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Migration of northern fur seal (*Callorhinus ursinus*) pups in the Bering Sea. Final Report.

Timothy J. Ragen
and
Paul K. Dayton

Scripps Institution of Oceanography
University of California, San Diego
La Jolla, California 92093

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AUTHORS AND RESPONSIBILITIES

This report was written by Timothy J. Ragen, under the supervision of Paul K. Dayton. Dr. Ragen and George A. Antonelis, Jr., National Marine Mammal Laboratory, conducted the field portion of this study.

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MIGRATION OF NORTHERM FUR SEAL (*CALLORHINUS URSINUS*) PUPS IN TEE BERING SEA

INTRODUCTION

The northern fur seal (*Callorhinus ursinus*) *is* arguably the most extensively studied marine mammal in the world. Nevertheless, significant elements of northern fur seal population biology and history remain poorly understood largely because of the difficulty of studying these animals at sea. The annual cycle of this fur seal includes a land-based phase from approximately June to November and a pelagic phase from December to May. Although the land-based phase has greatly facilitated the study of its behavior, biology, and population dynamics, our knowledge of this species' life history will remain incomplete until we have expanded our understanding of the pelagic phase.

There is some information on fur seal distribution during the pelagic phase, obtained primarily from records of pelagic sealing in the last half of the 19th century. Townsend (1899) charted the location where 304,713 northern fur seals were killed and collected by sealers from 123 sealing vessels (Fig. 1). This information was used in 1952 to guide research collections by Canadian, Japanese, and U.S. researchers (Taylor, et al. 1955), and again from 1958 to 1974 by the four signatories of the Interim Convention for the Conservation of Fur Seals of the North Pacific Ocean: Canada, Japan, the U.S., and the U.S.S.R (Kajimura 1980). From these research

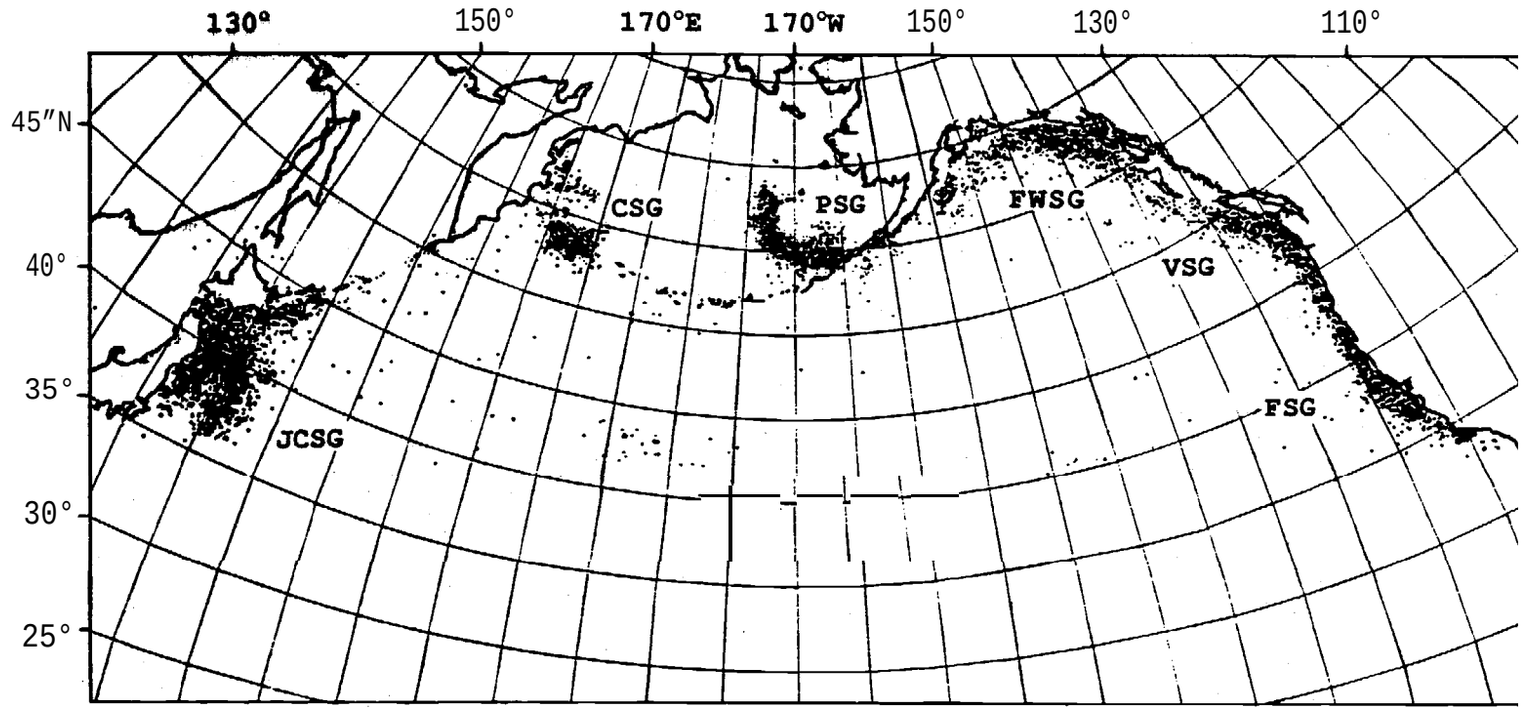

Figure 1. Location where 304,713 northern fur seals were killed and collected by 123 sealing vessels in the late 1800's (modified from Townsend 1899). Areas of heavily concentrated sealing were known as the Japan Coast Sealing Ground (JCSG), The Commander Sealing Ground (CSG), the Pribilof Sealing Ground (PSG), the Fairweather Sealing Ground (FWSG), the Vancouver Sealing Ground (VSG), and the Farallon Sealing Ground (FSG).

collections food habits, pregnancy rates, survival rates for adult females, and movement patterns at sea for some age and sex groups from different island populations are available (Taylor et al. 1955, Kajimura, et al. 1979, 1980).

These collections did not determine the pelagic distribution of northern fur seals. As Bigg (1982) points out, pelagic sealers were motivated by economic profit and had to consider such factors as seal size, molting season, distance from port, and sealing regulations. Similarly, Kajimura (1980) notes that researchers during the 1958-74 pelagic collections were charged with killing and collecting a quota of seals each season and, "Effort was therefore directed toward collecting seals and away from systematic surveys to determine the density, distribution, or relative abundance of fur seals by time and area." Loughlin, et al. (1987) evaluated the feeding distribution of fur seals in the Bering Sea and their movement patterns between feeding locations and St. Paul Island. However, this study focused on adult females during *summer* months and did not address the question of fur seal distribution during the pelagic phase of their annual cycle. Hence, certain aspects of this pelagic phase remain poorly understood.

Little Is known about the migration and distribution of young fur seals from the time they are weaned (or wean themselves) and enter the pelagic phase until they return to rookery or haul-out areas at age *2 or 3.* There is information on the survival of males from birth to age 3, due to extensive commercial harvesting of

juvenile males from 1918 to 1984. Juvenile females were not harvested (except from 1956 to 1968) and their survival from birth to age 3 is poorly understood. In addition, young females were conspicuously underrepresented in the pelagic collections taken in 1952 and from 1958 to 1974. Thus, it is apparent from the life table for northern fur seals that our understanding of the life history of young animals, particularly females, is poor. The potential significance of early life history information is underscored by the view that juvenile survival may be of major significance in the natural regulation of marine mammal populations (Eberhardt and Siniff 1977).

Survival of fur seals during their first two to three years must be determined, at least proximally, by events that occur at sea, because they spend relatively little time on land. Natural factors affecting the survival of young animals at sea include their ability to capture prey, avoid predators, resist disease and parasites, and withstand the rigorous climate of the North Pacific (Scheffer 1950). Factors influencing their distribution at sea may include the availability of prey, water temperature, currents, bathymetry, and other climatic or oceanographic features.

Knowledge of the distribution of fur seals in their first year of life can be summarized as follows. In this report animals in their first year of life will be referred to as "pups"; the term "yearling" (North Pacific Fur Seal Commission 1984) will not be used. It generally is assumed that pups from the Pribilof Islands leave the

Bering Sea and enter the North Pacific primarily through Unimak Pass (Kenyon and Wilke 1953, Kajimura 1979, Bigg 1982, French et al. 1989). They appear to segregate by sex *less* than older age classes (Kajimura 1979). Large numbers of pups have been observed off the coasts of Washington and British Columbia in the months of March and April (Townsend 1899, Bigg 1982), but they generally are underrepresented in coastal regions where seals have been taken by pelagic sealers (Fig. 1) and, later, by researchers (Kenyon and Wilke 1953, Wada 1969 and 1971, Kajimura 1979, Bigg 1982, Aschepkov and Kuzin 1987). Because pups have been less frequently seen on traditional sealing grounds, they are assumed to disperse more widely at sea (Kenyon and Wilke 1953; Wada 1969, 1971; Bigg 1982). Kenyon and Wilke (1953) reported that ".. pelagic sealers took young seals in June and July as far south as Latitude 40° in mid-Pacific areas." Finally, pups may not return to their islands of birth at the end of their first year, but instead may remain at sea (Kajimura 1980).

These points suggest at least two hypotheses for the pelagic distribution of northern fur seal pups originating from the Pribilof Islands. First, the vast majority of pups may follow the apparent path of older fur seals through Unimak Pass into the North Pacific, then eastward to the waters offshore of western Canada and the U.S. Thus, their distribution would be similar to the assumed distribution of older animals, which is primarily confined to the continental margin of the eastern North Pacific. While this hypothesis does not appear to be consistent with the underrepresentation of juveniles in

the various pelagic kills, the apparent discrepancy may have resulted from the failure to survey systematically offshore waters along the western coasts of Canada and the U.S., or from nonrandom selection of animals to be killed.

Alternatively, pups may exhibit greater dispersal in their migration. Rather than adhering to a well-defined migratory path consistent with that of older animals, pups may enter the North Pacific through many Aleutian Island passes, and then disperse widely into the North Pacific. This hypothesis was suggested by Kenyon and Wilke (1953) and is consistent with the underrepresentation of young animals in the pelagic kill, as well as with the sealers' records of young animals taken in the mid Pacific.

These hypotheses (Fig. 2) suggest substantially different life histories for young fur seals, including food habits, exposure to oceanic and climatic conditions, and interactions with human activities such as fisheries and oil and gas exploration and drilling. In view of the need to understand the early life history of fur seals, and its relationship to the natural regulation of fur seal populations, and the need to describe and quantify the interaction of fur seals with human activities such as fisheries activities in the Bering Sea and the North Pacific Ocean, it is critical that the pelagic distribution of young northern fur seals be determined.

Following animals at sea over long periods of time poses immense difficulties. However, the geography of the North Pacific

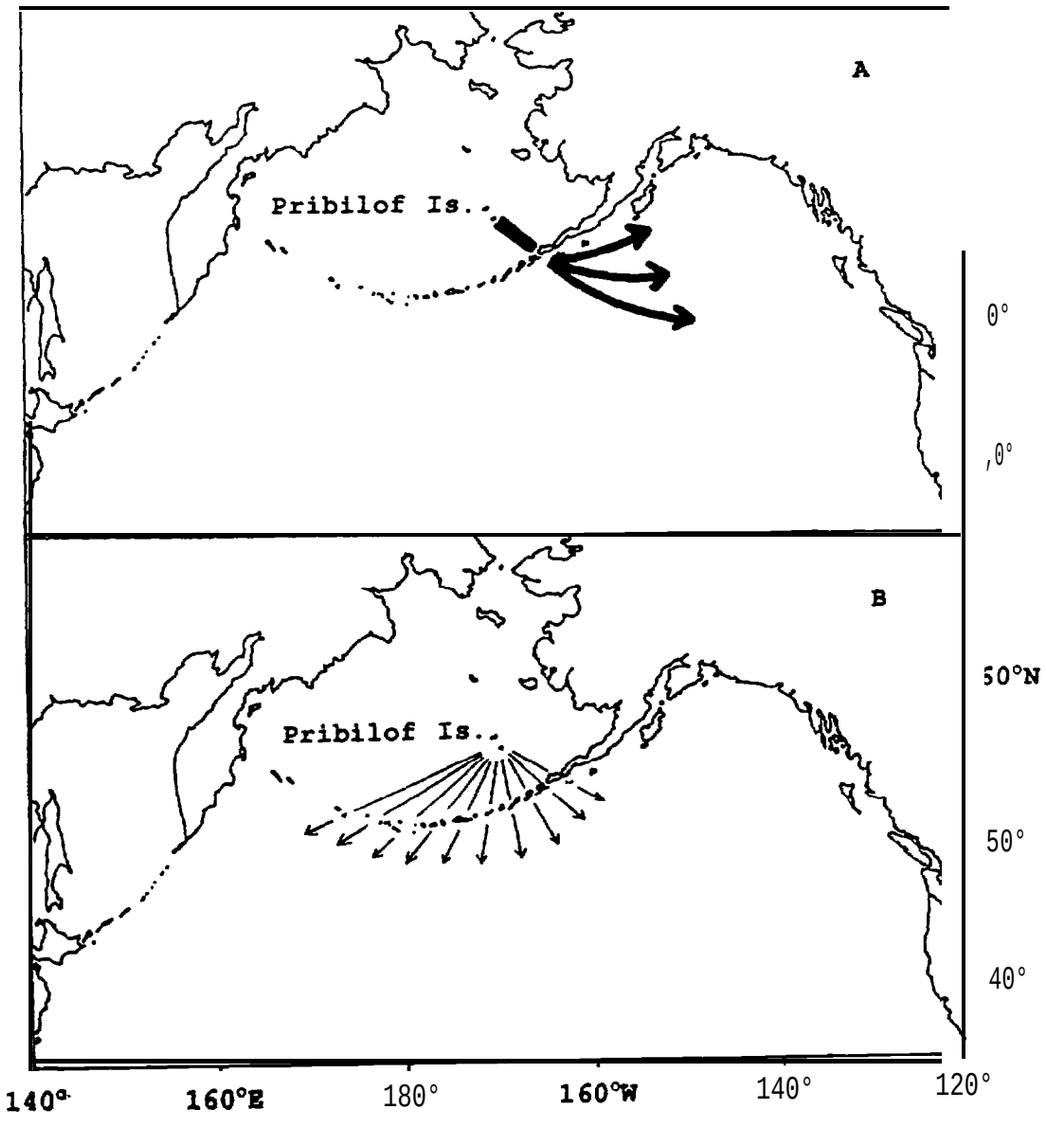

Figure 2. Two hypotheses of northern fur seal pup migration from the Pribilof Islands in the Bering Sea into the North Pacific Ocean. The first hypothesis (A) suggests pups enter the North Pacific primarily through Unimak Pass, and then migrate toward the eastern margin of the North Pacific and waters off western North America. The second hypothesis (B) suggests pups disperse widely, entering the North Pacific through many Aleutian Island passes.

region, and particularly the Aleutian Island arc, divides the migration into two stages: southward movement from the Pribilof Islands to the region of the Aleutian Islands, and migration south of the Aleutian Islands into the North Pacific Ocean. This study focused on the initial 'phase of fur seal pup migration. The specific objectives of the study were to determine 1) the length of time for migration from St. Paul Island (of the Pribilof Islands) to the Aleutian Islands, and 2) whether Unimak Pass is the principal migratory corridor through which pups enter the North Pacific Ocean.

METHODS

In October 1989, six automated VHF radio receiver stations were erected at locations along the eastern Aleutian Islands, including Scotch Cap of Unimak Island, Ugamak Island, Jackass Point of Akun Island, Unalga Island, Konet's Head of Unalaska Island, and Adugak Island (Fig. 3). These stations provided coverage of Unimak Pass, Akun Strait, Akutan Pass, Umnak Pass, and Samalga Pass (partial coverage) . Receivers were programmed to scan 101 frequencies, including a reference frequency emitted by transmitters located on land near each receiver station. Receivers seamed continuously, switching frequency every 4 seconds unless a transmitter pulse was detected, in which case the receiver continued to listen to that frequency for an additional 10 seconds. Data loggers were programmed to record frequency, date, time, and number of pulses heard whenever the receiver detected a transmitter signal.

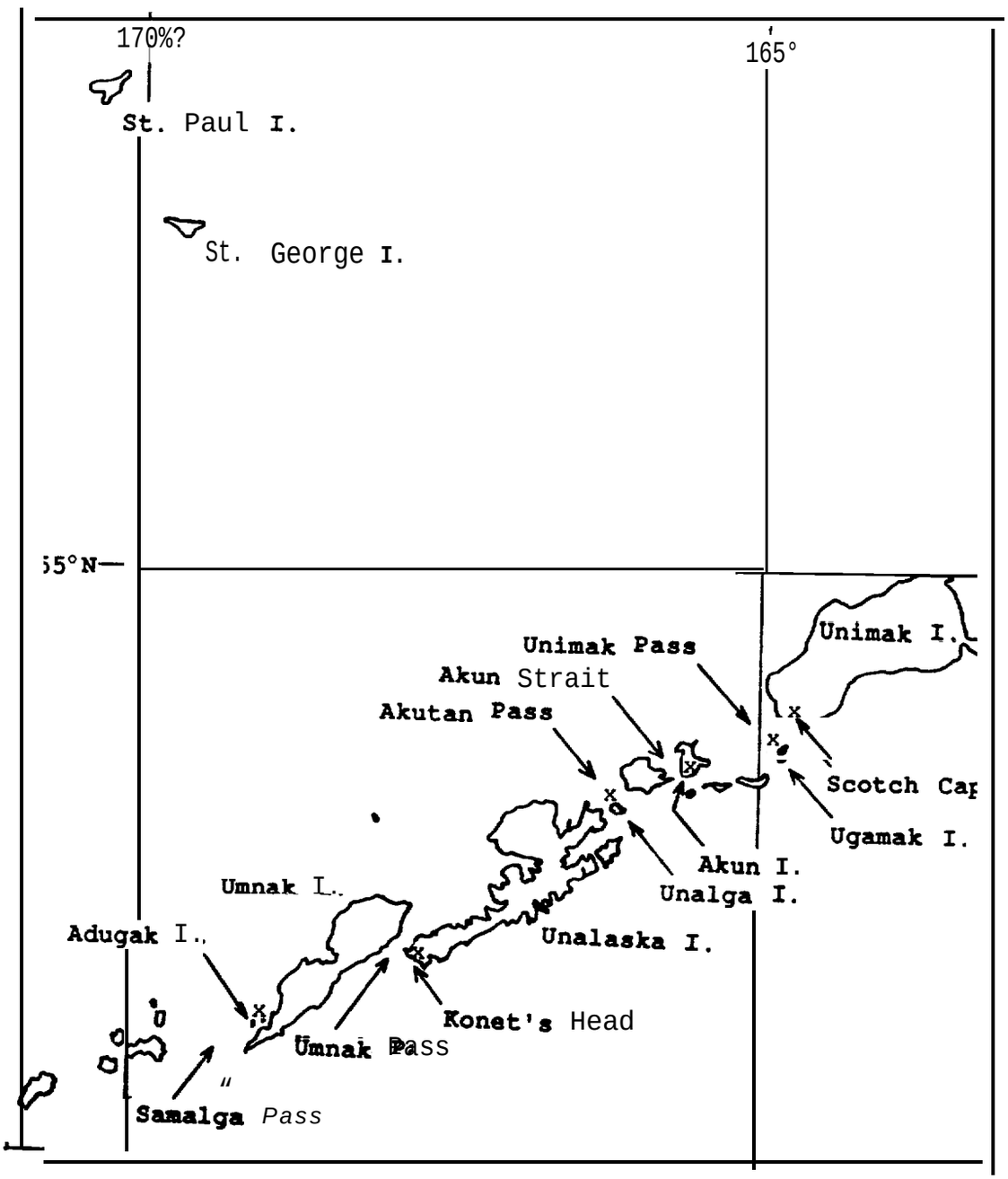

Figure 3. Approximate location of six automated VHF radio receiver stations (indicated by x) at Scotch Cap (Unimak Island), Ugamak Island, Jackass Point (Akun Island), Unalga Island, Konet's Head (Unalaska Island), and Adugak Island and the Aleutian Island passes these receiver stations *were* intended to cover. Distance from St. Paul Island to Unimak Pass is approximately 420 km.

In November 1989, prior to the onset of their pelagic migration, 90 northern fur seal pups (45 females and 45 males), 10 of which were from known mother-pup pairs, were instrumented with VHF radio transmitters. The ten mothers were also instrumented with transmitters. Transmitters were approximately 70 grams, with base dimensions approximately 4 x 6.5 cm, and height approximately 2 - 2.5 cm. Transmitters were equipped with a single antenna approximately 30 cm long projecting 15° back from vertical. Transmitters emitted 85 to 90 pulses per minute and were expected to have a battery life of 2.5 months minimum. Transmission range was measured at 12-15 miles with line of sight reception.

All study animals were captured at Reef rookery on St. Paul Island, except for three mother-pup pairs captured at Gorbatch rookery (also on St. Paul Island). Pups were chosen by weight; male pups less than 16 kg and females less than 15 kg were excluded (with the single exception of a male pup weighing 15.25 kg). Large animals were chosen to minimize possible effects of the transmitter on behavior or swimming. Qualitative observation of the pups on land and in the water did not reveal any changes in behavior or hydrodynamics, but no measurements or tests were conducted to confirm this.

Weight (± 0.25 kg) and length (± 1 cm) were determined for each pup. Prior to transmitter attachment each pup was manually constrained and the fur on the upper back between the scapuli was cleaned and dried with acetone. Neither length nor weight was

determined for adult females, and these animals were held in a constraint board (Gentry and Holt 1982) during transmitter attachment. Transmitters were attached to the fur using Devcon 5-Minute epoxy. Transmitters emitted 85-90 pulses per minute, and each transmitter was set to a different frequency to allow identification of individual animals. Animals equipped with transmitters but remaining on St. Paul Island were monitored by a stationary receiver at Reef rookery which scanned individual frequencies for 30 seconds each half hour, and by a hand-held receiver used to scan each rookery on the island on a daily basis from 12 November until 1 December, when all animals had been away from the island at least three days.

The Aleutian Island receiving stations *were* recovered in mid April 1990, well after migrating fur seals were expected to pass through the Aleutian Islands and enter the North Pacific Ocean.

RESULTS

Data storage problems resulted in the loss of 14, 5, 19, and 20% of the data from Scotch Cap (Unimak Pass), Unalga (Akutan Pass), Konet's Head (Umnak Pass), and Adugak (Samalga Pass), respectively. similar problems resulted in loss of 100% of the data at Ugamak (Unimak Pass) and Jackass Point (Akun Strait). The following results are based on 80 to 95% of the records from 4 Aleutian Island stations and the St. Paul station.

Male pups used in the study had a mean weight of 18.2 kg (± 1.48 kg standard deviation, range 15.25 - 21.0 kg, n = 45) and length

(tip of snout to base of tail) of **81.5 cm** (± **2.43** cm standard deviation, range 75 - 86 cm). Mean female weight was 17.0 kg (± 1.22 kg standard deviation, range 15.0 - 19.75 kg, n = 45) and length was " 79.9 cm (± 2.35 cm standard deviation, range 74 - 85 cm).

Radio-tagged pups remained on St. Paul Island an average of 11.0 days (± 5.7 days standard deviation, range O - 29 days, n = 90, no significant difference between male and female pups) . Adult females remained on St. Paul Island 3.5 days (± 1.6 days standard deviation, range 2 - 6 days, n = 10). Daily manual scanning did not detect movement of tagged animals to rookeries other than Gorbatch and possibly Ardiguen. These two rookeries are located on the same peninsula and are contiguous to Reef rookery. Thus, there was no indication of extensive interrookery. movement of pups during November. The day of departure for the 100 animals (45 female pups, 45 male pups, and 10 adult females) is shown in Figure 4. In 7 of the mother-pup pairs, the 'pup departed first, in 2 pairs the mother departed first. Records of the tenth mother-pup pair show departure of these animals was within **26** minutes of each other, indicating they may have departed together. The mother of this pair was relocated 12 days later at **Akutan** Pass; the pup was not relocated.

Thirty-four successful relocations of **30** different animals were **recorded in** the Aleutian Islands. These relocations were widely dispersed, including **3** in **Unimak** Pass, 16 in Akutan Pass, 5 in Umnak Pass, and **8** in **Samalga** Pass (Fig. 5). Presence **on St. Paul Island** and time of location in the Aleutian Islands **is** given for all 30

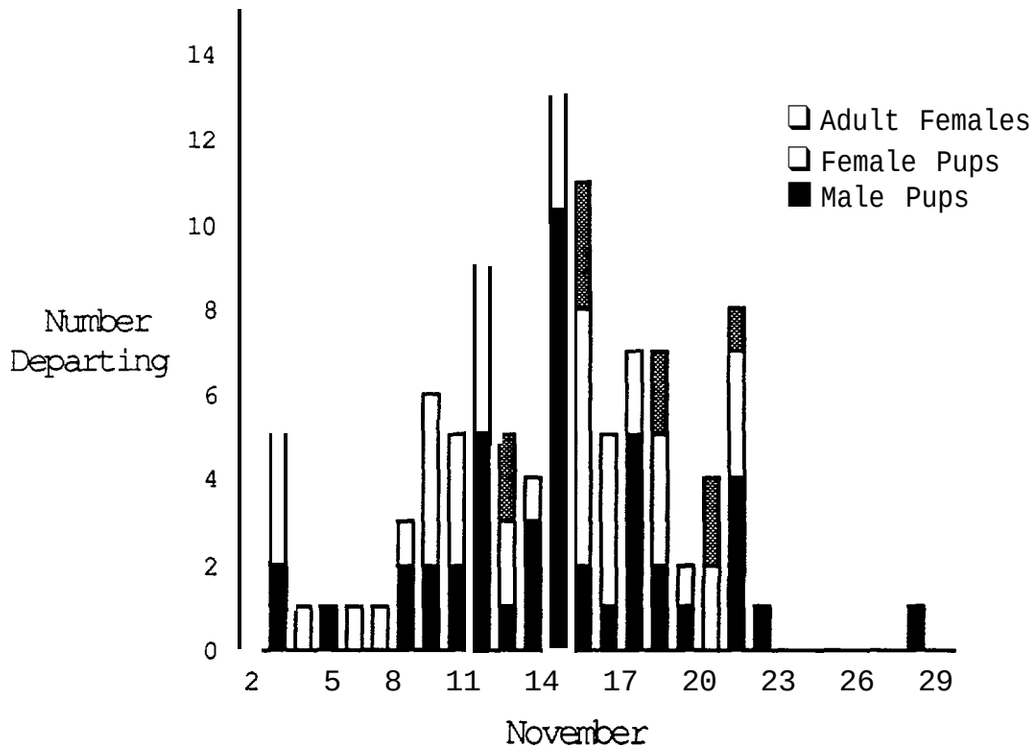

Figure 4. Histogram of departure dates for 90 northern fur seal pups and 10 adult females.

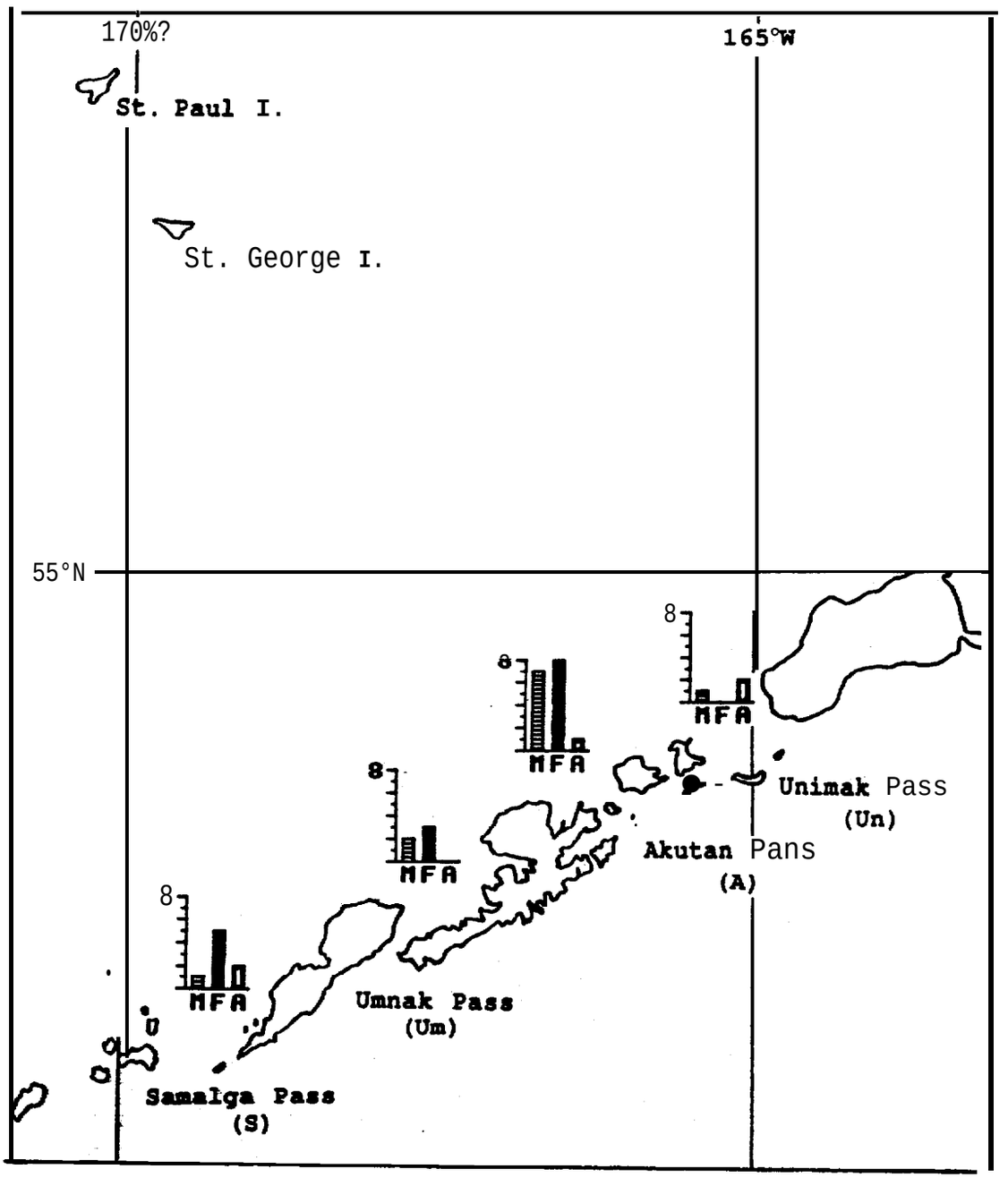

Figure 5. Distribution'of pups (F = females, M = males) and adults (A) located in Unimak Pass, Akutan Pass, Umnak Pass, and Samalga Pass. Two pups were seen at 2 different passes, hence the figure is based on 32 successful relocations.

animals in Figure 6. Successfully tracked animals included 15 female pups, 10 male pups, and 5 adult females. None of the pups from the mother-pup pairs was relocated. On 3 occasions there were concurrent relocations of tagged animals in the same pass, but these animals did not appear to be traveling together as either their departures from St. Paul Island differed by at least *one day, or* they departed from the vicinity of the Aleutian Island stations at different times. One male pup was located at Akutan Pass on 15-17 November and Umnak Pass on 20 November. A second male pup was located three times at Akutan Pass on 22 November, 10 December, and 30-31 December. A female pup was located at Samalga Pass on 24 November and again at Umnak Pass on 13-14 January. Of the five adult females located in the Aleutian passes, two were found at Unimak Pass, one was found at Akutan Pass, and two were found at Samalga Pass.

Mean number of days spent traveling from St. Paul Island to first detection in the vicinity of the Aleutian Island receiver stations in the Aleutian Islands was 10.4 days (± 5.1 days standard deviation, range 4 - 24 days, n = 25) for pups and 7.2 days (± 3.1 days standard deviation, range 4 - 12 days, n = 5) for adult females. The distance from St. Paul Island to Akutan Pass, for example, is about 420 km. To swim this distance in 10.4 days requires a mean speed of about 40.4 km per day, or 1.7 km per hour. The mean length of the data record for animals in the vicinity of the receiver stations was 15.1 hours (range 0.2 - 63.1 hours, n = 29) for pups and 8.3 hours (range 1.5 - 21.6, n = 5) for adult females.

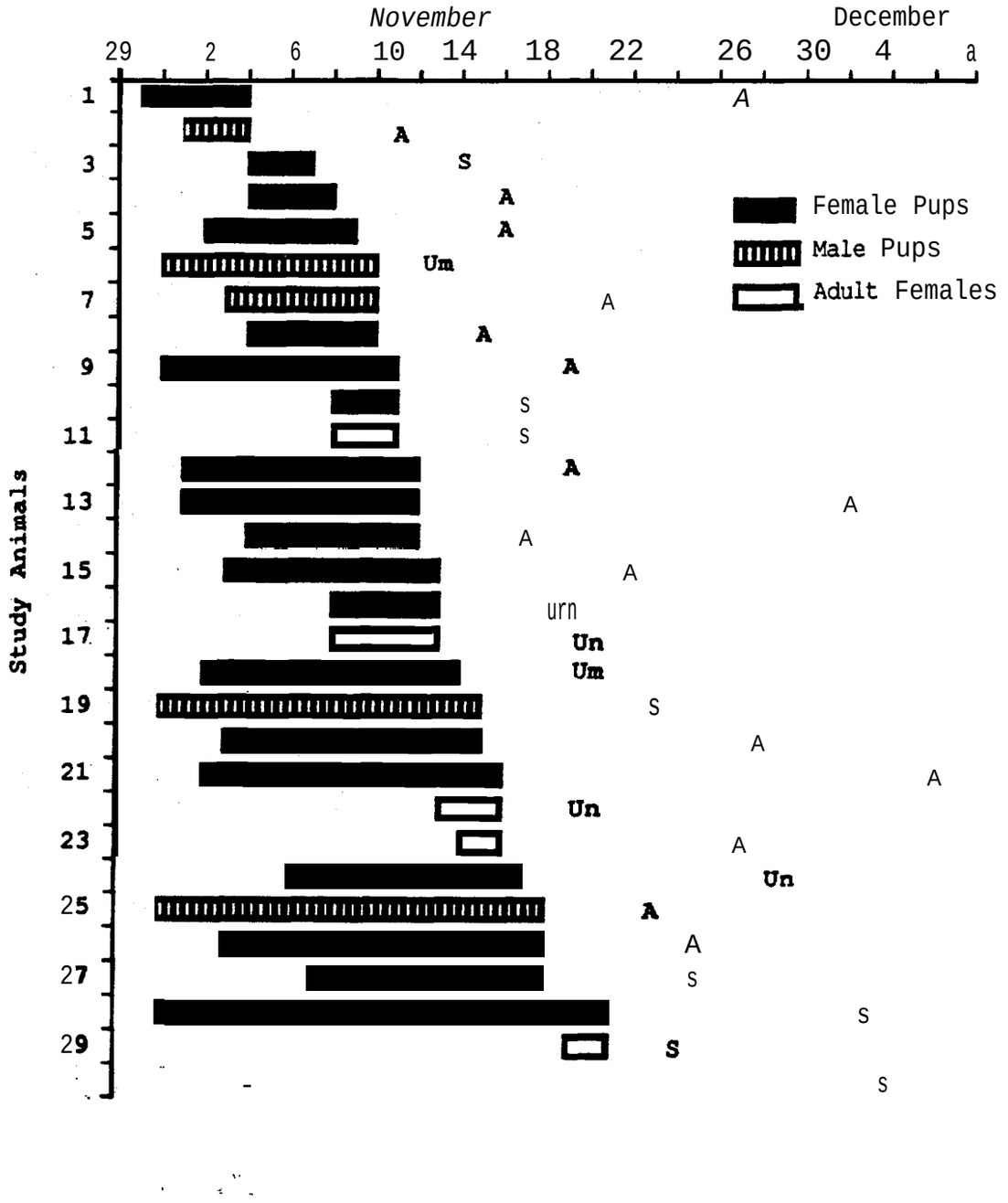

Figure 6. Presence on St. Paul Island of 25 northern fur seal pups and 5 adult females instrumented with radio transmitters, and date of first detection in the Aleutian Islands by receivers at Unimak Pass (Un), Akutan pass (A), Umnak pass (Um), and Samalga pass (S).

DISCUSSION

The distribution of pups at the four Aleutian Island passes that were monitored successfully is not consistent with the commonly assumed migratory route through Unimak Pass (Fig. 5) . Of the 30 relocated animals, only 3 were in Unimak Pass; 2 of those were adult females. In contrast, 27 animals were located at passes farther west, and importantly, 8 of those were as far west as Samalga Pass. Assuming that pups do, in fact, leave the Bering Sea, then failure to relocate the remaining 70 animals could have resulted from mortality prior to arrival at the Aleutian Islands, equipment failure (including failure of the transmitter attachment), or passage of these animals to the west of Samalga Pass (out of range of this westernmost receiver station) ,

It is doubtful that mortality accounts for more than a few animals because large (“healthy”) pups were chosen and the time interval for migration from St. Paul Island to the Aleutian Islands is relatively short. Transmitter failure is possible, but there was no indication of failure while the animals remained on St. Paul Island, even though they were monitored for a period of time as long, on average, as the time required to migrate from St. Paul Island to the Aleutian Islands.

Data storage was a significant problem at two receiver stations. The station located on Ugamak Island in the middle of Unimak Pass was intended to provide primary coverage of the western half of Unimak Pass, as well as corroborate the results of the

station at Scotch Cap on the eastern side of Unimak Pass. Still, had many pups used Unimak Pass, more than one of them should have been detected by the station at Scotch Cap if they were widely distributed within the pass. The significance of information lost at Jackass Point (Akun Strait) is unknown, although this strait is relatively narrow compared to the other passes in the area.

Aside from the possibilities of mortality and equipment failure, the low number of fur seal relocations suggests that a large number of pups left the Bering Sea and entered the North Pacific Ocean to the west of the region covered by our receiver stations. This is consistent with the hypothesis of wider dispersal of pups into the North Pacific, which is also supported by the low number of animals found in Unimak Pass. Although the sample size was small, it should also be noted that only two of the five adult females located in the Aleutian passes were at Unimak Pass, the previously assumed main corridor for adults from the Bering Sea into the North Pacific Ocean.

Because pups were chosen nonrandomly by size, and because many pups probably had already departed when radio tagging began, departure dates from St. Paul Island are not considered representative of departure dates for all pups. If pups must reach a certain physiological state related to weight or age before they begin their migration, larger/older pups may tend to leave the island at an earlier date. In addition, the stress of capture and tagging procedures may have induced pups to leave earlier than normal,

although this is not apparent in the attendance record collected on St. Paul Island. Only one pup left the island on the day she was tagged. The *earlier* departure date for 7 of 10 pups in mother-pup pairs suggests that in most cases pups may wean themselves, which is consistent with Macy (1982), but not with Peterson (1961). Peterson (1961) observed simultaneous departure of mother-pup pairs to be most common, followed by mother-initiated weaning, and finally pup-initiated weaning.

There is no indication that size is related to migratory heading, and we assume direction is representative for this age group. The degree to which oceanographic or meteorological factors influence their migratory path is unknown. Adult female fur seals are known to dive to depths greater than 200 m (Gentry, et al. 1986). If pups dive to half that depth, then it is reasonable to assume that bottom topography of the shallow southwestern Bering Sea (Fig. 7B) may influence migration in this region. Once migrating animals leave the Bering Sea and the margin of the North Pacific Ocean, bathymetry is presumably less significant in guiding migration (Fig. 7A).

These young fur seals are making their first transition to a pelagic existence. Because they are small, and probably not strong swimmers, the currents in the Bering Sea and North Pacific may substantially influence their distribution and migratory paths (Fig. 8). The currents depicted in Figure 8 are, however, estimates of yearly averages. Seasonal variation is likely to be significant, particularly in the region between the Pribilof Islands and the

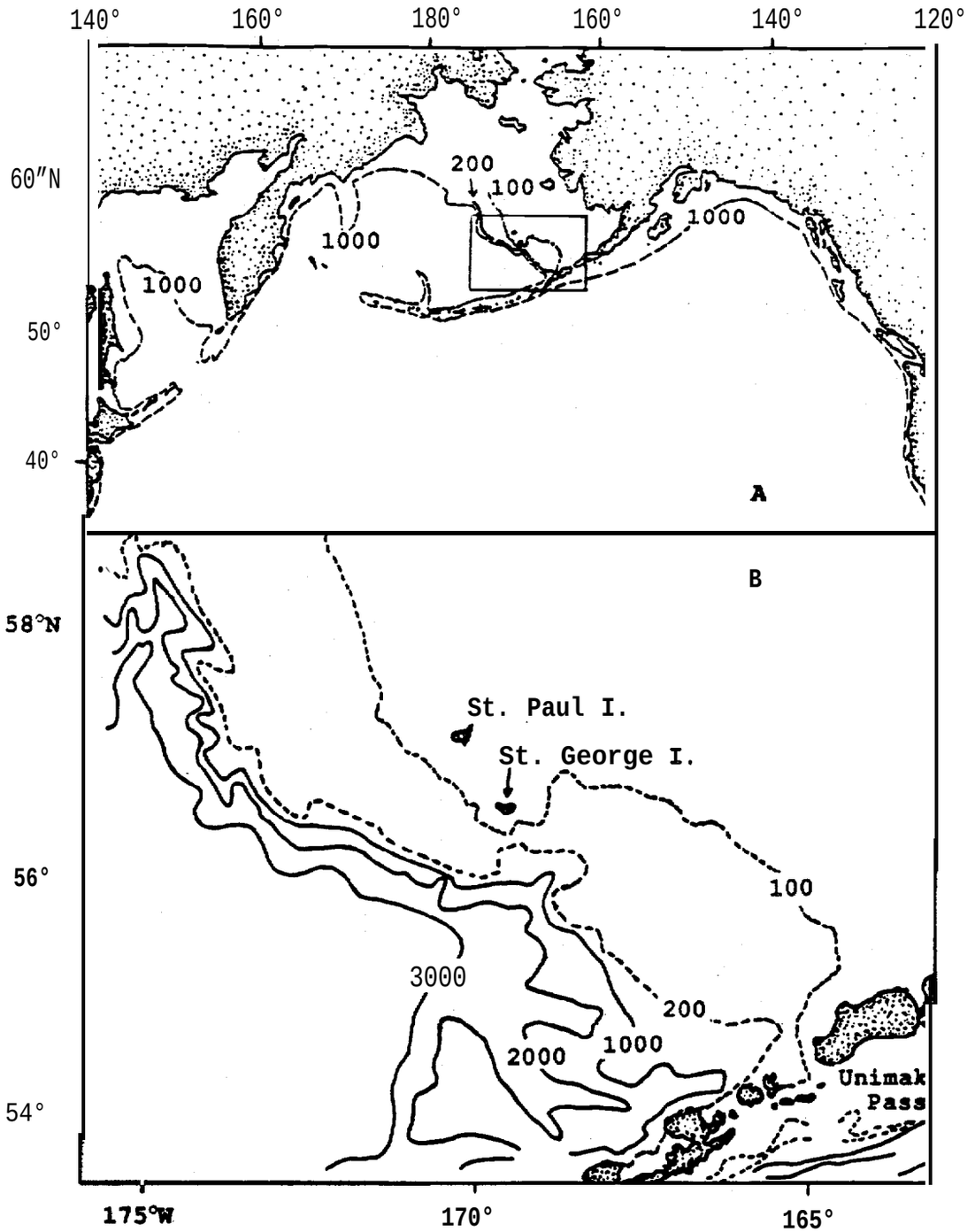

Figure '7. Bathymetry in the North Pacific Ocean (A) and Pribilof Islands - Aleutian Islands region of the Bering Sea (B) to indicate regions sufficiently shallow to be of possible-use to migrating fur seals (from Dodimead, Favorite, and Hirano 1963) . Illustration B is an enlargement of the framed area in illustration A.

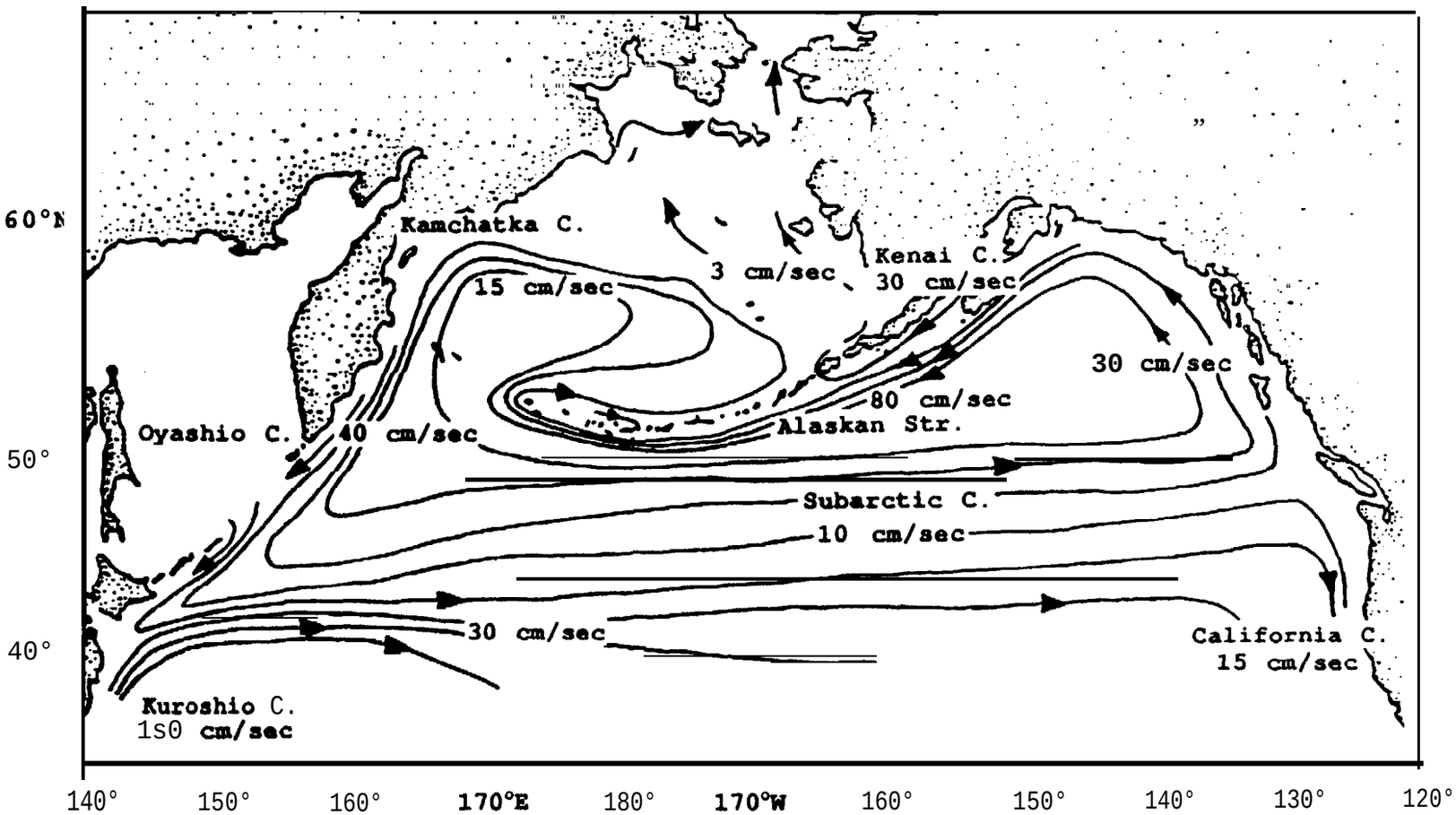

Figure 8. An estimate of average current patterns in the North Pacific Ocean (from Reed and Schumacher 1985) .

Aleutian Islands. On the basis of atmospheric pressure gradients, Ingraham (National Marine Fisheries Service, January 1990, pers. comm.) suggests surface currents in the Pribilof Island region may be changing from primarily eastward (toward the continental shelf) to primarily westward (off the continental shelf) in the autumn. However, the estimated average current flows in this region are not strong relative to the westward-flowing Alaskan Stream, which the seals encounter once they are through the Aleutians. If they maintain a southern heading they leave the Alaskan Stream and enter the slower eastward-flowing Subarctic Current.

Prey distribution may also determine migratory routes. The heavy concentration of fur seals killed by sealers (Fig. 1) near the Bering Sea shelf break suggests this. is the main summer feeding area, which was confirmed by Loughlin, et al. (1987). If prey concentrate in areas where they are available to recently weaned pups, then this food availability may determine the direction of migration. How prey distribution influences migration and distribution in the North Pacific is less obvious. In studies of fur seal feeding and distribution in the western Pacific, Taylor et al. (1955) noted the highest concentrations of fur seals in waters with an abrupt gradient in temperature, such as where the cold Oyashio Current meets the warm Kuroshio Current off northeastern Japan (Fig. 9). They suggested, however, that the distribution and abundance of prey, rather than water temperature, is more significant in determining fur seal distribution in these mixing waters.

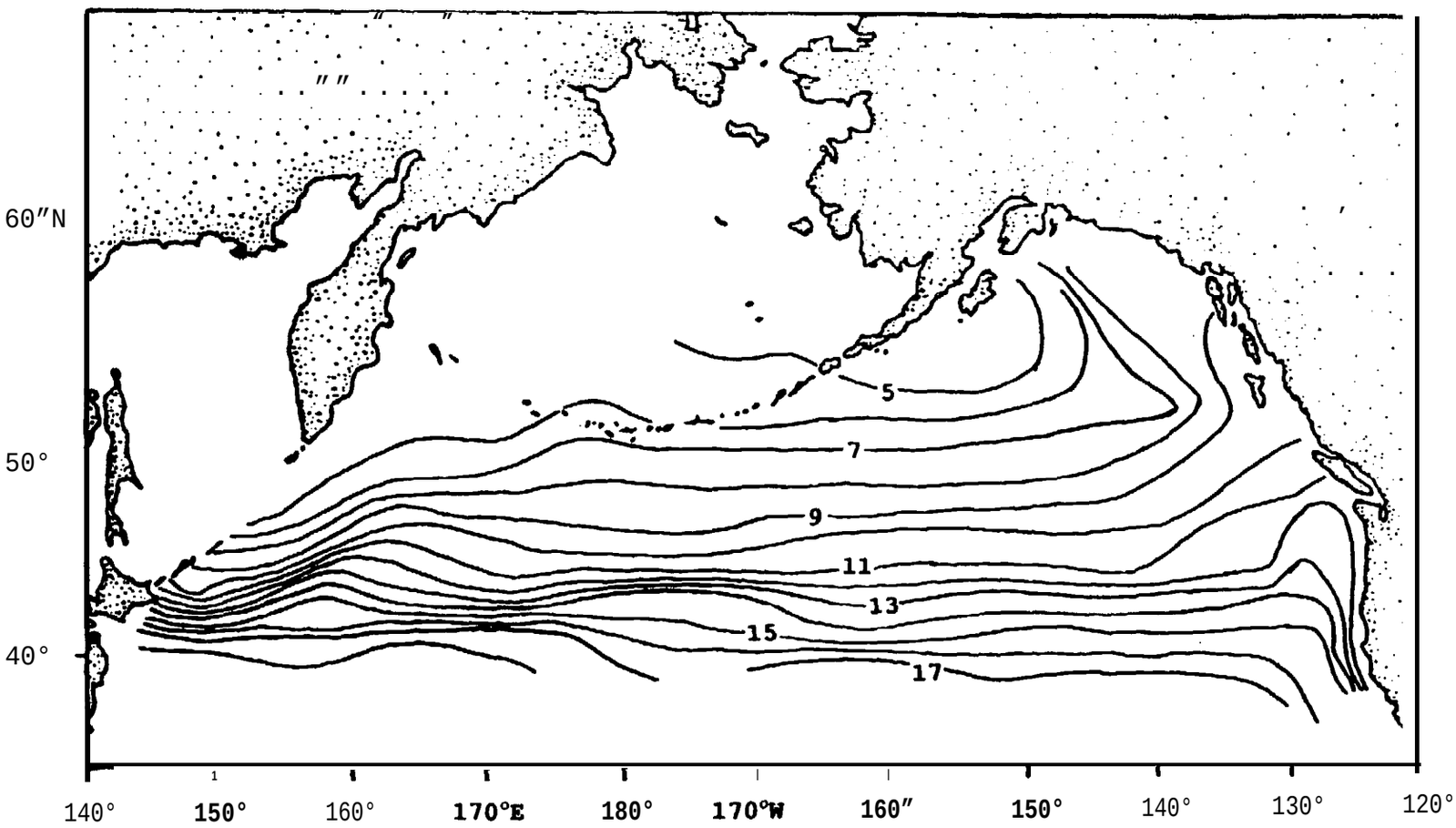

Figure 9. Surface water isotherms in the North Pacific Ocean in November 1956 (from Dodimead, Favorite, and Hirano 1963).

Direction of migration, particularly if strongly affected by prey distribution, should influence the nature of interaction of these pups with human activities. Movement within the Bering Sea may lead to interaction with various fisheries as well as oil and gas exploration and drilling activities. Exploratory drilling has already begun in Norton, Navarin, St. George, and North Aleutian Basins of the Bering Sea (Fig. 10). Unimak Pass is the major traffic lane for vessels leaving *or* entering the Bering Sea to or from the eastern North Pacific, and increased oil and gas activities could dramatically increase vessel traffic and pollution in this region. The results of this study suggest that vessel traffic through Unimak Pass may not be the main source of interaction of migrating pups with oil- and gas-related activities.

Migration patterns beyond the Aleutian Islands and into the North Pacific Ocean determine the potential for interaction of pups with fisheries in the North Pacific. Northern fur seal pup numbers declined severely from the late 1950's into the 1980's, and during that same period, trawl and gill net fisheries in the Bering Sea and North PacificOcean expanded rapidly. The significance of fur seal/fisheries interactions in this decline is uncertain. Development of these fisheries is reviewed extensively in Shomura and Yoshida (1985; see contributions by Uchida; Gong; Low, Nelson, and Narita; Merrel; Fredin; Shims; and Chen). Locations of groundfish, salmon, and squid fisheries are presented in Figures 11-14. Interactions detrimental to northern fur seals are of three types.

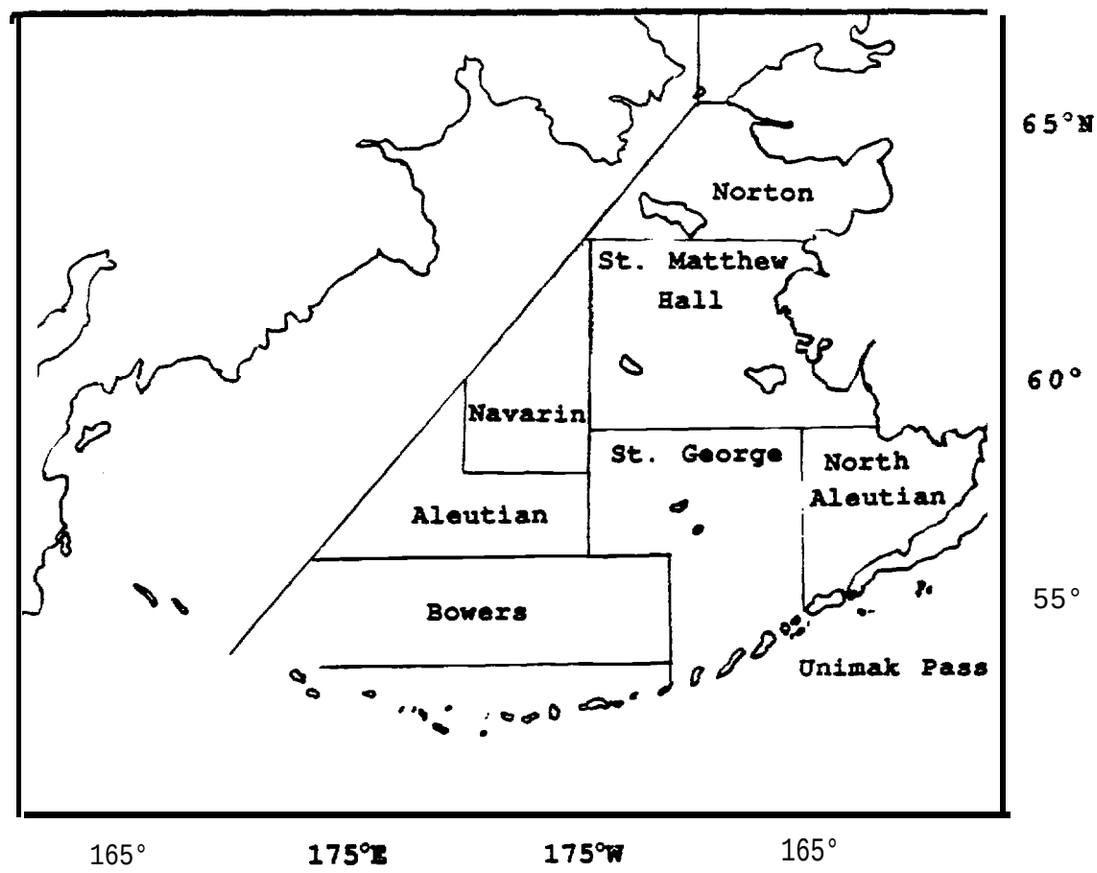

Figure 10. Oil and gas planning areas (Basins) in the Bering Sea (from Houghton, Blaylock, Zeh, and Segar 1987).

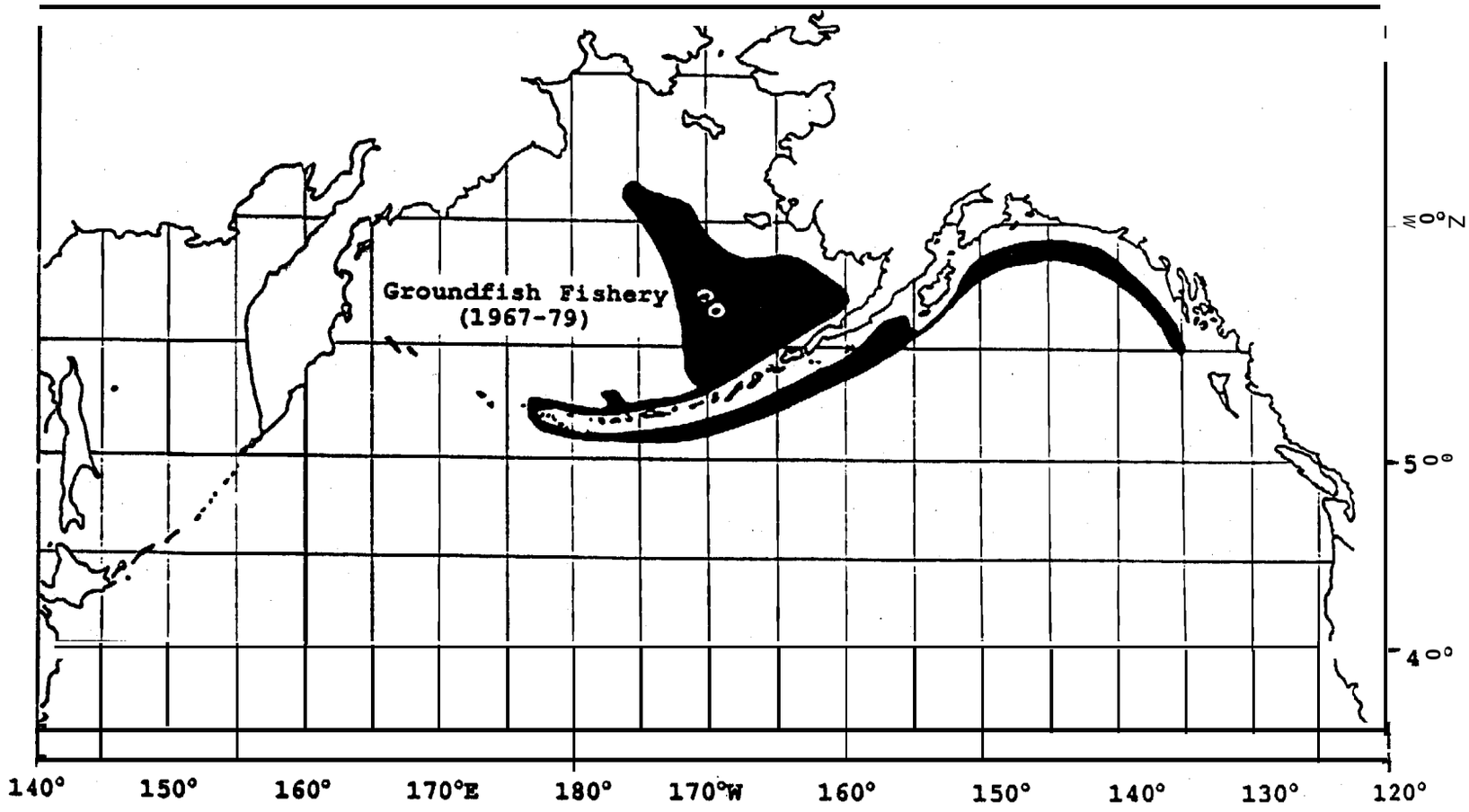

Figure 11. Location of the groundfish fishery in the Bering Sea and Gulf of Alaska, 1967-1979 (from Low, Nelson, and Narita 1985).

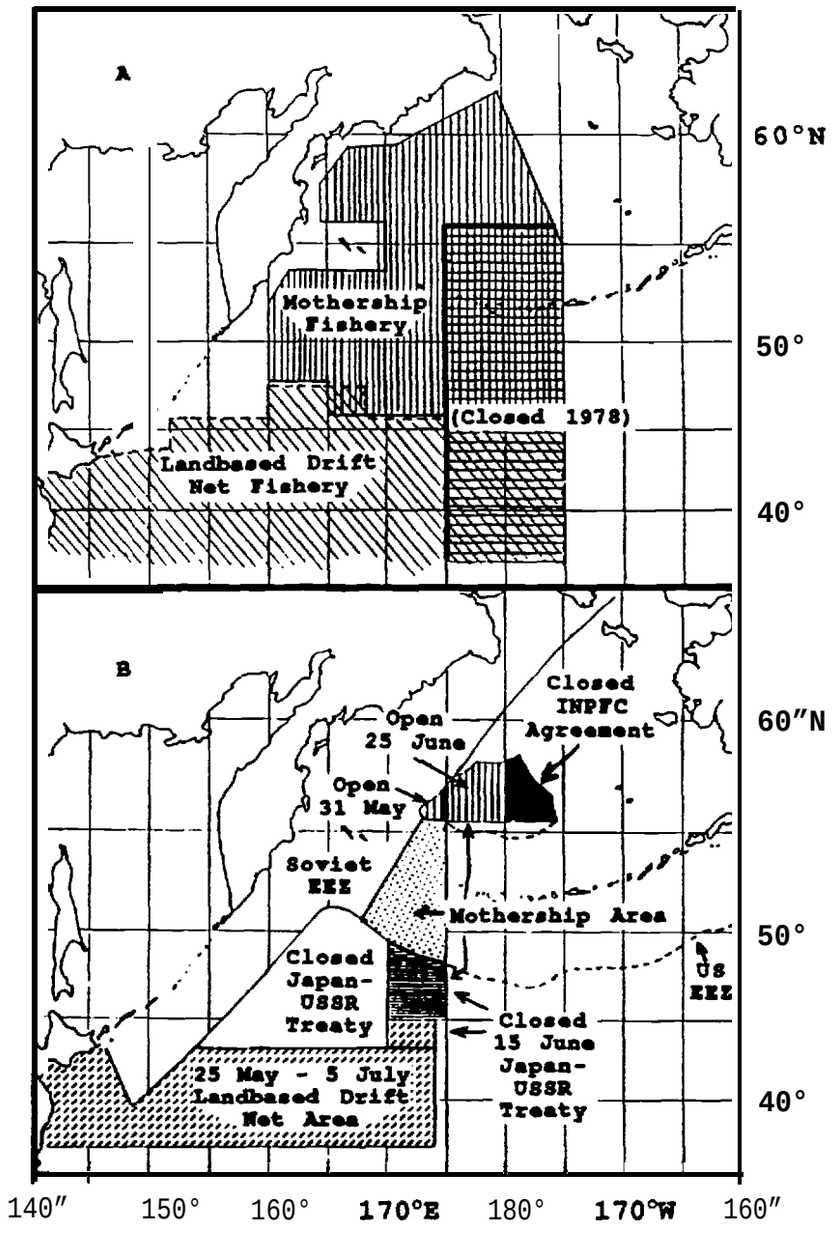

Figure 12. Location of the Japanese mothership and landbased salmon fisheries in the early 1980's (A, modified from Fredin 1985), and currently (B, modified from U.S. Dept. of Commerce 1989). Time-area restrictions including by not limited to those in illustration B were established by the International North Pacific Fisheries Commission Treaty of 1978 (amended 1986) and by bilateral agreement of Japan and the U.S.S.R. in 1988.

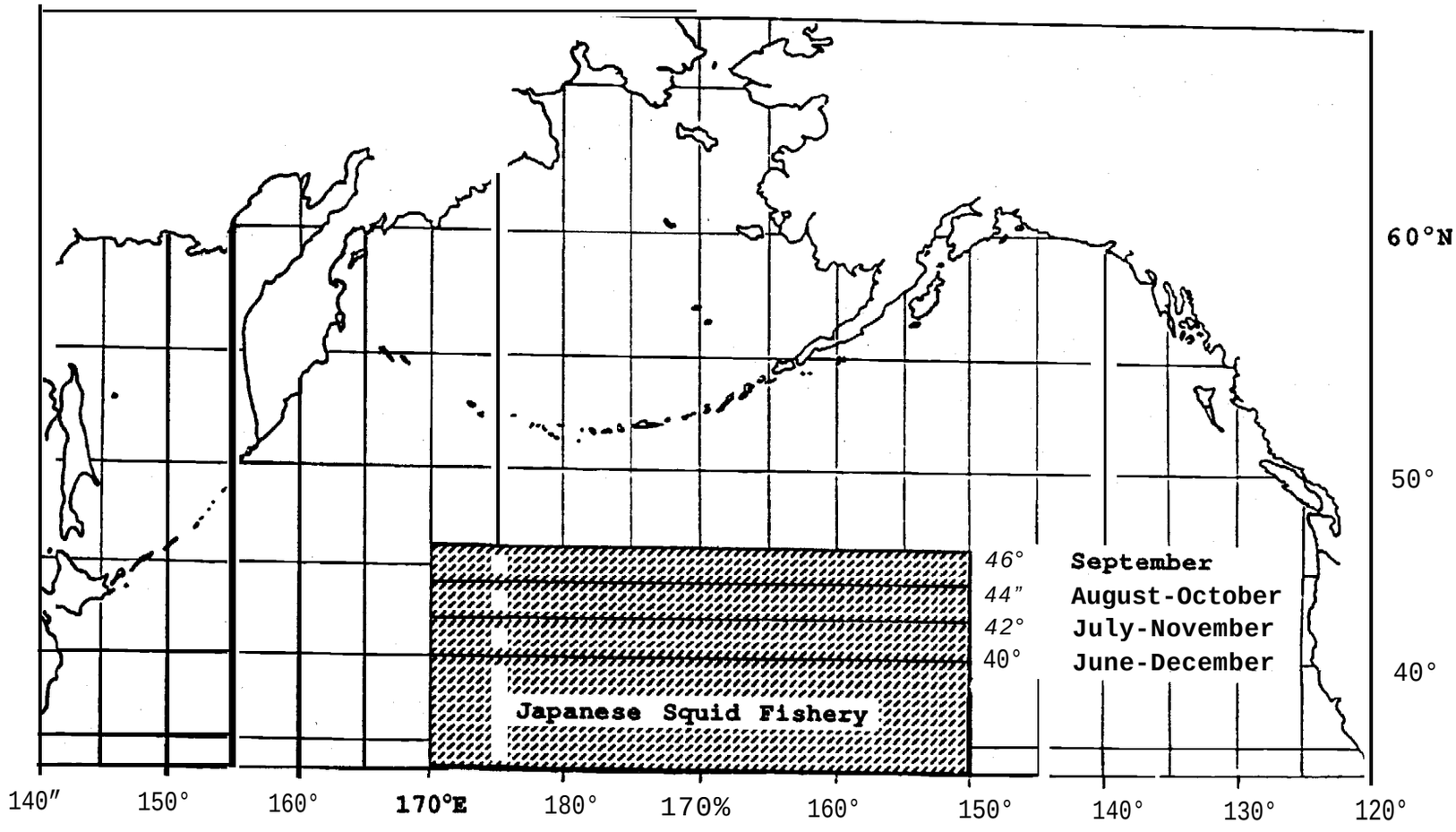

Figure 13. Location of the Japanese drift net squid fishery (modified from Merrell 1985), as established by Japanese regulations in 1981. The northern boundary varies with month in a manner intended to allow the fishery to track the 15° isotherm.

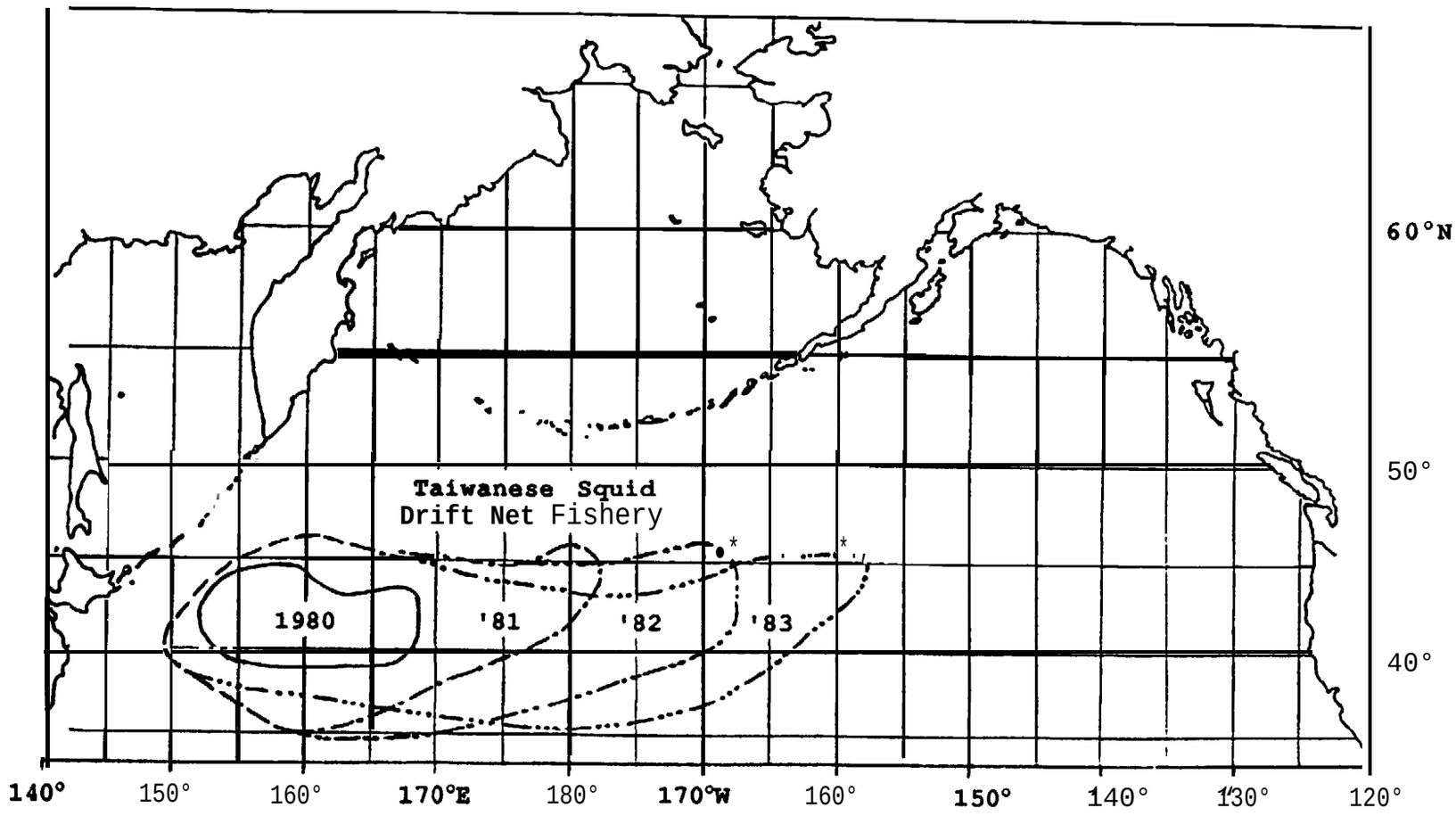

Figure 14. Location of the Taiwanese high seas drift net squid fishery, 1980-83 (from Chen 1985). The corresponding Korean fishery (1979-83) was located in the same general area, but extended further west to the waters offshore of eastern Japan (Gong 1985). In 1985 the Taiwanese established time-area restrictions on drift net squid fishing similar to the regulations of Japan (Fig. 13). The Korean fishery has no time-area restrictions.

Fur seals are killed incidentally in actively fishing gear (Jones *1982),* they are injured or killed by entanglement in marine debris, a large portion of which originates with fisheries (Fowler 1985), and they lose prey to competing fisheries. A current and growing concern is the development and impact of high seas drift net squid fisheries, particularly by Japan, Taiwan, and the Republic of Korea since the late 1970's (Figs. 13 and 14). The nonselective nature of these fisheries is well known; catches include marine birds, turtles, and mammals. Importantly, extensive regions of the North Pacific are being fished, and monitoring has been inadequate to determine effects on target and other species. If the distribution of young fur seals in the North Pacific is similar to adults, they may seldom interact with high seas drift net fisheries. If, on the other hand, these young fur seals widely disperse throughout the North Pacific, then interactions may be substantially greater. Due to the potential increase in mortality from high seas fisheries, it is apparent that more information should be obtained concerning the migration of pups from the Aleutian Island passes into the North Pacific. Such tracking will be constrained by the time and expense required to follow pups far out to sea. However, shore-based tracking stations, a vessel, and a fixed-wing aircraft in the vicinity of the Aleutian Islands should be able to determine the direction of migration of pups as they depart the Aleutian Islands, thus indicating the extent of their dispersal into the North Pacific. A follow-up study

including such monitoring, with increased tracking effort, is planned for the migration of 1990-91.

The telemetry systems for this second study will be modified to provide additional means of verifying telemetry results. The telemetry system used in this first study provides only a single indicator (the transmitter frequency) of the source of a radio signal. This leads to uncertainty in the interpretation of receiver records. In the second study, receivers will also be programmed to evaluate the time interval between signal pulses, thereby providing a secondary means of signal verification. Monitoring individual frequencies and interpulse interval should substantially increase confidence in relocation records.

SUMMARY

The life history and distribution of young northern fur seals at sea are poorly understood. These parameters are, however, critical to our understanding of the natural regulation of northern fur seal populations. Due to the difficulty of studying these animals at sea, the migration of fur seal pups was divided into two stages; the first stage consisting of migration from St. Paul Island to the Aleutian Islands, and the second stage consisting of migration from the Aleutian Islands into the North Pacific Ocean. This investigation began to characterize the first stage of that migration, and demonstrates that it is possible to investigate the

early part of this migration through the use of radio telemetry and land-based receiver stations.

One hundred fur seal pups and adult females were radio-tagged prior to their departure from St. Paul Island. Thirty animals were subsequently located in the eastern Aleutian Islands between Samalga Pass and Unimak Pass 10 days (on average) after their departure from St. Paul Island. A single pup was located in Unimak Pass, and 24 others were located further west, suggesting that 1) Unimak Pass is not the primary migratory corridor for pups from the Bering Sea into the North Pacific Ocean, and 2) pups disperse more widely than assumed to be the case with older northern fur seals. Wide dispersal of fur seal pups into the North Pacific Ocean has significant implications for their early life history, as well as for the nature of interactions with human activities such as North Pacific fisheries and oil and gas exploration and drilling. Clearly, additional study is needed to confirm these results and fully characterize the migration of northern fur seal pups into the North Pacific.

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Timothy J. Ragen
and
Paul K. Dayton