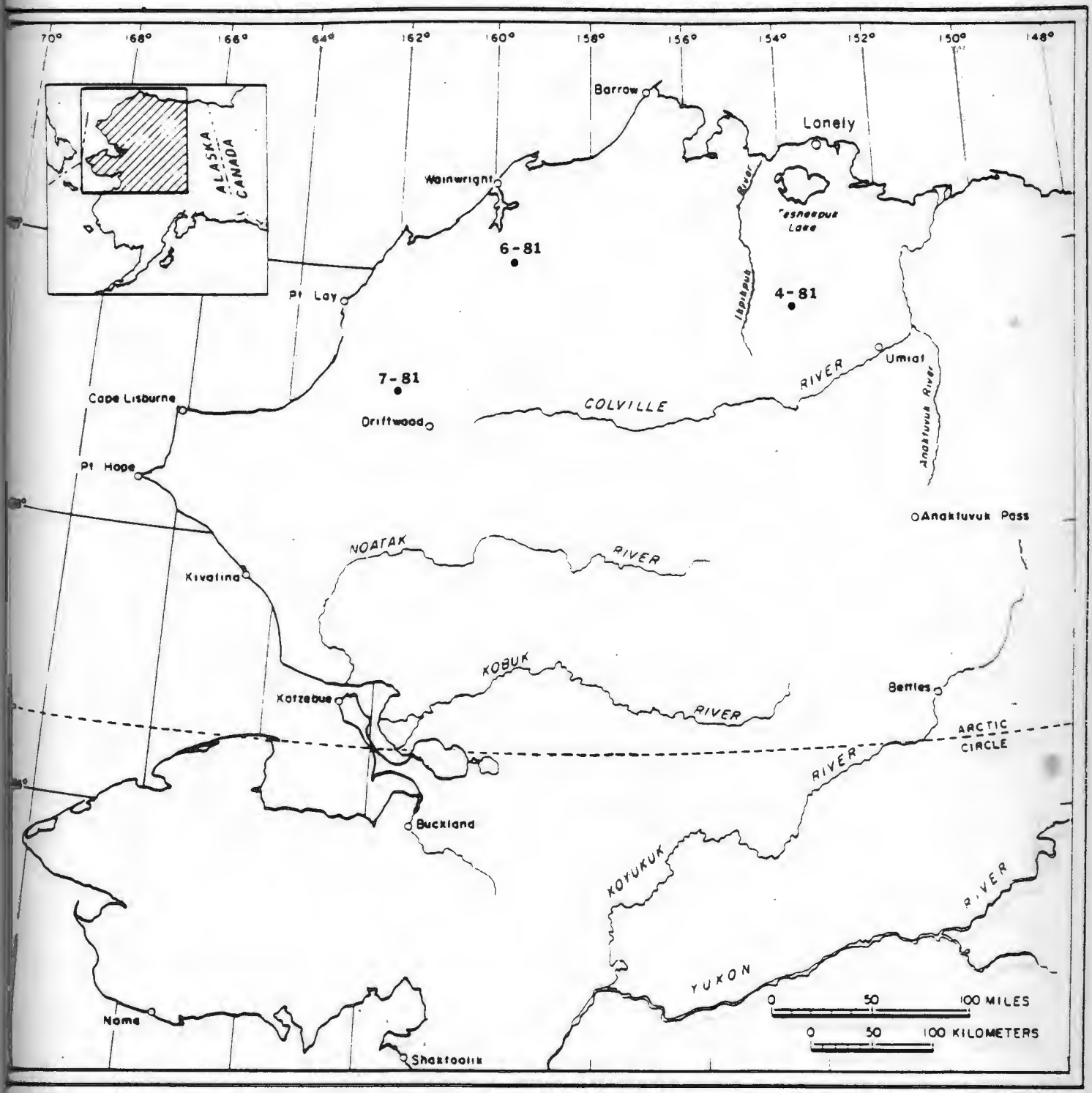


Fig. A-34. Relocations (month-year) of adult female caribou #58, radio-collared near the Price River, 25 April 1981.

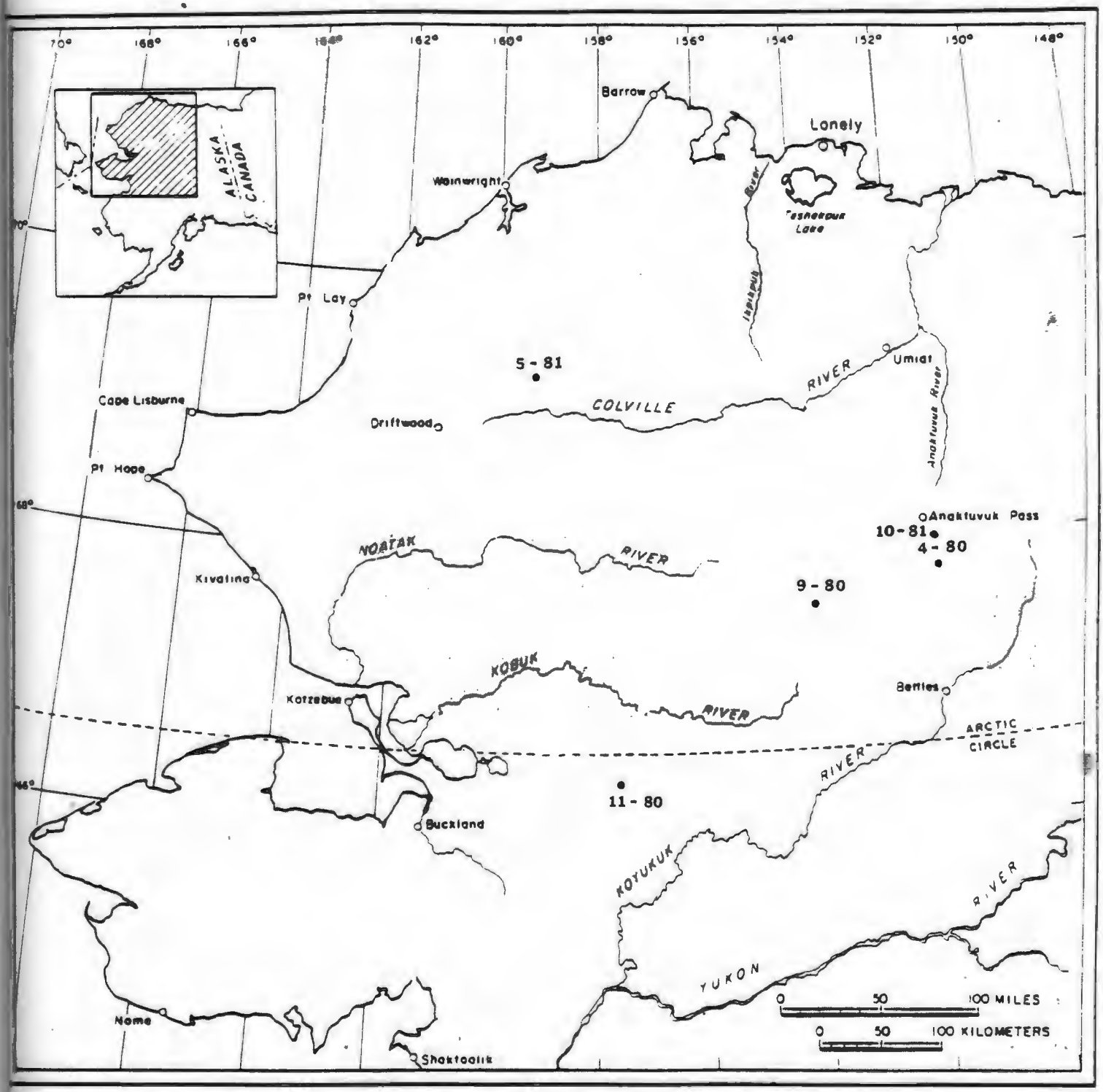


Fig. A-35. Relocations (month-year) of adult male caribou #60, radio-collared near the Tinayguk River, 17 April 1980.

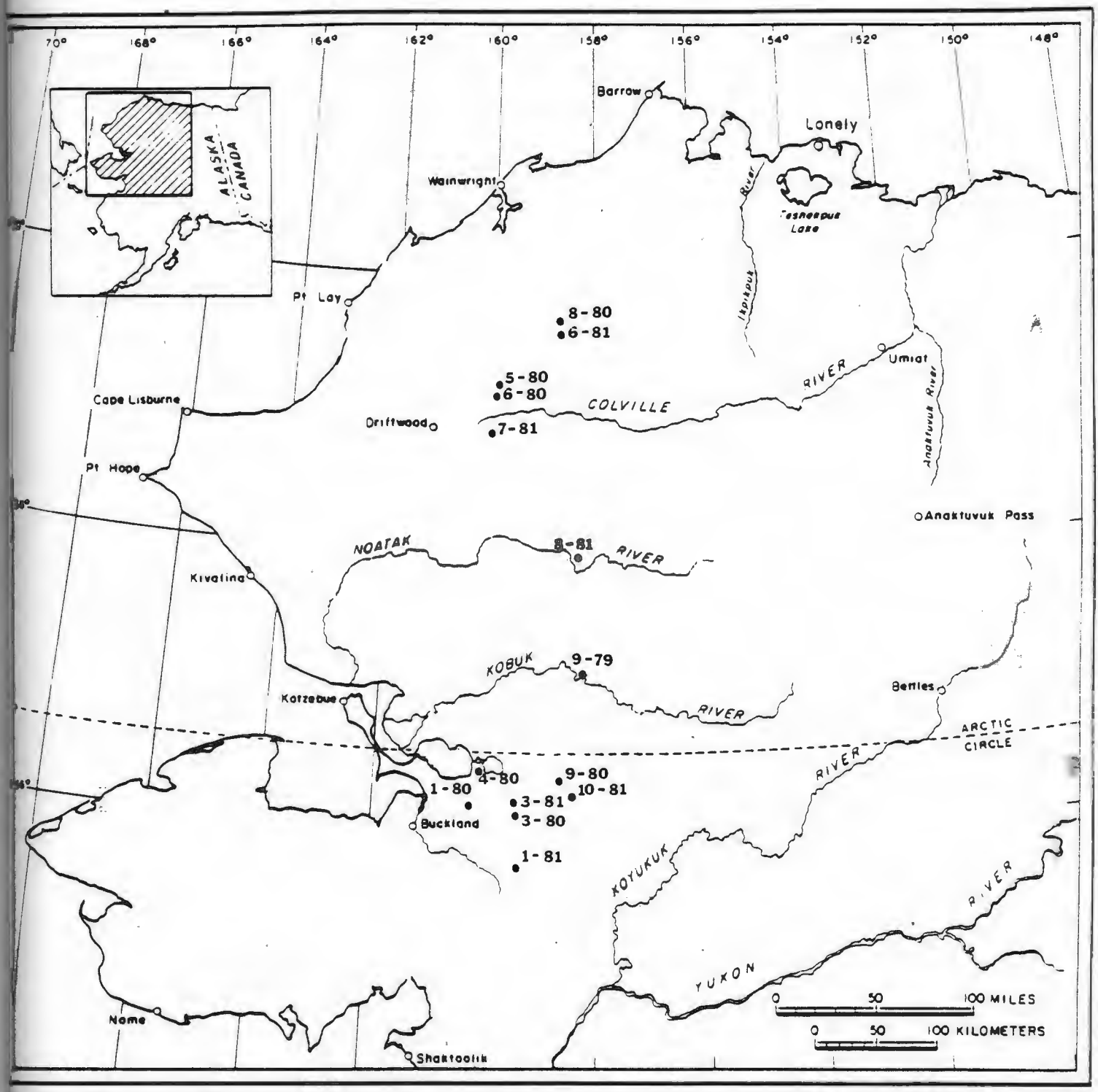


Fig. A-36. Relocations (month-year) of adult female caribou #61, radio-collared near Ambler, 29 September 1979.

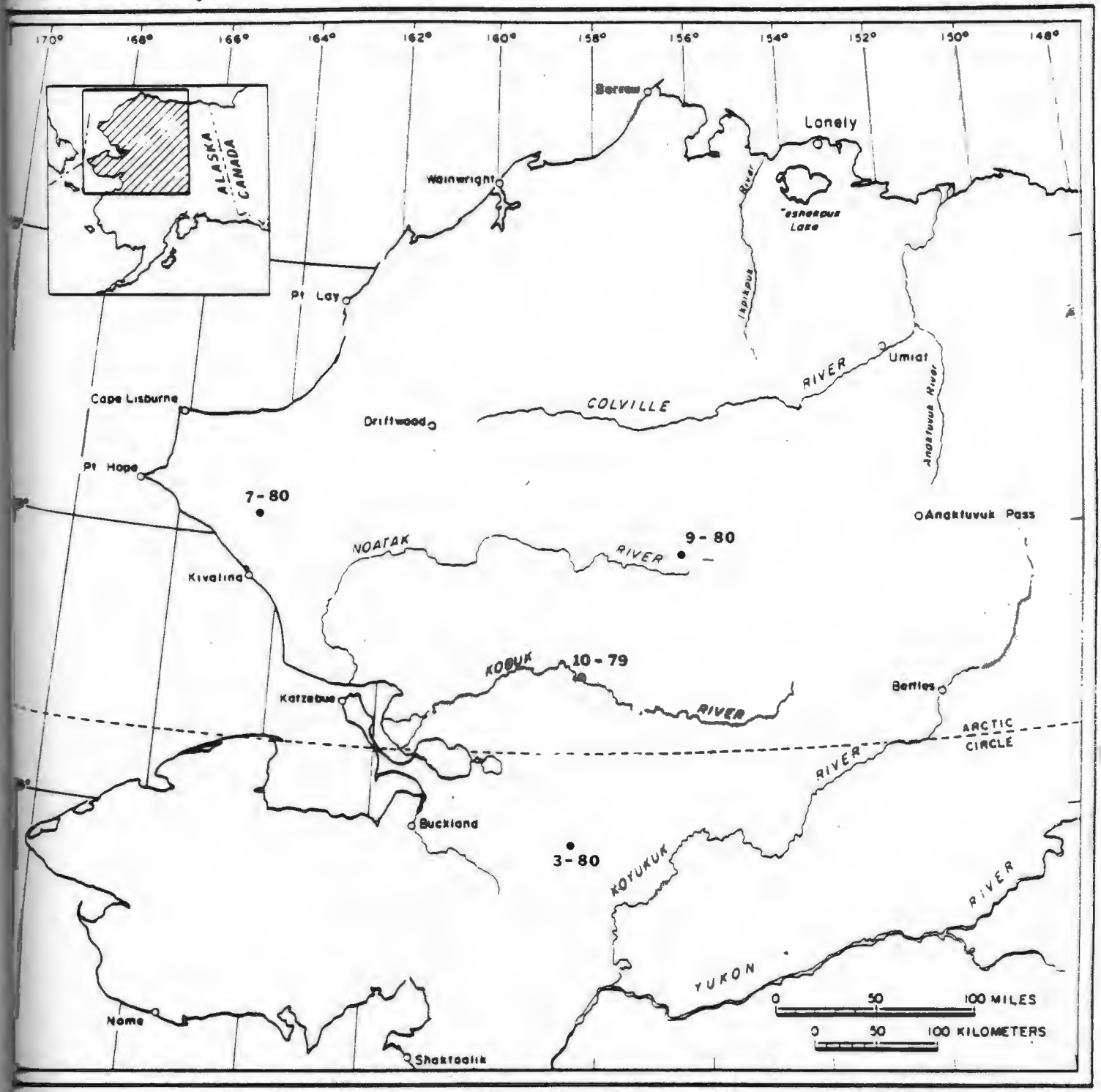


Fig. A-37. Relocations (month-year) of male caribou #62, radio-collared as a 2- or 3-year-old near Ambler, 2 October 1979.

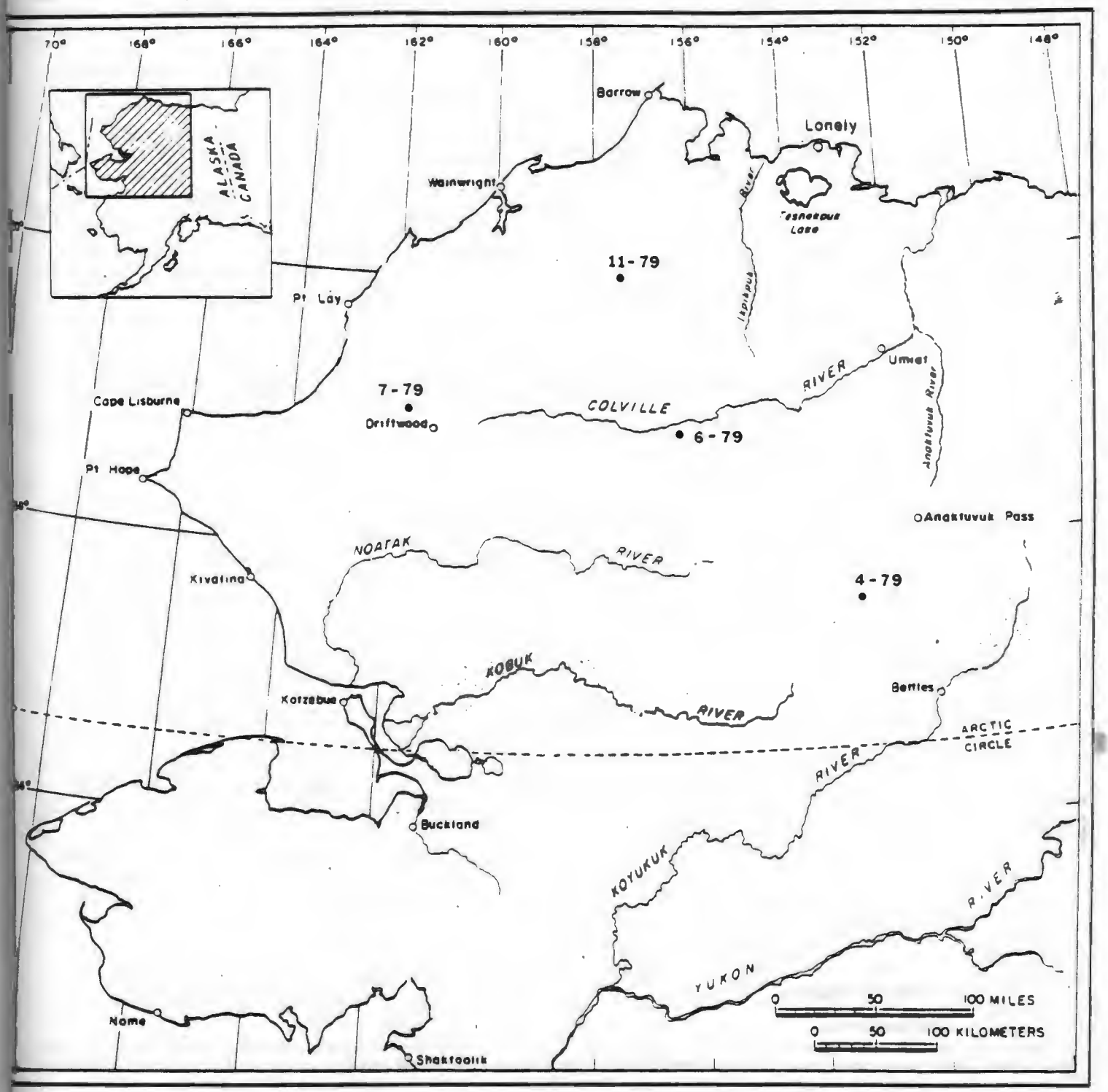


Fig. A-38. Relocations (month-year) of adult male caribou #64, radio-collared near Kevuk Creek, 19 April 1979.

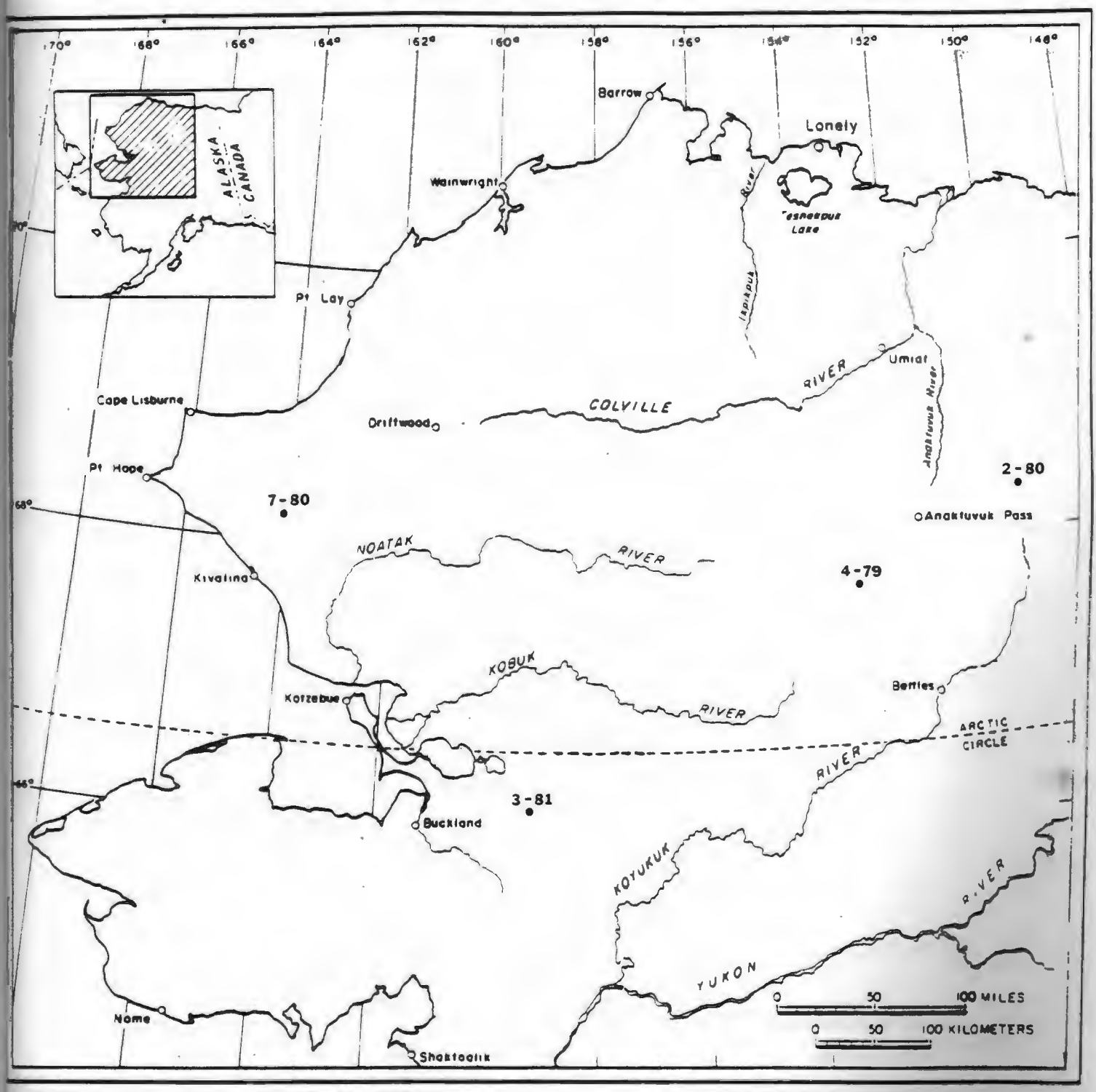


Fig. A-39. Relocations (month-year) of male caribou #67, radio-collared as a 2- or 3-year-old near Kevuk Creek, 19 April 1979.

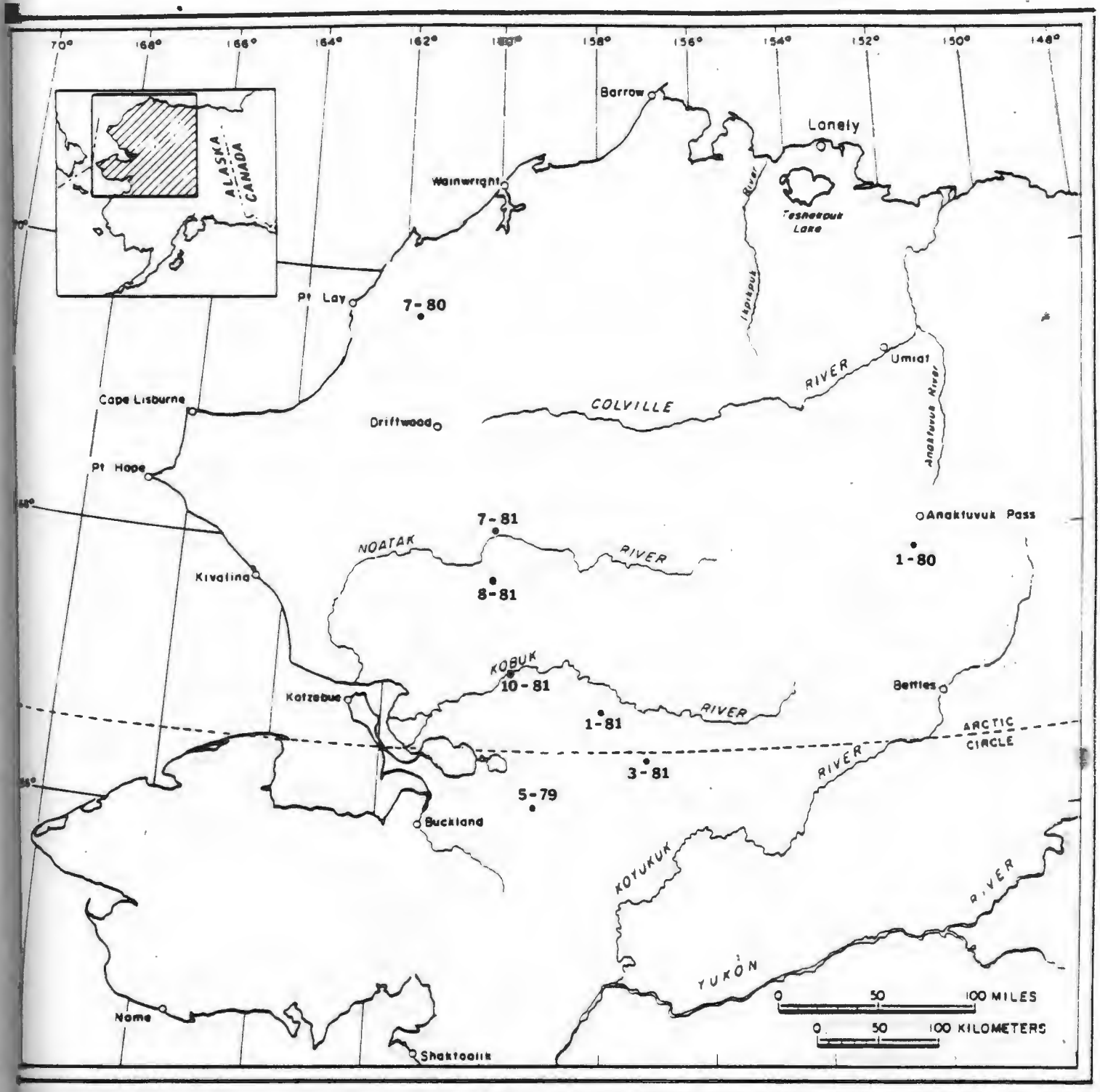


Fig. A-40. Relocations (month-year) of male caribou #68, radio-collared as a 2- or 3-year-old in the Selawik Hills, 1 May 1979.

Fig. A-41. Relocations (month-year) of male caribou #69, radio-collared as a 2- or 3-year-old near Kevuk Creek, 19 April 1979.

Fig. A-42. Relocations (month-year) of male caribou #78, radio-collared as a 2- or 3-year-old near Ambler, 28 September 1979.

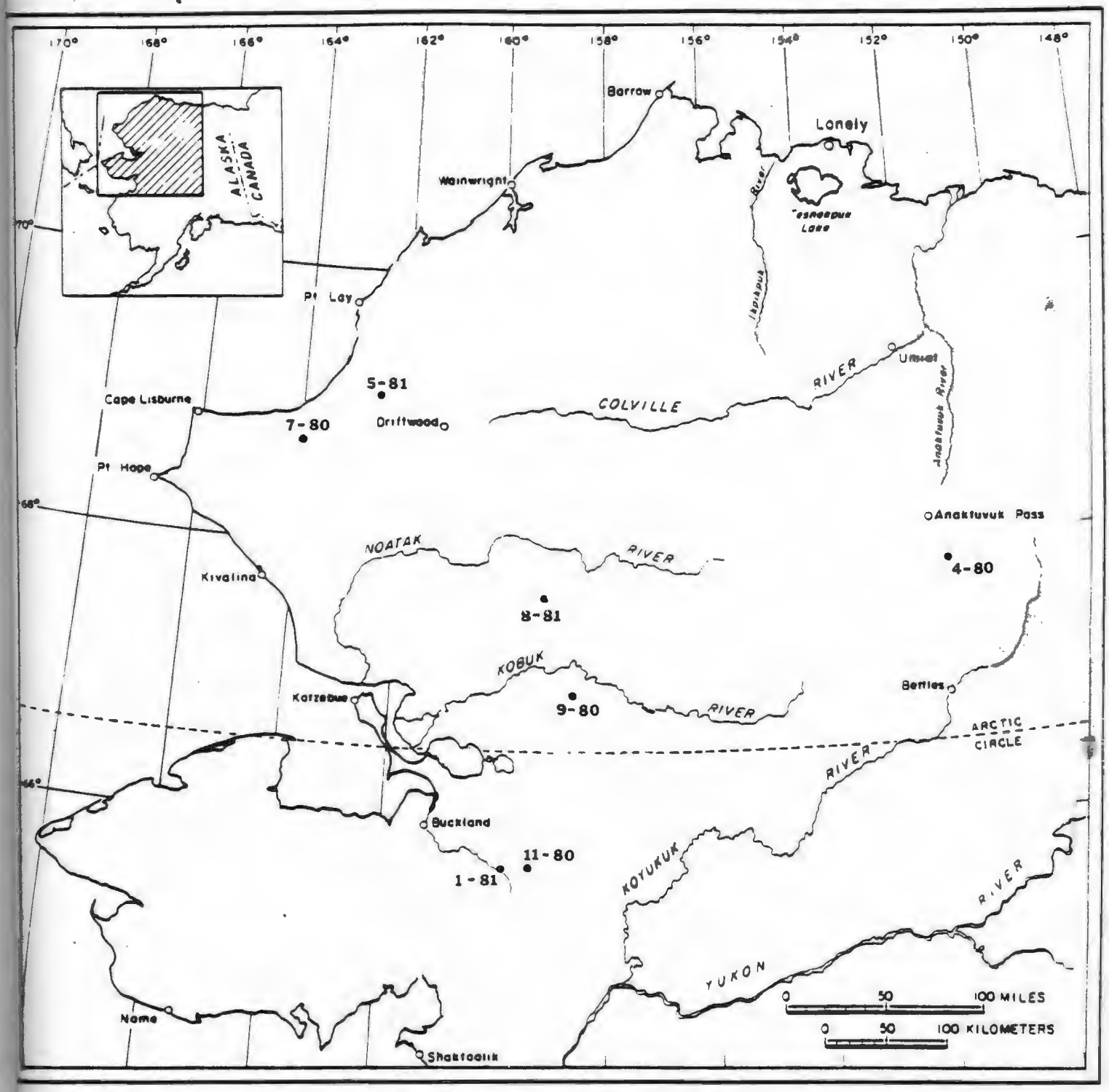


Fig. A-43. Relocations (month-year) of adult male caribou #81, radio-collared near the Tinayguk River, 17 April 1980.

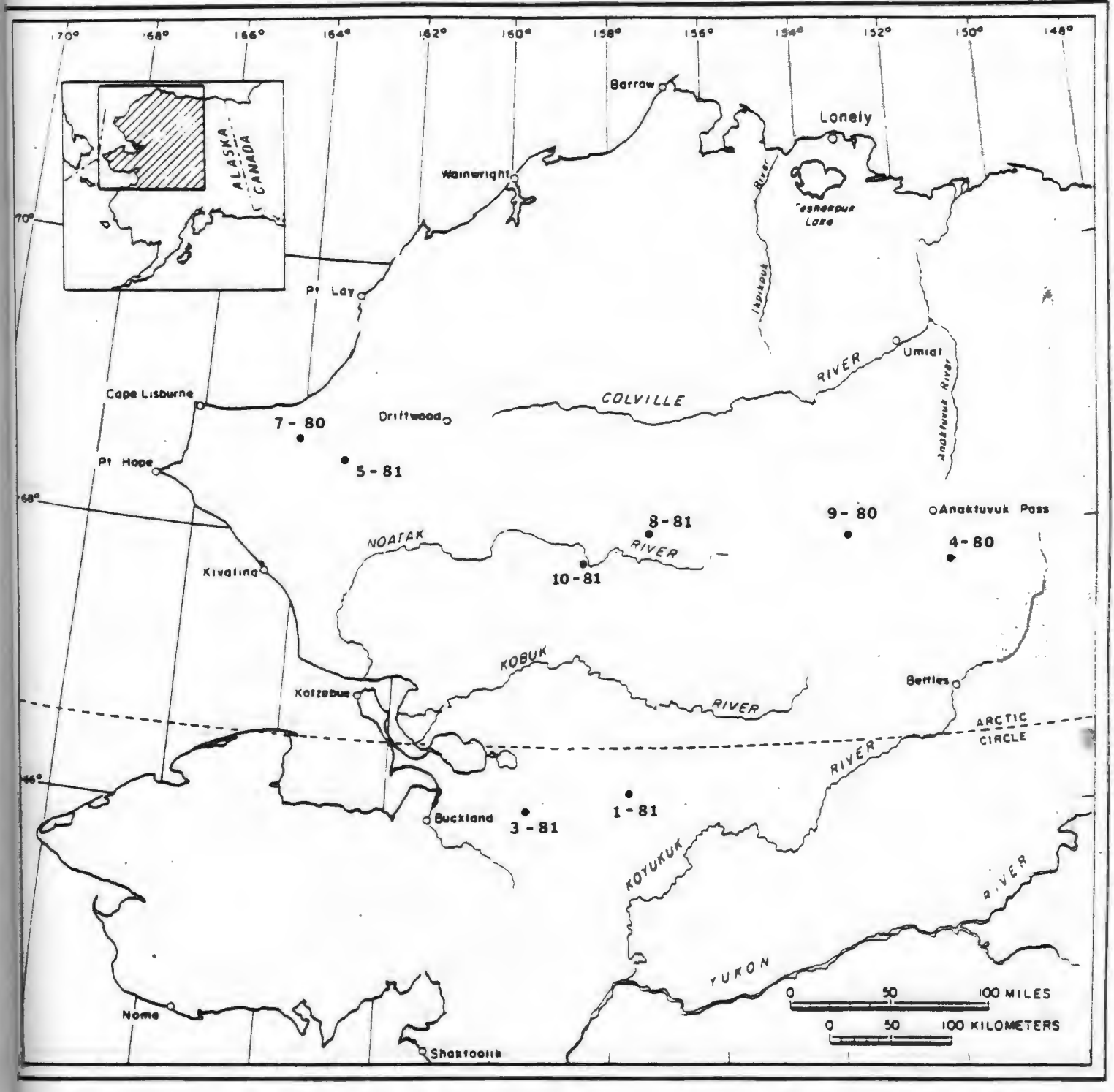


Fig. A-44. Relocations (month-year) of adult male caribou #82, radio-collared near the Tinayguk River, 17 April 1980.

Fig. A-45. Relocations (month-year) of adult female caribou #98, radio-collared in the Selawik Hills, 26 March 1981.

APPENDIX B

Forms used during this study to record data collected from monitoring radio-collared caribou.

WESTERN ARCTIC

RADIO COLLARED CARIBOU

SUMMARY SHEET

Date_____ Observers_____ Weather_____

Flight time_____

Collar #	Last Positive Location	Where & When Collared	Age/Sex	New Location
81/0.005		Tin/80	Adult/M	
69/0.020		Kev/79	Young/M	
82/0.022		Tin/80	Adult/M	
32/0.030		Amb/79	Young/M	
31/0.035		Akp/80	Adult/F	
60/0.040		Tin/80	Adult/M	
34/0.045		Hun/79	Adult/F	
61/0.055		Amb/79	Adult/F	
68/0.065		Sel/79	Young/M	
39/0.070		Chd/80	Adult/F	
55/0.075		Oum/81	Adult/F	
54/0.080		Sel/81	Adult/F	
73/0.085		Amb/79	Young/M	
37/0.100		Amb/79	Adult/F	
2/0.115		Chd/80	Young/F	
1/0.120		Dwd/79	Adult/F	
36/0.135		Amb/79	Adult/F	
9/0.150		Dwd/79	Adult/F	
6/0.160		Amb/79	Young/M	
89/0.165		Oum/81	Adult/M	
30/0.170		Dwd/79	Adult/F	
10/0.175		Chd/80	Adult/F	
33/0.190		Dwd/79	Adult/F	
67/0.195		Kev/79	Young/M	
0/0.200		Amb/79	Adult/F	
38/0.210		Amb/79	Adult/F	
5/0.215		Chd/80	Adult/F	
65/0.220		Amb/80	Adult/M	
35/0.230		Chd/80	Adult/F	
11/0.235		Amb/79	Adult/F	
24/0.260		Sel/81	Adult/F	
25/0.270		Pri/81	Adult/F	
27/0.290		Sel/81	Adult/F	
99/0.350		Pri/81	Adult/M	
19/0.370		Pri/81	Adult/F	
13/0.380		Pri/81	Adult/F	
28/0.390		Pri/81	Calf/F	
29/0.400		Pri/81	Adult/F	
40/0.410		Pri/81	Adult/F	
43/0.440		Pri/81	Adult/F	
44/0.450		Pri/81	Adult/F	
45/0.460		Sel/81	Adult/F	
46/0.470		Sel/81	Adult/F	

Collar #	Last Positive Location	Where & When Collared	Age/Sex	New Location
57/0.480		Oum/81	Adult/F	
58/0.520		Pri/81	Adult/F	
59/0.530		Sel/81	Adult/F	
91/0.540		Oum/81	Adult/M	
96/0.550		Oum/81	Adult/M	
98/0.560		Sel/81	Adult/F	
17/0.570		Pri/81	Young/M	
14/0.620		Pri/81	Adult/F	
15/0.630		Pri/81	Adult/F	
12/0.640		Pri/81	Adult/F	
16/0.650		Pri/81	Adult/F	
18/0.670		Oum/81	Adult/F	
	Teshekpuk Lake Caribou			
30/1.605		Tes/81	Adult/F	
31/1.610		Tes/81	Adult/F	
32/1.621		Tes/81	Adult/F	
33/1.625		Tes/81	Adult/F	
35/1.635		Tes/81	Adult/F	
36/1.640		Tes/81	Adult/F	
37/1.649		Tes/81	Adult/F	
38/1.660		Tes/81	Adult/F	
39/1.680		Tes/81	Adult/F	
40/1.690		Tes/81	Adult/F	
41/1.710		Tes/81	Adult/F	
70/0.720		Tes/81	Adult/M	
71/0.730		Tes/81	Adult/M	
72/0.740		Tes/81	Adult/M	
73/0.750		Tes/81	Adult/M	
74/0.760		Tes/81	Adult/M	
76/0.780		Tes/81	Adult/M	
77/0.790		Tes/81	Adult/M	
	Dropped or Dead Unretrieved Collars			

* All collars are yellow with black numbers.

RADIO-LOCATION FIELD DATA FORM

Col # _____ Best Frequ._____ Herd_____ Pilot PV JD JR BL _____

Obs PV JD DP _____ Plane S C P _____ Date_____ Time_____

Elev_____ Exp N E S W Calf Y N U Status A D M F _____

Cause of Death W GB HL HI WI DI _____ Antlers H S Length _____ Pts____

Weather: Snow Depth_____in Struct H S U Wind _____ Dir N E S W Temp ____F

Group Size_____ Comp M F C Y BY CC ALL U Behavior F R W M _____

Nearest Other Group_____mi Collar # of other caribou in same group_____

Disturb: Pass # 1 Horiz Dist_____ Vert Dist_____React 1 2 3 4 5

2 _____ _____ 1 2 3 4 5

3 _____ _____ 1 2 3 4 5

Location: _____

Map Code: UK LK SELH SELR BR SOB PAHR LKOY UNOA LNOA TIN JOHN ALAT APR
EAST NIGU CHAN KIL NAN ITKI CPWI CPEI PL/W K/PH

Lat_____ Long_____

HABITAT RBW BWS DRR SPW SPF ERT WTS BRE _____

_____

_____

Key to Radio-Location Field Data Form

Col # = collar number

Plane
S = Scout C = Cessna P = Piper

Calf
Y = yes N = no U = unknown

Status
A = alive D = dead M = missing F = failed

Cause of Death
W = wolf GB = grizzly bear HL = human (legal) HI = human (illegal)
WI = winter DI = disease

Antlers
H = hard S = soft Pts = points

Structure (snow)
H = hard S = soft

Comp (composition of groups)

M = male	BY = bulls and yearlings
F = female	CC = cows and calves
C = calf	ALL = all ages and sexes
Y = yearling	U = unknown

Behavior
F = feeding R = resting W = walking M = migrating

Disturb (disturbance)

1 = panic response	4 = stationary response
2 = strong escape response	5 = no visible response
3 = mild escape response	

Map Code

UK = upper Kobuk R.	LK = lower Kobuk R.
SELH = Selawik Hills	SELR = Selawik R.
BR = Buckland R.	SOB = south of Buckland R.
PAHR = Pah R.	LKOY = lower Kobuk R.
UNOA = upper Noatak R.	LNOA = lower Noatak R.
TIN = Tinayguk R.	JOHN = John R.
ALAT = Alatna R.	APR = April Creek
EAST = east of Anaktuvuk Pass	NIGU = Nigu R.
CHAN = Chandler R.	KIL = Killik R.
NAN = Nanuskuk R.	ITKI = Itkillik R.
CPWI = coastal plain west of the Ikpikpuk R.	CPEI = coastal plain east of the Ikpikpuk R.
PL/W = Pt. Lay/Wainwright vicinity	K/PH = Kivalina/Pt. Hope vicinity

Habitat

RWB = riparian willow bottom	BWS = birch/willow sidehill
DRR = Dryas ridge	SPW = spruce woodland
SPF = spruce forest	ERT = Eriophorum tussock
WTS = wet sedge	BRE = brushy Eriophorum