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BROWN BEAR HABITAT PREFERENCES AND BROWN BEAR LOGGING AND MINING RELATIONSHIPS IN SOUTHEAST ALASKA

By
John W. Schoen
and
LaVern Beier

Progress Report
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PROGRESS REPORT (RESEARCH)

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Project No.: W-22-3 Job Title: Brown Bear Habitat Preferences and Brown Bear Logging and Mining Relationships in Southeast Alaska

Job No.: 4.17R

Period Covered: 1 July 1983-30 June 1984

SUMMARY

From 1 May 1983 through 30 June 1984, 15 brown bears were captured on Admiralty Island and 11 on Chichagof Island. Since fall 1981, 57 bears have been captured. Six hundred and forty-eight relocations were recorded during this report period. Old-growth forest, including riparian forest, received the greatest use of all the habitat types throughout the year. Substantial seasonal variation in habitat use occurred, however, as well as differences between sites. As in 1982, bears on Admiralty were not uniformly distributed. Seven females remained in interior regions throughout the summer, while the majority of bears moved to anadromous fish streams in the late summer to feed on salmon. Mean home range size of 7 Admiralty Island males was 112 km^2 while the mean of 14 females was 34 km^2. A density of 67 bears per 100 km^2 was estimated for the Admiralty site. Reproductive history of radio-collared females is presented as well as denning dates and den site characteristics.

Key words: Admiralty Island, Chichagof Island, brown bear, habitat use, home range, Southeast Alaska, *Ursus arctos*.

CONTENTS

BACKGROUND

Historically, the brown/grizzly bear (*Ursus arctos*) was widely distributed in North America from central Mexico to northern Canada and Alaska, and from the Mississippi to the Pacific Coast (Hall and Kelson 1959). Today, populations of this species are restricted to northwestern Canada, Alaska, and a few scattered wilderness enclaves in Montana, Idaho, and Wyoming. Alaska has the last major population of brown/grizzly bears in the United States. An understanding of their ecology, including basic life history, population status, movement and home range patterns, and habitat relationships, is essential for good management.

Brown bears are indigenous to Southeast Alaska where they occur throughout the mainland and on islands north of Frederick Sound. Management concerns include hunting, habitat alteration resulting from logging and mining operations, and increased human activities associated with development and recreation.

A general background and literature review for this study was previously outlined (Schoen 1982). This investigation proposes to determine seasonal habitat preferences and distribution of brown bears in Southeast Alaska, and to evaluate the effects of mining and logging activities on brown bear populations in this region.

OBJECTIVES

To determine weekly and seasonal movement patterns and habitat utilization by brown bears in southeastern Alaska, particularly in respect to activities associated with mining and/or logging, and to locate and describe denning sites and determine reproductive rates and relate these to habitat and harvest levels.

STUDY AREA

The study area is located in the Alexander Archipelago of southeastern Alaska. Specific sites have been selected on northern Admiralty and eastern Chichagof Islands in the northern portion of the archipelago. The Admiralty site was described by Schoen (1982). The Chichagof site was described by Schoen and Beier (1983).

METHODS

Bears were captured in the alpine by darting them from a helicopter, and along beaches and salmon streams by snaring with Aldrich leg hold snares. Sernylan (phencyclidine hydrochloride, Bioceutic Laboratories, Inc., St. Joseph, Mo. [no longer manufactured]) was the primary immobilizing drug used, in combination with a tranquilizer (acepromazine, Prom Ace or Acepromazine, Fort Dodge Laboratories, Fort Dodge, Iowa). Etorphine hydrochloride (M99, Lemmon Company, Sellersville, Pa.) and its antagonist diprenorphine hydrochloride (M50-50, Lemmon Company Sellersville, Pa.) were also used to immobilize several bears. Movements, home range patterns, and habitat use were determined by relocating instrumented bears through radiotelemetry. A further description of this methodology is provided in Schoen (1982).

RESULTS AND DISCUSSION

This report represents data collected in 1983, from den emergence to denning. Also reported are capture data through June 1984. During this reporting period, 15 bears were captured on Admiralty Island. This includes 4 recaptured bears to which new radio-collars were attached. To date, 47 bears have been captured on Admiralty (Table 1). At the completion of this reporting period, 28 radio-collared bears were still transmitting. These included 19 females and 9 males. During this same period, 11 bears were captured and instrumented on Chichagof Island (Table 2). These included 5 females and 6 males. Eight radio-collared bears were transmitting at the end of this reporting period.

Since fall 1981, 57 brown bears have been captured. Thirty-six bears are currently transmitting, 3 bears have been shot by hunters, 4 bears died during capture, 1 female was killed and eaten by a male bear before she recovered from immobilization, and 13 bears are unaccounted for.

During this report period, we recorded 648 relocations of radio-collared bears. Seventy-five percent were from Admiralty Island and 25% were from Chichagof Island. To date, over 1,000 relocations have been recorded.

Seasonal Distribution and Habitat Use

Following exploratory analysis of our telemetry data, we divided the year into 4 seasons: spring (den emergence-15 May), early summer (16 May-15 July), late summer (16 July-15 September), and fall (16 September-denning). These were biologically meaningful periods in terms of bear distribution and activities. The distribution of 1983 bear relocations was broken down as follows:

Season	Admiralty	Chichagof
Spring	40	0
Early summer	175	21
Late summer	171	63
Fall	100	78

In 1983, radio-collared Admiralty bears were distributed higher than Chichagof bears; this distribution reflects, in part, the higher topography of the Admiralty study site (Table 3). Females were generally distributed higher than males in both areas. Bears were distributed higher in early summer and fall than during any other season. Early summer coincides with the breeding season when many bears utilized open alpine/subalpine habitat (primarily on Admiralty Island). In fall most bears moved to avalanche slopes to feed on berries, then later searched for den sites at higher elevations. Bears were distributed at the lowest elevations during late summer when most bears foraged for salmon in coastal streams. A cross-tabulation of elevational distribution by season and study area is presented in Table 4.

On Admiralty Island, radio-collared female bears were not distributed uniformly (Fig 1). This differential distribution follows that reported on Admiralty Island by Schoen et al. (in press). For 2 consecutive years, 4 bears have continued using interior habitats to the exclusion of anadromous fish streams. Additionally, 3 other bears also failed to move down to coastal salmon streams during 1983. These bears were all females ranging in age from 4 to 24 years and included females with and without cubs. No adult males have been observed to display this pattern.

Average slope of female relocations was steeper than that of males (Table 5). The steepest slopes were used during fall by both males and females. This reflects their increased use of steep avalanche slopes as well as their search for denning sites, most of which occur on slopes greater than 25°. During late summer, bears used terrain of gentle slopes coinciding with riparian habitat adjacent to salmon streams. A cross-tabulation of bear distribution relative to slope, by season and study area, is provided in Table 6.

There are no apparent trends in the distribution of seasonal bear relocations relative to aspect (Table 7).

Bears increased their use of broken terrain during fall when they used steep avalanche slopes prior to denning (Table 8). Broken terrain was used least during late summer when most bears were foraging along anadromous fish streams.

No distinct patterns are discernable in seasonal bear distribution relative to drainage (Table 9).

Distribution of brown bear relocations relative to habitat type, by season and study area, is presented in Table 10. There was substantial seasonal variability in habitat use. Habitat use also varied between study sites reflecting, to a large degree, differences in the habitat composition of the 2 study sites. In both sites, old-growth forest (including riparian old-growth) was the habitat type used most extensively throughout the year.

In spring, 72% of bear relocations on Admiralty Island occurred in old growth with avalanche slopes, alpine, and subalpine habitats contributing 10%, 8%, and 5%, respectively.

During early summer on Admiralty Island, bears continued to use old growth (44%) but substantially increased their use of alpine (31%), subalpine (14%), and avalanche slopes (10%). Clearcuts were used by bears on Chichagof Island much more during early summer than during any other season.

During late summer, bears in both sites greatly increased their use of riparian old growth. This coincided with peak spawning runs of salmon when most bears fished along coastal streams. Other habitat types receiving substantial use during this period included old-growth forest (24-34%) and avalanche slopes (19-26%). The high use of avalanche slopes, particularly on Admiralty Island, reflects the distribution of "interior" bears which foraged in these areas primarily on devil's club (Echinopanax horridum) and salmon berries (Rubus spectabilis).

By 15 September, most bears on Admiralty Island had begun moving away from fish streams in riparian old growth (7%). After leaving fish streams they increased their use of avalanche slopes (34%) where they foraged on currents (Ribes spp.) and devil's club berries. Old-growth forest continued to be heavily used (38%) and use of alpine/subalpine (16%) also increased.

At the Chichagof site, many bears continued fishing on late runs of salmon. Consequently, although use of old growth (40%) increased in fall, use of riparian old growth (21%) continued to be relatively high. Avalanche slopes were also used substantially (23%) though not as much as on Admiralty Island.

Although many of the radio-collared bears on Chichagof Island had access to clearcuts, this habitat type appeared to be used less than its availability would suggest, except perhaps during early summer. A detailed analysis of habitat preference (comparing use to availability) will be undertaken in the future. The Sitka District of the Forest Service is currently preparing a habitat inventory for this project.

A cross-tabulation of bear use relative to canopy cover, by season and area, is presented in Table 11. Generally, open canopy sites were used most in early summer. No other trends are obvious.

High percentage spruce (Picea sitchensis) sites were used most during late summer at both sites (Table 12). This coincided with high bear use of riparian old growth during salmon runs. Many fish streams are bordered by high volume riparian spruce stands and bear use relative to timber volume also follows this pattern (Table 13).

Home Range and Movements

Home ranges were determined by connecting the outer points of location to form convex polygons (Mohr 1947). Home range plots of radio-collared brown bears monitored during 1983 are presented in Appendices A and B. Means and standard errors of the size of home range areas follow:

	Admiralty Island		Chichagof Island	
	Male	Female	Male	Female
$\bar{x}$ =	$112km^2$ ($43mi^2$)	$34km^2$ ($13mi^2$)	$42km^2$ ($16mi^2$)	$11km^2$ ($4mi^2$)
$\overline{SE}$ =	30	5	6	0.8
$\underline{n}$ =	7	14	5	4

The home range size of males was about 4 times larger than that of females. Males moved greater distances during spring and also moved to more fish streams during the late summer than did females. Home range sizes of brown bears on Chichagof Island were smaller than on Admiralty Island. However, Chichagof bears were not captured until late June. Thus it is likely we underestimated the size of their annual ranges in 1983. The annual home range sizes of brown bears from Admiralty and Chichagof Islands are comparable to those from Kodiak Island (Smith and Van Daele 1984) but less than 10% of those reported by Miller (1984) for grizzly bears in the Susitna Basin.

There was considerable overlap in individual bear home ranges during consecutive years. Examples of annual home range fidelity are presented in Appendix C.

The maximum straight line distance across home ranges of radio-collared brown bears on Admiralty Island was 8 km for females and 17 km for males. Maximum recorded straight line distance moved was by a young female on Admiralty Island (32km) and a young male on Chichagof Island (48km). Both bears were observed and identified by colored ear flags. However, neither bear had a functional radio-collar.

On 6 July and again on 17 August, 12 radio-collared bears were located intensively throughout a 24-hour period. In July, we flew at 1000 hours, 1600 hours, 2200 hours, and again the next morning at 0500 hours. In August, we flew at 0800, 1400, and 2030 hours. In these intensive surveys, only 3 bears moved a maximum distance between points of from 3 to 6 km. Most bears moved only minimal distances (generally less than 1 km) within the 24-hour period. The 3 bears which made larger moves appeared to be just shifting location within their home ranges. There seemed to be no major habitat shifting related to time of day, nor was there a shift in distribution of either "coastal" or "interior" bears.

Density Estimates

During early summer (16 May-15 July), bears on Admiralty Island were highly visible because many were distributed in alpine/subalpine habitats (45% of telemetry locations occurred in the alpine/subalpine). On telemetry flights and/or helicopter capture trips, it was common to see 25-30 bears in several hours. On the evening of 29 June 1983, between 2000 and 2200 hours, 3 independent fixed-wing alpine surveys for bears were flown. These were conducted on north Admiralty (at our study site), south Admiralty, and east Chichagof.

Results of these surveys are summarized in Table 14. The greatest number of bears was observed in our study site on north Admiralty Island, the least on east Chichagof Island.

On the north Admiralty Island survey area (approximately 390 km^2), we had an opportunity to assess population density utilizing an index of marked versus unmarked animals. Within the north Admiralty site, we could account for at least 25 marked, adult bears. Thus, the observation of 4 marked bears on our survey represented 0.16 of the total observed bears. An estimate of the total adult population is then 175 bears. If there were 50 cubs per 100 adults, then correcting for cubs provides a total population density of 67 bears per 100 km^2 (170:100 mi^2).

We recognize this single estimate based on mark recapture to be only a general estimate prone to a variety of weaknesses. However, based on our knowledge of the area and observations of many bears, both marked and unmarked, we feel an estimate in the range of 40 bears per 100 km^2 (100:100 mi^2) or greater is reasonable. In 1932, Dufresne and Williams estimated 900 bears for all of Admiralty Island (4,443 km^2 or 50:100 mi^2).

Troyer and Hensel (1964) estimated a brown bear density of 65 bears per 100 km^2 at Karluk Lake on Kodiak Island, while Smith and Van Daele (1984) estimated 25 bears per 100 km^2 in the Terror Lake area of Kodiak. These are comparable to our estimates for Admiralty Island. In contrast, Miller (1984) estimated grizzly densities of 2 bears per 100 km^2 in the Susitna Basin in interior Alaska. We feel confident that the densities of brown bears in our Admiralty study area are as high as those recorded anywhere.

Reproduction

A summary of the reproductive status of radio-collared female brown bears is presented in Table 15. It will be necessary to continue collecting data over several more years on specific individuals of known ages before we can reach firm conclusions. However, these data suggest that bear No. 95 produced her first cubs at age 7, while bear No. 6 produced her first cubs at age 10, and bear No. 14 has yet to produce a litter at age 9. Four adult females have failed to successfully produce cubs (to our knowledge) 2 years in a row. Bear No. 60 left her 3 year-old cub in 1982, bred and produced a litter of 2 cubs in 1983. On 17 June, she was observed with an adult. We did not observe her cubs again and presume they were killed by the male who then bred No. 60 (she produced a single cub in 1984).

Denning

During the winter of 1982-83, Jack Lentfer conducted a winter denning study on Admiralty Island, on contract with the Department of Fish and Game. The results of this study are reported in Appendix D. A summary of 1983 denning results on Admiralty Island is presented in Table 16. In the winter of 1982-83, the mean den elevation of males and females was 780 m (SE ± 99) and 774 m (SE ± 61), respectively. Of 10 dens visited, 9 were located in natural cavities while only 1 was excavated. Denning habitat used by females was rock (60%), old-growth forest (30%), and avalanche slopes (10%). Sixty percent of the males denned in old growth and 30% in rock. There was no trend in den location relative to aspect. However, most dens were located on steep (>30°) slopes. Bears began to emerge from dens in the middle of April and the last bears had emerged by the 3rd week of May. Females with cubs of the year were the last to emerge.

The first fall denning began the 2nd week of October and all bears were denned by the 1st week of November. The average den elevation during the winter of 1983-84 was 537 m (SE ± 58) for males and 696 m (SE ± 62) for females. Forty-four percent of the females denned in old-growth forest, 31% in rock, and 25% in alpine/subalpine habitat during this denning season. Eighty percent of males denned in old-growth and 20% on avalache slopes. As in the previous year, most dens were on steep slopes but there was no pattern relative to aspect. Out of 10 bears which we monitored through consecutive years, only 2 may have used the same dens or denned in very close proximity to their previous year's den.

A summary of 1983 denning results from Chichagof Island is presented in Table 17. Bears generally denned later here compared to Admiralty Island. First denning occurred about mid-October with the last bear denning toward the end of

December. Throughout November and early December, we monitored bears or observed their sign on the Kadashan River where they were fishing for a late run of cohos. Mean den elevation for 5 females was 448 m (SE ± 59). Mean den elevation for 4 males was 473 m (SE ± 32).

Seventy-eight percent of the Chichagof bears denned in old-growth forest habitat while rock and avalanche slopes each accounted for 11%. Of 4 den sites actually visited, 3 were excavated. Two of those were under large diameter old-growth trees.

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PREPARED BY:

John W. Schoen
Game Biologist III

SUBMITTED BY:

Donald E. McKnight
Regional Supervisor

APPROVED BY:

W. Lewis Pamplin, Jr.
Director, Division of Game

Steven R. Peterson
Research Chief, Division of Game

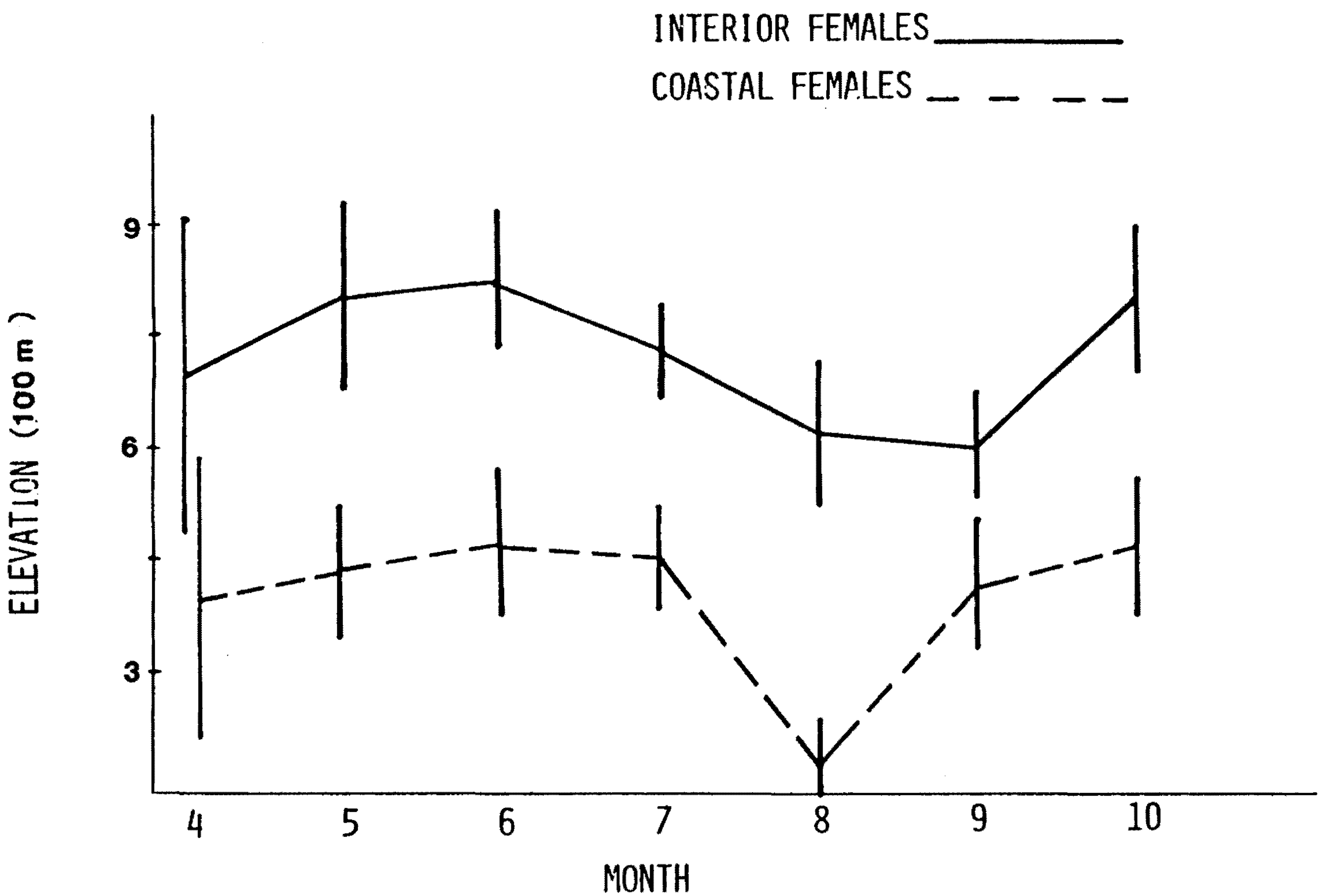


Fig. 1. Mean monthly elevation of radio-collared brown bears, Admiralty Island, 1983 (bars represent 95% confidence intervals).

Table 1. Summary and status of brown bears captured on Admiralty Island, Alaska, fall 1981 through 30 June, 1984.

Bear No.	Location	Sex	Capture (recapture) Age[a]	Weight[b]	Date	Capture techniques	Current status
51	Greens Cr.	M	1	60	8-28-81	snare	radio lost 9-81
60	Greens Cr.	F	20	160	9-21-81(7-2-82)	helicopter	transmitting
59	Greens Cr.	M	3	80	9-21-81(5-1-83)	mortality 5-1-83	mortality
58	Eagle Peak	M	4	180	9-21-81(8-8-82)	helicopter	last located 8-82
36	Mansfield Pen.	F	14	230	9-26-81	helicopter	radio lost 5-82
50	Greens Cr.	M	3	120	9-26-81(6-17-83)	helicopter	transmitting
14	Greens Cr.	F	7	120	9-26-81(7-2-82)	helicopter	transmitting
43	King Salmon	F	15	250	9-27-81	helicopter	radio lost 5-82
6	King Salmon	F	8	150	9-27-81(6-14-83)	helicopter	transmitting
B-14	King Salmon	F	2	100	9-26-81	helicopter	mortality
10	Greens Cr.	M	11	280[c]	7-2-82(7-6-84)	helicopter	transmitting
99	Greens Cr.	F	17	200	7-8-82(6-84)	helicopter	transmitting
63	Greens Cr.	F	17	160	7-8-82	helicopter	transmitting
20	Greens Cr.	M	5	100	7-30-82(5-1-83)	snare/helicopter	mortality 5-1-83
56	Greens Cr.	F	13	170	7-30-82	snare	transmitting
48	Greens Cr.	M	adult	300	8-3-82	snare	radio lost
38	Greens Cr.	F	23	280	7-2-82	helicopter	transmitting
39	Mansfield Pen.	F	9	270	8-7-82	snare	transmitting
37	Mansfield Pen.	F	10	270	8-3-82	snare	hunter kill 10-83
95	Mansfield Pen.	F	8	170	7-8-82	helicopter	transmitting
72	Eagle Peak	M	6	200	7-8-82	helicopter	transmitting
62	Admiralty Cove	F	14	150	6-16-82	snare	transmitting
34	Mansfield Pen.	F	2	70	7-8-82	helicopter	hunter kill 9-83
67	Greens Cr.	F	2	60	8-2-82	snare	?
7	Pack Cr.	F	11	150	8-26-82	darted	no radio
11	Pack Cr.	M	4	120	8-28-82	trap	hunter kill 5-83
8	Pack Cr.	F	10	150	8-26-82	trap	transmitting

Table 1. Continued.

Bear No.	Location	Sex	Capture (recapture) Age[a]	Weight[b]	Date	Capture techniques	Current status
9	Pack Cr.	F	1	54	8-26-82	darted	no radio
91	Pack Cr.	F	19	162[c]	6-21-83	helicopter	?
92	Pack Cr.	F	16	158[c]	6-21-83	helicopter	transmitting
93	Pack Cr.	M	5	158[c]	6-21-83	helicopter	transmitting
94	Pack Cr.	F	10	156[c]	7-13-83	trap	transmitting
40	Greens Cr.	M	10	180	6-21-83	helicopter	transmitting
45	Greens Cr.	M	15+	284[c]	6-14-83(7-6-84)	helicopter	transmitting
55	Greens Cr.	F	7	124	6-21-83	helicopter	transmitting
35	Wheeler Cr.	F	8	135[c]	6-17-83	helicopter	mortality
18	Greens Cr.	M	6	214[c]	6-17-83	helicopter	transmitting
16	Greens Cr.	F	4	90[c]	6-17-83	helicopter	transmitting
66	Greens Cr.	M	4	180[c]	6-22-83	helicopter	transmitting
64	Eagle Peak	F	14	190[c]	6-24-83	helicopter	transmitting
57	Greens Cr.	F	11	203[c]	9-28-83	helicopter	?
68	Greens Cr.	F	5	146[c]	9-28-83	helicopter	transmitting
4	Greens Cr.	F	6	214[c]	9-29-83	helicopter	transmitting
19	King Salmon	F	13	191	9-29-83	helicopter	mortality
41	Mansfield Pen.	M	adult	135	6-21-84	helicopter	transmitting
49	Mansfield Pen.	M	3	100	6-16-84	helicopter	no radio
81	Mansfield Pen.	F	adult	200	6-21-84	helicopter	transmitting

[a] Age determined by tooth sectioning.

[b] Weight estimated.

[c] Actual weight.

Table 2. Summary and status of brown bears captured on Chichagof Island, Alaska, summer 1983 through 30 June 1984.

Bear No.	Location	Sex	Capture (recapture) Age[a]	Weight[b]	Date	Capture techniques	Current status
23	Kadashan	M	5	158[c]	6-23-83	helicopter	unk
21	Corner Bay	F	adult	169[c]	6-23-83	helicopter	transmitting
88	Kadashan	M	5	167[c]	6-23-83	helicopter	transmitting
24	Corner Bay	F	16	225[c]	6-23-83	helicopter	transmitting
12	Kook L.	F	3	100	6-24-83	helicopter	transmitting
30	Kadashan	M	3	126[c]	6-24-83(9-16-83)	helicopter	transmitting
2	Crab Bay	M	6	216[c]	6-24-83	helicopter	transmitting
73	Kadashan	F	11	158	8-8-83	snare	transmitting
18	Kadashan	M	19	215	9-16-83	snare	hunter kill 5-84
44	Kadashan	F	adult	270	9-17-83	snare	transmitting
90	Corner Bay	M	4	135	9-22-83	darted	unk

[a] Age determined by tooth sectioning.

[b] Weight estimated.

[c] Actual weight.

Table 3. Mean elevation (m) of radio-collared brown bears on Admiralty and Chichagof Islands, Alaska, 1983.

Season		Admiralty Island		Chichagof Island	
		Male	Female	Male	Female
Spring (3/1-5/15)	$\bar{x}$	271	459		
	SE ±	84	57		
	Range	0-915	8-1067		
	n	13	13		
Early summer (5/16-7/15)	$\bar{x}$	587	591	65	392
	SE ±	66	26	45	110
	Range	3-1159	8-1067	0-549	15-823
	n	39	136	11	9
Late summer (7/16-9/15)	$\bar{x}$	88	344	52	212
	SE ±	28	27	16	46
	Range	2-915	3-1128	6-366	15-762
	n	43	128	29	28
Fall (9/16-12/1)	$\bar{x}$	471	558	111	348
	SE ±	58	30	26	37
	Range	15-854	8-1189	0-579	8-671
	n	23	77	35	35

Table 4. Percent seasonal distribution of radio-collared brown bears, relative to elevation, on Admiralty and Chichagof Islands, Alaska, 1983.

Elevation (m)	Spring A[a]	Spring C[b]	Early summer A	Early summer C	Late summer A	Late summer C	Fall A	Fall C
<300	40	--	28	71	62	83	22	67
300-600	38	--	21	19	21	16	37	31
600-900	20	--	34	10	14	2	36	3
>900	3	--	17	0	3	0	5	0
	40[c]	--	175	21	171	63	100	78

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 5. Mean slope (°) of relocations of radio-collared brown bears on Admiralty and Chichagof Islands, Alaska, 1983.

	Admiralty		Chichagof	
Season	Male	Female	Male	Female
Spring (3/1-5/15)	$\bar{x}$ = 15	18	--[a]	--
	SE ± 3.6	2.0		
	Range = 1-30	5-45		
	n = 12	27		
Early summer (5/16-7/15)	$\bar{x}$ = 15	20	7	17
	SE ± 1.6	1.0	2.3	4.6
	Range = 1-40	1-45	1-20	2-40
	n = 39	134	11	9
Late summer (7/16-9/15)	$\bar{x}$ = 5	18	4	17
	SE ± 1.0	1.3	1.3	3.3
	Range = 1-50	1-60	1-35	1-55
	n = 43	128	31	29
Fall (9/16-12/1)	$\bar{x}$ = 22	27	9	28
	SE ± 3.4	1.6	1.6	2.8
	Range = 1-50	1-60	1-35	1-55
	n = 23	76	43	34

[a] Data not recorded for this time period.

Table 6. Percent seasonal distribution of radio-collared brown bears, relative to slope, on Admiralty and Chichagof Islands, Alaska 1983.

Slope (degrees)	Spring A[a]	Spring C[b]	Early summer A	Early summer C	Late summer A	Late summer C	Fall A	Fall C
0-10	40		37	67	57	73	25	53
11-25	45		36	19	17	10	27	18
26-45	15		27	14	26	16	44	26
>45	0		0	0	0	2	4	4
	36[c]		145	21	159	63	90	78

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 7. Percent seasonal distribution of radio-collared brown bears, relative to aspect, on Admiralty and Chichagof Islands, Alaska, 1983.

	Season							
	Spring		Early summer		Late summer		Fall	
Aspect	A[a]	C[b]	A	C	A	C	A	C
North	20		40	66	33	46	43	59
East	5		10	6	11	2	9	8
South	43		40	22	43	48	33	26
West	32		10	6	13	4	15	7
	40[c]		161	18	148	50	92	70

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 8. Percent seasonal distribution of radio-collared brown bears, relative to terrain, on Admiralty and Chichagof Islands, Alaska, 1983.

	Season							
	Spring		Early summer		Late summer		Fall	
Terrain	A[a]	C[b]	A	C	A	C	A	C
Smooth	87		87	95	100	98	83	91
Broken	13		13	5	0	2	17	9
	38[c]		173	21	171	63	100	77

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 9. Percent seasonal distribution of radio-collared brown bears, relative to soil drainage, on Admiralty and Chichagof Islands, Alaska, 1983.

	Season							
	Spring		Early summer		Late summer		Fall	
Drainage	A[a]	C[b]	A	C	A	C	A	C
Poorly drained	9		21	50	17	24	10	13
Well drained	91		79	50	83	76	90	87
	32[c]		91	6	106	38	50	47

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 10. Percent seasonal distribution of radio-collared brown bears, relative to habitat type, on Admiralty and Chichagof Islands, Alaska, 1983.

Habitat type	Season: Spring		Early summer		Late summer		Fall	
	A[a]	C[b]	A	C	A	C	A	C
Beach/ tidal flat	3		1	19	1	3	0	5
Old-growth forest	67		38	14	34	24	38	40
Riparian old-growth	5		6	10	30	38	7	21
Avalanche slope	10		5	10	26	19	34	23
Subalpine	5		14	10	4	2	6	1
Alpine	8		31	14	5	0	10	0
Rock	2		2	0	0	0	5	1
Clearcut				14		6		4
Other	0		3	9	1	8	0	5
	40[c]		175	21	171	63	100	78

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 11. Percent seasonal distribution of radio-collared brown bears, relative to canopy cover, on Admiralty and Chichagof Islands, Alaska, 1983.

Canopy (percent)	Season: Spring		Early summer		Late summer		Fall	
	A[a]	C[b]	A	C	A	C	A	C
0-25	25		51	71	39	43	49	45
26-50	20		24	10	24	29	14	22
51-75	55		25	19	37	29	37	32
>75	0		0	0	0	0	0	1
	40		175	21	171	63	100	78

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 12. Percent seasonal distribution of radio-collared brown bears, relative to Sitka spruce composition, in habitat on Admiralty and Chichagof Islands, Alaska, 1983.

Percent Sitka spruce	Season							
	Spring		Early summer		Late summer		Fall	
	A[a]	C[b]	A	C	A	C	A	C
0-10	48		70	81	50	44	64	50
11-25	33		19	10	19	16	16	18
26-50	15		5	5	15	17	14	19
51-75	5		4	5	13	10	4	8
>75	0		1	0	4	13	2	5
	40[c]		175	21	171	63	100	78

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 13. Percent seasonal distribution of radio-collared brown bears, relative to timber stand volume, on Admiralty and Chichagof Islands, Alaska, 1983.

Volume class	Season							
	Spring		Early summer		Late summer		Fall	
MBF:acre	A[a]	C[b]	A	C	A	C	A	C
<8	16		25	50	15	16	30	21
8-20	42		38	33	26	26	34	34
21-30	35		27	17	41	24	22	21
>30	7		10	0	19	34	14	24
	32[c]		89	6	108	38	50	47

[a] Admiralty site.

[b] Chichagof site.

[c] No. of relocations.

Table 14. Summary of alpine bear surveys conducted on Admiralty and Chichagof Islands, Alaska, 29 June 1983.

	Area		
	North Admiralty	South Admiralty	East Chichagof
Survey time (hrs)	1.8	2	1.9
Adults	28	14	8
Cubs of year	7	7	3
Total cubs	14	11	11
Cubs:100 adults	50	78.5	137.5
Total bears	42	25	19
Bears:hour	23.3	12.5	4.2
Total marked bears observed	4	0	0
Total marked bears in area	25	0	0
Approximate size of survey area	390 km^2 (150 mi^2)	455 km^2 (175 mi^2)	416 km^2 (160 mi^2)

Table 15. Reproductive history of radio-collared female brown bears on Admiralty Island, Alaska, 1981, 1982, 1983.

Bear No.	Age at capture (yrs)	Offspring[a] by year		
		1981	1982	1983
60	20	1/2 yr	0	2/COY
14	7	0	0	0
36	14	2/COY		
6	8	0	0	1/COY
43	15	0	2/COY	2/1 yr
99	17		2/3 yr	2/COY
56	13		0	0
63	17		2 cubs	0
95	8		2/1 yr	2/2 yr
39	9		0	0
38	23		0	0
37	10		0	1/COY
62	14		0	0
34	2		0	0
67	2		0	
55	7			0
64	14			1/1 yr
16	4			0
35	8			0
57	11			2/2 yr
68	5			0
4	6			0
19	13			1/2 yr
8	10		1/1 yr	1/2 yr
91	19			0
92	16			0
94	10			0

[a] COY = cub of year
1 yr = yearling
2 yr = 2 year-old
cub = cub older than COY
0 = no cubs observed

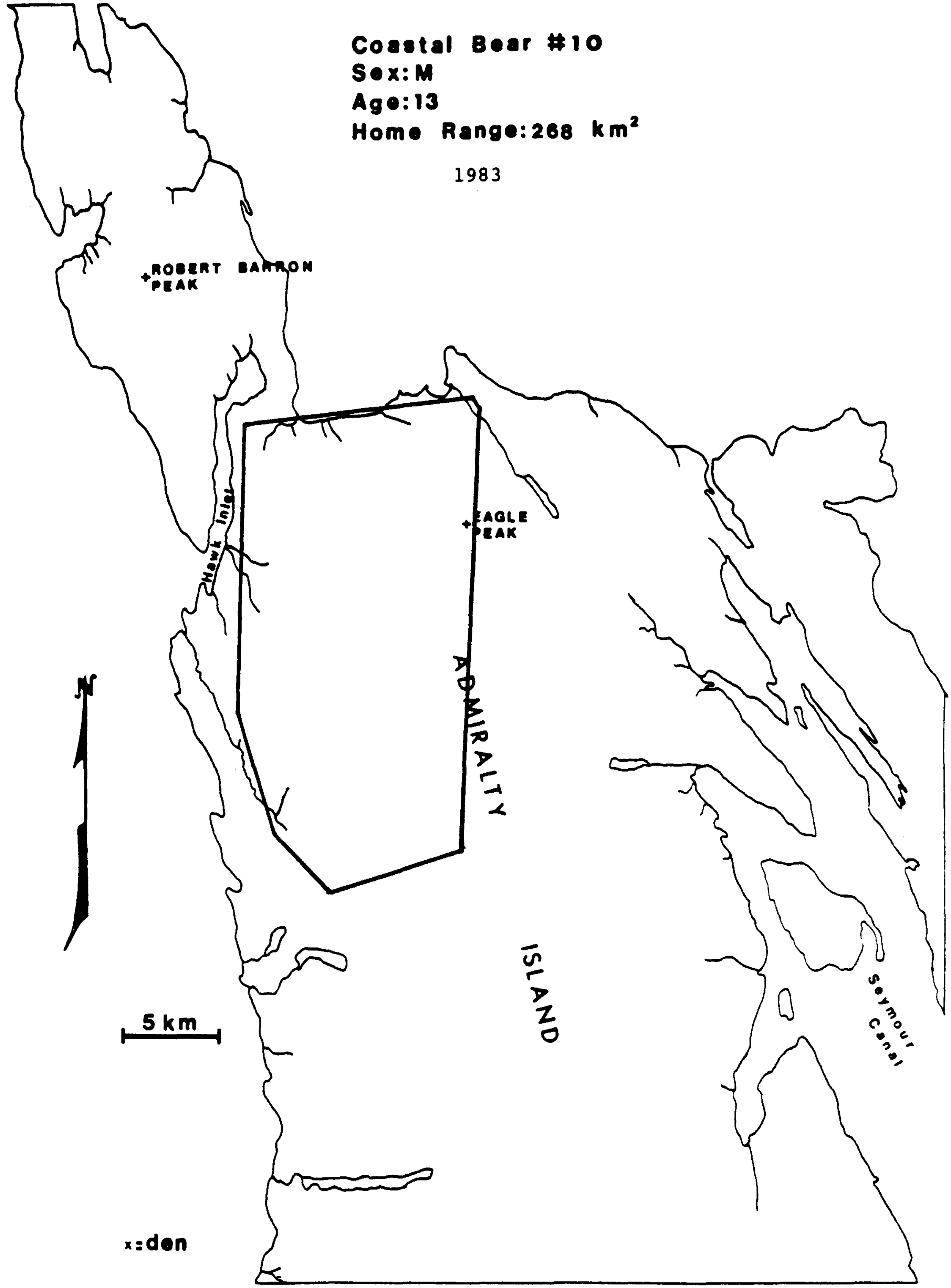
Table 16. Summary of 1983 denning of radio-collared brown bears on Admiralty Island, Alaska.

Bear No.	Sex	Reproductive status	Approx. date of spring den emergence	Elev. m	Approx. date of fall denning	Elev. m
14	F	w/o cubs	4/22	884	10/31	1067
56	F	w/o cubs	4/25	823	10/12	549
63	F	w/o cubs	4/29	915	10/28	305
95	F	w/ cubs	4/23	366	10/21	396
39	F	w/o cubs	4/25	823	10/28	518
38	F	w/o cubs	4/25	915	10/28	701
60	F	w/cubs of year	5/7	793	10/21	732
37	F	w/cubs of year	5/23	488		
99	F	w/cubs of year	5/23	823	10/31	793
62	F	w/o cubs	5/23		10/12	488
55	F	w/o cubs			10/28	518
64	F	w/ cub			10/12	1006
16	F	w/o cubs			10/28	823
68	F	w/o cubs			10/28	823
4	F	w/o cubs			10/28	671
6	F	w/cub of year			11/8	1189
57	F	w/ cubs			10/31	549
72	M		5/17	823	10/31	457
10	M		4/25	915		
50	M				10/28	427
18	M				10/12	457
40	M				10/12	732
66	M				10/31	610
48	M		4/22	396		
59	M		4/29	945		
20	M		4/29	823		

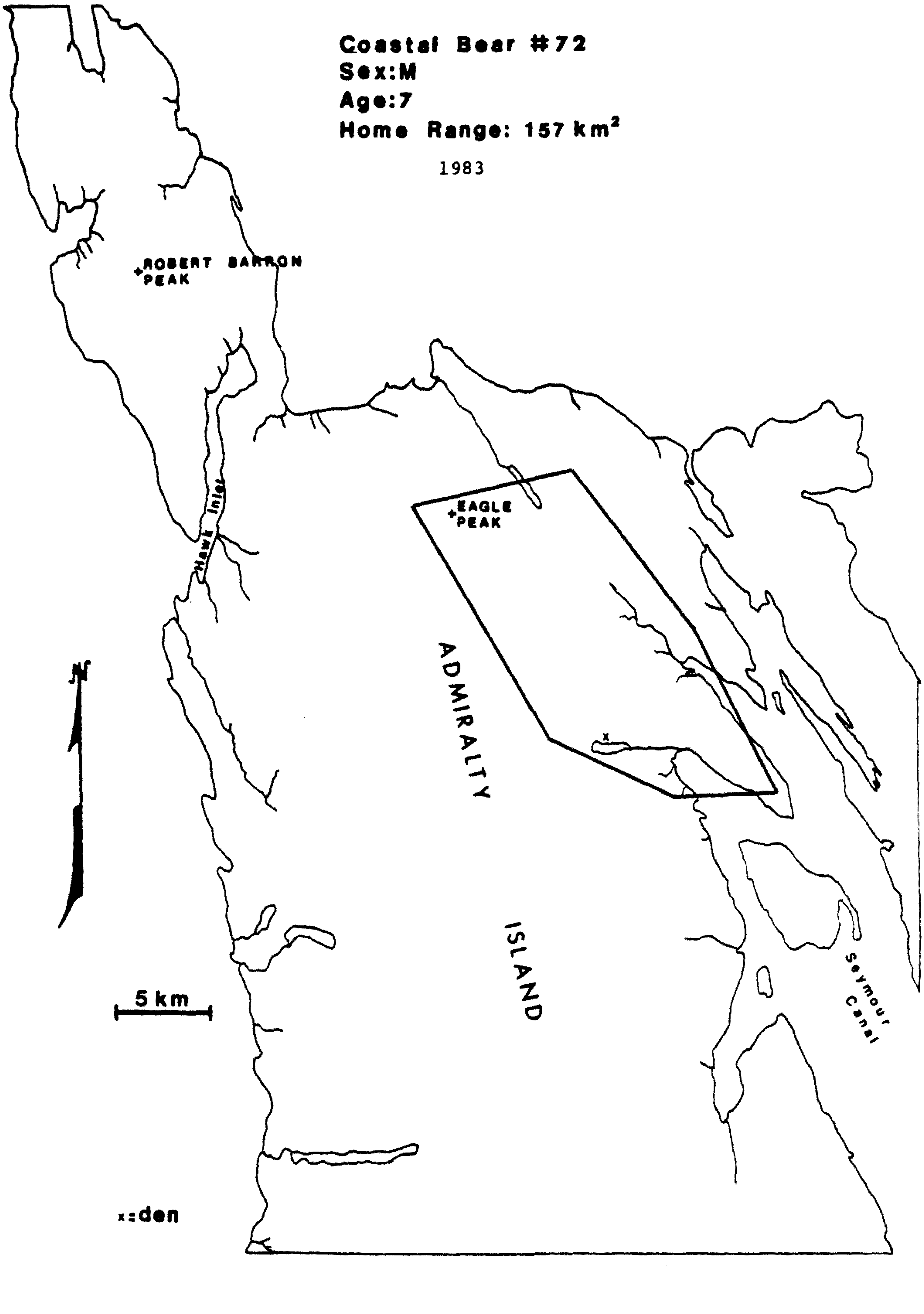
Table 17. Summary of 1983 denning of radio-collared brown bears on Chichagof Island, Alaska.

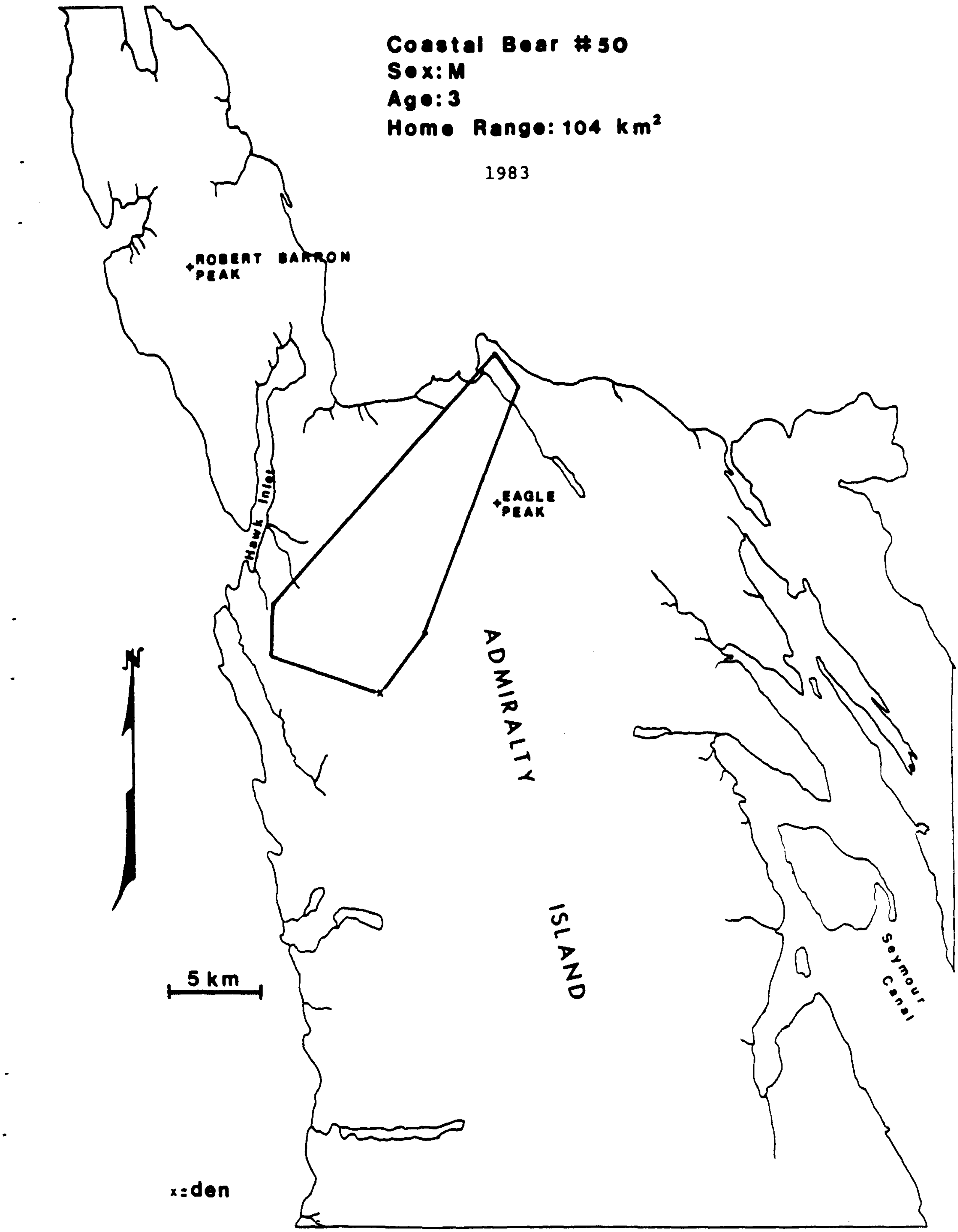
Bear No.	Sex	Reprod. status	Approx. date of denning	Elev. (m)
21	F	w/o cubs	10/31	610
24	F	w/o cubs	10/31	534
12	F	w/o cubs	11/21	457
44	F	w/o cubs	10/14	366
73	F	w/ cubs	10/31	274
18	M		12/20	396
88	M		10/14	549
30	M		11/8	489
2	M		12/9	457

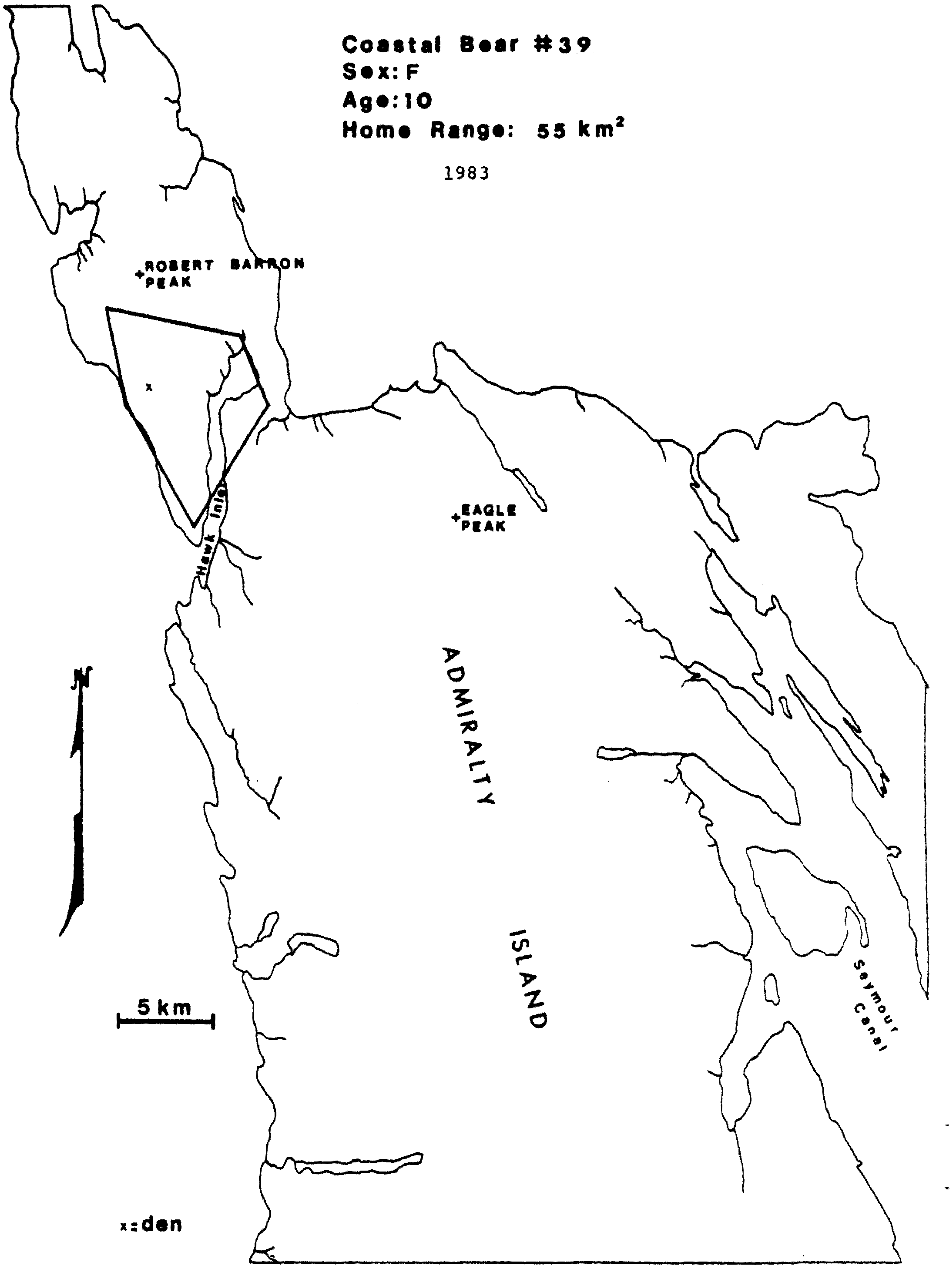
Appendix A. Home ranges of radio-collared brown bears, Admiralty Island, Alaska, 1983.

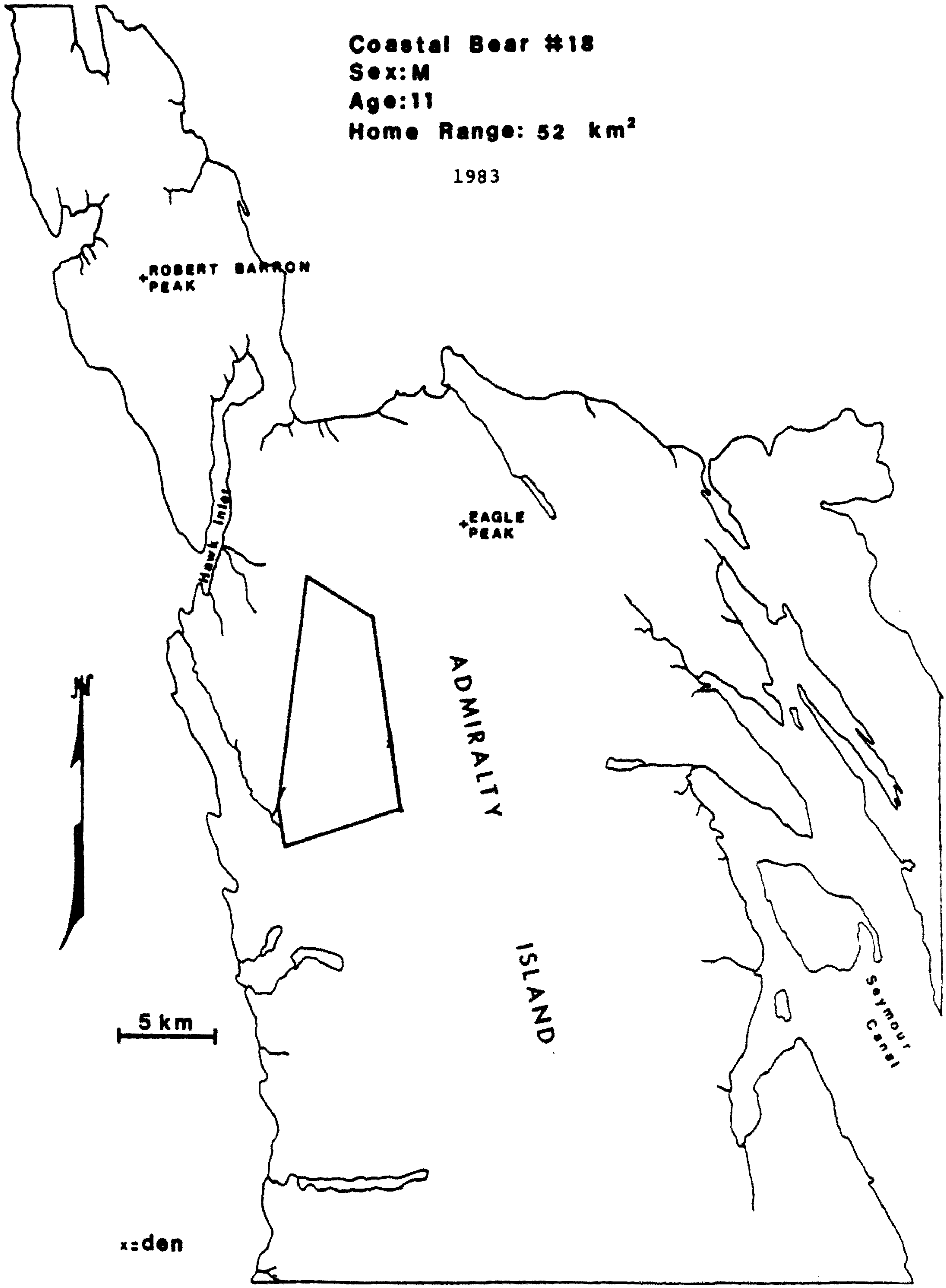


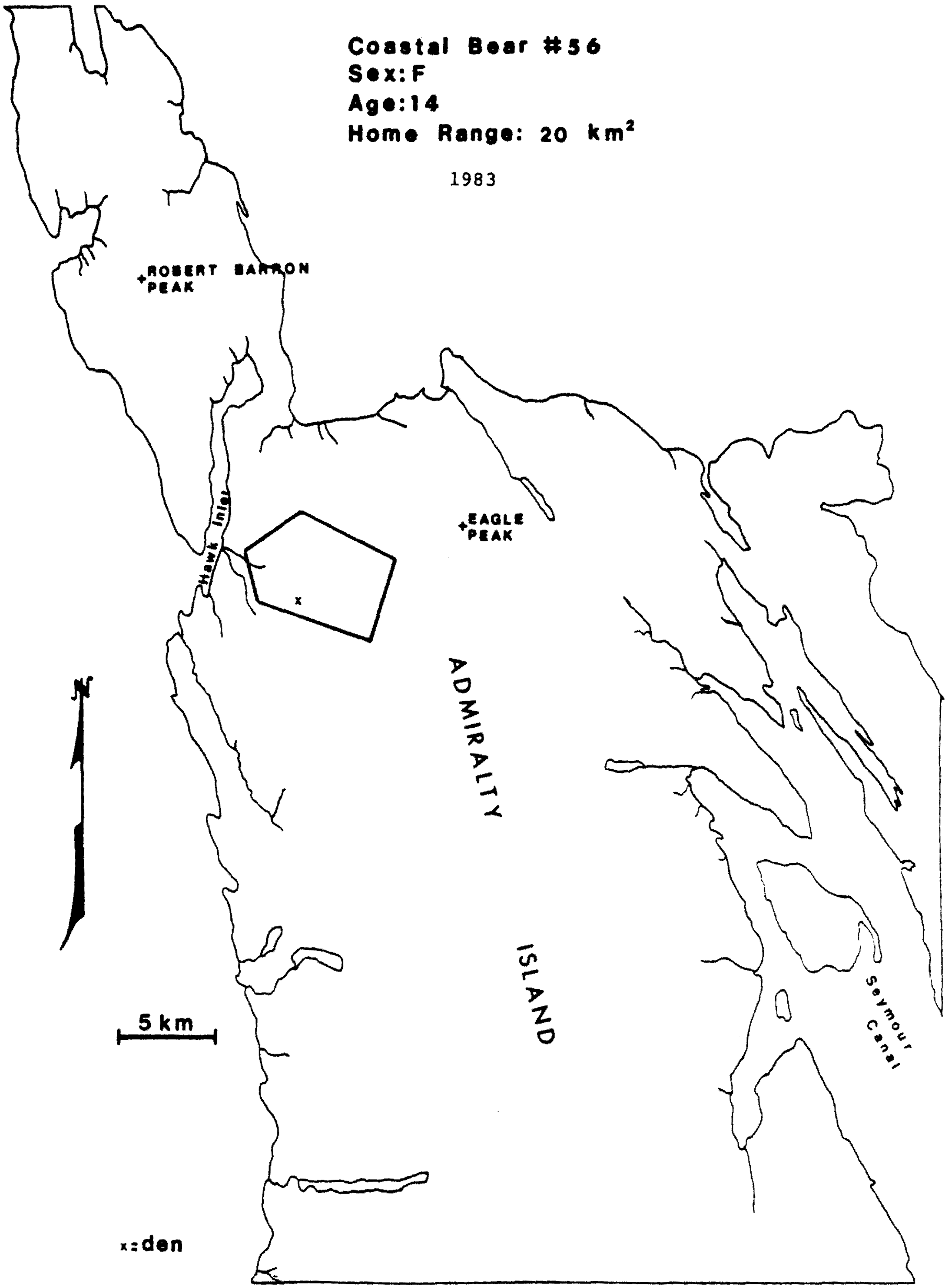
Coastal Bear #10
Sex:M
Age:13
Home Range:268 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den

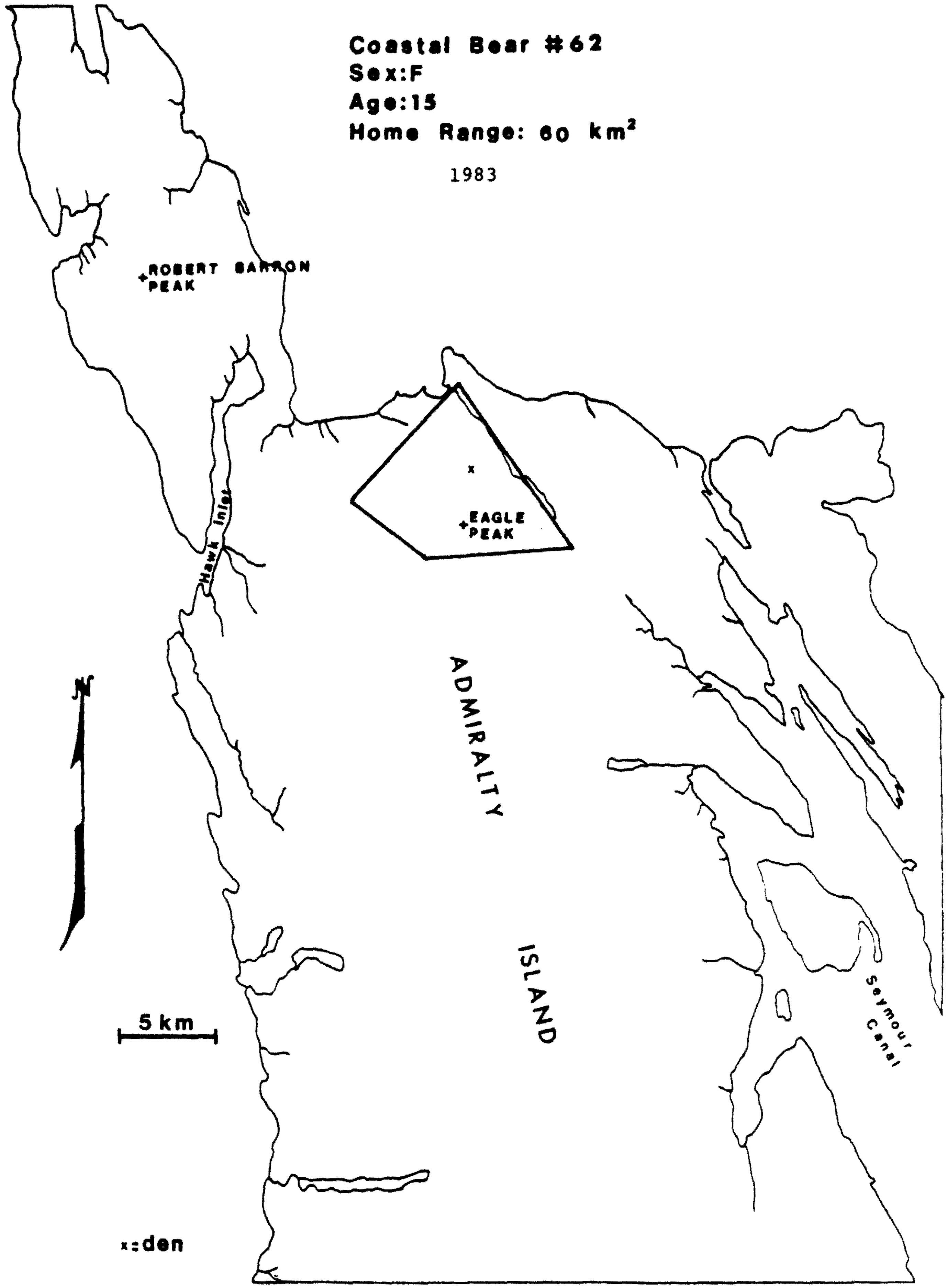

Coastal Bear #72
Sex:M
Age:7
Home Range: 157 km²
1983
ROBERT BARRON PEAK
Hawk Inlet
EAGLE PEAK
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den

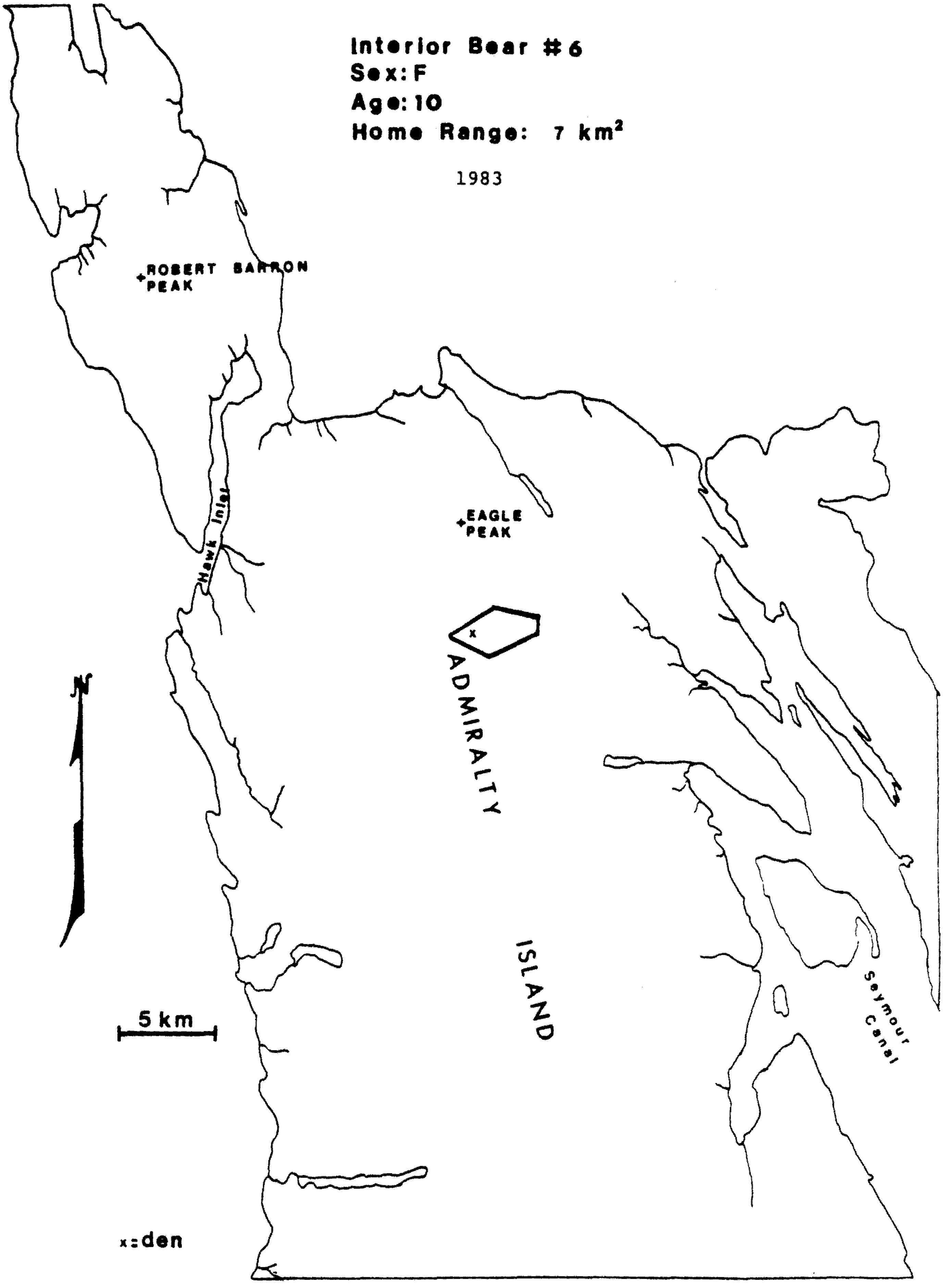

Coastal Bear #50
Sex: M
Age: 3
Home Range: 104 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x: den


Coastal Bear #39
Sex: F
Age: 10
Home Range: 55 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x=den

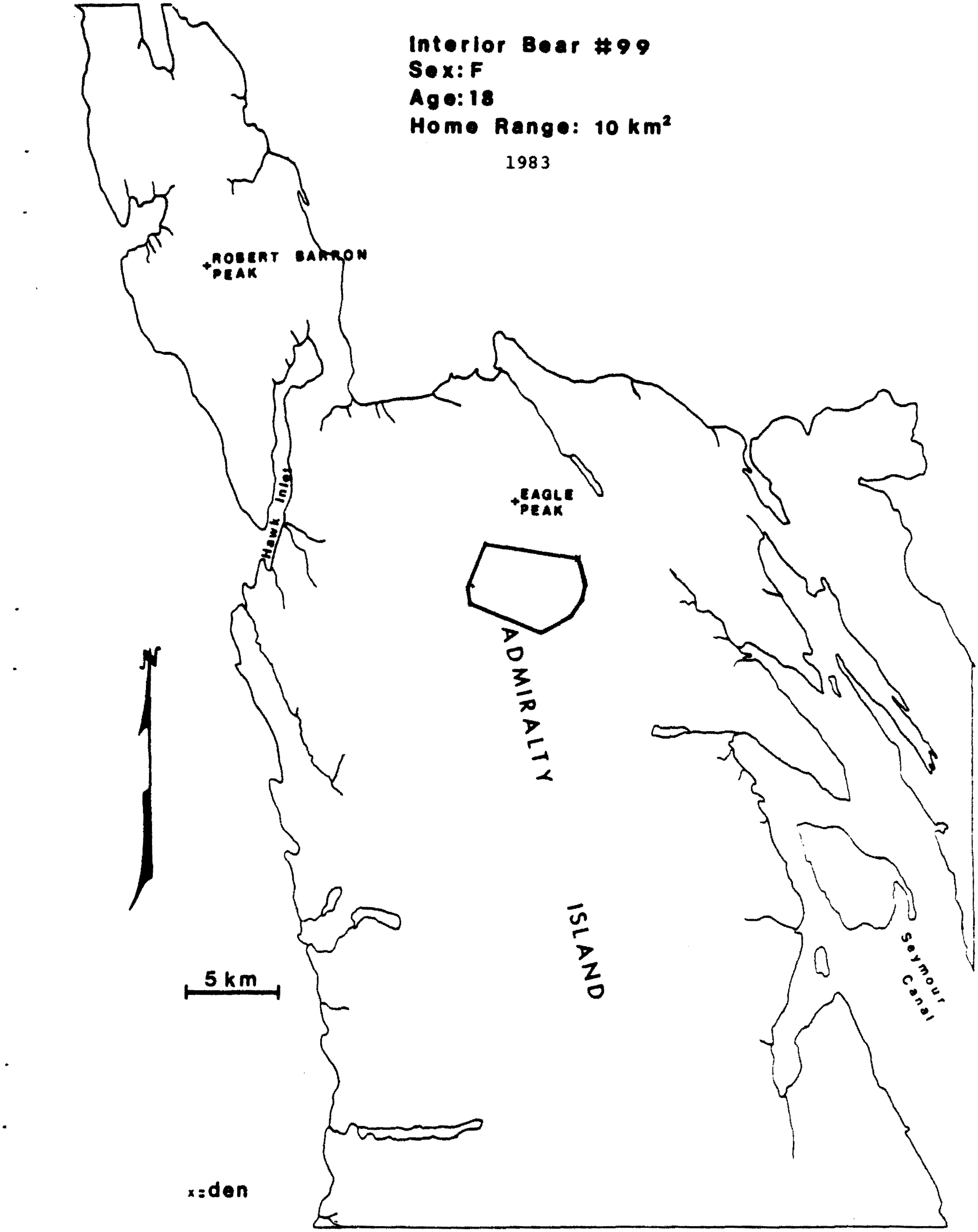

Coastal Bear #18
Sex:M
Age:11
Home Range: 52 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den


Coastal Bear #56
Sex:F
Age:14
Home Range: 20 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x:den

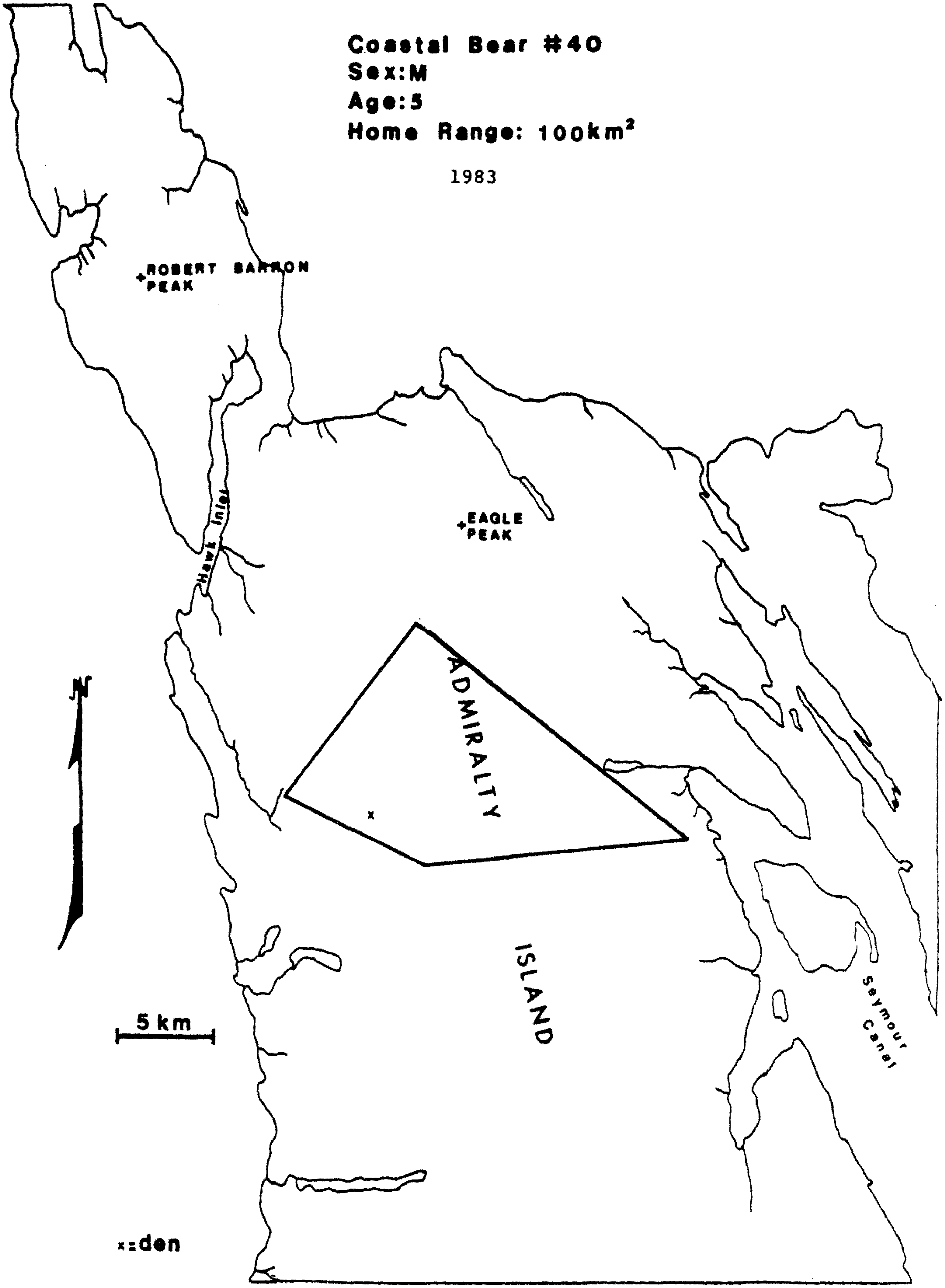

Coastal Bear #62
Sex:F
Age:15
Home Range: 60 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den



Interior Bear # 6
Sex: F
Age: 10
Home Range: 7 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x: den

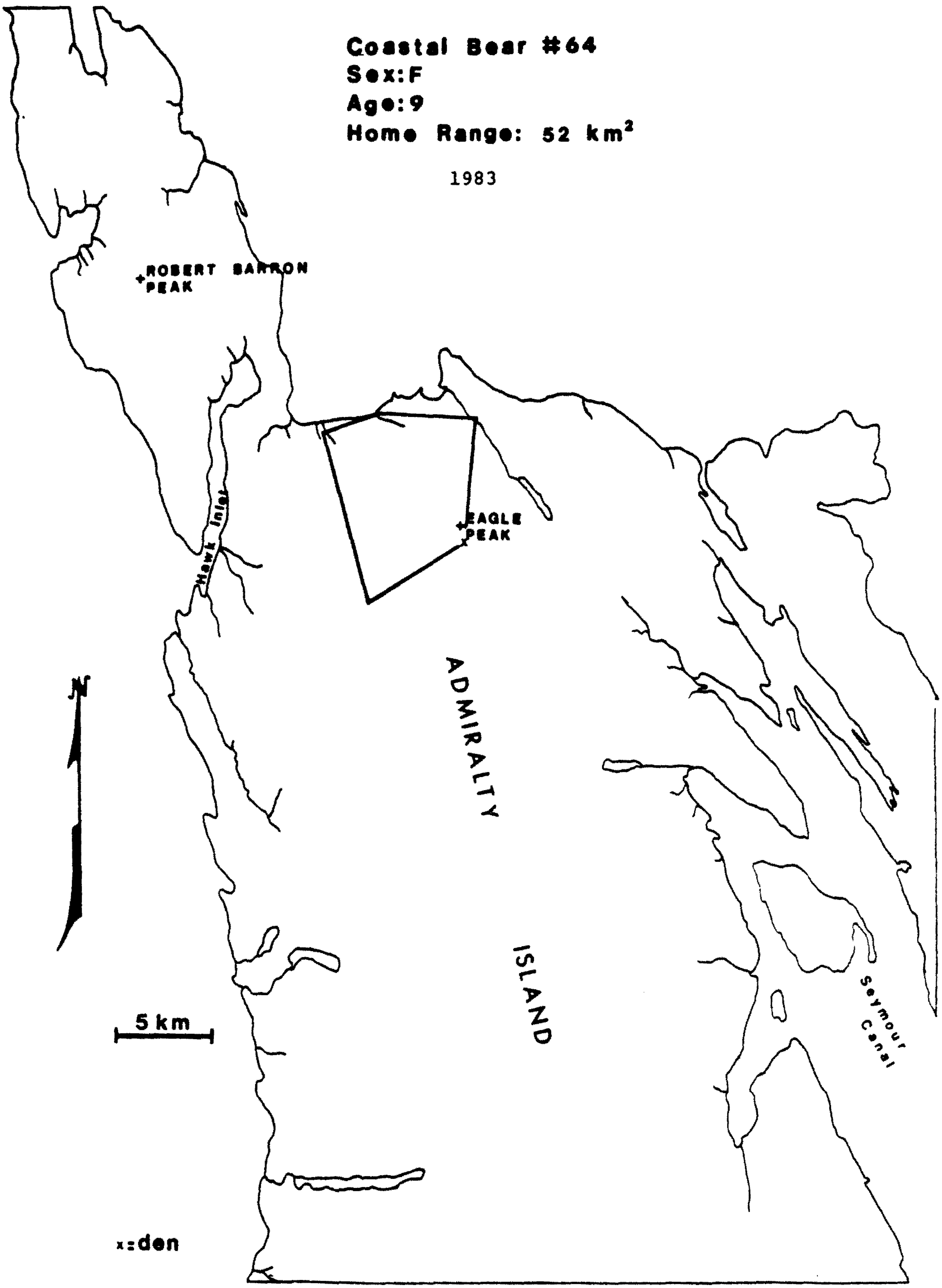


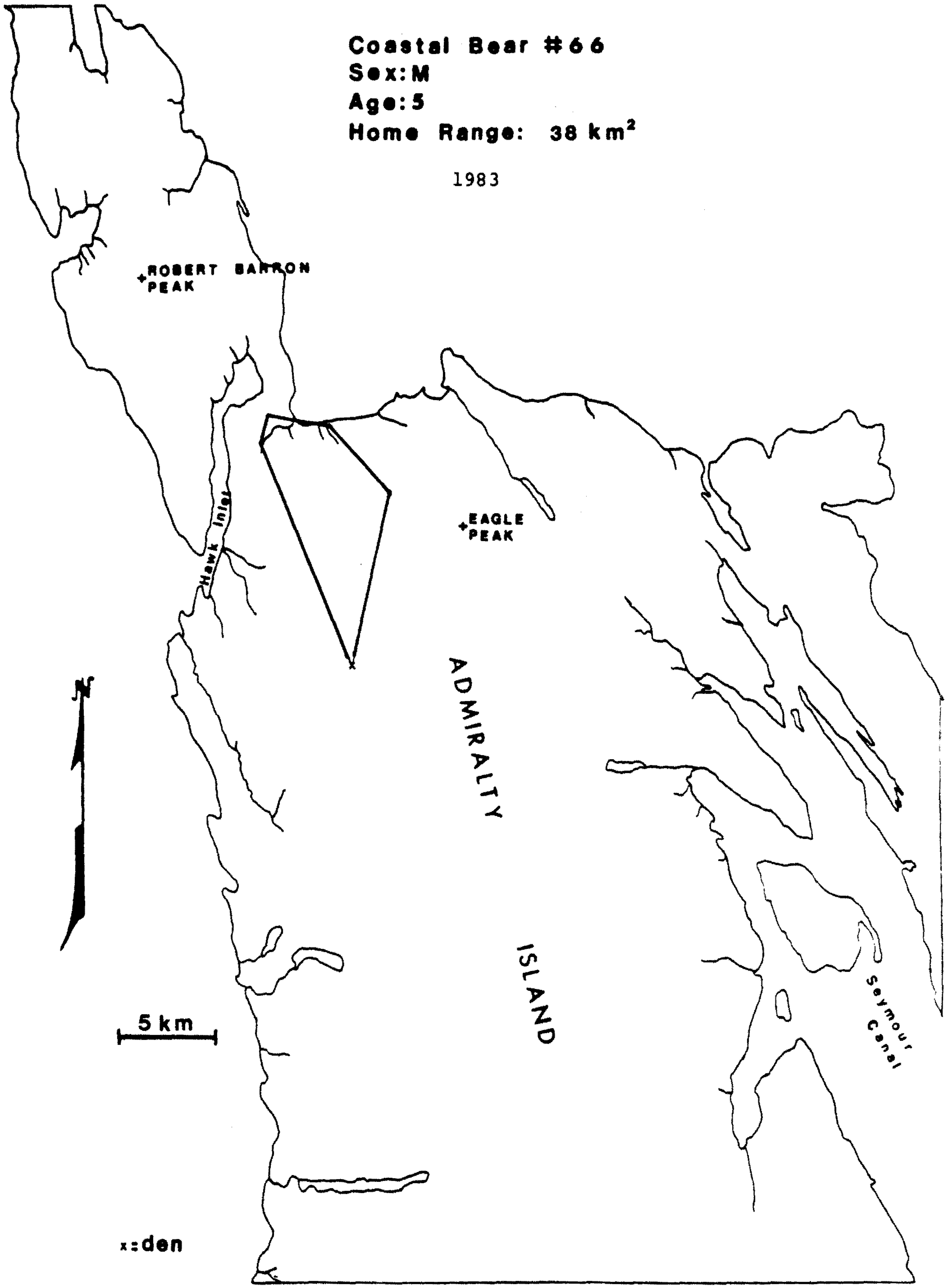
Interior Bear #99
Sex: F
Age: 18
Home Range: 10 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
N
ADMIRALTY
ISLAND
Seymour Canal
5 km
x:den

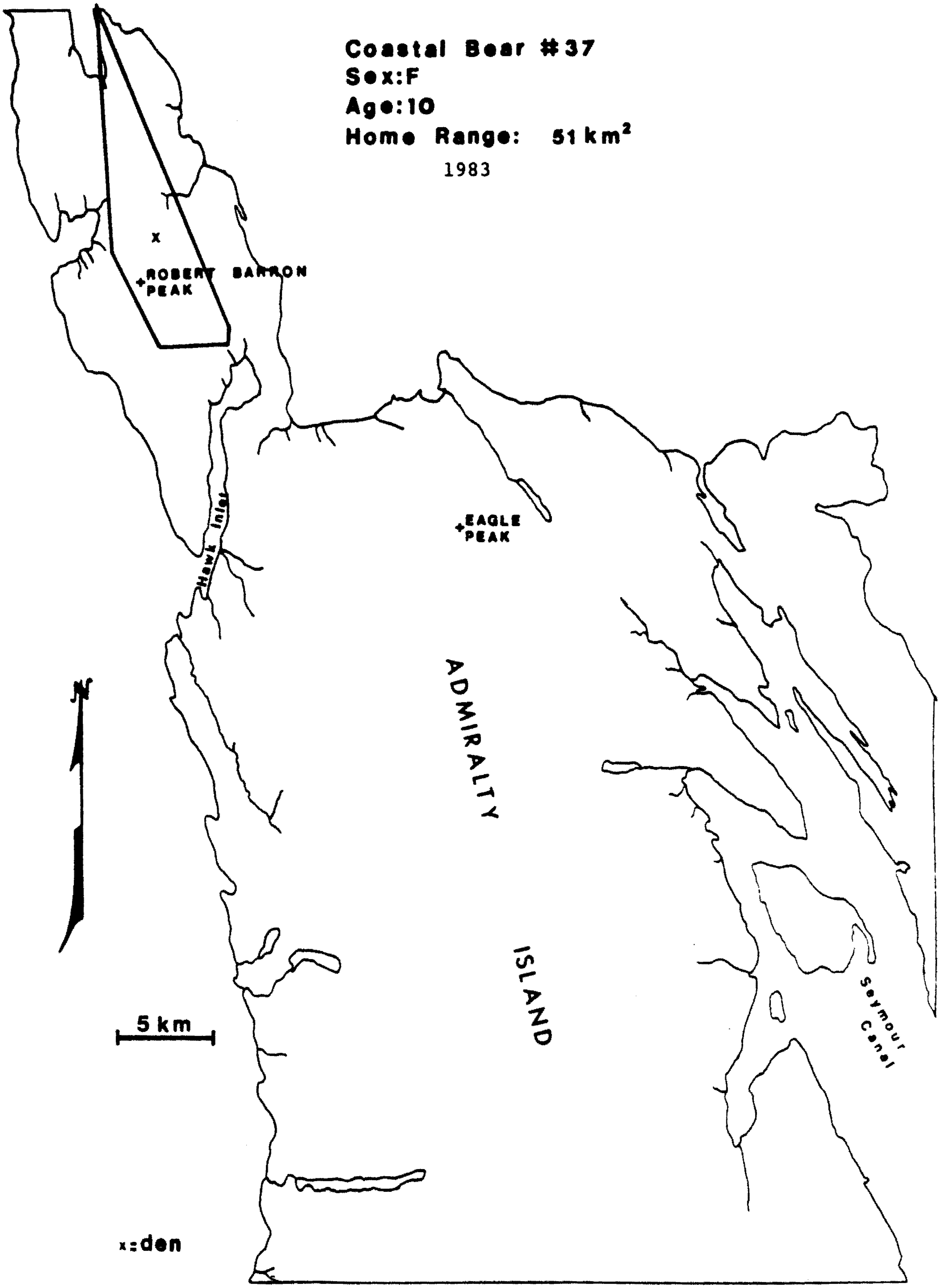

Coastal Bear #40
Sex:M
Age:5
Home Range: 100km^2
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den

Coastal Bear #64
Sex:F
Age:9
Home Range: 52 km²

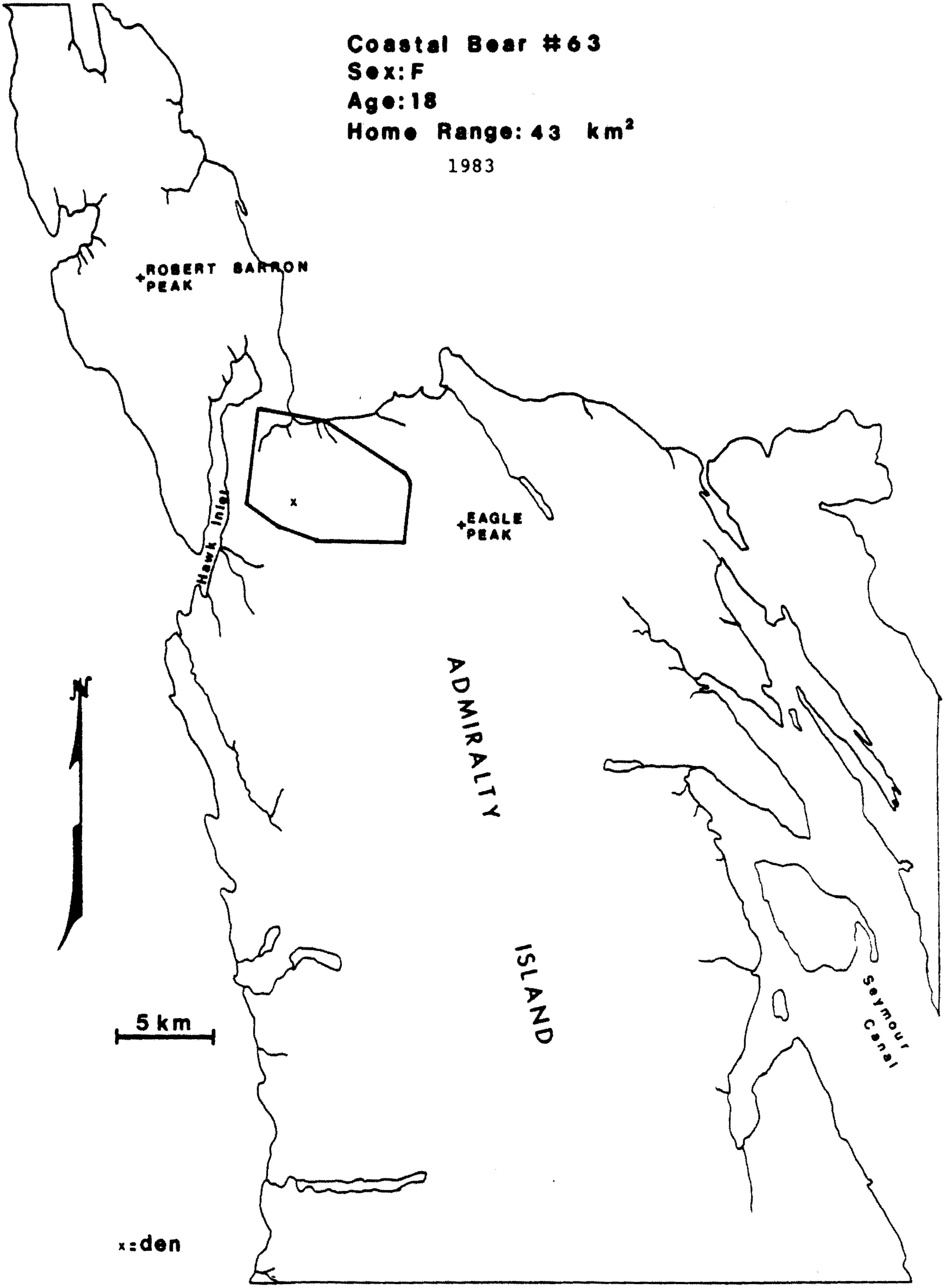
1983



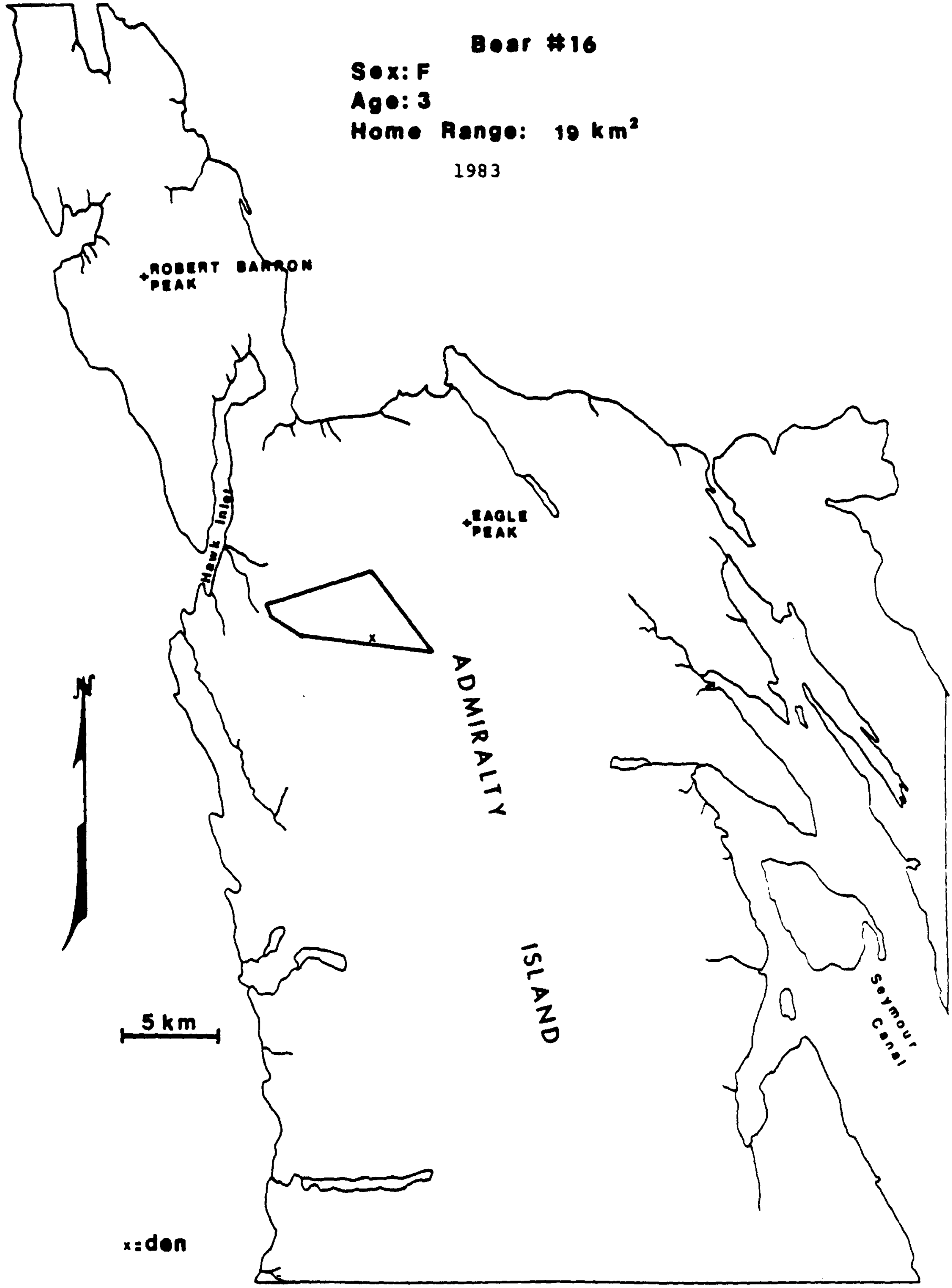

Coastal Bear #66
Sex:M
Age:5
Home Range: 38 km²
1983
ROBERT BARRON PEAK
Hawk Inlet
EAGLE PEAK
ADMIRALTY ISLAND
Seymour Canal
N
5 km
x:den

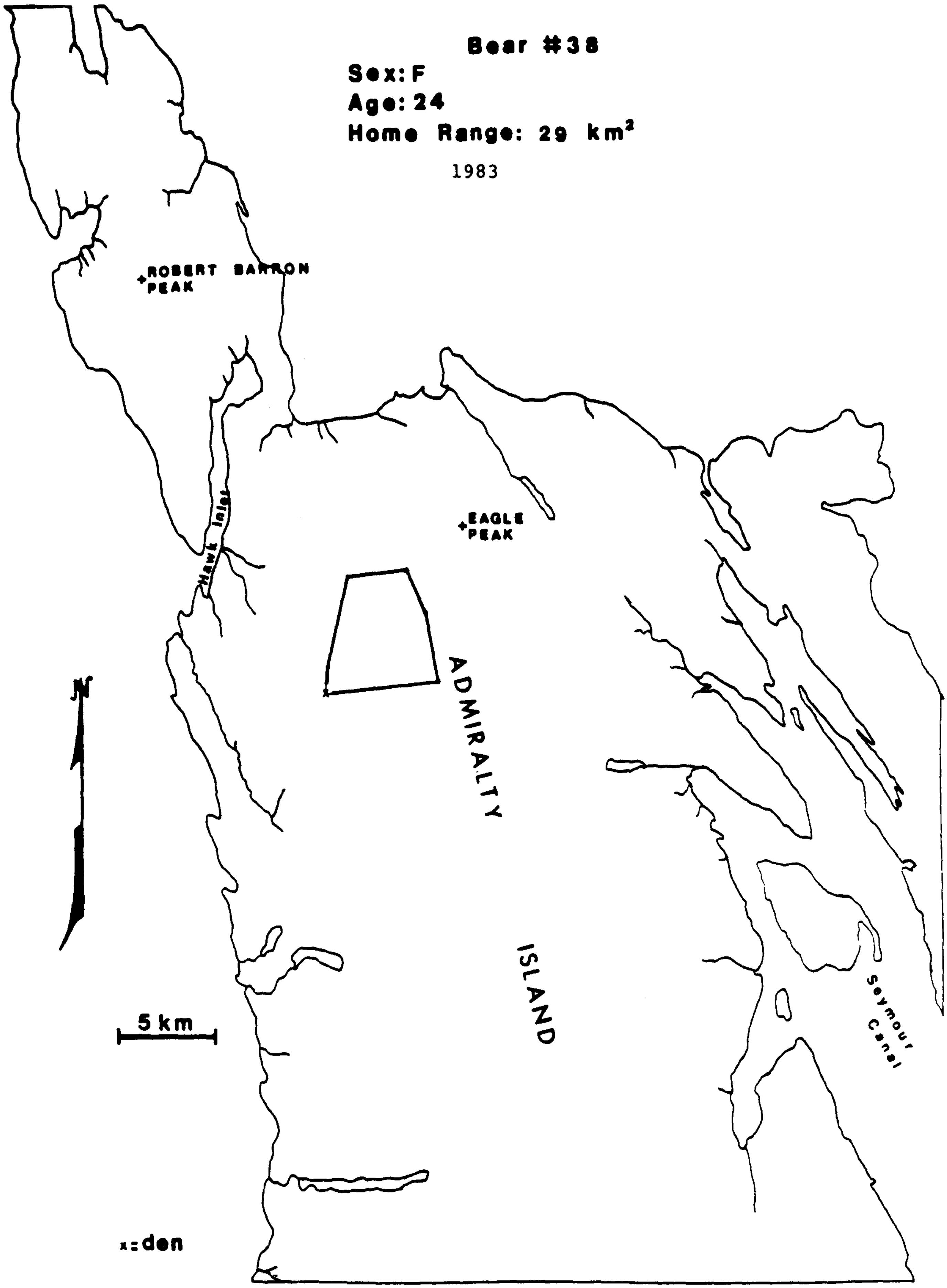

Coastal Bear #37
Sex:F
Age:10
Home Range: 51 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x:den

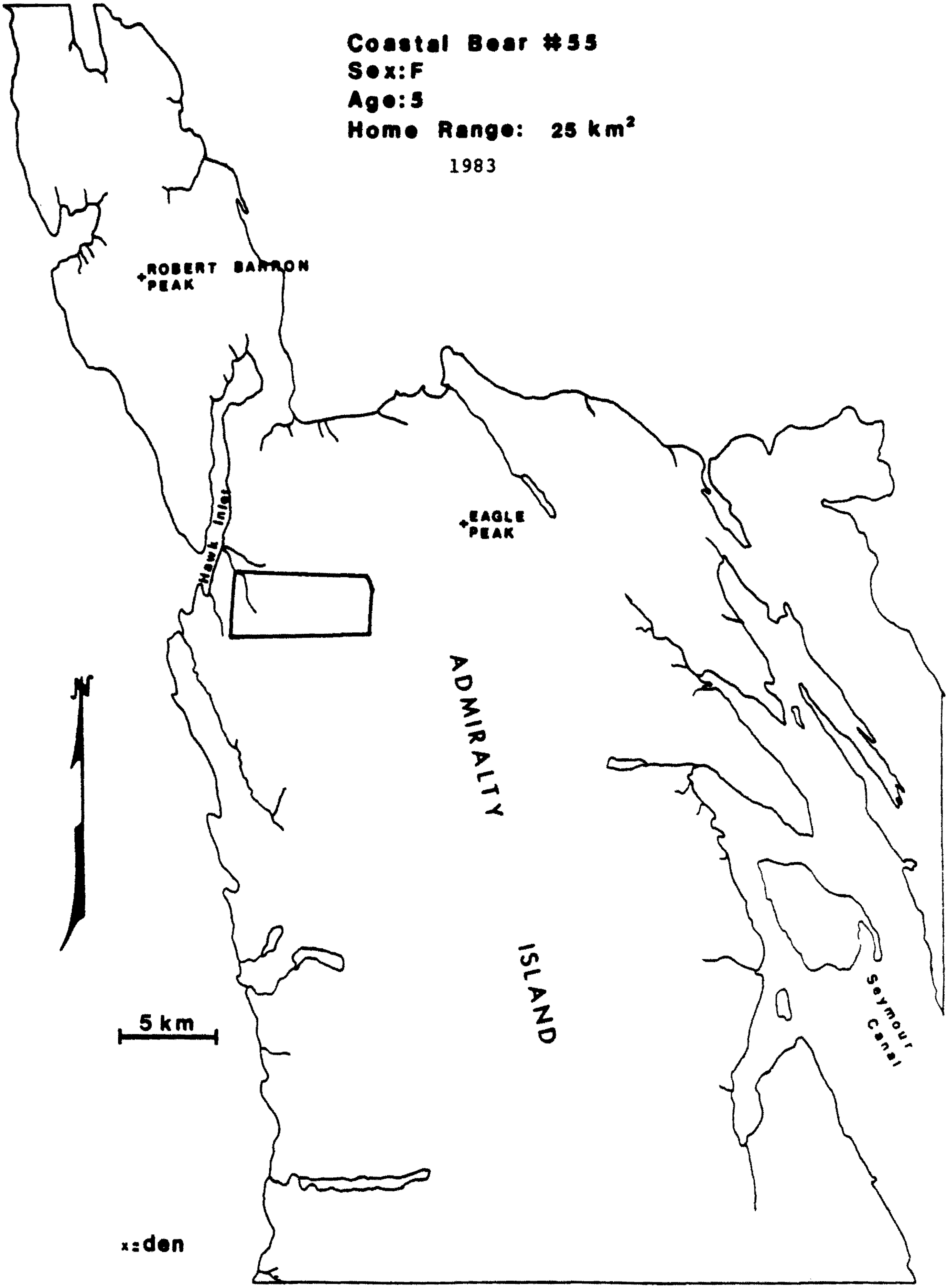
Coastal Bear #63
Sex: F
Age: 18
Home Range: 43 km^2
1983

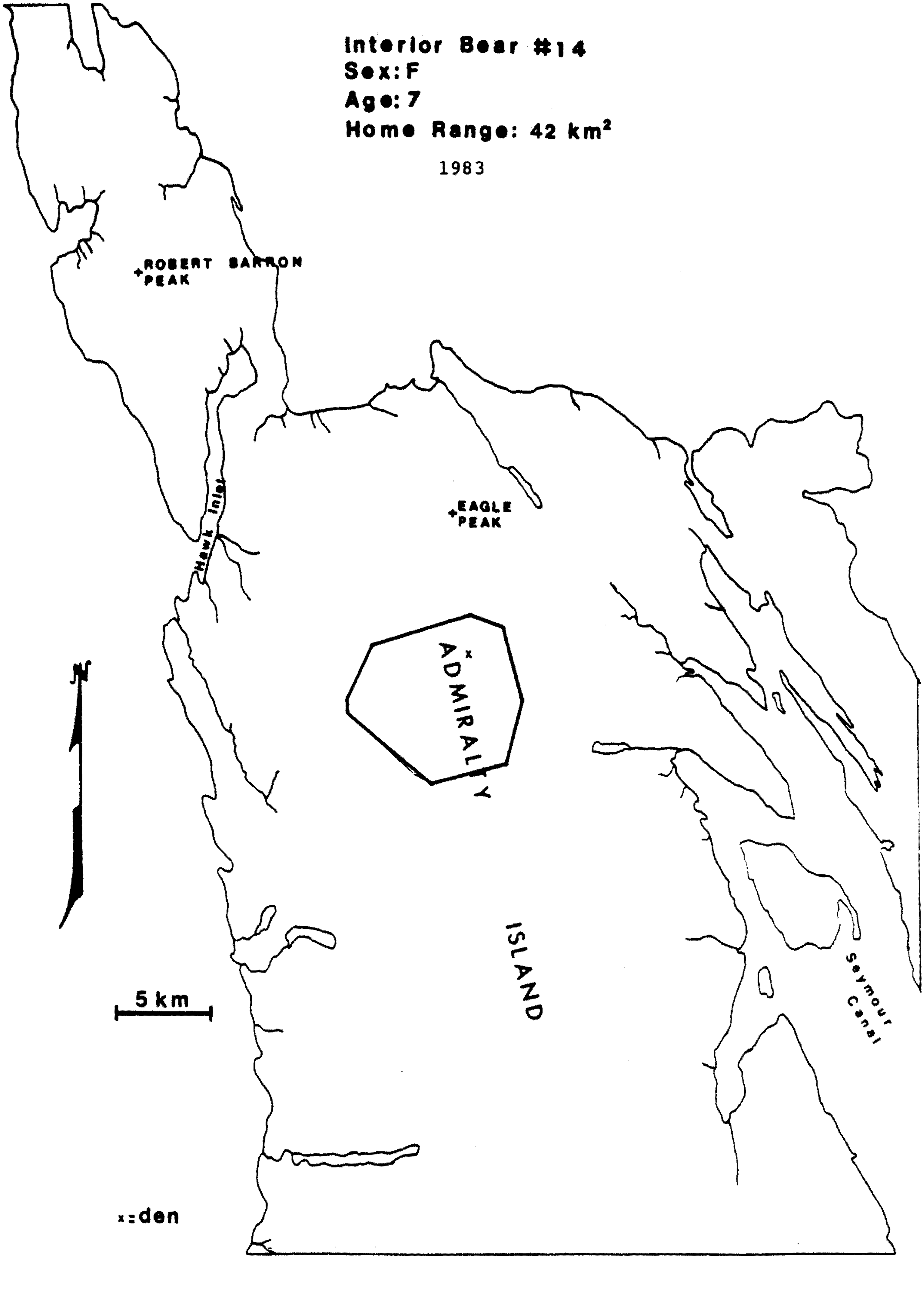


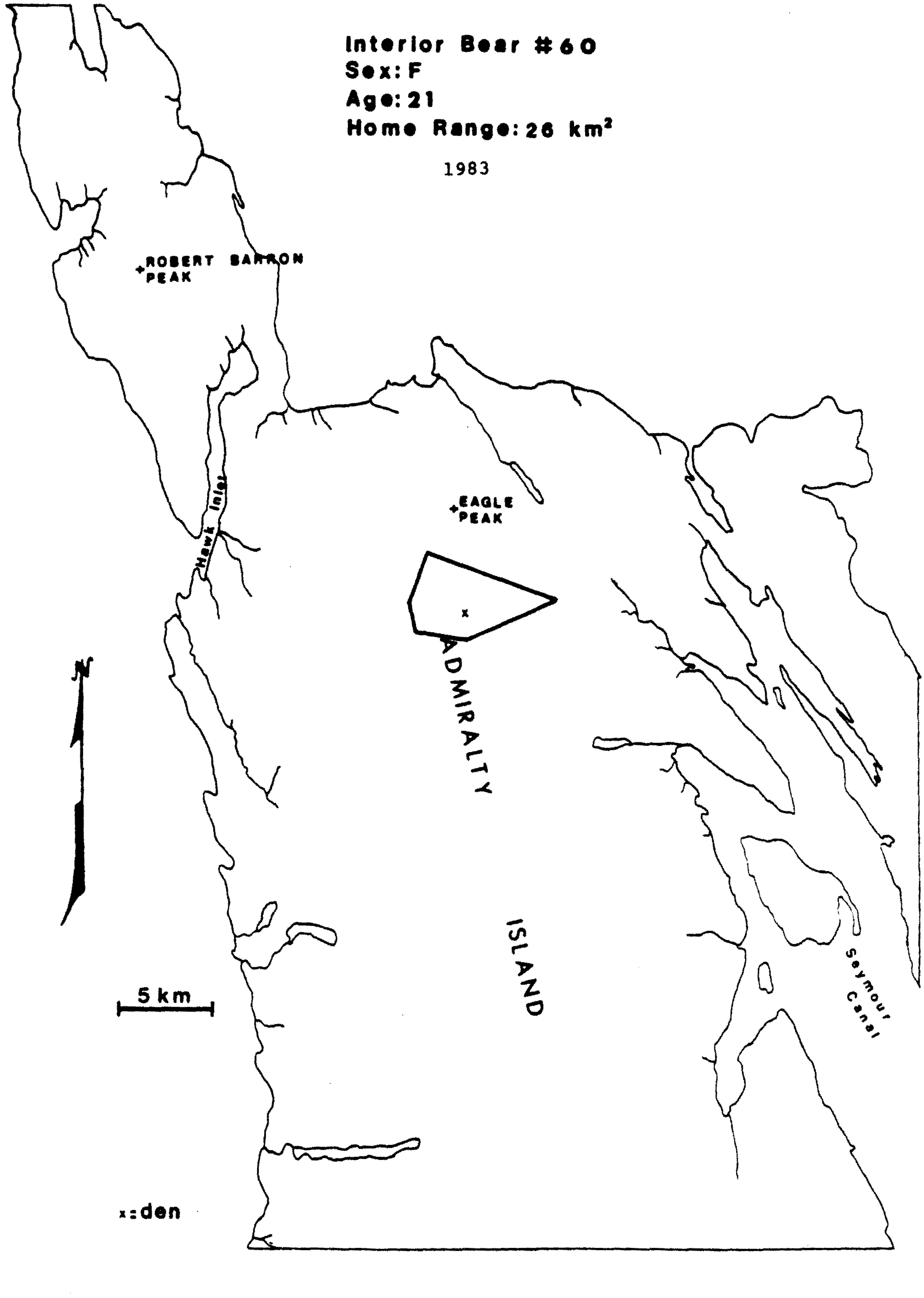
x: den


Bear #16
Sex: F
Age: 3
Home Range: 19 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den
x


Bear #38
Sex: F
Age: 24
Home Range: 29 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x=den

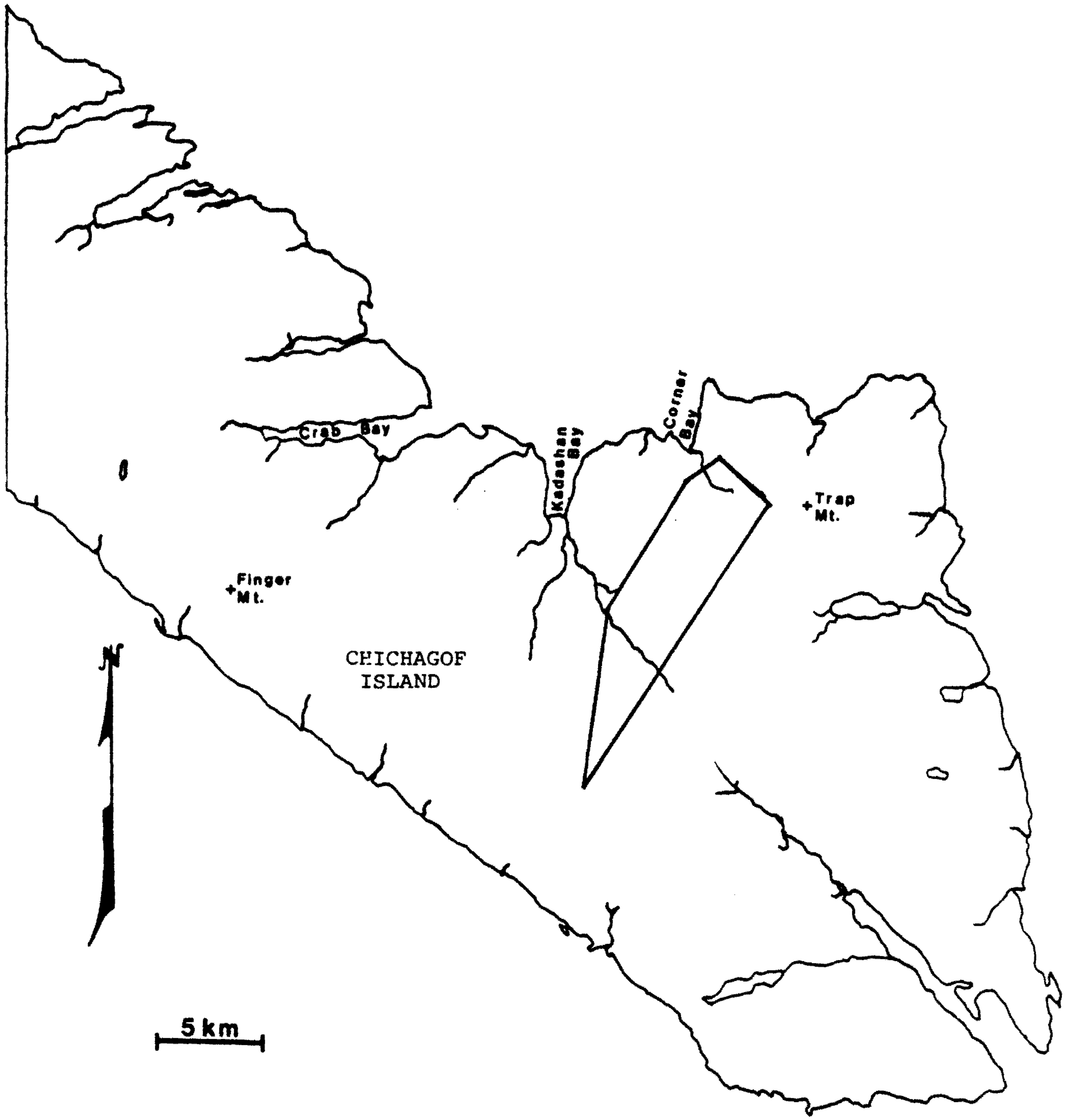

Coastal Bear #55
Sex:F
Age:5
Home Range: 25 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den


Interior Bear #14
Sex: F
Age: 7
Home Range: 42 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x: den


Interior Bear #60
Sex: F
Age: 21
Home Range: 26 km²
1983
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x: den

Appendix B. Home ranges of radio-collared brown bears, Chichagof Island, Alaska, 1983.

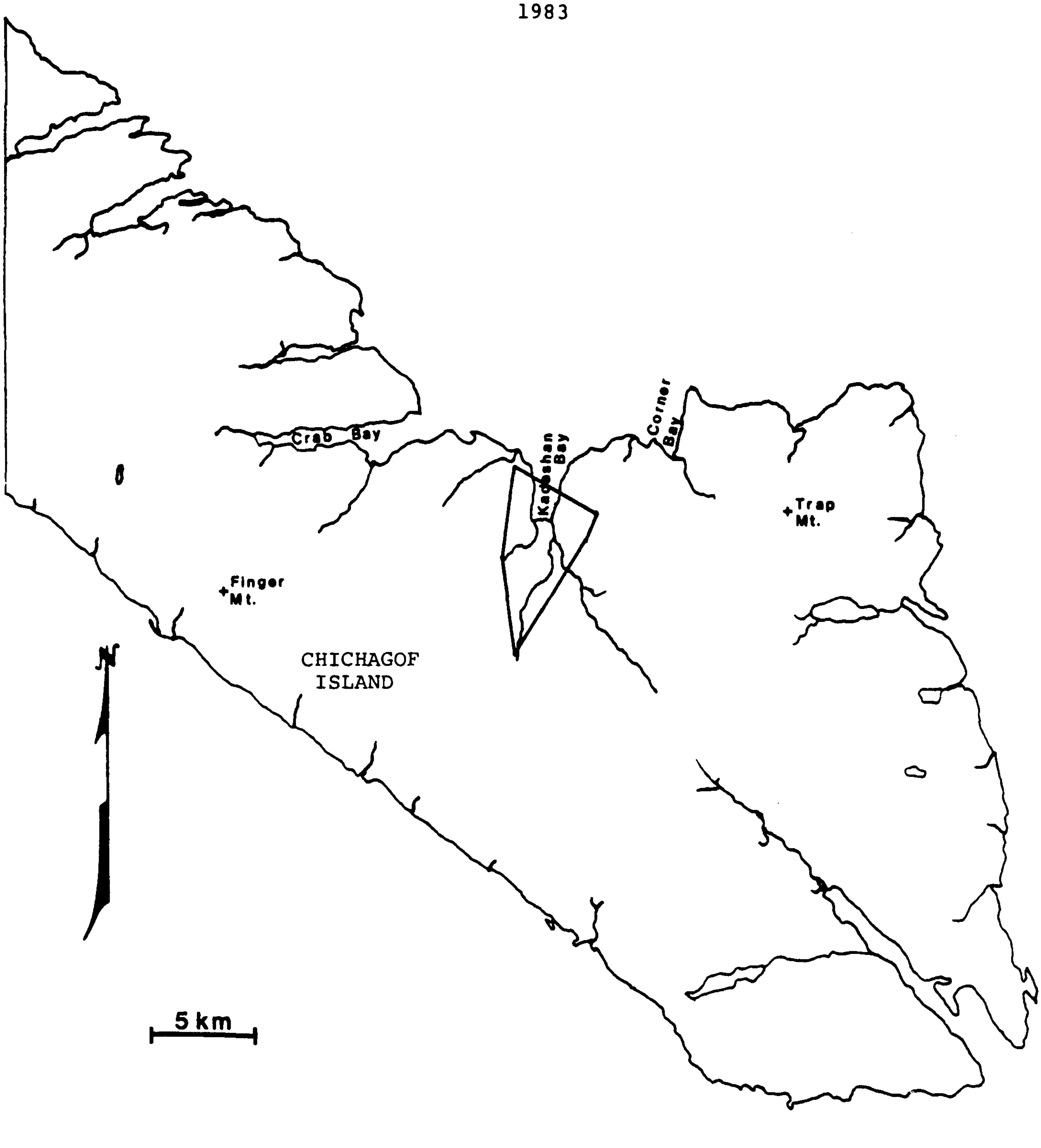
Bear # 88
Sex: M
Age: Adult
Home Range: 49 km²
1983



x:den

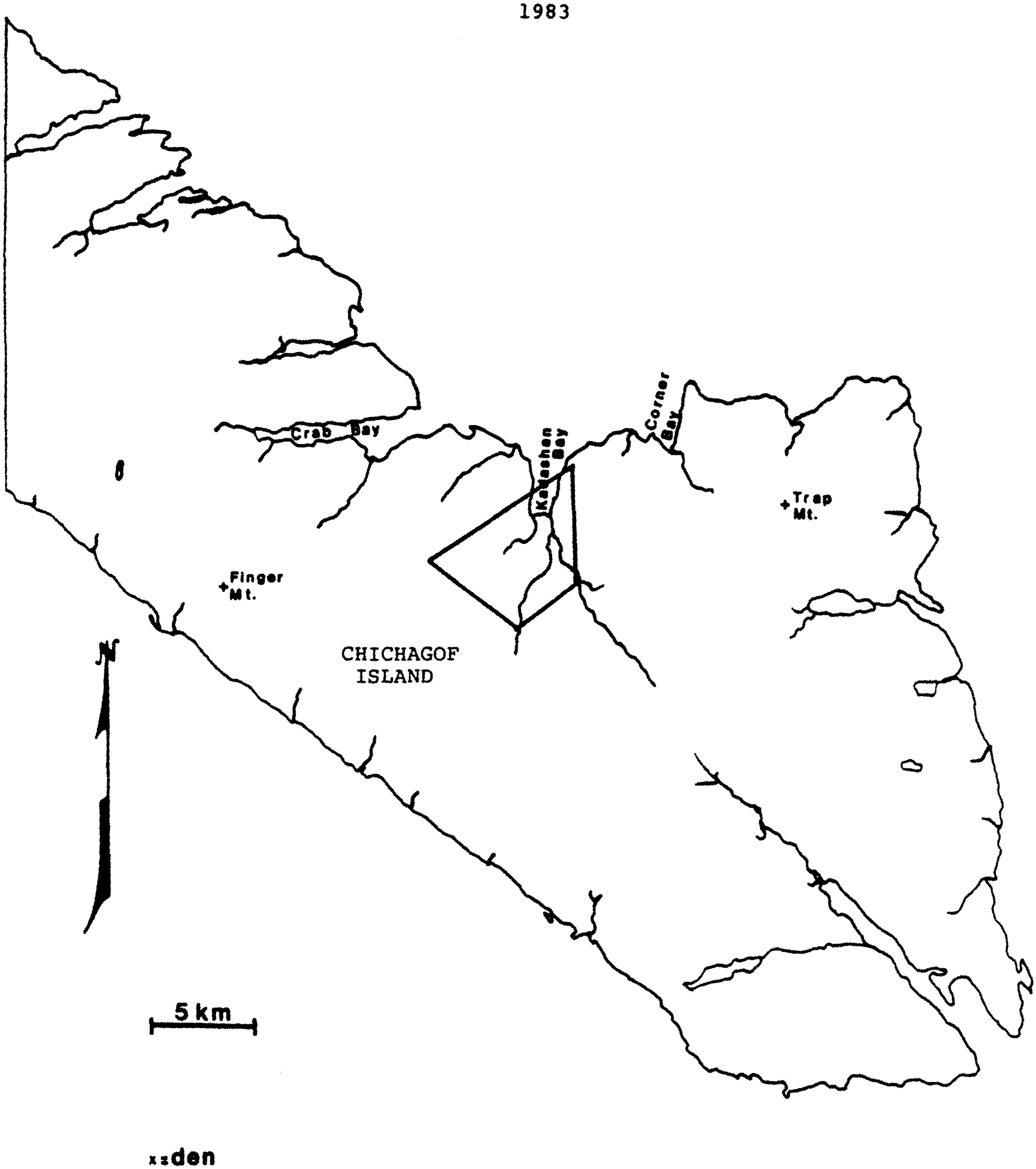
Bear#18
Sex:M
Age:Adult
Home Range: 22 **km²**

1983



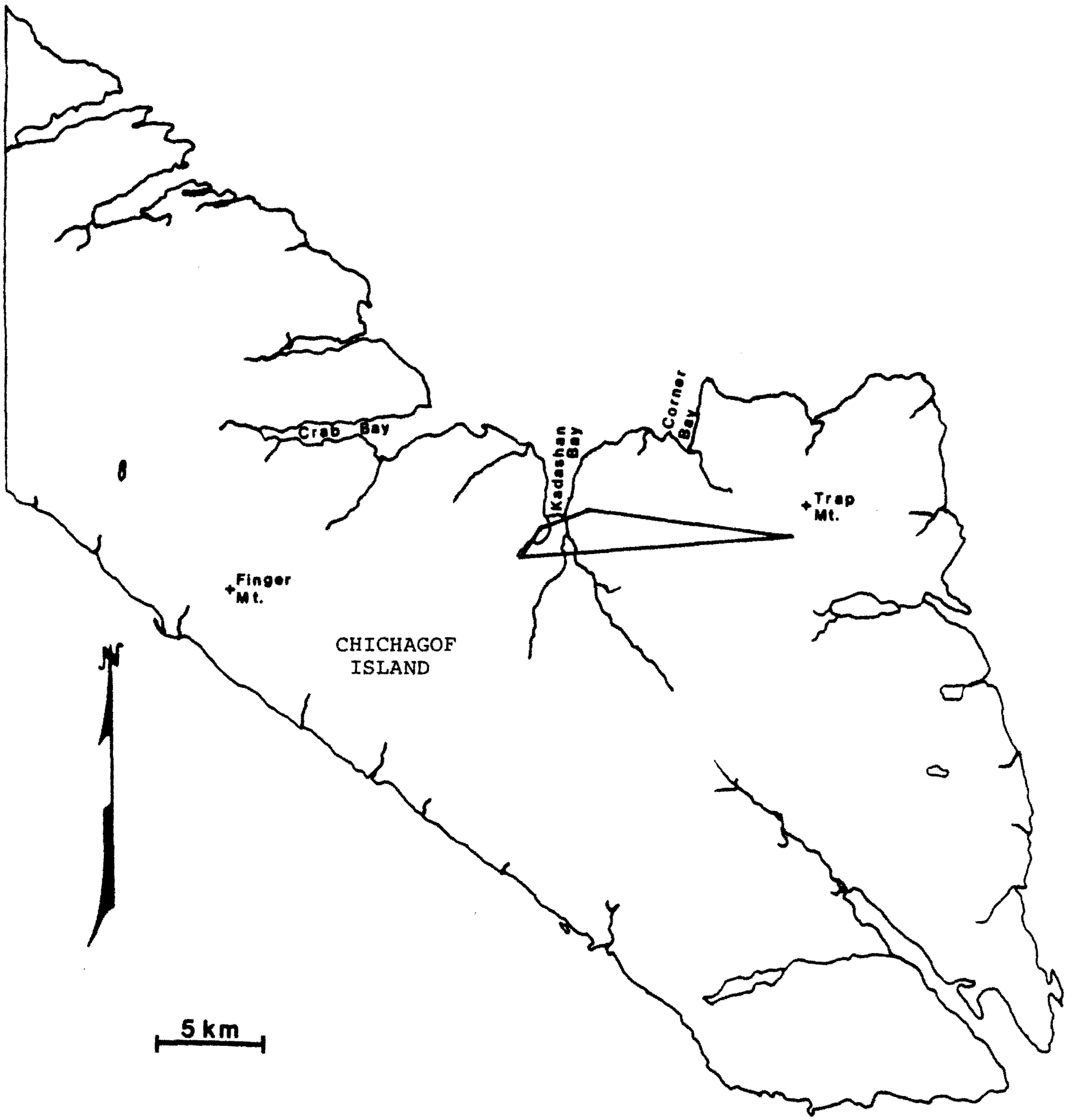
Bear #30
Sex: M
Age: Adult
Home Range: 34 **km²**

1983



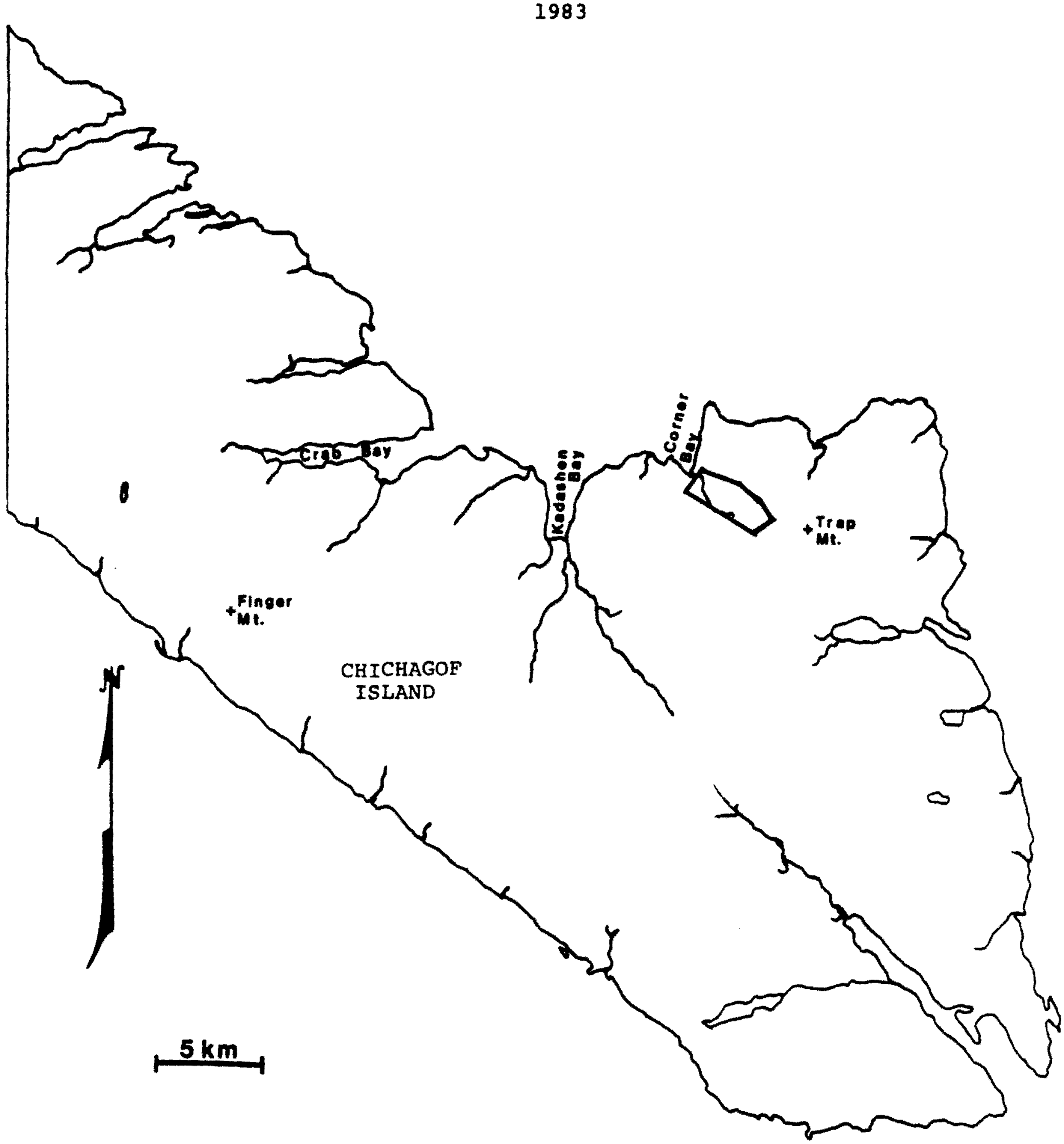
Bear # 73 w/2
Sex: F
Age: Adult
Home Range: 13 km²

1983



x=den

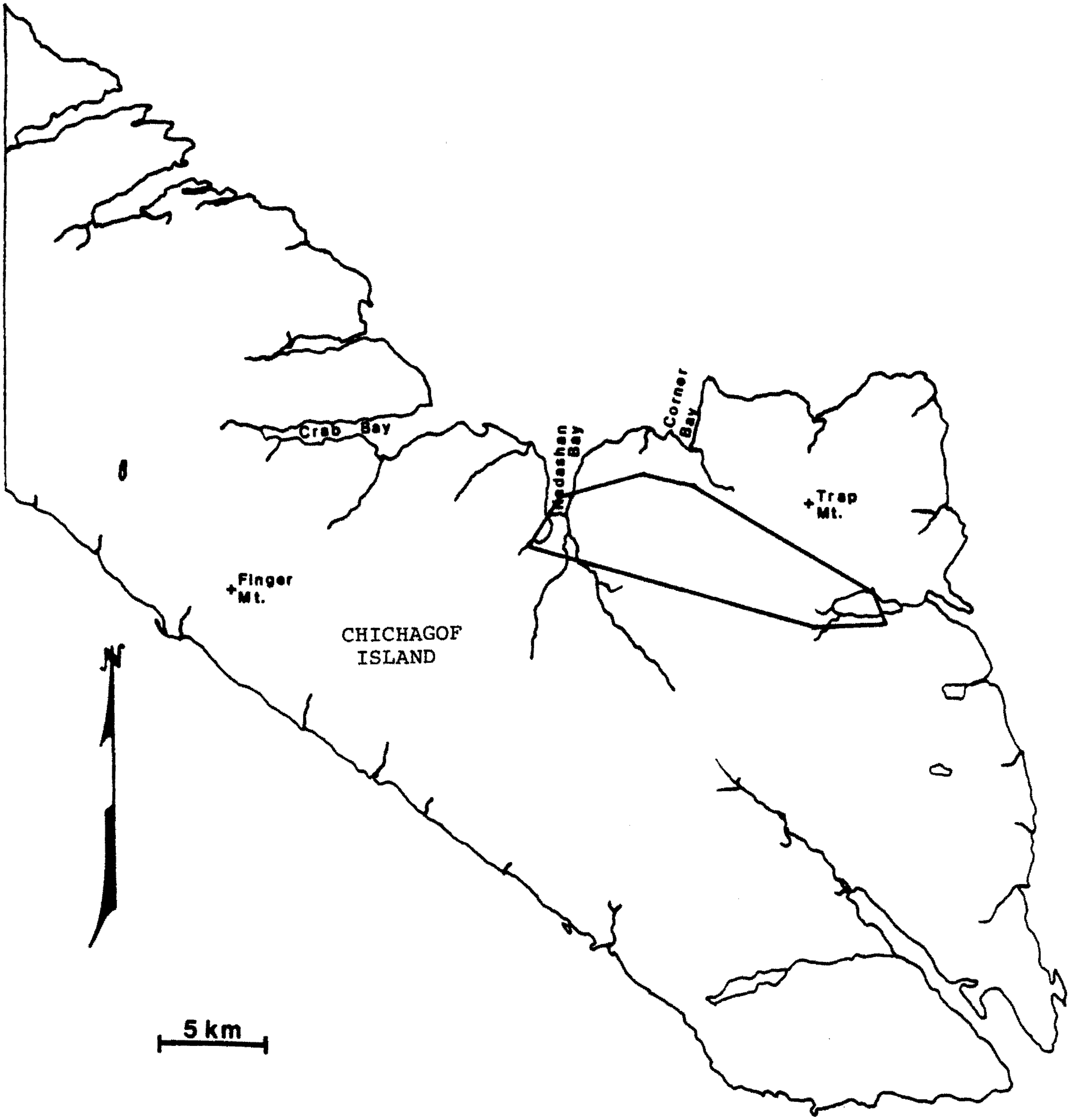
Bear#24
Sex: F
Age: Adult
Home Range: 10 km²
1983



xxden

Bear #23
Sex: M
Age: Adult
Home Range: 44 km²

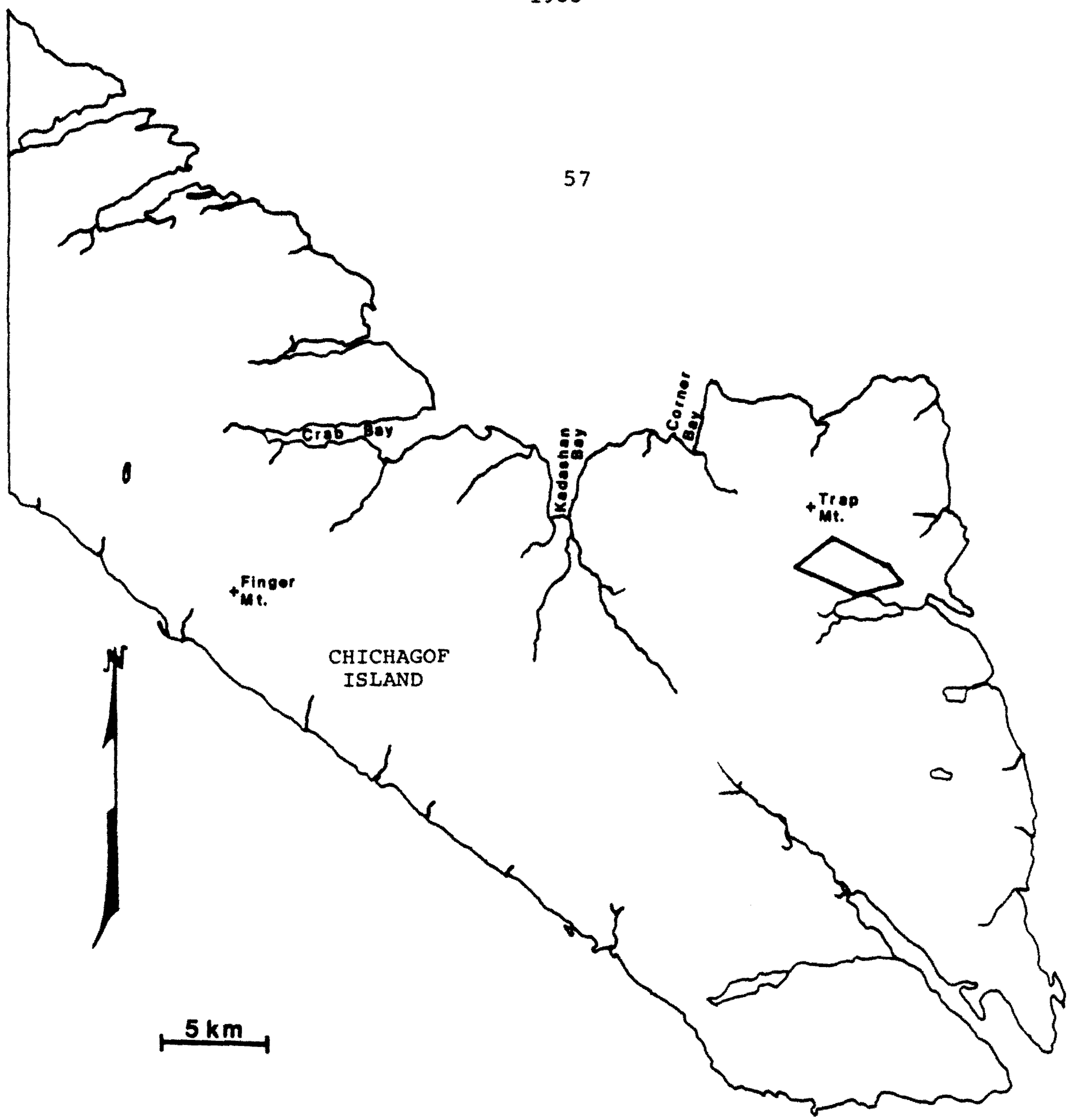
1983



x:den

Bear #12
Sex: F
Age: Adult
Home Range: 10 **km²**

1983

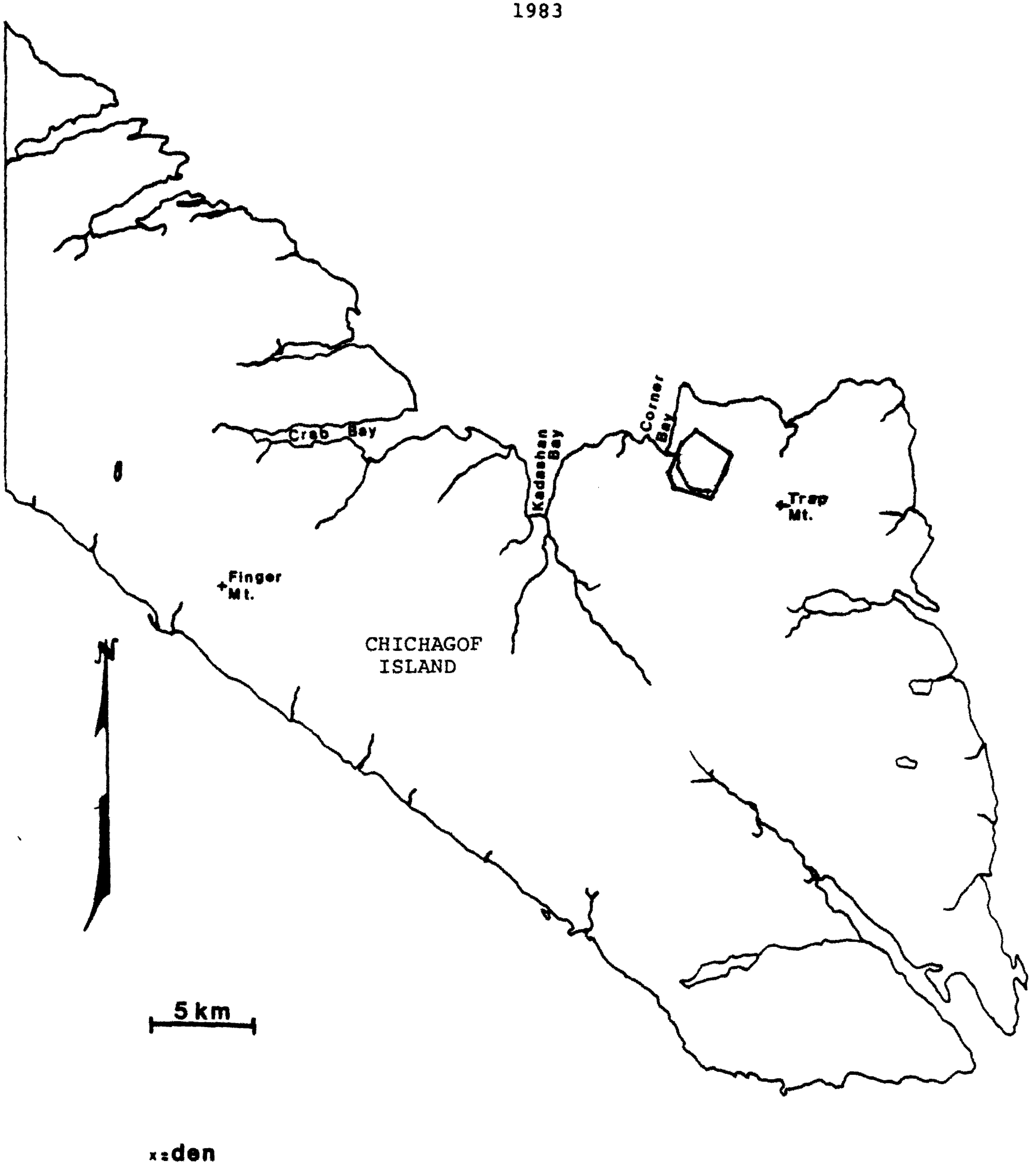


57

x:den

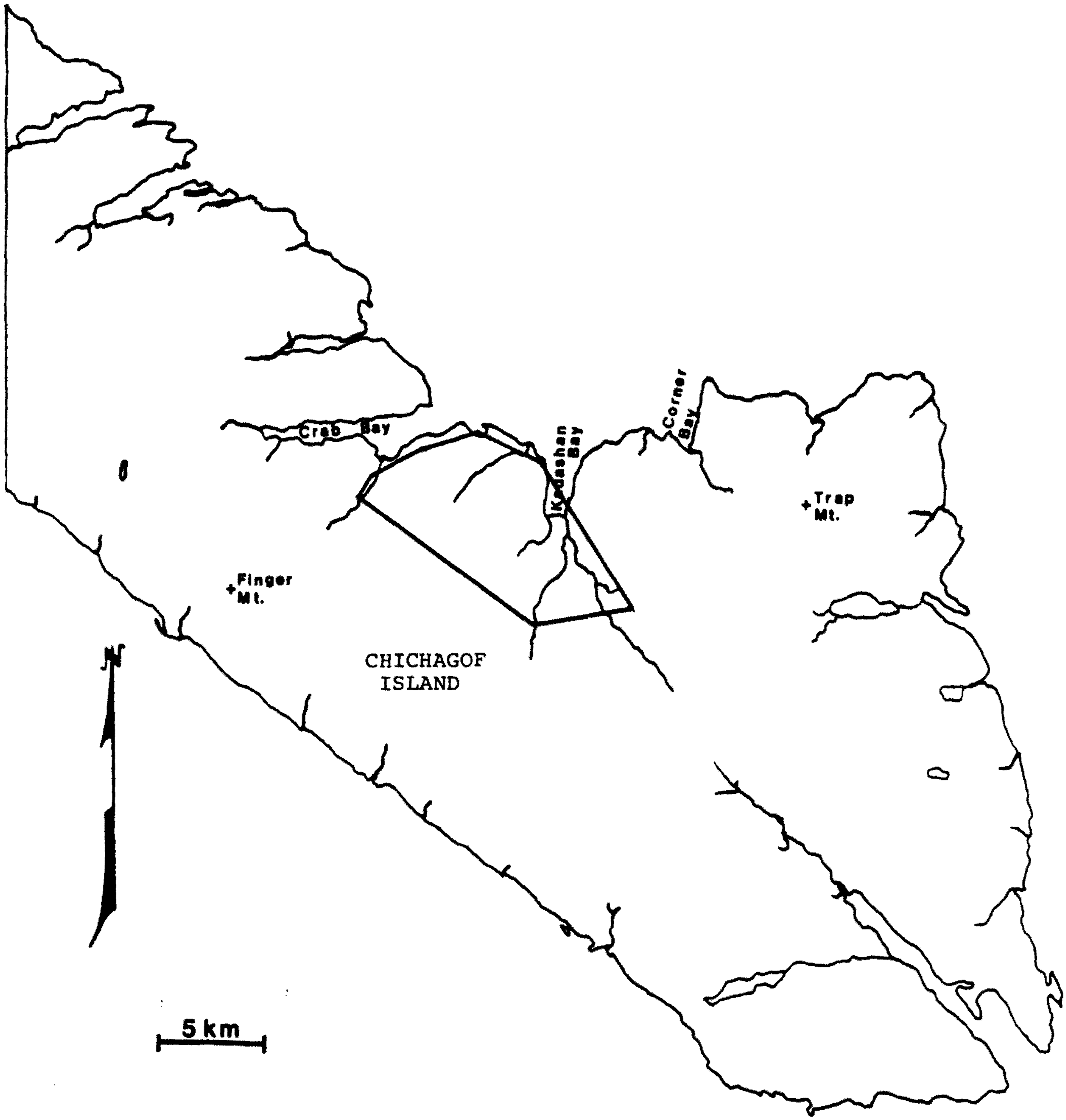
Bear # 21
Sex: F
Age: Adult
Home Range: 9 km²

1983



Bear # 2
Sex: M
Age: Adult
Home Range: 57 km²

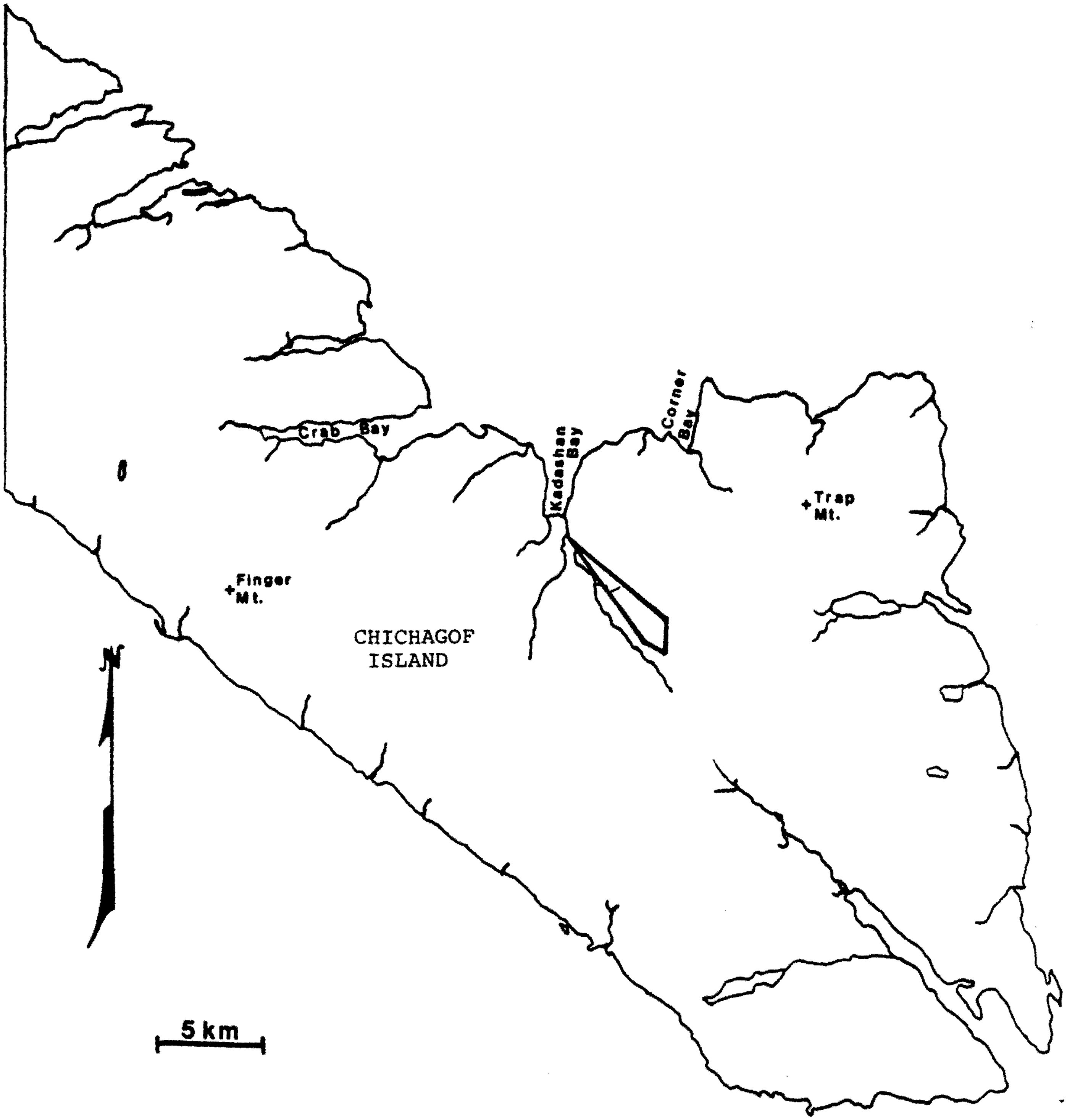
1983



x=den

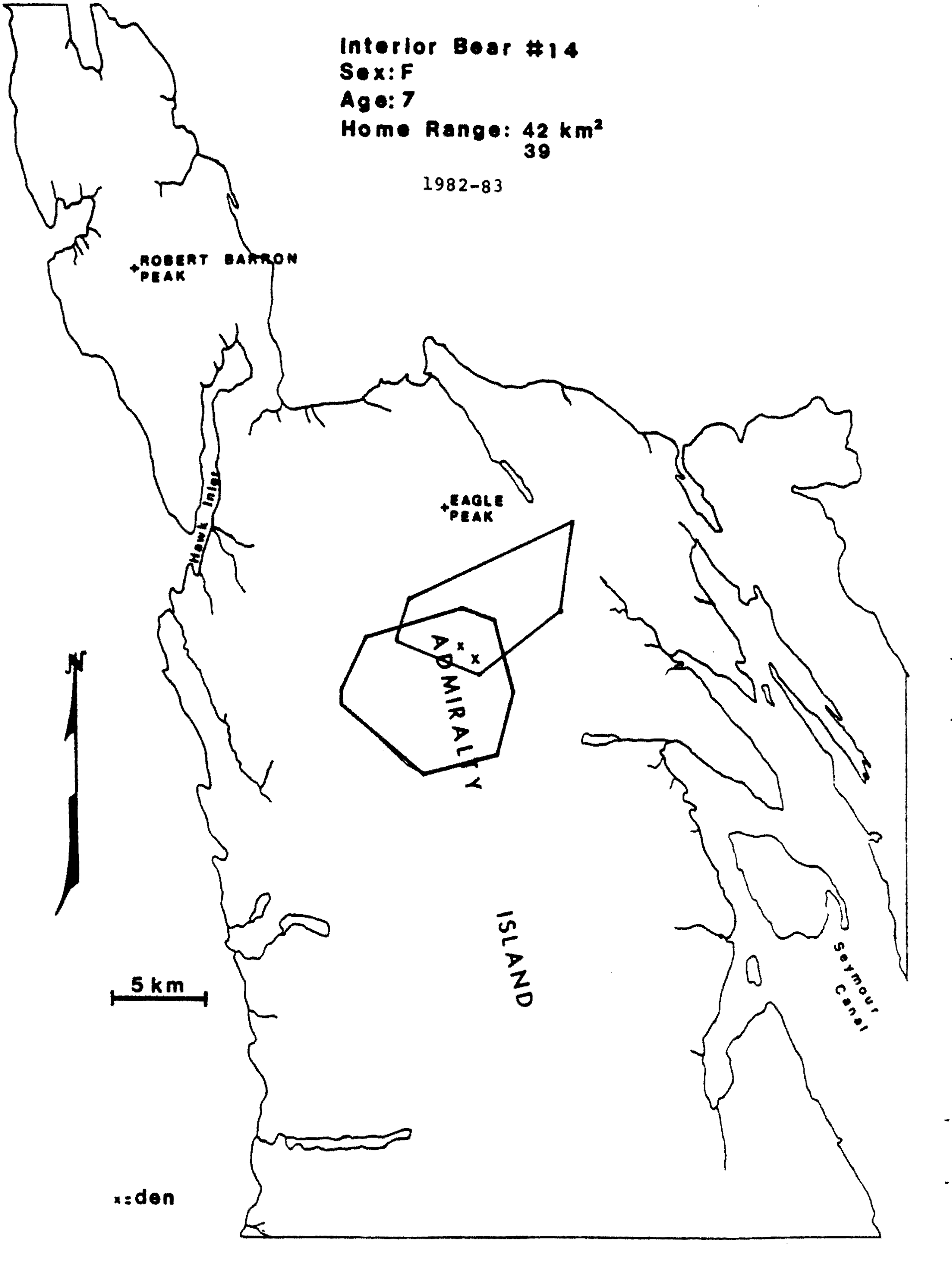
Bear # 44
Sex: F
Age: Adult
Home Range: 8 km²

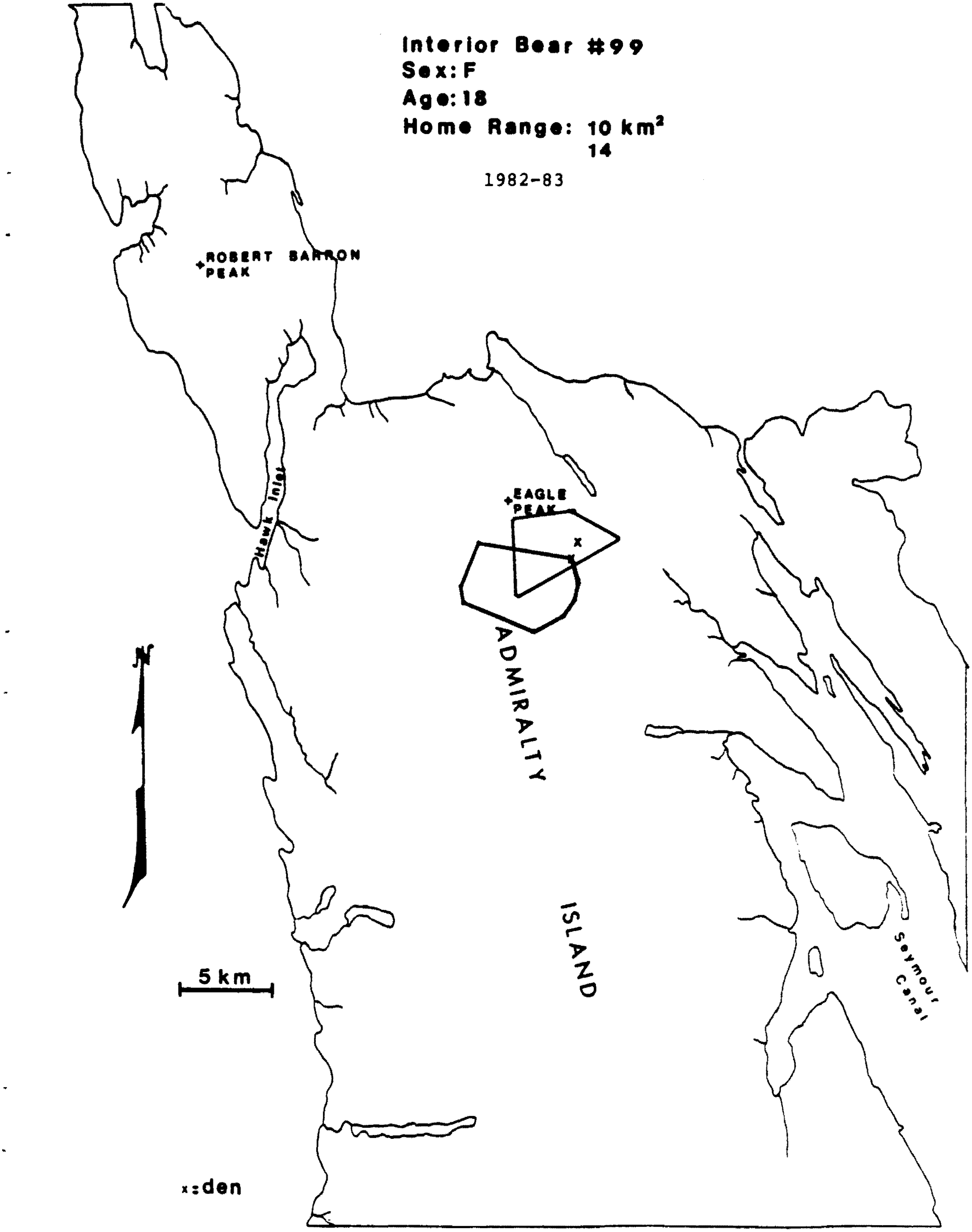
1983

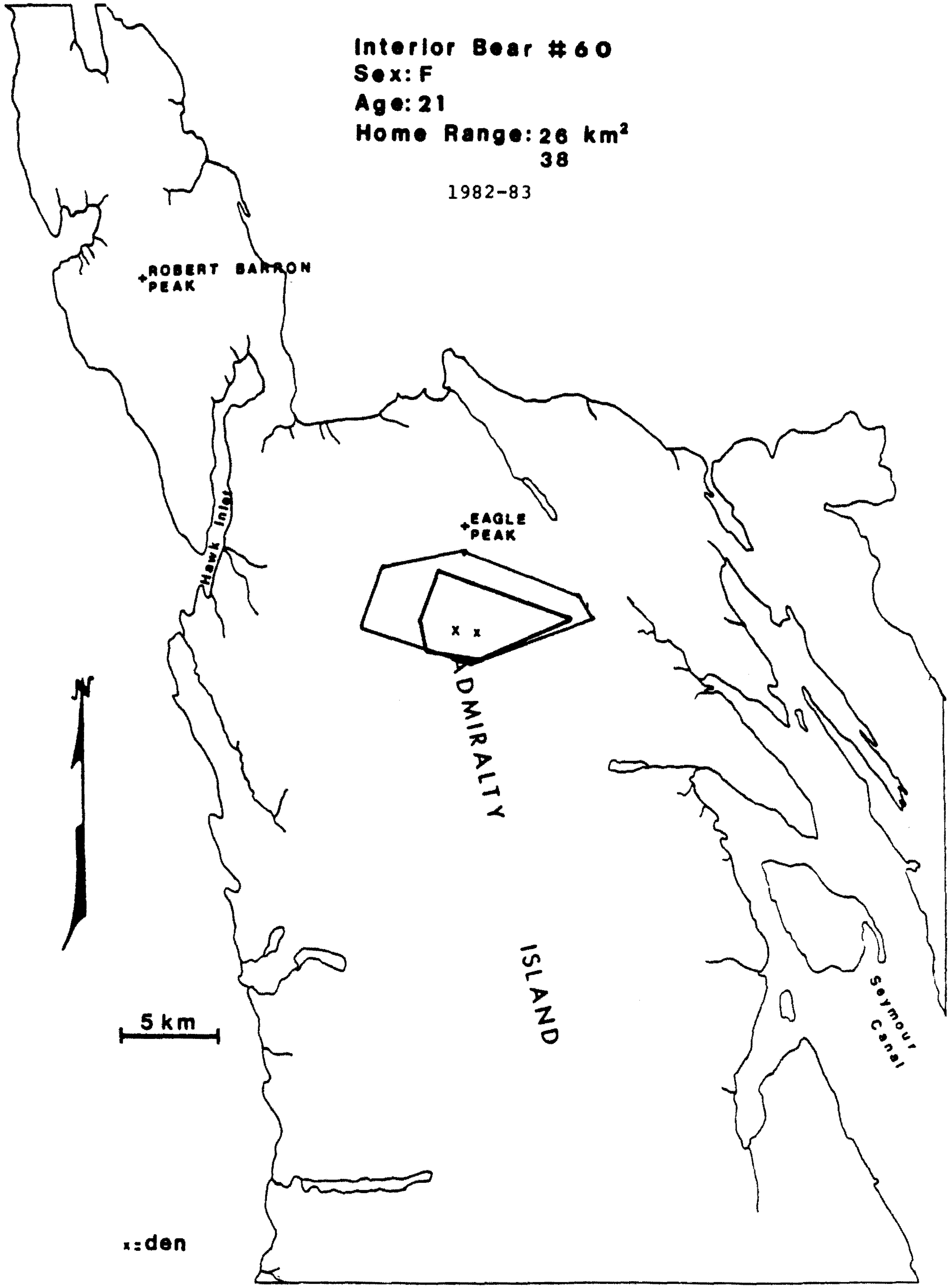


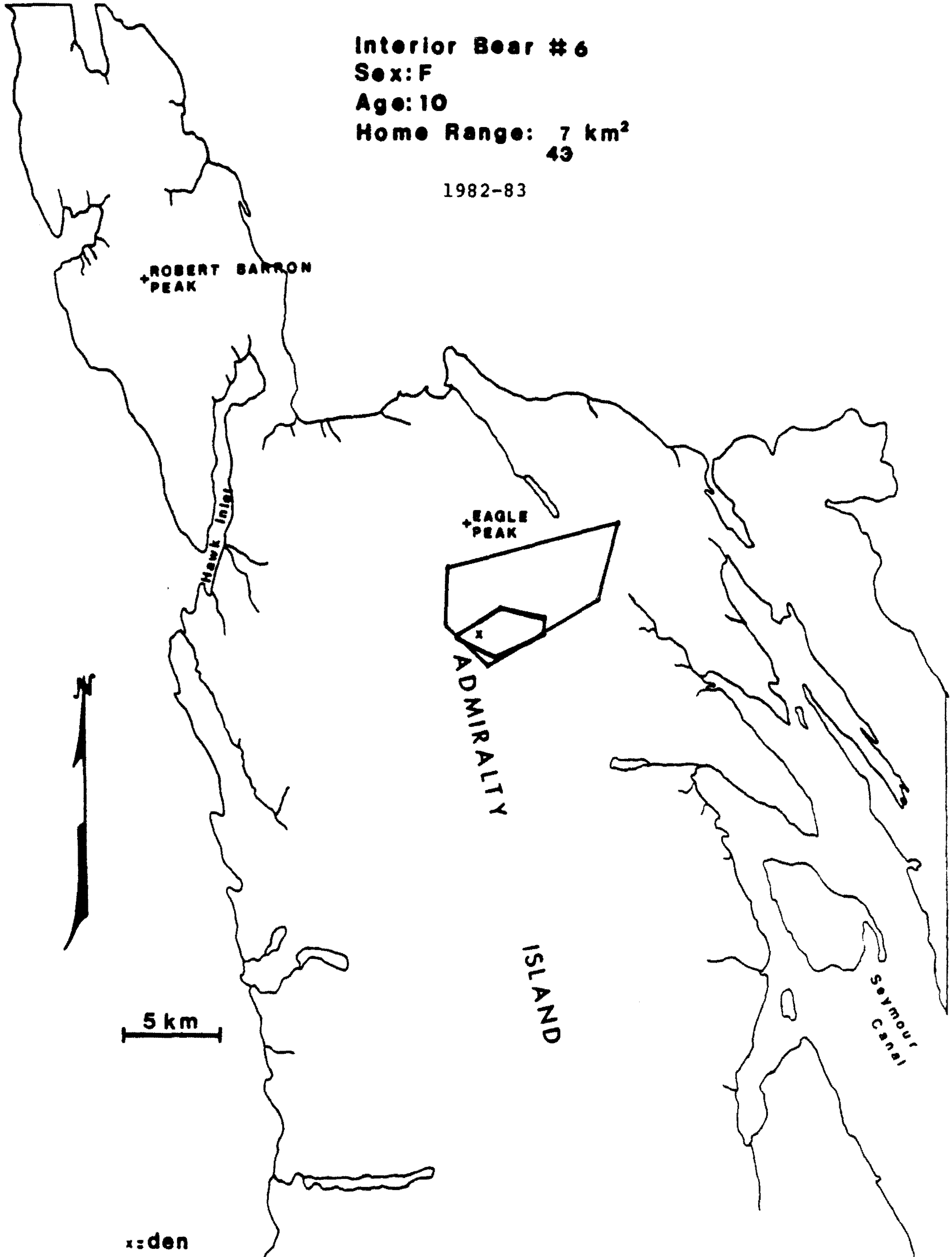
x:den

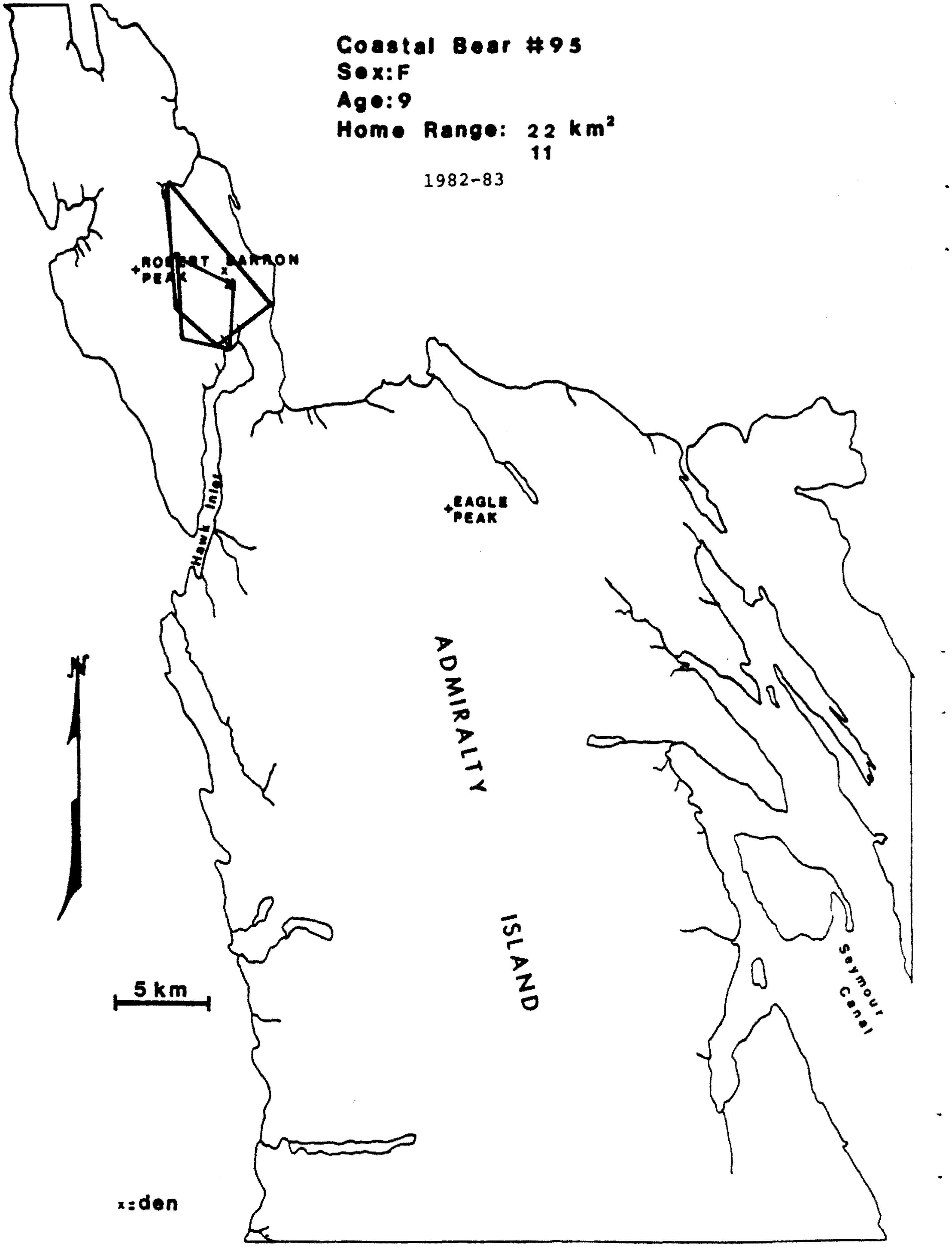
Appendix C. Home range overlap of radio-collared brown bears, Admiralty Island, Alaska, 1982-83.

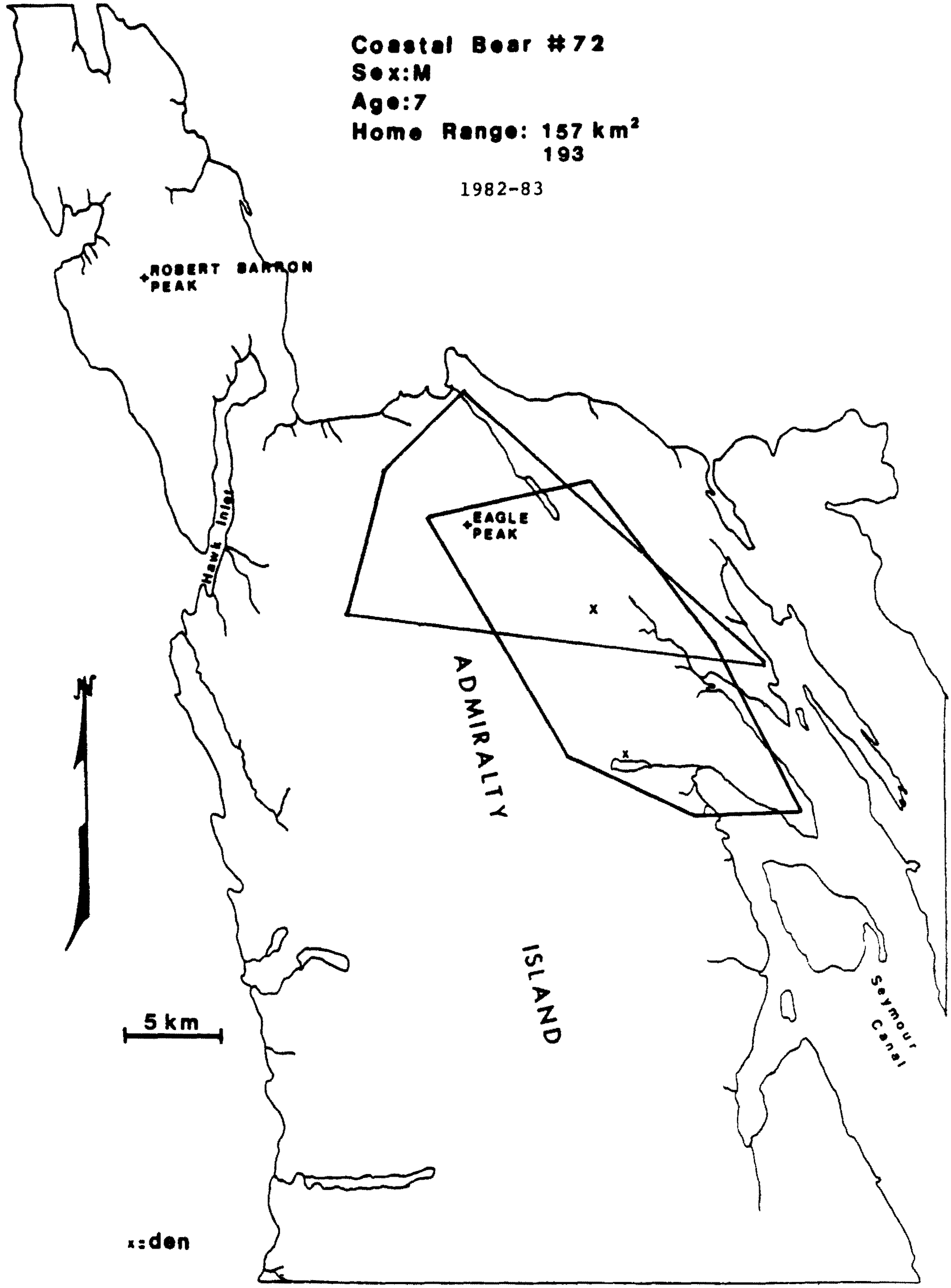

Interior Bear #14
Sex: F
Age: 7
Home Range: 42 km²
39
1982-83
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x = den

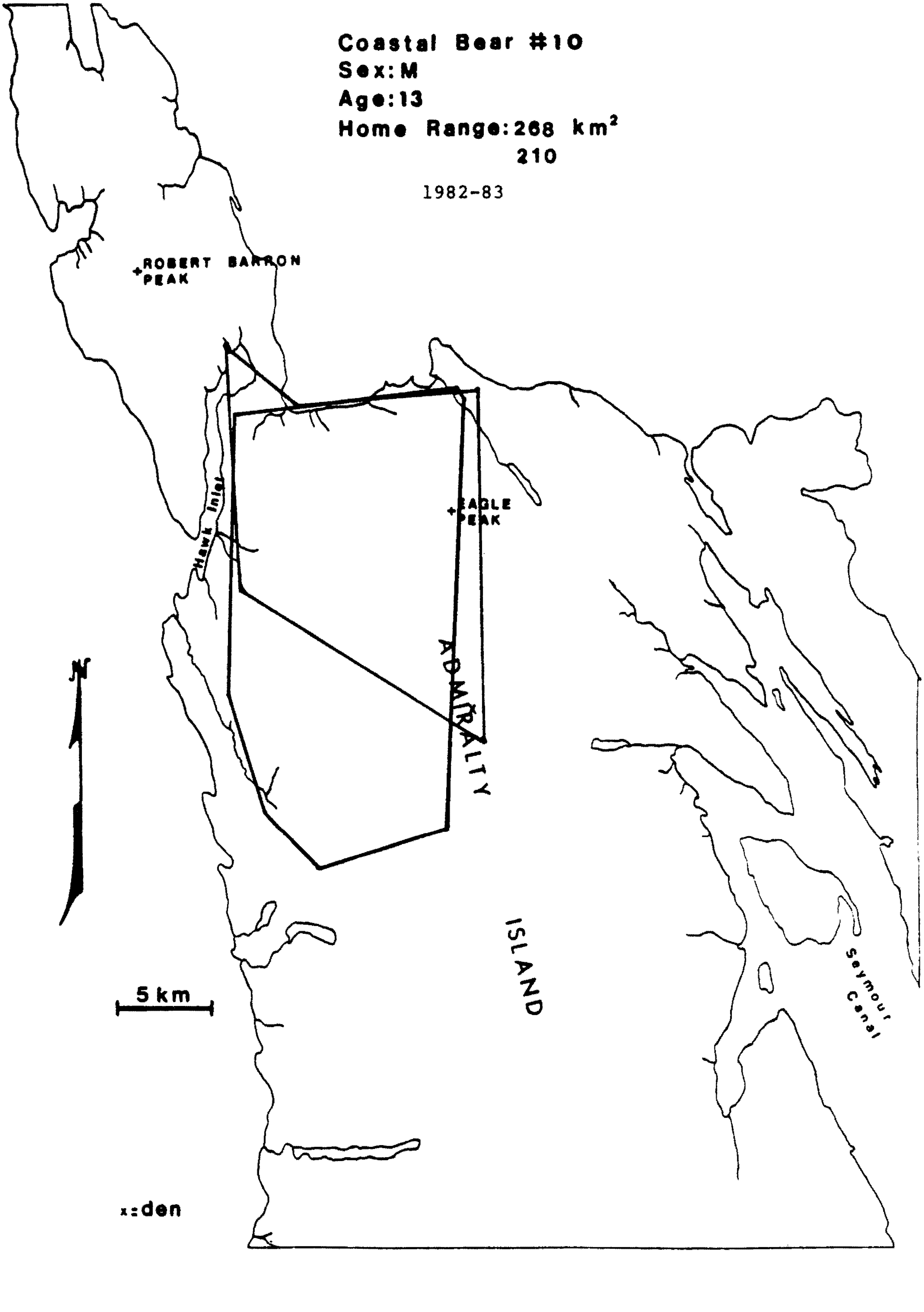

Interior Bear #99
Sex: F
Age: 18
Home Range: 10 km²
14
1982-83
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x: den


Interior Bear #60
Sex: F
Age: 21
Home Range: 26 km²
38
1982-83
ROBERT BARRON PEAK
Hawk Inlet
EAGLE PEAK
ADMIRALTY
ISLAND
Seymour Canal
5 km
N
x:den

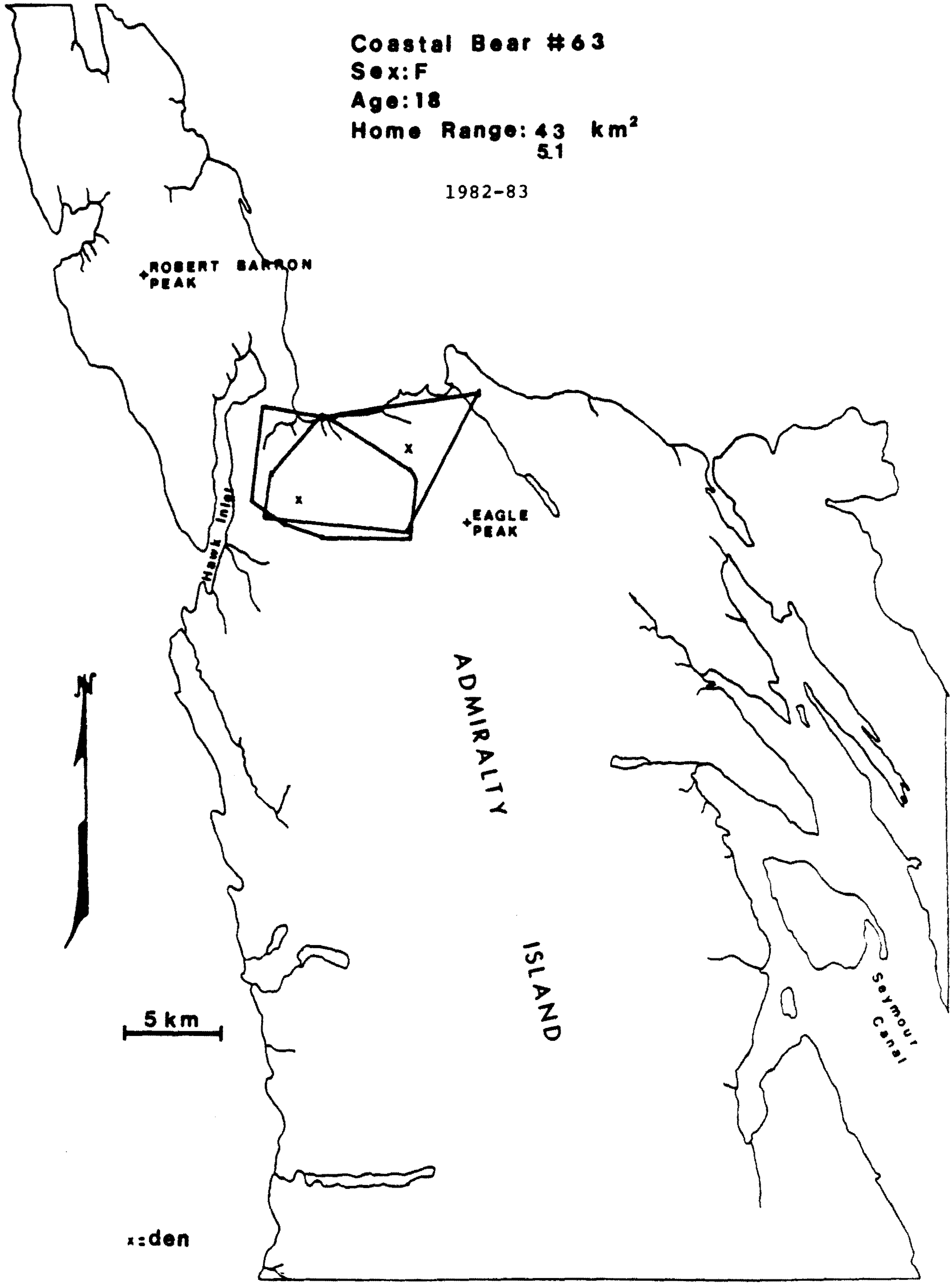

Interior Bear # 6
Sex: F
Age: 10
Home Range: 7 km²
43
1982-83
ROBERT BARRON PEAK
Hawk Inlet
EAGLE PEAK
ADMIRALTY
ISLAND
N
5 km
Seymour Canal
x: den


Coastal Bear #95
Sex:F
Age:9
Home Range: 22 km²
11
1982-83
ROBERT BARRON
PEAK
EAGLE
PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den


Coastal Bear #72
Sex:M
Age:7
Home Range: 157 km²
193
1982-83
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
5 km
x:den



Coastal Bear #10
Sex: M
Age: 13
Home Range: 268 km²
210
1982-83
ROBERT BARRON PEAK
Hawk Inlet
EAGLE PEAK
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x: den


Coastal Bear #63
Sex:F
Age:18
Home Range: 43 km²
5.1
1982-83
ROBERT BARRON PEAK
EAGLE PEAK
Hawk Inlet
ADMIRALTY
ISLAND
Seymour Canal
N
5 km
x:den

Appendix D.

BROWN BEAR WINTER DEN SITE CHARACTERISTICS NORTH ADMIRALTY ISLAND, SOUTHEAST ALASKA, 1982-83

Jack W. Lentfer, Environmental Research and Consulting, Juneau, Alaska
LaVern R. Beier, Alaska Department of Fish and Game, Juneau

Introduction

Brown bears are vulnerable to industrial development and related disturbances (Quimby 1974, Elgmork 1976, Harding and Nagy 1980, Mace and Jonkel 1984, Zager 1984). Ongoing and proposed mining and logging for portions of southeast Alaska inhabited by brown bears have been described by Schoen (1982). In 1981 the Alaska Department of Fish and Game started brown bear research on north Admiralty Island with emphasis on habitat preferences and effects of mining and logging on brown bears. Work reported here is part of this broader study.

Brown bear denning has not been studied previously in southeast Alaska, but has been studied elsewhere in Alaska, in other states, and in Canada (Craighead and Craighead 1972, Lentfer et al. 1972, Pearson 1975, Reynolds et al. 1976, Vroom et al. 1980). Most of these studies have been in areas with colder and drier climates than southeast Alaska. Information from the present study from the maritime climate of southeast Alaska might therefore be of special interest.

Objectives of the present study were to describe den site characteristics during the denning period, with emphasis on snow characteristics.

Funding was provided by Alaska Department of Fish and Game Federal Aid in Wildlife Restoration Project W-22-1, which included State Contract No. 83-0572. John Schoen assisted with project design and in the field, Matt Kirchoff assisted with statistical analysis and in the field, and Steve Peterson assisted in the field.

Methods

As part of a broader study, bears were immobilized and fitted with radio-collars in the Hawk Inlet area of northern Admiralty Island (Schoen 1982, Schoen and Beier 1983). Fifteen bears were located from aircraft in the fall of 1982 to obtain movement and habitat preference data and den locations (Schoen and Beier 1983). The present study entailed visiting den sites in January and April 1983. Prior knowledge of den locations allowed investigators to fly to the general location of each den with a helicopter. Dens were located more precisely by tracking with a hand-held antenna from the helicopter. Investigators were then landed and with the aid of the hand-held tracking antenna walked as close to each den as possible. Some dens could not be approached closely because of steep slopes and danger of snow slides.

A series of snow depth measurements was taken at or as close to each den as possible. Where open and forested areas were adjacent, snow depth measurements were taken in both habitat types. The number of measurements at a single location ranged from 2 to 16, with 6 being the most common. Examination of first measurements showed that six measurements would provide a series in which variance was not excessive. Maximum-minimum thermometers were placed in the vicinity of five representative dens. Snow characteristics were described subjectively based on surface appearance and probing. In April, snow profiles from the snow surface to the ground were examined at five dens. Snow moisture content and density were determined at five dens by weighing measured core samples (U.S. Department of Agriculture undated).

National Oceanic and Atmospheric Administration climatological data (National Oceanic and Atmospheric Agency 1983) for Juneau, the nearest weather station with complete long-term records, were used to compute the percent of the year's snow that had fallen at each den at the time it was visited and to derive an estimate of snow cover for years of low and high snowfall. These were based on the minimum and the maximum snowfall years during the period 1943-82. During the minimum snowfall year (1969-70), Juneau received 1.0 meters of snow, and during the maximum snowfall year (1975-76), it received 4.7 meters. During 1982-83, the winter of this study, it received 1.7 meters. Factors applied to snow depths of the present study to estimate depths at den sites in years of minimum and maximum snowfall were 1.0/1.7, or 0.6, for a minimum snowfall year and 4.7/1.7, or 2.8, for a maximum snowfall year. Differing effects of snow settling, of wind action, and of other factors, other than amount of snowfall, that might affect depths in minimum and maximum snowfall years were not known and were not included in computations.

Bears were grouped into the following five categories to examine if sex, age, or reproductive status affected denning behavior: single adult females, parturient females, females with young, subadult males, and adult males. Results of radio-tracking for two seasons suggest that individual animals show a habitat preference which is either coastal or interior (Schoen et al. in press). Animals were therefore grouped by habitat preference, and den characteristics compared. Data were available for 15 animals for the winter of 1982-83. To increase the data base, data from six dens during the previous winter were combined with the 1982-83 data.

Significance of differences between mean elevations at which different sex and age groups denned was tested by a non-parametric Kruskal-Wallis one-way analysis of variance. Significance of the difference between mean elevations at which bears with a coastal habitat preference denned and bears with an interior habitat preference denned was tested with a non-parametric Mann-Whitney U test.

Findings

Table 1 lists den site characteristics. Data are largely from Schoen and Beier (1983) and Schoen (pers. comm.).

Table 2 presents data on den characteristics by age and sex category. Data from the previous winter (1981-82) for five dens are included to expand the data base.

Den type, i.e, natural rock cavity or excavated, is known for 16 dens (Table 2). Thirteen were in natural rock cavities, and three had been excavated. Natural rock cavities were used by animals with both coastal and interior habitat preferences and by all sex, age, and family group categories of animals. All of the three excavated dens were occupied by bears with a coastal habitat preference.

Among sex, age, and family group categories, mean elevation of dens of parturient females was the highest (908 meters) and of adult males was the lowest (651 meters). Differences in mean elevation between the groups were not significant, however ($P > 0.05$).

Mean elevation of dens of bears with a coastal habitat preference was 706 meters (standard deviation = 210, range = 366-915, $n = 11$). Mean elevation for bears with an interior habitat preference was 946 meters (standard deviation = 165, range = 610-1160, $n = 10$). Interior bears denned at significantly higher elevations ($P < 0.01$).

Snow depth measurements are presented in Table 3. Because measurements could not be made at the exact location of most dens, snow depths were estimated for these dens (Table 4). Snow depths ranged from 0.1 to 2.7 meters in January and from 0 to 2.2 meters in April (Table 4). Table 4 also presents estimated percentages of annual snowfall that had accumulated to the dates when snow measurements were taken. Table 4 gives calculated snow depths at dens for minimum and maximum snowfall years based on an extrapolation of the range in snowfall at Juneau. Calculated depths at dens during a minimum snowfall year range from 0.1 to 1.6 meters in January and from 0 to 1.3 meters in April. Calculated depths at dens during a maximum snowfall year range from 0.3 to 7.3 meters in January and from 0 to 5.9 meters in April.

Snow in January on the surface ranged from light and dry to heavy and moist to hard-packed and dry, depending on air temperature and effect of wind at a particular site. Probing to obtain depth measurements indicated an occasional hard layer. Snow was consistently denser and contained more moisture in April than in January. Layers of consolidated ice occurred in three of five locations where snow profiles were examined (Table 5). Snow temperatures recorded for three profiles in April were 4 degrees C from the ground to the snow surface. Minimum air temperatures at five dens for the January-April period ranged from -22 C to -7 C, and maximum air temperatures ranged from 5 C to 16 C (Table 5).

Ten sets of comparable snow depth measurements were obtained in open areas and in adjacent areas with forest cover in the vicinity of seven dens. Snow was significantly deeper in the open than in adjacent forested sites in eight of the nine areas with measurements which could be compared statistically ($P < 0.05$, Table 6).

Discussion

Data for 1981-82 and 1982-83 can be combined to provide 20 observations on category of individual animals or family groups occupying dens (Table 2). These are too few for a population analysis, but numbers in the different categories do not suggest disproportionate representation of any sex or age class.

Results of radio-tracking for two seasons suggest that individual animals show a habitat preference which is either coastal or interior (Schoen et al. in press, Table 2). For denning bears, coastal and interior animals were not represented equally in the different animal categories, i.e., single adult females, parturient females, etc. Table 2 shows one parturient female with a coastal habitat preference and four parturient females, each with an interior habitat preference. Numbers are reversed for females with young older than cubs-of-the-year, i.e., four, each with a coastal preference, and one with an interior preference. Numbers are too low to draw conclusions, but something to examine in the future is whether an individual animal maintains the same habitat preference throughout its life or changes preference, perhaps in response to changing reproductive status.

Brown bears on north Admiralty Island use natural rock cavities for denning more than excavated cavities. The relatively low number of observations to date do not indicate a preference for either natural or dug dens by different categories of bears. The incidence of use of natural rock cavities for brown bear denning is greater on north Admiralty Island than in other locations in Alaska. Of 134 dens examined by Lentfer et al. (1970) on Kodiak Island and the Alaska Peninsula, all had been dug. Of 52 brown bear dens examined in the eastern Brooks Range, Reynolds (1976) found that 39 had been excavated and 13 were in natural rock cavities.

Bears denned successfully within a wide range of den snow depths (0.1 to 2.7 meters in January and 0 to 2.2 meters in April). Changes in snow depth from January to April were not correlated with snowfall. In most locations, differences between January and April snow depths were not great, and in some locations, snow was deeper in January than in April. This was due primarily to snow settling. In some locations, melting and sublimation also contributed to the lower snow depth in April.

The range of snowfall between years of minimum and maximum snowfall can be great as evidenced by long-term weather records for Juneau (1.0-4.7 meters). Snowfall was below average in 1982-83. Extrapolation on a proportionate basis of maximum snowfall data from Juneau to den sites suggests a maximum snow depth at a specific den of more than 7 meters (Table 4). It should be emphasized, however, that this is hypothetical and does not include any differing effects of snow settling, of wind, or of other factors, in a maximum snowfall year as compared to a normal or below average snowfall year.

No evidence of mortality among denning bears was observed in 1982-83, but this was not a year of either minimum or maximum snowfall, and the possibility of mortality related to denning during such years should not be discounted. Snowfall in recent years and subjective indicators of bear abundance show some correlation. For the 6 years, 1970-76, mean annual Juneau snowfall was 3.8 meters, and for the 5 years, 1976-77 to 1982-83, mean annual Juneau snowfall was 1.9 meters (National Oceanic and Atmospheric Agency 1983). Alaska Department of Fish and Game biologists, guides, and hunters generally reported fewer brown bears (and also fewer black bears) during the 1977-79 period, following the heavy snowfall years; since then, following several years when the average snowfall was substantially lower, biologists, guides, and hunters are reporting more bears (information in Alaska Federal Aid in Wildlife Restoration reports and Alaska Department of Fish and Game files). Another aspect to be considered is effects of shallow snow cover and resulting reduced insulation over dens. As bear studies are intensified, it is recommended that indicators of bear abundance or density be refined and population figures and snowfall data be examined for possible correlation. It is also suggested that dens be examined for evidence of mortality following winters of low and of high snow accumulation.

Snow temperatures were constant at 4 degrees C along profiles from the ground to the snow surface in late April. This differed from snow profiles in polar bear denning areas which showed a gradient of decreasing temperature from the ground to the snow surface (Blix and Lentfer 1979). The gradient in polar bear denning areas was explained by widely divergent temperatures on either side of the snow layer, i.e., warm earth temperatures and cold arctic air temperatures. It is possible that the snow layer on north Admiralty Island would have shown a similar gradient early in the winter. Denning in the relatively warm ground which is covered by insulating snow can be considered a strategy by bears for energy conservation during the long denning period when no food is consumed.

A question that comes to mind is whether a thick layer of snow which may have thinner ice layers at various levels within it would restrict gas exchange to the extent that respired carbon dioxide would concentrate in the den, and there would not be enough oxygen for the bear. This did not occur during the present study as evidenced by successful denning an emergency of all animals monitored. This may be because of reduced oxygen requirements during hibernation. Hoch (1960), with a preliminary analysis, reported hibernating black bears to consume from one-half to less than one-tenth as much oxygen as an active black bear. It is assumed that brown bears would show a similar decreased oxygen demand.

Admiralty Island, because of its high bear population, reoccurring use of some dens, extremes in snowfall, and ice layering in the snow, is ideal for studying certain aspects of denning in an extreme environment. One study possibility would be to monitor oxygen and carbon dioxide levels and temperatures in dens, and correlate with snow conditions and ambient air temperatures. Natural rock cavities used previously for denning could be instrumented in the summer, thus providing a means to monitor those used again.

The present study suggests that the following den site characteristics for brown bears in southeast Alaska can vary quite widely: vegetative cover, snow cover, substrate (natural rock cavity or excavated earth), elevation, slope, and aspect. Enough data are not yet available to determine if specific site conditions are necessary for specific segments of the populations. It could be argued that with bears able to den under a variety of conditions, development such as mining or logging in certain areas would merely push animals into adjacent undisturbed areas where they would den successfully. This gives rise to several questions. Will individual animals and the population as a whole tolerate an increased density of denning in limited areas? Is denning under a wide range of environmental conditions a strategy for maintenance of the population in case denning mortality occurs from year to year under different sets of environmental conditions? Will displacement of animals during summer and fall to less favorable feeding areas result in less than normal reserves of body fat at time of denning? Possible consequences are early desertion of dens, abortion of fetuses, malnourishment of cubs, and excessive stress during the post-denning period.

Disturbance during the denning period may be as important as displacement. Reynolds et al. (1976), in the eastern Brooks Range, reported abandonment of five brown bear dens that were approached by helicopter during or shortly after den construction. During the present study, a female (No. 39) left a den in mid-winter and spent the rest of the winter about one kilometer away, presumably in a newly formed den. This occurred after investigators had been landed near the original den on 29 January to take snow measurements. Bad weather prevented the helicopter (a large Sikorsky Coast Guard model) from picking them up, but in attempting to do so the helicopter made several low passes near the den on 29 and 30 January. The next radio-tracking flight on 18 February revealed the female in a different location. It was assumed that a single 2-year-old offspring that denned with her in the fall stayed with her during the winter, as the female was seen out of the den with a 2-year-old in June.

Monitoring flights when bears are in dens also suggests that bears are sensitive to aircraft. Animals in this study were fitted with activity and/or mortality transmitter collars. Often as the tracking plane approached the den the radio signal indicated that the bear, which had been motionless for at least six hours, became active as the plane approached. Such disturbance might not cause a bear to desert a den, but if it occurred frequently throughout the winter, the energy drain on the bear might be significant.

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Table 1. Brown bear den site characteristics, north Admiralty Island, winter, 1982-83.

Bear No.	Sex	Age	Accompanying Young: Enter Den	Accompanying Young: Leave Den	Habitat Preference [1/]	Location	Elevation (meters)	Aspect [3/]	Slope	Dug or Natural	Previously Used	Percent Canopy Coverage
14	F	7	0	0	Interior	Upper Wheeler Cr.	854	235	45-50°	Natural	Yes	0
38	F	23	0		Interior	Green's Cr.	915	20	40°	Natural	?	15
6	F	9	0	1C [2/]	Interior	King Salmon Cr.	1128	80	45°	Natural	?	0
37	F	10	0	1C	Coastal	Robt. Barron Peak	479	290	40°	Natural	Yes	45
99	F	17	0	2C	Interior	Upper King Salmon R.	823	5	50°	Natural	?	0
60	F	20	0	2C	Interior	Upper King Salmon R.	1098	10	45°	Natural	?	0
95	F	8	2Y [2/]		Coastal	Hawk Inlet	396	230	40°	Natural	?	50
39	F	9	1Y	1Y	Coastal	Robt. Barron Peak	823	80	35°	Natural	?	0
56	F	13	2Y		Coastal	Green's Cr.	823	300	20°	Natural	Yes	15
63	F	17	2Y		Coastal	Young Bay	915	70	50°	Dug	?	45
59	M	3	-	-	Interior	Upper King Salmon R.	945	165	50°	Natural	Yes	0
20	M	3	-	-	Coastal	Upper King Salmon R.	823	70	40°	Natural	?	10
72	M	6	-	-	Coastal	Upper King Salmon R.	671	110	45-50°	?	?	35
10	M	11	-	-	Coastal	Upper Wheeler Cr.	915	200	40°	Natural	No	50
48	M	17	-	-	Coastal	Upper Wheeler Cr.	366	190	10°	Dug	Yes	90

1/ Habitat preference based on radio-tracking (Schoen et al. in press).
2/ C = cub (young of the year), Y = yearling or older young.
3/ True compass bearing.

Table 2. Brown bear den characteristics by sex, age, and family group category, north Admiralty Island, winters, 1981-82 and 1982-83.

Category	I.D. Nos. 1/	N	Habitat Preference			Den Type			Elevation (meters)		
			Coastal	Interior	Unknown	Natural	Dug	Unknown	Mean	S.D.	Range
Single female	6, 14, 14 38	4	-	4	-	2	-	2	885	226	610-1160
Parturient female	43, 6, 37, 99, 60	5	1	4	-	4	-	1	908	267	479-1128
Female w/ young	60, 36, 95, 39, 56, 63	6	4	1	1	4	2	-	752	201	396-915
Subadult male	58, 59, 20	3	1	1	1	1	-	2	894	64	823-945
Adult male	72, 10, 48	3	3	0	-	1	1	1	651	275	366-915

1/ Underlined numbers refer to 1981-82 dens. Other numbers refer to 1982-83 dens.

Table 3. Measured snow depths (meters) at or near brown bear dens, north Admiralty Island, winter 1982-83. Where areas with and without forest cover occurred adjacent to one another, measurements were taken in both areas.

Den	January								April							
	Open				Forest				Open				Forest			
No.	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N	Mean	S.D.	Range	N
14	1.7	.4	1.2-2.3	5					1.5	.4	1.0-2.3	6				
38	1.9	.3	1.4-2.3	6	.9	.3	.6-1.3	6	2.2	.2	2.0-2.4	6	1.0	.3	.5-1.4	6
38	1.5	.3	1.1-2.0	6					2.0	.2	1.8-2.2	6				
6									1.5	.3	1.1-1.6	6				
60	1.8	.2	1.6-2.1	4												
37	1.8	.2	2.1-2.5	3	.9	.2	.7-1.1	4	1.9	.2	1.7-2.3	6				
63	1.7	.1	1.6-1.7	4					2.0	.04	2.0-2.1	6	1.6	.6	.8-2.3	6
39	1.3	.2	1.0-1.6	4					2.2	.1	1.1-3.5	12				
39	2.2	.5	1.4-3.0	10												
95	.9	.1	.8-1.0	10	.6	.2	.2- .9	15	.5	.4	.4- .5	6	.2	.1	0- .3	6
56	1.5	-	-	1					2.2	.1	2.1-2.4	6	1.6	.2	1.4-1.9	6
59	1.4	.5	.8-2.0	6					1.8	.3	1.6-2.2	5				
20	2.7	-	-	1					3.0	.3	2.8-3.2	2				
48	.1	-	-	1					.4	-	-	1	0	-	-	-
10	1.2	.1	1.1-1.4	6	.9	.1	.7-1.1	6	1.2	.2	.9-1.5	6	.7	.2	.5- .9	6

Table 4. Snow depths (meters) at brown bear dens, north Admiralty Island, winter 1982-83, and estimated depths during low and high snowfall years.

Den No.	Date	Method 1/	Snow Depth	Percent Snow Accumulation to Date	Estimated Depth: Low Snow-fall year	Estimated Depth: High Snow-fall year
14	1/16	E	1.7	49	1.0	4.6
	4/22	E	1.5	100	0.9	4.0
38	1/16	E	1.7	49	1.0	4.6
	4/19	E	2.0	100	1.2	5.4
6	4/22	E	1.5	100	0.9	4.0
60	1/15	E	1.6	47	1.0	4.3
37	1/14	E	1.3	46	0.8	3.5
	4/23	E	1.4	100	0.8	3.8
63	1/15	E	1.5	48	0.9	4.0
	4/19	E	1.8	99	1.1	4.9
39	1/15	E	1.3	47	0.8	3.5
	1/27	E	2.2	70	1.3	5.9
	4/23	E	2.2	100	1.3	5.9
95	1/27	E	0.7	70	0.4	1.9
	4/23	E	0.4	100	0.2	1.1
56	1/8	A	1.5	34	0.9	4.0
	4/19	E	2.0	100	1.2	5.4
59	1/15	E	1.5	47	0.9	4.0
	4/22	E	1.8	100	1.1	4.9
20	1/15	E	2.7	47	1.6	7.3
48	1/8	A	0.1	34	0.1	0.3
	4/22	A	0	100	0	0
10	1/16	E	1.1	49	0.7	3.7
	4/22	E	1.1	100	0.7	3.0

1/ E - Snow depth at den estimated from measurements in nearby locations and from tree canopy cover, topographic features, and snow drift patterns which would affect snow accumulation.

A - Snow depth measured at actual den site.

Table 5. Snow characteristics and air temperatures (°C) at selected brown bear den sites, north Admiralty Island, winter 1982-83.

Den No.	Date	Elevation (meters)	Aspect	Snow Depth (meters)	Snow Density	No. Ice Layers	Snow Temp. (°C)	Air Temp. - Jan.- Apr. Min.	Max.
48	4/22	366	S	0.4	.45	1	-	-7	9
95	4/23	396	W	0.4	.45	0	-	-9	16
37	4/23	479	W	1.4	-	-	-	-10	8
56	4/19	823	W	2.7	.53	0	4	-22	13
14	4/22	854	W	1.4	.38	-	-	-	-
59	4/22	945	S	1.4	-	2	4	-9	5
6	4/22	1128	E	1.5	.31	1	4	-	-

Table 6. Measured snow depths (meters) in the vicinity of brown bears in open areas and in adjacent areas with forest cover, north Admiralty Island, winter, 1982-83.

Den				Open			Forest			
No.	Date	Elevation	Aspect	Mean	S.D.	N	Mean	S.D.	N	P
48	4/22	366	S	0.4	-	1	0	-	1	-
95	1/27	396	W	0.9	0.1	10	0.6	0.2	10	.002
95	4/23	396	W	0.5	0.04	6	0.2	0.1	6	.002
37	1/14	479	W	1.8	0.2	3	0.9	0.2	3	.011
56	4/19	823	W	2.2	0.1	6	1.6	0.2	6	.001
38	1/16	915	N	1.9	0.3	6	0.9	0.3	6	.000
38	4/19	915	N	2.2	0.2	6	1.0	0.3	6	.001
63	4/19	915	E	2.0	0.04	6	1.6	0.6	6	.104*
10	1/16	915	S	1.2	0.1	6	0.9	0.1	6	.006
10	4/22	915	S	1.2	0.2	6	0.7	0.2	6	.009
All	-	-	-	1.5	0.6	55	0.9	0.5	55	.000

* Den 63 is the only site with no significant difference between snow depths in the open area and in an adjacent area with forest cover.