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MOVEMENT PATTERNS OF WESTERN ALASKA PENINSULA SEA OTTERS

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ABSTRACT

During 1986, sixteen adult sea otters were captured in waters adjacent to the northern coasts of the Alaska Peninsula and Unimak Island and instrumented with radio-transmitters. They were monitored periodically from the summer of 1986 through the winter of 1987-8 to test the hypothesis that sea otters in that region make a seasonal migration between the Bering Sea and the Pacific Ocean through Bechevin Bay and Isanotski Strait. It was found that some individuals had large home ranges that included areas in both the Bering Sea and Bechevin Bay, or in the Pacific Ocean and Bechevin Bay. However, results of this study do not support the contention that animals residing in the Bering Sea during the summer routinely undergo a mass seasonal migration to the Pacific Ocean and overwinter there.

A substantial population of sea otters (*Enhydra lutris*) is known to reside in waters along the northern shores of the Alaska Peninsula and Unimak Island (Lensink 1960, 1962; Kenyon 1969; Schneider 1976; Cimberg, et al. 1984). Data from censuses and surveys (Lensink 1962; Cimberg, et al. 1984) suggest that the distribution of individuals in this population is unusual in two respects.

First, it is generally. believed that sea otters typically reside in shallow waters (depth < 35 m) within a few kilometers of shore (e.g., Kenyon 1969). However, in the southeastern Bering Sea, the 80-m depth contour can lie as far as 50 km offshore (Schneider 1976). It is believed that as a consequence, some individual sea otters may travel far offshore and maintain a relatively pelagic existence (Lensink 1958, 1962; Kenyon 1969; Schneider 1976), spending much, or possibly all, of their lives in the offshore waters of the open Bering Sea.

Second, although sea otters are usually considered to be non-migratory (e.g., Kenyon 1969), it has been suggested that many of the individuals that reside in the unprotected waters of the Bering Sea make a seasonal migration. This migration may be between nearshore and more distant areas offshore (Lensink 1962) , or between the Bering Sea and the Pacific Ocean through Bechevin Bay and Isanotski Strait (Cimberg, et al. 1984).

The aforementioned characteristics have been attributed to the north Alaska Peninsula population based on data obtained from censuses and surveys. These techniques, especially when they are applied to sea otter populations! have acknowledged limitations (e.g. , Schneider 1976) and conclusions may be subject to more than one interpretation. Moreover, data obtained using such methods cannot provide information about the causes of any changes in distribution. Insight into the reasons for changes in distribution can be obtained by monitoring the movements of individuals over time , In this paper, data are given that are relevant to observed patterns in the distribution of the north Alaska Peninsula sea otter population.

In order to evaluate whether the movement patterns of individuals could be construed to be a seasonal migration as proposed above, individual sea otters were monitored by radio-telemetry and the results are compared with data from other populations.

STUDY AREA AND METHODS

Dates and location.--This study was conducted in waters adjacent to the Alaska Peninsula in the vicinity of False Pass, Alaska (Fig. 1). Sea otters were caught and implanted with radio-transmitters during August, 1986, in Bechevin Bay and on the southeast side of Amak Island in the Bering Sea. Dependent pups were caught in Bechevin Bay during July and August, 1986. Instrumented otters were monitored approximately every two-three months between August, 1986 and March, 1988 in order to detect major movements about the

Alaska Peninsula and Unimak Island. Areas that were routinely searched included the waters between Cold Bay and southwestern Unimak Island in the Pacific Ocean and between Port Moller and Cape Sarichef in the Bering Sea.

Methods. --Adults were captured with modified, floating gill nets (e.g. , Odemar and Wilson 1969; Garshelis, et al. 1984). Dependent pups were caught with a dip net from the bow of a 21 foot Boston Whaler. Upon capture, otters were weighed and each was marked with a red, numbered plastic “temple” tag (Temple Tag Company, Temple, TX) through the interdigital webbing of its hind flipper (e.g. , Ames, et al. 1983) . Individuals to be implanted with radio-transmitters were immobilized with a combination of fentanyl (0.05 mg/kg) and azaperone {0.20 mg/kg) (Williams, et al. 1981) . A 164 MHz radio-transmitter was surgically implanted in the peritoneal cavity by a licensed veterinarian using a procedure similar to that described by Garshelis and Siniff (1983). Radio-transmitters measured 85 mm X 5 mm X 25 mm and weighed 150 g (Cedar Creek Bioelectronics Lab, Bethel, MN 55005)0 Transmitters had an expected life of about 18 months and transmitted at unique frequencies. After completion of the approximately 20 minute surgery, the individuals were injected with naloxone (0.01 mg/kg) , an antagonist to fentanyl. They were released when they had fully recovered from the anesthetic. Instrumented otters were monitored from various aircraft (Piper Supercub and Piper Arctic Tern: 50 hrs. ; Piper Navajo: 25 hrs. ; and

DeHavilland Twin Otter: 20-30 hrs.) that were equipped with four element yagi antennas mounted on wing struts on each side (Gilmer, et al. 1981). Radio-transmitter frequencies were monitored with 2000-channel, programmable, scanning receivers (Cedar Creek Bioelectronics Lab) . Aircraft were flown at 80-150 knots at altitudes varying from 80-2000 m, depending upon aircraft type, weather conditions and research protocols. When searching from single engined aircraft, flight paths were parallel along the coastline and separated by about two km. Altitude was increased as distance from shore was increased so that aircraft remained within gliding distance of land at all times (i.e. approximately one unit of altitude for every five units of distance from shore). Searches from dual engined aircraft were flown as described above or, more frequently, along north-south transects separated by about two km. Relatively offshore portions of the Bering Sea and waters north of the Sanak Islands were searched in this pattern. The minimum area searched (all surveys) and maximum area searched are illustrated in Appendix 1. Otter locations were determined by geographic features and marked directly on U.S.G.S. contour maps and marine charts. When individuals were found offshore, locations were recorded as loran coordinates, Individual locations were summarized as latitude-longitude. Distances between locations are measured directly from maps.

Survival rates.--Survival rate estimates, based on telemetry data, were calculated using the method developed by Trent and Rongstad (1974). Following the notation of Boutin and Krebs (1986):

$$S = X - Y / X$$

where,

s = survival rate per day,

x = otter days (one otter day is one otter surviving on day) in time interval t to t + 1,

Y = number of deaths during time interval t to. t + 1.

Estimation of home range size.--As Garshelis and Garshelis (1984) pointed out, the home range of sea otters is composed of numerous centers of activity connected by travel corridors. The area of any portion of the annual home range, or rather, any cluster of fixes, can be estimated by measuring the area of the minimum convex polygon enclosing the position fixes of radio-instrumented individuals (Odum and Kuenzler 1965; Garshelis and Garshelis 1984). However, since sea otter travel corridors often cross and enclose deep, broad and presumably inhospitable expanses of water, the above procedure substantially overestimates home range when more than one center of activity is involved. The accurate measurement of either annual or longer-term home range is impractical in many cases because of the large number of fixes required for characterization of habitat utilization patterns such as those of sea otters. At least 40 fixes are required to estimate the area over a relatively short period (Garshelis and Garshelis 1984). Monitoring was infrequent during this study, thus sufficient data were not available to calculate the home ranges of instrumented individuals. An index of home range dimensions, "distance between extreme locations" (DBEL), is employed, as suggested by Garshelis and Garshelis (1984)* The DBEL is the minimum distance an otter would have to swim to travel between its two most widely spaced fixes during some time interval. It is approximately equal to the maximum dimension of the. home range during that time interval ,

RESULTS AND DISCUSSION

Capture, tagging and instrumentation. --Sixteen adult sea otters, 12 females and four males, were caught and instrumented (Table 1) . Two adult males were captured but not instrumented because they did not respond well to anesthesia, An undetermined number of additional females were captured but released, either because they were accompanied by dependent pups or because environmental conditions posed unacceptable risks to the sea otters or research staff. Twenty-two dependent pups were dip-netted and marked in the vicinity of Bechevin Bay (Table 2).

Four individuals (two female-pup pairs) died while entangled in nets during capture activities at Amak Island. All four animals were apparently killed during fighting between the adult females and a single large male that was entangled in the same section of net. Because of stipulations in the permit under which the Fish and Wildlife

Permit Office had authorized these activities, this event, which occurred during the second day of activities at Amak Island, forced cessation of all capture efforts. Further information on this incident can be found in Monnett and Siniff (1987).

Monitoring. --Attempts were made to locate instrumented sea otters from aircraft on 22 days and 181 fixes were obtained (Table 3). All individuals except one male, number 86114, were relocated after instrumentation. The long term status of number 86114 is not known but he behaved normally when released following surgery.

Survival. --Ten of the 12 females were monitored for periods ranging from 539 to 580 days (Table 4). Two of the 10 individuals were not located during the March 1988 survey. However, since these intervals compare favorably with the expected life of the transmitters, approx. 550 days, it seems more likely that the transmitters expired than that the individual females died. With respect to the other two females, contact was lost with one of these females, 86108, after 208 days. The twelveth female, 86113, was resighted only one time, 59 days following instrumentation. At that time, she was located at the far eastern edge of the study area, The lack of further sightings may be because she traveled beyond the bounds of the area surveyed. The estimated annual rate of survival for the females is either 0.89, 0.94, or 1.0 depending upon whether both, one, or neither 86108 and 86113 are assumed to have died. These values are similar to the range of values reported for similar telemetry studies of sea otters in Alaska and California. Siniff and Rails (1988) measured an annual adult female survival rate of 0.91 in California. Monnett et al. (1988, unpubl. data) observed a survival probability of 1.0 (20,718 otter days) for adult females in Prince William Sound, Alaska.

Excluding the male that was not resighted following surgery, the remaining three males were monitored for periods ranging from 206 to 572 days (Table 5). If male 86101 (monitored 206 days) is assumed to have died, male survival is calculated as p = 0.76. We regard three males to be an insufficient sample to permit any conclusions. Adult male survival in California was observed to be 0.67-0.71, depending upon assumptions made about missing individuals (Siniff and Rails 1988). Adult males in Prince William Sound exhibited an annual probability of survival of 0.95 (6725 otter days) (Monnett et al. 1988, unpubl. data).

Movement Patterns and Distribution

The observation periods, number of fixes and distances between extreme locations for the various individuals are summarized in Table 6.

Males.--The instrumented males occupied home ranges near where they were originally captured. None exhibited a tendency to make a seasonal migration between the Bering Sea and Pacific Ocean. The geographical locations of the telemetry fixes for each male are summarized visually in

Appendix 11. During the period of the study, the respective distances between extreme locations (DBEL) of the males were 10.5, 20.0 and 23.5 km. The telemetry data suggested that the movements of male 86101 were restricted to the relatively protected waters within Bechevin Bay and adjacent Catherine Cove. Given the predominance of females in that general area, his movements suggest that he occupied a breeding territory along the western border of Catherine Cove. The other two instrumented males (86115 and 86116) traveled routinely about the less protected waters north of Izembek Lagoon, between Amak Island and a sand bar at Cape Glazenap. That bar had apparently been used by large aggregations of males as a haulout site for a number of years (J. Sarvis pers. ohs.) .

The distances of the movements observed for the three males fall within the range of magnitudes of movement observed during telemetry studies in Prince William Sound, Alaska. However, they are somewhat more restricted than the movements of males in California (Fig. 2). The distribution of DBEL of males in Prince William Sound is clearly bimodal. This bimodality reflects differences between males that remain on breeding territories throughout the year versus those that travel between breeding areas in the eastern Sound and wintering aggregations in Orca Inlet. Males in the Prince William Sound study occupied breeding territories that were located about 30-40 km from haulouts in the non-breeding area. Thus, males that overwintered in such aggregations needed to travel about 40 km to reach such locations. In an earlier study in eastern Prince William Sound, Garshelis and Garshelis (1984) found that four territorial males moved about 100 km between breeding areas at Green Island in central Prince William Sound and the non-breeding area in Orca Inlet.

Adult male movements in California appear to be typically greater than those reported in Alaska. Rails et al. (1988) observed several males to travel over 100 km, including one male that traveled 181 km. R. Jameson (in prep., cited in Riedman 1986) observed that the movements of 13 males averaged 80.1 km between breeding areas and male groups . However, it is important to consider that studies in Alaska have been concentrated near male aggregations, whereas studies in California have generally been at greater distance from such aggregations. Thus, it is likely that differences in the extent of movement observed between males in Alaska and California are spurious and simply result from differences in the distance between male breeding and non-breeding areas in the two locations.

Females.--During the period of monitoring, some females showed a tendency to move between Bechevin Bay and the Bering Sea and/or between Bechevin Bay and the Pacific Ocean (Appendix 11), Movements to the Bering Sea occurred during the summer, whereas movements to Isanotski Strait and Ikatan Bay occurred during the fall and winter. Such movements suggest that some seasonal differences may exist in the distribution of females. However, females did not appear to make a mass seasonal migration during either the winter of 1986-7 or 1987-8. Periodic short-duration movements into the Bering Sea and Pacific Ocean by a few females suggested that female home ranges could be large and that such movements may be routine. The home ranges of all 11 females captured in Bechevin Bay in August appeared to include at least a portion of Bechevin Bay during late-summer, fall and winter. Several case histories are significant and presented below.

Two females traveled at least as far south as Isanotski Strait. Female 86104 moved through Isanotski Strait into the Pacific Ocean between 25 August and 9 October 1986, When observed on 9 October 1986, she was in a resting group of over 100 females, some of which were accompanied by small pups . She had returned to Bechevin Bay when monitored on 16 December and was in Isanotski Strait near False Pass on 25 February 1987, and again during January and March of 1988, Female 86112 was observed in Isanotski Strait on 16 December 1986. However, she apparently did not spend the bulk of the winter outside Bechevin Bay as she was located near Isanotski Islands, in Bechevin Bay, during both October and February.

Two females moved from Bechevin Bay to the Bering Sea. One of these females was instrumented (Female 86112), and was one of the females observed in Isanotski Strait. This female apparently made a brief trip to nearshore areas of the Bering Sea in October, 1986, but was observed back in Bechevin Bay shortly thereafter. The non-instrumented female traveled from Bechevin Bay to Amak Island (50 km) during early August, 1986. She was observed at Amak Island with a pup that had been marked with a red flipper tag in Bechevin Bay.

The movement of that female and her pup to Amak Island was apparently associated with a large scale movement of females from Bechevin Bay to the Bering Sea. When capture operations were initiated in Bechevin Bay during early August, several large rafts of females (estimated 750-1000 animals total) were present. Bechevin Bay was clearly a female area, as evidenced by the females captured for instrumentation and the 22 pups captured for tagging. Shortly after capturing was initiated, the aggregations dispersed and new aggregations were formed in the Bering Sea at Amak Island and near Sea Otter Point. A raft observed at Amak Island on October 13, 1986, included the female mentioned above. By early September, the rafts in the Bering Sea had dispersed and new aggregations had been formed in Bechevin Bay.

Two factors may have contributed to the observed changes in female distribution. First, it is possible that disturbance from the aforementioned research activities encouraged females to move out of Bechevin Bay. Garshelis and Garshelis (1984) suggested that the distribution of male sea otters in male areas near Cordova may have varied in response to seasonal changes in the amount of boat traffic, However, sea otters in Bechevin Bay had been subjected to about the same degree of disturbance from pup catching activities during the previous week and had not moved from the area. Second, movements of females into the exposed waters of the Bering Sea may have been permitted by a period of favorable weather (light offshore winds from the southeast) that occurred during early August. Prevailing winds shifted to the northwest shortly before females reaggregated in less exposed waters in Bechevin Bay in late-August .

Female 86113, a very large adult, moved 48 km across the Bering Sea between Amak Island and Cape Leontovich, which lies northeast of Izembek Lagoon. When observed, she was in one of several moderately sized pods that were situated about seven km offshore,

The results discussed above do not suggest that a seasonal migration by female sea otters between the Bering Sea and Pacific Ocean is a common or required feature of their movement patterns. However, they do indicate that the home ranges of some females may include portions on both sides of the Alaska Peninsula.

Female sea otters in this study appeared to be somewhat sedentary as compared to females in Prince William Sound. The median DBEL of the Alaska Peninsula females was 15.5 km; range 7 km to 48 km, Table 7 (cf. median DBEL of Prince William Sound females = 25 km). However, the distribution of DBEL for Alaska Peninsula females is not appreciably different from the total distribution of DBEL reported in telemetry studies in Alaska and in California (Fig. 3).

"General comments--- These data do not support the hypothesis that male or female sea otters normally make seasonal migrations between the Bering Sea and the Pacific Ocean, either through Isanotski Strait or around the western end of Unimak Island. However, weather conditions in the study area, and in all of southern Alaska, were unusually mild during the winters of 1986-7 and 1987-8. Lakes in the vicinity of Cold Bay, on the Alaska Peninsula, remained unfrozen for most of both winters during this study. Sea ice was not formed in the study area at times of the year when it would normally have been present during more severe winters. Since the western Alaska Peninsula sea otter population is unusual in that its northward expansion has apparently been limited by the occasional formation of sea ice (Kenyon 1969; Schneider and Faro 1975), the lack of such severe conditions during the monitoring period may be important to interpreting the general significance of the observed movements. A significant number of sea otters are known to have died during a period of record-breaking cold in the early 1970's. Individuals died of malnutrition and related stresses when they were excluded from feeding areas by the formation of continuous shore fast ice and/or by the encroachment of sea ice (Schneider and Faro 1975), A similar situation apparently has been known to develop in the Russian Kurile Islands and along the southeast Kamchatka coast (Nikolaev 1941). There, it was found that when winter drift ice blocked all open water, sea otters starved unless they were able to move to ice-free areas. I-t is possible that sea otters would make migrations such as those hypothesized by earlier authors, when subjected to more severe weather patterns, such as are common in this area in many winters.

Need for further research. --Large scale sea otter movements from the Bering Sea to the Pacific Ocean should be most likely to occur during periods of extreme cold, especially when sea or pack ice are present in the Bering Sea portions of the study area. Because such conditions did not exist during the winters of 1986-7 and 1987-8 and because shore fast ice was not present in protected areas where it normally forms (e.g. Izembek Lagoon and Bechevin Bay) (J. Sarvis pers. ohs.) , the observed sea otter movement patterns may be typical only of relatively mild winters. A general conclusion about the extent and causes of sea otter movements between the Bering Sea and the Pacific Ocean cannot be reached until observations are made over a wider range of weather conditions.

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Figure 1. Map of study area with locations identified in the text.

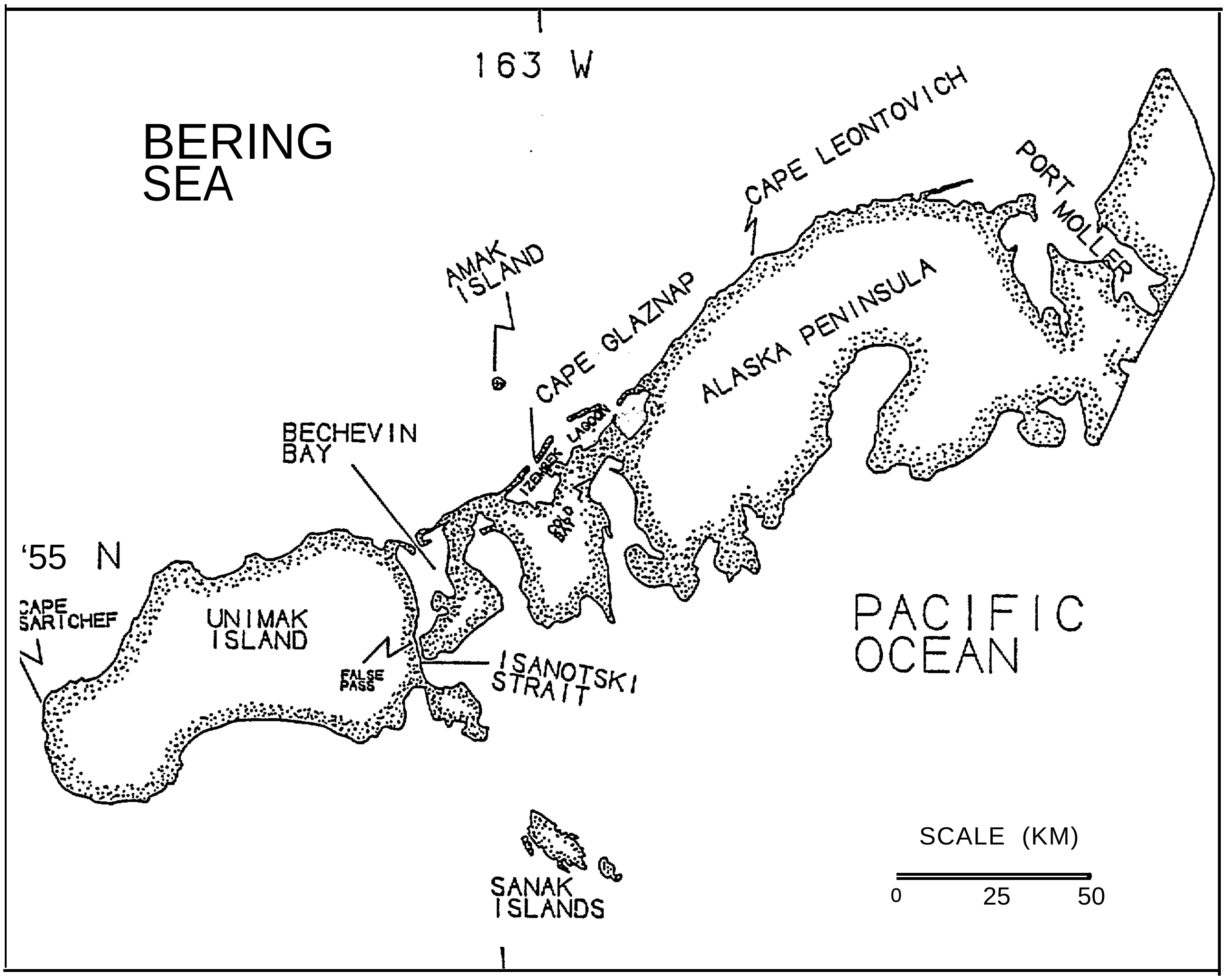


Figure 2. Distances between extreme locations (kilometers) of radio-instrumented male sea otters. Data from 3 males in this study are plotted with data from those in other studies for comparison.

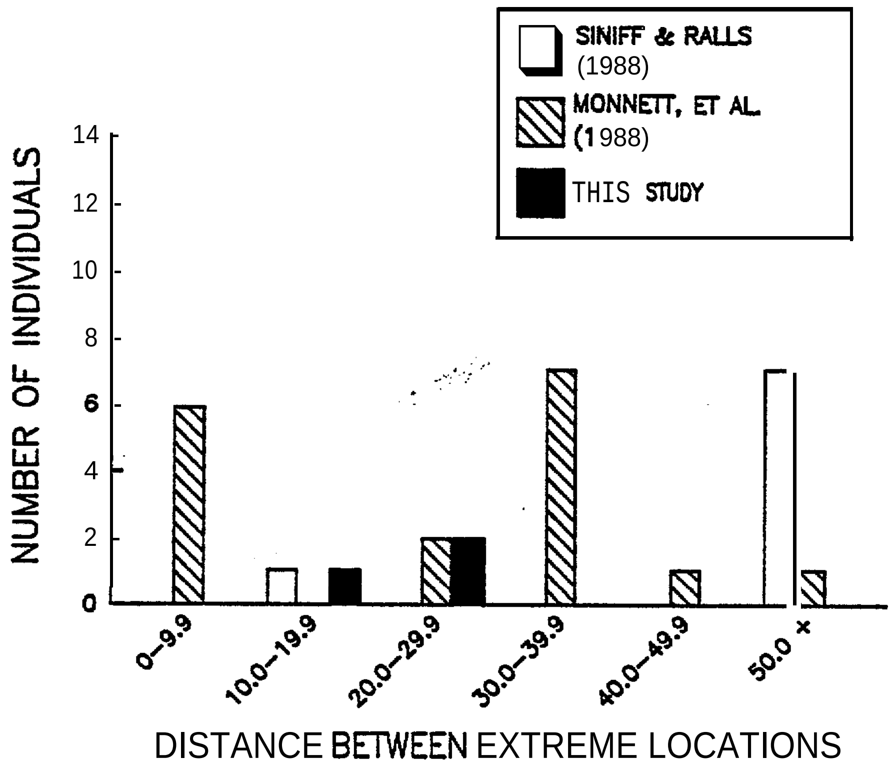


Figure 3. Distances between extreme locations (kilometers) of radio-instrumented female sea otters. Data from females in this study are plotted with data from those in other studies in Alaska and California for comparison.

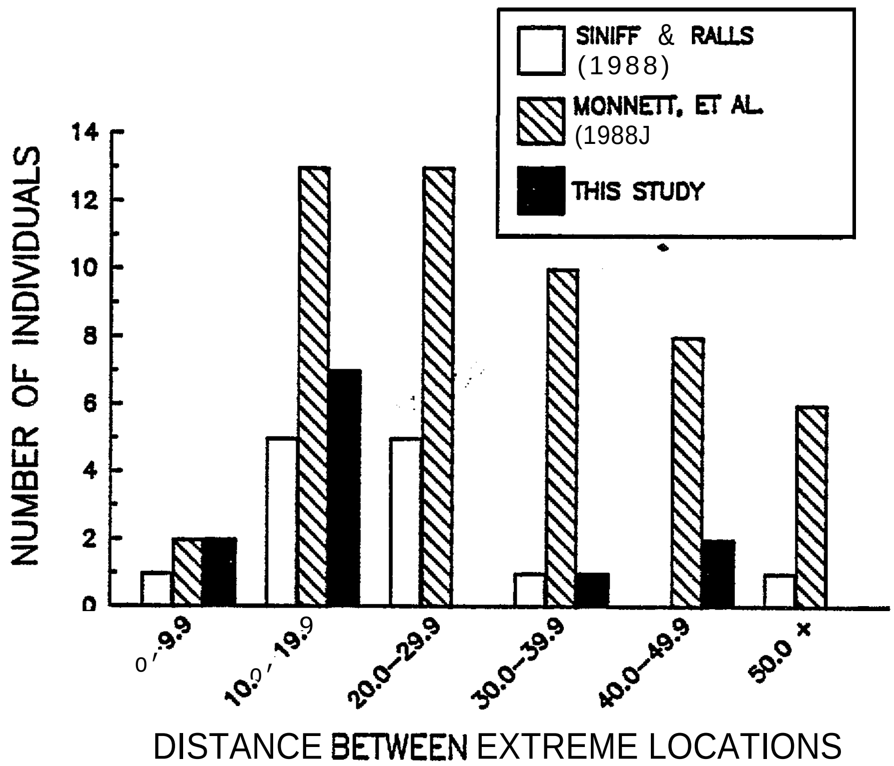


Table 1. Identification and physical attribute data on adult sea otters captured in the vicinity of False Pass, Alaska, 1986.

ID	DATE	TX FREQ	SEX	LOCATION	WEIGHT (lb.)	LENGTH (in.)	TAG
86101	8/03	164.280	M	BECHEVIN BAY			NONE
86102	8/03	164.470	F	BECHEVIN BAY			NONE
86103	8/04	164.093	F	BECHEVIN BAY	36.0		NONE
86104	8/04	164.133	F	BECHEVIN BAY	51.0	53.0	RED122
86105	8/04	164.932	F	BECHEVIN BAY	37.0	46.0	RED123
86106	8/04	164.073	F	BECHEVIN BAY	51.0		RED124
86107	8/05	164.412	F	BECHEVIN BAY	52.0		RED125
86108	8/05	164.451	F	BECHEVIN BAY	51.0		RED126
86109	8/07	164.793	F	BECHEVIN BAY	41.0	45.5	RED127
86110	8/07	164.289	F-	BECHEVIN BAY	57.5		RED128
86111	8/07	164.672	F	BECHEVIN BAY	50.0	50.5	RED129
86112	8/07	164.974	F	BECHEVIN BAY	68.0	50.0	RED130
86113	8/13	164.352	F	AMAK ISLAND	60.0		RED131
86114	8/14	164.872	M	AMAK ISLAND	83.5	54.0	RED132
86115	8/14	164.513	M	AMAK ISLAND	68.0	54.0	RED134
86116	8/14	164.611	M	AMAK ISLAND	83.0	54.5	RED135
86117	8/14	NONE	M	AMAK ISLAND	88.0	52,5	NONE
86118	8/14	NONE	M	AMAK ISLAND	76.0		NONE

Tags were nylon, temple tags placed in the right flipper.

Radio-transmitters were surgically implanted in the abdominal cavity.

Table 2. Identification and physical attribute data on dependent sea otter pups captured in the vicinity of False Pass, Alaska, 1986.

ID	SEX	DATE	LOCATION	WEIGHT (lb.)	LENGTH (in.)	TAG
86001	F	29 Jul	BECHEVIN BAY	17.0	34.0	red181
86002	M	29 Jul	BECHEVIN BAY	13.0	31.0	red128
86003	M	29 Jul	BECHEVIN BAY	7.5	25.0	red142
86004	F	29 Jul	BECHEVIN BAY	14.5	31.0	red137
86005	M	29 Jul	BECHEVIN BAY	12.0	30.0	red147
86006	M	30 Jul	BECHEVIN BAY	21.5	34.5	red131
86007	M	30 Jul	BECHEVIN BAY	24.5	36.5	red130
86008	F	30 Jul	BECHEVIN BAY	13.0	30.5	red150
86009	F	30 Jul	BECHEVIN BAY	21.5	37.0	red127
8601"0	U	30 Jul	BECHEVIN BAY	7.5	25.5	red129
86011	M	30 Jul	BECHEVIN BAY	10.5	28.0	red134
86012	M	30 Jul	BECHEVIN BAY	17.5	34.5	red143
86013	F	30 Jul	BECHEVIN BAY	11*5	29.0	red141
86014	M	30 Jul	BECHEVIN BAY	9.0	27.5	red139
86015	F	30 Jul	BECHEVIN BAY	11,0	28.5	red144
86016	M	20 Aug	BECHEVIN BAY	14.5	30.5	red126
86017	F	20 Aug	BECHEVIN BAY	18.0	34.0	red145
86018	M	20 Aug	BECHEVIN BAY	16.0	33,5	red146
86019	F	20 Aug	BECHEVIN BAY	19*5	34,5	red132
86020	M	20 Aug	BECHEVIN BAY	9.5	27.5	red148
86021	M	22 Aug	BECHEVIN BAY	18.5	34.5	red149
86022	F	22 Aug	BECHEVIN BAY	17.0	33.0	red140
86920	M	4 Aug	BECHEVIN BAY	13.0	34.0	none
86921	M	14 Aug	AMAK ISLAND	9.5	28.0	none
86923	F	14 Aug	AMAK ISLAND	29.0	3900	none

All tags are nylon, button tags in right flipper,

TABLE 3. OBSERVATIONS OF RADIO-IMPLANTED SEA OTTERS

(TELEMETRY FIXES IN DEGREES-MINUTES-SECONDS)

ID#	Date	Latitude (N)	Longitude (W)	Craft
86101	3 Aug 86	55-01-00	163-29-00	Whaler
(Male)	19 Aug 86	55-59-20	163-26-20	Arctic Tern
	25 Aug 86	54-59-00	163-26-00	Twin Otter
	9 Ott 86	54-56-40	163-24-10	Arctic Tern
	10 Ott 86	54-56-40	163-24-10	Twin Otter
	15 Ott 86	54-58-40	163-25-10	Arctic Tern
	16 Dec 86	55-01-40	163-24-00	Arctic Tern
	25 Feb 87	55-00-40	163-28-50	Supercub
86102	3 Aug 86	55-01-00	163-29-00	Boat
(Female)	19 Aug 86	55-00-40	163-29-10	Arctic Tern
	9 Ott 86	55-00-40	163-28-50	Arctic Tern
	16 Dec 86	54-58-50	163-26-10	Arctic Tern
	25 Feb 87	54-59-18,	163-21-12	Arctic Tern
	26 Feb 87	55-01-20"	163-29-40	Navajo
	2 Mar 87	55-00-50	163-30-00	Supercub
	17 Jun 87	55-01-50	163-30-00	Supercub
	18 Jun 87	55-01-50	163-30-00	Supercub
	19 Jun 87	55-01-50	163-30-00	Supercub
	1 Sep 87	54-57-00	163-15-00	Supercub
	27 Jan 88	55-00-00	163-29-50	Supercub
	28 Jan 88	54-57-00	163-20-30	Navajo
	5 Mar 88	55-00-00	163-29-30	Navajo
86103	4 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-00-40	163-19-40	Arctic Tern
	9 Ott 86	55-00-30	163-18-10	Arctic Tern
	10 Ott 86	55-01-00	163-19-00	Twin Otter
	15 Ott 86	54-59-40	163-19-40	Arctic Tern
	16 Dec 86	55-03-10	163-17-40	Arctic Tern
	25 Feb 87	55-03-00	163-22-40	Supercub
	26 Feb 87	55-01-50	163-21-40	Navajo
	2 Mar 87	55-02-10	163-20-50	Supercub
	17 Jun 87	55-02-30	163-20-30	Supercub
	19 Jun 87	55-03-00	163-20-00	Supercub
	1 Sep 87	55-02-20	163-19-30	Supercub
	27 Jan 88	55-02-10	163-17-00	Supercub
	28 Jan 88	55-02-10	163-17-00	Navajo
	5 Mar 88	55-02-30	163-17-20	Navajo

TABLE 3 (CONT.)

ID#	Date	Latitude (N)	Longitude (W)	Craft
86104	4 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-02-20	163-22-20	Arctic Tern
	25 Aug 86	55-01-00	163-29-00	Twin Otter
	10 Ott 86	54-53-40	163-07-20	Twin Otter
	15 Ott 86	54-54-20	163-06-20	Arctic Tern
	16 Dec 86	54-59-40	163-19-10	Arctic Tern
	25 Feb 87	55-51-10	163-23-30	Supercub
	17 Jun 87	55-01-30	163-00-10	Supercub
	18 Jun 87	55-01-30	163-00-10	Supercub
	19 Jun 87	55-01-30	163-00-10	Supercub
	1 Sep 87	55-01-10	163-22-00	Supercub
	27 Jan 88	53-50-10	163-22-10	Supercub
	28 Jan 88	54-51-00	163-22-10	Navajo
	8 Mar 88	54-48-10	163-21-00	Navajo
86105	4 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-03-50	163-20-20	Arctic Tern
	25 Aug 86	54-58-30.	163-20-00	Twin Otter
	9 Ott 86	54-59-40"	163-19-30	Arctic Tern
	10 Ott 86	55-01-00	163-19-00	Twin Otter
	15 Ott 86	55-00-50	163-20-50	Arctic Tern
	16 Dec 86	54-59-40	163-18-20	Arctic Tern
	26 Feb 87	55-00-00	163-22-00	Navajo
	17 Jun 87	55-00-30	163-19-00	Supercub
	19 Jun 87	55-03-00	163-20-00	Supercub
	1 Sep 87	55-00-50	163-24-40	Supercub
	27 Jan 88	55-00-40	163-22-10	Supercub
	5 Mar 88	55-02-10	163-20-00	Navajo
	8 Mar 88	55-00-50	163-20-30	Navajo
86106	4 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-00-40	163-29-10	Arctic Tern
	25 Aug 86	55-01-00	163-29-00	Twin Otter
	9 Ott 86	55-00-40	163-29-30	Arctic Tern
	15 Ott 86	54-59-20	163-19-20	Arctic Tern
	16 Dec 86	54-57-40	163-20-50	Arctic Tern
	25 Feb 87	54-58-20	163-20-20	Supercub
	26 Feb 87	55-00-30	163-28-00	Navajo
	17 Jun 87	54-58-50	163-17-20	Supercub
	1 Sep 87	55-01-40	163-31-20	Supercub
	27 Jan 88	54-59-40	163-27-30	Supercub
	28 Jan 88	54-59-00	163-20-30	Navajo
	8 Mar 88	55-00-30	163-28-30	Navajo

TABLE 3 (CONT.)

ID#	Date	Latitude (N)	Longitude (W)	Craft
86107	5 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-03-50	163-20-20	Arctic Tern
	25 Aug 86	54-58-30	163-20-00	Twin Otter
	9 Ott 86	55-01-20	163-18-50	Arctic Tern
	15 Ott 86	54-57-1o	163-16-40	Arctic Tern
	16 Dec 86	54-59-40	163-18-20	Arctic Tern
	25 Feb 87	54-59 20	163-28-00	Supercub
	2 Mar 87	54-57-20	163-25-10	Supercub
	17 Jun 87	54-58-50	163-19-00	Supercub
	1 Sep 87	55-02-00	163-31-10	Supercub
	27 Jan 88	55-00-20	163-29-30	Supercub
	28 Jan 88	54-58-1o	163-24-10	Navajo
86108	5 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-03-50	163-20-20	Arctic Tern
	25 Aug 86	55-02-10	163-22-00	Twin Otter
	9 Ott 86	54-59-00	163-20-00	Arctic Tern
	15 Ott 86	54-59-30	1.63-18-40	Arctic Tern
	16 Dec 86	55-00-30	163-28-10	Arctic Tern
	25 Feb 87	55-01-10	163-26-20	Supercub
	26 Feb 87	55-01-40	163-30-00	Navajo
86109	7 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	54-59-1o	163-20-00	Arctic Tern
	25 Aug 86	55-01-00	163-20-00	Twin Otter
	9 Ott 86	55-01-00	163-18-50	Arctic Tern
	10 Ott 86	55-01-00	163-19-00	Twin Otter
	15 Ott 86	55-00-20	163-18-50	Arctic Tern
	16 Dec 86	54-59-40	163-18-20	Arctic Tern
	25 Feb 87	55-00-20	163-21-40	Supercub
	2 Mar 87	55-00-40	163-20-20	Supercub
	17 Jun 87	54-59-50	163-18-30	Supercub
	19 Sun 87	55-02-00	163-22-00	Supercub
	1 Sep 87*	55-01-42	163-22-06	Supercub
	5 Mar 88	54-56-00	163-23-10	Navajo
	8 Mar 88	54-54-30	163-21-50	Navajo

*Accompanied by pup

TABLE 3 (CONT.)

ID#	Date	Latitude (N)	Longitude (W)	Craft
86110	7 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-00-00	163-17-50	Arctic Tern
	25 Aug 86	55-01-00	163-20-00	Twin Otter
	9 Ott 86*	55-00-50	163-17-20	Arctic Tern
	10 Ott 86	54-59-00	163-20-00	Twin Otter
	15 Ott 86	54-59-30	163-19-30	Arctic Tern
	16 Dec 86	54-58-10	163-18-10	Arctic Tern
	25 Feb 87	54-59-20	163-26-20	Supercub
	2 Mar 87	54-58-50	163-18-10	Supercub
	17 Jun 87	55-00-00	163-20-00	Supercub
	1 Sep 87	54-56-50	163-16-10	Supercub
	27 Jan 88	54-59-40	163-23-50	Supercub
	8 Mar 88	54-58-20	163-23-50	Navajo
86111	7 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	54-57-40	163-17-20	Arctic Tern
	9 Ott 86	55-00-20	163-19-20	Arctic Tern
	10 Ott 86	54-58-00	1.63-19-00	Twin Otter
	15 Ott 86	55-02-40..	163-18-00	Arctic Tern
	16 Dec 86	54-57-16	163-18-10	Arctic Tern
	25 Feb 87	55-00-50	163-26-50	Supercub
	26 Feb 87	55-01-20	163-29-40	Navajo
	2 Mar 87	55-01-10	163-30--20	Supercub
86112	7 Aug 86	55-02-00	163-20-00	Boat
(Female)	19 Aug 86	55-02-20	163-22-20	Arctic Tern
	23 Aug 86	55-09-20	163-16-00	Twin Otter
	25 Aug 86	55-01-00	163-20-00	Twin Otter
	9 Ott 86	55-00-10	163-18-40	Arctic Tern
	15 Ott 86	55-00-20	163-21-20	Arctic Tern
	16 Dec 86	54-49-50	163-23-00	Arctic Tern
	25 Feb 87	54-56-40	163-24-30	Supercub
	26 Feb 87	54-57-20	163-25-10	Navajo
	2 Mar 87	54-59-1o	163-18-10	Supercub
	17 Jun 87	55-03-40	163-20-00	Supercub
	19 Jun 87	55-03-00	163-20-00	Supercub
	1 Sep 87*	55-02-20	163-17-00	Supercub
	27 Jan 88	54-59-40	163-24-00	Supercub
	28 Jan 88	54-59-40	163-22-30	Navajo

*Accompanied by PUP

TABLE 3 (CONT.)

ID#	Date	Latitude (N)	Longitude (W)	Craft
86113	13 Aug 86	55-24-30	163-06-50	Boat
(Female)	11 Ott 86	55-36-00	162-27-00	Twin Otter
86114	14 Aug 86	55-24-30	163-06-50	Boat
(Male)				
86115	14 Aug 86	55-24-30	163-06-00	Boat
(Male)	21 Aug 86	55-01-50	163-12-00	Twin Otter
	23 Aug 86	53-11-30	163-07-00	Twin Otter
	25 Aug 86	55-16-00	163-02-00	Twin Otter
	9 Ott 86	55-14-30	163-04-00	Twin Otter
	10 Oct 86	55-15-00	163-03-10	Twin Otter
	16 Dec 86	55-22-00	163-02-00	Arctic Tern
	25 Feb 87	55-20-40	163-02-20	Supercub
	26 Feb 87	55-19-40	162-55-00	Navajo
	27 Feb 87	55-22-20	162-59-30	Navajo
	18 Jun 87	55-20-00	162-58-00	Supercub
	1 Sep 87	55-16-20	162-59-30	Supercub
	2 Sep 87	55-15-00	163-02-00	Navajo
	27 Jan 88	55-15-00	162-59-40	Supercub
	5 Mar 88	55-22-00	163-00-00	Navajo
86116	14 Aug 86	55-24-30	163-06-50	Boat
{Male)	19 Aug 86	55-16-10	163-08-50	Arctic Tern
	23 Aug 86	55-15-00	162-59-00	Twin Otter
	25 Aug 86	55-18-00	163-15-00	Twin Otter
	10 Ott 86	55-22-50	163-08-50	Twin Otter
	16 Dec 86	55-20-00	163-08-00	Arctic Tern
	25 Feb 87	55-18-10	163-06-10	Supercub
	27 Feb 87	55-16-30	162-59-10	Navajo
	18 Jun 87	55-23-40	163-08-50	Supercub
	2 Sep 87	55-15-00	162-59-40	Navajo
	28 Jan 88	55-08-00	163-02-00	Navajo
	8 Mar 88	55-20-00	163-05-00	Navajo

Table 4. Dates of instrumentation, dates of last observation and length of total observation period for individual female sea otters in western Alaska Peninsula telemetry study .

ID	CAPTURE DATE	LAST OBSER DATE	OTTER DAYS
86102	03-Aug-86	05-Mar-88	580
86103	03-Aug-86	05-Mar-88	580
86104	04-Aug-86	08-Mar-88	582
86105	04-Aug-86	08-Mar-88	582
86106	04-Aug-86	08-Mar-88	582
86107	05-Aug-86	28-Jan-88	541
86108	05-Aug-86	26-Feb-87	205
86109	07-Aug-86	08-Mar-88	579
86110	07-Aug-86	08-Mar-88	579
86111	07-Aug-86	02-Mar-88	573
86112	07-Aug-86	28-Jan-88	539
86113	13-Aug-86	11-Ott-86	59
		TOTAL	5981 OTTER DAYS

"Table 5. Dates of instrumentation, dates of last observation and length of total observation period for individual male sea otters in western Alaska Peninsula telemetry study .

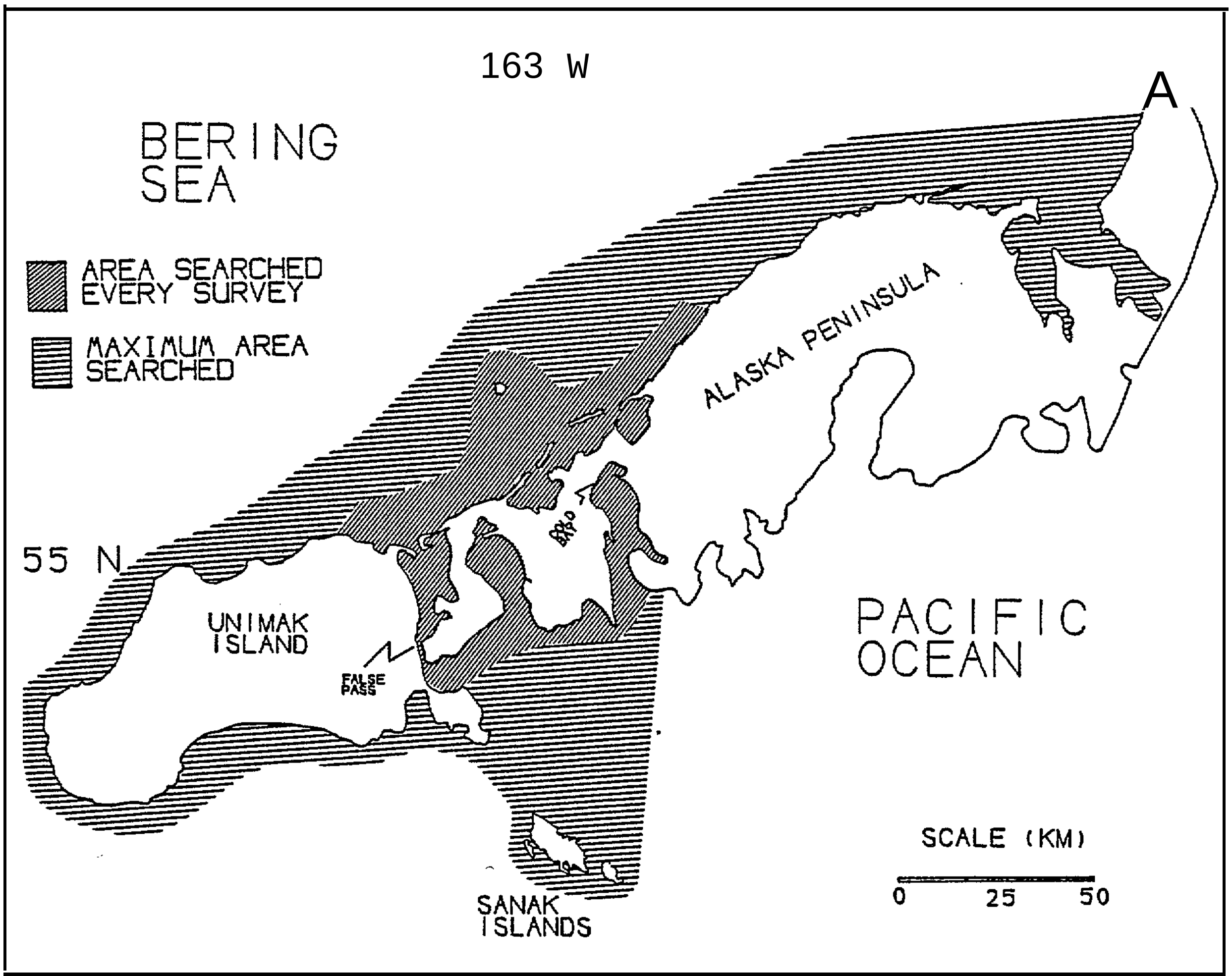
ID	CAPTURE DATE	LAST OBSER DATE	OTTER DAYS
86101	03-Aug-86	25-Feb-87	206
86114	14-Aug-86	14-Aug-86	0
86115	14-Aug-86	05-Mar-88	569
86116	14-Aug-86	08-Mar-88	572

TOTAL
1347 OTTER DAYS

Table 6. Number of telemetry fixes and distances between extreme locations (DBEL) in kilometers for instrumented sea otters in western Alaska Peninsula study.

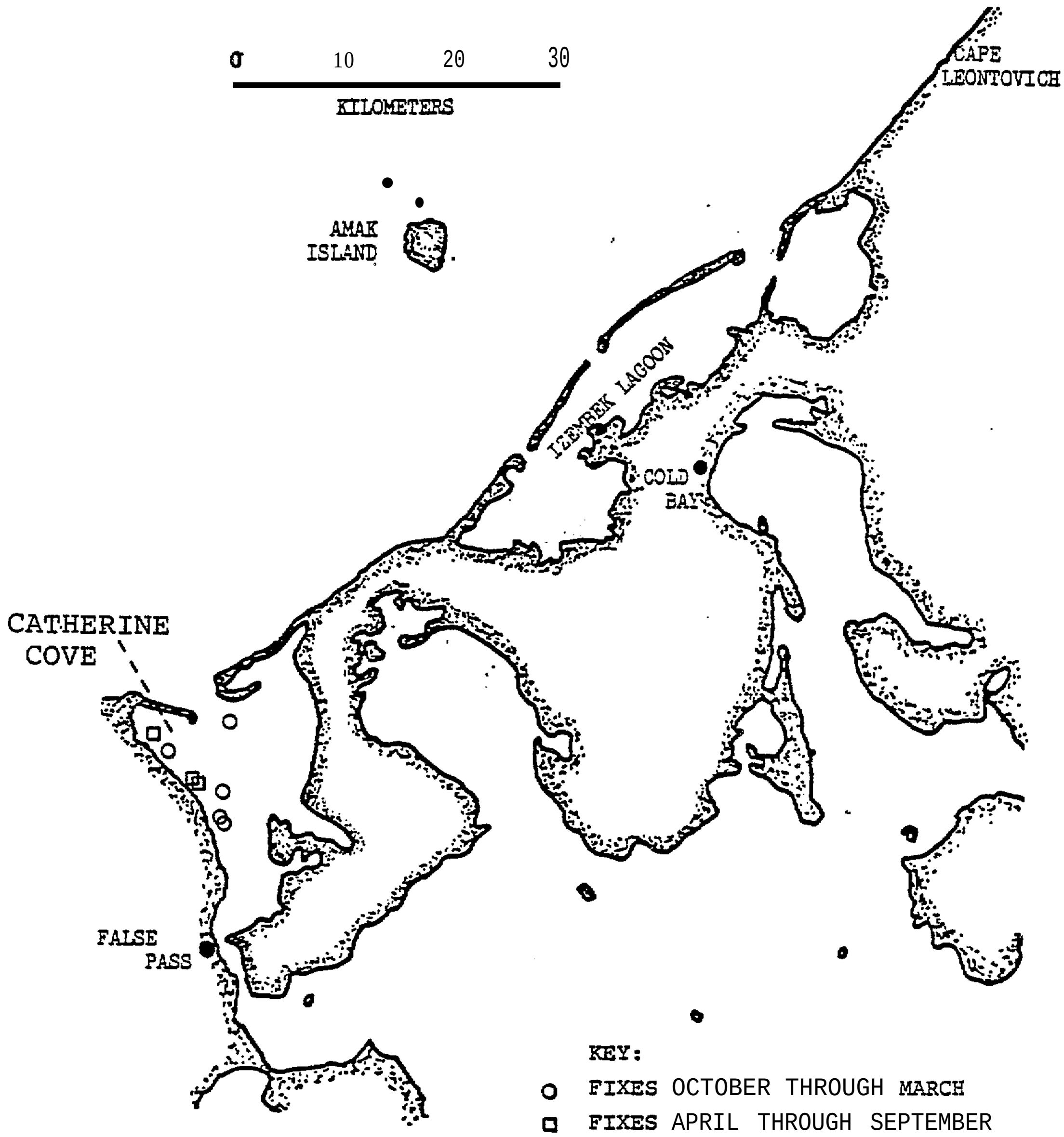
ID	CAPTURE DATE	LAST OBSER DATE	TOTAL FIXES	DBEL
86101	03-Aug-86	25-Feb-87	8	10.5
86102	03-Aug-86	05-Mar-88	14	18,0
86103	03-Aug-86	05-Mar-88	15	7.5
86104	04-Aug-86	08-Mar-88	13	47.0
86105	04-Aug-86	08-Mar-88	14	7.5
86106	04-Aug-86	08-Mar-88	13	15.0
86107	05-Aug-86	28-Jan-88	12	18.0
86108	05-Aug-86	26-Feb-87	8	13.0
86109	07-Aug-86	08-Mar-88	14	13*O
86110	07-Aug-86	08-Mar-88	13	11*5
86111	07-Aug-86	02-Mar-88	9	16.0
86112	07-Aug-86	28-Jan-88	15	37.5
86113	13-Aug-86	11-Ott-86	2	48.0
86114	14-Aug-86	14-Aug-86	1	
86115	14-Aug-86	05-Mar-88	15	23.5
86116	14-Aug-86	08-Mar-88	12	20.0

Appendix I. Map of study area (hatched); fine hatch indicates portion of study area that was searched during every survey; coarse hatch indicates maximum extent of area that was searched during the project. The northernmost areas were searched predominately during the summer/fall seasons whereas, the southernmost areas were emphasized during the winter/spring seasons.

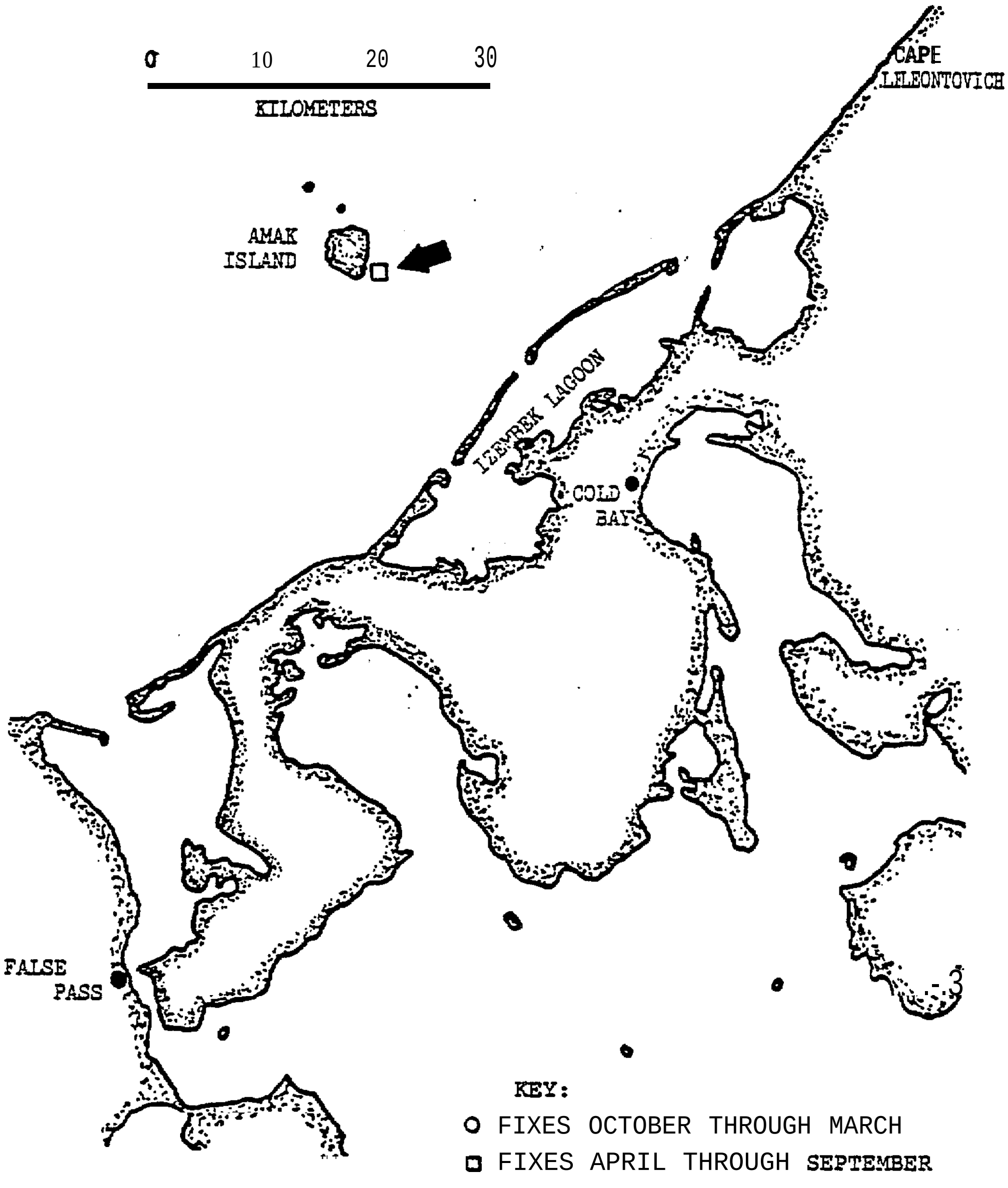


Appendix 11. Locations of telemetry fixes of western Alaska Peninsula sea otters, 1986-8.

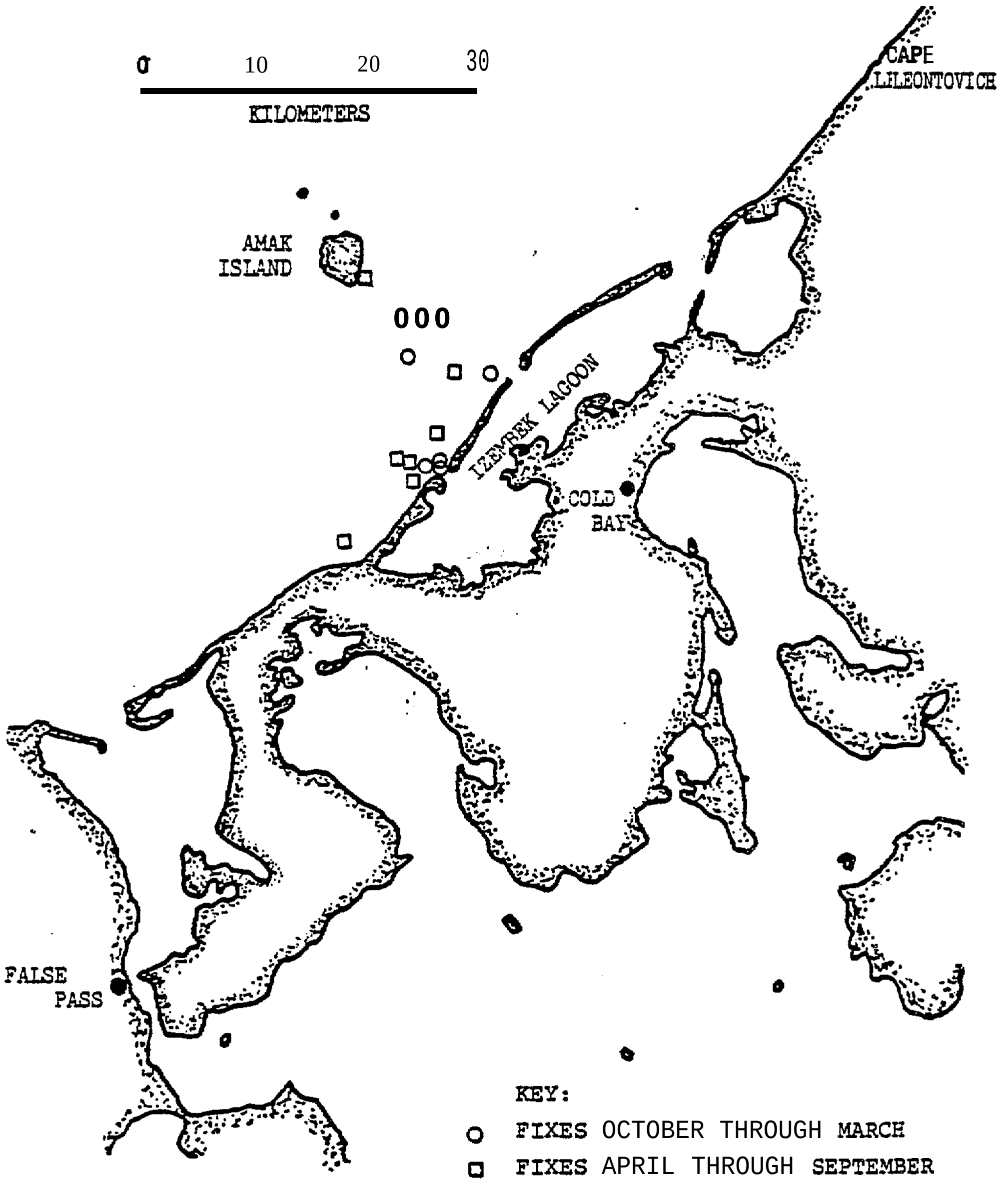
Telemetry fixes of western Alaska Peninsula sea otter male, identification number 86101,



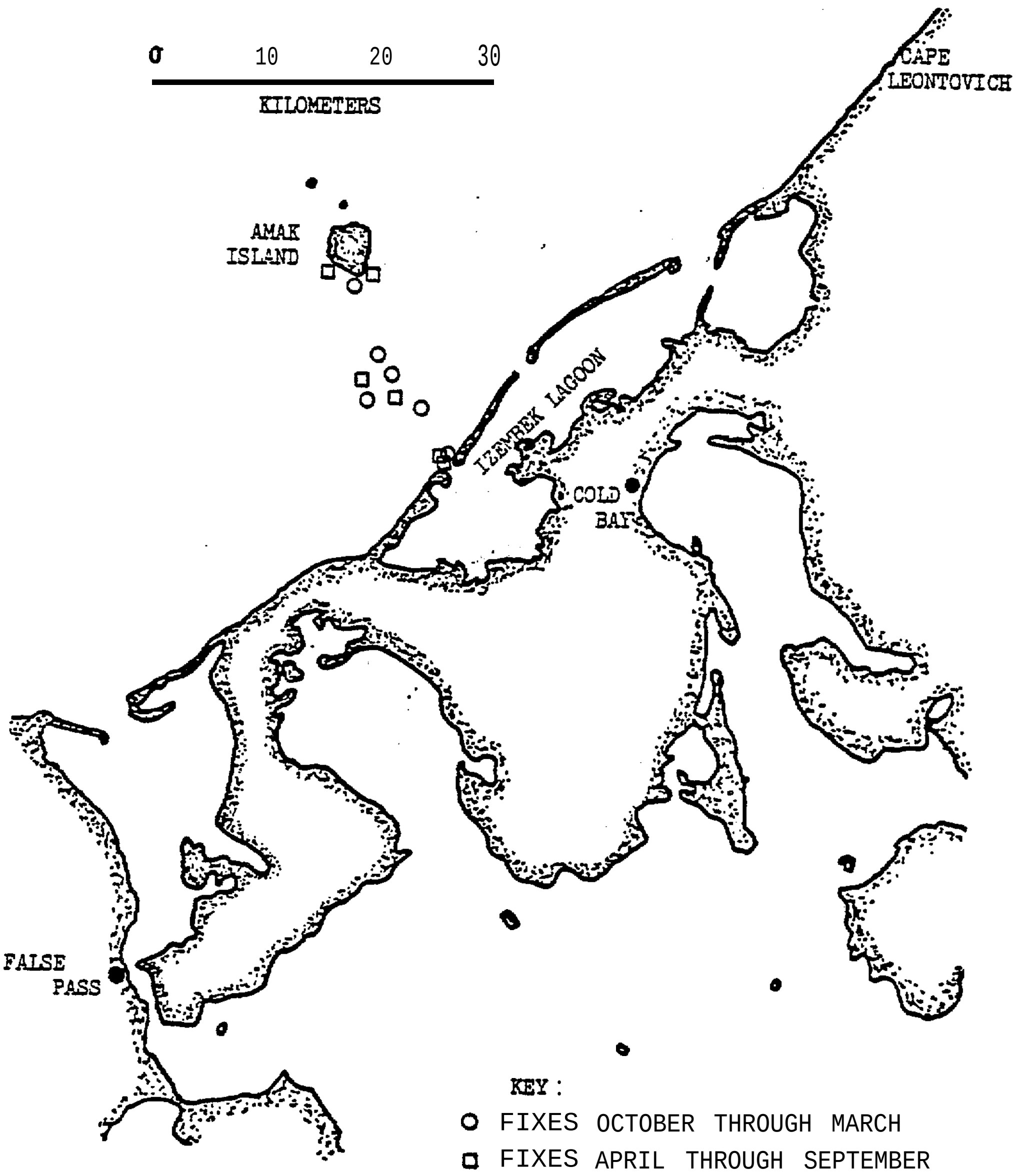
Telemetry fixes of western Alaska Peninsula sea otter male, identification number 86114.



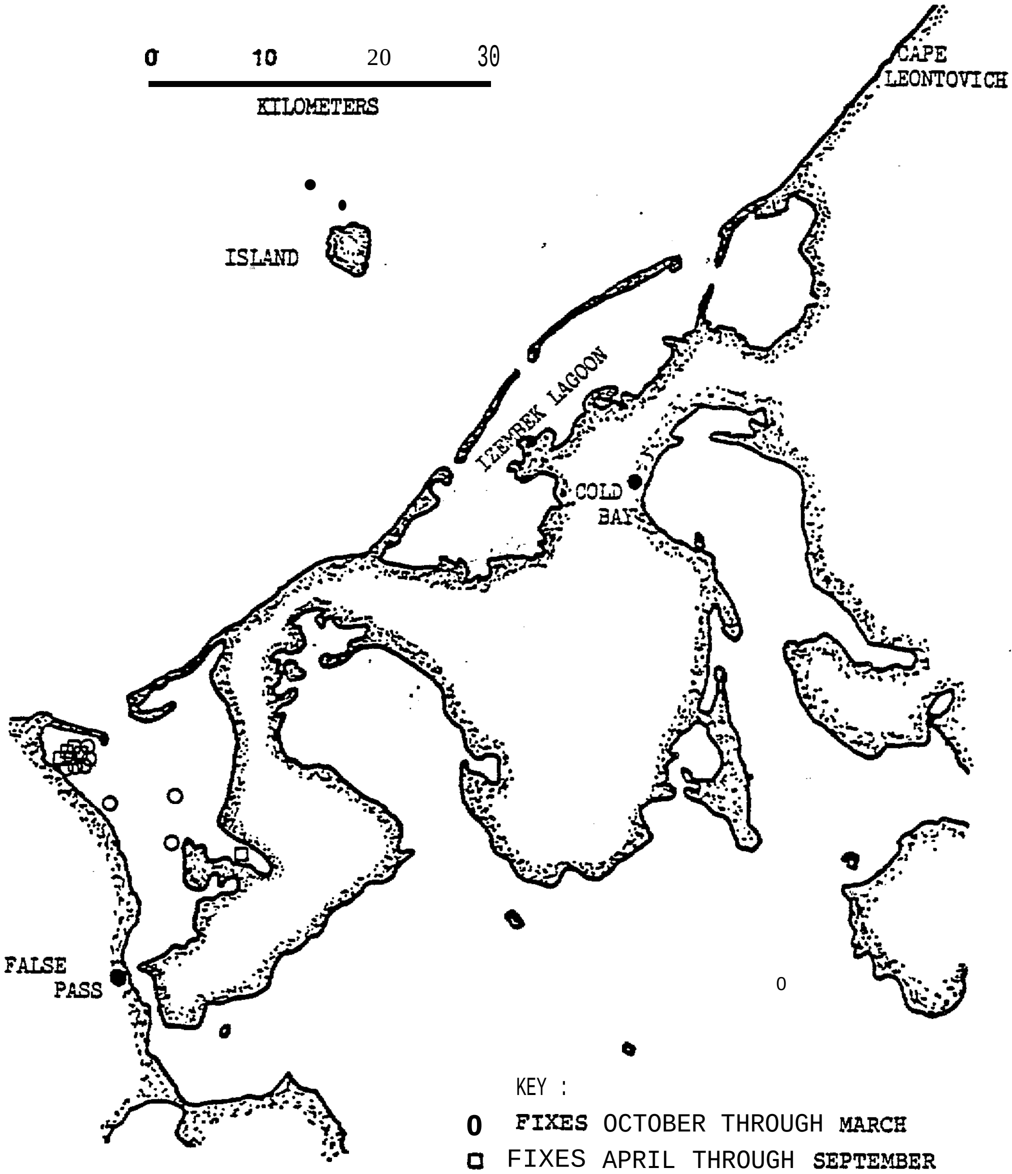
Telemetry fixes of western Alaska Peninsula sea otter male, identification number 86115.



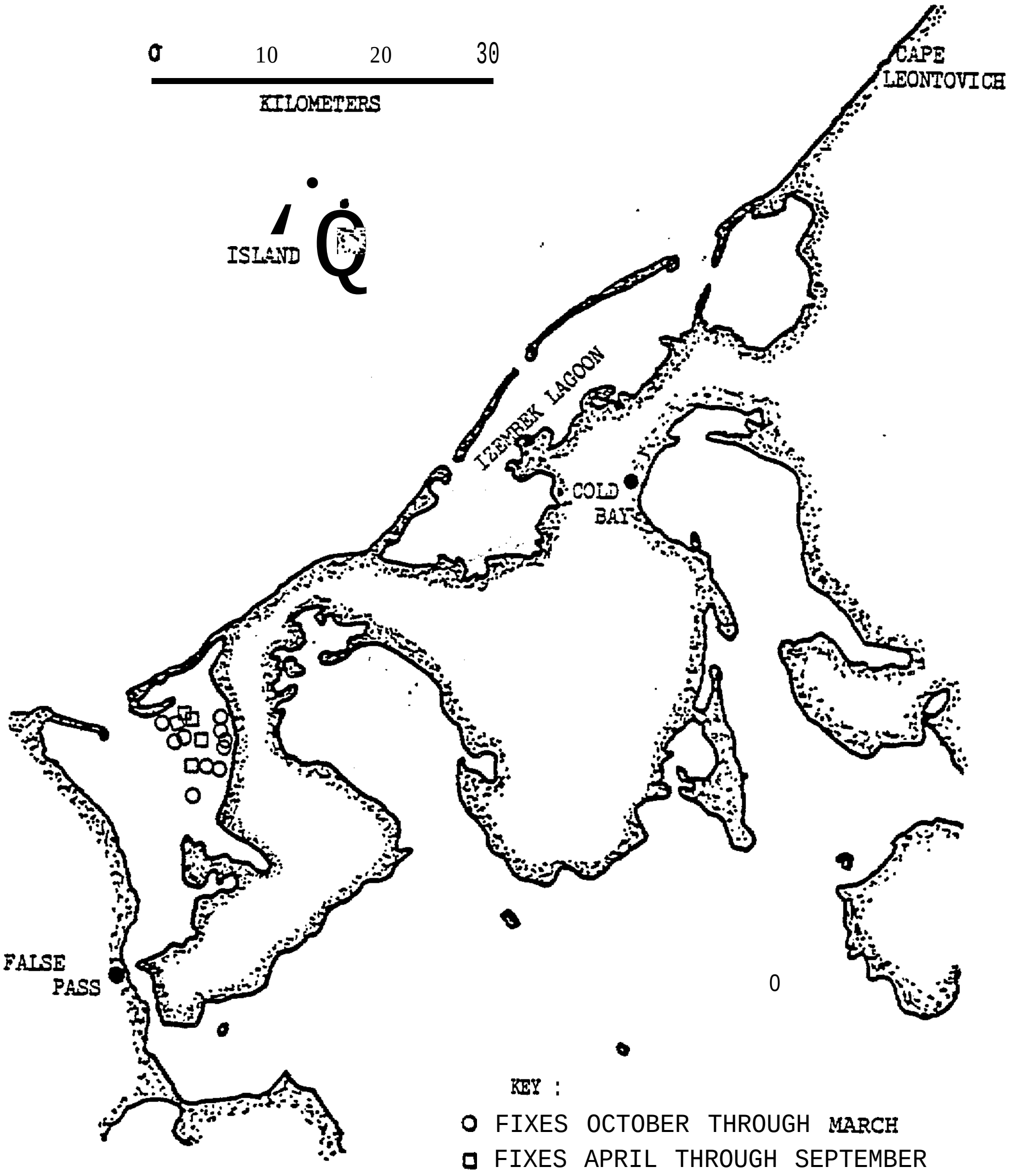
Telemetry fixes of western Alaska Peninsula sea otter male, identification number 86116.



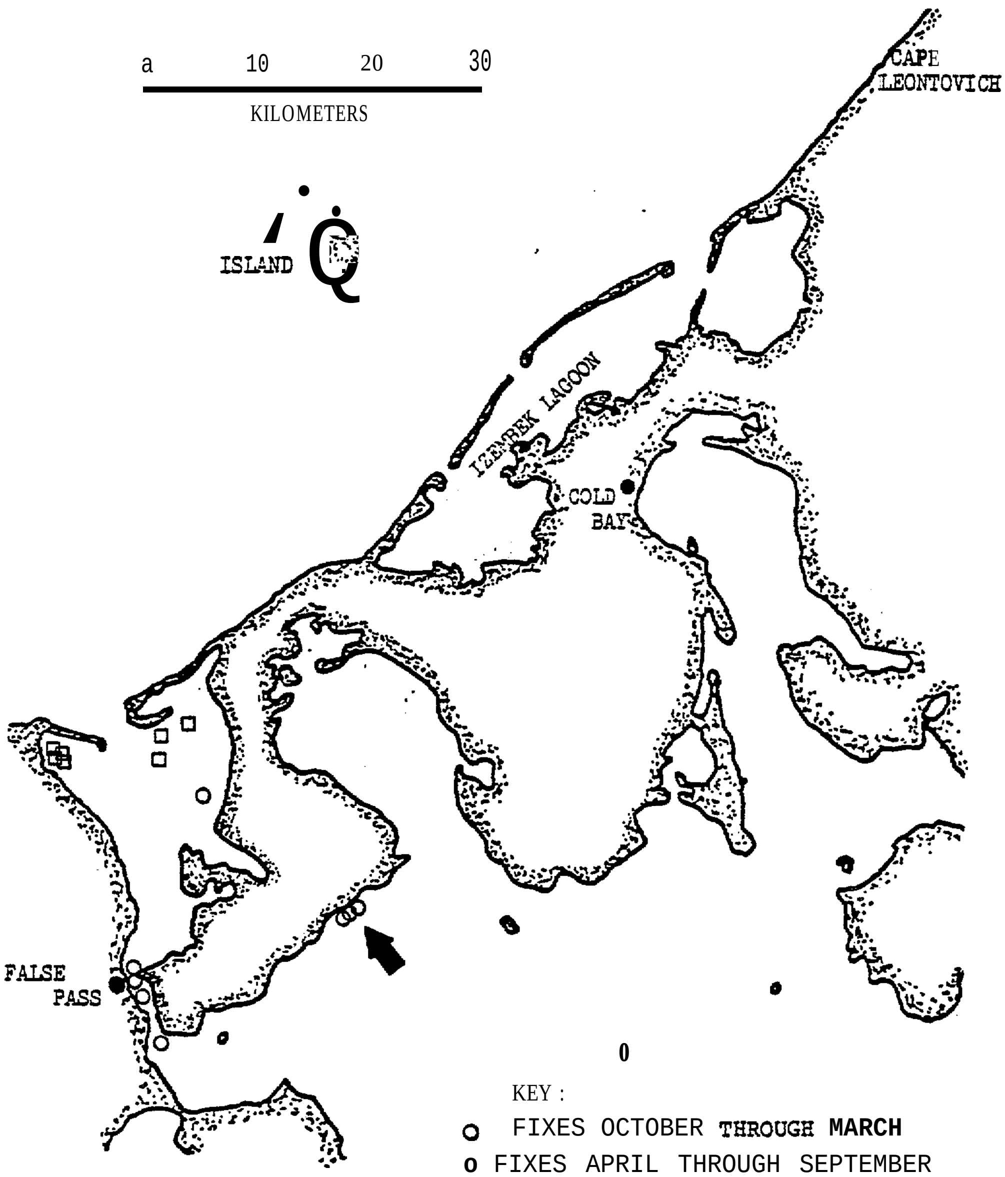
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86102.



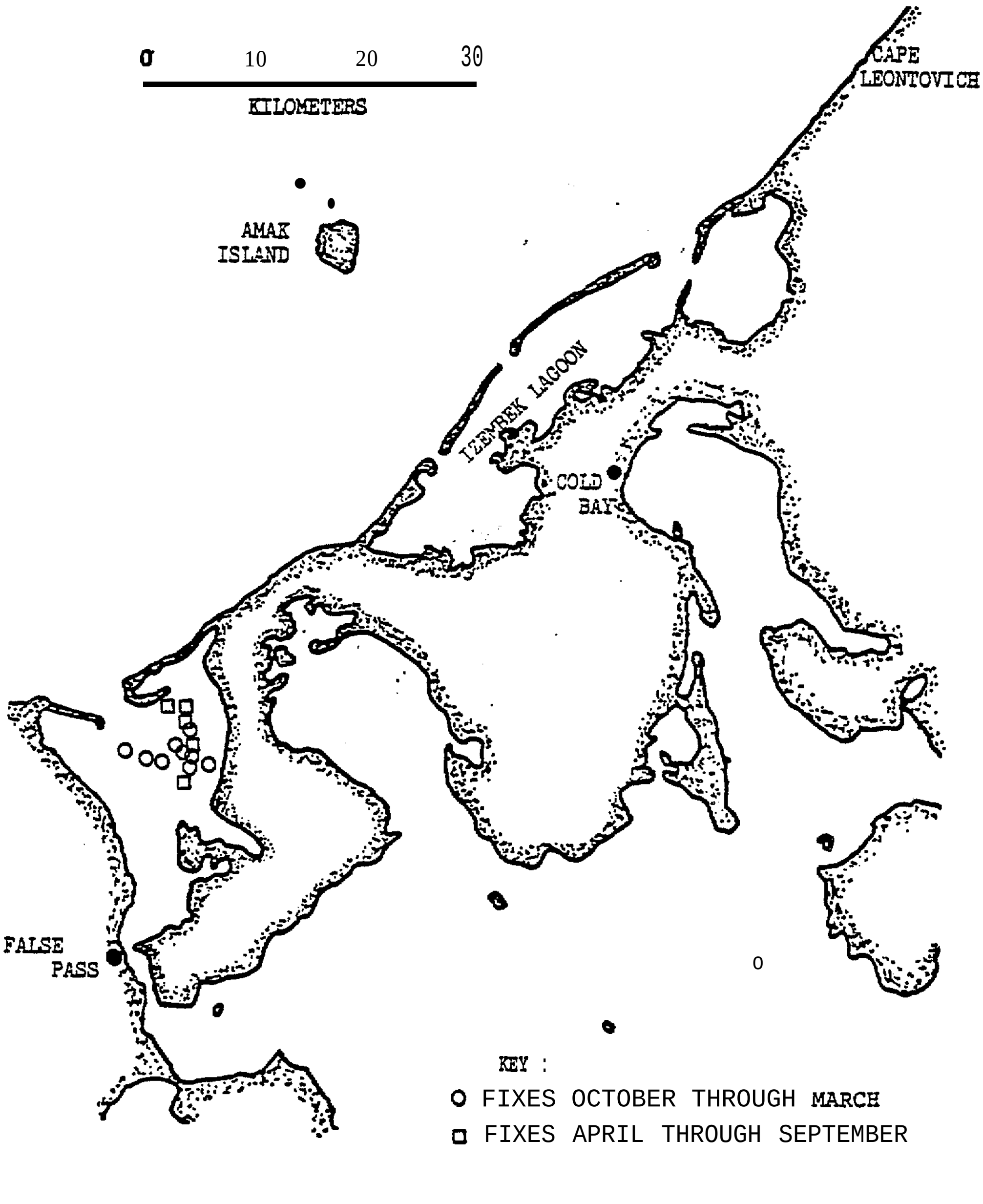
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86103.



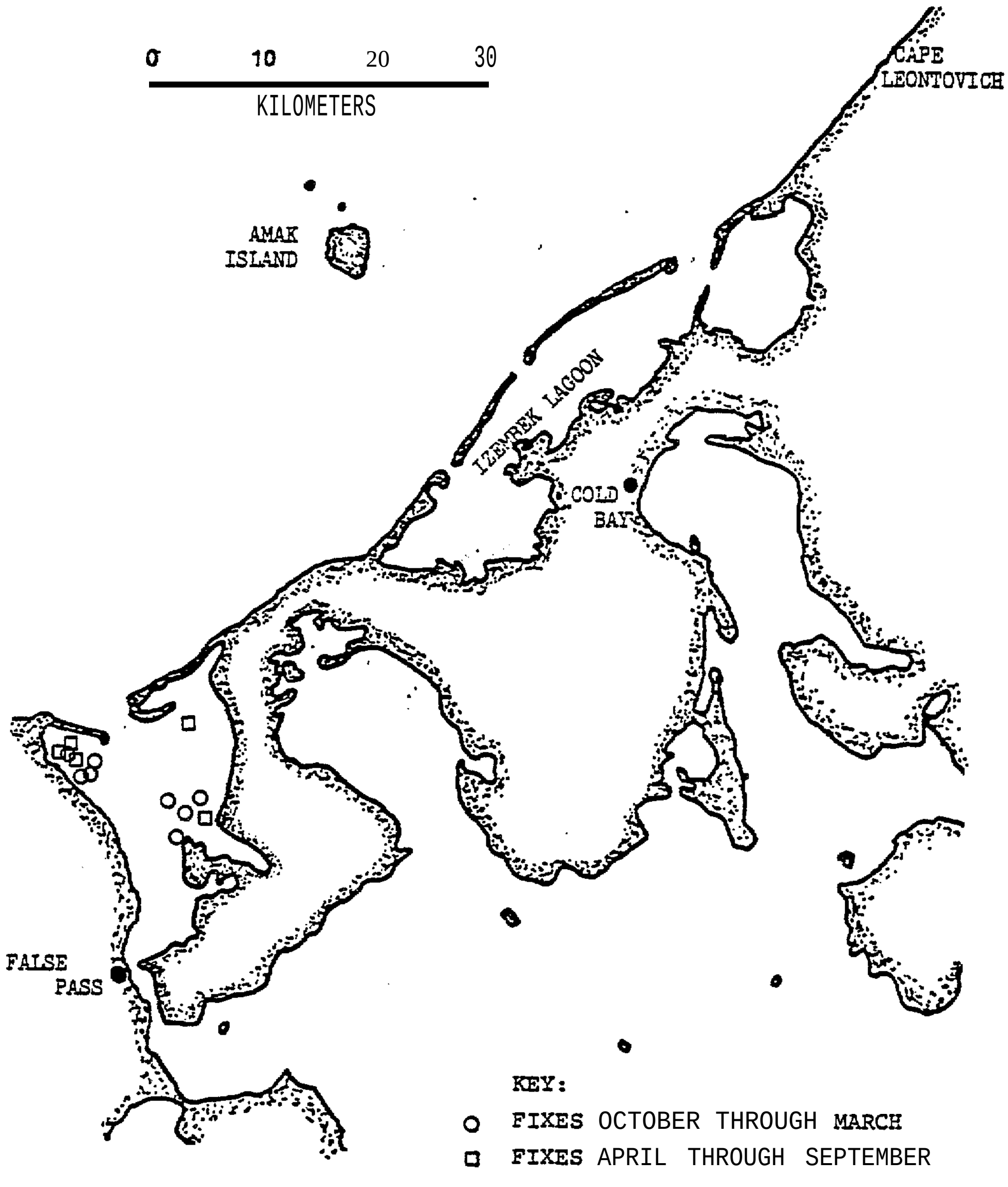
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86104.



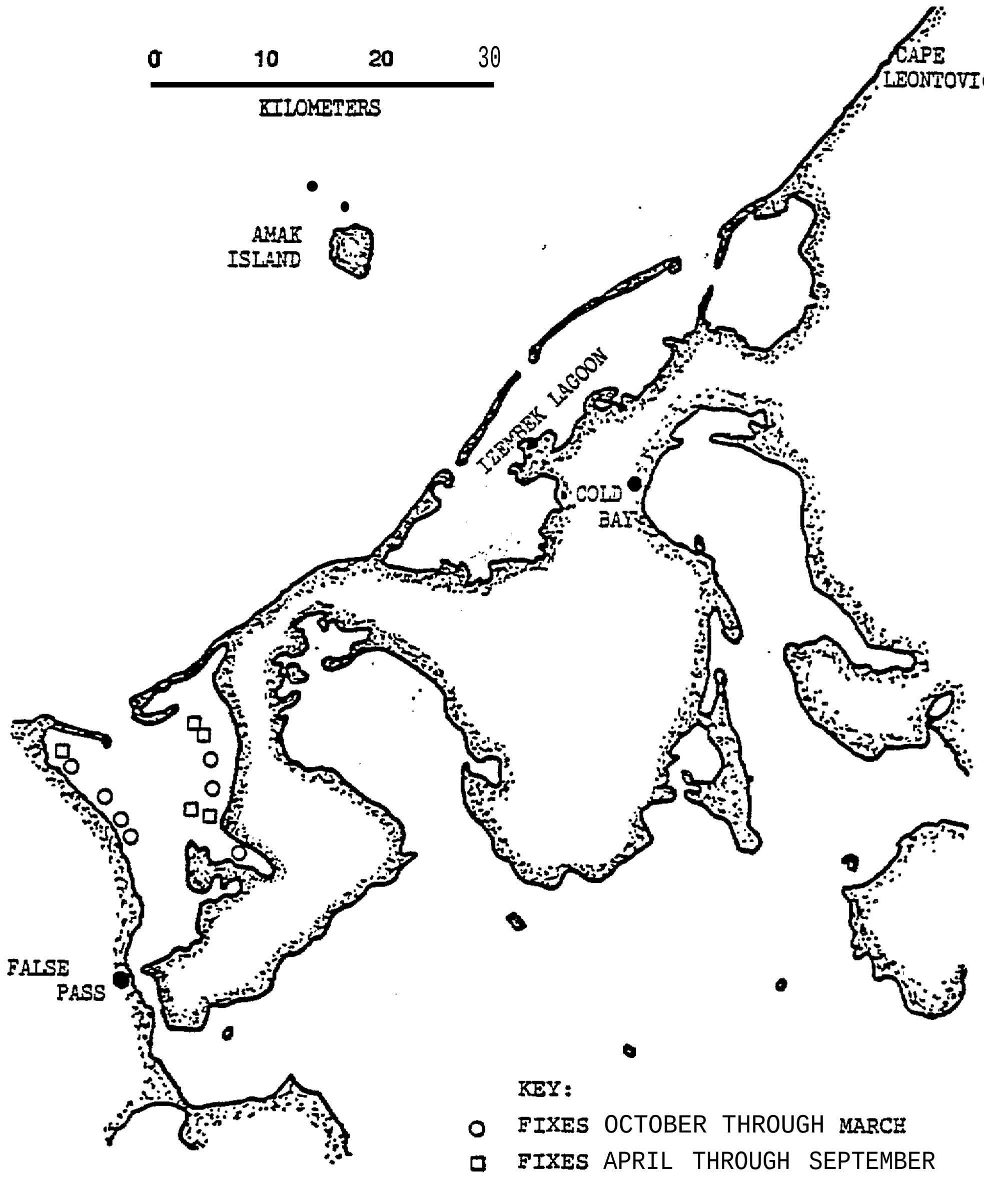
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86105.



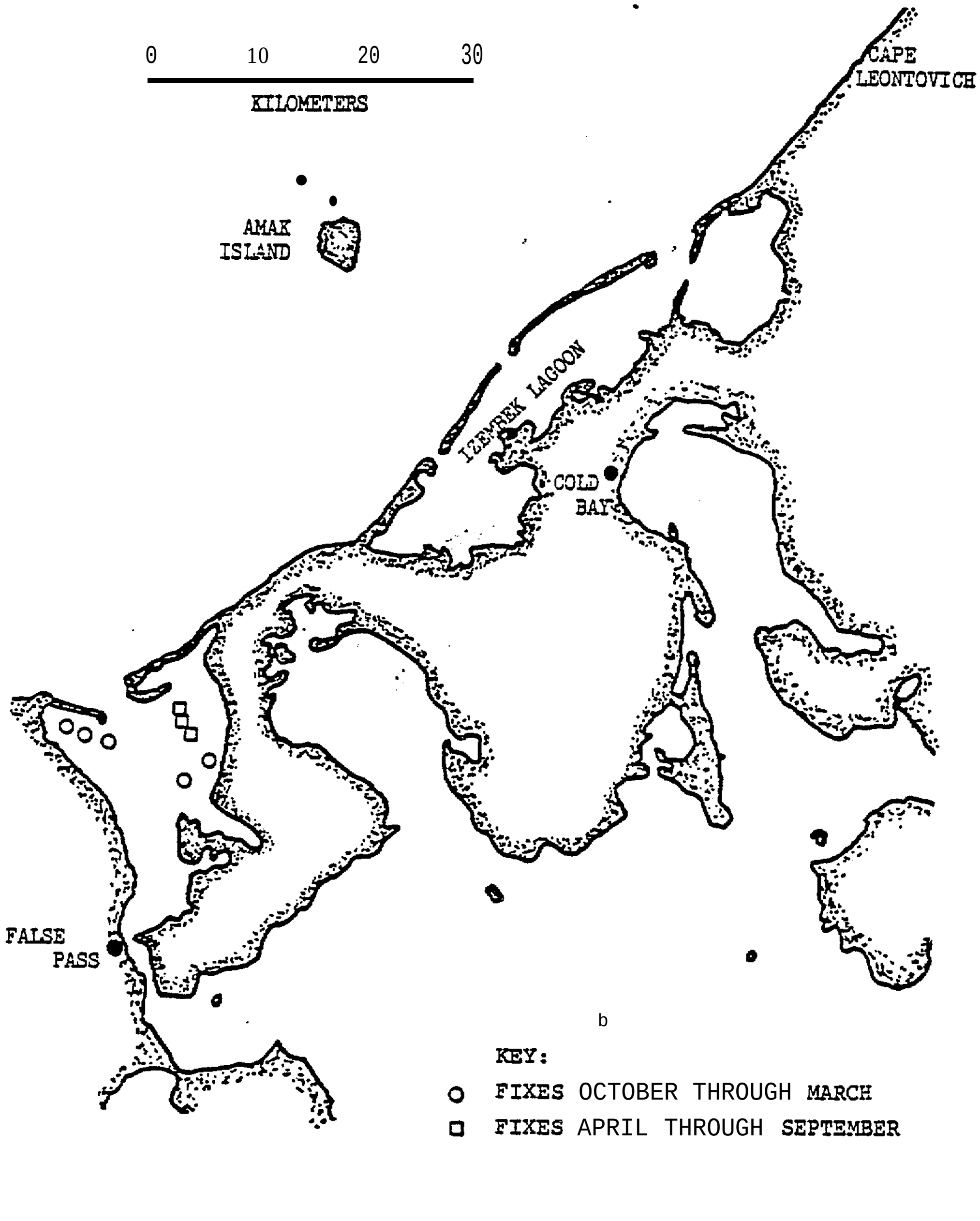
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86106.



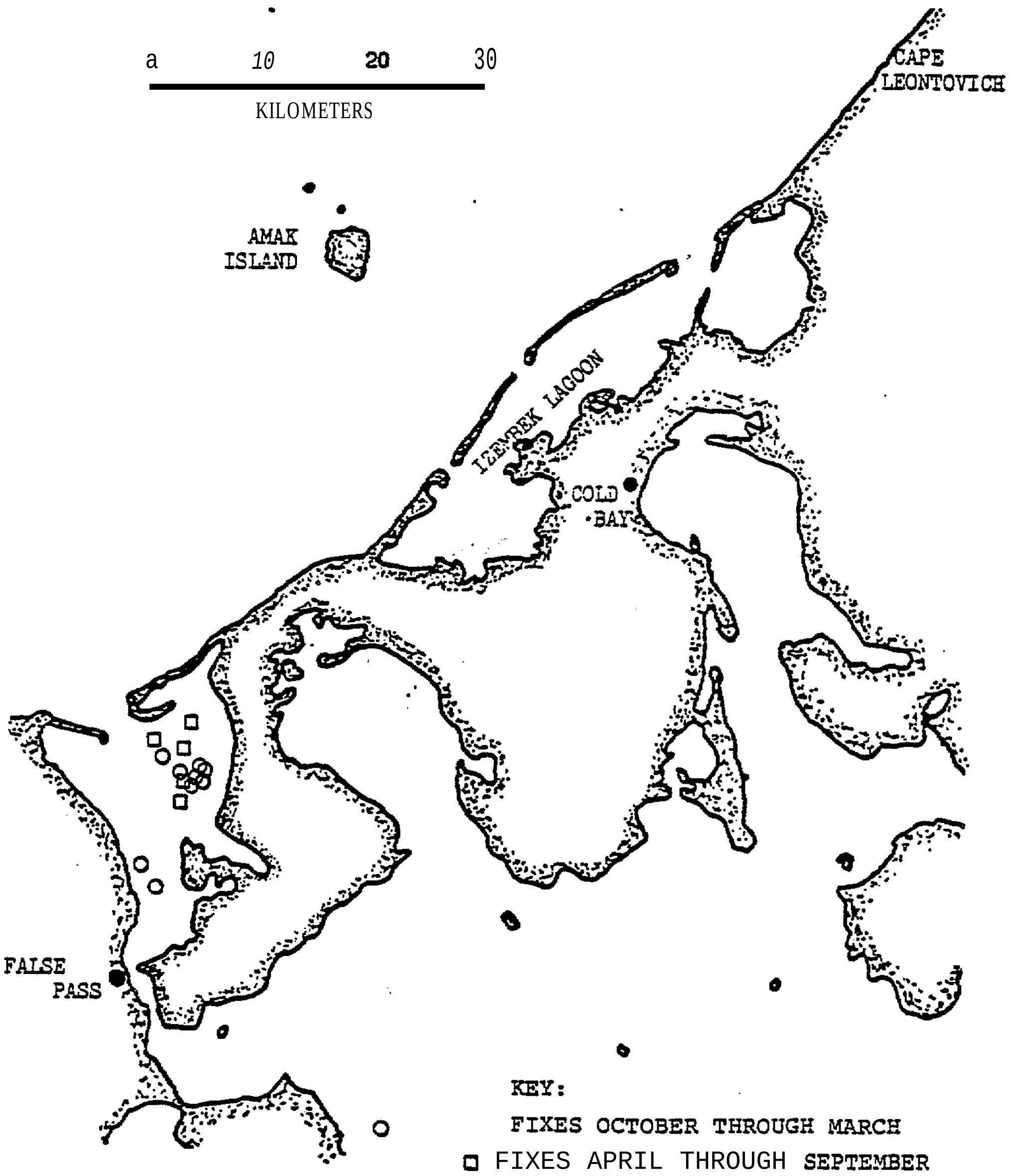
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86107.



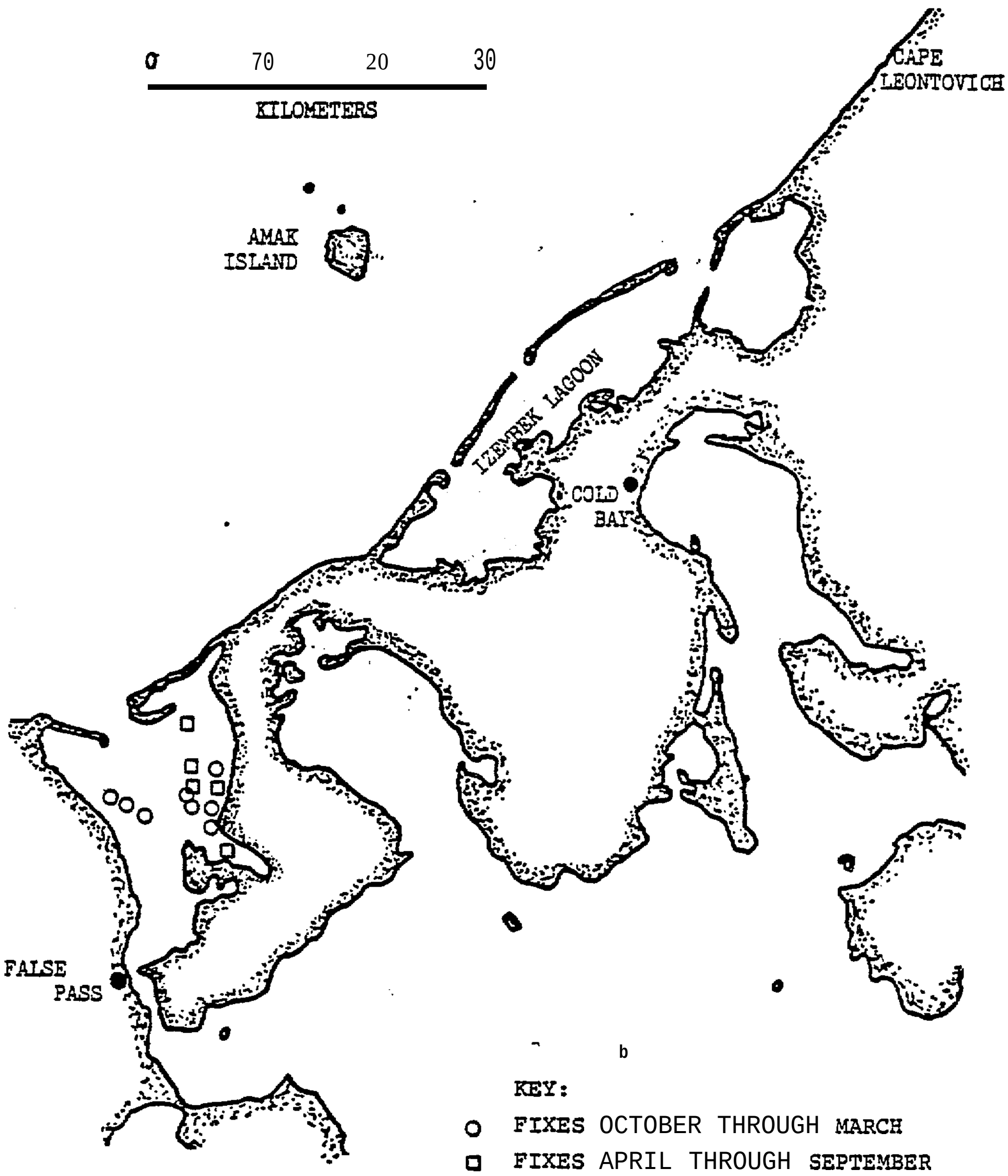
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86108.



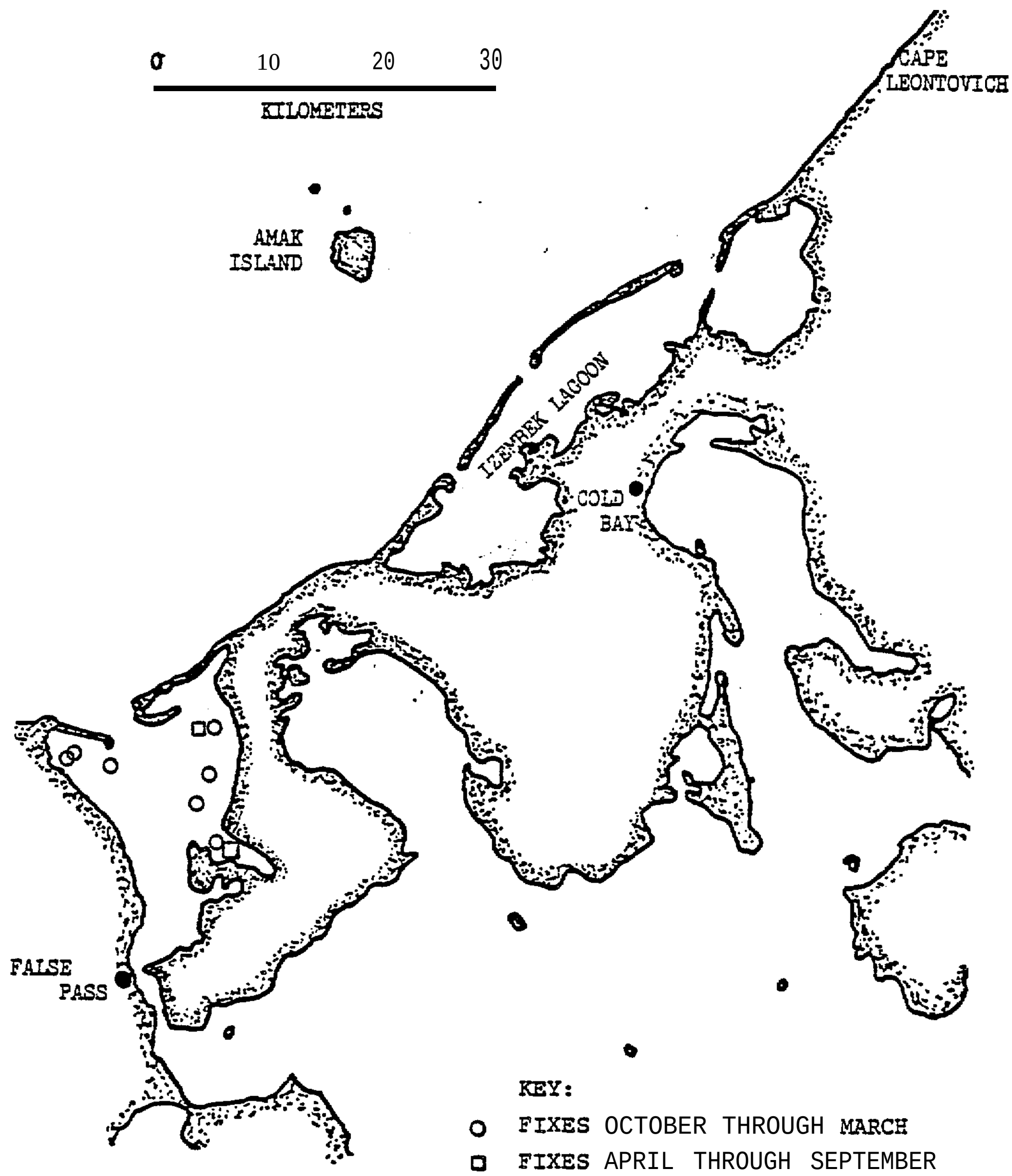
Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86109.



Telemetry fixes of western Alaska Peninsula sea otter female , identification number 86110,



Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86111.



Telemetry fixes of western Alaska Peninsula sea otter female, identification number 86112.