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Canadian Science Advisory Secretariat | **Secrétariat canadien de consultation scientifique**

Research Document 2012/040 | **Document de recherche 2012/040**

Pacific Region | **Région du Pacifique**

Habitat utilization by northern fur seals (*Callorhinus ursinus*) in the Northeastern Pacific Ocean and Canada

Utilisation de l'habitat par les otaries à fourrure (*Callorhinus ursinus*) dans le secteur nord-est de l'océan Pacifique et du Canada

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ISSN 1499-3848 (Printed / Imprimé)
ISSN 1919-5044 (Online / En ligne)

Canada

Correct citation for this publication:

Olesiuk, P.F. 2012. Habitat utilization by northern fur seals (*Callorhinus ursinus*) in the Northeastern Pacific Ocean and Canada. DFO Can. Sci. Advis. Sec. Res. Doc. 2012/040. ii + 27 p.

ABSTRACT

Historic sealing logbooks from 1882-1911, NPFSC research collections and sightings from 1958-1974, the NMML platform of opportunity sighting database from 1957-2007, and published reports on satellite tags deployed since 1991 are used to describe the distribution and migration patterns of northern fur seals in the northeastern Pacific Ocean. GIS analysis identified several important foraging areas used by high densities of fur seals migrating along the west coast of North America. The highest densities occurred on what sealer's referred to as the Vancouver ground on the continental shelf from the Columbia River to La Perouse Bank off southern Vancouver Island. The area is used predominately by adult females during spring as they gain weight prior to making the trip to breeding sites. Stomachs collected in 1958-1974 indicated fur seals in the area were feeding mainly on herring, and La Perouse Bank supports the largest herring stocks on WCNA. The area would be a candidate for designation as critical habitat if northern fur seals are listed under SARA, but further studies are required to assess whether diet and distribution may have changed in recent years.

RÉSUMÉ

Afin de décrire la répartition et les habitudes migratoires des otaries à fourrure dans le nord-est de l'océan Pacifique, on se sert des journaux de bord historiques de la chasse au phoque qui s'est déroulée entre 1882 et 1911, des collections de recherche et des observations de 1958 à 1974 de la Commission du phoque à fourrure / otarie / du Pacifique Nord, de la base de données des observations occasionnelles survenues entre 1957 et 2007 et des rapports publiés sur les étiquettes émettrices fixées aux animaux depuis 1991. L'analyse du SIG a permis de découvrir un certain nombre d'aires d'alimentation où se nourrissent de grands nombres d'otaries à fourrure qui migrent le long de la côte Ouest de l'Amérique du Nord. Les plus grands nombres ont été observés sur ce que les chasseurs de phoques appellent la terre de Vancouver du plateau continental entre le fleuve Columbia et le banc La Perouse, au large de la partie sud de l'île de Vancouver. Dans cette zone on retrouve surtout des femelles adultes au printemps qui prennent du poids en vue de leur déplacement vers les lieux de reproduction. Grâce aux estomacs recueillis entre 1958 et 1974, on s'est rendu compte que les otaries à fourrure se nourrissaient surtout de hareng dont les stocks les plus nombreux de la COAN se trouvent justement sur le banc La Perouse. Cet endroit serait candidat à la désignation comme habitat essentiel si les otaries à fourrure du Nord étaient inscrits en vertu de la LEP, mais il faudra des études plus poussées pour évaluer si l'alimentation et la répartition ont changé ces dernières années.

INTRODUCTION

The northern fur seal (*Callorhinus ursinus*) is the most widely distributed and abundant pinniped in the North Pacific Ocean. The species undertakes a large-scale migration from breeding areas typically situated at high latitudes in the Bering Sea and Sea of Okhotsk, to more southerly feeding areas. Animals segregate by sex and age during the pelagic migration; adult males tend to winter at higher latitudes, adult females tend to congregate in coastal areas or along the front of the transitional domain, and juveniles tend to be widely dispersed on the open ocean and in coastal waters (Bigg 1990; Ream et al. 2005). Fur seals do not breed and normally do not come ashore in Canada, but the waters along the west coast of North America (WCNA), including British Columbia, represent an important wintering area (Bigg 1990; Olesiuk 2008).

Despite its abundance, the Committee on the Status of Endangered Wildlife in Canada (2011) recommended the northern fur seal be listed as threatened due to declines in pup production on the Pribilof Islands, the largest breeding site. As part of the listing process, DFO will undertake an assessment of the socio-economic implications, and consult the public and stakeholders. Listing of northern fur seals under the Species at Risk Act (SARA) would mandate the development of a recovery plan with recovery targets, and designation of any critical habitat in Canadian jurisdiction. This process will require a better understanding of when and where fur seals occur in Canada, and their habitat requirements.

In this report, I compile information on the distribution of fur seals in the northeastern Pacific Ocean based on sealing logbooks from 1882-1911 (Murie 1981), North Pacific Fur Seal Commission (NPFSC) sighting and specimen collection data from 1958-74 (Lander 1980), fur seal sightings recorded in the National Marine Mammal Laboratory's platform-of-opportunity database from 1958-2007 (Mizroch in NMFS 2007; R. Angliss and V. Helker, National Marine Mammal Laboratory, Seattle, pers. comm.), and from published reports on movement patterns of satellite-tagged animals (Loughlin et al. 1993; Ragen et al. 1995; Baba et al. 2000; Robson et al. 2004; Ream et al. 2005). The data were incorporated into a Geographic Information System (GIS) to evaluate the spatial and seasonal patterns of occurrence in Canada. Geo-referenced data collected from biological specimens were also tabulated to evaluate the sex- and age-structure and feeding habits of fur seals migrating through Canadian waters.

METHODS

DATA SOURCES

Four sources of data were used to describe the distribution and habitat of northern fur seals in the northeast Pacific Ocean and particularly within Canadian waters: 1) pelagic sealing logbooks for commercial sealing vessels operating during 1882-1911; 2) North Pacific Fur Seal Commission sighting and specimen data collected during research cruises during 1958-1974; 3) fur seal sightings in National Marine Mammal Laboratory's platform of opportunity database for the North Pacific Ocean collected from 1957-2007; and 4) published satellite telemetry studies.

After the U.S. attempted to prohibit or restrict pelagic sealing in the 1880s, Victoria on Vancouver Island served as the main port for sealing vessels during 1882-1911. The vessels maintained logbooks on their daily position, and number of fur seals taken (Murie 1981). The pelagic sealers were quite familiar with the general movements of fur seals and the higher densities that occurred in coastal areas (Townsend 1899; Murie 1981). Seals were hunted from canoes or skiffs launched from sailing schooners, the position of which was determined using celestial navigation, providing a record of the general location and number of kills. The sealing schooners traveled broadly, usually making either year-long trips across the Pacific, spring trips along the WCNA, or summer trips to the Bering Sea (Murie 1981). Murie (1981) tabulated data from logbooks for the eastern Pacific Ocean, representing kill records for 258,120 seals, of which 14,554 (6%) were taken in Canadian waters. The logbooks provide information on seasonal occurrence and movements along the west coast, but no data on age or pregnancy status, and the information on sex were not deemed to be reliable (Murie 1981). Townsend (1899) also tabulated data from sealing logbooks when the fleet was based in the U.S., but I did not have access to those records.

The second source of information was the pelagic data collected by the North Pacific Fur Seal Commission on research cruises during 1958-74. The research program was conducted under the auspices of the North Pacific Fur Seal Treaty, and was a joint effort between Canada, United States, Soviet Union and Japan. Canada and the U.S. focused pelagic sampling efforts in the northeast Pacific Ocean, while Japan focused pelagic sampling efforts in coastal waters off Japan. The U.S. and Soviet Union also conducted land-based research program on their breeding sites. The pelagic research was focused on collecting biological specimens to assess population biology and fisheries interactions, and fur seals sightings were also recorded. The NPFSC pelagic research program was well-funded under the treaty with proceeds from the harvests. Research vessels made multiple trips each year, spending an average of 83 days per year collecting specimens. A total of 18,449 seals were shot and sampled, of which 2,981 (16%) were taken in Canadian waters. Various measurements were recorded including sex, length, weight, age, reproductive status, stomach contents, and presence of tags. Sampling methods are described in Lander (1980a, 1980b), and the diet data were summarized by Perez and Bigg (1986), Perez and Mooney (1986) and Perez (Perez, M.A. 1996. Northern fur seal (*Callorhinus ursinus*) prey association and diel feeding behaviour determined from stomach contents. Unpublished Report. 70p.).

During the NPFSC research cruises, sightings of fur seals were also recorded (Kajimura 1980; Bigg 1982). The position of research vessels was recorded intermittently, and based on the speed and direction of the vessel a crude estimate of sighting effort can be obtained. However, the data were insufficient for delineating effort on a fine scale, and therefore only useful for assessing abundance in broad regions (e.g. Antonelis and Perez 1984; Olesiuk 2008). The NPFSC data were originally summarized by region (California, Oregon-Washington, British Columbia, eastern Gulf of Alaska, western Gulf of Alaska) and I adopted the same regions with one exception. The NPFSC drew the boundary between Washington and BC at the 49th parallel, such that an important part of the Canadian range that falls on La Perouse Bank had been included the Washington region. I redrew that boundary between British Columbia and Washington to coincide with the international boundary as indicated by the Pacific Fishery Management Area boundaries.

The third source of information was National Marine Mammal Laboratory's platform of opportunity database for marine mammal sightings. NMFS (2007) plotted fur seal sightings for 1958-1997, and I was kindly provided with a copy of the fur seal sightings up to 2007 with dates so I could examine seasonal patterns. The database contained 7,950 high-quality fur seal sightings, but 1,119 sightings by fishery observers were excluded for privacy concerns, leaving 6,831 sightings (R. Angliss and V. Helker, National Marine Mammal Laboratory, Seattle, pers. comm.). The data were collected opportunistically by various vessels, and effort varied widely by season and region. Nevertheless, I consider the data useful for examining large-scale distribution patterns, and these sightings provide the most contemporary data for assessing whether migration patterns have changed since the pelagic sealing and NPFSC research periods.

Finally, I reviewed satellite telemetry tracklines presented in published reports (Loughlin et al. 1993; Ragen et al. 1995; Baba et al. 2000; Ream et al. 2005). Sample sizes are limited, but these data provide very detailed information on movements of individual seals.

GIS ANALYSIS

A GIS database was developed using ArcGIS 10. Sealing records were geo-referenced by the approximate position of the support vessel determined each day using celestial navigation. The latitudes, which required a relative measure of time, were quite accurate, but longitudes, which required the absolute time, were subject to considerable bias. Moreover, the smaller vessels used to hunt seals sometimes ventured considerable distances from the support vessel, so these positions indicated the general vicinity of seal kills. For the NPFSC research cruises, the position at which each seal was collected was recorded to the nearest minute (~1-2 km) using LORAN. Sightings were tabulated and reported in 10' X 10' cells, such that the areas were taller than wide depending on latitude. The area of each cell was calculated depending on its latitude, and sightings expressed in densities per square kilometre plotted at the centre of each cell. Efforts have also been made to quantify sighting effort in hours based on vessel direction and likely speed, but these were not considered useful at a fine scale. Methods used to determine the positions in the platform of opportunity sightings database were not specified, and undoubtedly varied widely among vessels and over the years. I did not have access to the positional data for satellite tracklines, so they were not incorporated into the GIS database.

The analysis began by plotting large-scale maps to determine general distribution and migration patterns. This was intended to provide a context for finer-scale analysis in Canadian waters. Data were plotted by month or season to illustrate temporal changes in distribution. The NPFSC collections, and to a lesser degree the sightings by cell, were considered the most precise data, and I calculated point density kernels to identify areas with high densities of kills and sightings.

The point density kernels in Canadian waters were examined in greater detail to delineate potential critical habitat. I fit contours to the density kernels using XTools 7.1, converted the contours to polygons, and clipped just the portion falling within Canadian waters. I used these clipped polygons to select and examine what proportion of specimens or sightings fell within a particular density contour. To illustrate this process, a density contour that encompassed 75% of the specimens collected in Canada was

selected. The 75% contour polygon was then used to select specimen records and examined the monthly occurrence, sex, age, and diet of animals within the area. The objective was to identify the geographic area most important for fur seals in Canadian waters, and then to explore how seals were utilizing that area so as to develop a better understanding of their habitat requirements.

RESULTS

DISTRIBUTION AND MIGRATION PATTERNS

The sealing fleet appeared to follow the seasonal migration of fur seals, and hunted seals wherever they could find the greatest concentrations (hunting was not permitted within 60 nautical miles of breeding rookeries) (Figure 1). Along the west coast of North America, there was northward shift in harvest areas through the wintering period (Figure 2). Sealing began off California in December, peaked in January-February, and only a few seals were taken after March. Sealing off Oregon and Washington did not begin until February, peaked in March, and only a few seals were taken after April. Sealing off British Columbia began in March, peaked in April, and few taken in May. Off SE Alaska, most seals were taken in April. Few seals were taken in coastal areas in May, suggesting that the seals, or perhaps the sealing fleet, had already started the trek across the open ocean toward breeding sites in the Bering Sea.

There were several areas where sealers took large numbers of animals, which included what was referred to as the Farallon Ground off California, the Vancouver Ground off Washington and southern Vancouver Island, and the Fairweather Ground in the eastern Gulf of Alaska (Figure 1).

The NPFSC research collections and sightings indicated a similar pattern, with most seals collected and sighted along the west coast of North America or in the vicinity of the major breeding site on the Pribilof Islands (Figures 3 and 4). Sightings along WCNA indicated a similar timing of the migration, with seals appearing off California in December-January and peaking in February-March (Figure 5). Seals also appeared off Washington and southern Vancouver Island in December- January, but the peak was somewhat later in April-May. By June-July most of the sightings off WCNA were offshore.

An important caveat in interpreting the both the pelagic sealing and NPFSC research data is that vessels sought out and spent time harvesting or collecting animals. There was thus little effort offshore, but a few excursions by NPFSC vessels indicated that seals occurred, albeit in lower densities, on the high seas.

In contrast, the platform of opportunity data was collected opportunistically, and there was presumably no bias toward observing in areas with high seal densities. However, effort was likely influenced by a variety of factors such as shipping lanes and ports, great circle routes, location of fishing grounds, etc. There were also large seasonal differences in the number of sightings, so these data need to be considered on a seasonal basis (Figure 6). In autumn (563 sightings; September-November), most seals were observed in the vicinity of the Pribilof Islands, and very few along WCNA. However, there were considerable numbers of seals seen on the high seas between 40ºN and 50ºN. Since it would have been too early for breeding animals to have

migrated that far south, these were presumably juvenile and non-breeding animals. In winter (142 sightings; December-February) there were far fewer sightings, presumably due to lower effort and poorer sighting conditions. Most of the sightings were along WCNA, and a few around the Pribilof Islands. In spring (608 sightings; March-May) there were more sightings, mostly along WCNA, and a few scattered offshore or in the Bering sea. During summer (5,518 sightings; June-August) there was a dramatic increase in sightings, presumably due to more vessel traffic and better sighting conditions. The sightings show large concentrations in the vicinity of breeding sites in the Bering Sea and Sea of Okhotsk. There were relatively few sightings along WCNA considering the large number of observations, which supports the notion that adults migrate between breeding sites at higher latitudes and wintering areas in coastal waters. However, there were also many sightings widely scattered across the Pacific Ocean. Since these sightings occurred during the breeding season, they must have been immature or non-breeding animals. In the author's opinion, the platform of opportunity data provide the best indication of the virtually ubiquitous distribution of juvenile and non-breeding fur seals throughout the Pacific Ocean, albeit in densities too low to have attracted sealers or NPFSC researchers.

Sample sizes were small, but the limited number of long-term tracks of female fur seals from the Pribilof Islands supports the notion that many females winter along WCNA (Figure 7) (Ream et al. 2005). However, the data also show that many adult females, typically younger animals (R. Ream, National Marine Mammal Laboratory, Seattle, pers. comm.) also winter on the open ocean near the boundary of the transitional zone (see Ream et al. 2005 for details). To my knowledge, this aspect of the migration was not appreciated by either the sealers or NPFSC researchers.

Point density kernels fitted to the NPFSC sightings (Figure 8) and specimen collections (Figure 9) show several areas of high density. For the most part, these coincided with the main sealing grounds that had been identified by sealers in the 1800s, although it appears the Fairweather Ground may have shifted from the eastern Gulf of Alaska to the western Gulf of Alaska. High densities of seals were also collected and sighted in the vicinity of the Pribilof Islands, and Unimak Pass which is a major migration corridor for animals leaving the Bering Sea (NMFS 2007). However, the highest densities of both sightings and kills occurred on the Vancouver Ground off Washington and southwest Vancouver Island.

HABITAT UTILIZATON IN CANADA

Both the historic sealing records and NPFSC collections and sightings indicate a high concentration of fur seals on the Vancouver Ground off Washington and southwest Vancouver Island (Figures 8 and 9). Since the sealing records only indicated the general vicinity of harvests, and the NPFSC sightings data had been pooled into large cells, I used the NPFSC collections to delineate this core area.

The high density kernel extended from the Columbia River to central Vancouver Island (Figure 10). Although much of the high density kernel falls within U.S. waters, the Canadian portion accounted for a high proportion of the seal specimens collected in Canada. One can delineate an area that encompasses a larger proportion of the specimens collected in Canada by extending the boundaries out to lower densities, or delineate an area that encompasses a smaller proportion of the specimens by restricting the boundaries to higher densities. For illustrative purposes, I arbitrarily selected a

contour that encompassed 75% of the specimens collected in Canadian waters. It accounted for 73% of the NPFSC sightings in Canadian waters, and for 34% of the seals harvested in Canadian waters. The latter figure may have been lower due to the imprecision of positions for sealing vessels, or sealers may have hunted in other, less disturbed areas.

The La Perouse Bank core area measures 28,800 km^2, and in terms of physical characteristics represents the continental shelf from near shore to the shelf break (Figure 11). Both the sealing records and the NPFSC collections and sightings indicate that the La Peruse Bank core area was utilized by fur seals from about December-January to May-June, with peak abundance in March-May (Figure 12). Based on the sex and age of specimens collected in the La Perouse Bank core area, juveniles and males were under-represented and adult females over-represented relative to what would be expected in a population based on life tables (Table 1) (Loughlin et al. 1994; Olesiuk 2008). Females are an important component of the population, as they appear to limit productivity of fur seals (see Olesiuk 2012). Moreover, spring is a critical period for reproductive females. Pregnant females exhibit marked seasonal fluctuations in body mass, gaining weight in spring as they pass through Canadian waters (Trites and Bigg 1996; Figure 13). Thus, energy requirements of seals wintering in Canada are probably high.

Stomach contents collected during 1958-74 indicate that fur seals in the La Perouse Bank core area were feeding predominately on herring (Figure 14), a high-energy forage fish (Perez and Bigg 1986). Other prey consumed in lesser quantities included salmon, sticklebacks, rockfish, squid, sablefish, eulachon, anchovy, shad, and hake.

DISCUSSION

The northern fur seal is the most widely distributed pinniped in the North Pacific Ocean. Indeed, it is almost ubiquitous between roughly 60ºN and 40ºN, encompassing an area of some 45 million km^2.

COSEWIC (2011) suggested the northern fur seal was at risk of extirpation due to a limited index area of occupancy (AOO) while on rookeries (<50 km^2). IUCN (2011) included the AOO in listing criteria for two main reasons. The first was to identify species with restricted spatial distribution, which usually have restricted habitat. Such species are often habitat specialists, which are generally considered to be at greater risk of extinction. Secondly, in many cases, AOO can be a useful proxy for population size, because there is generally a positive correlation between AOO and population size. In the case of fur seals, formation of dense aggregations on rookeries reflects their polygamous mating system, and is a common feature of all fur seals (Gentry and Kooyman 1986; Gentry 1998). The lack of suitable beaches does not currently appear to be limiting pup production on the Pribilof Islands, and productivity is more likely limited by prey resources surrounding the islands. Fur seals are income breeders (Houston et al. 2007) and need to forage adjacent to rookeries as they tend their pups. The home range of lactating fur seals is typically a few hundreds square kilometres (Robson et al. 2004). Moreover, rookeries tend to be widely distributed, both among and within subpopulations. For example, there are about 20 distinct rookeries distributed throughout St. George and St. Paul Islands in the Pribilofs (see Figures 2 and 3 in Testa 2008).

GIS analysis indicated that some of the highest densities of northern fur seals occur on the Vancouver Ground on the continental shelf that extends from the Columbia River to central Vancouver Island. In previous NPFSC reports, the importance of the Canadian portion of this core area was obscured. For convenience, the border between the Washington and British Columbia was taken as the 49th parallel, such that most of La Perouse Bank was included with Washington State.

While critical habitat has not been defined for northern fur seals in Canada, La Perouse Bank would be a prime candidate. Information dating from the sealing era in the late 1800s and pelagic research sightings and collections in 1958-74 indicated the area was important for fur seals migrating along WCNA. Seals using the area were disproportionately adult females, which appear to play a key role in limiting the productivity of northern fur seal populations. Moreover, the females utilize the area at a critical time of year, as they are gaining weight just before the trek to breeding sites at higher latitudes. Herring and other forage fish were the main prey, and La Peoruse Bank is a productive area that supports the largest herring stocks found along WCNA (DFO 2005).

The distribution of foraging fur seals is likely influenced by the distribution of their prey (Baker 1978; Kajimura 1985; Perez and Bigg 1986). It is possible that the diet and distribution of northern fur seals may have changed since the NPFSC collected the stomach samples and made the sightings during 1958-74. For example, sardine stocks along WCNA collapsed during the 1940s, and this prey was not detected in the 18,404 stomachs collected along WCNA during 1958-74 (Perez and Bigg 1986). However, sardine stocks along WCNA have recently made a dramatic recovery in recent decades (Phillips 2000), and this forage fish reappeared in B.C. waters in the early 1990s (McFarlane and MacDougall 2000). One might therefore expect sardines to have become a more important prey species for fur seals in Canadian waters. Clemens and Wilby (1933) found sardines in 6 of 25 (24%) fur seal stomachs collected off southwest Vancouver Island in 1931 (before the stock collapsed), and the prevalence of sardines increased in the diet of fur seals off Japan following the recovery of sardine stocks in Japanese waters in the 1970s (Yoshida et al. 1981; Yoshida and Baba 1983, 1984; Kondo 1980). DeLong and Melin (2000) noted that sardines tend to occur further offshore in pelagic habitats that other forage fish, and there is some indication from recent satellite tracks of adult female fur seals that the core area off southwest Vancouver Island has shifted from the continental shelf to the area along and seaward of the shelf break (J. Sterling, National Marine Mammal Laboratory, Seattle, WA, pers. comm.). Diet data thus need to be updated, and satellite telemetry data warrant more detailed analysis to delineate the habitat currently utilized by northern fur seals in Canadian waters.

ACKNOWLEDGEMENTS

The northern fur seal has been a sorely neglected species in Canada since the North Pacific Fur Seal Treaty and interim agreements lapsed in 1984. I express my gratitude to the late Mike Bigg for organizing the pelagic fur seal database – his efforts many years ago insured it was available for this assessment. Given the lapse in Canadian research, this assessment would not have been possible without the support of numerous colleagues – both past and present – at the National Marine Mammal Laboratory in Seattle, Washington. I express my gratitude to Robyn Angliss, Vladimir Burkanov, Bob DeLong, Chuck Fowler, Tom Gelatt, Van Helker, Tom Loughlin, Mike Perez, Rolf Ream, Jeremy Sterling, Rod Towell, and Ann York for graciously sharing ideas and insight, providing access to preliminary pup counts, compiling and sharing satellite telemetry and platform-of-opportunity data, and/or for serving as expert reviewers. Clearly the spirit of international cooperation persists despite the lapse of the fur seal treaty. I am also grateful to Debra Murie for her effort in compiling the sealing logbook data, and allowing me to use it; Gordon Miller and George Pattern for helping to track down literature; Tom Brown, Chris Wood and Sheila Thornton for providing background information on the SARA process and listing criteria; and members of the National Marine Mammal Peer Review Committee for their constructive comments on earlier drafts of the report.

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Table 1. *Relative proportion of NPFSC specimens collected in the La Perouse Bank core area during 1958-74 by sex- and age-group compared to the sex-m and age-composition expected in a population based on life tables (Loughlin et al. 1994).*

Sex- and Age-Group	La Perouse Bank		Life Table
	N	%	
Juveniles	1,951	41%	56%
Males Age 6+ Years	19	0.3%	7%
Females Age 4+ Years	2,828	59%	37%
Total	4,798	100%	100%

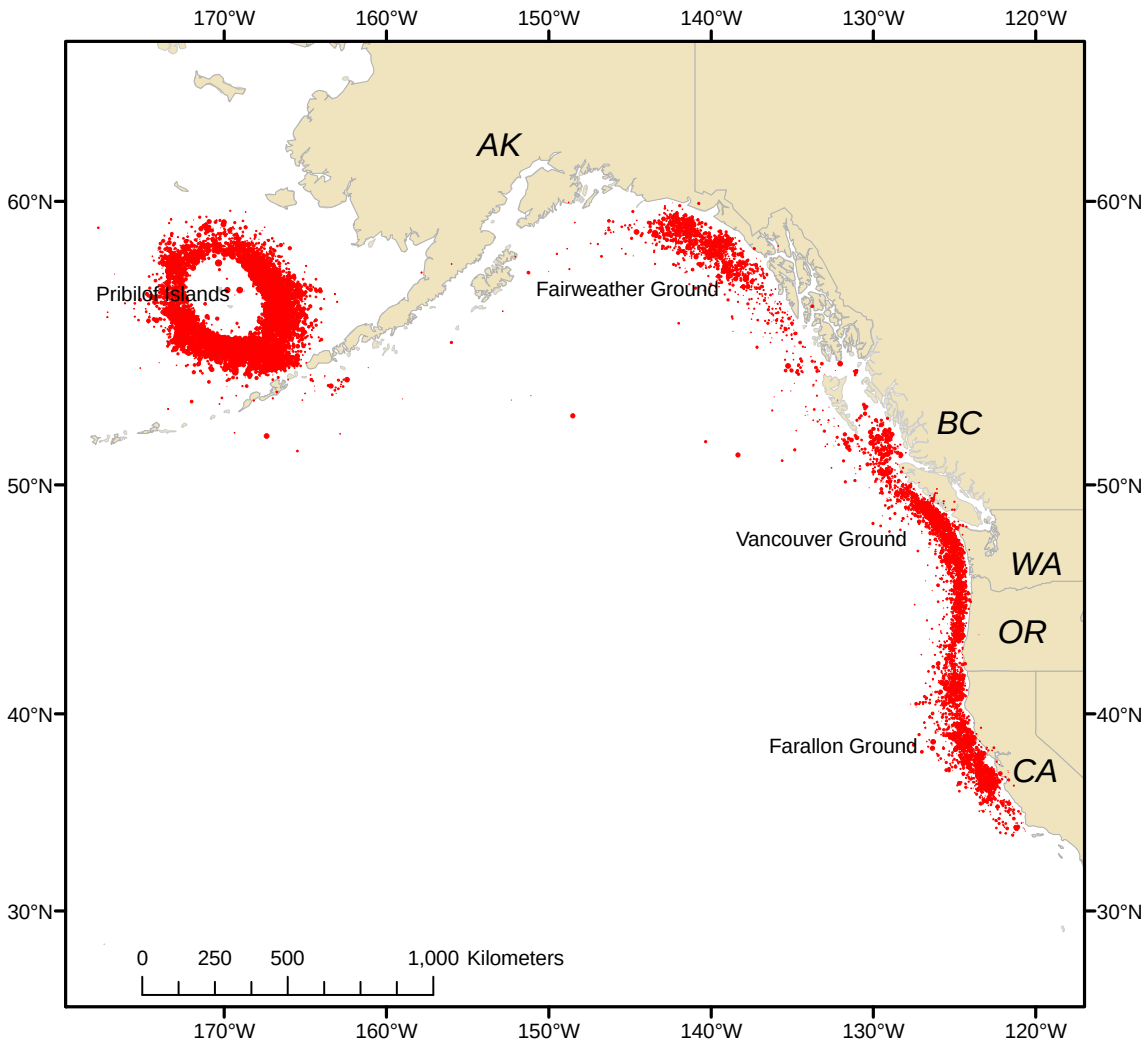


***Figure 1**. Overview map showing the distribution of fur seals harvests (n=258,120 seals) during pelagic sealing from 1891-1911, with the main hunting areas also noted (data from Murie 1981).*

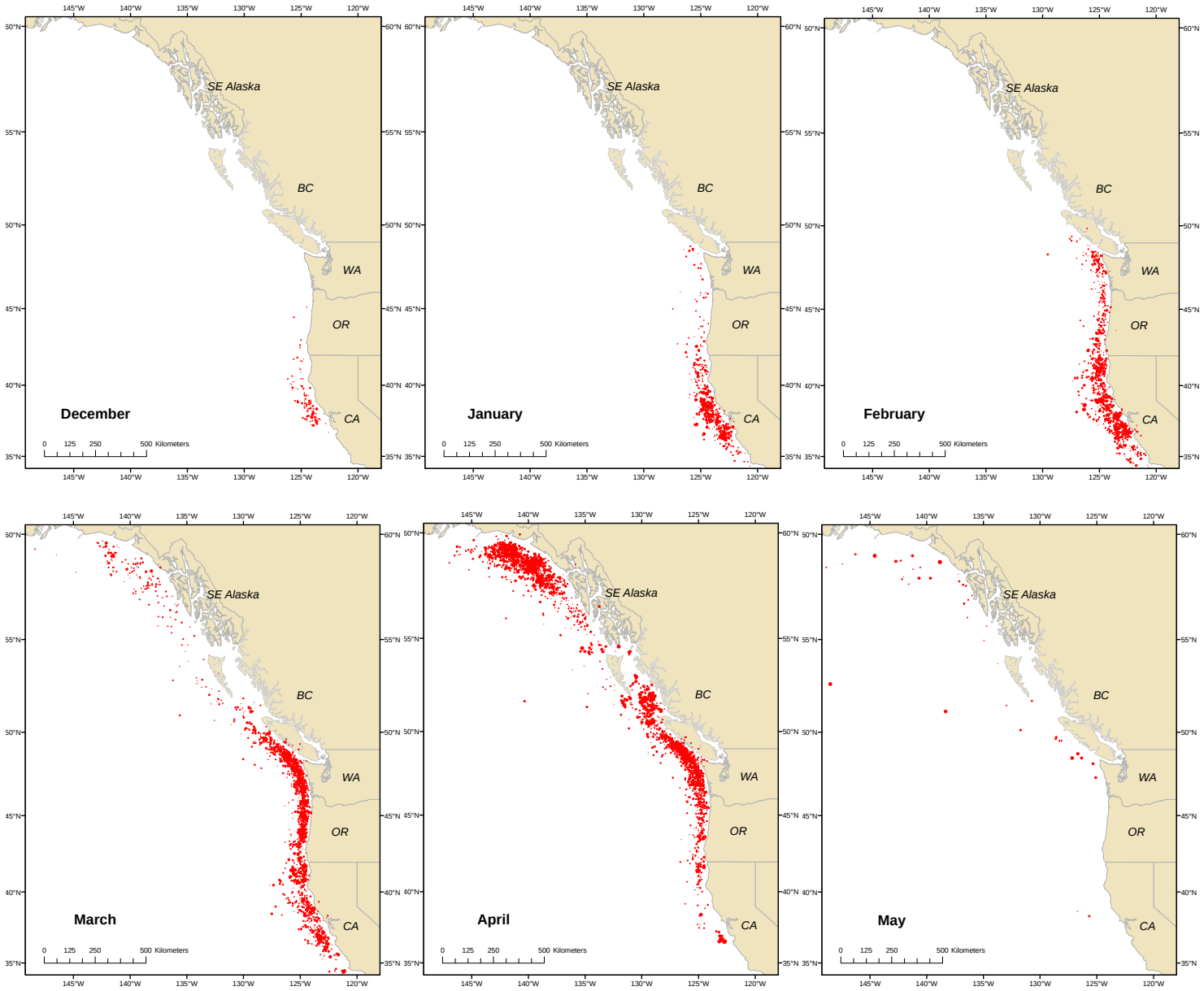


***Figure 2**. Seasonal shift in distribution of pelagic sealing kills during 1891-1911 (data from Murie 1981).*

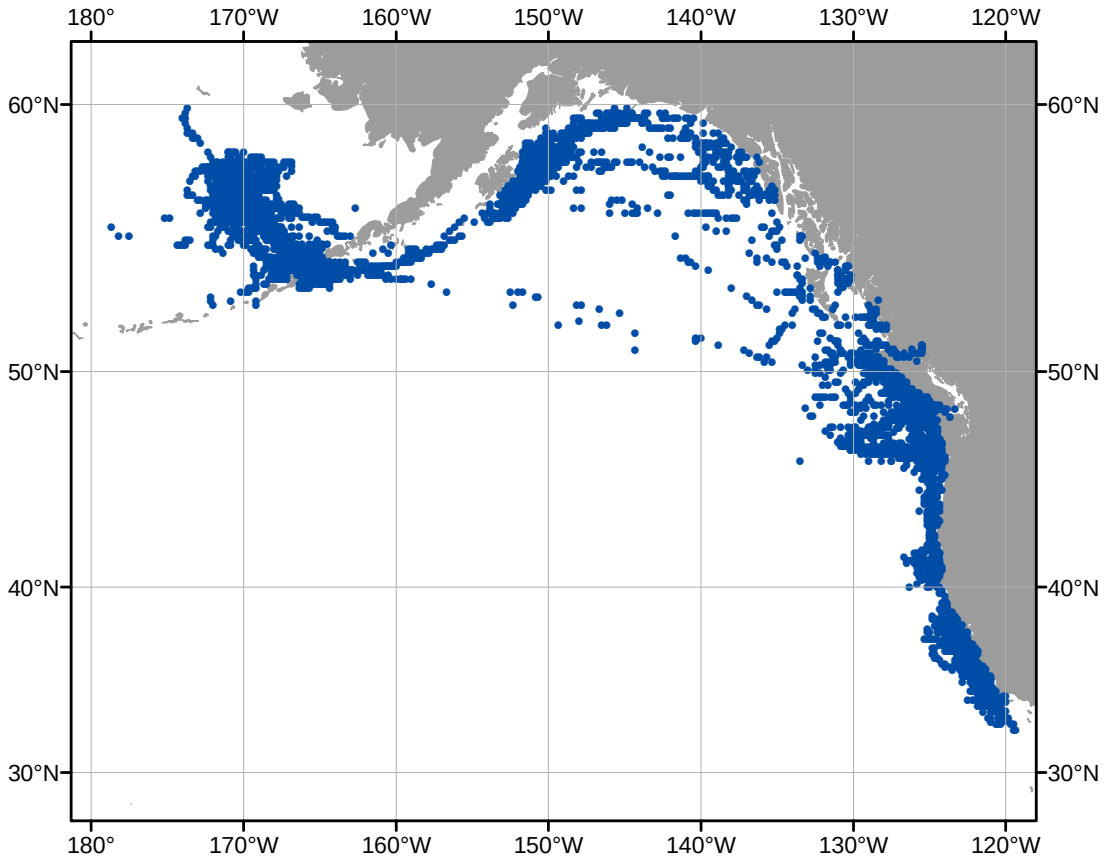


Figure 3. *Distribution of fur seal sightings on NPFSC research cruises during 1958-74.*

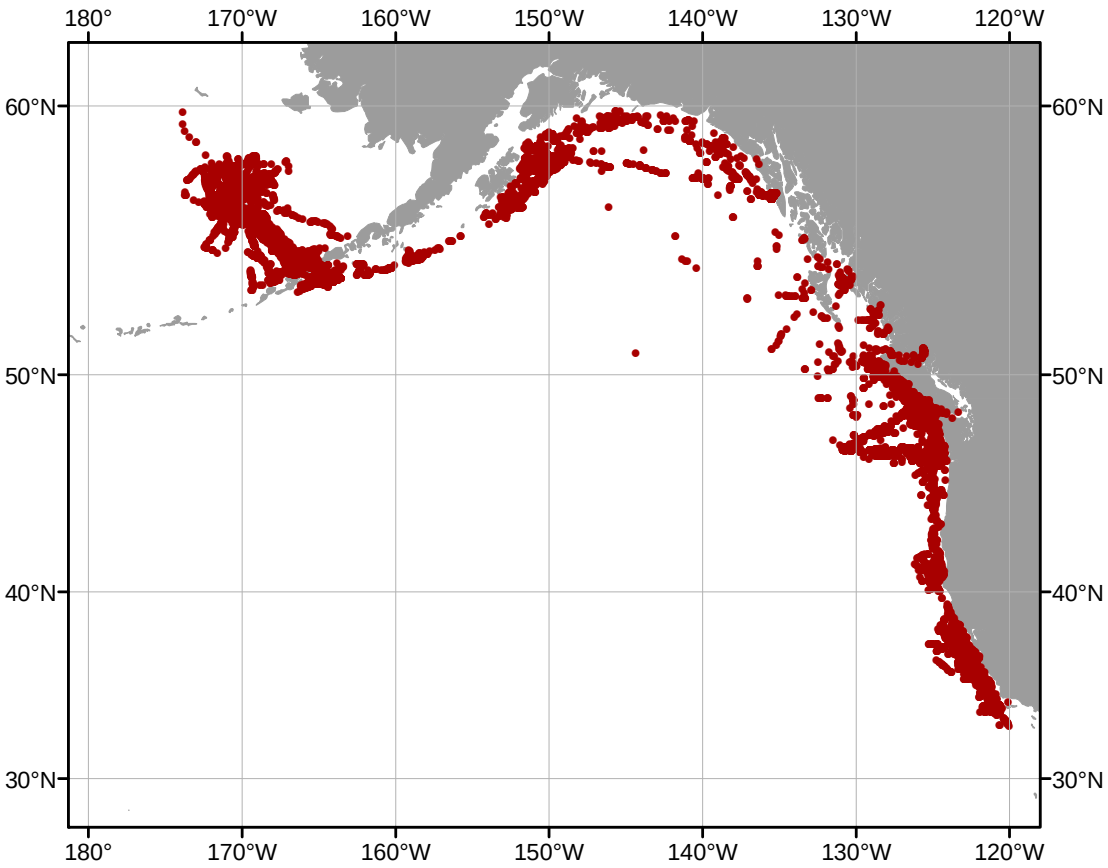


Figure 4. *Distribution of fur seal specimen collections on NPFSC research cruises during 1958-74.*

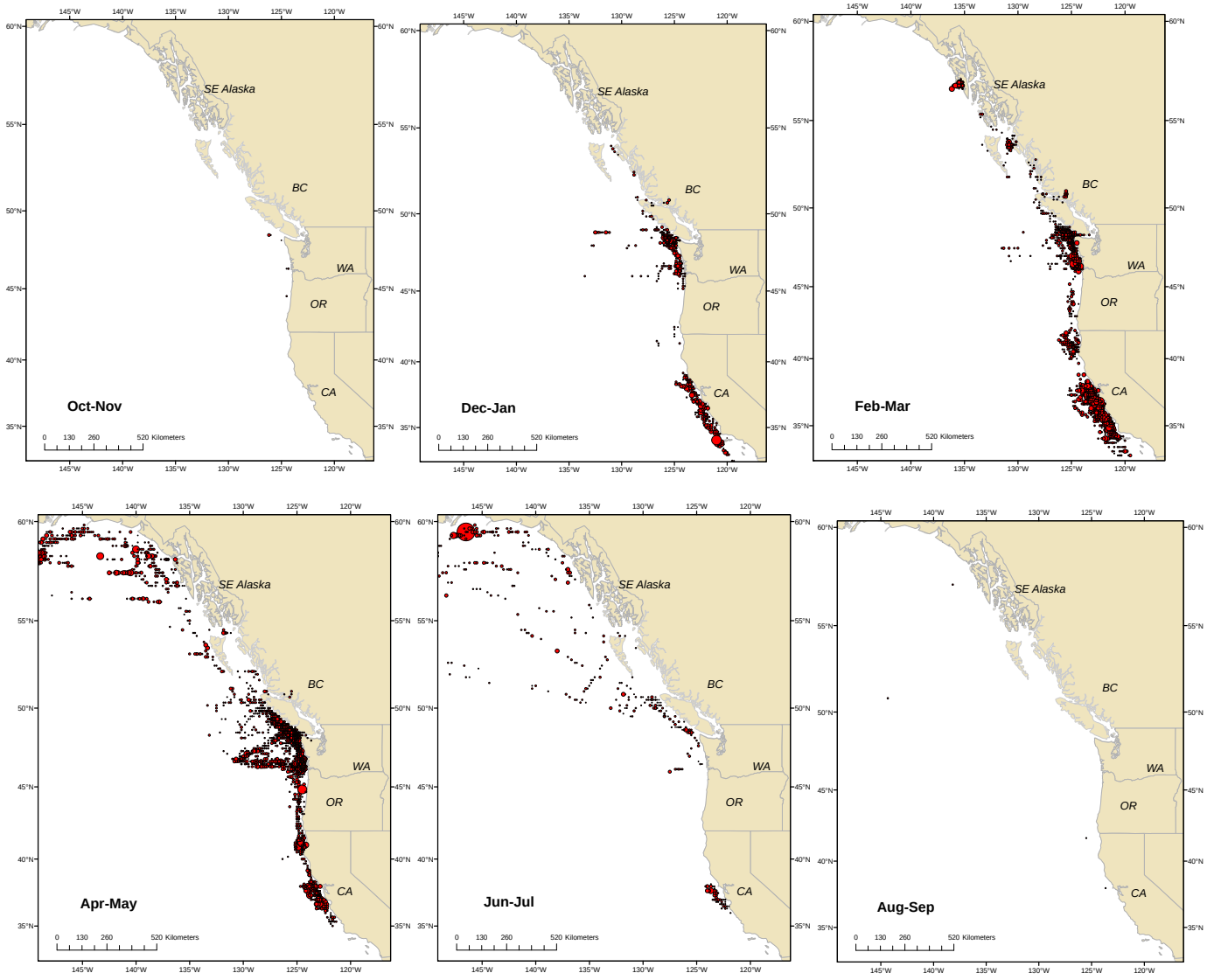


***Figure 5**. Maps showing seasonal shift in relative distribution of fur seal sightings during pelagic research trips from 1958-1974.*

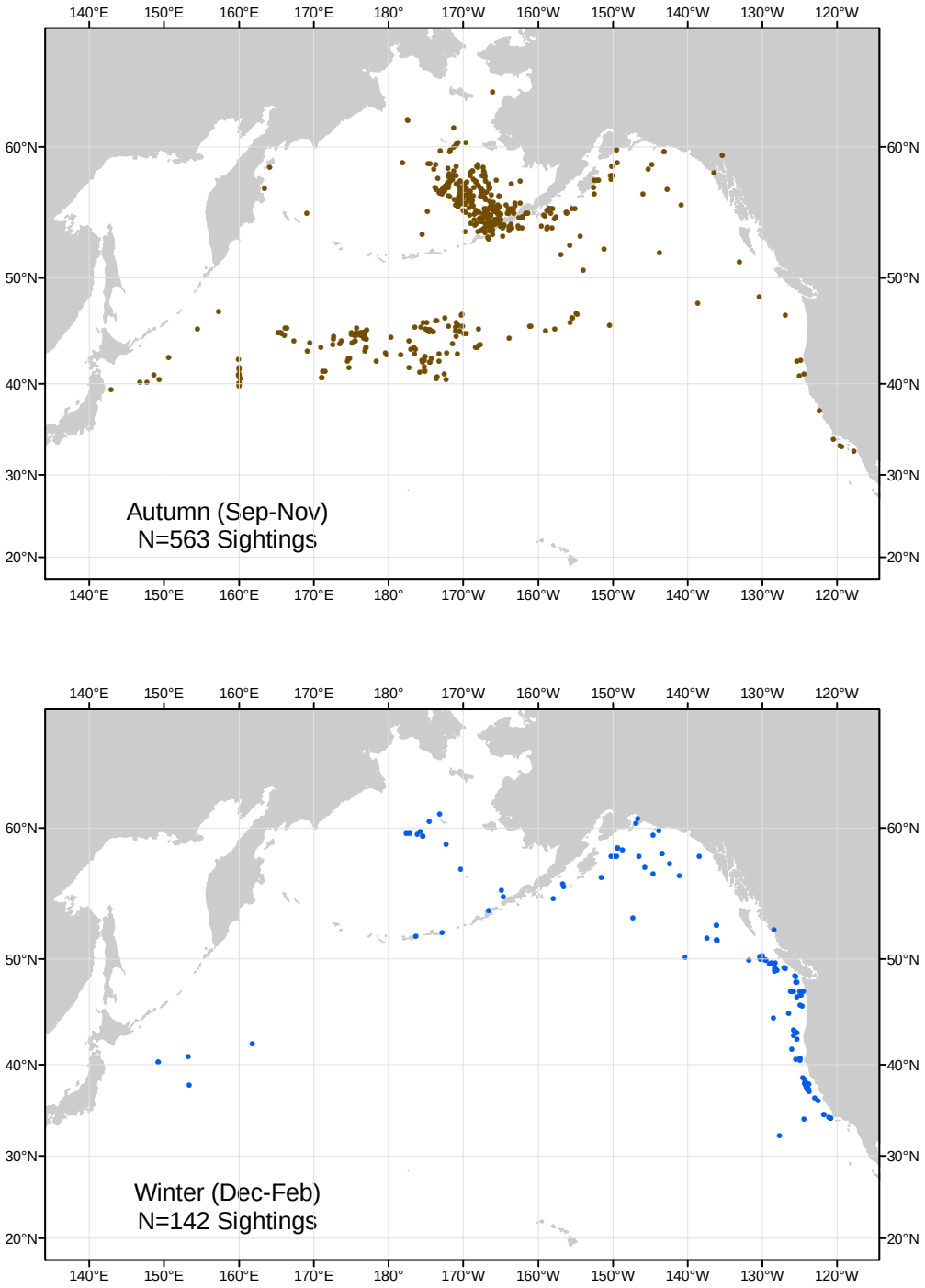
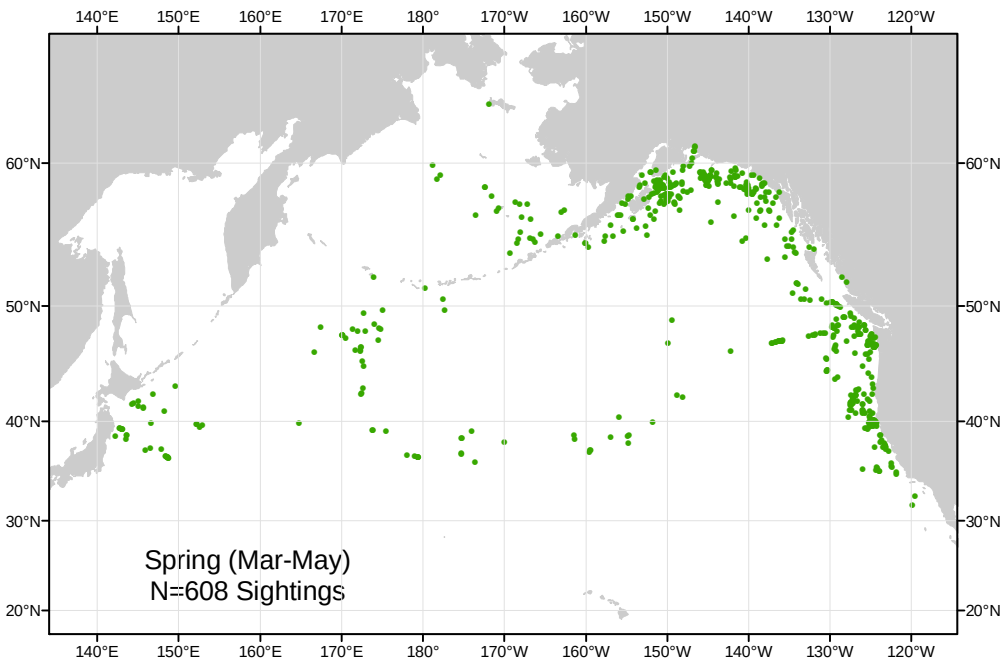


Figure 6. *High quality fur seal sightings by season from National Marine Mammal Laboratory's platform of opportunity database for 1958-2007 by season (after NMFS 2007; R. Angliss and V. Helker, National Marine Mammal Laboratory, Seattle, pers. comm..).*



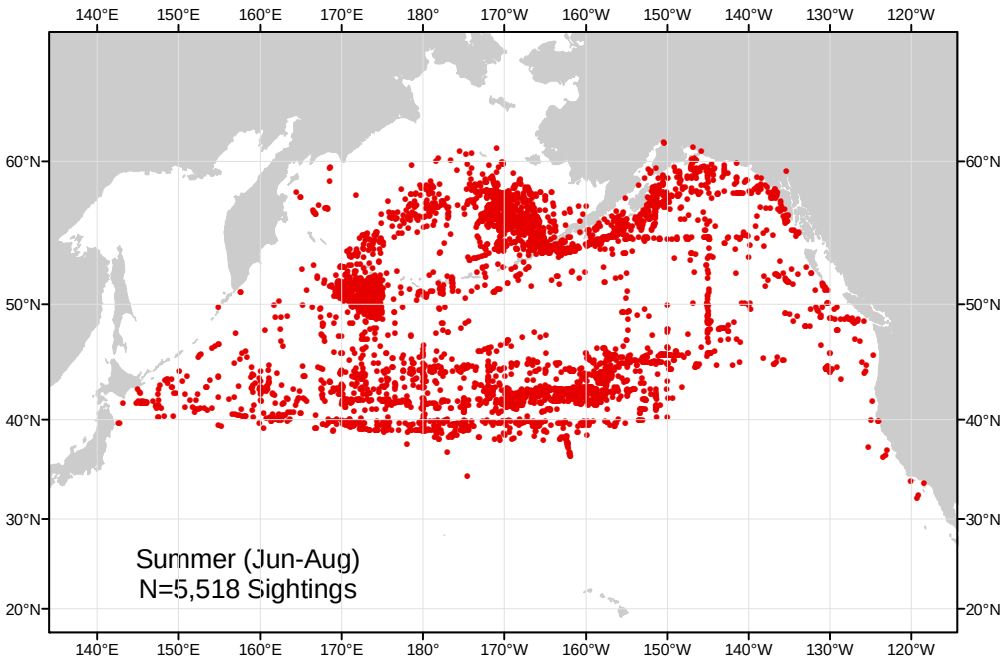


Figure 6. *(continued).*

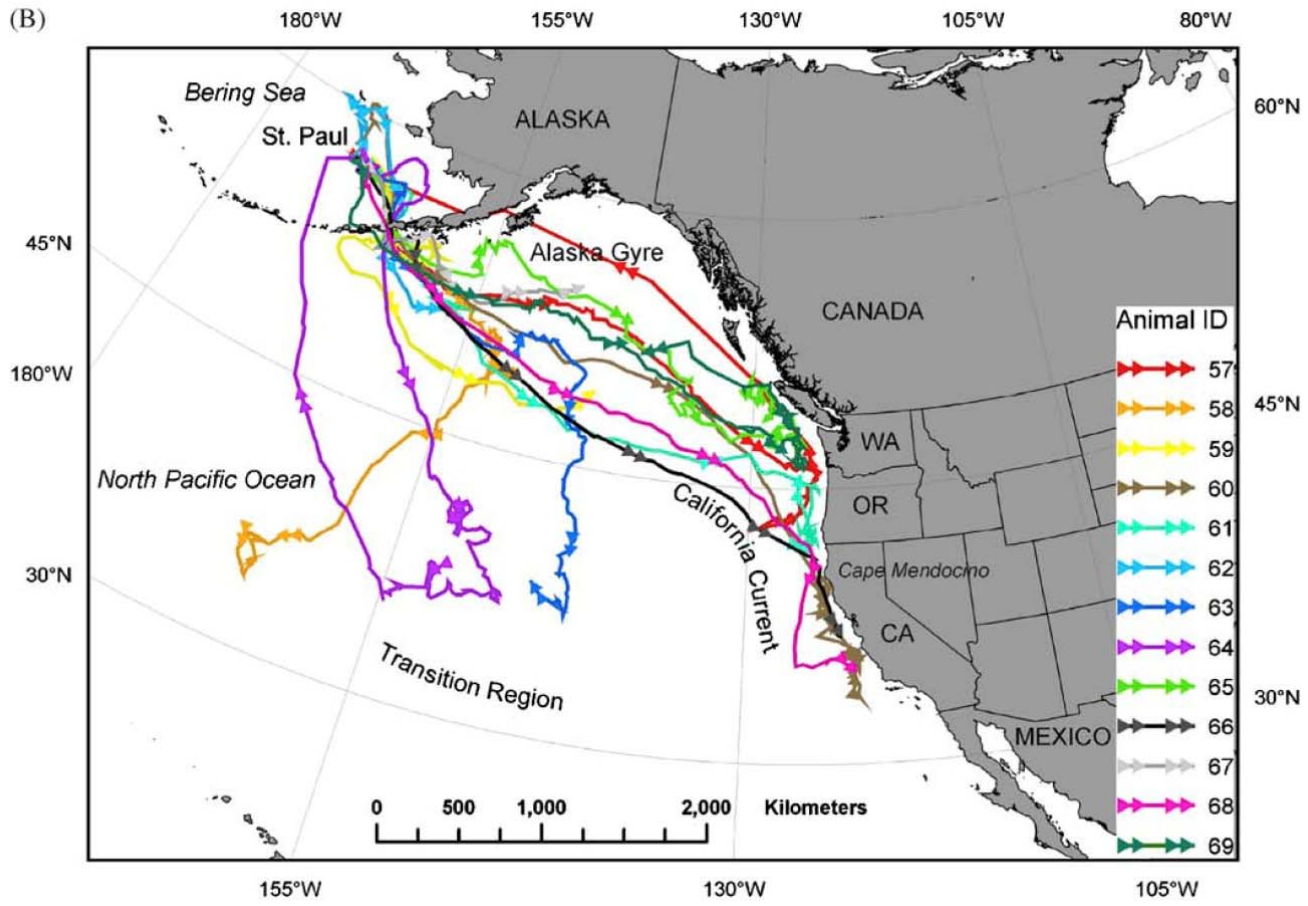


Figure 7. *Satellite tracks for a sample of adult female fur seals tagged on the Pribilof Islands (from Ream et al. 2005).*

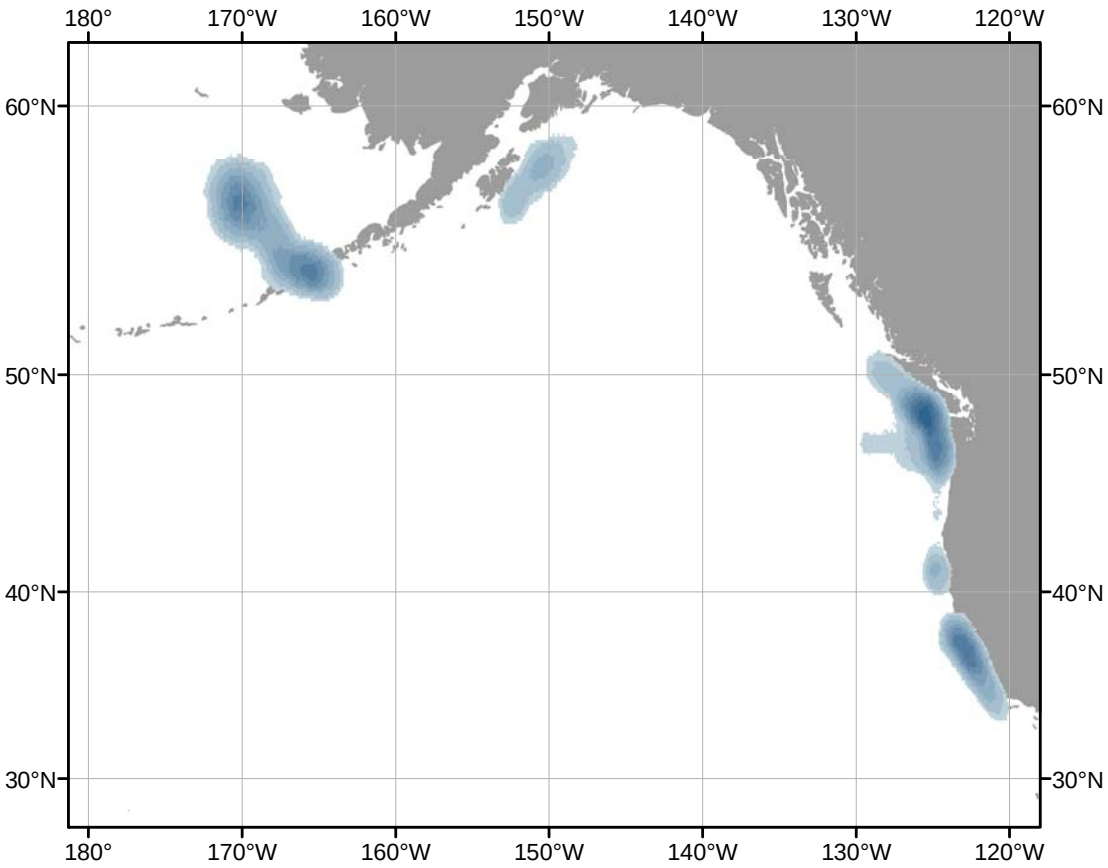


***Figure 8**. Point kernel densities for fur seal sightings on NPFSC research cruises during 1958-74.*

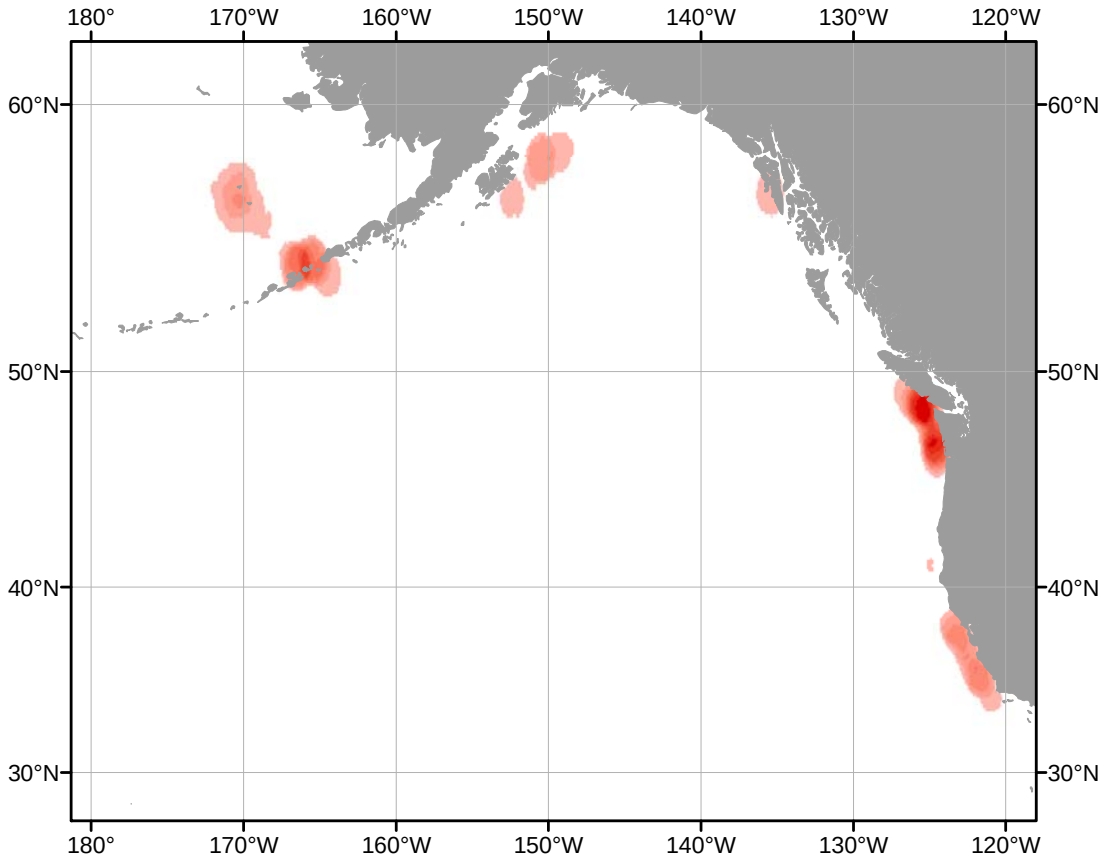


***Figure 9**. Point kernel densities for fur seal specimen collections on NPFSC research cruises during 1958-74.*

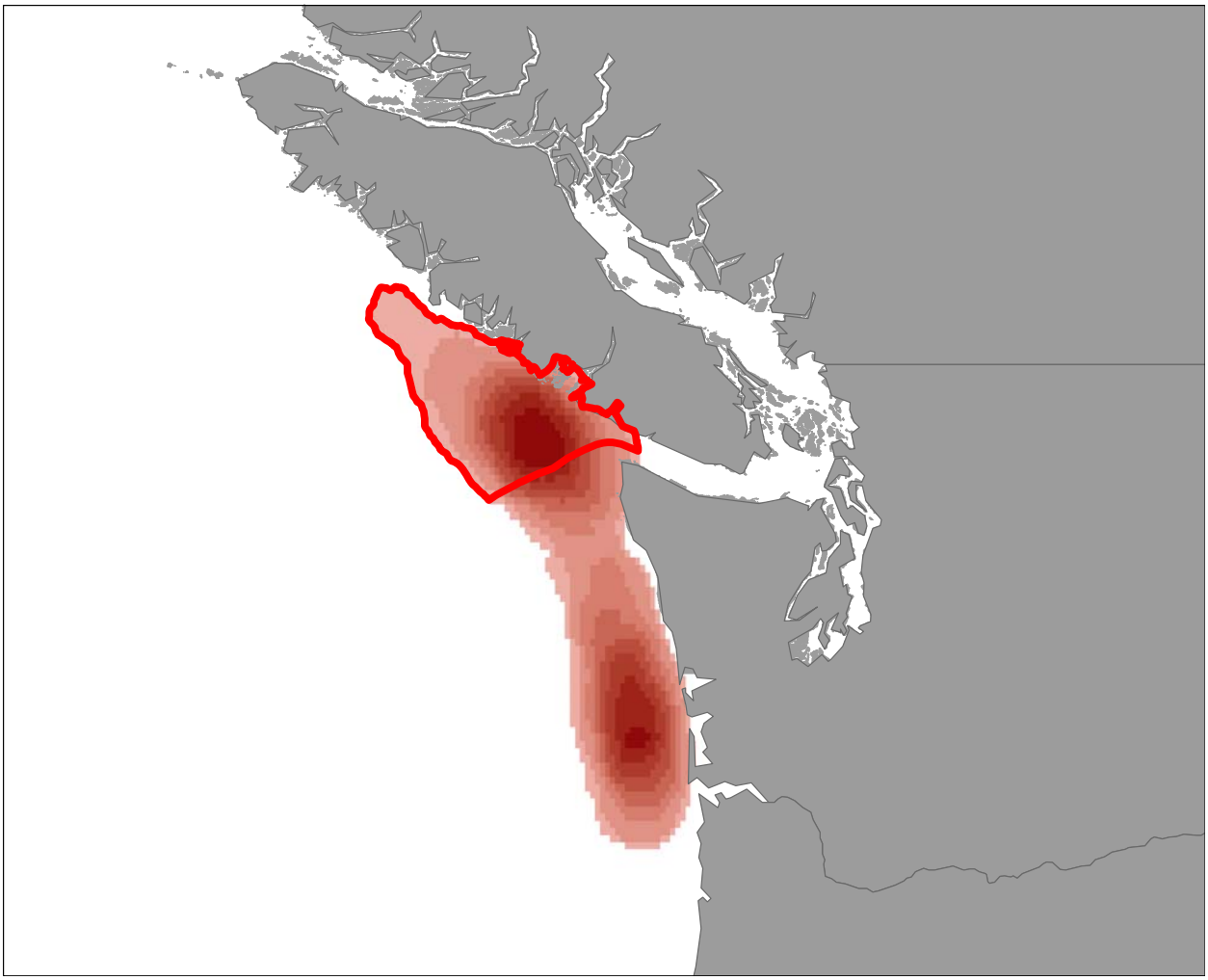


Figure 10. *Point density kernel of sightings showing the high concentration off on the Vancouver ground that extends from the Columbia River to southern Vancouver Island. The red polygon shows the density contour that contains 75% of specimens collected in Canadian waters.*

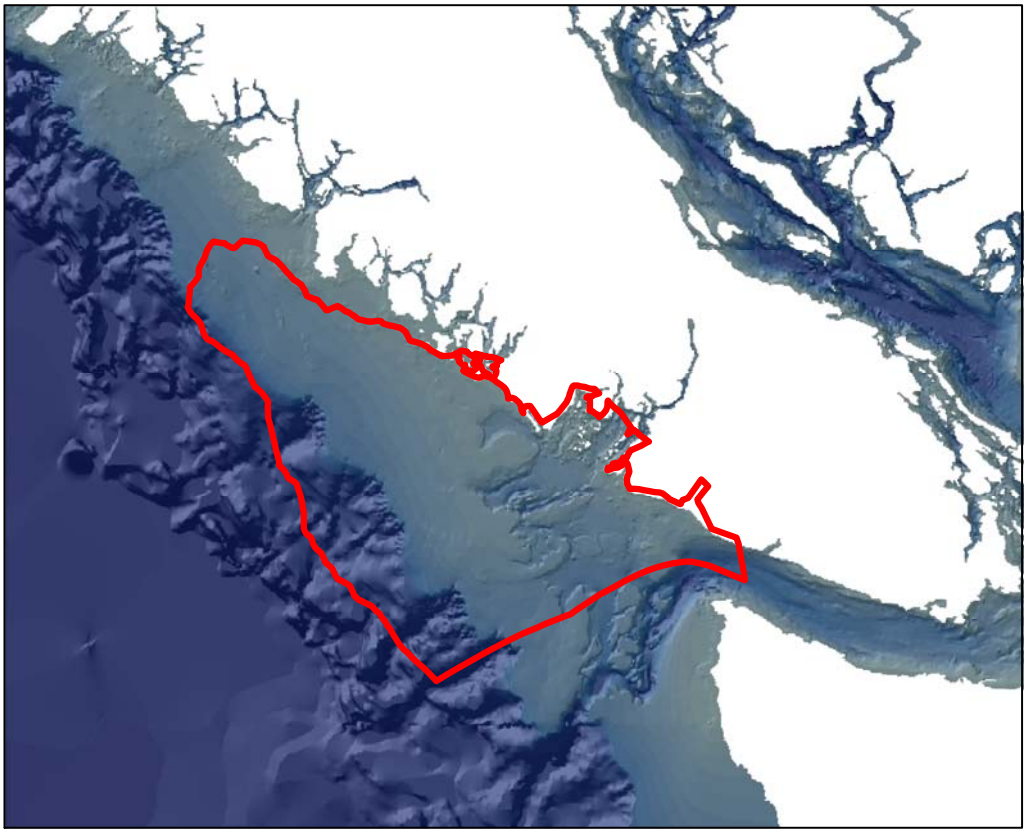


Figure 11. *Bathymetry of the La Perouse Bank core area showing its extent over the continental shelf to the shelf break.*

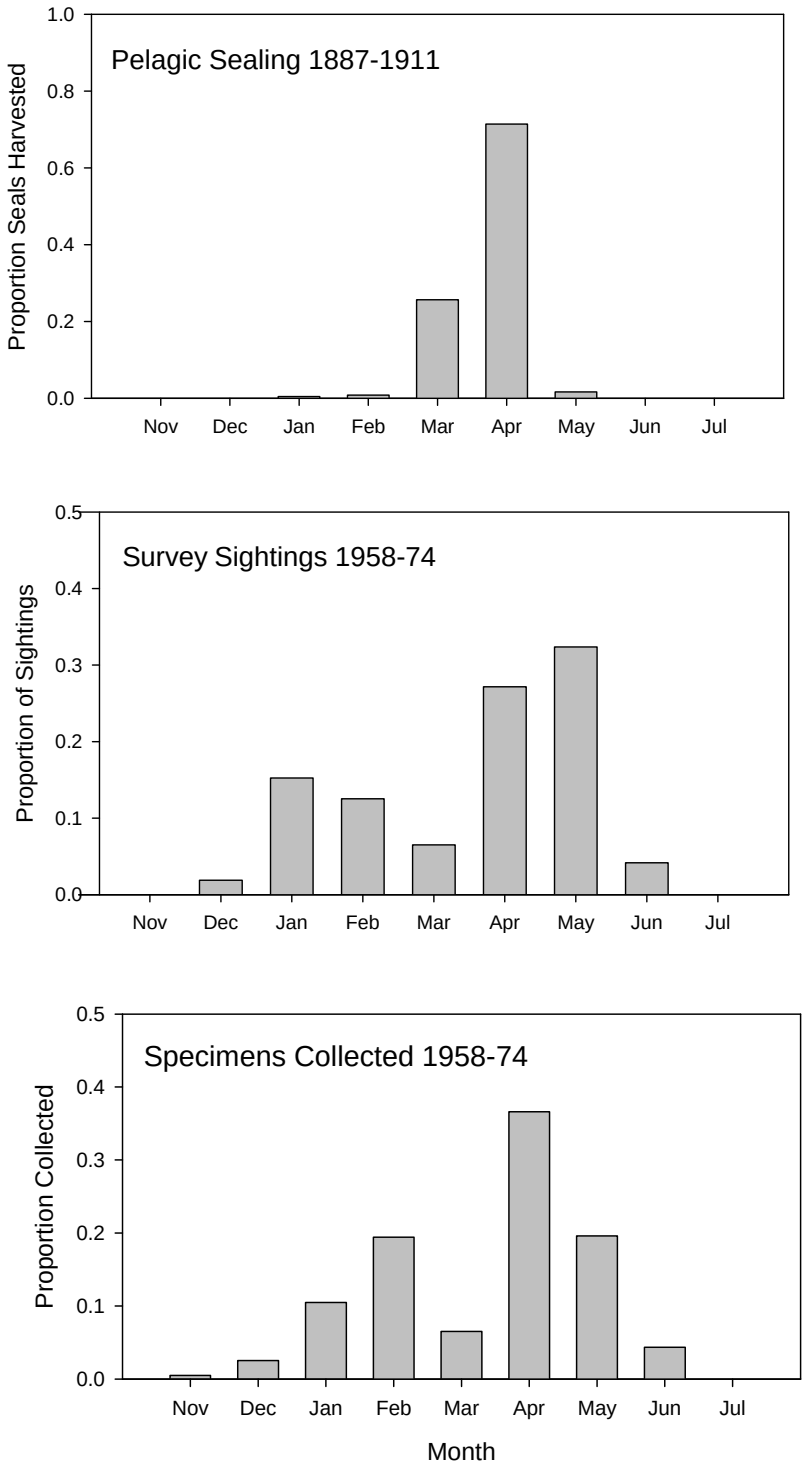


Figure 12. *Seasonal distribution of seal harvests (top), NPFSC seal sightings (middle), and NPFSC specimen collections in the La Perouse core area.*

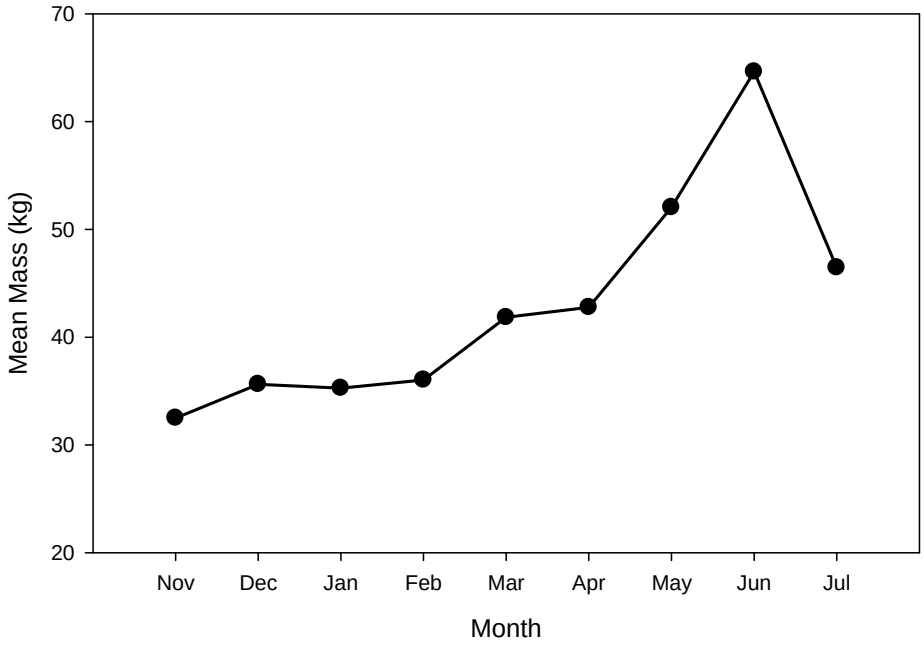


Figure 13. *Seasonal change in mean body mass of pregnant female fur seals showing weight gain during latter part of migration through Canadian waters. See Trites and Bigg (1996) for details.*

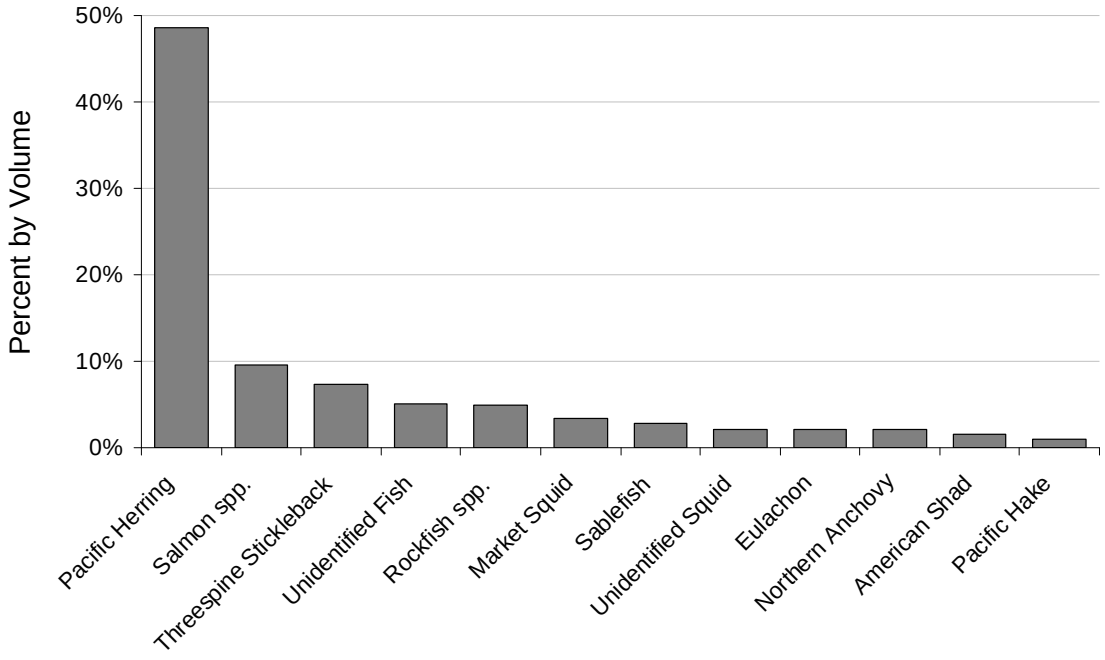


Figure 14. *Principle prey species of northern fur seals in the La Perouse Bank core area. Data are percent volume.*