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DEVELOPMENT AND ALTERATION OF CARIBOU MOVEMENT PATTERNS

by
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SUMMARY

This study was designed to determine the mechanisms by which caribou (*Rangifer tarandus granti*) movement patterns are established and subsequently sustained or altered. Through an examination of the movements and habitat use of marked individuals from birth to 4 years of age, we had hoped to gain insights to the fidelity of caribou to certain areas within their annual range. During spring, 1982-84, we radio-collared 17 short yearlings of cows that had been relocated periodically during each of the preceding years. Twelve of these yearlings were radio-tracked during the 12-41 months following collaring; an aggregate total of 485 relocations were obtained. Unfortunately, all radio collars deployed in 1984 failed within 16 months, rendering the overall sample size insufficient to meet the primary objectives of the study. However, all geographic point locations obtained since 1980 have been digitized and filed on computer discs, several base maps have been prepared, 4 papers on various aspects of the data have been written, and a 1st attempt has been made to use home range software in a seasonal analysis of the distribution of radio-collared females.

We recommend that satellite telemetry be used in subsequent studies of this nature.

Key Words: caribou, distribution, movements, radio-collaring.

CONTENTS

BACKGROUND

Caribou (Rangifer tarandus granti) surveys conducted along the Trans-Alaska Pipeline (TAP) Corridor and within the Prudhoe Bay Complex (PBC) between 1975 and 1982 yielded overall calf percentages that were generally lower than corresponding regional estimates, particularly during summer (Cameron and Whitten 1980; Cameron et al. 1979, 1985; Smith and Cameron 1983). We interpret these results as avoidance of disturbed areas by cows and calves.

Given that female caribou and their calves respond negatively to certain combinations of structures and human activity, one might predict that increasing disturbance would further deter cows and calves. Conversely, a diminution of adverse stimuli should encourage reoccupancy of areas previously avoided. In addition, repeated exposure to disturbance might result in some degree of accommodation or habituation by some cow-calf bands.

The above premises are not supported by available data. Despite a net decrease in disturbance within the TAP Corridor or PBC after 1976 (Cameron and Whitten 1980, Cameron et al. 1983), local calf representation remained lower than in adjacent areas (Cameron et al. 1983, 1985). Thus, cow-calf occupancy did not increase in response to a seemingly more favorable local environment. Similarly, there was apparently no accommodation to the relatively stable disturbance conditions within the corridor after 1976, although the fact that cows and calves did not totally abandon the area suggests that some individuals can tolerate--or readily accommodate to--certain adverse stimuli.

The central point is that an increase in local calf representation did not accompany the decline in development activity between 1976 and 1982. Possibly even the lowest of disturbance levels characterizing the corridor in recent years is above the avoidance threshold of maternal cows. It is also conceivable that, once displaced, caribou modify their seasonal movement patterns, which tend to persist as new traditions. The latter possibility forms the basis of this study. We attempted to test the hypothesis that the distribution and movements of caribou are maintained along matriarchal lines. If not disproved, the applicable corollary is that changes in range use, whether natural or human induced, are initiated by adult cows and sustained by subsequent generations of female offspring. Hence components of range, once abandoned by adult females, may not be reoccupied for many years and perhaps only then by chance.

Through an examination of these mechanisms, we had hoped to gain some insights into the dynamics of range use and thereby improve our ability to predict the effects of industrial development in terms of the probable extent and duration of habitat loss. Although technical and logistical difficulties precluded our satisfying the original study objectives, considerable progress has been made in the management and analysis of radio-relocation data and 4 related reports have been published.

OBJECTIVES

1. To evaluate the degree to which the seasonal movements of individual adult caribou are influenced by their 1st-year movements as calves.

2. To identify and describe any disturbance-related alteration of seasonal distribution and movements of such caribou.

3. To determine sexual differences in the development of caribou movement and dispersal patterns, social relationships, habitat preferences, and range fidelity.

PROCEDURES

During spring 1982, 1983, and 1984, we radio-collared (Whitten and Cameron 1983) 2, 8, and 7 short yearlings, respectively, of radio-collared cows that had been relocated periodically by fixed-wing aircraft (Whitten and Cameron 1983) during the previous 9-11 months. Of these 17 yearlings, 5 either died or lost their collars within 8 months. The remaining 12 were radio-tracked for about 1-4 years after collaring (Tables 1 and 2).

The following data were recorded for each observation of a radio-collared caribou:

1. Date of relocation or collaring, as appropriate.
2. Method--aerial tracking or observation only.
3. Status--alive with collar in place and transmitter operational, dead or collar shed, inoperative transmitter, or unknown.
4. Visual contact--yes or no.
5. Map location (1:250,000 USGS) with accuracy rating.
6. Group size with accuracy rating
7. Group type--predominantly cow and calf, bulls, mixed, or unknown.
8. Cow accompanied by calf--yes or no.
9. Hard antlers (adult cows, Apr-Jun only)--yes or no.
10. Direction of movement--none, north, south, east, west, or unknown.

Point locations were transferred to a permanent map file, and geographic coordinates were generated using an Altek digitizing table connected to an IBM XT; the appropriate software was developed by Game Division. All of the above information was coded numerically and entered on computer discs compatible with IBM PC hardware. Base maps were prepared using a variant of the digitizing software and an HP plotter.

FINDINGS AND DISCUSSION

The number of relocations of caribou radio-collared as yearlings is disappointingly few. Only two of the 17 radio collars were confirmed to be operational for the projected life of the transmitters. Nine of the 10 collars deployed in 1982 and 1983 functioned for at least 2 years, but none of the 7 collars deployed in 1984 were known to be operational for more than 16 months (Table 1). Structural failure of the expandable neck band is the probable cause of these losses. Three of the 6 radio collars that had been shed were recovered and examined; the collar material had shredded in each instance. It appears likely that the remaining 3 radio collars deployed successfully in 1984 were lost for the same reason.

With reasonably complete data on only 2 radio-collared caribou (1M, 1F; Table 2), it will not be possible to meet the primary objectives of this study. Because of the generally small numbers of relocations obtained, little more than tentative conclusions can be drawn from observations made during the first 2 or 3 years. A previous analysis of location data from June 1981 through 1984 indicated that yearlings are no more likely to return to their approximate birth sites than cows are to reuse previous calving sites; 2-year-olds were even farther from their birth sites than they had been as yearlings (Smith et al. 1985). Otherwise, little can be gleaned from the available data. An inspection of all point locations for each caribou (Figs. 1-12) reveals only a weak tendency for repeated use of specific areas within their overall range; however, it is noteworthy that the majority of locations appear to be on one side of the Sagavanirktok River or the other for each caribou within a given year. This conclusion is consistent with the findings of Cameron et al. (1983), Whitten and Cameron (1983, 1984), and Smith et al. (1985), indicating that caribou crossings of the TAP Corridor or PBC are relatively infrequent.

Our recent advances in the management and analysis of data on radio-collared caribou represent the most important contribution of this study. The locations of <u>all</u> radio-collared caribou tracked by aircraft since 1980 have been digitized and computer-filed. We are now in a position to examine long-term patterns of range use by a number of adult females, many of which have been recollared. In addition, our digitizing capabilities now permit graphic illustrations of seasonal/annual changes in distribution of the Central Arctic Herd (CAH) and trends in the relative use of developed areas.

Three manuscripts and 1 technical report, based totally or partially on radio-tracking data, have been prepared under the auspices of this Job:

Whitten, K. R., and R. D. Cameron. 1983. Movement of collared caribou in relation to petroleum development on the Arctic Slope of Alaska. Can. Field-Nat. 97:143-146.

Cameron, R. D., K. R. Whitten, and W. T. Smith. 1986. Summer range fidelity of radio-collared caribou in Alaska's Central Arctic Herd. Rangifer, Spec. Issue No. 1:51-55.

Cameron, R. D., W. T. Smith, and R. T. Shideler. In press. Variations in initial calf production of the Central Arctic Caribou Herd. Proc. 3rd North Am. Caribou Workshop, Chena Hot Springs, Alaska, 4-6 Nov 1987. Alaska Dep. Fish and Game Spec. Rep., Fairbanks. (Appendix A).

Lawhead, B. E., and R. D. Cameron. 1988. Caribou distribution and abundance on the calving grounds of

the Central Arctic Herd, Alaska, 1987. Final Rep., prepared for ARCO Alaska, Inc., and the Kuparuk River Unit, Anchorage, by Alaska Biological Research, Inc. and Alaska Dep. of Fish and Game, Fairbanks (Executive Summary, Appendix B).

Additionally, a preliminary attempt has been made to describe the multiyear, seasonal distribution of the CAH by applying home range software to the point locations of radio-collared female caribou that were obtained from 1981 through 1987 (Appendix C). We hope to further refine this analysis and prepare a short paper for publication.

RECOMMENDATIONS

Despite the technical difficulties encountered during the course of this study that resulted in our inability to satisfactorily test the stated hypothesis with the available data, we remain convinced that questions regarding range fidelity merit further investigation. Although problems with collar integrity can be overcome, the field technique itself has serious limitations. The logistical requirements and costs of conventional radio-tracking in the Arctic preclude the frequent relocations necessary to precisely characterize range use. We therefore recommend that the study be reinstated at some future time using satellite telemetry.

ACKNOWLEDGMENTS

Primary funding for this study was provided by the Alaska Department of Fish and Game through Federal Aid in Wildlife Restoration Project W-22-1 through W-22-7. Supplemental support was obtained from the U.S. Fish and Wildlife Service (Arctic National Wildlife Refuge). Alaska Biological Research cooperated in radio-tracking flights during May-August 1983 and June 1984. We are grateful to J. R. Dau, C. S. Gewin, and L. M. McManus for skilled technical assistance. Thanks to D. J. Reed and J. A. Venable for aid in digitizing and data formating.

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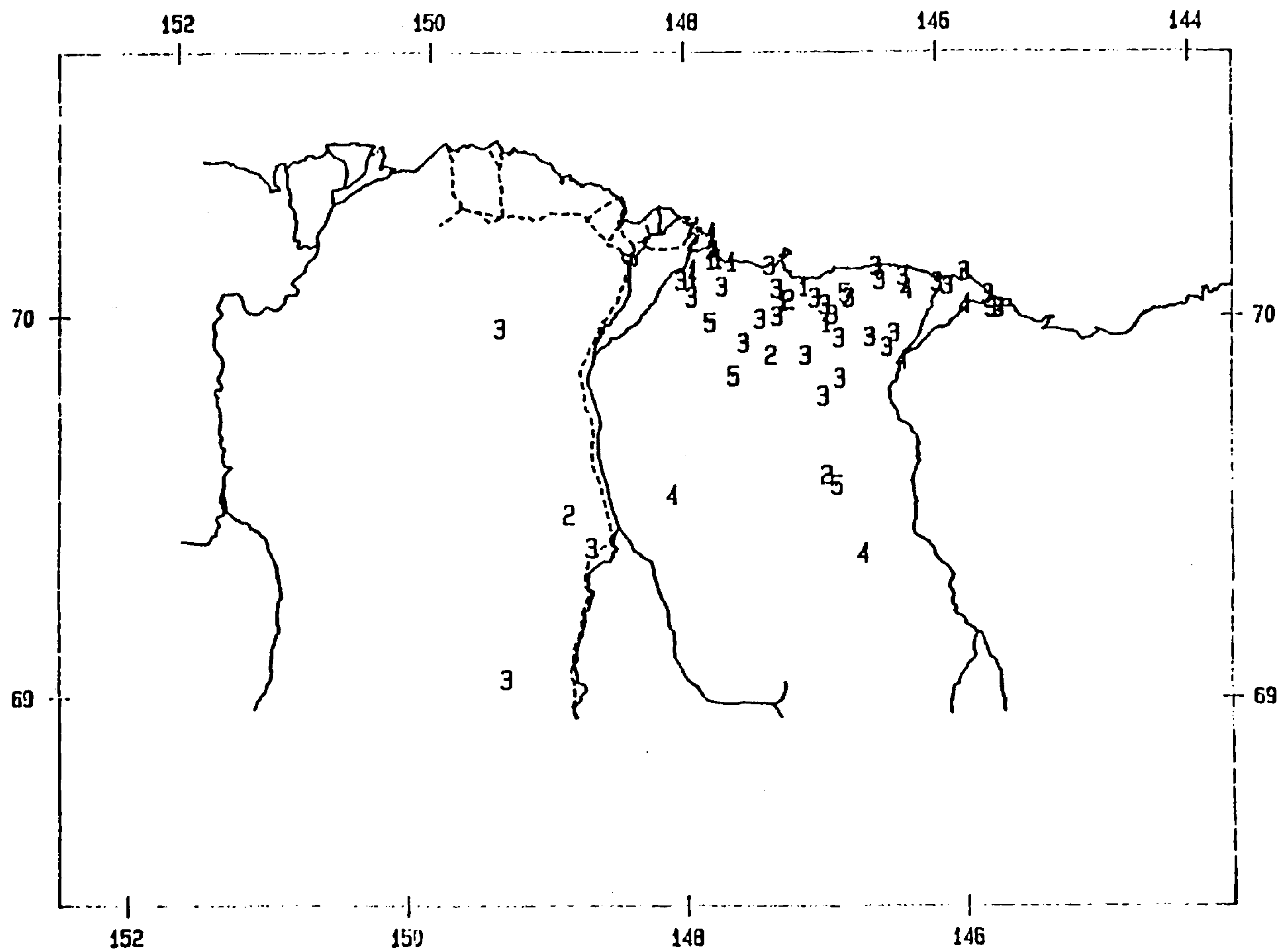


Fig. 1. Locations of radio-collared caribou 8221 (F) by year (see Table 2, footnote b).

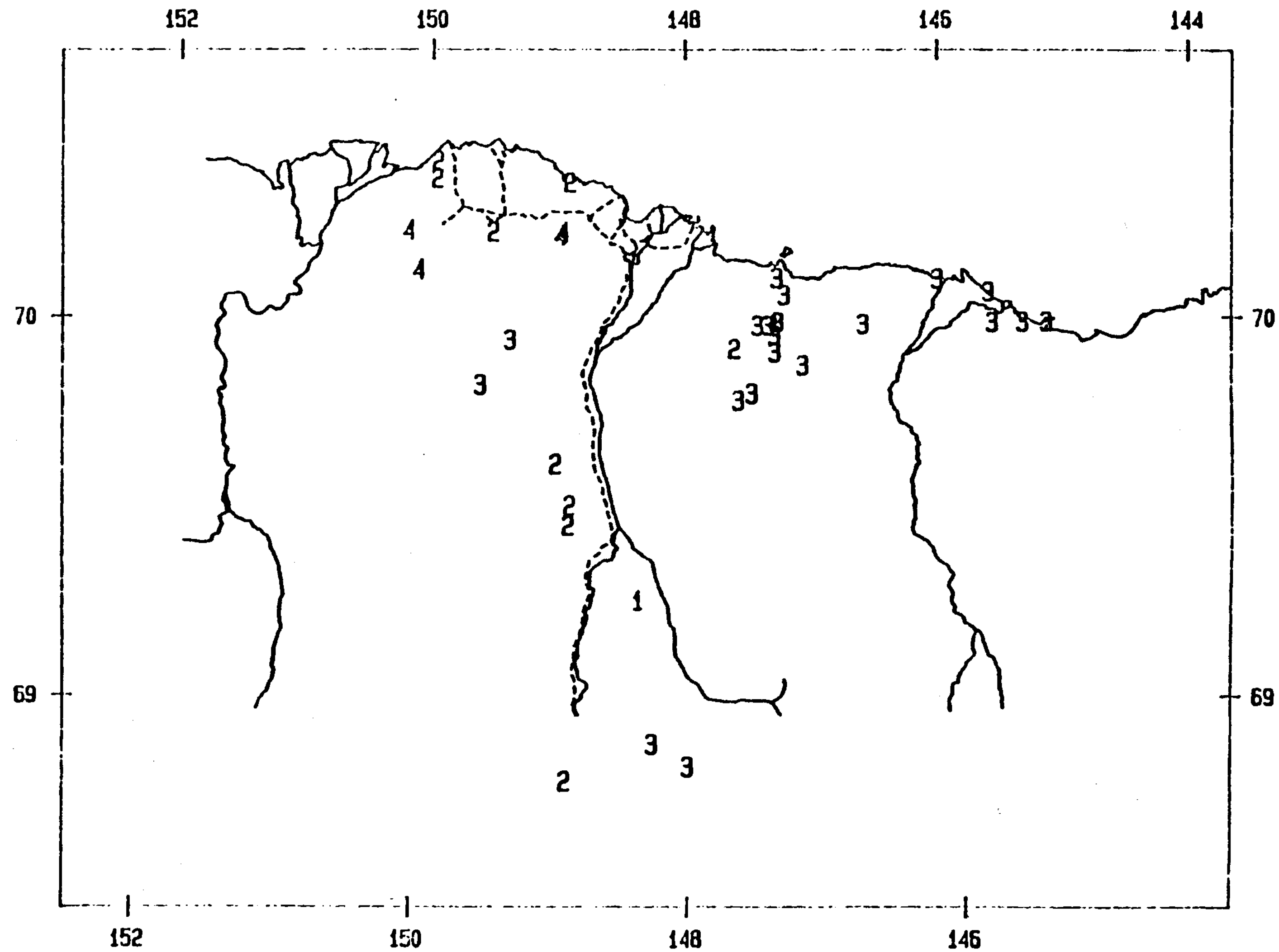


Fig. 2. Locations of radio-collared caribou 8222 (M) by year (see Table 2, footnote b).

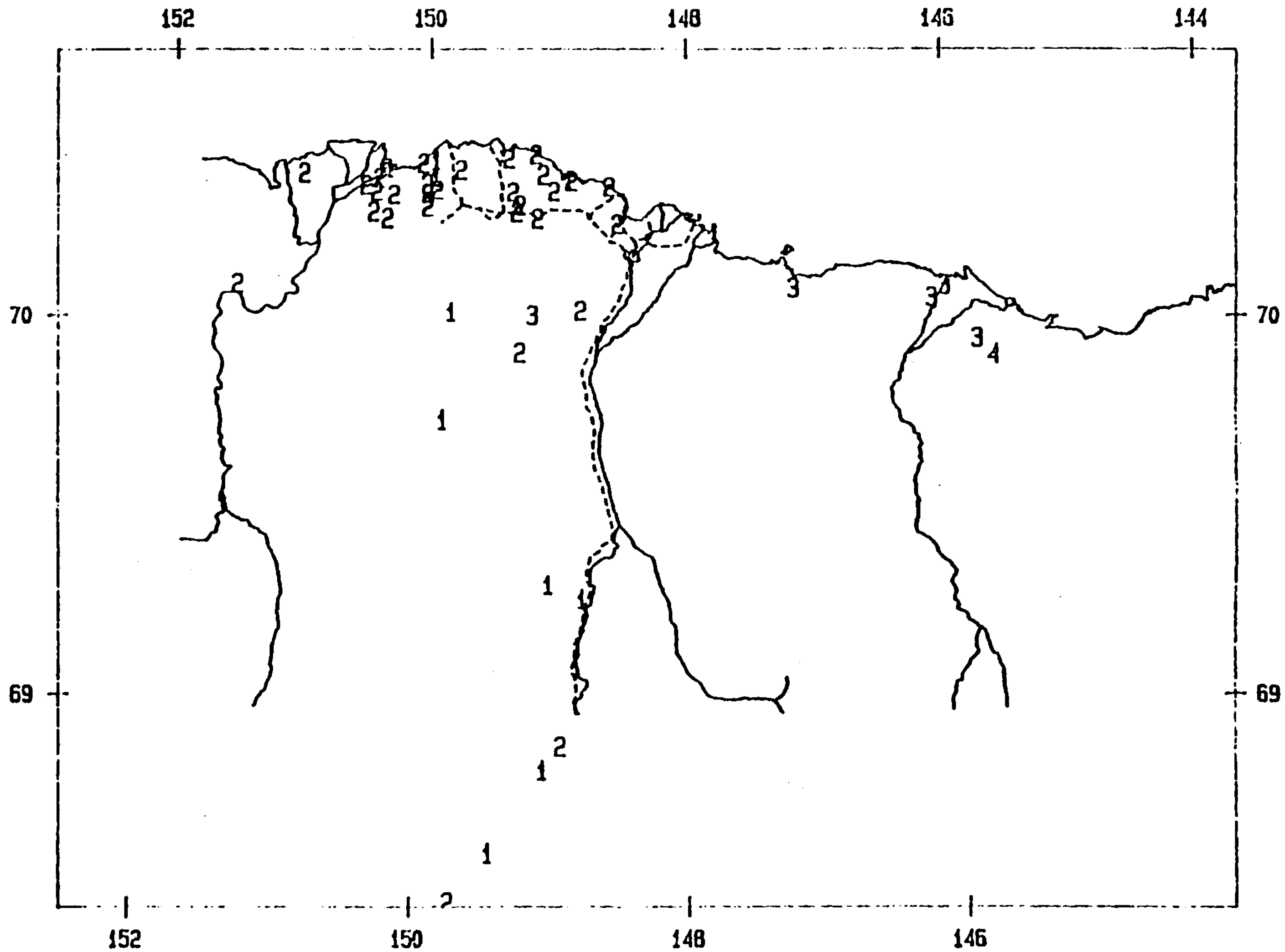
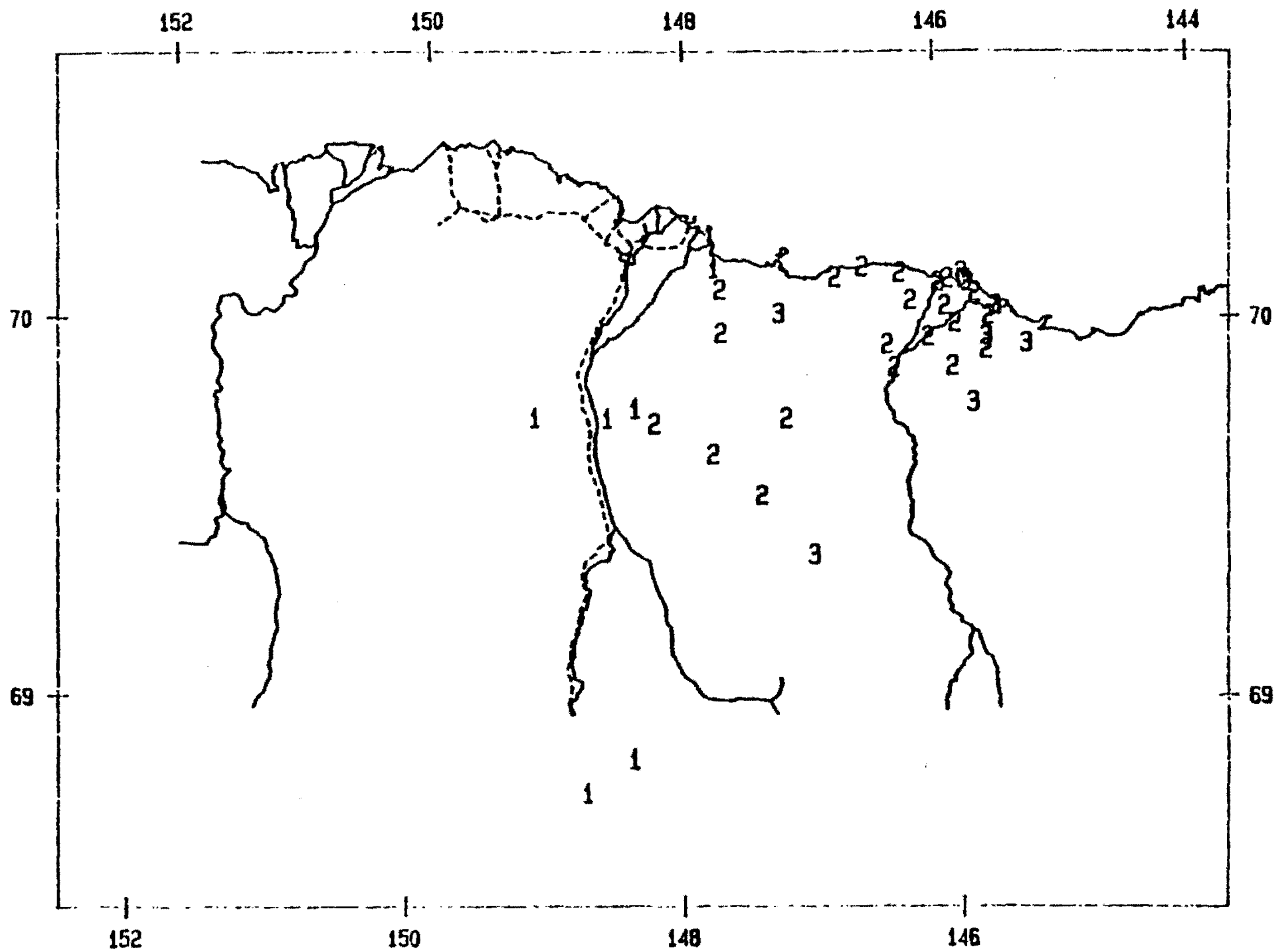


Fig. 3. Locations of radio-collared caribou 8302 (F) by year (see Table 2, footnote b).



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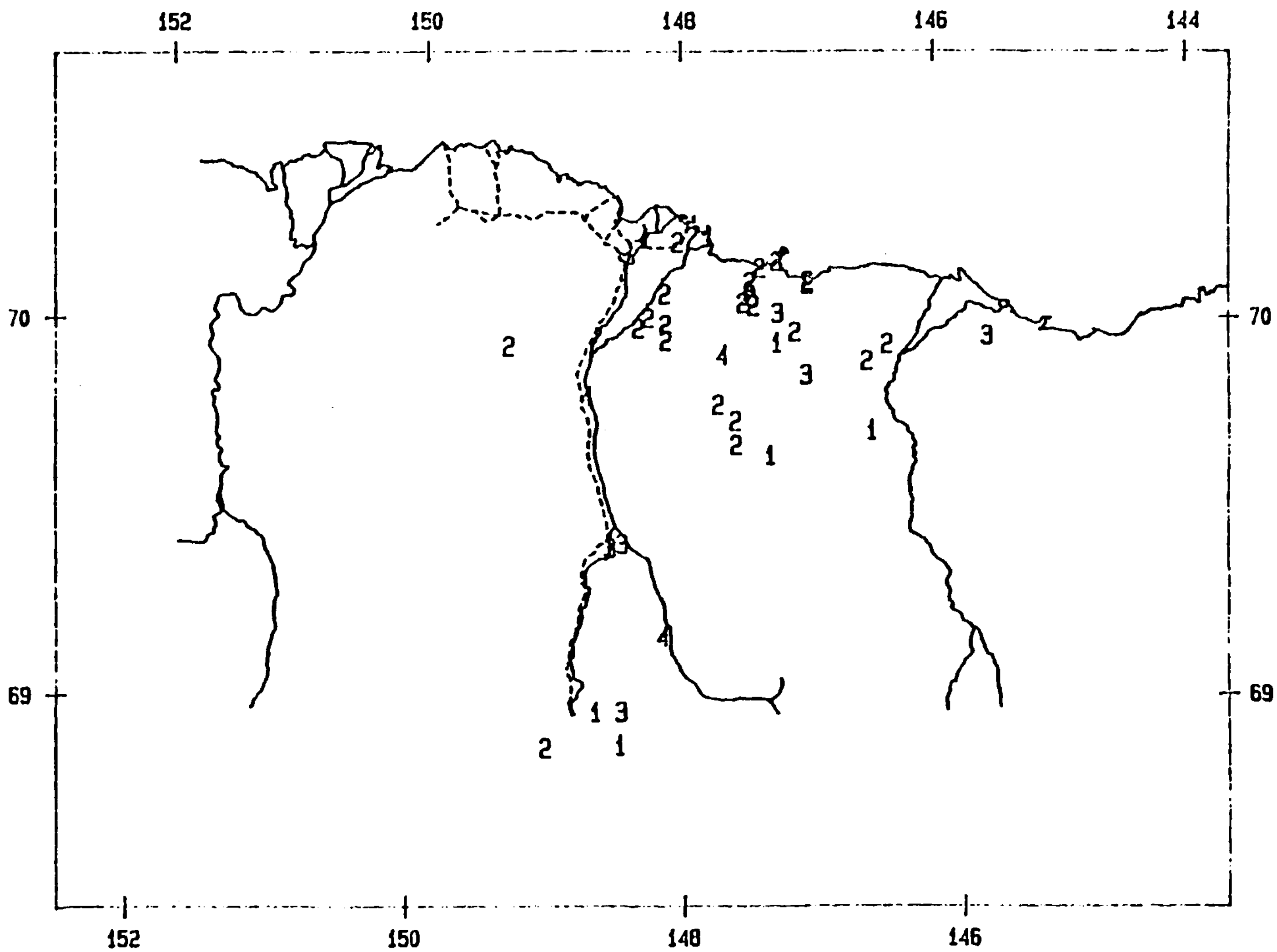

Fig. 5. Locations of radio-collared caribou 8304 (M) by year (see Table 2, footnote b).

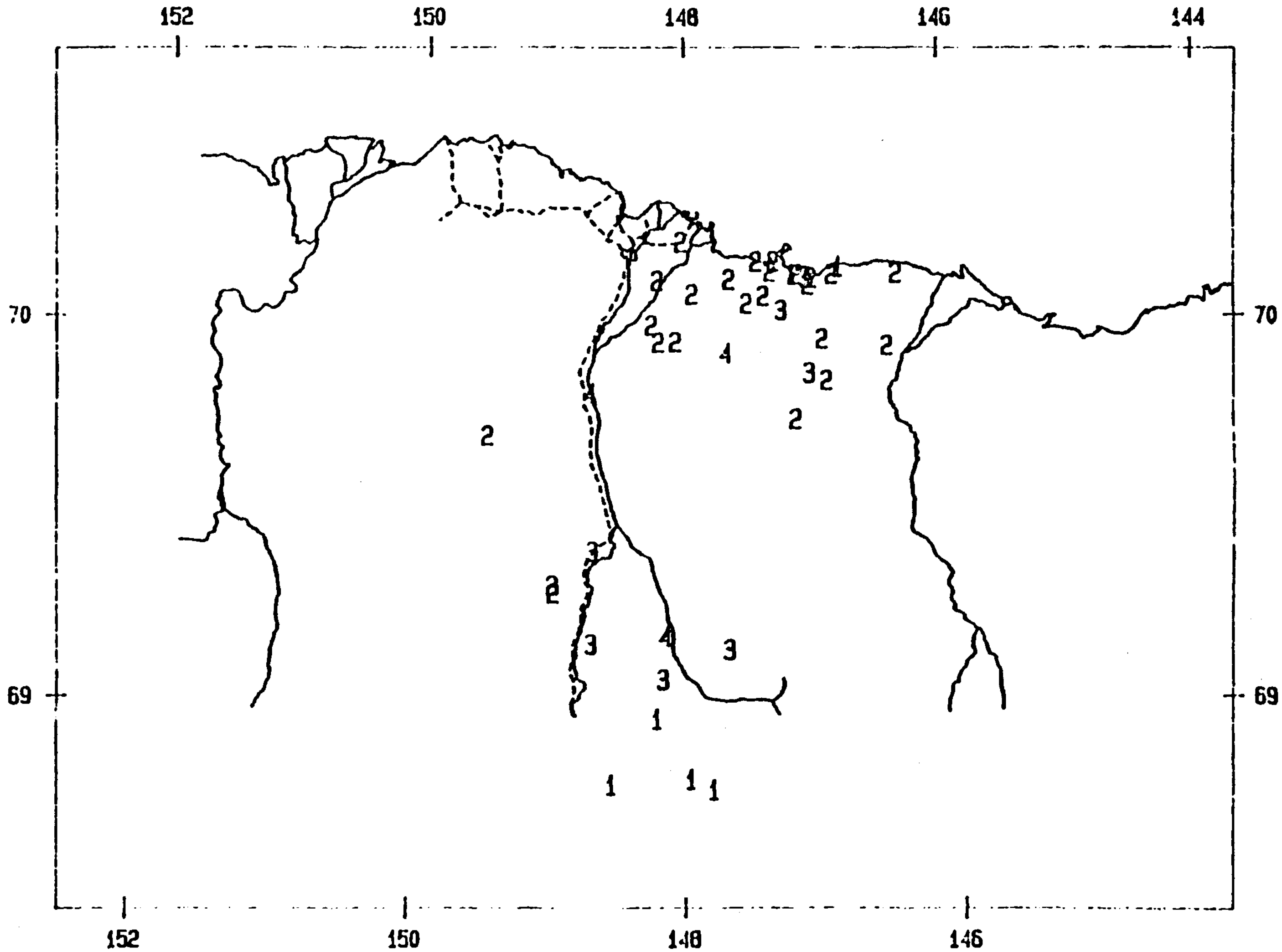

Fig. 6. Locations of radio-collared caribou 8305 (F) by year (see Table 2, footnote b).

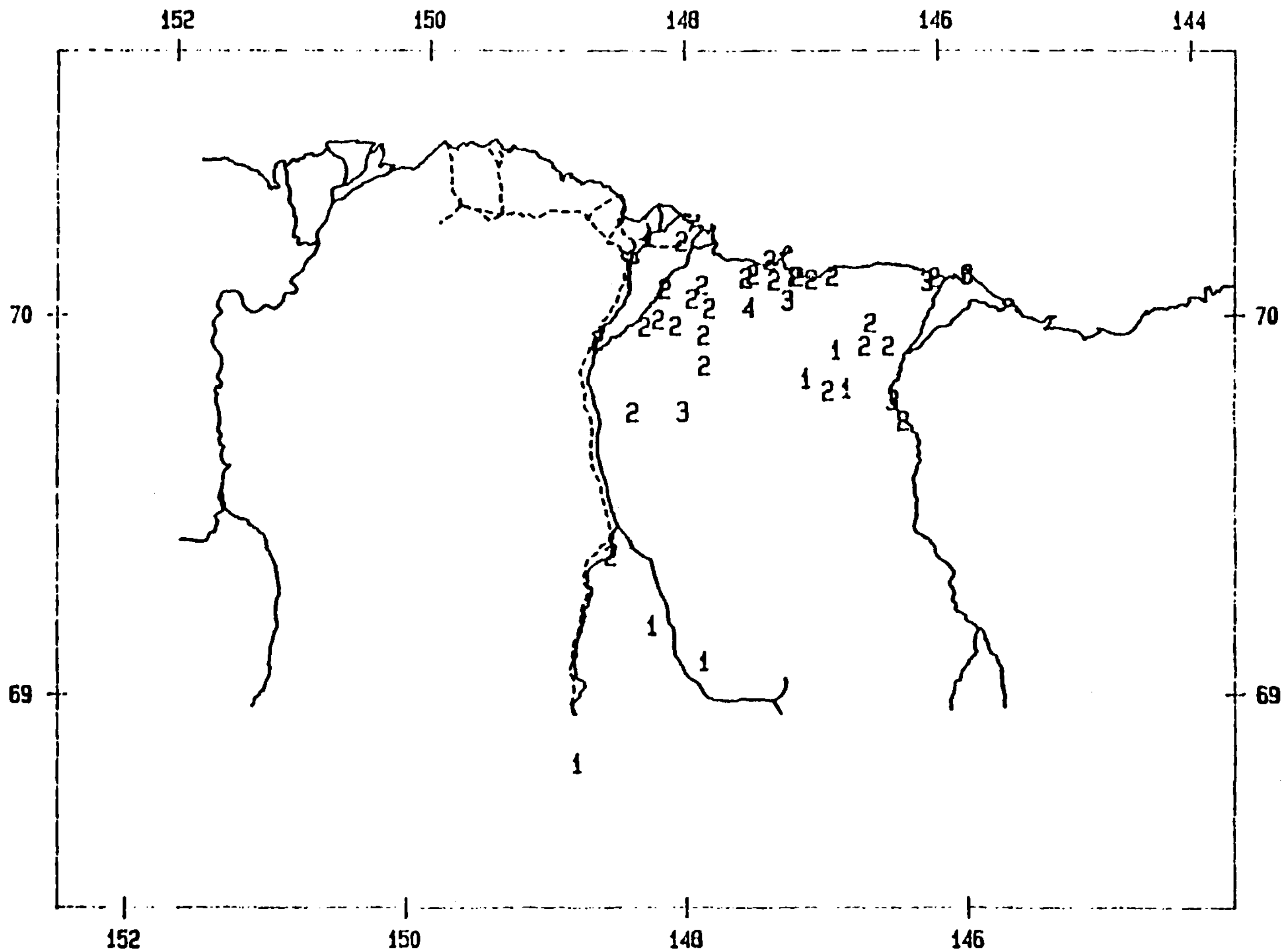

Fig. 7. Locations of radio-collared caribou 8306 (F) by year (see Table 2, footnote b).

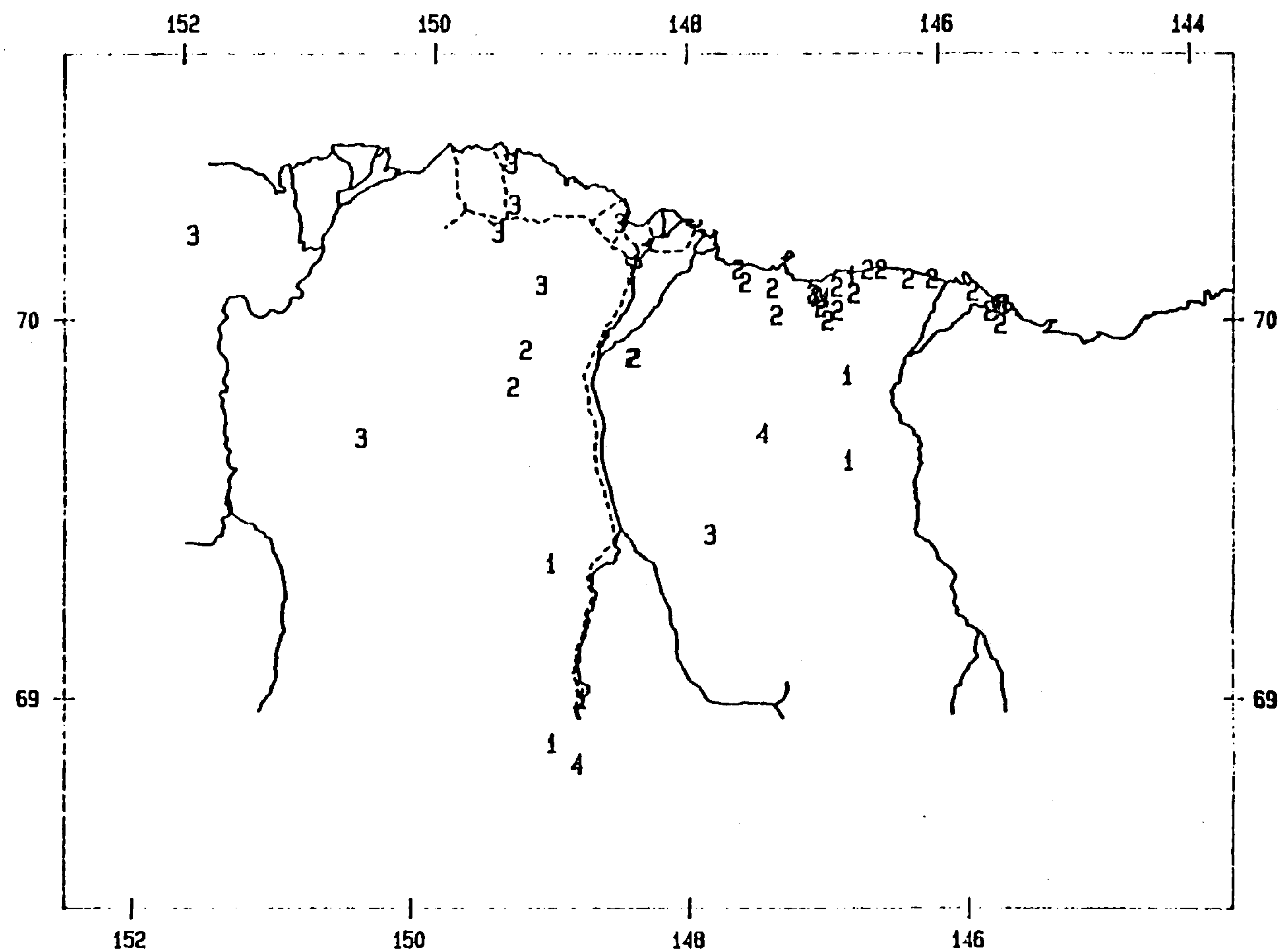

Fig. 8. Locations of radio-collared caribou 8307 (F) by year (see Table 2, footnote b).

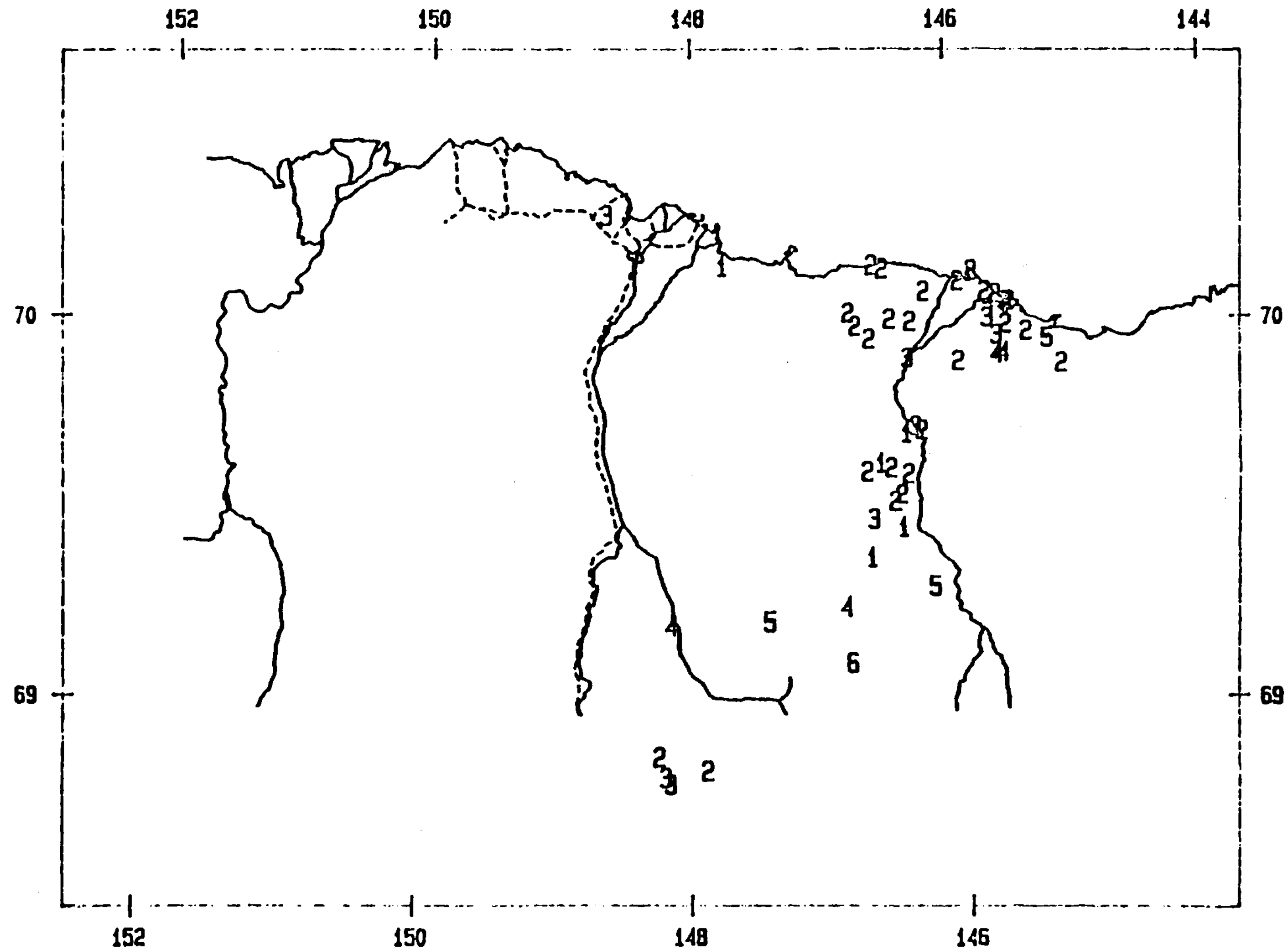

Fig. 9. Locations of radio-collared caribou 8308 (M) by year (see Table 2, footnote b).

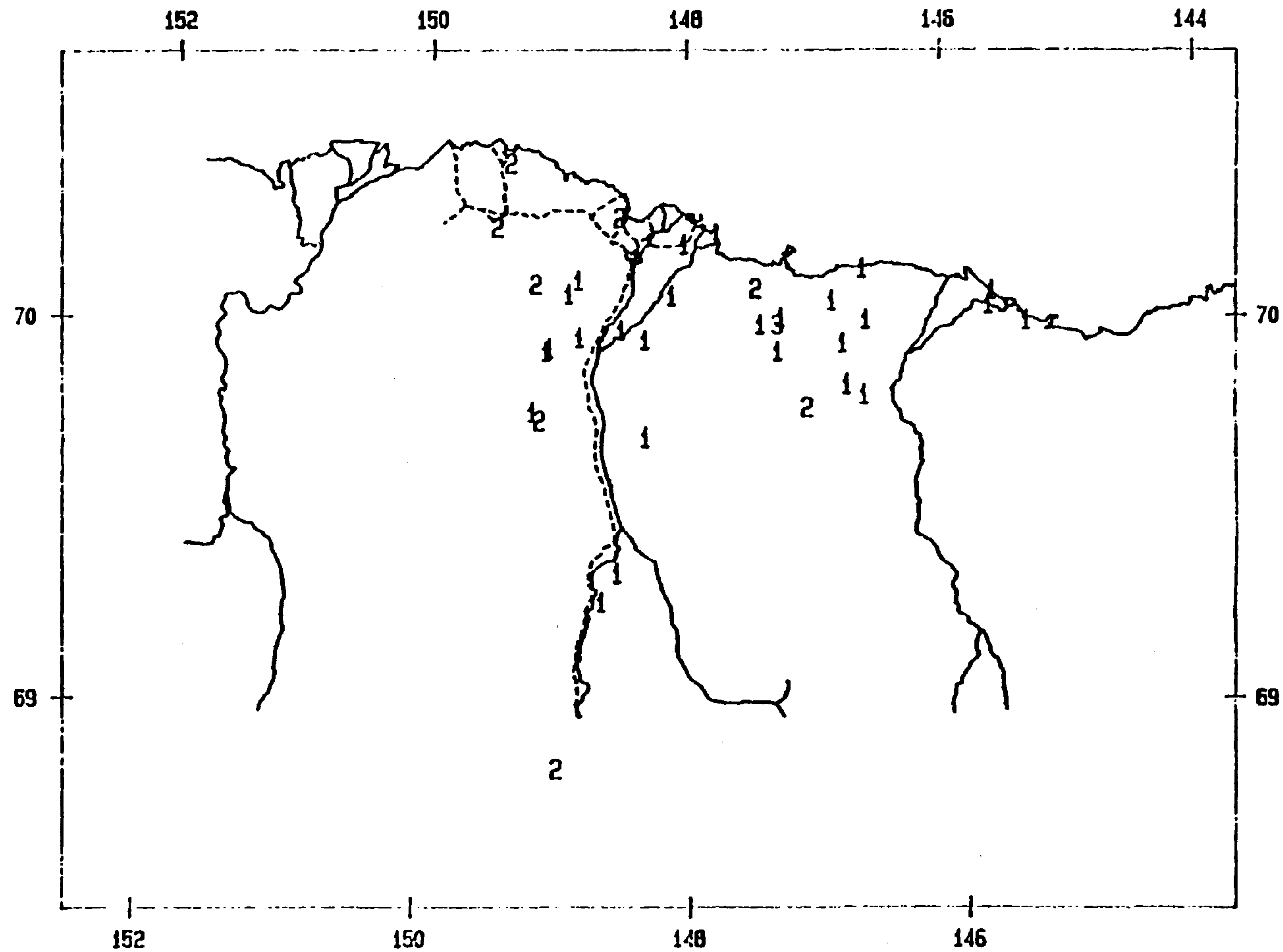

Fig. 10. Locations of radio-collared caribou 8415 (F) by year (see Table 2, footnote b).

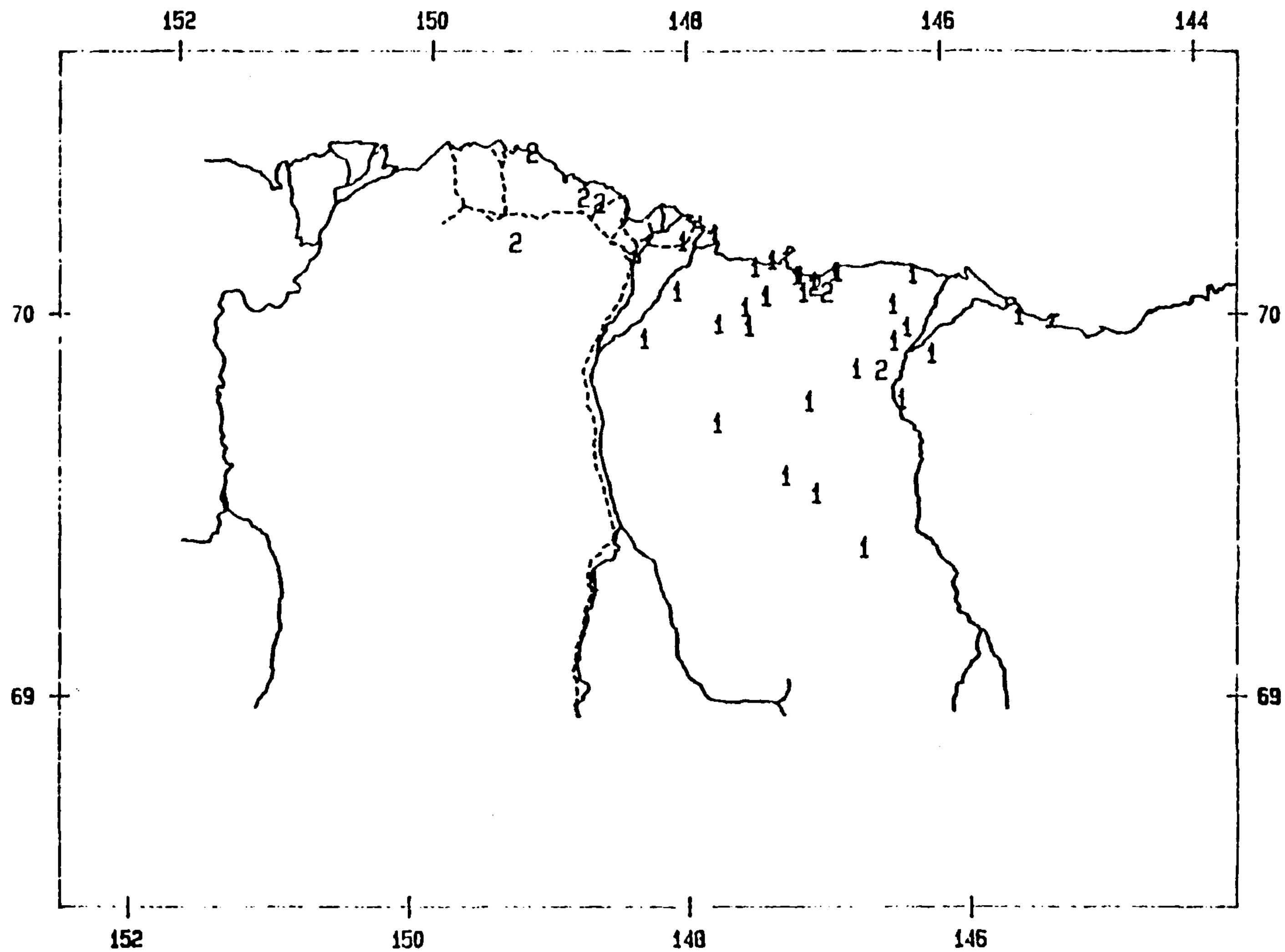

Fig. 11. Locations of radio-collared caribou 8417 (F) by year (see Table 2, footnote b).

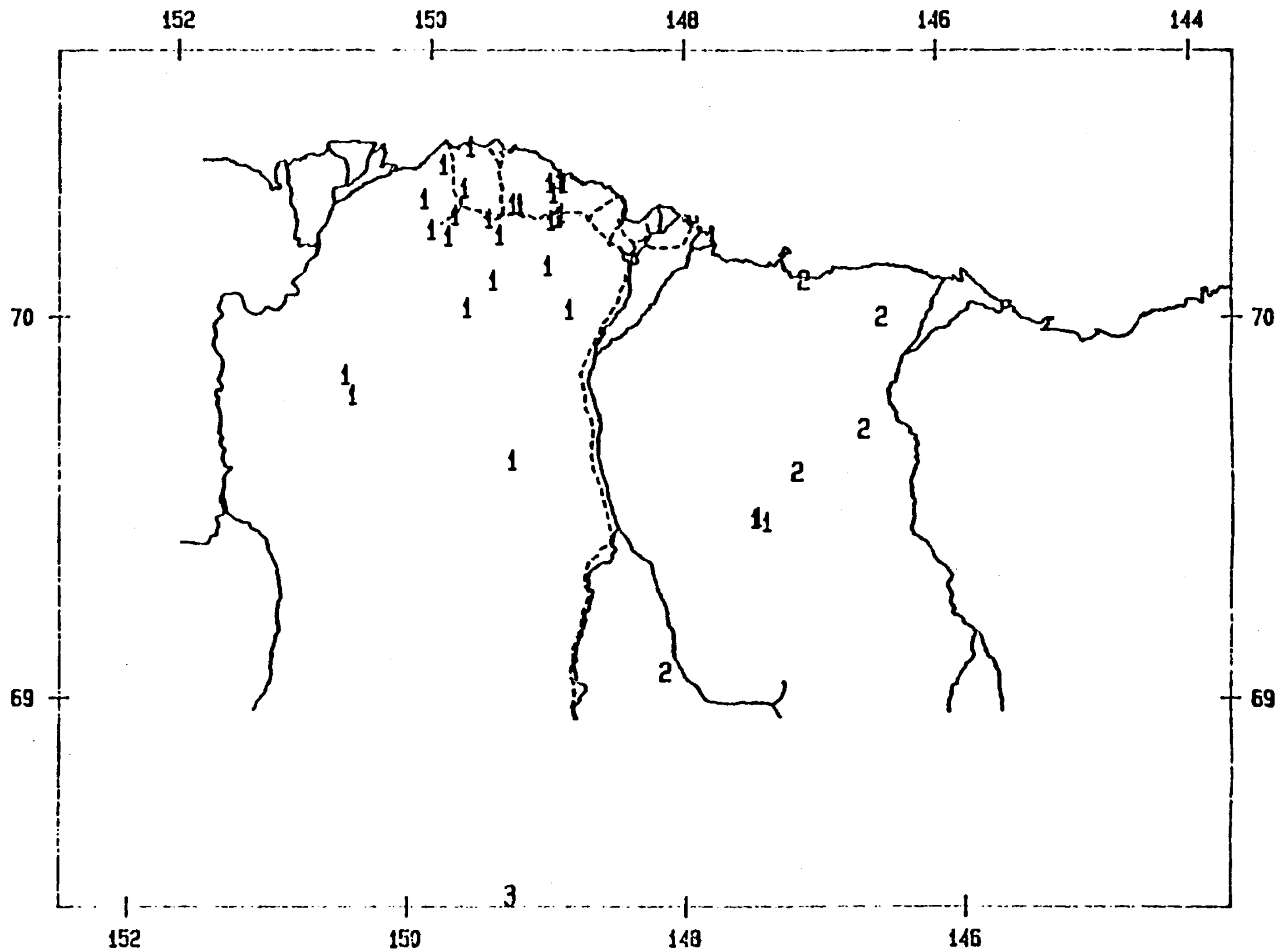

Fig. 12. Locations of radio-collared caribou 8418 (M) by year (see Table 2, footnote b).

Table 1. Disposition of radio-collared offspring of radio-collared female caribou, Central Arctic Herd, 1982-87.

Accession number	Month/year collared	No. months active[a]	Fate/remarks
8221	4/82	41	Normal transmitter life
8222	5/82	26	Dead or collar shed
8301	3/83	0	Dead
8302	3/83	28	Unknown
8303	3/83	16	Dead or collar shed
8304	3/83	28	Unknwon
8305	3/83	28	Unknown
8306	3/83	28	Unknown
8307	3/83	32	Unknown
8308	3/83	50	Normal transmitter life
8413	3/84	4	Collar shed
8414	3/84	8	Collar shed
8415	3/84	16	Unknown
8416	3/84	0	Dead
8417	4/84	12	Unknown
8418	4/84	12	Unknown
8419	4/84	7	Collar shed

[a] Excluding terminal observations of mortality or shed collar.

Table 2. Relocations of radio-collared offspring[a] of radio-collared female caribou, Central Arctic Herd, 1981-87.

Accession number	Sex	Year[b] and season[c]															Total
		1[d]			2			3			4			5			
		Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	Su	Fa	Sp	
8221	F	7	1	2	4	2	3	26	2	1	3	1	1	3			56
8222	M			1	7	2	2	19			4						35
8302	F	5	2	2	28	2	1	4			1						45
8303	F	3	1	2	24	1	1	4									36
8304	M	2	2	2	20	2	1	4	1	1	2						37
8305	F	1	2	2	23	2	2	4	1		2						39
8306	F	3	2	2	25	2	1	5									40
8307	F	3	1	2	24		1	6	1		2	1					41
8308	M	2	1	2	24	2	2	5	1	1	3	1	1	2		1	48
8415	F	21	2	2	7	1		1									34
8417	F	26	2	2	7	1	1										39
8418	M	25	2	2	4	1	1										35

[a] Only those confirmed to have operational transmitters for at least 12 months after collaring (Table 1).

[b] Corresponds to the age of each individual.

[c] Su = summer (Jun-Aug); Fa = fall (Sep-Nov); Sp = spring (Mar-May).

[d] Determined by locating the radio-collared dam.

APPENDIX A.

VARIATIONS IN INITIAL CALF PRODUCTION OF THE CENTRAL ARCTIC CARIBOU HERD

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Proceedings of the 3rd North American Caribou Workshop, November 1987 (in press).

Abstract: Caribou (*Rangifer tarandus granti*) were surveyed annually by helicopter from 1978 to 1987 in a 1,700 km^2 portion of the calving grounds of the Central Arctic Herd. Calf:cow ratios in early June varied between 56 calves:100 cows in 1986 and 91 calves:100 cows in 1983; during postcalving, trends in the percentage of radio-collared females with calves were similar. As the calving grounds are virtually predator-free, and because consistently few dead calves were observed, it appears that differences in the calf:cow ratio are primarily attributable to variations in conception rate and/or *in utero* survival. The relatively low calf:cow ratio recorded in 1986 correlated with poor body condition of adult females captured ca. 1 month before calving, suggesting that reproduction for that year was influenced by nutritional status.

Key Words: calving, caribou, Central Arctic Herd, mortality, natality, *Rangifer*.

The pregnancy rate of adult ($\geq$3 years old at calving) barren-ground caribou (*Rangifer tarandus granti*) reportedly ranges from 48% to 90% (Skoog 1968, Dauphiné 1976, Bergerud 1983). The proportion of females with viable calves immediately after parturition varies with the conception rate, and the incidence of abortion, stillbirths, and lethal birth defects. Subsequent causes of neonatal mortality include predation, abandonment, accidents, starvation, and disease. We define "initial" calf production as the calf:cow ($\geq$2 years old) ratio 1-2 weeks post-partum. This represents the upper limit of recruitment of that cohort and, as such, is an important indicator of the growth potential of the population.

In this paper, we report estimates of initial calf production of the Central Arctic Herd (CAH) (Cameron and Whitten 1979) over a 10-year period based on helicopter surveys of the calving grounds (Whitten and Cameron 1985) and observations of the reproductive performance of radio-collared females.

We are grateful to K. R. Whitten, J. R. Dau, and C. S. Gewin for assistance in data collection and analysis. The work was funded primarily through Federal Aid in Wildlife Restoration Projects W-17-10/11, W-21-1/2, and W-22-1 through W-22-7. Supplemental support was provided by grants from ARCO, EXXON, SOHIO/BP, and Conoco.

METHODS

On 11-14 June 1978-87, at least 1 week after the peak of calving, we surveyed a 1,700-km^2 portion of the CAH calving grounds by helicopter. We searched within 11-13 north-south strip-transects, each 3.2 km wide and 41 km long (Fig. 1), and recorded the sex/age composition (i.e., bulls, cows $\geq$2 years old, calves, and yearlings) of all caribou observed (Cameron et al. 1985, Whitten and Cameron 1985).

Between early June and late August 1980-87, 9-40 radio-collared adult ($\geq$3-year-old) females were relocated at least once by fixed-wing aircraft (Whitten and Cameron 1983, Cameron et al. 1986). For each sighting, the presence of a calf at heel was recorded.

RESULTS AND DISCUSSION

Calf:cow ratios determined from calving ground surveys in 1978-87 varied from 56 to 91 calves:100 cows. By comparison, the 1980-87 percentages of radio-collared cows observed with calves (the equivalent of calf:cow ratios) ranged from 64 to 100 (Table 1).

The 2 data sets are not entirely comparable for several reasons. First, much radio-tracking was done well after the peak of calving, and observations of females without calves would include mortality that occurred subsequent to the strip-transect surveys. Second, in the strip-transect observations, all females older than yearlings were classified as cows for calculating the calf:cow ratio, whereas all radio-collared cows were $\geq$3 years old. Third, strip-transect surveys were centered on a calving concentration area (Whitten and Cameron 1985, Dau and Cameron 1986) and presumably excluded most nonparous females present in the general region, thereby overestimating calf production. Finally, among-year differences in the patterns of snow ablation and flooding strongly influenced the use of coastal vs. inland habitats during calving (Whitten and Cameron 1985), and possibly also affected the relative distribution of parous and/or non-parous females between the 2 areas.

Despite the several sources of potential sampling error, the 2 sets of independent estimates of calf production are correlated (1980 estimates excluded because of the particularly small sample of radio-collared females: $r = 0.71$, $\underline{P} < 0.1$). Most importantly, the extremes were apparent from both samples in the same 2 years: 56 and 64 in 1986, 91 and 100 in 1983 (Table 1). Thus, while the individual values may not be entirely representative of the herd at large, the paired estimates, overall, are in reasonable agreement.

The variation in initial calf production is apparently not attributable to annual differences in predation rate. Golden eagles (*Aquila chrysaetos*) are rare on the CAH calving grounds, and no wolves (*Canis lupus*) or grizzly bears (*Ursus arctos*) have been observed during our helicopter surveys--either in the study area (Fig. 1) or in other areas to the east that have been surveyed less frequently and less intensively over the past decade. Of the few dead calves encountered during our surveys (see below), all were intact, and in no case was there evidence of predator-related mortality. In summary, we are confident that predation has been negligible on the CAH calving grounds in general, and within our study area in particular.

Likewise, it appears that variations in early post-natal mortality are insufficient to account for the observed annual differences in calf production. No more than 4 dead calves have been observed during any one survey of the study area. However, because surveys were conducted ca. 1 week after most calving occurred, frequently under poor sighting conditions (e.g., mottled snow cover), and because searches for dead calves were of an opportunistic nature, we cannot entirely rule out the possibility of annual differences in the rate of early post-partum mortality. But the circumstantial evidence indicates that such an effect was minimal.

It appears, then, that the variation in CAH calf production is attributable to changes in the conception and *in utero* survival rates, but the relative influence of these 2 factors is not readily apparent. Dauphiné (1976), Reimers (1983), and Skogland (1985) reported a direct relationship between fall body weight/condition and pregnancy rate. However, Dauphiné (1976) and Reimers (1983) found low rates of prenatal mortality, irrespective of nutritional status during the previous fall or winter, whereas Skogland (1985) detected significant fetal mortality during late gestation among females on low-quality winter ranges. It is noteworthy that in 1986, the year of lowest CAH calf production, all females collared ca. 1 month before calving were in exceptionally poor condition--in fact, obviously thinner than any others we had handled since 1977. This strongly suggests that the apparent low natality rate was related to the nutritional status of females during the previous fall and/or winter. Ironically, however, insect activity during summer 1985 was unusually low, theoretically enhancing foraging opportunity, and winter snow conditions in 1985-86 were unremarkable. The specific cause of the observed change is, therefore, in question.

At the very least, these data on the CAH indicate that substantial variations in calf production can occur in mainland populations of barren-ground caribou in the absence of predation. While the exact response mechanism is uncertain, variations in body condition, and therefore energy retention, emerge as the likely cause of the changes in reproductive performance. Hypothetically, any environmental change that depresses energy intake or increases energy expenditure can adversely affect calf production and, hence, the growth potential of a caribou herd.

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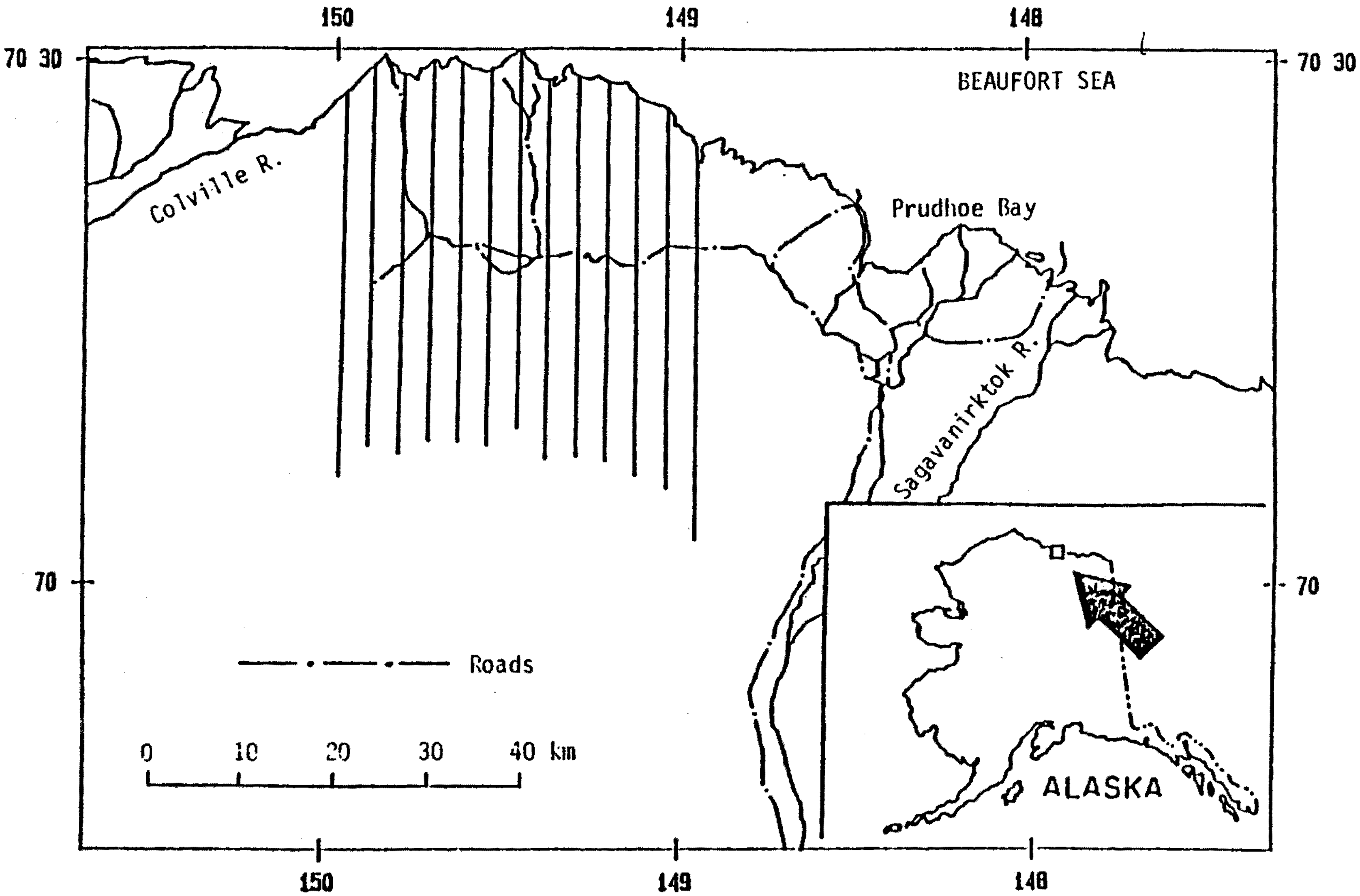

Fig. 1. Centerlines of strip-transects surveyed by helicopter, 11-14 June 1978-87.
Note: Westernmost 2nd and 3rd transects not flown in 1978.

Table 1. Estimates of calf production in the Central Arctic Herd, Alaska, 1978-87.

Year	Strip-transect surveys[a]		Radio-collared females[b]	
	No. calves/ 100 cows[c]	N	% with calves[d]	N
1978	85	771[e]	--	--
1979	85	1,162[e]	--	--
1980	67	509	89	9
1981	88	1,361	90	20
1982	69	1,021	87	31
1983	91	1,796	100	22
1984	89	2,682	79	34
1985	88	2,344	82	28
1986	56	881	64	28
1987	76	991	80	40

[a] See Fig. 1.

[b] Females ≥ 3 years old within the Central Arctic Herd at large.

[c] Females ≥ 2 years old.

[d] Within ca. 5 weeks after the peak of calving.

[e] Excludes caribou in groups with 1 or more unclassified adults.

APPENDIX B.

CARIBOU DISTRIBUTION ON THE CALVING GROUNDS OF THE CENTRAL ARCTIC HERD, 1987

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Final Report to ARCO Alaska, Inc. and the Kuparuk River Unit, March 1988

Executive Summary

1. In 1987, Alaska Biological Research, Inc. (ABR) and the Alaska Department of Fish and Game (ADF&G) cooperated in extensive aerial surveys of caribou on the calving grounds of the Central Arctic Herd of northern Alaska. The study goal was to compare distribution, relative abundance, and chronology of use among various portions of the calving grounds, with emphasis on the Kuparuk Oilfield and vicinity.

2. Caribou were counted and classified into sex and age categories on fixed-width, systematically spaced strip transects oriented in north-south directions between the Colville and Canning River deltas, within 64 km of the Beaufort Sea coast. Between 23 May and 17 June, a fixed-wing aircraft was used to survey 1.6-km width strip transects, spaced at intervals of 1.6 km to 4.8 km, in 5 survey areas. Between 11 and 15 June, a helicopter was used to survey 3.2-km wide strip transects, spaced at intervals of 3.2 km and 9.7 km across the calving grounds. Between 5 and 14 June, 38 radio-collared cows were tracked and located on the calving grounds. Snow cover percentages were estimated from aerial photographs taken in various portions of the study area during the calving period.

3. Variability in the patchiness of snow cover, and generally delayed snowmelt in 1987, causes differences in sightability (probability of detection) of caribou among surveys; hence, results were not directly comparable among all surveys. However, relative differences in distribution and abundance within surveys provided a basis for comparisons. From the presumed peak of calving through the end of the calving period, the highest densities of caribou, including calves, were southwest of the 2 concentration areas delineated in previous years between Oliktok Point and the Kuparuk River (west of the Sagavanirktok River) and between Bullen Point and

the Canning River (east of the Sagavanirktok River). Those 2 areas were still used, but to a much lesser degree than observed previously. Numbers of adult caribou using those areas remained relatively stable during the calving period.

4. The number of caribou counted in the western concentration area, encompassing the Kuparuk Oilfield and vicinity, was among the lowest on record, particularly in terms of proportional use (given herd expansion over the last decade). The numbers of adult caribou counted in the overall area near the coast between the Colville and Kuparuk Rivers remained stable or increased slightly during the calving period. Within that area, however, the numbers observed on transects between Kalubik Creek and the Milne Point Road (including all Kuparuk Oilfield facilities) decreased, indicating redistribution of caribou during the period. In late May, before peak calving, use of dust shadows along roads in the oilfield was extensive, but caribou moved away from roads by peak calving and thereafter; this movement was attributed primarily to increased forage availability as snow melted and to the sensitivity to disturbance of cows with young calves.

5. The sex and age composition of all caribou classified on helicopter and fixed-wing surveys during the period 11-17 June (totaling 4,937 and 2,950 animals, respectively) was 49-51% cows, 38% calves, 10-11% yearlings, and 2% bulls. The observed calf:cow ratio was 75-78 calves:100 cows, and the yearling:cow ratio was 19-21 yearlings:100 cows.

APPENDIX C.

SEASONAL DISTRIBUTION OF FEMALE CARIBOU OF THE CENTRAL ARCTIC HERD, 1981-87: PRELIMINARY APPLICATION OF HOME RANGE SOFTWARE

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Unpublished Note

SUMMARY

At variable intervals between April 1981 and October 1987, we obtained 1,890 locations on a total of 107 radio-collared adult (3+-year-old) female caribou of the Central Arctic Herd using aerial tracking techniques (Table 1). Point locations were recorded on 1:250,000 USGS topographic maps, from which geographic coordinates were generated on a digitizing table. All position data were entered on computer file, collated by month (across years), and plotted as percentage distribution among 4 latitudinal intervals (Fig. 1). Months judged to be similar in terms of caribou distribution were grouped into 4 seasons: spring (Apr-May), summer (Jun-Aug), fall (Sep-Oct), and winter (Nov-Mar). Within a designated season, individual locations for each caribou were weighted according to the fraction of the period represented. All caribou were assigned equal weight within a year, and all years for which data are available contributed equally. Caribou home ranges were estimated using Anderson's (1982)[a] nonparametric technique. Figures 2-5 depict the actual locations and a 70% utilization distribution for each of the 4 seasons.

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[a] Anderson, D. J. 1982. The home range: a new nonparametric estimation technique. Ecology 63:103-112.

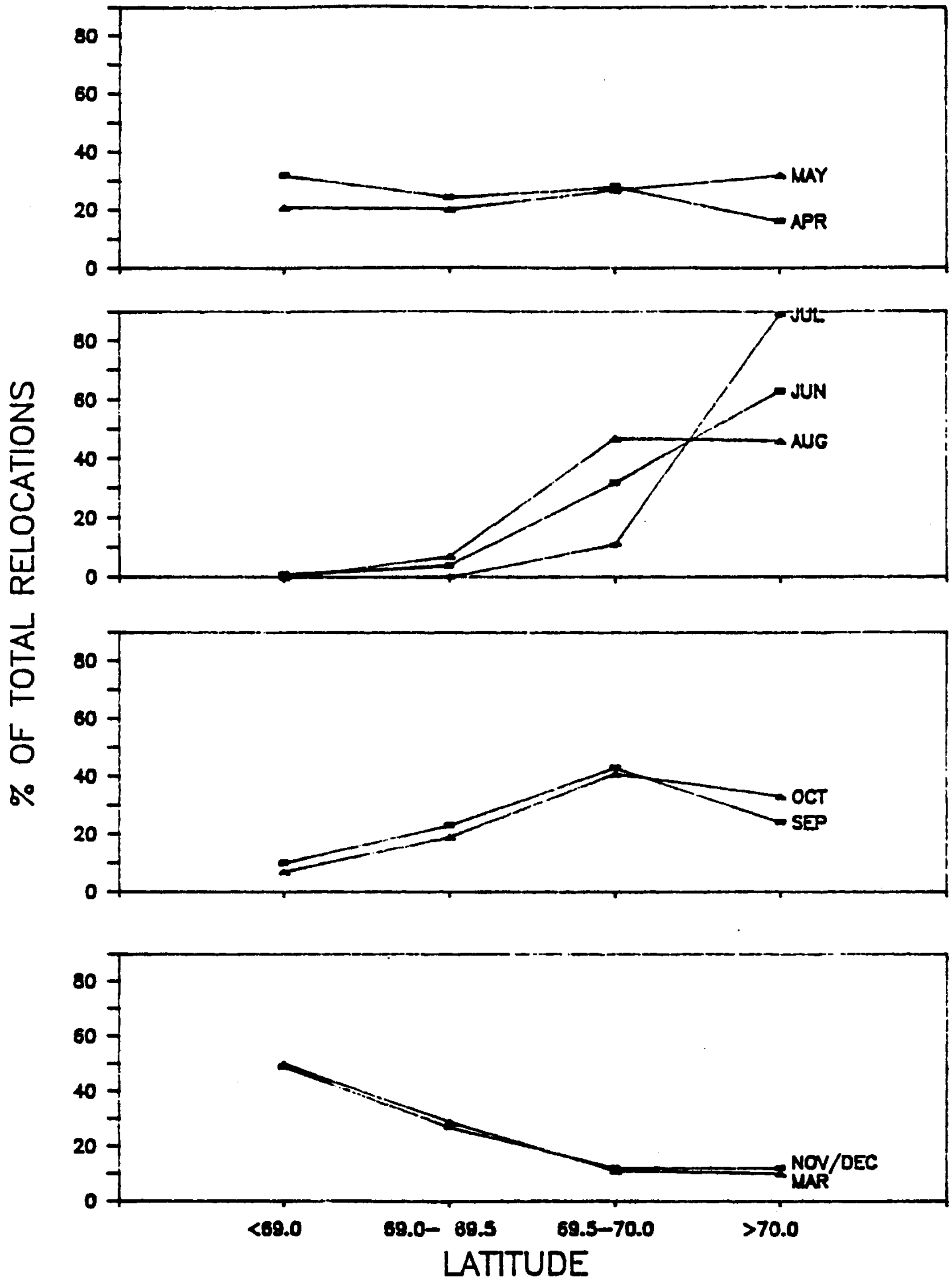

Fig. 1. Seasonal changes in latitudinal distribution of radio-collared female caribou of the Central Arctic Herd, 1981-87.

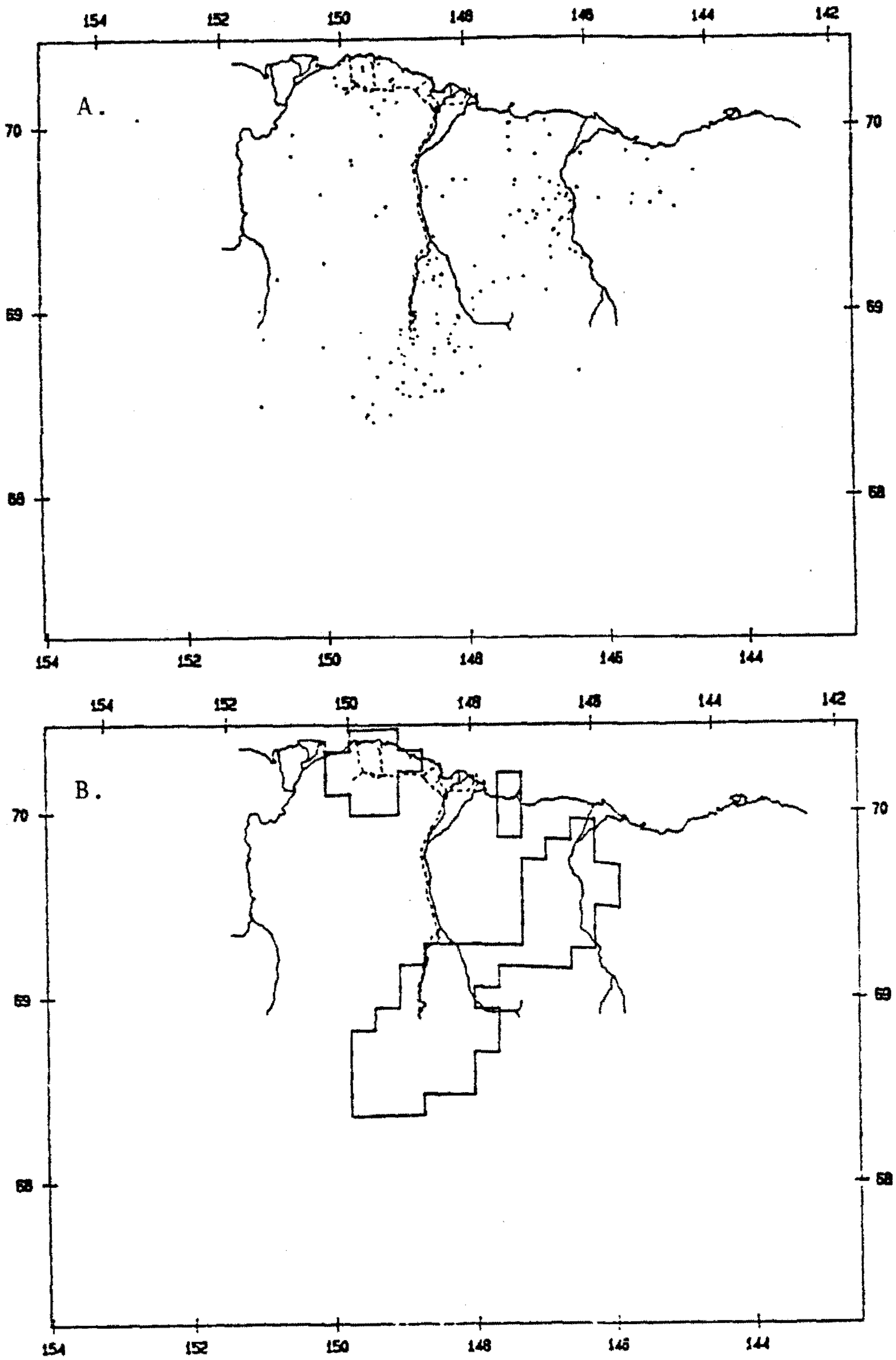

Fig. 2. Point locations of radio-collared female caribou of the Central Arctic Herd (A) and their weighted 70% utilization distribution (B), spring 1981-87.

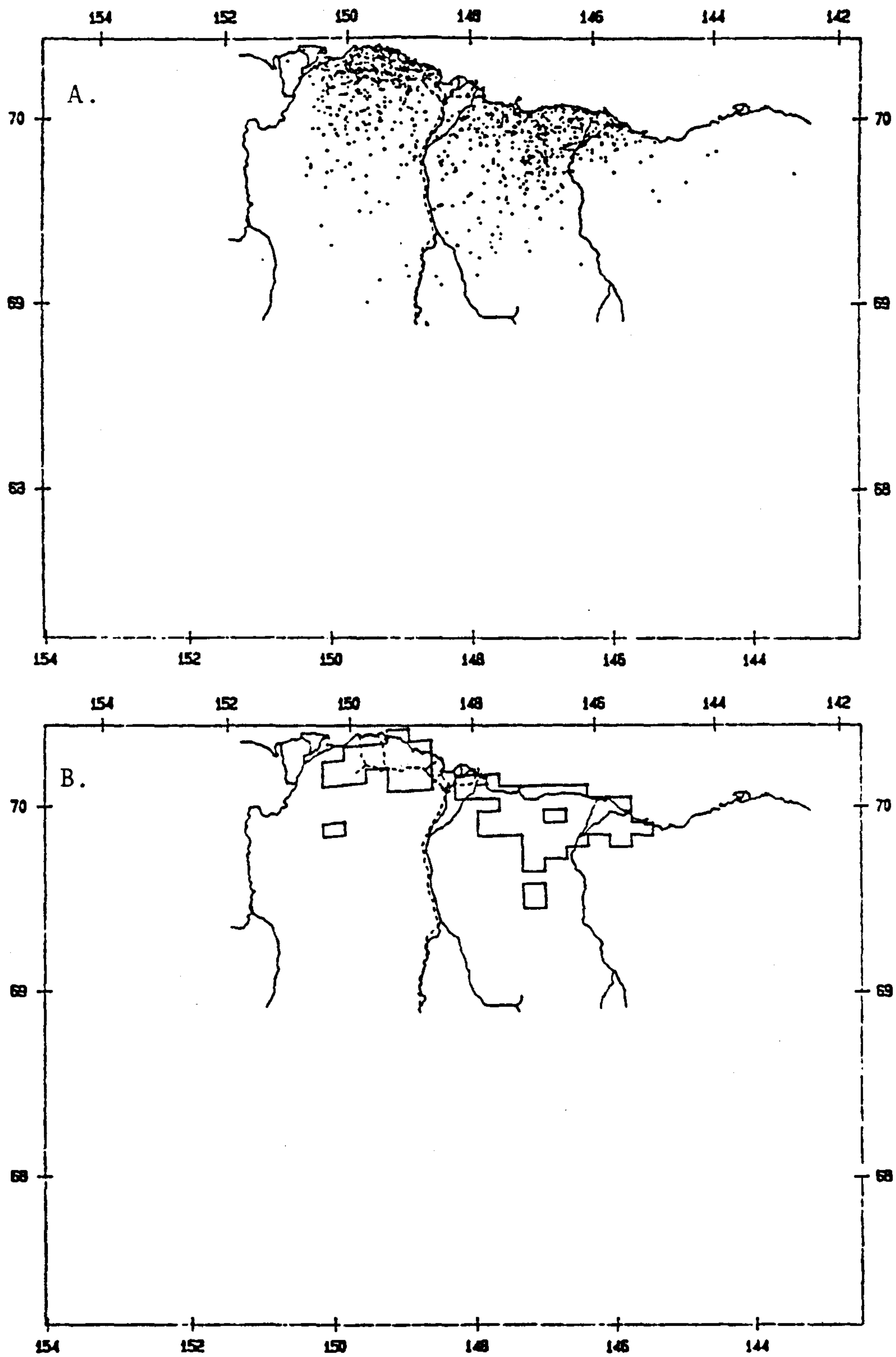

Fig. 3. Point locations of radio-collared female caribou of the Central Arctic Herd (A) and their weighted 70% utilization distribution (B), summer 1981-87.

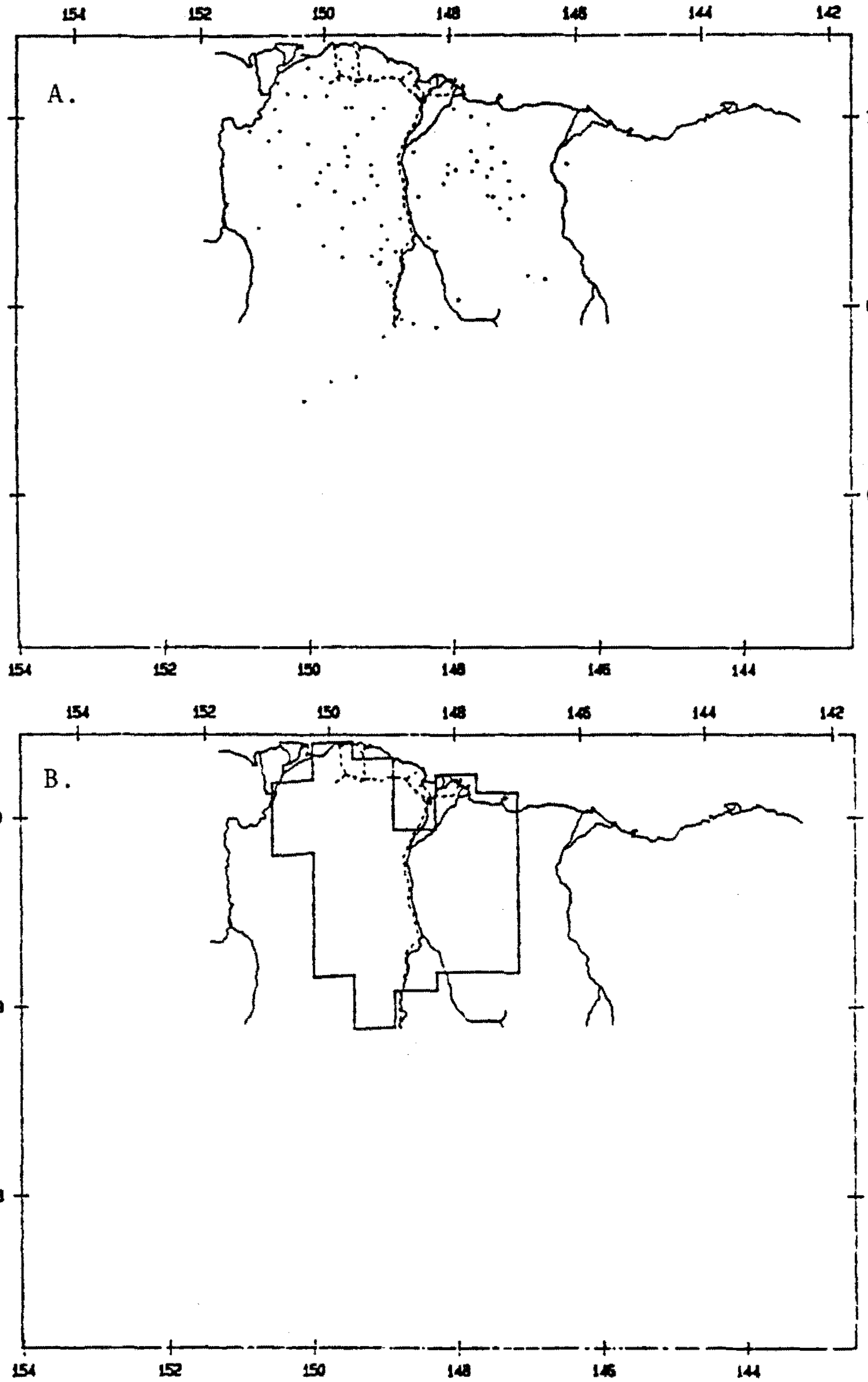

Fig. 4. Point locations of radio-collared female caribou of the Central Arctic Herd (A) and their weighted 70% utilization distribution (B), fall 1981-87.

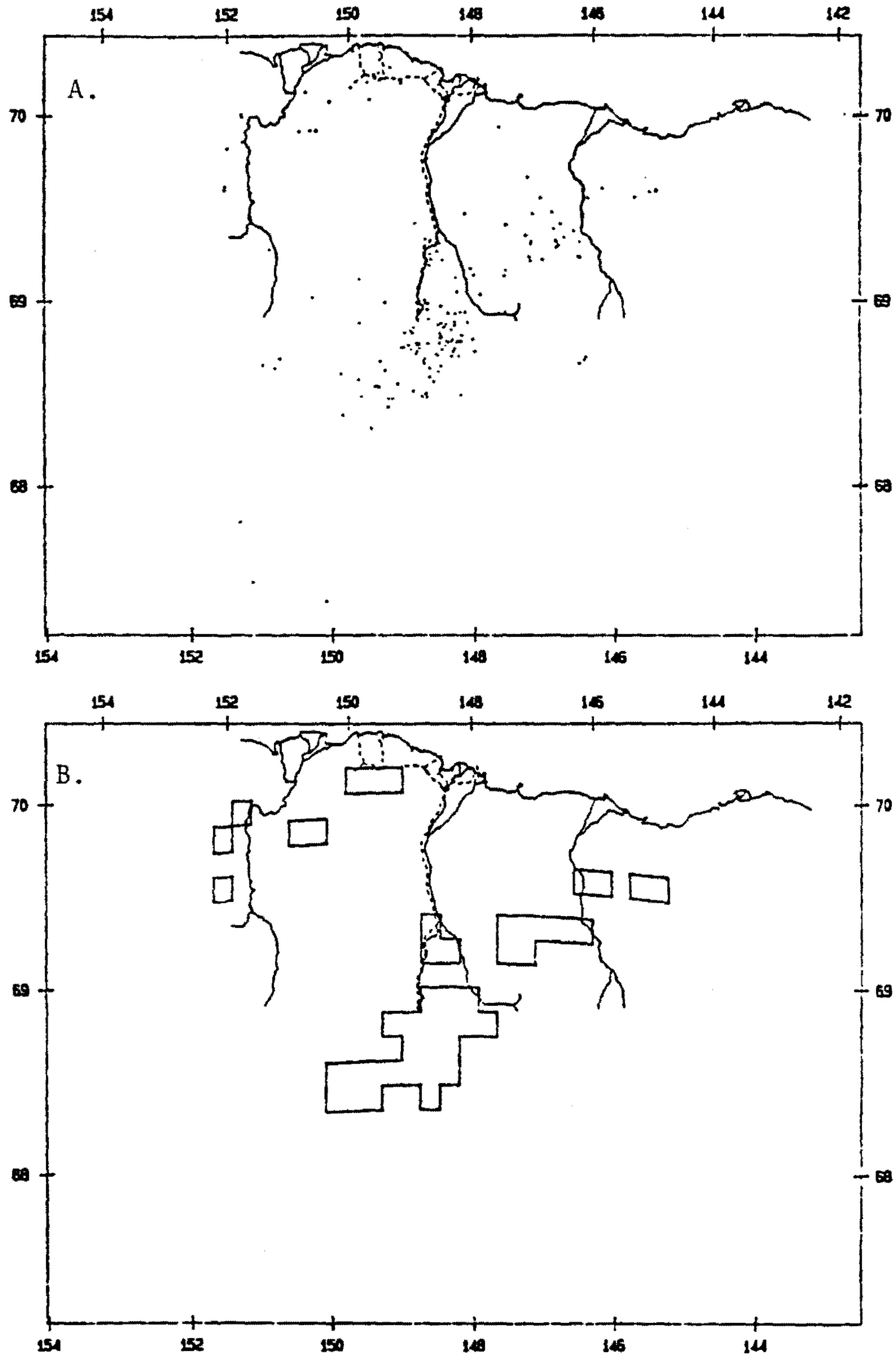

Fig. 5. Point locations of radio-collared female caribou of the Central Arctic Herd (A) and their weighted 70% utilization distribution (B), winter 1981-87.

Table 1. Number of locations (number of caribou represented) of radio-collared female caribou by season and year, Central Arctic Herd, 1981-87.

	Months				
Year	Apr-May	Jun-Aug	Sep-Oct	Nov-Mar	All
1981-81	16(16)	141(20)	16(16)	11(11)	184(23)
1982-83	33(31)	110(31)	27(27)	52(29)	222(36)
1983-84	38(27)	640(25)	17(17)	43(25)	738(33)
1984-85	24(24)	148(34)	0(0)	29(29)	201(35)
1985-86	36(32)	108(35)	0(0)	24(24)	168(39)
1986-87	20(19)	106(35)	0(0)	20(20)	146(43)
1987-88	38(38)	154(48)	39(39)	0(0)	231(57)
Total	205(90)	1,407(93)	99(68)	179(66)	1,890(107)