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Atlas of pelagic birds of western Canada

Occasional Paper
Number 72
Canadian Wildlife Service

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The Canadian Wildlife Service of Environment Canada handles wildlife matters that are the responsibility of the Canadian government. These include protection and management of migratory birds as well as nationally significant wildlife habitat. Other responsibilities are endangered species, control of international trade in endangered species, and research on wildlife issues of national importance. The Service cooperates with the provinces, territories, Canadian Parks Service, and other federal agencies in wildlife research and management.

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Abstract

Observations from more than 20 675 km of transects (10-min counts) carried out during 45 ship-of-opportunity cruises (1981–1990) were analyzed to determine the seasonal distribution of pelagic birds along the British Columbia coast to 320 km (200 statute miles) offshore. The seasonal distributions of each of the following 20 species were mapped: Black-footed Albatross *Diomedea nigripes*, Northern Fulmar *Fulmarus glacialis*, Pink-footed Shearwater *Puffinus creatopus*, Buller's Shearwater *P. bulleri*, Leach's Storm-Petrel *Oceanodroma leucorhoa*, Fork-tailed Storm-Petrel *O. furcata*, Pomarine Jaeger *Stercorarius pomarinus*, Parasitic Jaeger *S. parasiticus*, Long-tailed Jaeger *S. longicaudus*, California Gull *Larus californicus*, Glaucous-winged Gull *L. glaucescens*, Black-legged Kittiwake *Rissa tridactyla*, Sabine's Gull *Xema sabini*, Arctic Tern *Sterna paradisaea*, Common Murre *Uria aalge*, Marbled Murrelet *Brachyramphus marmoratus*, Ancient Murrelet *Synthliboramphus antiquus*, Cassin's Auklet *Ptychoramphus aleuticus*, Rhinoceros Auklet *Cerorhinca monocerata*, and Tufted Puffin *Fratercula cirrhata*. Data for another six species — Sooty and Short-tailed shearwaters (*Puffinus griseus* and *P. tenuirostris*); Herring and Thayer's gulls (*Larus argentatus* and *L. thayeri*); and Red-necked and Red phalaropes (*Phalaropus lobatus* and *P. fulicaria*) — are presented as species pairs because of difficulties in identification. The dates and locations involved in the observations of an additional 12 rare or accidental species were also mapped and tabulated. Waters over the continental shelf (shallower than 200 m) generally supported the highest pelagic bird density (all species combined), as well as maximal numbers of most species. The waters off Vancouver Island have been thoroughly surveyed, whereas those north of the island have received less coverage.

Résumé

Les observations effectuées sur plus de 20 675 km de transects (dénombrements de 10 minutes) à bord de 45 navires de passage (1981–1990) ont été analysées afin de déterminer la distribution saisonnière des oiseaux pélagiques le long de la côte de la Colombie-Britannique, jusqu'à 320 km au large (200 milles terrestres). On a cartographié la distribution saisonnière de chacune des 20 espèces suivantes : Albatros à pattes noires *Diomedea nigripes*, Fulmar boréal *Fulmarus glacialis*, Puffin à pattes roses *Puffinus creatopus*, Puffin de Buller *P. bulleri*, Pétrel cul-blanc *Oceanodroma leucorhoa*, Pétrel à queue fourchue *O. furcata*, Labbe pomarin *Stercorarius pomarinus*, Labbe parasite *S. parasiticus*, Labbe à longue queue *S. longicaudus*, Goéland de Californie *Larus californicus*, Goéland à ailes grises *L. glaucescens*, Mouette tridactyle *Rissa tridactyla*, Mouette de Sabine *Xema sabini*, Sterne arctique *Sterna paradisaea*, Marmette de Troïl *Uria aalge*, Alque marbrée *Brachyramphus marmoratus*, Alque à cou blanc *Synthliboramphus antiquus*, Alque de Cassin *Ptychoramphus aleuticus*, Macareux rhinocéros *Cerorhinca monocerata*, et Macareux huppé *Fratercula cirrhata*. En raison des difficultés d'identification, les oiseaux suivants et les données qui les concernent sont présentés par groupes d'espèces : Puffin fuligineux et Puffin à bec mince (*Puffinus griseus* et *P. tenuirostris*), Goéland argenté et Goéland de Thayer (*Larus argentatus* et *L. thayeri*), Phalarope hyperboréen et Phalarope roux (*Phalaropus lobatus* et *P. fulicaria*). Les dates et endroits où l'on a observé 12 autres espèces rares ou accidentelles sont également consignés sur les cartes et dans les tableaux. Les eaux recouvrant le plateau continental (moins de 200 m de profondeur) accueillaient généralement les plus fortes densités (toutes espèces regroupées) d'oiseaux pélagiques ainsi que les plus grands nombres d'oiseaux pour la plupart des espèces. Les eaux au large de l'île de Vancouver ont été visitées au complet, mais non pas celles au nord de l'île.

1. Introduction

The species composition and distribution of inshore birds along the British Columbia coast were described in an atlas by Vermeer et al. (1983). In that atlas, some information was given on the distribution of pelagic birds; however, no serious attempt was made to cover the subject in detail. Pelagic bird surveys off British Columbia were first initiated in 1981 on an opportunity basis, mostly from ships of the Institute of Ocean Sciences at Sidney, but also from those of the Pacific Biological Station at Nanaimo and the Defence Research Establishment Pacific at Esquimalt. There were two reasons for initiating the surveys: to obtain a better knowledge of the numbers and species of pelagic birds visiting British Columbia, and to collect baseline data for assessing potential effects of environmental perturbations on pelagic bird populations. Hecate Strait–Queen Charlotte Sound was the first region to be surveyed, because of the possibility of offshore oil drilling there, which could adversely affect seabird populations (Vermeer and Rankin 1984). Pelagic bird surveys in Dixon Entrance (Vermeer and Rankin 1985) and on the west coast of Vancouver Island (Vermeer et al. 1987) followed, also because of oil drilling considerations.

In 1989, one of us (Vermeer), impressed with the number of census data that had been collected, felt that an up-to-date summary for the whole British Columbia coast would provide managers with information on where and at which times pelagic bird species (as well as their populations) would be most at risk from human disturbances. Such information on birds in British Columbia has been requested on many occasions by several government agencies.

The Canadian Wildlife Service supported the development of an atlas of western Canada, as it would address to some extent the recommendation of the West Coast Offshore Exploration Assessment Panel that the Canadian Wildlife Service undertake inventory surveys of the British Columbia coast before the onset of exploratory drilling, to establish baseline information on seabird populations for the purpose of contingency planning. Vermeer contracted Morgan to analyze the census data, which had been compiled primarily by Vermeer and to a lesser extent by McKelvey. Morgan prepared the maps and the text, and all three authors edited later drafts.

Although this atlas provides the first comprehensive overview of what is known of pelagic birds in British Columbia, much more census work is needed. There is only minimal information on seabird populations in winter. At other times of the year, there is a paucity of data on the distribution of seabirds in waters off the west coast of the Queen Charlotte Islands and to the west of Queen Charlotte Sound. Although the continental shelf has been covered up to the 200-m depth contour, waters beyond the shelf need much further research.

We hope that the atlas will become an important reference for biologists, researchers, field workers, and ornithologists, as well as for managers concerned with the impact of human activities on British Columbia's pelagic birds.

2. Methods

2.1 Pelagic bird surveys

Forty-five pelagic bird surveys were conducted along the British Columbia coast, some as far seaward as the 320-km (200-statute-mile) territorial limit, from 1981 through January 1990. The majority of these surveys were carried out on a ship-of-opportunity basis, from research vessels involved in oceanographic work. Consequently, the areas visited in these surveys were not under our control, with the exception of two dedicated cruises conducted over the continental shelf off southwestern Vancouver Island in September and October 1986 (Vermeer et al. 1989). The edge of the continental shelf is depicted in this atlas at the 200-m depth contour.

In 1972, the Canadian Wildlife Service began systematic pelagic bird surveys of the western North Atlantic following the PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques) system. Birds were counted in 10-min intervals using unbounded corridors. In 1975, the results of these surveys (as well as data collected prior to 1972) were published (Brown et al. 1975). Data for each bird species were presented as the average number of birds per 10-min watch within 1°N × 1°W blocks. A revised atlas was published 11 years later (Brown 1986). The method for collecting data for the revised atlas was the same as that used for the original atlas; however, the data were summarized as the average number of birds per linear kilometre.

Since 1981, the Canadian Wildlife Service has conducted pelagic bird surveys off British Columbia, closely following the method used by Brown (1986). Observations were carried out from above the bridge at a height of approximately 15 m above the water. Observations were made only when the ship was steaming at or at more than 5 knots (9.25 $km \cdot h^{-1}$) during daylight; they were halted during very heavy rain, fog, or rough seas. The sea was scanned with binoculars in a 180° field forward, normally centred on the ship's bow. When the ship was heading into strong, direct sunlight, the field was scanned either at right angles to the sun or with the sun at the observer's back. Transects were a running series of 10-min counts, carried out for as long as the ship steamed at a constant speed on a constant course. The position and time of the beginning and end of each transect were noted. Observations were terminated when the ship stopped.

The species and number of birds observed during each transect were noted. Birds that could be identified only to genus were also tallied. Waterfowl, cormorants, grebes, and loons were included in the calculation of the total number of birds in each transect; the presence of passerines, raptors, and shorebirds was only noted. Ship followers, such as large gulls and albatrosses, were counted only once. Observations were halted within 1 km of land. The observer also noted whenever the research vessel passed a working fishing boat or a factory ship.

The standard technique currently used off the west coast of the United States and the Gulf of Alaska involves scanning in a corridor of a predetermined width, on either side of the bow (150–200 m on either side) (Tasker et al. 1984; Briggs et al. 1987). Birds were counted as either inside or outside the band. Birds within the band contributed to the density calculations (number per unit area). This method can result in overestimations of the standing stock of certain species, especially those species that are attracted to the vessel. Species that avoid the ship and do not enter the band are noted but are not considered in the calculation of the total bird density. Consequently, their numbers are likely underestimated. Brown (1986) expressed reservations about using the number of birds per unit area as a method of determining seabird populations at sea. His goal, like ours, was to provide an accurate measurement of the relative variation in the numbers of seabirds and to demonstrate the patterns of seasonal distribution.

2.2 Treatment of data

The many observers participating in this project possessed differing degrees of skill in identifying birds. This created a potential problem during the interpretation of the data. We were at first faced with two options: we could either discard all observations that seemed questionable (e.g., a rare species or a more common species that was out of season) or accept every record as given. We settled on a compromise, accepting all records of a core group of observers determined by their identification skills. For the remaining observers, we used the following criteria for any noteworthy record:

(1) a record that was accompanied by a convincing field description of a rare species would be accepted;

(2) a record involving a rare species that was easily identified but lacking a field description would be accepted only if that species had previously been observed in British Columbia waters by an experienced observer; or
(3) a record of a common species that was easily identified but the time of year was unusual would be accepted.

We acknowledge that this method deviates from the standard acceptance protocol — that is, a sighting made by more than one individual, or the sighting is accompanied by a photograph or a specimen. However, as our goal was to increase the understanding of the diversity and distribution of pelagic birds off the west coast of Canada, we were willing to risk the inclusion of a few erroneous observations. The alternative of leaving out all unproven records would, in our opinion, have greatly diminished the value of this atlas.

The initial stage of the data analysis involved plotting the location of each transect on charts that had been divided into 15′N × 15′W cells. Each such cell covered approximately 490 km^2. A transect that crossed more than one cell was assigned to the ell containing the greatest proportion of the transect. If a cell boundary bisected a transect, the data were split evenly between the two cells involved. In order to reduce the number of shoreline and terrestrial birds, we did not include any transect within 5 km of land. We also excluded all transects that were less than 3 km from a working fishing boat or factory ship.

All transect data were grouped according to the following seasons:

(1) Winter — 16 December through 15 March;
(2) Spring — 16 March through 15 June;
(3) Summer — 16 June through 15 September; and
(4) Fall — 16 September through 15 December.

The data from each season were treated separately. For each surveyed cell, we calculated the average linear densities (defined here as the number of birds per kilometre of transect) of each species observed (20 species and three species pairs) and of the total number of birds. These values were used to provide a linear density symbol for each cell. As the symbols were positioned in the centre of a cell, some symbols are found on land: they refer to adjacent waters at least 5 km away. Cells without symbols reflect an absence of survey data, not an absence of birds. The legend is presented only once for each series of maps (e.g., Fig. 2a–d). Data from all years were combined, rather than being analyzed separately. This was done because a cell with a high density might not be particularly significant if it represented, for example, a "one time only" aggregation due to adverse weather conditions halting migration (Guzman and Myres 1983). Grouping of the data from all years should reduce the effect of such aggregations.

For an additional 12 species of birds that are considered rare in British Columbia, we prepared maps and tables showing the approximate locations and dates of their sightings. All observations of these species have been shown, including those from beyond the 320-km (200-mile) limit.

Certain species groups consistently created identification problems for most observers. It can be very difficult to distinguish Sooty Shearwaters *Puffinus griseus* from Short-tailed Shearwaters *P. tenuirostris*, especially in poor light. Consequently, many observers tallied these as Sooty/Short-tailed shearwaters, making it impossible for us to determine the proportion of each species. Therefore, we analyzed all sightings of Sooty and Short-tailed shearwaters as data from a species pair. To be consistent, we did this even when the two species had been tallied separately. Thayer's Gull *Larus thayeri* was, until recently, considered to be a subspecies of the Herring Gull *L. argentatus* (Harrison 1983). As a result, most of the early observers tallied these two species as Herring Gull. Red-necked and Red phalaropes (*Phalaropus lobatus* and *P. fulicaria*) frequently disperse long before the ship gets within range for positive species identification. Consequently, we analyzed our Herring/Thayer's gull and our Red-necked/Red phalarope data in the same manner as we did those for Sooty and Short-tailed shearwaters.

In addition to plotting the seasonal distribution, we calculated a quantity called the "seasonal distribution index." This was the number of cells in which a species occurred (regardless of the number of individuals or the number of times that a species was found in that cell), divided by the total number of cells surveyed during a given season. The resulting proportion was then used to describe the seasonal distribution of the species by means of the following criteria:

(1) Restricted — observed in fewer than 33% of the surveyed cells;
(2) Common — observed in 33–66% of the cells; and
(3) Widespread — observed in more than 66% of the cells.

We determined the average relative abundance (ARA, a unitless value) of 44 species of pelagic birds using the following method. For each month (or half month), the total number of birds observed (by species) was calculated for all years. The proportion of the total number of transects in which the species occurred during that time period was then calculated. Finally, the species total was multiplied by the transect proportion, and the resultant value was divided by the number of surveys in that time period. For example,

if, over the entire project period, there were three surveys in the month of June, with totals of 125, 300, and 292 Common Murres *Uria aalge* seen in each, in 28 out of 75, 63 out of 196, and 70 out of 146 transects, the ARA would be:

$$[(125+300+292) \times ([28+63+70]/[75+196+146])]/3 = 92.3$$

The ARA provides an estimate of the average abundance of a species during a certain time period. For waters south of 51°N, we calculated the ARA on a half-monthly basis. As there were fewer data from waters north of 51°N, we calculated the ARA monthly. The resultant ARA values were used to place each species in one of the following categories:

(1) Rare, 0.01–1.00;
(2) Few, 1.01–10.00;
(3) Common, 10.01–100.00;
(4) Abundant, 100.01–1000.00; and
(5) Numerous, >1000.00.

The ARA of a species pair (e.g., Herring/Thayer's gulls) does not indicate which species was more numerous, nor if one of the species was absent. Data that had been collected by experienced observers were examined to estimate the proportions of the individual species within the three species pairs.

3. Results and discussion

3.1 Numbers of observers and transects

A total of 18 observers aboard 45 cruises gathered data on the distribution of seabirds. To generate the distribution maps and species accounts, 5355 transects were analyzed, traversing 20 675 km of ocean. Of these, 1561 transects (6605 km) occurred in spring, 1870 transects (7057 km) in summer, 1553 transects (5516 km) in fall, and 371 transects (1497 km) in winter. Figure 1a–d shows the number of transects within each 15′ × 15′ cell by season (all years combined), and Appendix 1 presents the number of transects by survey year in each 1°N × 1°W block.

3.2 Overall distribution pattern of birds

Throughout the year, the greatest average total bird densities occurred over the continental shelf (Fig. 2a–d). This trend has been noted in many other parts of the world, including the Antarctic (Ainley and Jacobs 1981), the Gulf of Alaska (Harrison 1982), the northwest Atlantic (Brown 1986), and off California (Briggs et al. 1987). Whereas a one-time aggregation of a large number of birds will inevitably produce a localized high average density, the consistently observed pattern of maximal numbers occurring over the shelf cannot be attributed to chance. Seabird biologists are still attempting to identify the factors that regulate the distribution of pelagic birds (see Brown 1980). Whatever those factors are — e.g., physical and/or chemical processes, concentrated commercial fishing activity, etc. — they appear to be optimal over the shelf, as that area supports the greatest seabird density as well as the highest species diversity. Areas with particularly high density and species diversity were Amphitrite, La Pérouse, and Swiftsure banks off southwestern Vancouver Island; the waters over and adjacent to Cook Bank at the northern end of Vancouver Island; and the shallow waters of Hecate Strait (Fig. 3).

Many papers dealing with seabird distribution include a synopsis of the oceanographic features of the area covered (e.g., Brown et al. 1975; Briggs et al. 1987). We have not followed that method, as the complex processes that occur off the coast of British Columbia cannot be adequately covered in a few pages. Thomson (1981) provides a comprehensive overview of the subject, and we strongly recommend it.

Figure 1
Number of transects within each 15′N×15′W cell by season (all years combined)

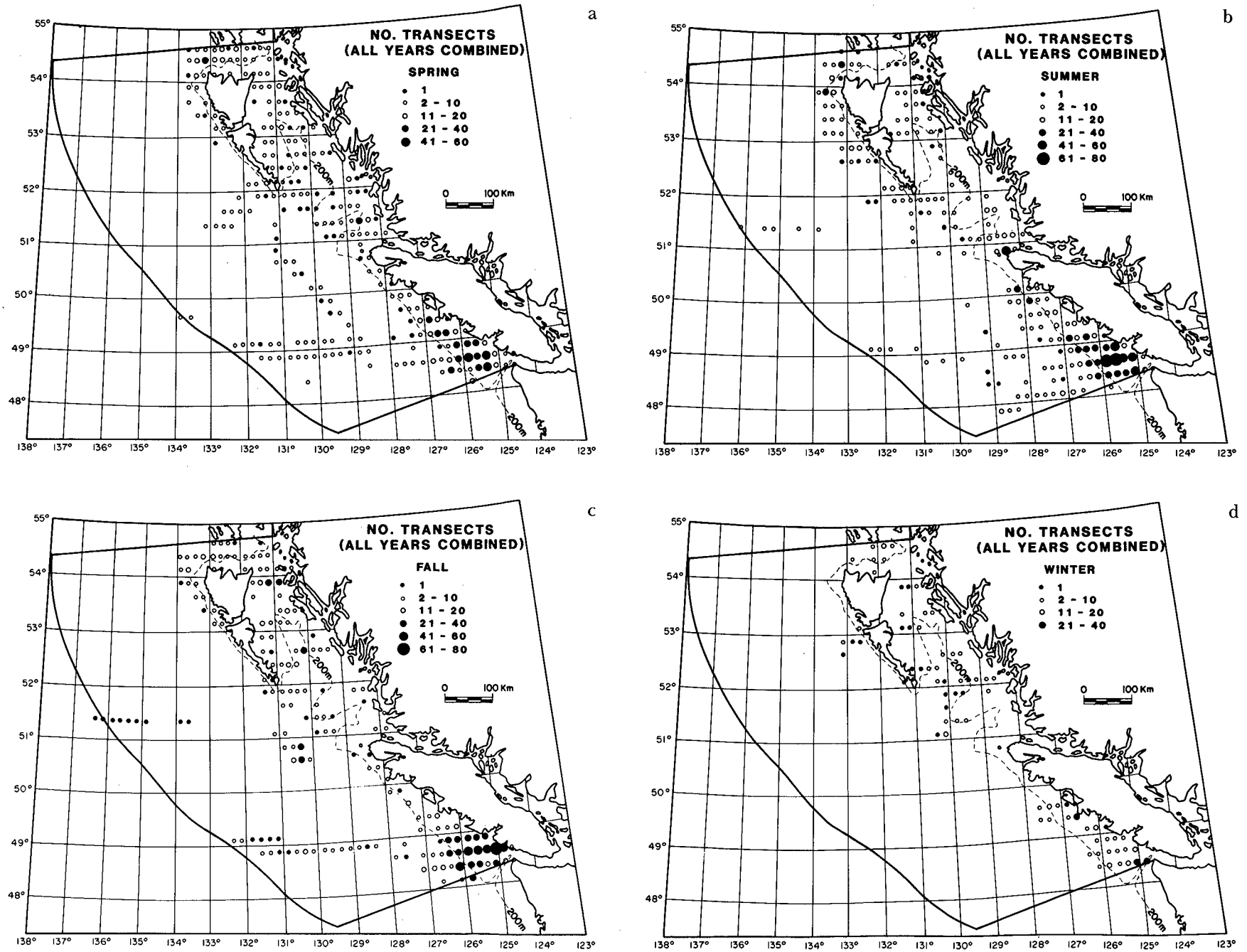


Figure 2
Average total bird density (no. birds/km) by season

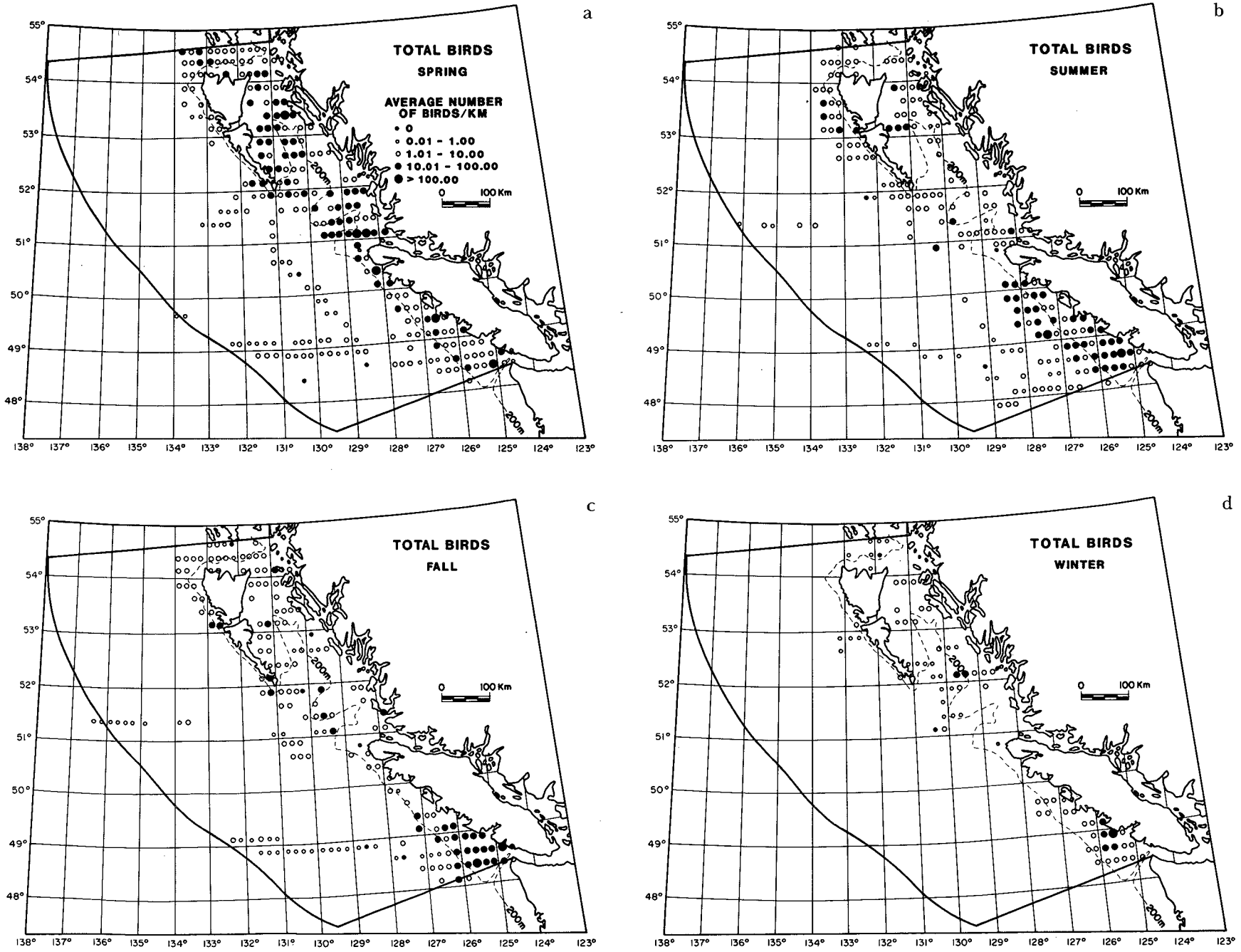
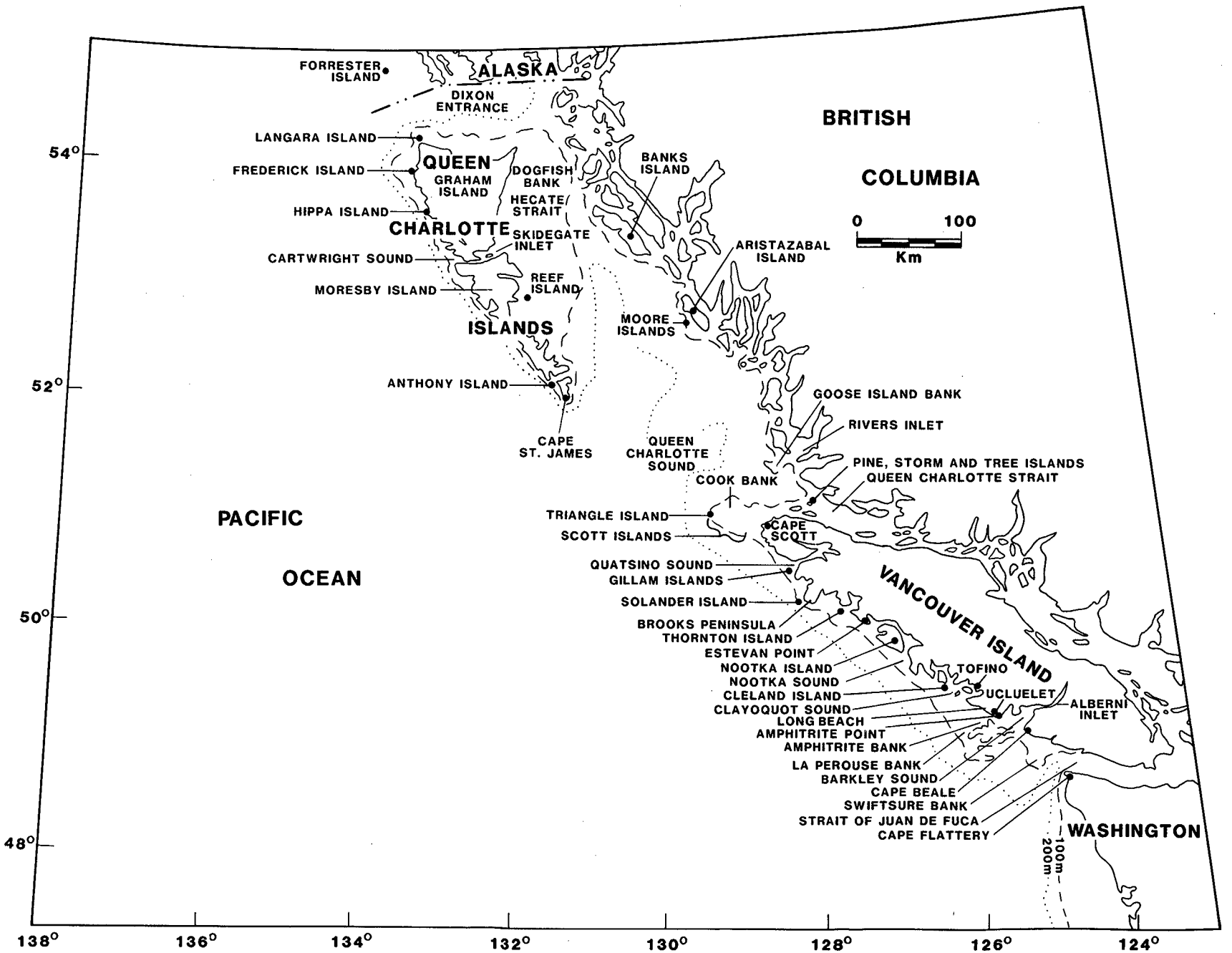


Figure 3
Location of places mentioned in text



3.3 Seasonal abundance

Figures 4 and 5 depict the average relative abundance (ARA) for each species in each month. These figures not only provide an estimate of the abundance of each species in the 1980s but also illustrate their co-occurrence.

Both figures show that Sooty/Short-tailed shearwaters dominated the bird community from May through September. South of 51°N, California Gulls *Larus californicus* were the second most numerous species, although their period of abundance was restricted.

Several species, such as Glaucous-winged Gull *L. glaucescens*, Black-legged Kittiwake *Rissa tridactyla*, Common Murre *Uria aalge*, and Cassin's Auklet *Ptychoramphus aleuticus*, had two (or more) seasonal peaks. These peaks not only were separated in time but also were geographically distinct. For example, kittiwakes were abundant in early March only south of 51°N, whereas they were most numerous during September and October in northern waters. The differences in the location and time of relative abundance likely represent migration patterns.

Figure 4
Average relative abundance for each bird species for areas south of 51°N

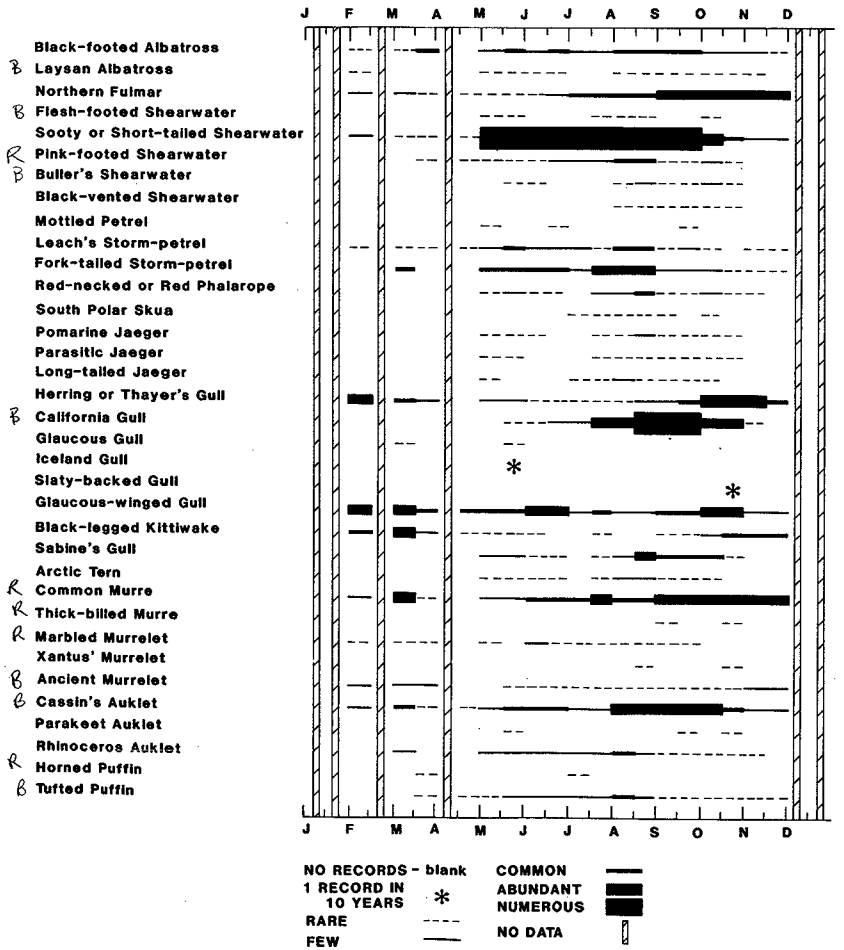
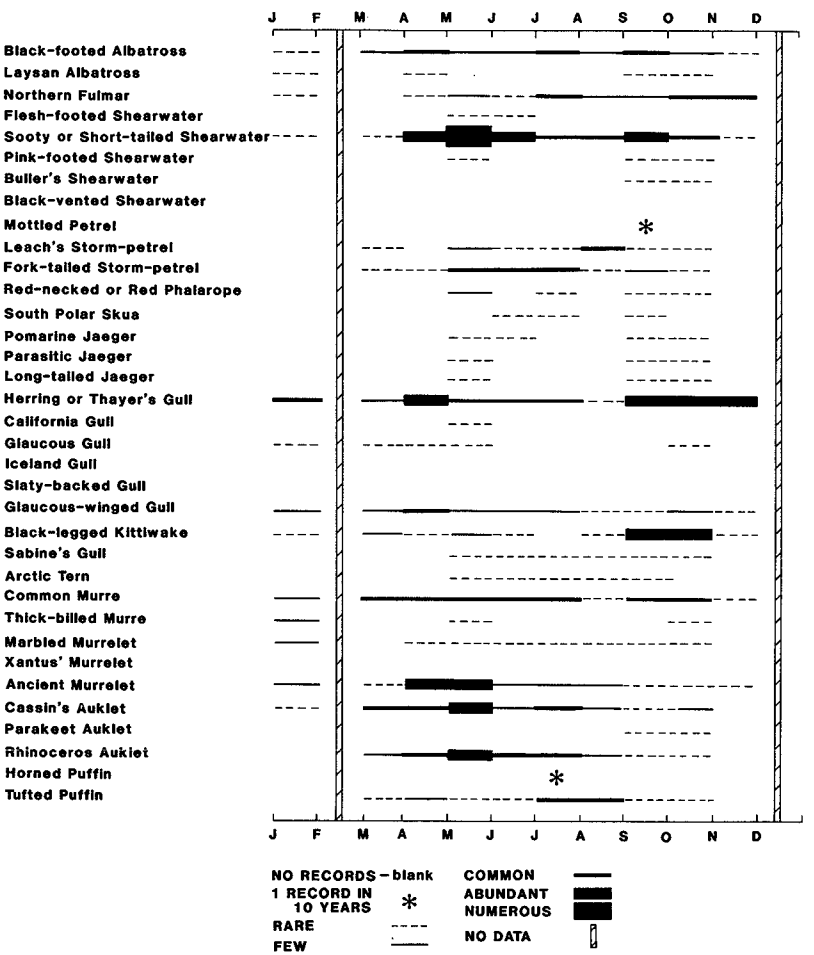


Figure 5
Average relative abundance for each bird species for areas north of 51°N



Black-footed Albatross *Diomedea nigripes*

(Fig. 6a–d)

Black-footed Albatrosses were observed in every month that we conducted surveys, although they were considerably more common from about mid-March to October. Throughout most of the year, the species was widespread both nearshore and far offshore. The spring and summer distributions suggest a preference for the edge of the continental shelf, as noted previously by Vermeer et al. (1987) for the waters off southwestern Vancouver Island.

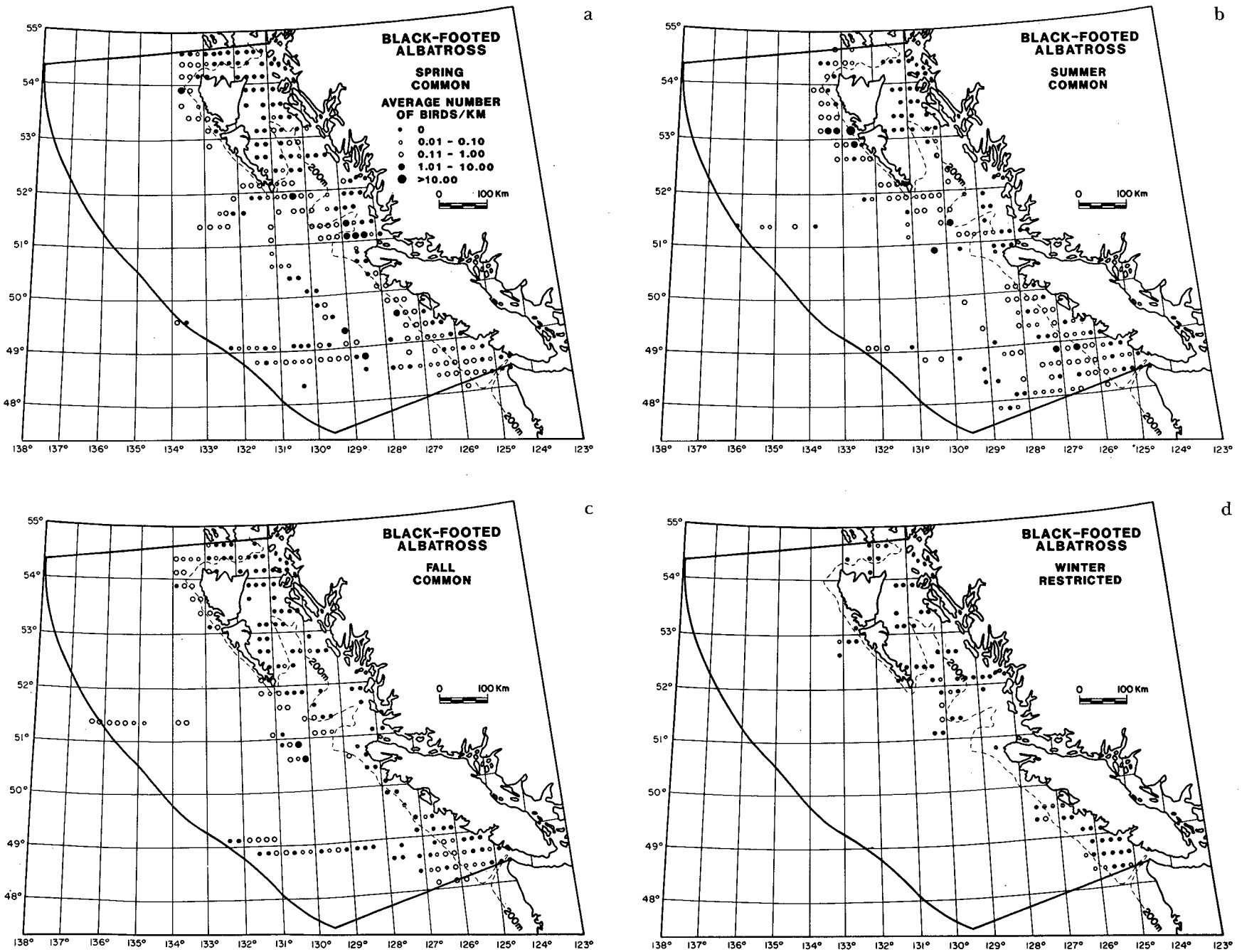
In the spring, the highest average densities occurred off the west coast of Graham Island, south of Cape St. James, at the edge of Cook Bank (Queen Charlotte Sound), and off the west coast of Vancouver Island. Most spring observations were either of single birds or of small groups, typically fewer than 10 individuals.

During summer, the Black-footed Albatross increased in numbers and became more gregarious. Highest average densities occurred west of Skidegate Inlet, northwest of Cape Scott, and west of Barkley Sound. Although sightings of solitary birds still dominated, it became more common to see larger flocks (20 to 40 individuals) as summer progressed. Martin and Myres (1969) similarly noted a tendency towards larger flock size during summer. The largest single group observed, on 22 June 1988, approximately 80 km west of Barkley Sound, consisted of 180 Black-footed Albatrosses and one Laysan Albatross *D. immutabilis* rafting together on the water.

Average densities decreased in fall, with the pattern of distribution suggesting a shift offshore. McHugh (1955) observed a similar trend, with a general movement of the population from inshore in spring to offshore in fall. There were too few records of this species to discern any distributional pattern in winter.

The year-round presence of the Black-footed Albatross off the coast of British Columbia suggests a substantial number of nonbreeders and/or immature birds. Black-footed Albatrosses nest throughout the northwestern Hawaiian Islands, with a few on Torishima Island off Japan and on Muko Shima in the Bonin Islands. Most breeding birds reach their nesting colonies by late October. Egg laying occurs in the latter half of November, and departure from the islands (young and old) takes place primarily in June. After leaving the colonies, young Black-footed Albatrosses scatter both east and west, possibly favouring the eastern Pacific. By the end of their second winter at sea, a few individuals will return to their natal colonies. First breeding usually occurs by about the fifth year (Rice 1984).

Figure 6
Average density of Black-footed Albatrosses by season



Northern Fulmar *Fulmarus glacialis*

(Fig. 7a-d)

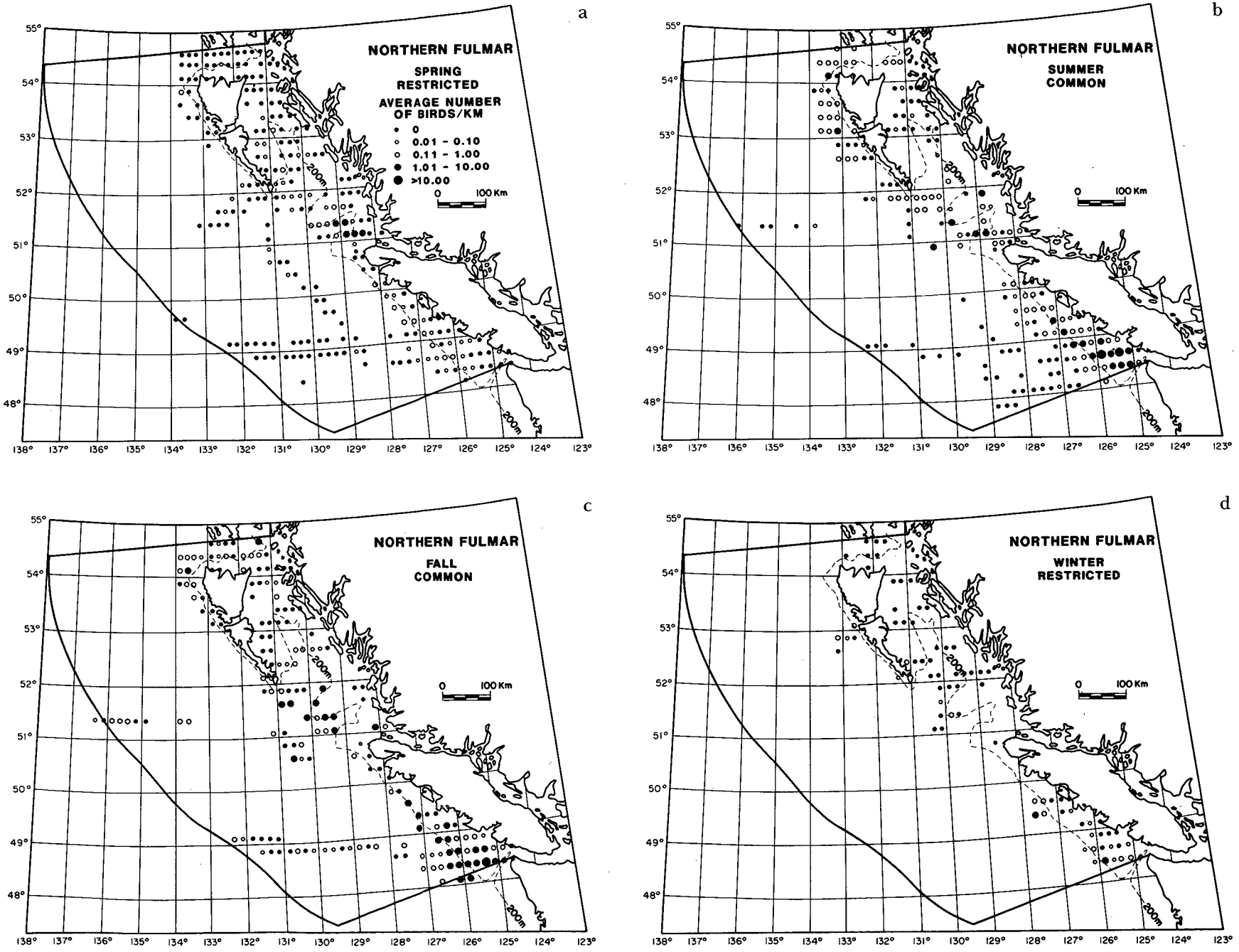
Northern Fulmars were observed in each survey month, with peak numbers in September, October, and November. During spring, fulmars were relatively scarce and were concentrated primarily along the seaward edge of the shelf, especially near Cook Bank. The tendency for fulmars to concentrate near the shelf break has been observed in the Bering Sea (Iverson et al. 1979), in the Gulf of Alaska (Forsell and Gould 1981), and off California (Briggs et al. 1987).

By July, this species had become common and moved inshore. It was rare to find a fulmar farther than 100 km from land during summer. The highest average summer densities occurred over Amphitrite, La Pérouse, and Swiftsure banks, perhaps because of high biological productivity there (Vermeer et al. 1989). Although we did not analyze any data closer than 3 km from a working fishing boat, it is worth noting that we observed flocks of 5000 to 10 000 fulmars around factory ships in late summer and early fall (Vermeer et al. 1987). Wahl and Heinemann (1979) found a strong correlation between the occurrence of Northern Fulmars and that of fishing boats. The relatively high number of Northern Fulmars found off British Columbia in summer probably consisted of nonbreeding adults, failed breeders, and immature birds that are highly pelagic.

Fulmars were abundant from September to the end of November, especially off southwestern Vancouver Island and the entrance to Queen Charlotte Sound. As in spring, the highest concentrations of fulmars were found to be primarily seaward of the shelf break (excluding the concentrating effects of boats). It was much more common to find a Northern Fulmar far offshore during fall than in either spring or summer. Based on our limited data, it appeared that fulmars were relatively rare during winter and that their distribution was primarily pelagic.

In the North Pacific, this species breeds on the Kurile, Commander, and Aleutian islands, as well as on islands in the Gulf of Alaska and the Bering Sea. Breeding birds arrive at Alaskan colonies usually by March or early April; eggs are laid in June, and the young fledge in mid-September to early October (Shallenberger 1984). It was first suspected in 1974 that Northern Fulmars may breed on Triangle Island (Vermeer et al. 1976). Neither eggs nor young have yet been found, but birds have been observed on nests.

Figure 7
Average density of Northern Fulmars by season



Sooty and Short-tailed shearwaters (*Puffinus griseus* and *P. tenuirostris*)

(Fig. 8a–d)

The total population of Sooty and Short-tailed shearwaters visiting the North Pacific has been roughly estimated at 30 million of each (Shallenberger 1984). Off British Columbia, the Sooty Shearwater is far more abundant than the Short-tailed Shearwater, which is considered to be a rare summer visitor. It is believed that Short-tailed Shearwaters cross the equator northward on a broad front in the central Pacific Ocean and that only under certain wind conditions do they spread as far east as the coast of British Columbia (Guzman and Myres 1983). As a result of identification problems, we cannot at present provide any clearer picture of the status of Short-tailed Shearwaters off the west coast of Canada.

We observed this species pair in each month that surveys were conducted. The highest average spring densities occurred over the shallow waters of the outer and middle shelf, especially west of Banks Island, off the entrances to Quatsino and Nootka sounds, and west of the Strait of Juan de Fuca. Previous studies have noted that Sooty Shearwaters concentrate over shelf waters in the Bering Sea (Hunt et al. 1981), in the Gulf of Alaska (Harrison 1982), in Hecate Strait and Queen Charlotte Sound (Vermeer and Rankin 1984), and off California (Briggs et al. 1987). Guzman (1981) believed that the majority of Sooty Shearwaters migrating to the Gulf of Alaska and the Bering Sea during the northern spring utilized the deeper oceanic waters well beyond the shelf break. Data from Ocean Station "P" (50°N, 145°W, approximately 1150 km west of Cape Scott) did not show a large spring movement of shearwaters; in fact, they were rarely observed there (Vermeer et al. 1983). Similarly, unpublished cruise data obtained between the coast and Station "P" did not demonstrate a large offshore spring movement of Sooty Shearwaters. Data from British Columbia to Baja California indicate a pattern of movement very different from that proposed by Guzman (K.T. Briggs, pers. commun.). We observed the largest concentrations of shearwaters in spring. A single flock of 10 000 to 12 000 birds feeding on the water was found on 13 May 1982, southwest of Nootka Sound; on 11 May 1983, a flock estimated at 80 000 to 100 000 birds was encountered 30 km off Banks Island (Vermeer and Rankin 1984). Another flock of approximately 12 000 birds was seen on 9 June 1985 west of the mouth of the Strait of Juan de Fuca. We suggest that although we rarely observe spectacular groupings of Sooty Shearwaters off British Columbia, cumulatively there is a significant nearshore migration of shearwaters during spring. From a small subsample, it appears that Sooty Shearwaters outnumber Short-tailed Shearwaters during this migration by several orders of magnitude. However, we acknowledge that many Short-tailed Shearwaters could have gone unobserved and that many of the unknown shearwaters could have been Short-tailed Shearwaters.

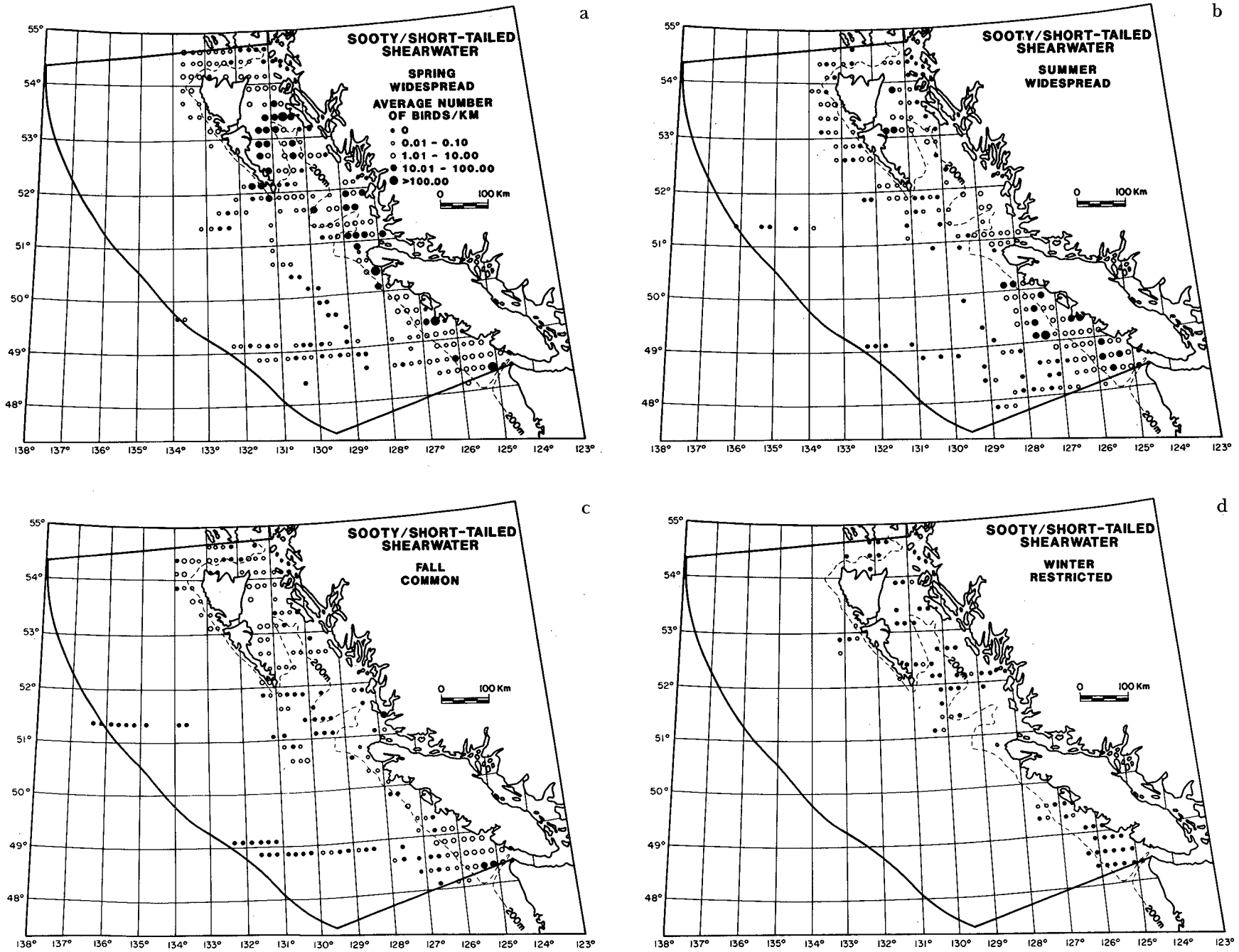
Although shearwaters were the most abundant bird during summer, their flocks diminished in size and became less numerous near the Queen Charlotte Islands during this season. This species pair was most frequently observed over the shelf. Highest average densities occurred over Dogfish Bank, west of Brooks Peninsula, near Estevan Point, and southwest of Barkley Sound. The largest summer concentration of shearwaters (3300) was observed on 15 July 1983, seaward of the shelf break off Nootka Sound. Similar-sized flocks were also encountered attending factory ships during late August and early September. We estimated that less than 1% of the shearwaters encountered during summer were Short-tailed Shearwaters.

During the last half of September and the first half of October, shearwaters were still common, frequenting shelf waters. We found the highest average fall densities near the mouth of Rivers Inlet and west of the Strait of Juan de Fuca. We estimate that at least 30% of the shearwaters encountered during fall were Short-tailed Shearwaters. This is somewhat higher than our earlier estimate of 10–20%, based only on surveys in September and October in 1986 and 1987 (Vermeer et al. 1989). It is not known whether this higher percentage of Short-tailed Shearwaters represents an actual increase of that species or a decline in Sooty Shearwaters.

Shearwaters were rare during winter and were observed primarily seaward of the shelf break. During a survey off Queen Charlotte Sound in the first week of February 1990, we observed only 27 Short-tailed and two Sooty shearwaters. This limited sample suggests that, in winter, Short-tailed Shearwaters are more abundant than Sooty Shearwaters.

Sooty Shearwaters breed in small numbers on islands off New South Wales and southeast Tasmania. Their main colonies are located off New Zealand at Snares, Auckland, Campbell, Chatham, Antipodes, and Stewart islands. They also breed on islands off Cape Horn and on the Falkland Islands. Short-tailed Shearwaters breed in huge numbers on islands in Bass Strait and off Tasmania, New South Wales, Victoria, and southern Australia (Guzman 1981; Harrison 1983). Guzman (1981) observed that subadult, nonbreeding Sooty Shearwaters were far less attached to the colonies, with some remaining in the northern hemisphere all year long. Our observations suggest that a few nonbreeding Short-tailed Shearwaters similarly overwinter in the northern hemisphere.

Figure 8
Average density of Sooty/Short-tailed shearwaters by season



Pink-footed Shearwater *Puffinus creatopus*

(Fig. 9a–c)

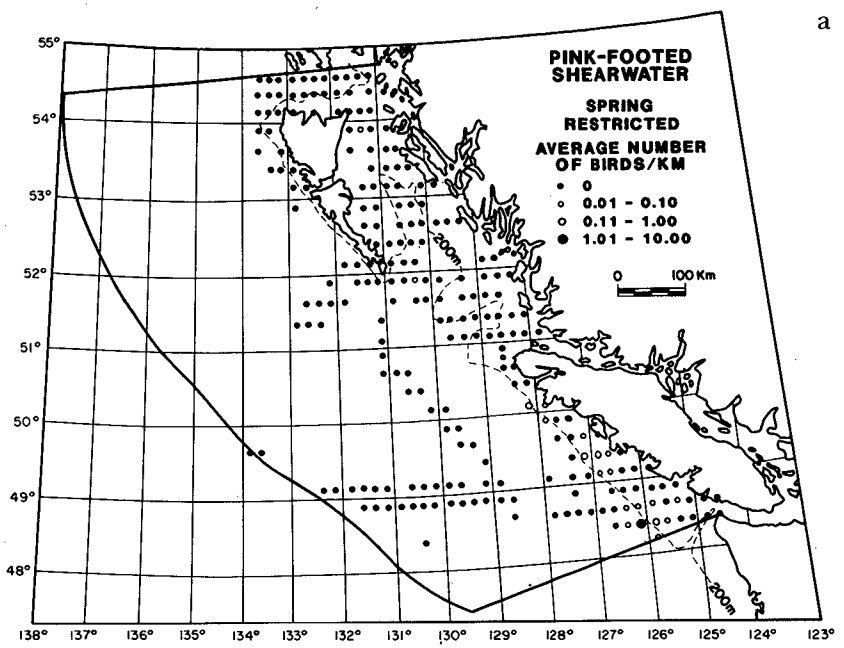
Pink-footed Shearwaters were observed from late March to the end of October. Martin and Myres (1969) reported seeing this species as early as 28 April, but they felt that Pink-footed Shearwaters did not occur in substantial numbers until mid-June. Our earliest record was of two birds seen on 29 March 1983, off the mouth of Barkley Sound. This species was rarely observed north of Brooks Peninsula during spring, when most Pink-footed Shearwaters were seen over the shelf or at the shelf break. Briggs et al. (1987) similarly found that although this species was encountered from nearshore to 150 km offshore, the numbers were highest over the shelf and at the shelf break. During spring, Pink-footed Shearwaters occurred individually or in small groups. The largest single flock seen in spring (26 birds) was encountered on 14 June 1988, about 83 km southwest of Cape Beale.

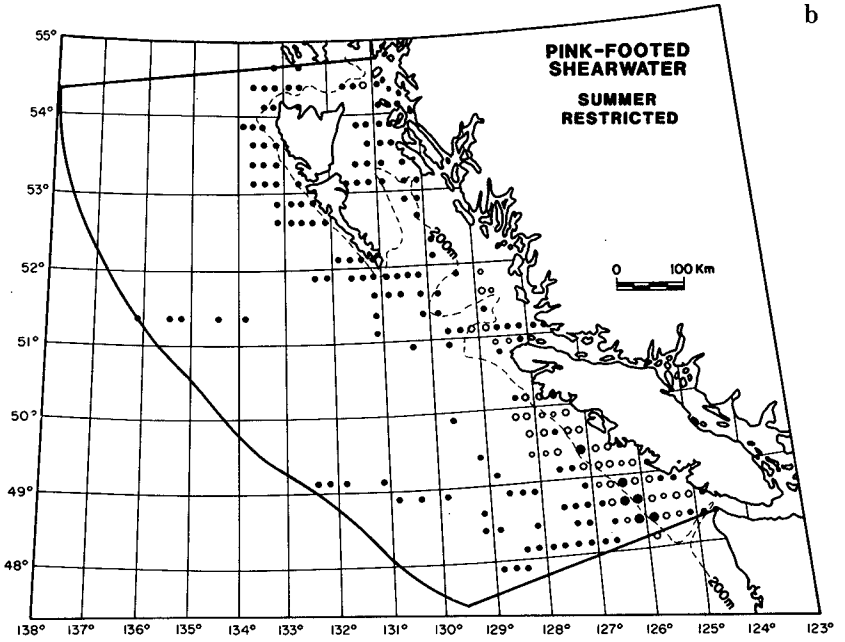
Pink-footed Shearwaters were most numerous from late June through August. The highest average densities again occurred over the shelf, especially at the shelf break off Nootka and Barkley sounds. On 24 August 1986, a flock of 140 birds was seen approximately 75 km southwest of Barkley Sound. Again, very few Pink-footed Shearwaters were observed north of Brooks Peninsula, nor were many encountered beyond the shelf break. Vermeer et al. (1987) suggested that the west coast of Vancouver Island may be the northern limit of the area in which they are regularly seen. The concentration of Pink-footed Shearwaters off Barkley Sound may have been related to the distribution of fishing boats. Wahl and Heinemann (1979) found that this species was significantly more abundant on days when there were fishing vessels present, suggesting that its distribution was being thus influenced over a large area.

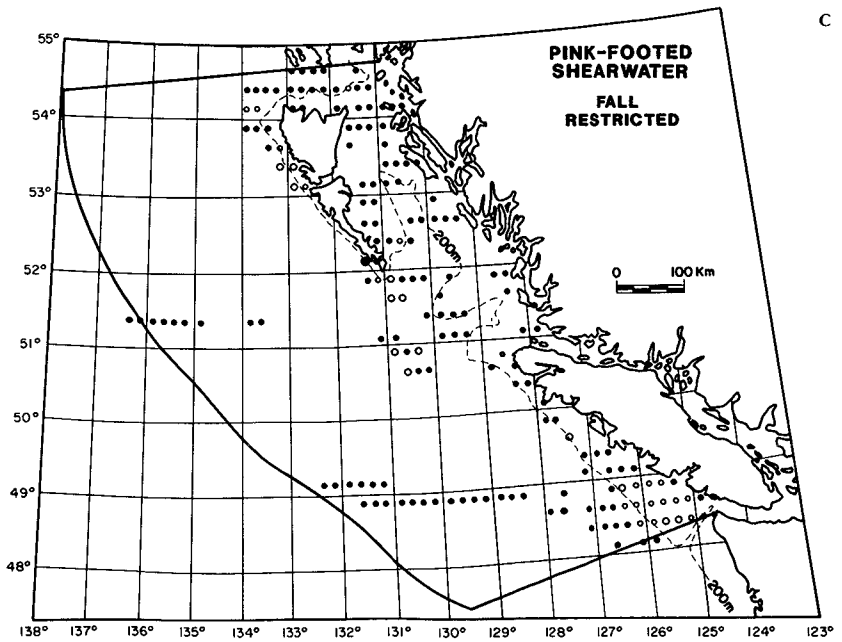
During fall, the largest group of Pink-footed Shearwaters was encountered on 21 October 1986, approximately 55 km southwest of Cape Beale. Twenty-five Pink-footed Shearwaters were seen feeding with an estimated 9000 to 10 000 California Gulls *Larus californicus*, 1200 Herring/Thayer's gulls (*L. argentatus/thayeri*), 900 Sooty/Short-tailed shearwaters (*Puffinus griseus/tenuirostris*), 650 Sabine's Gulls *Xema sabini*, and 500 Black-legged Kittiwakes *Rissa tridactyla*. Proportionately more birds were observed in fall near the Queen Charlotte Islands (especially along the west coast) than at any other time of the year. The largest group of Pink-footed Shearwaters observed near the Queen Charlotte Islands was a flock of 10 birds on 13 October 1984, 15 km southwest of Anthony Island. As usual, most Pink-footed Shearwaters were encountered over the shelf or at the shelf break. The latest date in the year on which this species was observed was 24 October 1984.

Pink-footed Shearwaters breed on Mocha and Juan Fernandez islands off the coast of central Chile. They return to their colonies in November and December; eggs are laid during December and January, and fledging and dispersal begin in late March to mid-May. Northbound migrants travel along the western coasts of South, Central, and North America, reaching California during April (Harrison 1983).

Figure 9
Average density of Pink-footed Shearwaters by season







Buller's Shearwater *Puffinus bulleri*

(Fig. 10a–c)

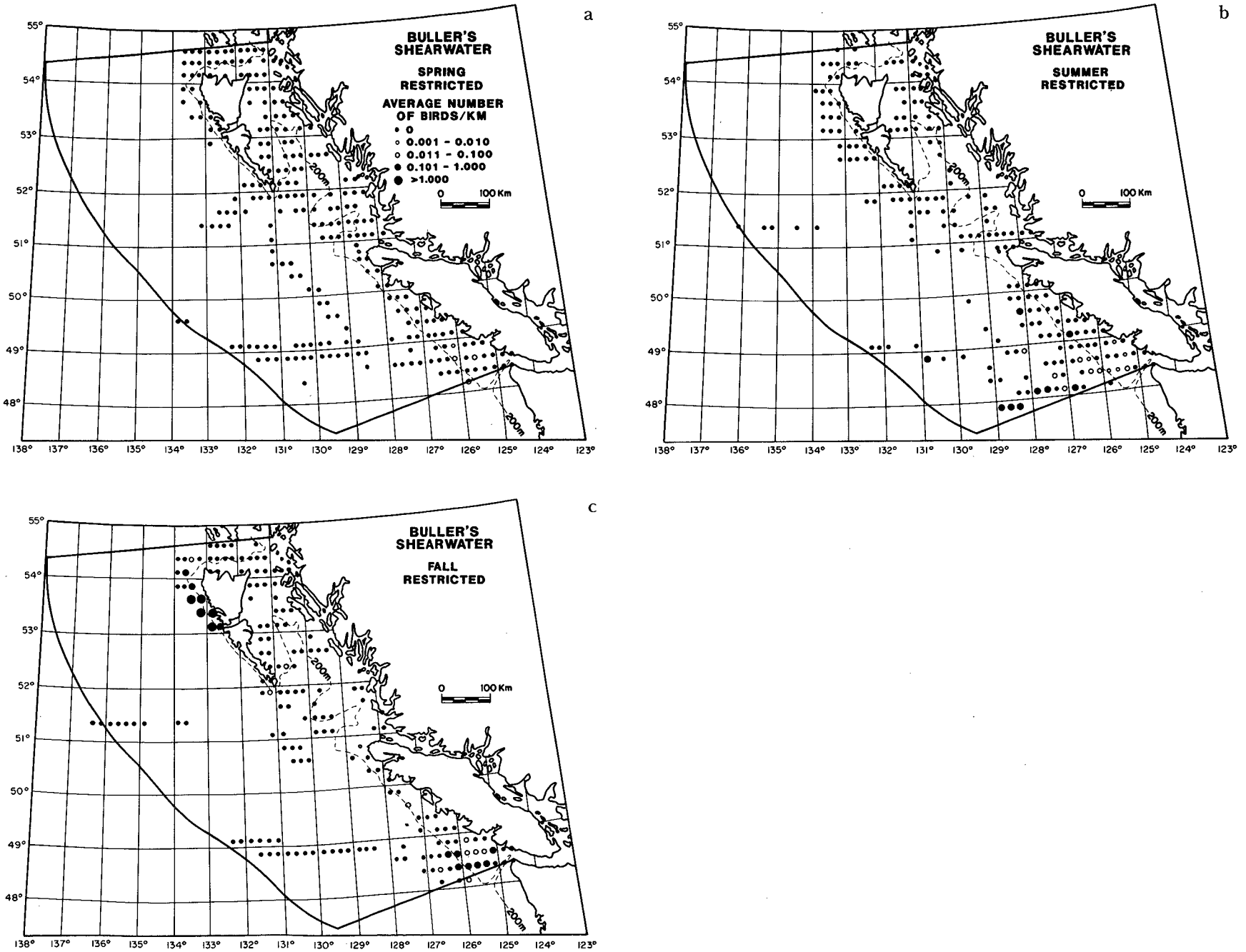
Buller's Shearwaters were observed in small numbers from late May to mid-June. The few records that we have for spring were obtained from the shelf waters off Barkley Sound. Our earliest observation of this species was on 24 May 1988.

Following an absence of a month and a half, this shearwater began to show up again, in greater numbers than in spring, in early August. Most Buller's Shearwaters occurred individually during summer, although they did occur occasionally in small flocks, usually of fewer than 10 birds. Most were seen well beyond the shelf break, although they were infrequently encountered less than 10 km from shore. Briggs et al. (1987) similarly found that the majority of Buller's Shearwaters off the coast of California were encountered seaward of the shelf break, usually on the warmer side of temperature fronts. We did not observe this species north of Vancouver Island during spring or summer.

Numbers were seen to build during early fall, with the highest densities occurring in October, when there was a major shift in distribution. In early fall, Buller's Shearwaters suddenly began to show up off the west coast of the Queen Charlotte Islands, being found almost exclusively over the shelf. The largest flock observed consisted of 50 birds resting on the water on 14 October 1984, about 12 km off the west coast of Graham Island. The latest observations of this species in the year occurred on 16 October 1984, off the Queen Charlotte Islands, and on 30 October 1984, off Barkley Sound.

According to Harrison (1983), Buller's Shearwaters return to the breeding colonies on the Poor Knights Islands, off New Zealand, during August and September. Egg laying takes place in November and December, and dispersal from the colonies begins in April. The two distinct periods of occurrence of Buller's Shearwaters that we observed off the British Columbia coast suggest that, in spring, the majority of the migrants pass British Columbia, well beyond the western limits of this atlas, perhaps en route to the Gulf of Alaska. The birds observed beyond the shelf during late August and early September could be individuals that spent the northern summer in the warmer pelagic waters off Vancouver Island. During fall, the sudden presence of Buller's Shearwaters off the west coast of the Queen Charlotte Islands suggests that the southward migration, in contrast to the movement in spring, follows the continental shelf.

Figure 10
Average density of Buller's Shearwaters by season



Leach's Storm-Petrel *Oceanodroma leucorhoa*

(Fig. 11a–d)

Leach's Storm-Petrels were observed, usually in low numbers, in each month in which surveys were conducted. Throughout most of the year, they were most abundant beyond the shelf break, most often seen as individuals or in small flocks of fewer than six birds, but occasionally in flocks of 80 to 100 birds. Off British Columbia, Vermeer and Rankin (1984) found a significant positive correlation between Leach's Storm-Petrel densities and surface water temperatures. Off California, Briggs et al. (1987) found that thermal and optical fronts coincided with the shoreline limit of the distribution of the species.

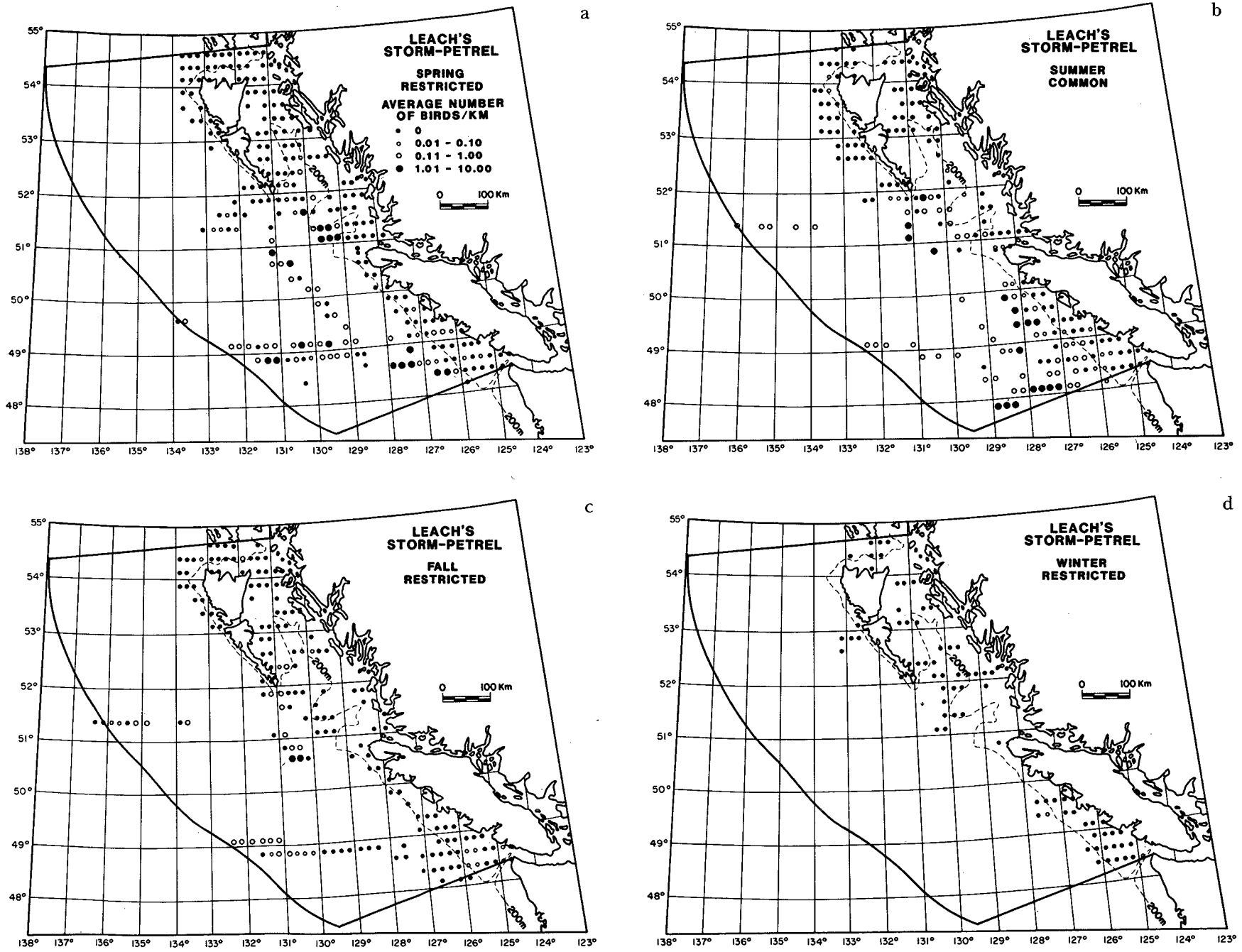
In spring, the areas with the highest average densities were the entrance to Queen Charlotte Sound and the deep oceanic waters off southern Vancouver Island. Leach's Storm-Petrels were rarely encountered north of Cape St. James. The largest group observed in spring was a feeding flock of 97 birds on 18 May 1989, approximately 100 km northwest of Triangle Island. The cluster of higher average densities northwest of Cape Scott may represent a prebreeding staging area for birds nesting in the Duke of Edinburgh Ecological Reserve.

The summer distribution of this species was similar to that observed in spring, although the birds were more widely dispersed, and the areas of high density were farther offshore. As in spring, very few Leach's Storm-Petrels were seen north of Cape St. James. The largest flock, consisting of 86 birds, was encountered on 13 August 1988, about 100 km west of Nootka Island.

In fall, smaller numbers of birds were observed at fewer locations, with most birds seaward of the shelf. The highest average density of Leach's Storm-Petrels occurred approximately 200 km west of Triangle Island. By October, this species was rare off the coast; thereafter, until late April to early May, it appeared to be almost absent from British Columbia waters — we recorded only three birds along nearly 1500 km of transects during winter.

On the Pacific coast, Leach's Storm-Petrels breed from Hokkaido, Japan, northeast to the Aleutian Islands and Alaska, and south along the continental North American coast to Islas San Benitos, Mexico (Harrison 1983). An estimated 550 000 pairs breed in British Columbia in at least 40 colonies. Approximately 275 000 pairs breed in the Duke of Edinburgh Ecological Reserve (Pine, Storm, and Tree islands at the entrance to Queen Charlotte Strait). An estimated 72 000 pairs nest on the Gillam Islands (at the entrance to Quatsino Sound), and roughly the same number nest on Solander Island (M.S. Rodway, unpubl. data). In the Queen Charlotte Islands, most egg laying occurs in July, hatching takes place primarily in August, and fledging occurs in October and November (Vermeer et al. 1988).

Figure 11
Average density of Leach's Storm-Petrels by season



Fork-tailed Storm-Petrel *Oceanodroma furcata*

(Fig. 12a–d)

Fork-tailed Storm-Petrels were observed from early March to late November, the majority over the outer shelf, although they were also encountered farther seaward. In the Bering Sea, the highest densities similarly occurred in the vicinity of the shelf break and over the outer shelf (Iverson et al. 1979). With the exception of waters close to breeding colonies, Fork-tailed Storm-Petrels off California were most abundant in upwelling areas that were seaward of the break but shoreward of the main Leach's Storm-Petrel foraging areas (Briggs et al. 1987).

The highest average spring density we found occurred seaward of La Pérouse Bank, approximately 60 km southwest of Barkley Sound. The cluster of higher average densities at the north end of Vancouver Island suggests that these waters may be important areas for prebreeding staging or foraging for the largest British Columbia colony at the Storm Islands. Although mostly individual birds or small flocks were seen, occasionally larger aggregations were found. The largest spring flock was a group of 220 birds seen on 12 June 1986 at the shelf break, approximately 60 km southwest of Barkley Sound.

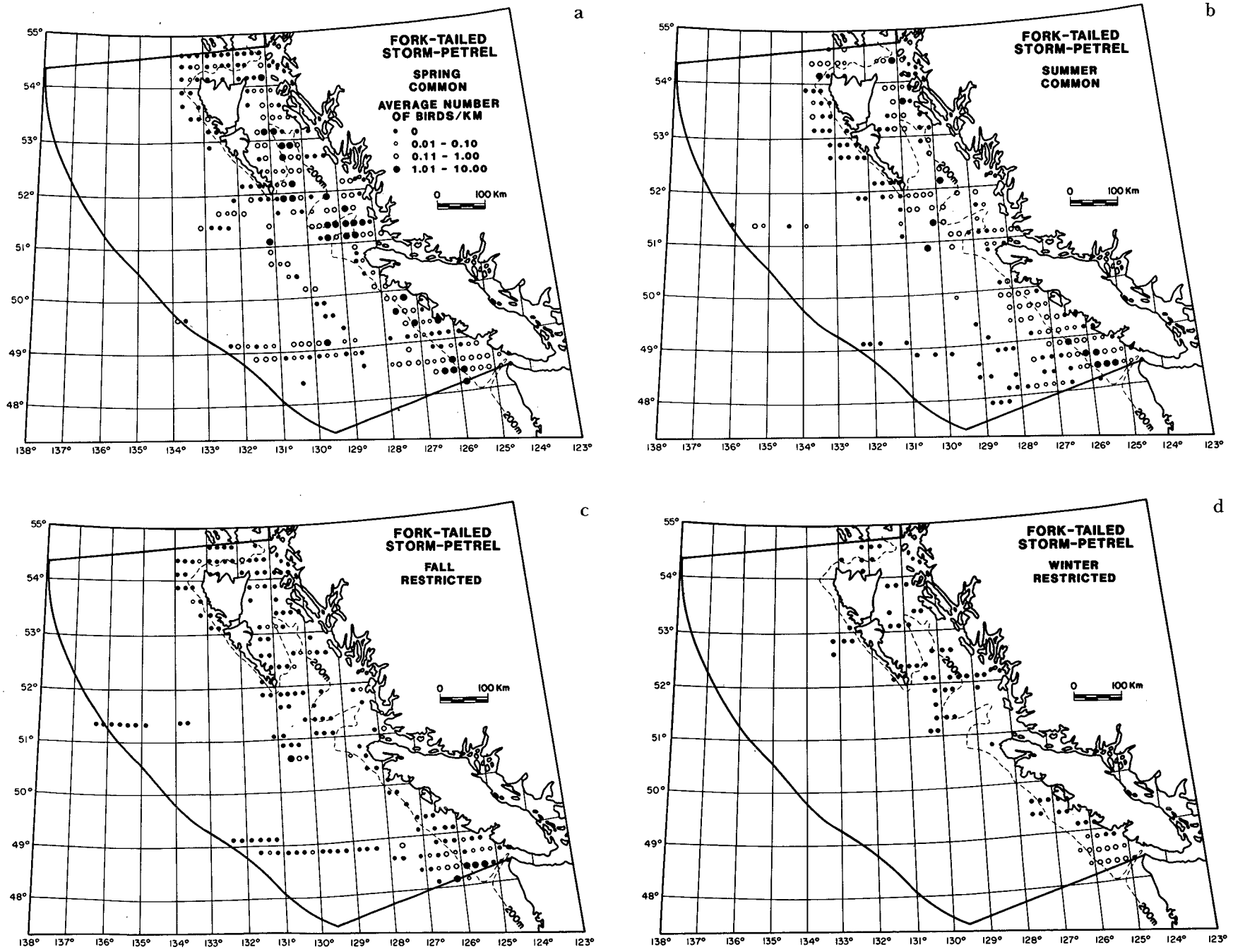
During summer, Fork-tailed Storm-Petrels were relatively more abundant but somewhat less widely distributed than in spring. Flocks of 50 to 100 birds were commonly encountered; the largest flocks were estimated at 2200 and 1050 birds on 18 August 1988 and 24 August 1989, respectively. Both of these flocks were found over La Pérouse Bank. Martin and Myres (1969) similarly found flocks with more than 500 birds over La Pérouse Bank during late August. On numerous occasions, Fork-tailed Storm-Petrels were seen foraging in mixed flocks behind fishing vessels that were discharging offal. This species frequently follows ships (Sanger 1970), yet Wahl and Heinemann (1979) noted that Fork-tailed Storm-Petrels were rarely attracted to boats discharging large-sized fragments.

Fork-tailed Storm-Petrels were still common in the last half of September but were rare by early October. Few birds were observed north of Cape Scott in the fall, with the majority occurring off the Strait of Juan de Fuca. As in spring and summer, shelf waters were preferred. The largest flock, consisting of about 275 birds resting on the water at the edge of La Pérouse Bank, was observed on 30 September 1988. By November, Fork-tailed Storm-Petrels were absent north of Cape Scott.

Fork-tailed Storm-Petrels were not observed during January and early February surveys. However, they are occasionally encountered, and two were sighted on 7 February 1990, approximately 40 km off Barkley Sound (J. Anderson, pers. commun.). During winter aerial surveys over the eastern Bering Sea, Hunt et al. (1981) observed Fork-tailed Storm-Petrels only over deep oceanic waters, never over the shelf. The rarity of this species in the fall, together with the concentration of winter sightings at the south-eastern limit of this atlas, suggests that the majority of Fork-tailed Storm-Petrels winter either far offshore or to the south of Canadian waters. The reappearance of this species in early March (our late winter) over La Pérouse and Swiftsure banks likely represents a northward movement back into Canadian waters.

Fork-tailed Storm-Petrels breed from the Kurile and Commander islands through the Aleutian Islands, along the Gulf of Alaska, and south to northern California (Harrison 1983). M.S. Rodway (unpubl. data) estimated that 190 000 pairs breed in at least 44 colonies in British Columbia. The largest colonies (Storm and Gillam islands) support almost 50% of the total British Columbia population. Fork-tailed Storm-Petrels likely return to their colonies during April; eggs are laid during May and June, and fledging occurs during August and early September (Vermeer et al. 1988).

Figure 12
Average density of Fork-tailed Storm-Petrels by season



Red-necked and Red phalaropes (*Phalaropus lobatus* and *P. fulicaria*)

(Fig. 13a–c)

Red-necked and Red phalaropes were observed usually in small numbers from early May to mid-November. The earliest sighting was that of two birds over Swiftsure Bank on 4 May 1982. During spring, most phalaropes were observed over the inner shelf, often close to shore. Several spring flocks of 100 to 200 birds were encountered. The largest flock, estimated at 540 birds, was seen on 21 May 1982, approximately 10 km east of Reef Island in the Queen Charlotte Islands. Of the phalaropes identified to species in spring, 98% were Red-necked. Martin and Myres (1969) stated that Red Phalaropes normally stayed well offshore of the British Columbia coast during their northward migration. Similarly, Briggs et al. (1987) noted that it was rare to find Red-necked Phalaropes more than 50 km from the California coastline.

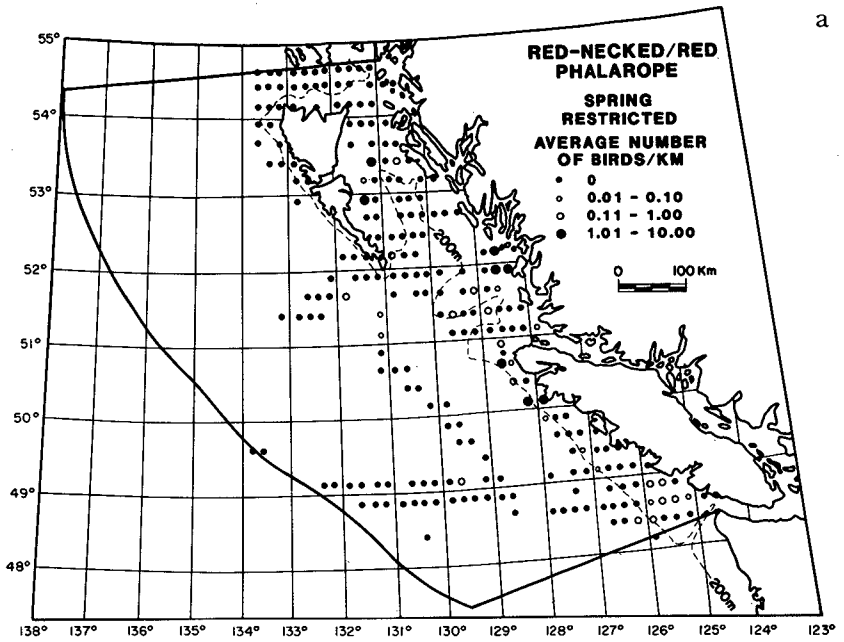
Phalaropes were more common during summer, especially in late August. Most birds were still observed over the shelf, but they became more common beyond the break than in spring. The biologically productive waters of Swiftsure and La Pérouse banks had the greatest densities of phalaropes. The concentration of phalaropes in areas of upwelling and along convergence fronts is well known (Haney 1986a). However, the high density of the birds over these banks may also have been related to the many cetaceans foraging in the area, especially humpback whales *Megaptera novaeangliae* and Dall's porpoises *Phocoenoides dalli*. For example, on 17 August 1988, a flock of at least 350 phalaropes was observed closely following two or three actively feeding humpback whales. Associations between phalaropes and whales have been well documented (Mayfield 1984). Approximately 94% of the summer phalaropes that were identified to species were Red-necked Phalaropes.

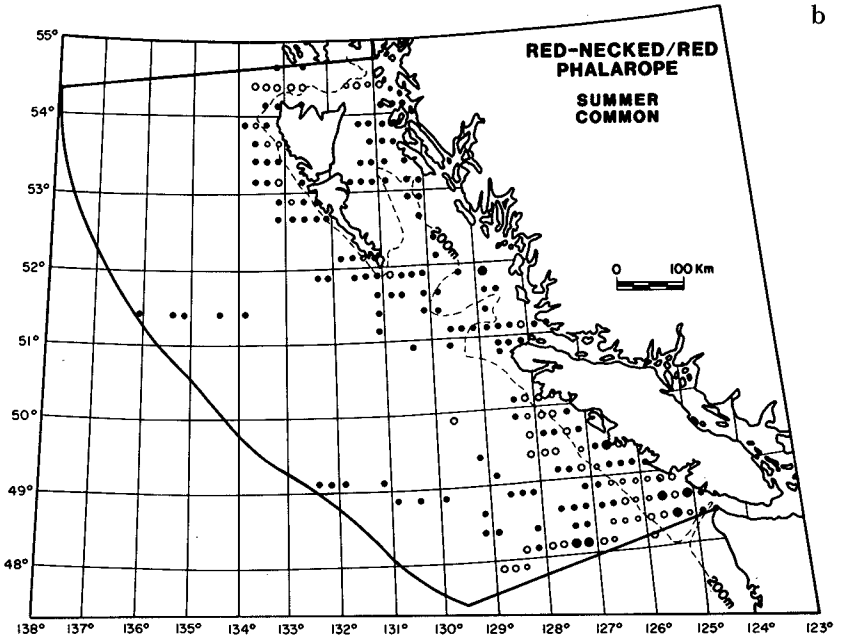
By fall, phalaropes had a more restricted distribution, and the number of birds observed had decreased. Flock size diminished as well, it being unusual to see more than 10 birds together. The largest group observed during this season was a flock of 36 birds on 6 October 1987, at the edge of Swiftsure Bank. Most phalaropes occurred over the shelf, although they were occasionally encountered far offshore. The birds that were observed far offshore were most likely Red Phalaropes. Harrison (1983) suggested that, during the fall migration, Red Phalaropes that have bred in northern Asia move southeast across the North Pacific. Of the phalaropes that were identified to species in the fall, roughly 70% were Red-necked Phalaropes. Whether this represents an actual increase in the number of Red Phalaropes or simply a decline in the number of Red-necked Phalaropes is unknown. The latest dates in the year on which this species group was sighted were 21 October 1984 in Hecate Strait and 2 November 1988 off Barkley Sound.

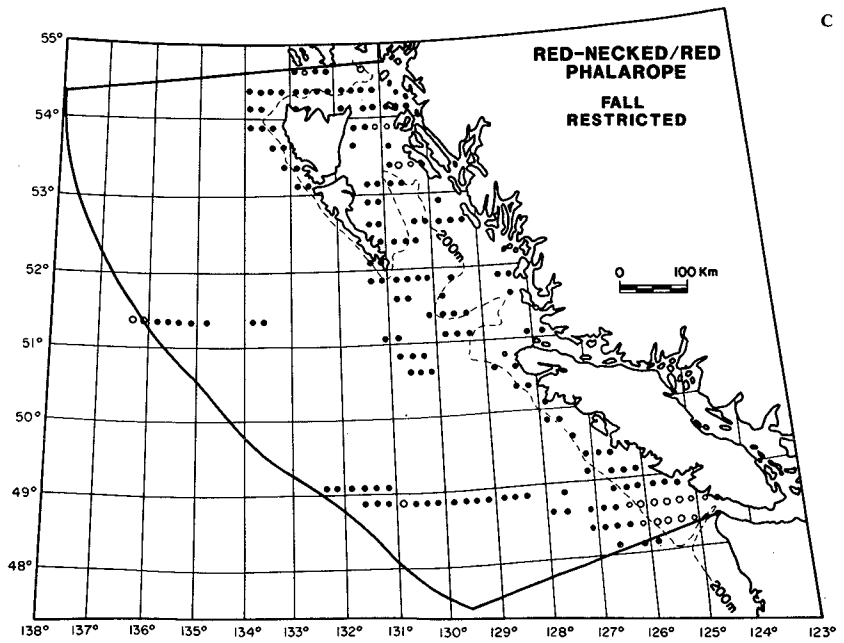
The breeding range of the Red Phalarope is circumpolar: in northern Siberia, Alaska, Canada, Greenland, and Iceland (Harrison 1983). Red Phalaropes are among the latest of the Arctic-breeding shorebirds to return north, even though they often gather by the tens of thousands in the Gulf of Alaska during May, waiting for the tundra to become relatively snow-free (Mayfield 1984). Most eggs are laid in late June to early July, and the departure begins in early August. The different breeding populations winter in different areas, mostly pelagically. Some apparently overwinter in the Gulf of Alaska and also off Washington and Oregon (T.R. Wahl, pers. commun.). The majority, however, spend the winter from California south to Peru, as well as in the Gulf of Mexico, off the west coast of Africa, and off the west coast of South America (Harrison 1983; Cramp et al. 1985).

Red-necked Phalaropes generally nest south of the main Red Phalarope breeding areas. They breed in low-Arctic and sub-Arctic zones, in Alaska, Canada, southern Greenland, Iceland, the Shetland Isles, Spitsbergen, Scandinavia, and the Soviet Union. Red-necked Phalaropes reach their breeding areas, via coastal and inland routes, between late May and early June; eggs are laid as little as 4 d later, and departure begins in mid-July (Harrison 1983; Mayfield 1984). This species may be encountered anywhere throughout the lower latitudes of the southern hemisphere during the austral summer, with concentrations off the coast of Peru and in the Arabian Sea, the northwest Indian Ocean, and the South China Sea (Harrison 1983; Cramp et al. 1985).

Figure 13
Average density of Red-necked/Red Phalaropes by season







Pomarine Jaeger *Stercorarius pomarinus*

(Fig. 14a–c)

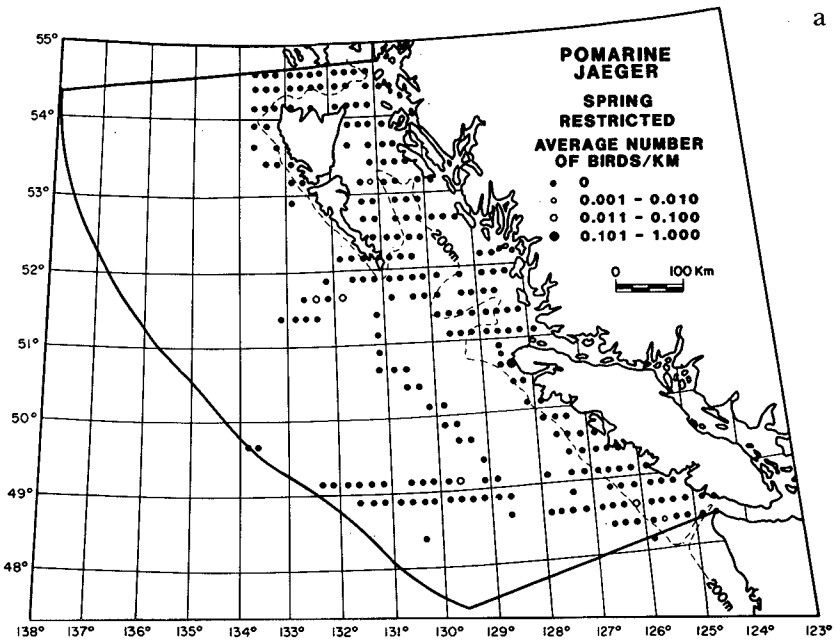
Pomarine Jaegers were found to be the most numerous of the four jaegers that frequent the North Pacific Ocean. The earliest record was on 11 May 1982. There were too few data from spring to provide any significant distribution pattern, but it appeared that most Pomarine Jaegers passed the British Columbia coast at or beyond the shelf break. The highest average spring density occurred north of Quatsino Sound.

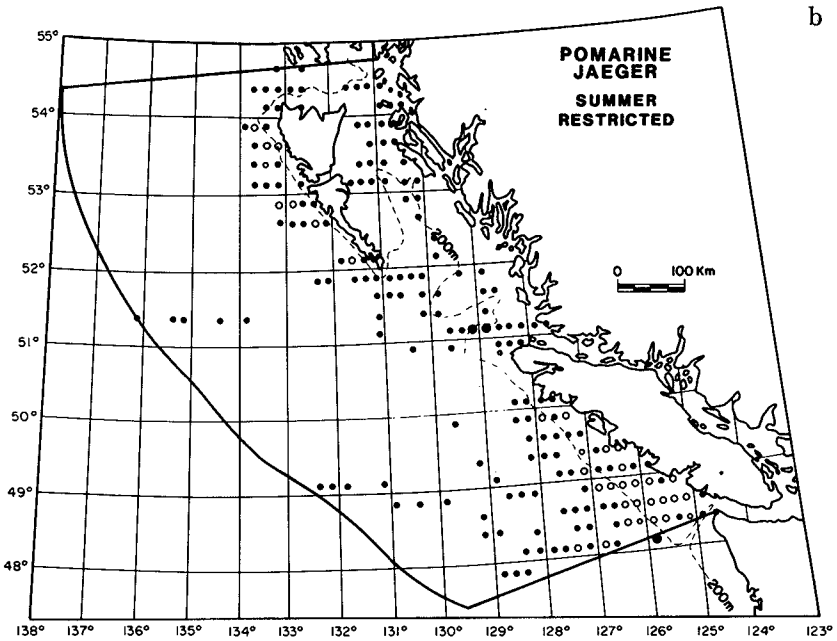
During summer, most Pomarine Jaegers were seen over the shelf or at the break. The highest average density occurred just north of Triangle Island. Martin and Myres (1969) noted that this species was a regular migrant over the Goose Island Bank, northeast of the area in which we found the highest density. The number of Pomarine Jaegers was highest during the last half of August and then quickly declined in early September. In years when there are sufficient prey (lemmings) for successful breeding, adults begin the southbound migration in late August to early September (Harrison 1983).

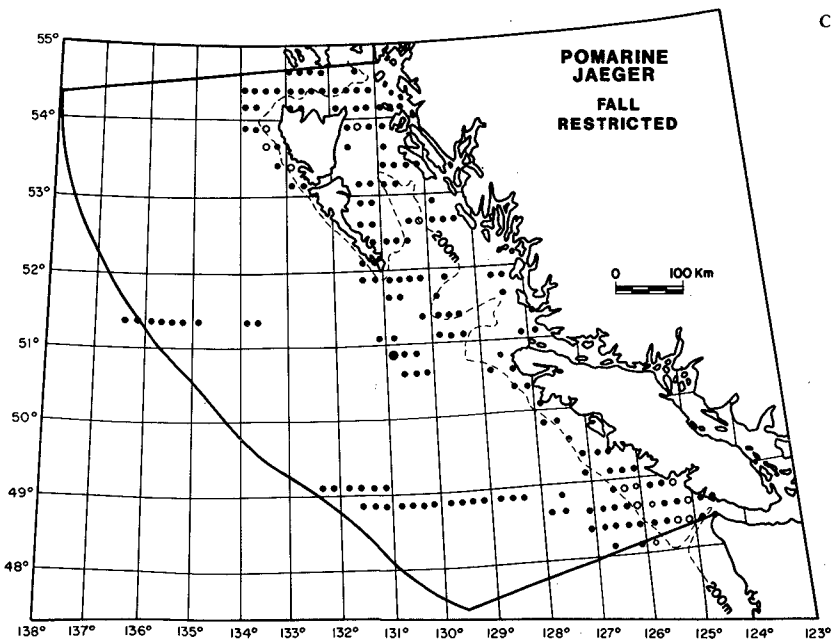
During fall, most Pomarine Jaegers were seen over the shelf, although they were occasionally found migrating well offshore. The highest average density occurred approximately 175 km west of Cape Scott. Vermeer et al. (1987) suggested that Pomarine Jaegers concentrated over the shelf break, primarily because this was the usual foraging area of Sabine's Gull *Xema sabini*, possibly one of their favourite piracy targets. The latest record of this jaeger species was on 31 October 1984.

Pomarine Jaegers have a circumpolar breeding range. In the Pacific, the main wintering area is off southeast Australia; a smaller number are found from southern California to Peru (Harrison 1983; Maher 1984; Cramp et al. 1985).

Figure 14
Average density of Pomarine Jaegers by season







Parasitic Jaeger *Stercorarius parasiticus*

(Fig. 15a-c)

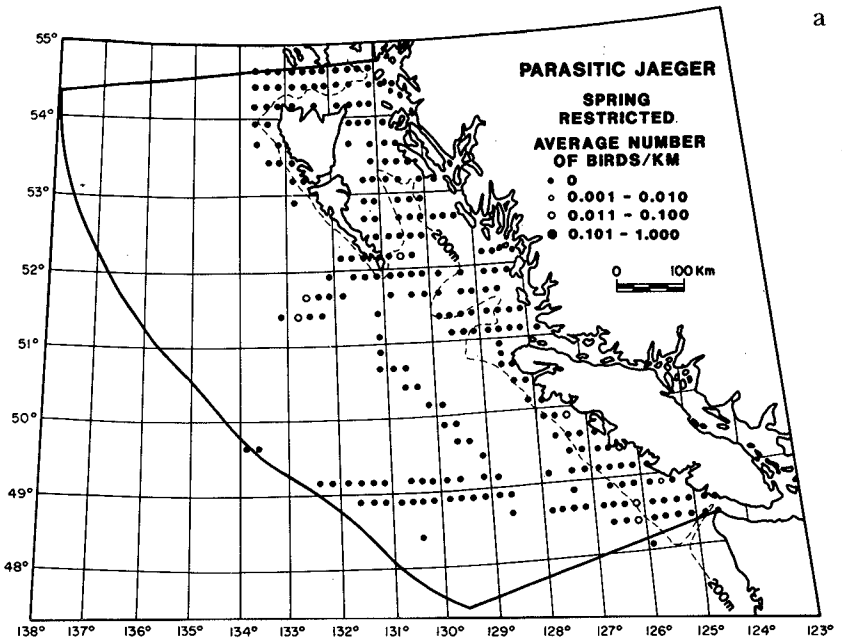
Parasitic Jaegers were observed during May and then again from mid-July to the end of October, always in small numbers. The earliest record was on 12 May 1982. There were too few data to demonstrate a distributional pattern for spring, although it appeared that Parasitic Jaegers are found off the British Columbia coast more briefly during spring than are Pomarine Jaegers.

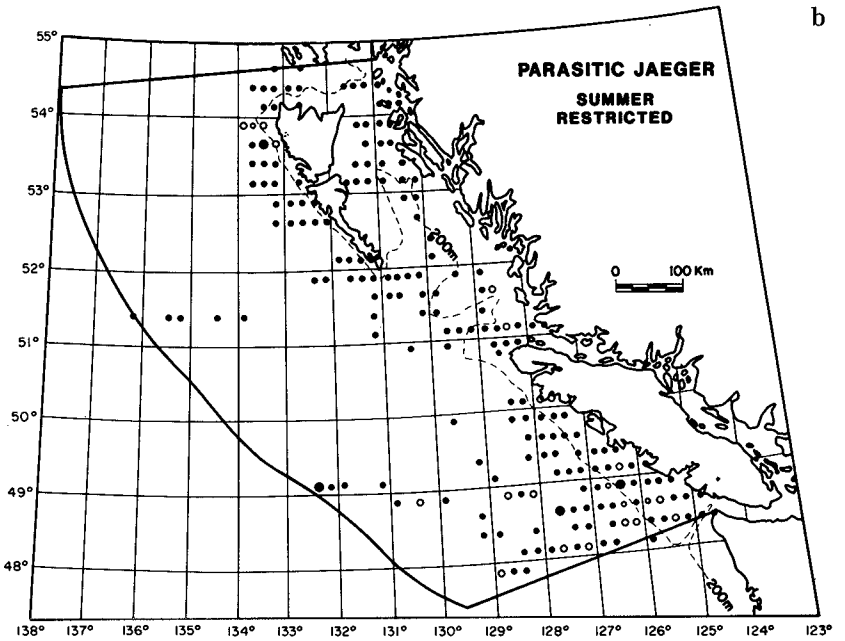
In the summer, most birds were seen at or beyond the shelf break. Two periods during which Parasitic Jaegers were relatively abundant were the last two weeks of August and, to a somewhat lesser degree, late September. We suggest that the earlier, greater peak consisted primarily of non-breeders or failed breeders, whereas successful breeders and immature birds dominated the secondary peak. Although Vermeer et al. (1987) found that this species was most frequent beyond the shelf, Briggs et al. (1987) noted that Parasitic Jaegers were a significant part of the avifauna only within 15 km of the California shore. The highest average summer density of this species occurred about 150 km west of Barkley Sound. Nonbreeding birds begin to leave the Arctic in July, and the main departure takes place from late August to early September (Harrison 1983).

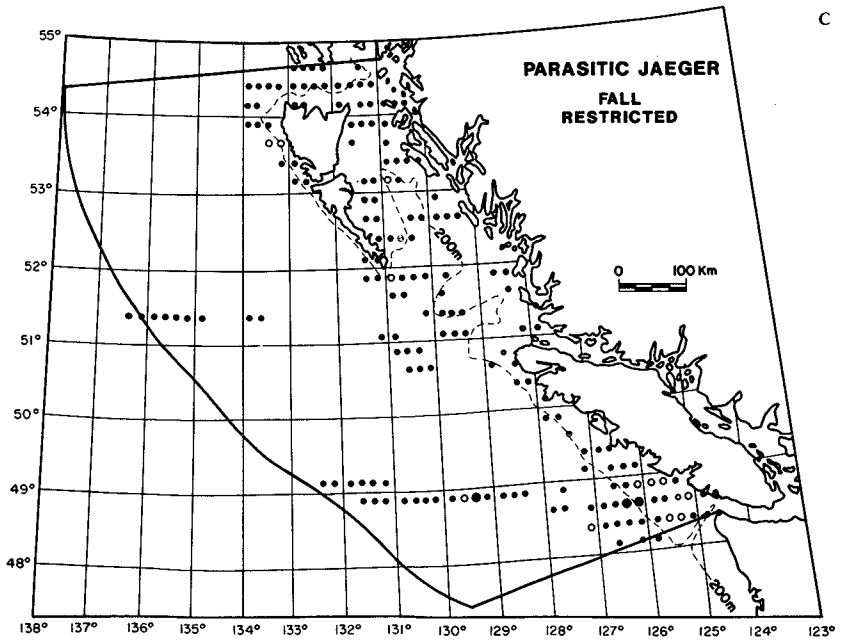
During fall, Parasitic Jaegers were observed over the shelf as well as far offshore. The highest average densities occurred at the shelf break. Harrison (1983) and Cramp et al. (1985) stated that most Parasitic Jaegers accompanied migrating Arctic Terns *Sterna paradisaea* during the fall passage. The latest date in the year on which this species was seen was 27 October 1988.

Breeding is circumpolar in Arctic areas. Known nesting areas include western Alaska, the Aleutian Islands, and northern Canada, south to Great Slave Lake, Hudson Bay, and northern Labrador. The species also nests in Greenland, Iceland, on islands off Scotland, in northern Europe, and along the Arctic coast of the Soviet Union. Parasitic Jaegers winter extensively in the Coral and Tasman seas and off western South America (Cramp et al. 1985).

Figure 15
Average density of Parasitic Jaegers by season







Long-tailed Jaeger *Stercorarius longicaudus*

(Fig. 16a–b)

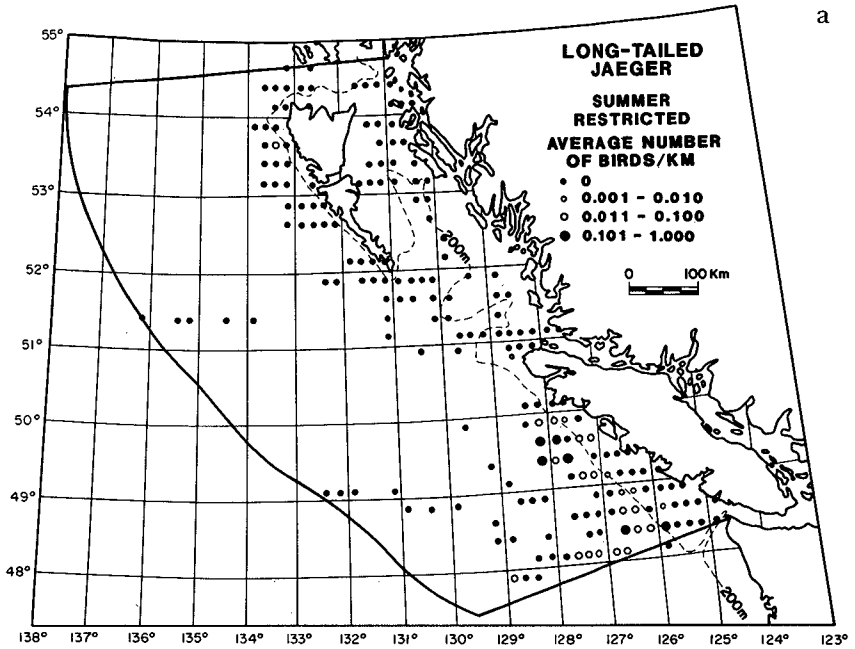
Long-tailed Jaegers were observed only twice during spring: offshore Barkley Sound on 12 May 1982 and northwest of Cape Scott on 14 May 1984.

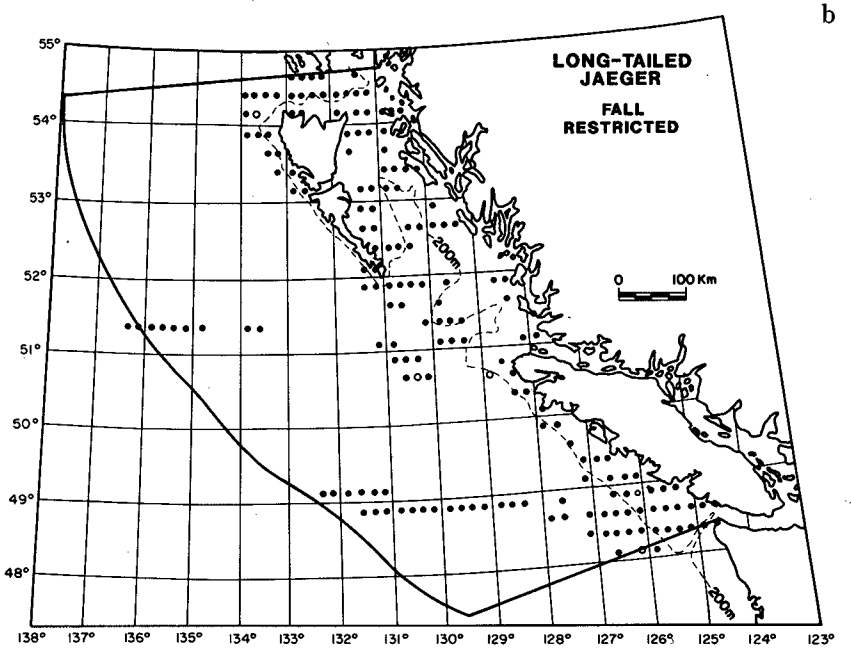
The majority (90%) of all sightings occurred in August, followed by a rapid decline in early September. Almost all observations of Long-tailed Jaegers occurred beyond the shelf break and south of Brooks Peninsula. The highest average density occurred approximately 100 km west of Nootka Sound. There were very few fall records of this species, and most of those occurred at the shelf break. The latest date on which this species was observed was 15 October 1984.

Long-tailed Jaegers are circumpolar high-Arctic nesters. Most birds reach their breeding grounds by late May, with nonbreeders arriving after the main influx. Eggs are usually laid between mid-June and early July (Harrison 1983; Maher 1984). In poor lemming years, Long-tailed Jaegers may fail to breed and can depart as early as mid-June. During successful breeding years, fledging and departure usually take place in late August. The southward migration occurs both overland (Morgan, pers. obs.) and far offshore. Long-tailed Jaegers are thought to overwinter in both the southern Atlantic and southern Pacific oceans, especially off South America, as well as off Namibia and South Africa (Harrison 1983; Cramp et al. 1985).

The scarcity of northbound birds observed off the British Columbia coast suggests that Long-tailed Jaegers migrate northward beyond the western limits of this atlas. In contrast, the southward movement, primarily during August, appears to be much more coastal. This species may be the least piratical of the jaegers; during migration, it feeds on carrion and offal from trawlers (Harrison 1983). The concentration of fishing vessels over the banks and the shelf break off Vancouver Island during late summer and early fall (Vermeer et al. 1989) might account for this apparent difference between the northward and southward migration routes of Long-tailed Jaegers.

Figure 16
Average density of Long-tailed Jaegers by season





Herring and Thayer's gulls (*Larus argentatus* and *L. thayeri*)

(Fig. 17a–d)

Herring and Thayer's gulls were observed in every month that surveys were conducted, primarily over shelf waters, but occasionally far offshore. Vermeer et al. (1987) were of the opinion that Herring Gulls were irregular visitors off the southwest coast of Vancouver Island from May until March, whereas Thayer's Gulls were numerous only from October to March.

The highest average spring densities of this species pair occurred in Hecate Strait, especially to the northwest of Banks Island. The largest single aggregation found was a resting flock of 115 birds, observed on 12 April 1984 about 30 km west of Banks Island. We estimate that, for the entire coast, Herring Gulls represented at least 90% of this species pair during spring.

In summer, all observations of this species pair occurred over the shelf or just seaward of the shelf break. The highest average densities again occurred near the west coast of the Queen Charlotte Islands. In summer, most Herring Gulls seen off the coast of Vancouver Island were subadults and first-year birds (Vermeer et al. 1987). The largest single summer flock of this species pair was encountered on 15 September 1983 — a feeding flock of 96 birds approximately 50 km west of Hippa Island.

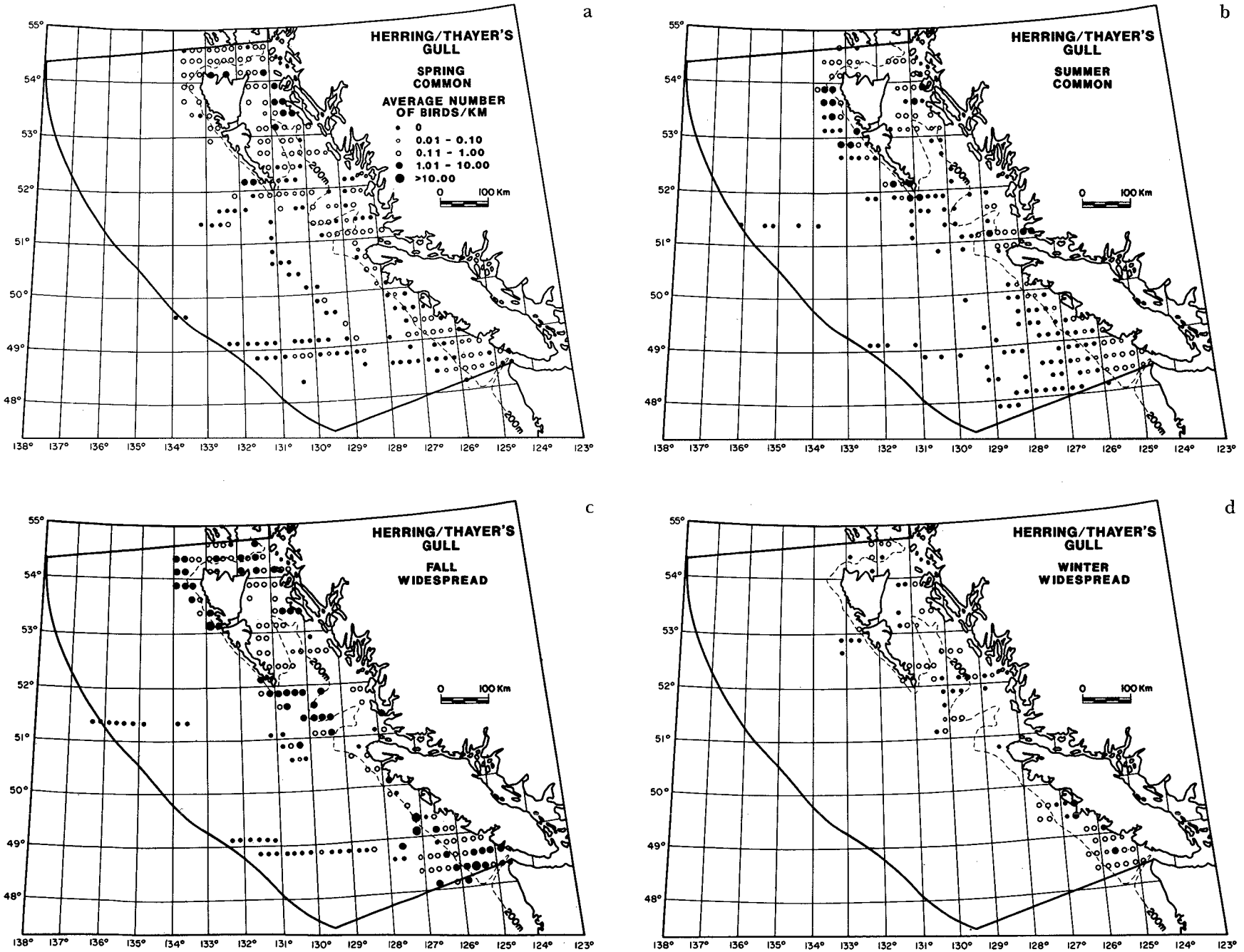
The influx of Thayer's Gulls began in early September. By October, it was estimated that Thayer's Gulls comprised at least 75% of this species pair off southwest Vancouver Island; by the last half of November, the percentage had increased to at least 95%. Along the northern coasts, a limited sample of birds identified to species indicated that no more than 25% of this species pair were Thayer's Gulls during the fall. The majority of Herring/Thayer's gulls were observed over the shelf, with the highest average densities occurring at the shelf break. The overall highest average fall density occurred approximately 65 km southwest of Nootka Sound, and the largest single flock (1200 birds) was observed on 21 October 1986, about 55 km southwest of Cape Beale. Examining the fall distribution of seabirds off southwestern Vancouver Island, Vermeer et al. (1989) found no significant difference in the average number of Thayer's Gulls in various water depths and distances from land, suggesting that Thayer's Gull was not truly a pelagic species. Instead, their presence and distribution in fall were likely determined by the location of the fishing fleet. During the present study, flocks of many hundreds of Herring/Thayer's gulls were encountered around fishing boats. Wahl and Heinemann (1979) observed that Herring Gulls were often attracted to fish remains.

The limited data indicate that this species pair was relatively abundant during winter. Although most of the winter surveys took place over the shelf, it seemed that this species pair was found mostly inshore of the shelf break. The highest average winter density occurred south of Estevan Point. Off Vancouver Island, approximately 90% of this species pair was composed of Thayer's Gulls; north of Cape Scott, Thayer's Gulls represented only about 35% of the birds observed.

The taxonomy of the Herring Gull is complex; there are at least 10 subspecies, many having distinct breeding areas. The subspecies that occurs in British Columbia (*L. a. smithsonianus*) is confined chiefly to North America, breeding from southeast Alaska south to south-central British Columbia, east through Alberta, Saskatchewan, Manitoba, and Ontario, and south to North Carolina. This subspecies winters from Alaska south to California, in the Great Lakes region, and from Newfoundland south to Panama and the West Indies (Harrison 1983; Campbell et al. 1990). Many of the birds that overwinter on the Pacific coast move south, sometimes well offshore, to scavenge from the fishing fleet (Drury 1984).

The taxonomy of Thayer's Gull is even more complex than that of the Herring Gull. The former has been treated as a separate species, then as a race of the Herring Gull, and then reinstated as a full species in 1972 (American Ornithologists' Union 1973). Recent information on interbreeding between Thayer's Gulls and Iceland Gulls *L. glaucoides* prompted Godfrey (1986) to treat Thayer's Gull as a subspecies of the Iceland Gull. Thayer's Gulls breed in Arctic Canada east to Baffin Island, as well as in northwestern Greenland. Most overwinter along the Pacific coast of North America as far south as California and, occasionally, Mexico. The main wintering areas are northwestern Washington and southwestern British Columbia (Campbell et al. 1990).

Figure 17
Average density of Herring/Thayer's gulls by season



California Gull *Larus californicus*

(Fig. 18a–c)

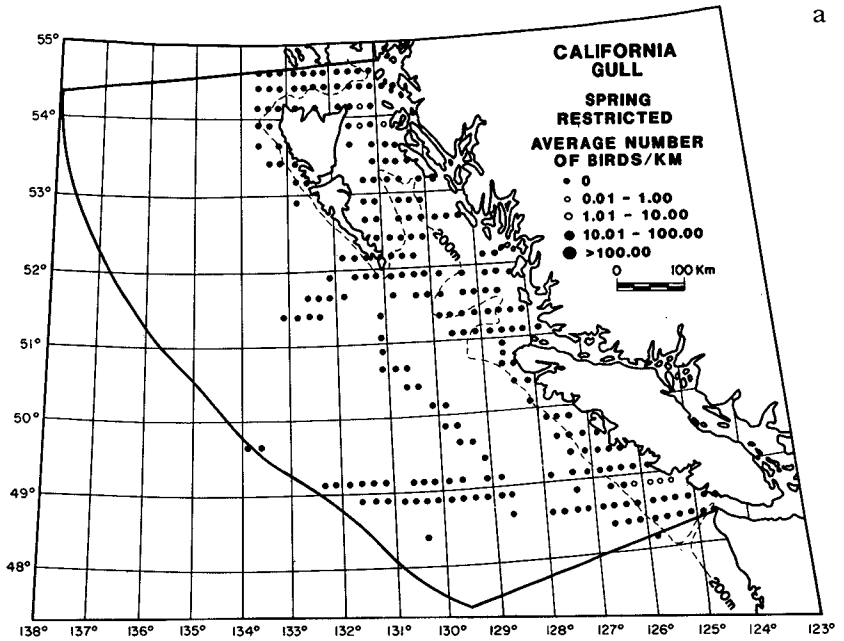
California Gulls were observed from late May until mid-November, almost always over the shelf. The earliest sighting was on 29 May 1988. During spring, only immature and subadult birds were observed. The highest average spring density of California Gulls occurred between Long Beach and Tofino. Martin and Myres (1969) noted that California Gulls were numerous off Ucluelet during the first week of April but were rare by May. This suggests either that there was a rapid northward migration past southwestern British Columbia in the latter part of April or that some of the gulls seen by Martin and Myres (1969) were birds that had overwintered. Campbell et al. (1990) stated that many California Gulls overwinter along the south coast, that the peak spring movement occurs in the first half of April, and that some immature birds remain along southwestern Vancouver Island during the breeding season, rather than migrating to the colonies.

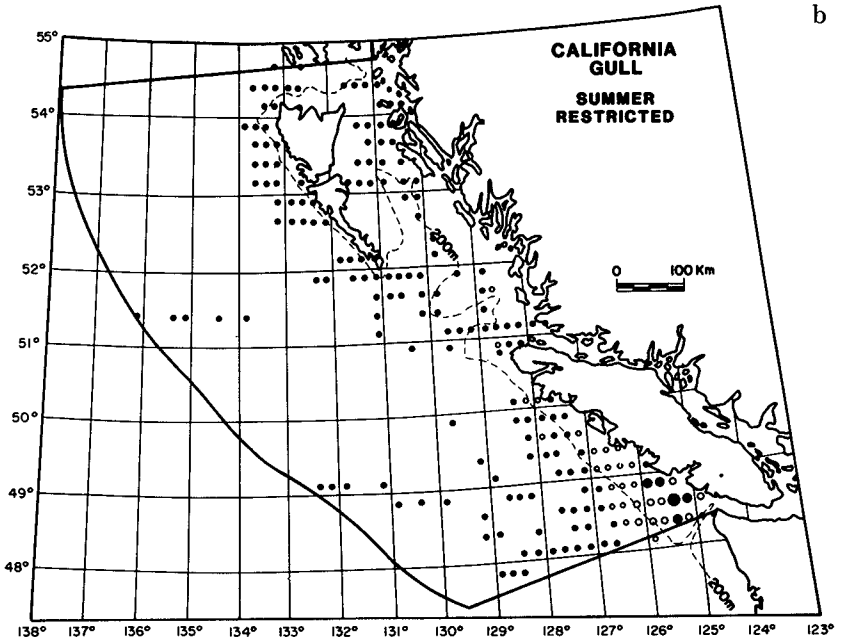
The influx of California Gulls to southwest Vancouver Island began in late June, and they were abundant by mid-July. In contrast, this species was not observed in pelagic waters north of Queen Charlotte Sound during summer. Recent observations indicate that this species begins to build up on the east coast of the Queen Charlotte Islands in late July (Morgan, pers. obs.). The largest single flock (15 000 birds), and consequently the area with the highest average density, occurred just west of Swiftsure Bank on 24 August 1989. These gulls, about 5 km from the nearest of several factory ships, appeared to be either resting after having fed or awaiting the discharge of offal.

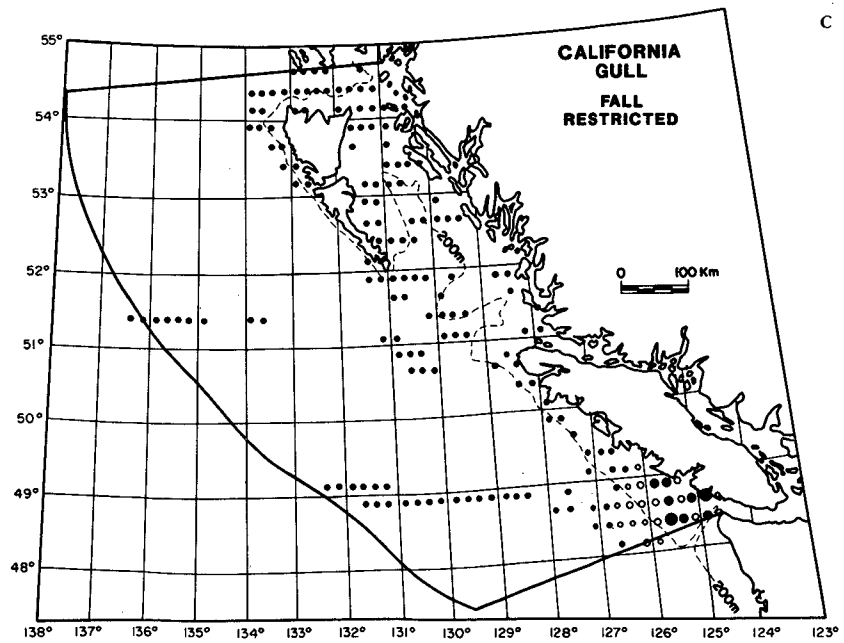
The number of birds continued to increase in early fall, peaking in September. Although the California Gull was numerically the dominant species in fall, it was very restricted in its pelagic distribution. No sightings of this species were made in fall north of Clayoquot Sound, almost all sightings being from the shelf waters off Barkley Sound and the Strait of Juan de Fuca. On 18 September 1986, the largest single fall aggregation of California Gulls was observed over Swiftsure Bank. An estimated 10 000 to 12 000 gulls in a loose flock were feeding on schools of small, unidentified fish. On numerous occasions during fall, very large flocks (10 000 to 15 000 birds) were encountered around factory ships, and as many as 20 000 were observed roosting along the shoreline. These were not included in this analysis. Vermeer et al. (1989) found that this species occurred significantly more often close to shore, but in significantly higher numbers offshore. This apparent contradiction resulted from a few observations of huge flocks over the outer shelf. The departure of California Gulls from the waters off the southwest coast was very rapid. By mid-October, the number of birds had dramatically declined; by the second week in November, they were gone from the pelagic waters off British Columbia. The latest in the year California Gulls were observed was 2 November 1988.

California Gulls breed in the interior of North America, from the southern Mackenzie delta through the Canadian prairies, in south-central British Columbia, and in Washington, Oregon, east-central California, Utah, Montana, and North Dakota. Egg laying occurs from May through June, and fledging and dispersal begin in August (Vermeer 1970). California Gulls overwinter from southern British Columbia to Baja California (Harrison 1983; Campbell et al. 1990).

Figure 18
Average density of California Gulls by season







Glaucous-winged Gull *Larus glaucescens*

(Fig. 19a-d)

Glaucous-winged Gulls were encountered in every month that surveys took place. The highest densities were observed over the shelf, although the birds were occasionally seen far offshore. At Ocean Station "P," Glaucous-winged Gulls were numerous during the winter and spring. This was followed by a rapid decline in numbers as the gulls moved inshore to coastal breeding colonies in late April and early May (Vermeer et al. 1983). The highest average spring densities occurred west of Estevan Point and over the inner shelf waters off Tofino and Long Beach. Vermeer and Rankin (1984) found that Glaucous-winged Gulls were abundant near the Queen Charlotte Islands during May, but their numbers declined after May. During spring, most Glaucous-winged Gulls were seen either as individuals or in small flocks of typically fewer than 10 birds.

The summer distribution of this species was restricted primarily to shelf waters, especially those off Barkley Sound. The areas of highest average densities corresponded roughly with the locations of the larger Glaucous-winged Gull colonies found along the outer coast of British Columbia (Cleland, Solander, Thornton, and Gillam islands; Vermeer, unpubl. data). Martin and Myres (1969) similarly observed that Glaucous-winged Gulls were seldom seen far from the colonies during the nesting season. The largest single group observed in the summer was found on 16 June 1988 at the edge of La Pérouse Bank. Approximately 135 gulls were feeding on a raft of Pacific hake *Merluccius productus* floating on the water. These fish had, either accidentally or intentionally, been dropped from the nets of a fishing vessel. Other than this large flock, most birds were seen as individuals or in small groups.

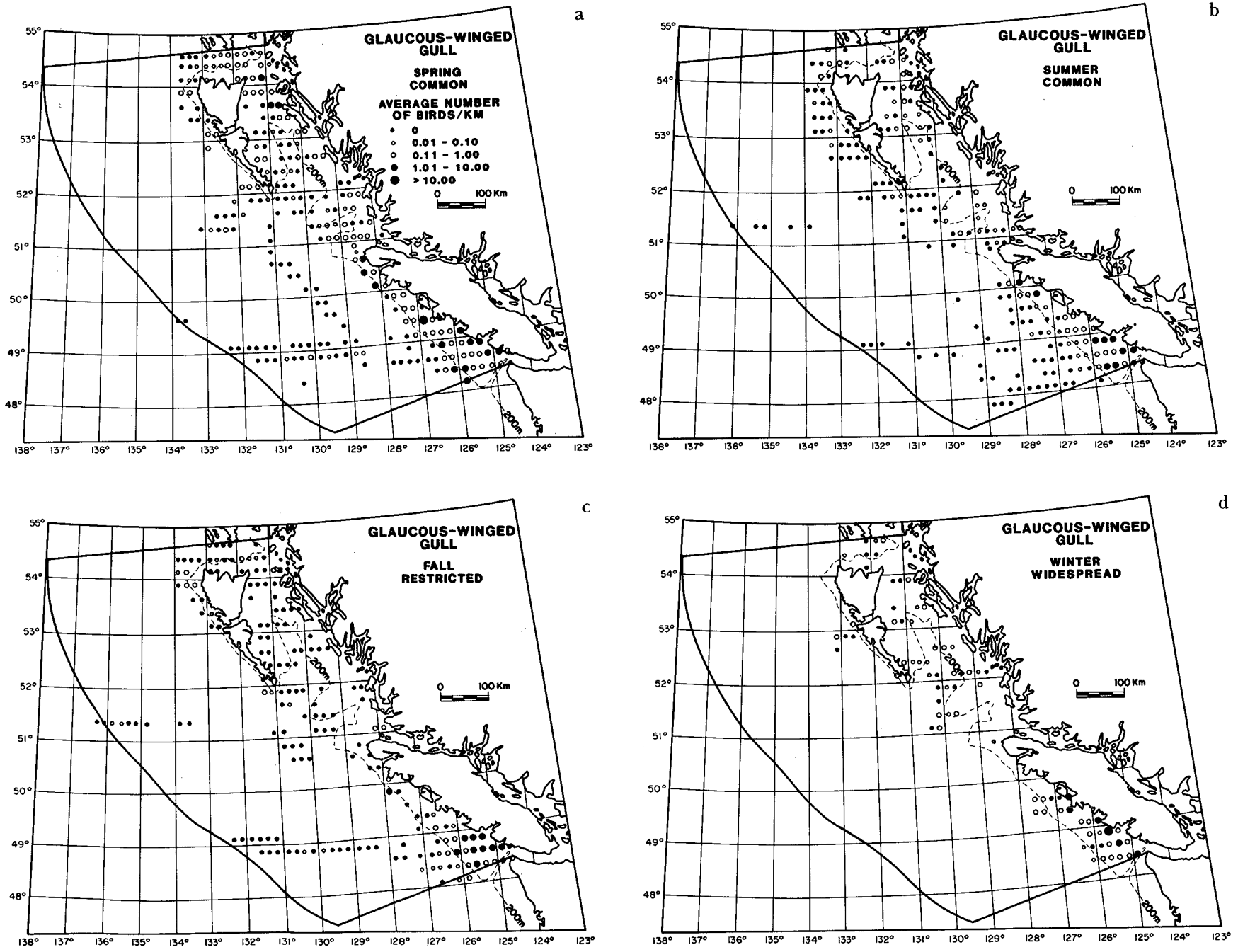
During fall, this species occurred mostly over the shelf, although it was also common farther offshore. Vermeer et al. (1989) found that, during September and October, adult and immature Glaucous-winged Gulls occurred significantly more often over nearshore, shallow waters (those within 15 km of land and less than 60 m deep) than over more distant, deeper waters. Flocks of hundreds of Glaucous-winged Gulls were encountered attending trawlers and factory ships during this study. Wahl and Heinemann (1979) suggested that this species was attracted to offal and to mixed feeding flocks.

Not including birds associated with fishing vessels, the largest single fall flock encountered was one of approximately 175 gulls, feeding on small fish near the water's surface, about 2 km east of Swiftsure Bank, on 20 October 1986. On 28 September 1986, a group of 140 Glaucous-winged Gulls had been found in the same location.

Glaucous-winged Gulls were relatively abundant and widespread during the winter, with the highest average densities occurring over the inner shelf. The largest winter flock, and consequently the highest average density, was encountered on 3 March 1982 — a group of approximately 1800 birds was observed feeding over Amphitrite Bank.

The Glaucous-winged Gull breeds on the coast and islands of the southern Bering Sea and from the Commander and Aleutian islands south throughout the Gulf of Alaska to northwest Washington (Harrison 1983). This is the only gull species that breeds on marine islands off the coast of British Columbia (Drent and Guiguet 1961). There were about 6000 pairs breeding along the west coast of Vancouver Island in 1989 (Vermeer, Morgan, and P.J. Ewins, unpubl. data), and the total breeding population in the Queen Charlotte Islands was estimated at 2600 pairs in 1986 (Rodway 1988). Along the west coast of Vancouver Island, adult Glaucous-winged Gulls begin to establish territories in April. Clutch commencement likely begins during the last half of May and the beginning of June, and fledging and colony departure occur during August (Vermeer, pers. obs.). Most Glaucous-winged Gulls overwinter within their breeding range, although some disperse as far south as Baja California and as far west as Japan (Harrison 1983).

Figure 19
Average density of Glaucous-winged Gulls by season



Black-legged Kittiwake *Rissa tridactyla*

(Fig. 20a–d)

Black-legged Kittiwakes were observed in every month that surveys were conducted, except July and August. During spring, off Vancouver Island, most birds occurred over shelf waters, whereas north of Cape Scott this species was seen both nearshore and offshore. The highest average density occurred about 100 km southwest of Cape St. James. Most kittiwakes were seen either individually or in small flocks. The largest flock observed in spring was of 35 birds, found on 15 May 1983 approximately 12 km west of Banks Island. Martin and Myres (1969) stated that this species was regularly encountered from the end of March, although only immature birds were present after the second week of May.

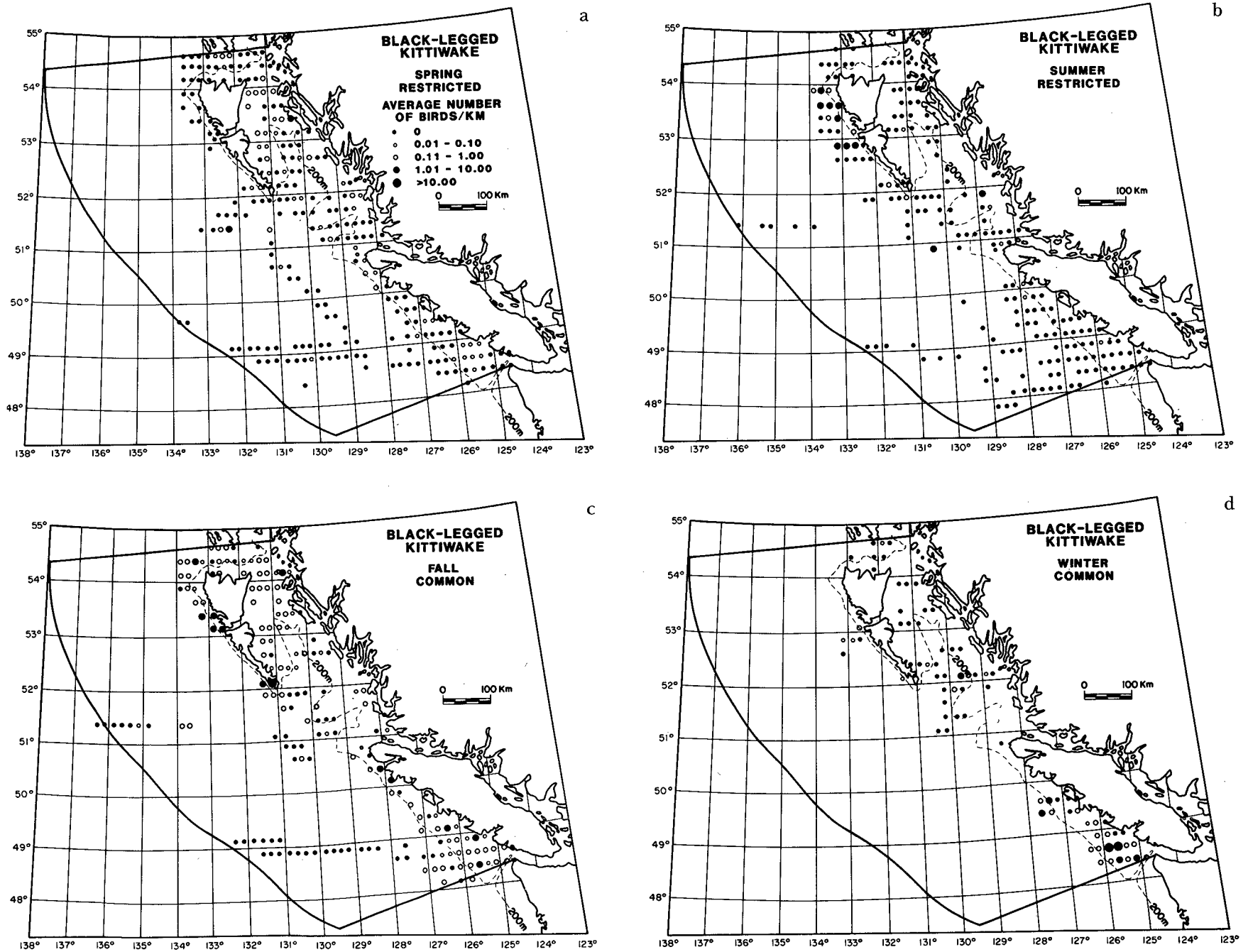
During the last two weeks of summer, kittiwakes were relatively abundant, primarily off the west coast of the Queen Charlotte Islands. This sudden increase in abundance likely represented postbreeding dispersal from Alaskan colonies. Although single kittiwakes were still encountered, it became more common to find flocks of 10 to 20 birds. The largest flock observed, on 14 September 1983, consisted of a mixed feeding flock, estimated to contain 105 kittiwakes, about 50 km west of Graham Island.

Most kittiwakes observed in fall were found either over the shelf or just seaward of the shelf break; they were more common far offshore in fall than at other times of the year, as has been noted elsewhere. Vermeer et al. (1983) found that kittiwakes reached their peak abundance at Ocean Station "P" between September and late November. The highest average fall density of kittiwakes occurred southwest of Cape St. James, whereas the largest group was found at the edge of La Pérouse Bank: an estimated 500 kittiwakes in a mixed flock feeding on small fish on 21 October 1986.

Black-legged Kittiwakes, together with Glaucous-winged and Thayer's gulls (*Larus glaucescens* and *L. thayeri*), were among the most frequently observed species during pelagic surveys in late January and early February 1990. Off southwest British Columbia, kittiwakes were at their highest relative abundance in early March, which may be related to the timing of their northbound migration. From our limited data, it appears that kittiwakes were most abundant over the shelf in winter. The highest average winter density occurred at the edge of La Pérouse Bank. The largest group seen was a flock of 70 birds resting on the water approximately 25 km southwest of Barkley Sound on 7 March 1985.

This species is almost circumpolar, nesting on rocky cliff faces in sub-Arctic and Arctic regions. The subspecies that occurs off the coast of British Columbia (*R. t. pollicaris*; Godfrey 1986) breeds from Wrangel Island south to the Aleutian and southern Kurile islands. Breeding birds return to their colonies between February (southern colonies) and May (northern). Eggs are laid between May and July, and fledging occurs between July and August. The birds overwinter oceanically, as far south as Japan and Baja California (Harrison 1983).

Figure 20
Average density of Black-legged Kittiwakes by season



Sabine's Gull *Xema sabini*

(Fig. 21a-c)

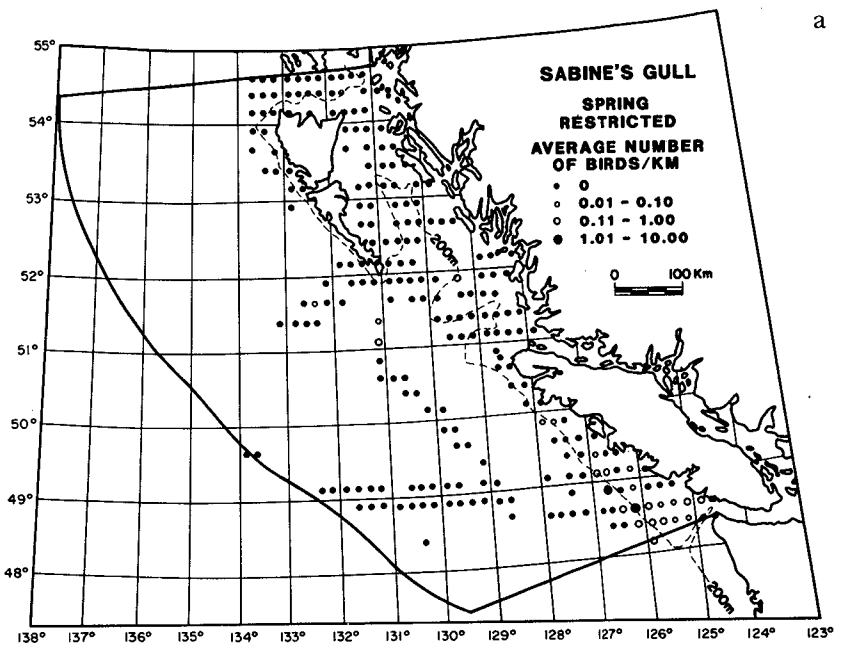
Sabine's Gull is the most pelagic of the gull species that regularly visit the west coast of Canada (Vermeer et al. 1989). Sabine's Gulls were observed from mid-May until the end of October. The earliest record was of a single bird seen on 11 May 1982, approximately 75 km southwest of Cape St. James. The majority of spring observations were over the shelf and the shelf break, especially off southwest Vancouver Island. Martin and Myres (1969) found this species to be numerous in Queen Charlotte Sound in late spring; in the 1980s, Sabine's Gulls were relatively scarce north of Clayoquot Sound. The highest average spring density occurred at the shelf break approximately 60 km southwest of Barkley Sound, the location of the largest single flock observed in any spring. On 25 May 1988, an estimated 255 Sabine's Gulls were seen foraging over an actively feeding school of Dall's porpoise *Phocoenoides dalli*. The absence of this species before mid-May and its temporary rarity after that month (see below) suggest a rapid northward movement of Sabine's Gulls past the British Columbia coast.

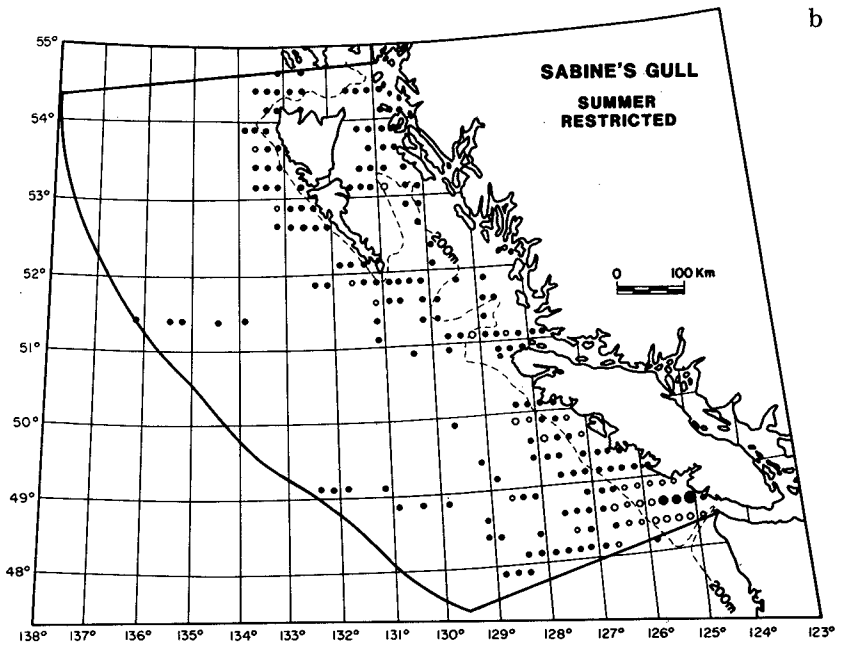
During the first half of summer, Sabine's Gulls were very rare. However, in the latter half of August, they suddenly became abundant again, mainly off southwest Vancouver Island. This likely represented the peak arrival of postbreeding adults en route from their Arctic nesting areas. Martin and Myres (1969) found that the southward migration began about the end of July. The highest average density of Sabine's Gulls occurred over the shelf, especially at Swiftsure Bank, where a group of at least 500 was observed on 9 September 1986, and a flock of 620 birds on 24 August 1989. This species was seen occasionally in close proximity to working fishing boats. Wahl and Heinemann (1979) also noted this, although they could not tell if the birds were feeding upon waste or upon natural prey.

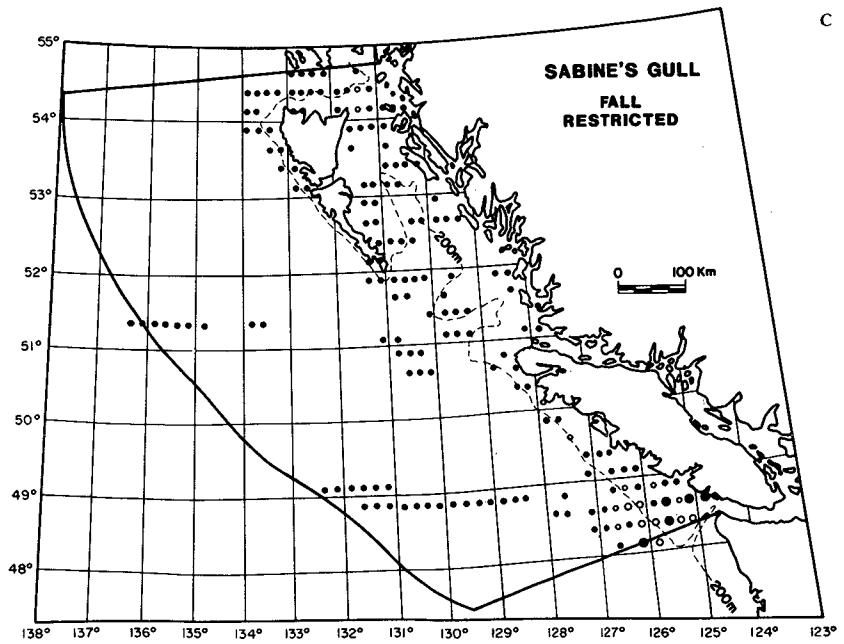
The fall distribution of Sabine's Gulls followed the same general pattern as that of spring and summer, although the concentrating effect of the banks off southwest Vancouver Island was even more pronounced. Although at higher densities over the banks during fall, Sabine's Gulls were more frequently encountered over deeper waters near the shelf break (Vermeer et al. 1989; Vermeer, Morgan, and G.E.J. Smith, unpubl. data). This apparent contradiction stemmed from the fact that a few large flocks were seen over inshore banks: roughly 975 Sabine's Gulls feeding over Swiftsure Bank on 18 September 1986, and about 650 in a huge mixed feeding flock at the edge of La Pérouse Bank on 21 October 1986 (Vermeer et al. 1987). The latest record during any year was on 29 October 1984. The apparently protracted movement off the British Columbia coast during fall (noted by Vermeer et al. 1989) suggested that nutrient-rich waters there, especially those off southwestern Vancouver Island, are an important feeding area for Sabine's Gulls during their southward migration.

Sabine's Gulls are circumpolar, breeding in primarily low-Arctic areas of western Alaska, Greenland, and the Soviet Union. The birds that occur off the British Columbia coast are thought to belong to the races that breed in Alaska (*X. s. wosnesenskii*) and in Siberia (*X. s. tschuktschorum*) (Harrison 1983; Godfrey 1986). Breeding birds return to their colonies from late May through June. Egg laying in western Alaska usually begins in the third week of May. Most clutches are complete by the first week of June, and young have fledged by the end of July (Brown et al. 1967). Failed breeders may depart in early July. Sabine's Gulls overwinter off the coast of Colombia, Peru, West Africa, and Namibia (Harrison 1983; Cramp et al. 1985). Their preferred wintering quarters are areas of intense upwelling (Chapman 1969).

Figure 21
Average density of Sabine's Gulls by season







Arctic Tern *Sterna paradisaea*

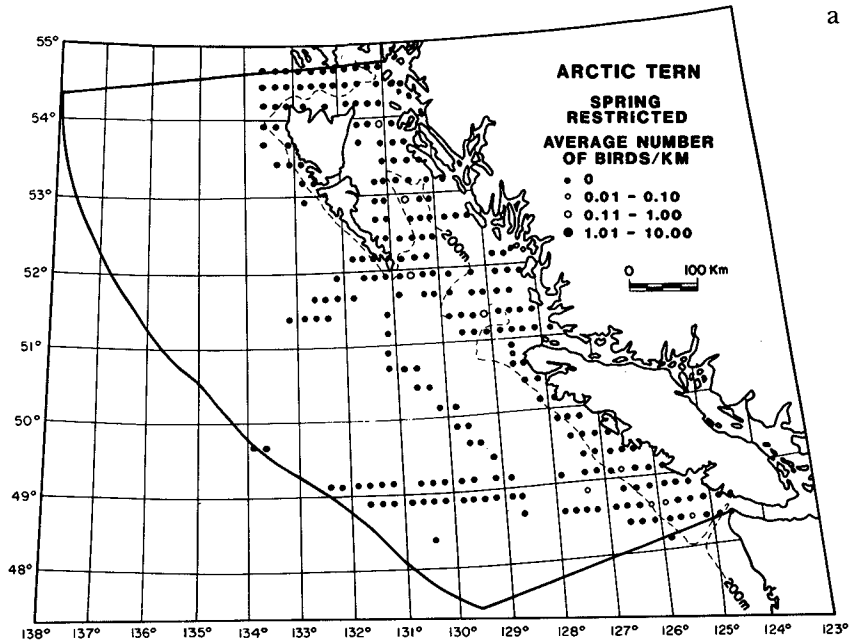
(Fig. 22a–c)

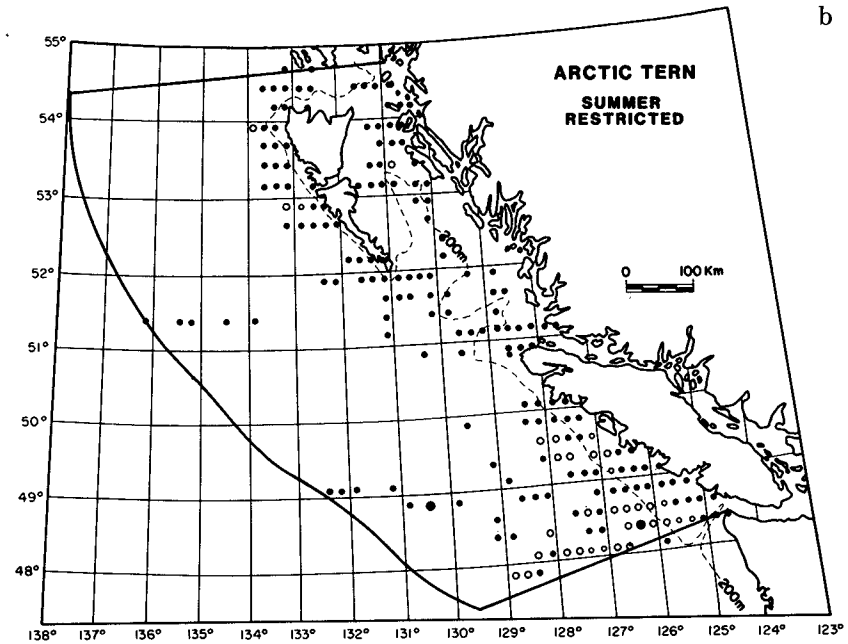
Arctic Terns were observed from approximately mid-May until early October. Harrison (1984) reported this species present in the Gulf of Alaska by 20 April, more than three weeks before our earliest observation of a single bird on 13 May 1982, approximately 75 km southeast of Estevan Point. The majority of our spring observations of Arctic Terns occurred at or just seaward of the shelf break. In the Gulf of Alaska, these terns were most numerous over the shelf and above the shelf break (Harrison 1984); off California, they were most frequently encountered at least 25 km from shore (Briggs et al. 1987). The highest average spring density of Arctic Terns occurred in Hecate Strait, approximately 45 km east of Graham Island. Most Arctic Terns were seen either individually or in flocks of up to four birds.

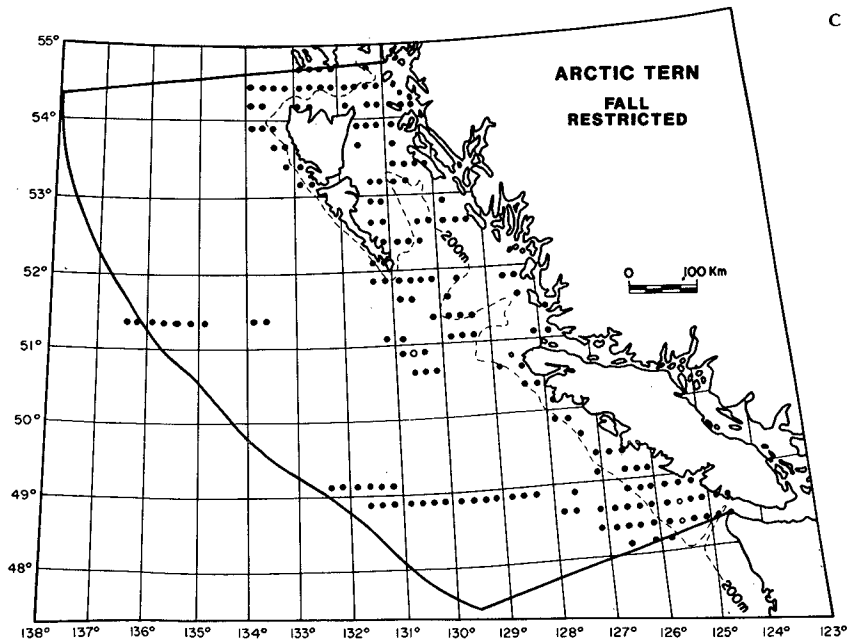
Extremely rare during June and July, Arctic Terns were at their maximum abundance in August, which presumably represents the peak of their southbound movement past the British Columbia coast. During summer, most Arctic Terns were observed seaward of the shelf break, especially off southwestern Vancouver Island. The highest average summer density occurred about 100 km southwest of Barkley Sound. During August, when terns were most numerous, they were often observed at rest on driftwood and on floating kelp mats. Haney (1986b) noted the importance of kelp mats in the North Atlantic to terns (and many other seabirds) for both roosting and foraging; he found higher densities of zooplankton on and beneath floating kelp mats, as well as a greater abundance of juvenile fish. After the end of August, Arctic Terns were rarely encountered, the latest record being 6 October 1987.

The breeding range of Arctic Terns is circumpolar. In North America, they breed as far south as northern British Columbia on the west coast and Massachusetts on the east coast. They also breed across northern Europe and the Soviet Union (Harrison 1983; Harrison 1984; Godfrey 1986). Breeding birds return to the colonies in late May, and eggs are laid in June to early July. Although dispersal may start in late July, most colony departures occur in August (Harrison 1983). This species spends each austral summer near the pack ice off Antarctica, thus making a remarkable yearly migration of more than 35 000 km.

Figure 22
Average density of Arctic Terns by season







Common Murre *Uria aalge*

(Fig. 23a–d)

Common Murres were encountered in each month in which surveys were made. During spring, murres were observed primarily over the shelf and occasionally far offshore. Their distribution was inversely related to water depth, distance from land, surface water temperature, and salinity (Vermeer, Morgan, and G.E.J. Smith, unpubl. data), indicating a preference for colder, less saline inshore waters. The highest average spring density, as well as the largest flock, occurred about 10 km southwest of Tofino, where 690 Common Murres were seen resting on the water on 11 June 1986. This species was far more numerous in Hecate Strait than along the west coast of the Queen Charlotte Islands (Vermeer and Rankin 1984).

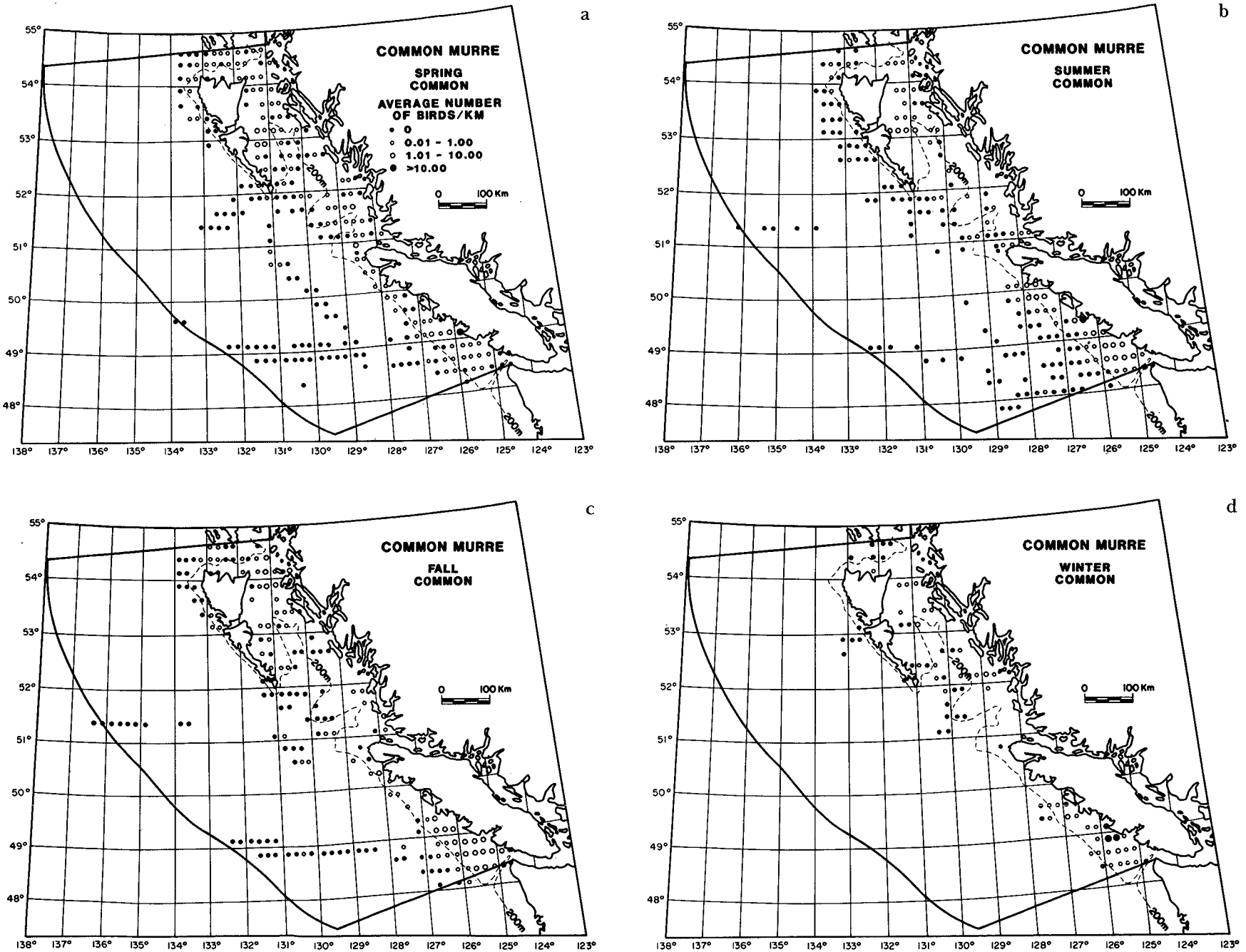
During summer, Common Murres concentrated even more over the shelf. The highest average summer density of murres occurred just off Clayoquot Sound, and the largest single group was encountered approximately 10 km west of Amphitrite Point. On 9 September 1986, 185 birds were observed feeding over Amphitrite Bank. As in spring, murres were rarely encountered on the west coast of the Queen Charlotte Islands.

Common Murres were more numerous in fall than in spring and summer, still being found primarily over the shelf. Campbell et al. (1990) suggested that, during late summer, adult and immature murres begin to swim north from their breeding colonies in Washington, Oregon, and California into the Strait of Juan de Fuca and along the west coast of Vancouver Island. How far north this population may move is unknown. During fall, Common Murres occurred significantly more over water less than 60 m deep than over deeper waters (Vermeer et al. 1989). Murres were also more abundant in Dixon Entrance and Hecate Strait in fall. The overall highest average density occurred in Hecate Strait, approximately 40 km east of Moresby Island. This may have been due to a southward postbreeding dispersal from southeastern Alaskan colonies. An estimated 3600 pairs nest in the Forrester Island group, just north of Dixon Entrance (Sowls et al. 1978). The largest group of Common Murres seen in fall was of approximately 370 birds feeding over Swiftsure Bank on 29 September 1988.

During winter, the murres were concentrated over the shelf, especially off southwestern Vancouver Island. The highest average winter density occurred over Amphitrite Bank, and the largest flock was encountered over La Pérouse Bank, approximately 15 km southwest of Long Beach, where a feeding flock of 100 birds was found on 11 March 1985.

Common Murres breed on islands in the North Atlantic and North Pacific oceans and in the Bering Sea. The subspecies found off the British Columbia coast (*U. a. inornata*) breeds throughout the Bering Sea south to Hokkaido, Japan, and the Gulf of Alaska, as well as in British Columbia (Harrison 1983; Godfrey 1986). In 1989, there were an estimated 4300 pairs breeding in British Columbia, with approximately 95% of them nesting on Triangle Island. Breeding has been confirmed, or suspected, at seven sites in the province (M.S. Rodway, unpubl. data). The most southern colony in British Columbia is on Starlight Reef off Barkley Sound. In British Columbia, eggs are laid from late May through early August, with peak laying between mid-June and mid-July. The eggs are incubated for 28–35 d, and the young leave the colonies 18–25 d after hatching (Tuck 1960; Campbell et al. 1990).

Figure 23
Average density of Common Murres by season



Marbled Murrelet *Brachyramphus marmoratus*

(Fig. 24a–d)

Marbled Murrelets were a minor component of the total pelagic seabird population of the British Columbia coast, usually observed in small numbers in all months that surveys were conducted, except November. With few exceptions, the species occurred over the shelf waters. Although Martin and Myres (1969), Harrison (1983), and Briggs et al. (1987) stated that this species is invariably found close to shore, our data suggest that it sometimes occurs in pelagic waters, albeit in low numbers. Throughout all seasons, almost all Marbled Murrelets occurred either individually or in small flocks. The exception was a flock of approximately 235 birds seen on 11 June 1986, 12 km southwest of Clayoquot Sound, representing the highest average spring density of Marbled Murrelets. That location is just offshore from where Sealy and Carter (1984) found their highest density of Marbled Murrelets in June surveys between Estevan Point and Cape Beale.

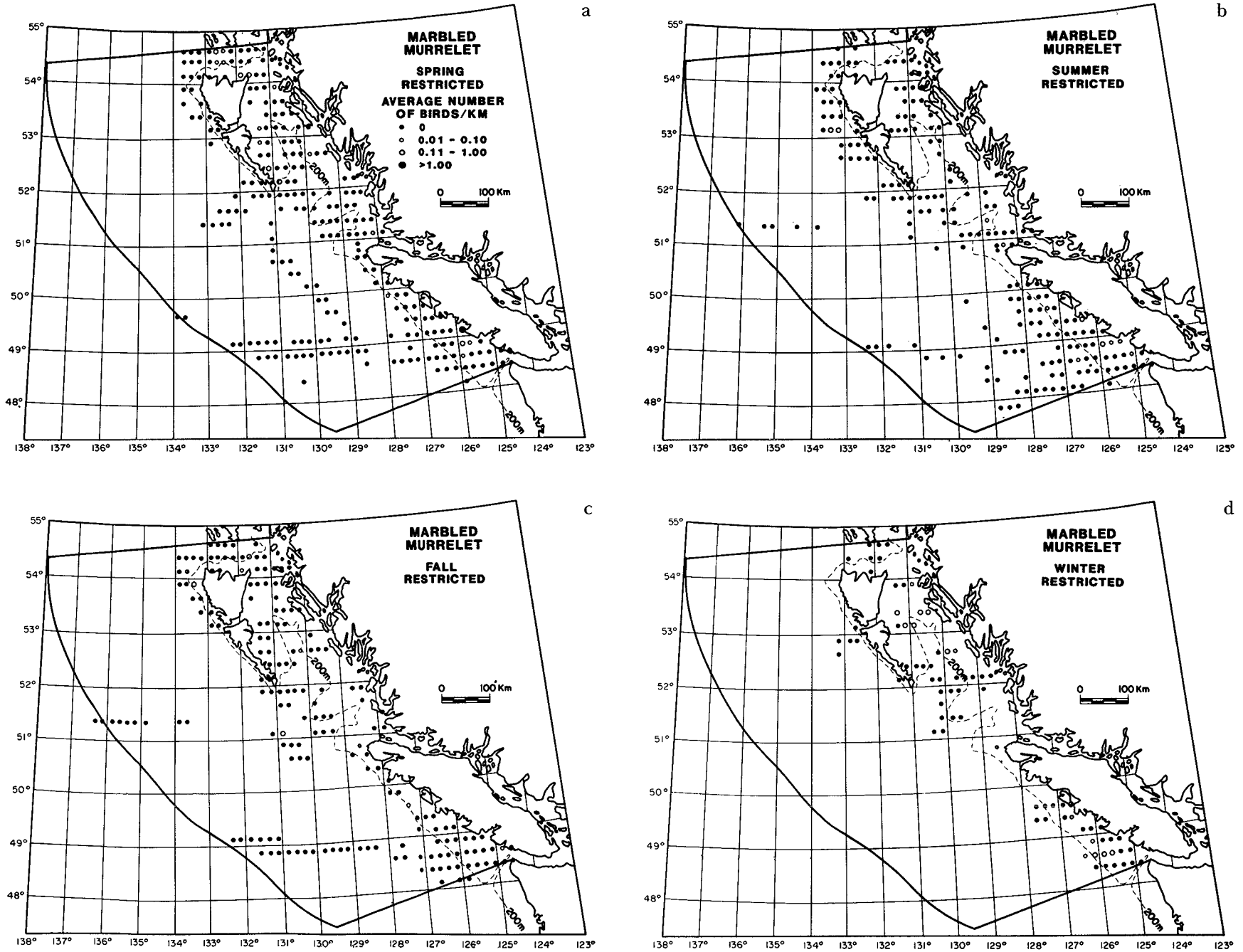
During summer, fewer Marbled Murrelets were found offshore, although they occurred as far as 75 km from land. The highest average summer density occurred over Amphitrite Bank, west of Barkley Sound, just offshore of another location where Sealy and Carter (1984) found high densities.

Most Marbled Murrelets observed in fall occurred at the shelf break, although an unusual sighting of two birds on 27 October 1982 was made more than 100 km south of Cape St. James. The highest average fall density occurred off the northwest coast of Graham Island.

During winter, there appeared to be two areas where Marbled Murrelets were relatively common: in Hecate Strait between the Queen Charlotte Islands and Banks Island, and over La Pérouse Bank. The highest average winter density occurred about 65 km east of Moresby Island.

As so few nests of Marbled Murrelets have been found, the precise limits of their breeding range are unknown. They are thought to nest from northern California to Adak Island in the Aleutian Islands, and from the Kamchatka Peninsula south to northern Japan (Harrison 1983). In British Columbia, nests of Marbled Murrelets could contain eggs from the third week of April through July (Sealy 1974; Carter and Sealy 1987). Carter (1984) reported that newly fledged young were present in the Cape Beale–Estevan Point region as early as 24 June. Farther north in Quatsino Sound, the earliest record we have of young is on 2 July (Morgan, pers. obs.).

Figure 24
Average density of Marbled Murrelets by season



Ancient Murrelet *Synthliboramphus antiquus*

(Fig. 25a-d)

Although Ancient Murrelets were observed in all months in which surveys were made, they were most abundant from early April to the end of May. Most birds were observed over the shelf, especially near the shelf break, as noted by Vermeer et al. (1985) and Briggs et al. (1987). Vermeer et al. (1985) found a significant positive correlation between Ancient Murrelet density and water depth. The surveys carried out in that study did not extend far offshore, and the highest observed murrelet density occurred at the shelf break. The locations having high average spring densities of murrelets may also have been staging grounds. These are areas near nesting colonies, where adult murrelets assemble at predictable times in the evening before entering the colonies and in the morning before going to sea (Sealy 1976). These staging grounds are also areas where the breeding adults gather in anticipation of the precocial chicks walking to the water (Vermeer and Lemon 1986).

The largest aggregation encountered in this study was a flock of about 1400 birds, seen on 30 May 1982, 55 km east of Cape St. James. The earliest record of young at sea was on 24 May 1988, when two juveniles accompanied by two adults were observed approximately 85 km west of Cape Flattery, Wash.

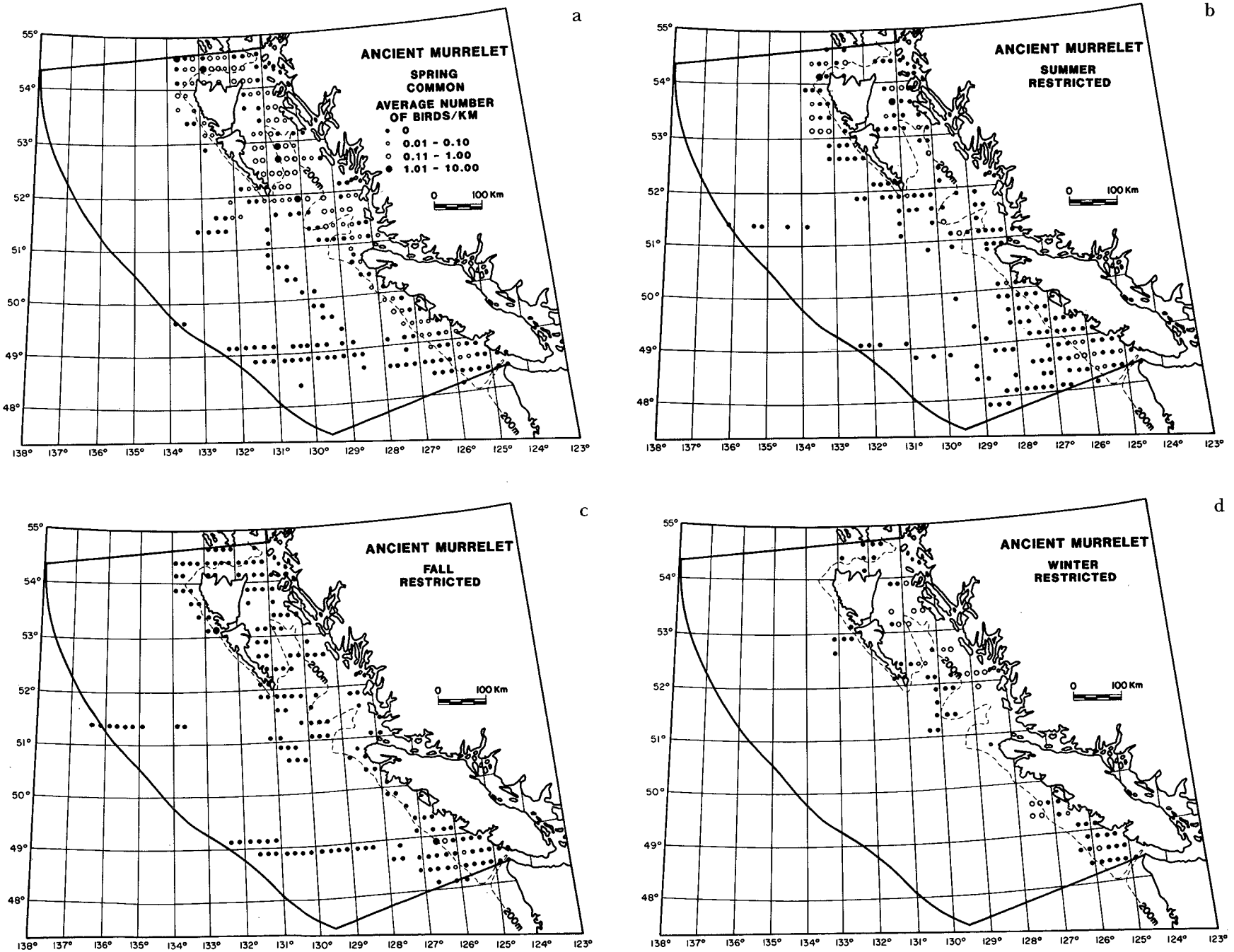
After the beginning of June, the number of Ancient Murrelets declined, and their distribution was less extensive. The highest average summer density occurred off northwestern Graham Island, in relatively close proximity to two large colonies. There were an estimated 71 500 pairs nesting on Frederick Island in 1980 and another 22 500 pairs on Langara Island in 1981 (Vermeer et al. 1984). The relative scarcity of this species off Vancouver Island reflects the absence of colonies along this stretch of the British Columbia coast. No large flocks of Ancient Murrelets were seen during the summer. Only single birds or immatures accompanied by one or two adults were recorded.

Few Ancient Murrelets were observed during the fall. The highest average density during this season occurred at the shelf break, approximately 45 km southwest of Clayoquot Sound. The largest group of murrelets encountered in the fall was a flock of 57 birds on the water, approximately 8 km west of Cartwright Sound.

The limited winter data suggest that this species was still abundant over the outer shelf and near the shelf break. The highest average winter density occurred at the shelf break in Hecate Strait.

Ancient Murrelets breed from the Commander Islands south through the Kurile Islands, from the Aleutian Islands east to southeastern Alaska, and on the Queen Charlotte Islands (Harrison 1983). An estimated 270 000 pairs nest in British Columbia (Campbell et al. 1990). In Alaska, another 30 000 birds breed on Forrester Island, to the northwest of Langara Island (Sowls et al. 1978). Breeding adults are present in the colonies from late March until early July, whereas subadults visit the colonies until at least mid-July (Sealy 1976). Eggs are laid, on average, between the third week of April and mid-May. Hatching starts in late May and continues through June (Vermeer et al. 1984). Some birds winter at sea near their breeding colonies, but most disperse south, occasionally to Baja California and to Korea (Harrison 1983; Godfrey 1986).

Figure 25
Average density of Ancient Murrelets by season



Cassin's Auklet *Ptychoramphus aleuticus*
(Fig. 26a–d)

Cassin's Auklets were observed during every month surveyed. In the spring, this species was regularly encountered offshore, but most birds were seen over the outer shelf. Northwest of Graham Island, Vermeer et al. (1985) observed that Cassin's Auklets commonly foraged over banks and seamounts during late May and early June. The highest average spring densities of Cassin's Auklets were found off the northern end of Vancouver Island, in relatively close proximity to Triangle Island, the largest known breeding colony (Vermeer et al. 1979a). The largest flock located in our study was a raft of 575 birds sighted on 26 May 1982, approximately 35 km north of Cape Scott.

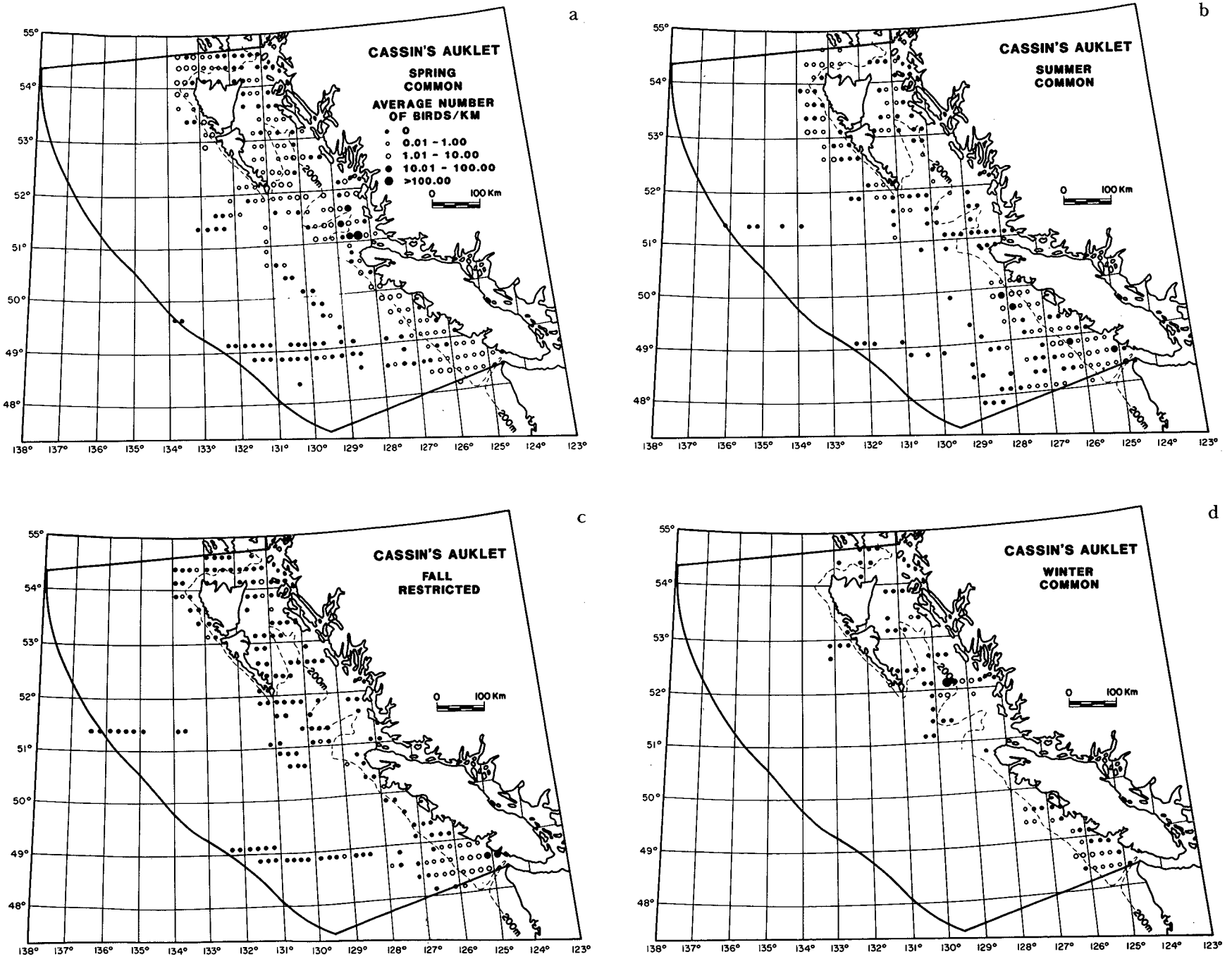
During summer months, especially from August onward, this species was most numerous near the outer shelf off Vancouver Island, indicating a movement away from the colonies. Most nesting Cassin's Auklets hatch in May and June and fledge in July and August (Vermeer 1981; Vermeer et al. 1985). Therefore, the sudden increase in abundance during August probably included young of the year. The highest average summer density of Cassin's Auklets, as well as the largest flocks, occurred at the edge of La Pérouse Bank, where five flocks totalling nearly 6000 auklets were found on 24 August 1986 (Vermeer et al. 1987). The largest aggregation consisted of 1950 birds in a large loose raft approximately 55 km southwest of Long Beach.

In the fall, to mid-October, Cassin's Auklets were abundant off southwestern Vancouver Island, whereas relatively few were found around the Queen Charlotte Islands. Although a few birds were encountered far offshore, most were observed over the inner shelf. This shift towards the inner, shallower waters may have reflected a change in diet (Vermeer 1984; Vermeer et al. 1989). The highest average fall density of Cassin's Auklets, as well as the largest group, occurred over Swiftsure Bank, when approximately 1350 birds were observed feeding actively on 18 September 1986.

Cassin's Auklets were relatively rare offshore during the winter. Almost all of the birds seen in January occurred at the shelf break in Queen Charlotte Sound and at the edge of La Pérouse and Amphitrite banks. In early March, a buildup of Cassin's Auklets was seen, primarily over the shelf. This may have represented prebreeding migration towards the colonies. The highest average winter density of Cassin's Auklets occurred over the shelf break, about 100 km east of Cape St. James. Throughout the winter, either single birds or small groups, usually consisting of fewer than 10 individuals, were seen.

Cassin's Auklets breed from the Aleutian Islands east through the Gulf of Alaska and south to Guadalupe Island off Baja California (Harrison 1983). This species is the most abundant breeding seabird in British Columbia. It is estimated that 1.18 million pairs breed in British Columbia, with roughly 73% nesting in the Scott Islands (Campbell et al. 1990). The majority of Cassin's Auklets overwinter from southern British Columbia to Baja California (Harrison 1983).

Figure 26
Average density of Cassin's Auklets by season



Rhinoceros Auklet *Cerorhinca monocerata*

(Fig. 27a–d)

Rhinoceros Auklets were observed from early March to mid-November. Our earliest record was on 8 March 1985. Rhinoceros Auklets were most numerous during spring, especially in May, and were found all along the British Columbia coastline. They tended to concentrate over the shelf and at the shelf break, although they were occasionally found well offshore. The highest average spring density occurred just seaward of the shelf, approximately 55 km east of Cape St. James. The springtime concentrations near the northern end of Vancouver Island, especially southern Queen Charlotte Sound and Queen Charlotte Strait and in Dixon Entrance, were probably associated with prebreeding staging and foraging. The largest colonies in British Columbia are located in Queen Charlotte Strait, on Triangle Island, and near Aristazabal Island (Campbell et al. 1990). There is also a large colony (54 000 pairs) at Forrester Island, Alaska (Sowls et al. 1978).

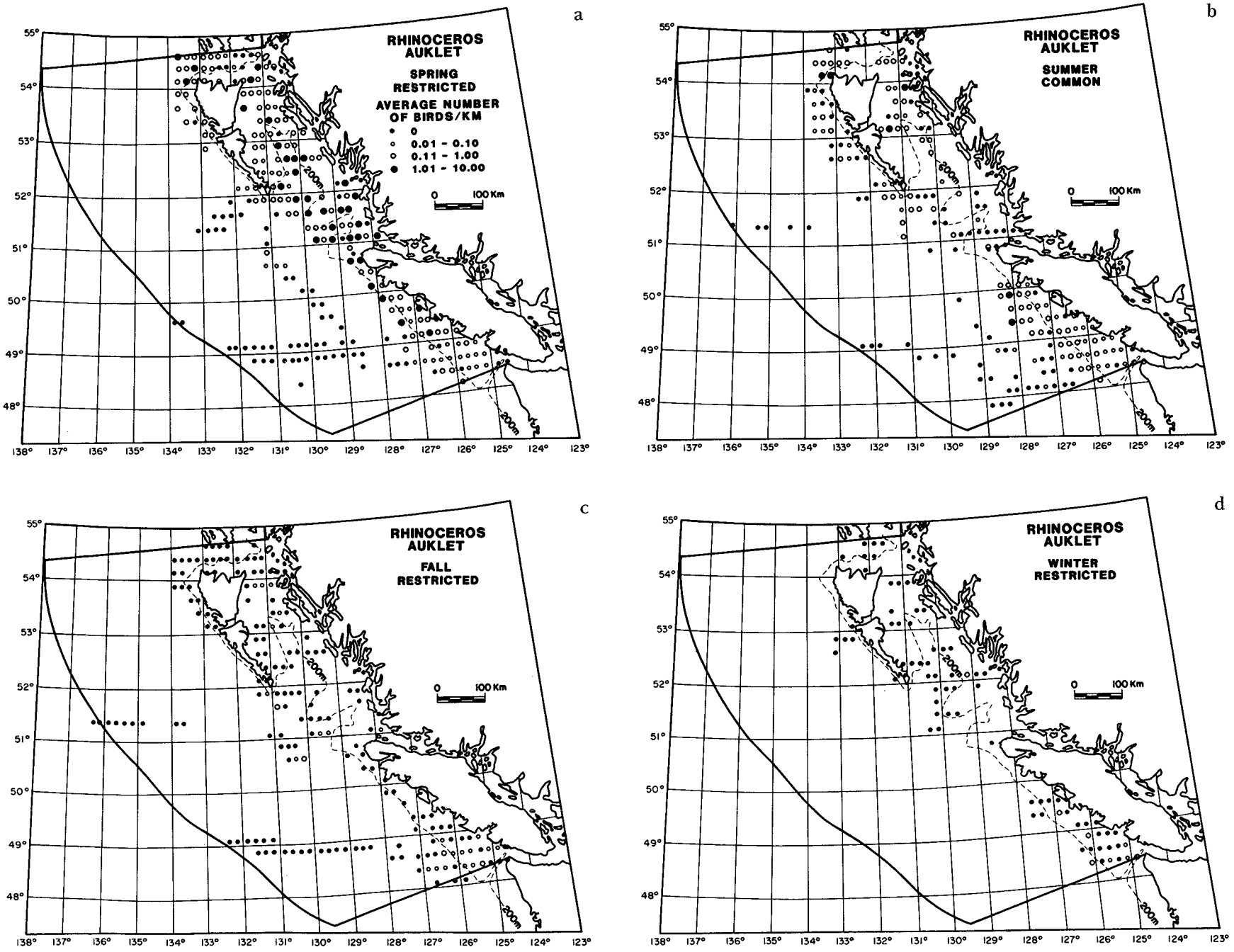
Rhinoceros Auklets were less numerous and less widely distributed during summer than during spring, and they were relatively rare by the end of August. They were seen over the shelf as well as beyond the shelf break, being generally most abundant within the first 100 km seaward of land, although the highest average summer density occurred about 110 km west of Estevan Point. Throughout the year, individual birds or small groups, usually with fewer than a dozen birds, were observed. The largest summer flock was a raft of 43 birds observed on 6 July 1983, about 20 km southeast of Skidegate Inlet.

Both the number and the extent of distribution of Rhinoceros Auklets continued to decline in fall. Most birds were encountered over the shelf, although a few were seen farther offshore. Sightings of this species were aggregated over the shallow waters of Hecate Strait and over Amphitrite, La Pérouse, and Swiftsure banks. However, the highest fall density of Rhinoceros Auklets occurred beyond the shelf break, about 35 km south of Cape St. James. The latest fall record of this species during any year was on 9 November 1982.

Rhinoceros Auklets were not observed from early November until the second week of March; we therefore assume that they were either absent or very scarce offshore British Columbia for most of the winter. Figure 27d, showing the winter distribution, actually indicates birds observed in the second week of March. This reappearance likely represents the start of the spring migration.

Rhinoceros Auklets breed in scattered locations in Korea and Japan, on the Kurile and Aleutian islands, and in southern Alaska south through British Columbia to the Farallon Islands off California (Harrison 1983; Manuwal 1984). There may be as many as 340 000 pairs nesting at 35 sites in British Columbia, with the four largest colonies (Pine, Storm, Triangle, and Moore islands) supporting more than 121 000 pairs (Campbell et al. 1990). Rhinoceros Auklets first appear at the colonies in early March (Manuwal 1984). Eggs may be found between the middle of April and the last week of July, although typically most are laid in May. In British Columbia, hatching commences during the last week of May. Most eggs hatch in June and July, and fledging and colony dispersal take place during August and early September (Vermeer 1980). Most Rhinoceros Auklets overwinter south of their colonies (Harrison 1983; Campbell et al. 1990).

Figure 27
Average density of Rhinoceros Auklets by season



Tufted Puffin *Fratercula cirrhata*

(Fig. 28a–c)

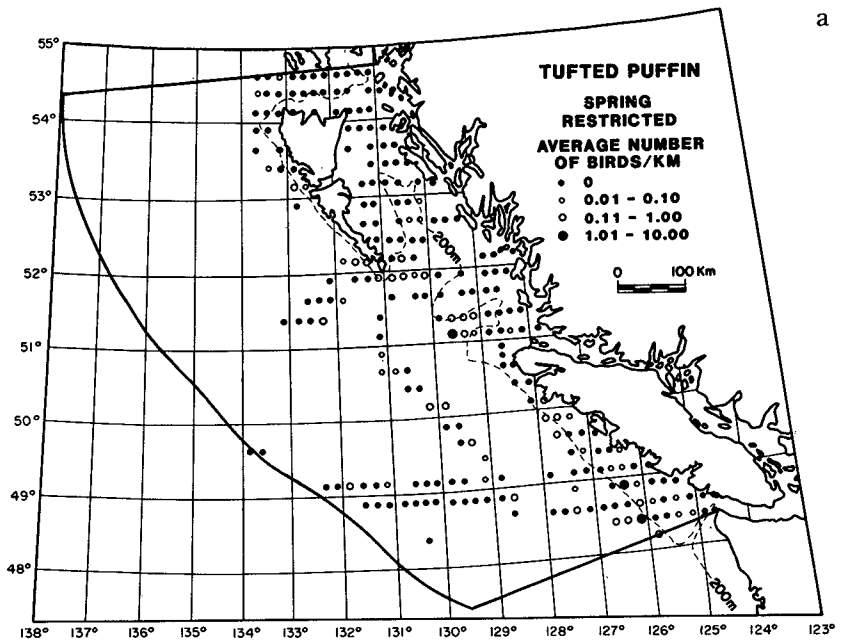
Tufted Puffins were observed between mid-March and the end of November, our earliest record being on 18 March 1983. Although puffins were encountered over the shelf, sometimes close to shore, most were found at or seaward of the shelf break. Occasionally, this species was observed well offshore. Vermeer, Morgan, and G.E.J. Smith (unpubl. data) found that, during spring, the occurrence of Tufted Puffins was correlated positively with both water depth and distance from land. The highest average spring density of puffins occurred about 70 km northwest of Triangle Island, the location of the largest colony in the province. The concentration of observations at the entrance to Queen Charlotte Sound likely reflects the presence of birds from that colony. Most of the puffins observed in spring occurred either individually or in pairs. According to Hunt et al. (1981), Tufted Puffins are individual foragers, although some rafting does occur.

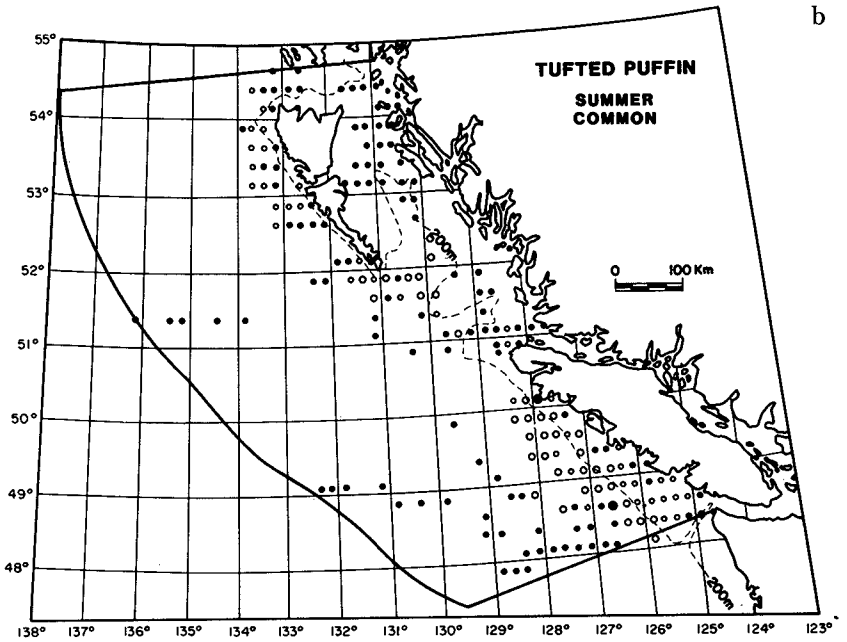
Puffins were at their peak of abundance and distribution in the summer, especially during July and August. Off Vancouver Island, the preferred location appeared to be at or just seaward of the shelf break; off the Queen Charlotte Islands, most birds were found farther offshore. The occurrence of Tufted Puffins off southern Vancouver Island during summer was inversely correlated with distance from land (Vermeer, Morgan, and G.E.J. Smith, unpubl. data). The highest average summer density, as well as the largest aggregation, occurred near Solander Island. A feeding flock of about 75 birds was seen approximately 6 km south of the island on 11 August 1988, while several hundred more were feeding very close to the island. An estimated 3000 pairs nest on Solander Island (M.S. Rodway, unpubl. data), and this island was likely the source of the above-noted feeding flocks.

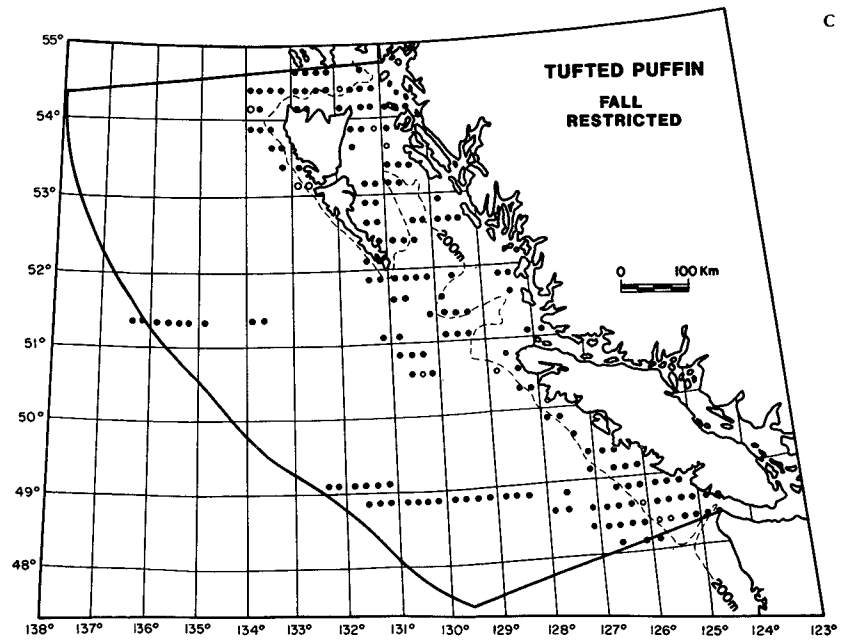
From September onward, Tufted Puffins were rarely encountered. The highest average fall density of birds occurred in Cartwright Sound. At this time of year, most puffins were found at the shelf break. The latest fall record of this species during any year was on 24 November 1986.

Tufted Puffins breed from northeastern Siberia and Cape Lisburne in the Chukchi Sea south through the Bering Sea and Aleutian Islands to California (Harrison 1983). There are an estimated 38 000 pairs breeding in British Columbia, with approximately 87% nesting on the Scott Islands and 8% on Solander Island (M.S. Rodway, unpubl. data). Tufted Puffins begin to arrive at their colonies in April (Manuwal 1984). Most eggs are laid in June and hatch during July. The young fledge and leave their colonies during August and early September (Vermeer et al. 1979b; Vermeer, unpubl. data). Shortly after colony departure, most Tufted Puffins disperse either south or west. During the winter, they occur well offshore, to as far as about 35°N in mid-ocean (Harrison 1983).

Figure 28
Average density of Tufted Puffins by season







Rare and accidental species

(Figs. 29–36, Appendix 2)

The following rare and accidental species were observed: Laysan Albatross *Diomedea immutabilis*, Flesh-footed Shearwater *Puffinus carneipes*, Black-vented Shearwater *P. opisthomelas*, Mottled Petrel *Pterodroma inexpectata*, South Polar Skua *Catharacta maccormicki*, Slaty-backed Gull *Larus schistisagus*, Iceland Gull *L. glaucoides*, Glaucous Gull *L. hyperboreus*, Thick-billed Murre *Uria lomvia*, Horned Puffin *Fratercula corniculata*, Xantus' Murrelet *Synthliboramphus hypoleucus*, and Parakeet Auklet *Cyclorrhynchus psittacula*. The approximate locations at which rare and accidental species were observed are listed in Appendix 2 in calendar sequence.

Laysan Albatrosses were observed in all months surveyed except March and July. Although they were encountered most often in September, October, and May, in descending order of frequency, this may be an artifact of the greater number of surveys carried out during those months. This species breeds on the Hawaiian Islands, as well as on the Bonin Islands, south of Japan (Harrison 1983). Most breeding birds return to their colonies in the first half of November and depart in June and July (Robbins and Rice 1974).

Flesh-footed Shearwaters were observed during May through August and in October, frequently over the shelf and the shelf break. This species was also observed by Guzman and Myres (1983), but only west and northwest of Barkley Sound. Because these birds are readily attracted to fishing boats (Wahl and Heinemann 1979), their distribution off British Columbia may be strongly influenced by the locations of the various fishing fleets. Flesh-footed Shearwaters breed on islands off Australia and New Zealand. Breeders return to their colonies in late September, and departure from the colony takes place during April and May (Harrison 1983).

Black-vented Shearwaters were observed in August, September, and October, mainly over the shelf. Martin (1942) and Guzman and Myres (1983) observed this species from July through November. These shearwaters breed on islands off the west coast of Baja California, returning to their colonies during January and February and dispersing north and south in June and July (Harrison 1983).

Mottled Petrels were observed during May and June and from September to November, with all but two sightings occurring outside the main atlas study area. This species breeds on islands off New Zealand. The birds return to their colonies in October and November and disperse during March and April. Following dispersal, they rapidly migrate north, on a broad front, to as far as the Aleutian Islands and the Gulf of Alaska (Harrison 1983).

South Polar Skuas were regularly observed from June through to mid-October. They were seen primarily over the shelf and adjacent shelf break off Vancouver Island, although they were also encountered off the Queen Charlotte Islands and far offshore. These skuas breed in Antarctica, returning to their colonies in September and October. Adults may not disperse far from the colonies, whereas juveniles regularly migrate into both the North Atlantic and the North Pacific (Harrison 1983). The concentration of skua observations off southwest Vancouver Island suggests that their distribution was most likely linked to the location of the fishing fleets, which they readily attend (Harrison 1983).

A single adult Slaty-backed Gull was observed on 20 October 1986 over Swiftsure Bank (Vermeer et al. 1987). This species breeds in eastern Siberia and disperses south starting in August.

On 27 May 1989, a bird that most closely resembled a first-year Iceland Gull was observed by one of us (Morgan) over La Pérouse Bank. Almost exactly a year earlier, a bird identical to this had been seen (also by Morgan) in Alberni Inlet, close to Barkley Sound. This species breeds from Ellesmere Island to Greenland (Harrison 1983).

Glaucous Gulls were observed off British Columbia from January through mid-May, as well as in the last half of October. Both adult and immature birds have been reported, although the latter group dominated. The breeding range of this species is circumpolar, mainly north of the Arctic Circle (Harrison 1983).

Thick-billed Murres were observed in January, May, September, and October between 1982 and 1984, and only over the shelf. The only known breeding colony in British Columbia is on Triangle Island (Vallee and Cannings 1983). Elsewhere, this species breeds on the coasts of northern North America, Greenland, Iceland, and Siberia (Harrison 1983).

Horned Puffins were observed only four times, during May and July, both inshore and far offshore. This species breeds along the Siberian coast, the Kurile Islands, and from the Aleutian Islands through coastal Alaska to the Queen Charlotte Islands (Harrison 1983). Although breeding in British Columbia has been confirmed at only one site (a small islet off Anthony Island; Campbell et al. 1979), it is suspected that Horned Puffins have bred at an additional

Figure 29
Locations of Laysan Albatross observations

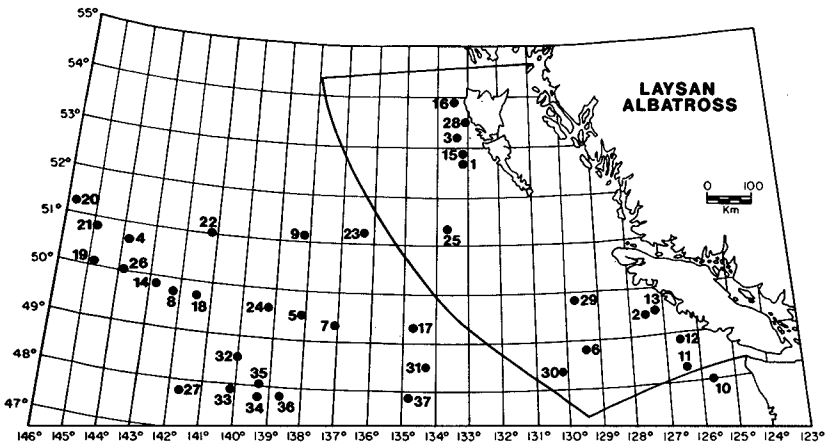


Figure 30
Locations of Flesh-footed Shearwater observations

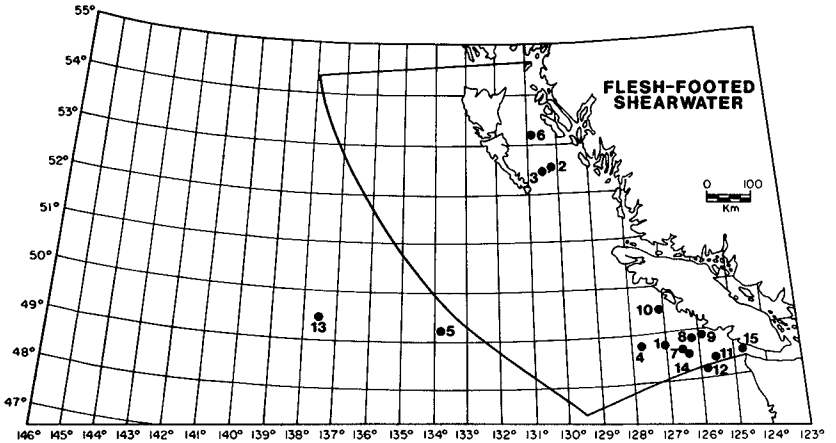


Figure 31
Locations of Black-vented Shearwater observations

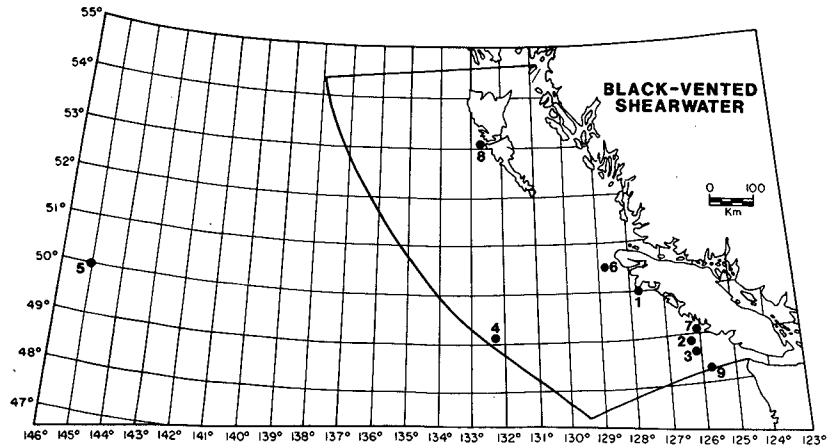
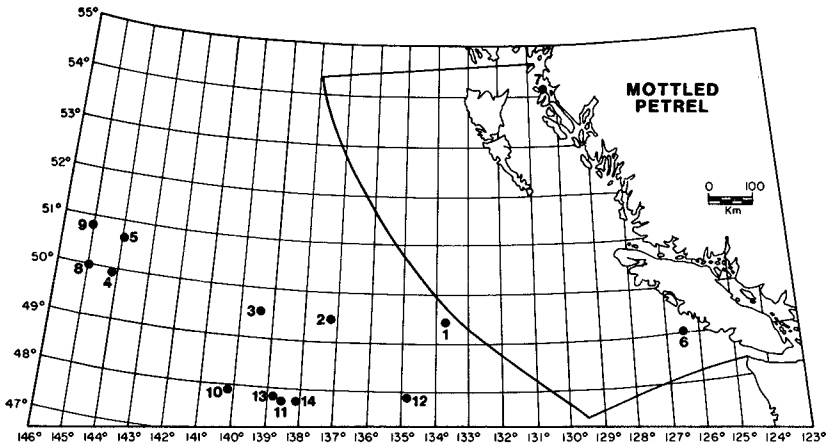


Figure 32
Locations of Mottled Petrel observations



11 sites (Campbell et al. 1990). Birds begin to arrive at the breeding colonies in mid-May, and dispersal occurs in September and October (Harrison 1983).

Xantus' Murrelets were observed twice off British Columbia, once in August and once in October of 1988. On both occasions, two birds were seen. As the locations were less than 80 km apart, it is possible that both observations were of the same two birds. This species is irregularly observed off Gray's Harbor, Wash. (T.R. Wahl, pers. commun.). Xantus' Murrelets breed on small islands off southern California and Baja California. They normally winter offshore from their colonies, although they regularly wander north during August to October (Harrison 1983).

Parakeet Auklets were seen on nine different occasions off British Columbia during May, September, and October. Most observations were from waters over the shelf break near the Queen Charlotte Islands. There have been other observations of this species from British Columbia. Early in 1989, 15 oiled birds were found on Vancouver Island (A.E. Burger, unpubl. data). This species breeds from Cape Lisburne in the Bering Strait south through the Bering Sea, on the Pribilof and Aleutian islands east to Prince William Sound (Sowls et al. 1978). Breeding birds return to the colonies during April and May, whereas dispersal occurs in August and September (Harrison 1983). During some years, they disperse as far south as Japan and California (Roberson 1980).

Figure 33
Locations of South Polar Skua observations

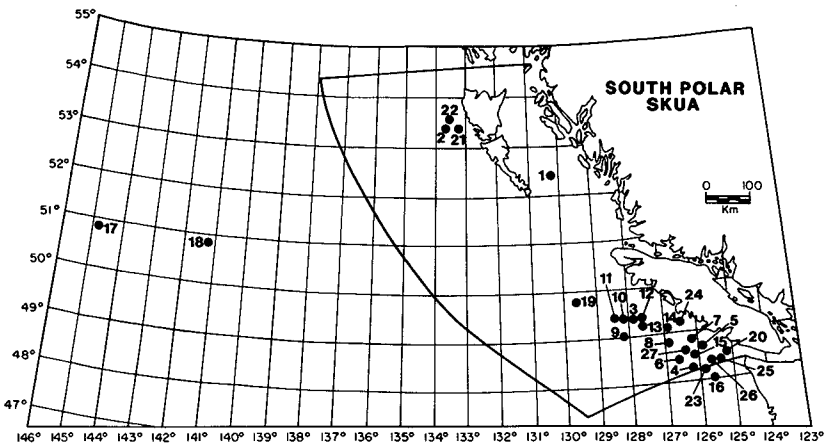


Figure 34
Locations of Slaty-backed, Glaucous, and Iceland gull observations

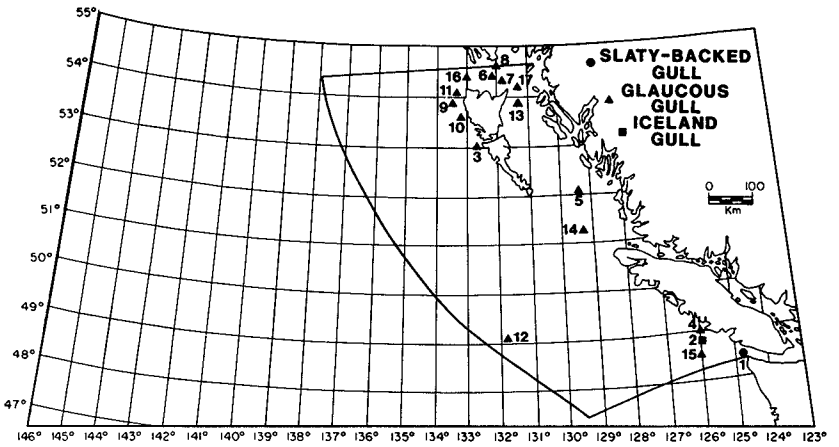


Figure 35
Locations of Thick-billed Murre observations

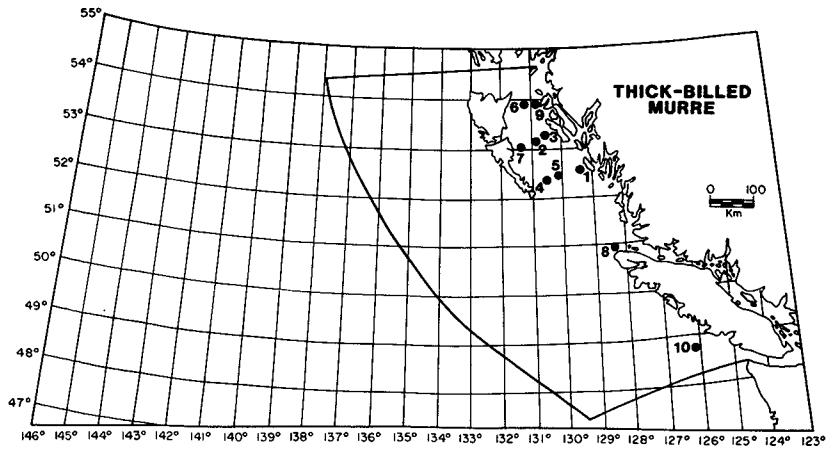
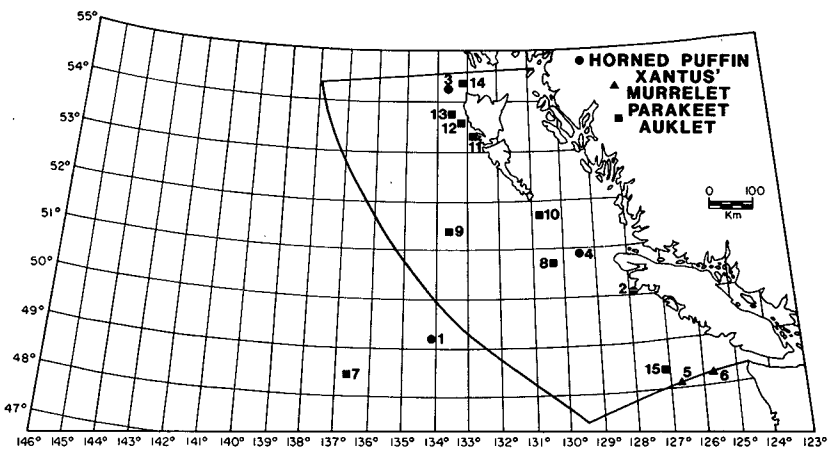


Figure 36
Locations of Horned Puffin, Xantus' Murrelet, and Parakeet Auklet observations



4. Conclusions

The British Columbia pelagic seabird fauna is dominated by 26 species that can be divided into four main groups based on their seasonal abundance and breeding distribution. Although it is possible to place each species into a generalized category, there is much variability in their seasonal occurrence and distribution. This variability can be ascribed to the "out-of-season" presence of immature birds, nonbreeders, and failed nesters, as well as meteorological conditions, physical and chemical oceanographic features, and prey abundance, all of which affect bird distribution.

There are nine **breeding resident** species found off the British Columbia coast: Leach's and Fork-tailed storm-petrels, Glaucous-winged Gull, Common Murre, Marbled and Ancient murrelets, Cassin's and Rhinoceros auklets, and Tufted Puffin.

The most numerous **winter resident** species include Northern Fulmar, Herring and Thayer's gulls, and Black-legged Kittiwake. These species breed in the interior or along the northern coast of North America and typically show a pronounced fall migration influx.

The **summer visitor** group is numerically dominated by the Sooty/Short-tailed shearwater pair complex. Numbers of this species pair dramatically increase when it migrates into British Columbia waters in late April through early May; it is extremely abundant and widespread until early October. Black-footed Albatross and Pink-footed Shearwater are also common summer visitors. The three shearwater species breed in the South Pacific, whereas the Black-footed Albatross nests primarily on the Hawaiian Islands; all four species breed during the boreal winter.

The fourth group consists of the **spring** and **fall migrants** and includes Buller's Shearwater, Red and Red-necked phalaropes, Pomarine, Parasitic, and Long-tailed jaegers, California and Sabine's gulls, and Arctic Tern. Except for Buller's Shearwater, these migrants pass through the area en route to and/or from their northern or interior breeding grounds.

The biologically productive waters over the continental shelf support the highest density and diversity of pelagic birds throughout the year. Although there is considerable overlap, the 26 species are associated with two broad habitat classes: those that occur most often and in highest numbers over the shelf, and those that are found mostly at or beyond the shelf break. Species that are primarily associated with shelf waters are Sooty, Short-tailed, and Pink-footed shearwaters, Fork-tailed Storm-Petrel, Red and Red-necked phalaropes, Herring, Thayer's, California, Glaucous-winged, and Sabine's gulls, Black-legged Kittiwake, Common Murre, Marbled and Ancient murrelets, and Cassin's and Rhinoceros auklets. Species that tend to concentrate at or beyond the shelf break include Black-footed Albatross, Northern Fulmar, Buller's Shearwater, Leach's Storm-Petrel, Pomarine, Parasitic, and Long-tailed jaegers, Arctic Tern, and Tufted Puffin.

We have made no attempt to identify or rank pelagic waters along the British Columbia coast according to their vulnerabilities to human activities (e.g., oil pollution, drift nets, overfishing). It is clear, however, that the shelf waters, especially near inshore banks, support the highest abundance and diversity of birds. Consequently, the shelf and waters near major breeding colonies generally represent areas that would be most at risk from harmful human activities. Obviously, the type and seasonality of the activity greatly influence the severity of its impact.

In summary, we suggest that this atlas can serve three purposes:

(1) the maps enable marine resource managers to identify areas of importance to pelagic birds and allow managers to make informed decisions regarding resource exploitation, shipping routes, and emergency contingency plans;
(2) the maps identify the gaps in our knowledge of the distribution and seasonality of the millions of pelagic birds that utilize the waters off the west coast of Canada; and
(3) the gaps identified in (2) will, it is hoped, encourage further research efforts, as there is still much to be learned.

Literature cited

Ainley, D.G.; Jacobs, S.S. 1981. Seabird affinities for ocean and ice boundaries in the Antarctic. Deep-Sea Res. 28A(10):1173–1185.

American Ornithologists' Union. 1973. Thirty-second supplement to the American Ornithologists' Union check-list of North American birds. Auk 90:411–419.

Briggs, K.T.; Tyler, W.B.; Lewis, D.B.; Carlson, D.R. 1987. Bird communities at sea off California: 1975 to 1983. Stud. Avian Biol. 11.

Brown, R.G.B. 1980. Seabirds as marine animals. Pages 1–39 *in* Burger, J.; Olla, B.L.; Winn, H.E. (eds.). Behavior of marine animals. Vol. 4. Plenum Press, New York.

Brown, R.G.B. 1986. Revised atlas of eastern Canadian seabirds. Can. Wildl. Serv., Dartmouth.

Brown, R.G.B.; Blurton Jones, N.G.; Hussell, D.J.T. 1967. The breeding behaviour of Sabine's Gull (*Xema sabini*). Behaviour 28:110–140.

Brown, R.G.B.; Nettleship, D.N.; Germain, P.; Tull, C.E.; Davis, T. 1975. Atlas of eastern Canadian seabirds. Can. Wildl. Serv., Ottawa.

Campbell, R.W.; Carter, H.R.; Sealy, S.G. 1979. Nesting of Horned Puffins in British Columbia. Can. Field-Nat. 93:84–86.

Campbell, R.W.; Dawe, N.K.; McTaggart-Cowan, I.; Cooper, J.M.; Kaiser, G.W.; McNall, M.C.E. 1990. The birds of British Columbia. Vol. 1. Loons through woodpeckers. R. B.C. Mus./Can. Wildl. Serv.

Carter, H.R. 1984. At-sea biology of the Marbled Murrelet (*Brachyramphus marmoratus*) in Barkley Sound, British Columbia. M.Sc. thesis, Univ. Manitoba, Winnipeg.

Carter, H.R.; Sealy, S.G. 1987. Inland records of downy young and fledgling Marbled Murrelets in North America. Murrelet 68:58–63.

Chapman, S.E. 1969. The Pacific winter quarters of Sabine's Gull. Ibis 111:615–617.

Cramp, S.; Simmons, K.E.L.; Brooks, D.J.; Collar, N.J.; Dunn, E.; Gillmor, R.; Hollom, P.A.D.; Hudson, R.; Nicholson, E.M.; Ogilvie, M.A.; Olney, P.J.S.; Roselaar, C.S.; Voous, K.H.; Wallace, D.I.M.; Wattel, J.; Wilson, M.G. 1985. Handbook of the birds of Europe, the Middle East and North Africa: the birds of the Western Palearctic. Vol. 3. Waders to gulls. Oxford Univ. Press, Oxford.

Drent, R.H.; Guiguet, C.J. 1961. A catalogue of British Columbia sea-bird colonies. Occas. Pap. No. 12, B.C. Prov. Mus., Victoria.

Drury, W.H. 1984. Gulls. Pages 130–145 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Forsell, D.J.; Gould, P.J. 1981. Distribution and abundance of marine birds and mammals wintering in the Kodiak area of Alaska. FWS/OBS-81/13, Off. Biol. Serv., U.S. Fish Wildl. Serv., Washington, D.C.

Godfrey, W.E. 1986. The birds of Canada. Rev. ed. Natl. Mus. Can., Ottawa.

Guzman, J.R. 1981. The wintering of Sooty Shearwaters and Short-tailed Shearwaters (genus *Puffinus*) in the north Pacific. Ph.D. thesis, Univ. Calgary, Calgary.

Guzman, J.R.; Myres, M.T. 1983. The occurrence of shearwaters (*Puffinus* spp.) off the west coast of Canada. Can. J. Zool. 60:2064–2077.

Haney, J.C. 1986a. Seabird affinities for Gulf Stream frontal eddies: responses of mobile marine consumers to episodic upwelling. J. Mar. Res. 44:361–384.

Haney, J.C. 1986b. Seabird patchiness in tropical oceanic water: the influence of *Sargassum* "reefs." Auk 103:141–151.

Harrison, C.S. 1982. Spring distribution of marine birds in the Gulf of Alaska. Condor 84:245–254.

Harrison, C.S. 1984. Terns. Pages 146–160 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Harrison, P. 1983. Seabirds: an identification guide. Houghton Mifflin Co., Boston, Mass.

Hunt, G.L.; Gould, P.J.; Forsell, D.J.; Peterson, H. 1981. Pelagic distribution of marine birds in the eastern Bering Sea. Pages 689–718 *in* Hood, D.W.; Calder, J.A. (eds.). The eastern Bering Sea shelf: oceanography and resources. Vol. 2. NOAA/BLM, Washington Press, Seattle, Wash.

Iverson, R.L.; Coachman, L.K.; Cooney, R.T.; English, T.S.; Goering, J.J.; Hunt, G.L.; Macauley, M.C.; McRoy, C.P.; Reeburg, W.S.; Whitledge, T.E. 1979. Ecological significance of fronts in the southeastern Bering Sea. Pages 437–466 *in* Livingston, R.J. (ed.). Ecological processes in coastal and marine systems. Plenum Press, New York.

Maher, W.J. 1984. Skuas and jaegers. Pages 120–129 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Manuwal, D.A. 1984. Alcids. Pages 168–187 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Martin, P.W. 1942. Notes on some pelagic birds of the coast of British Columbia. Condor 44:27–29.

Martin, P.W.; Myres, M.T. 1969. Observations on the distribution and migration of some seabirds off the outer coasts of British Columbia and Washington state, 1946–1949. Syesis 2:241–256.

Mayfield, H.F. 1984. Phalaropes. Pages 112–119 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

McHugh, J.L. 1955. Distribution of Black-footed Albatross, *Diomedea nigripes*, off the west coast of North America, 1949 and 1950. Pac. Sci. 9:375–381.

Rice, D.W. 1984. Albatrosses. Pages 32–41 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Robbins, C.S.; Rice, D.W. 1974. Recoveries of banded Laysan Albatrosses (*Diomedea immutabilis*) and Black-footed Albatrosses (*D. nigripes*). Pages 232–277 *in* King, W.B. (ed.). Pelagic studies of seabirds in the central and eastern Pacific Ocean. Smithson. Contrib. Zool. No. 158, Washington, D.C.

Roberson, D. 1980. Rare birds of the west coast of North America. Woodcock Publ., Pacific Grove, Calif.

Rodway, M.S. 1988. British Columbia seabird colony inventory: report #3. Census of Glaucous-winged Gulls, Pelagic Cormorants, Black Oystercatchers, and Pigeon Guillemots in the Queen Charlotte Islands, 1986. Tech. Rep. Ser. No. 43, Can. Wildl. Serv., Delta, B.C.

Sanger, G.A. 1970. The seasonal distribution of some seabirds off Washington and Oregon, with notes on their ecology and behavior. Condor 72:339–357.

Sealy, S.G. 1974. Breeding phenology and clutch size in the Marbled Murrelet. Auk 91:10–23.

Sealy, S.G. 1976. Biology of nesting Ancient Murrelets. Condor 78:294–306.

Sealy, S.G.; Carter, H.R. 1984. At-sea distribution and nesting habitat of the Marbled Murrelet in British Columbia: problems in the conservation of a solitarily nesting seabird. Pages 737–756 *in* Croxall, J.P.; Evans, P.G.H.; Schreiber, R.W. (eds.). Status and conservation of the world's seabirds. Int. Counc. Bird Preserv. Tech. Publ. No. 2, Cambridge.

Shallenberger, R.J. 1984. Fulmars, shearwaters, and gadfly petrels. Pages 42–56 *in* Haley, D. (ed.). Seabirds of eastern north Pacific and arctic waters. Pacific Search Press, Seattle, Wash.

Sowls, A.L.; Hatch, S.A.; Lensink, C.J. 1978. Catalog of Alaskan seabird colonies. FWS/OBS-78/78, Off. Biol. Serv., U.S. Fish Wildl. Serv., Washington, D.C.

Tasker, M.L.; Hope Jones, P.; Dixon, T.; Blake, B.F. 1984. Counting seabirds at sea from ships; a review of methods employed and a suggestion for a standardized approach. Auk 101:567–577.

Thomson, R.E. 1981. Oceanography of the British Columbia coast. Can. Spec. Publ. Fish. Aquat. Sci. 56. Ottawa.

Tuck, L.M. 1960. The murres: their distribution, populations and biology — a study of the genus *Uria*. Queen's Printer, Ottawa.

Vallee, A.; Cannings, R.J. 1983. Nesting of the Thick-billed Murre, *Uria lomvia*, in British Columbia. Can. Field-Nat. 97:450-451.

Vermeer, K. 1970. Breeding biology of California and Ring-billed Gulls. Can. Wildl. Serv. Rep. Ser. 12, Ottawa.

Vermeer, K. 1980. The importance of timing and type of prey to reproductive success of Rhinoceros Auklets (*Cerorhinca monocerata*). Ibis 122:343-350.

Vermeer, K. 1981. The importance of plankton to Cassin's Auklets during breeding. J. Plankton Res. 3:315-329.

Vermeer, K. 1984. The diet and food consumption of nesting Cassin's Auklets during the summer, and a comparison with other plankton-feeding alcids. Murrelet 65:65-77.

Vermeer, K.; Lemon, M. 1986. Nesting habits and habitats of Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands, British Columbia. Murrelet 67:33-44.

Vermeer, K.; Rankin, L. 1984. Pelagic seabird populations in Hecate Strait and Queen Charlotte Sound: comparison with the west coast of the Queen Charlotte Islands. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 52, Sidney, B.C.

Vermeer, K.; Rankin, L. 1985. Pelagic seabird population in Dixon Entrance. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 65, Sidney, B.C.

Vermeer, K.; Summers, K.R.; Bingham, D.S. 1976. Birds observed at Triangle Island, British Columbia, 1974 and 1975. Murrelet 57:35-42.

Vermeer, K.; Vermeer, R.A.; Summers, K.R.; Billings, R.D. 1979a. Numbers and habitat selection of Cassin's Auklets breeding on Triangle Island, British Columbia. Auk 96:143-151.

Vermeer, K.; Cullen, L.; Porter, M. 1979b. A provisional explanation of the reproductive failure of Tufted Puffins (*Lunda cirrhata*) on Triangle Island, British Columbia. Ibis 121:348-354.

Vermeer, K.; Robertson, I.; Campbell, R.W.; Kaiser, G.; Lemon, M. 1983. Distribution and densities of marine birds on the Canadian west coast. Can. Wildl. Serv. Tech. Rep., Vancouver, B.C.

Vermeer, K.; Sealy, S.G.; Lemon, M.; Rodway, M. 1984. Predation and potential environmental perturbances on Ancient Murrelets nesting in British Columbia. Pages 757-770 *in* Croxall, J.P.; Evans, P.G.H.; Schreiber, R.W. (eds.). Status and conservation of the world's seabirds. Int. Counc. Bird Preserv. Tech. Publ. No. 2, Cambridge.

Vermeer, K.; Fulton, J.D.; Sealy, S.G. 1985. Differential use of zooplankton prey by Ancient Murrelets and Cassin's Auklets in the Queen Charlotte Islands. J. Plankton Res. 7:443-459.

Vermeer, K.; Hay, R.; Rankin, L. 1987. Pelagic seabird populations off southwestern Vancouver Island. Can. Tech. Rep. Hydrogr. Ocean Sci. No. 87, Sidney, B.C.

Vermeer, K.; Devito, K.; Rankin, L. 1988. Comparison of nesting biology of Fork-tailed and Leach's Storm-petrels. Colonial Waterbirds 11:46-57.

Vermeer, K.; Morgan, K.H.; Smith, G.E.J.; Hay, R. 1989. Fall distribution of pelagic birds over the shelf off SW Vancouver Island. Colonial Waterbirds 12:207-214.

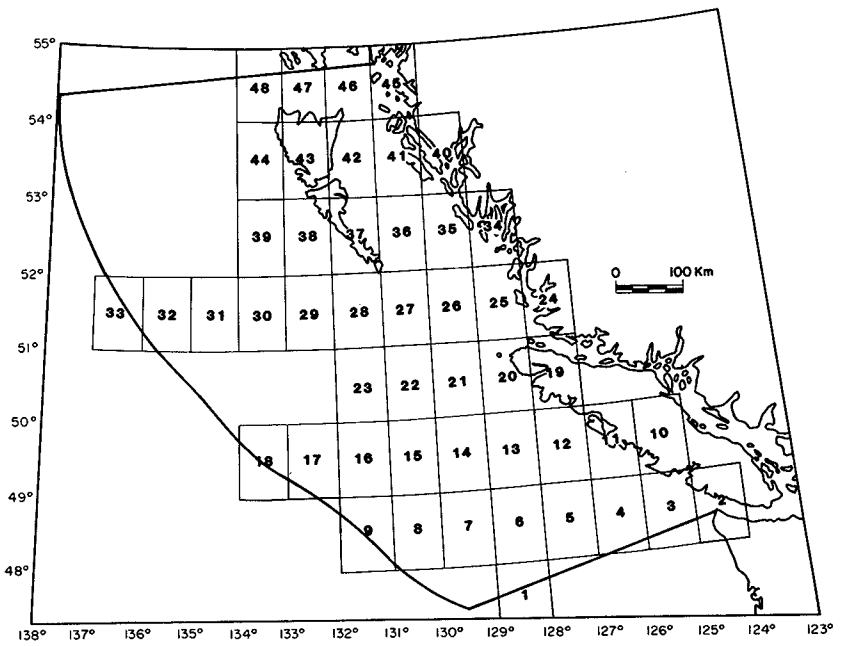
Wahl, T.R.; Heinemann, D. 1979. Seabirds and fishing vessels: co-occurrences and attraction. Condor 81:390-396.

Appendix 1
Number of transects conducted along the west coast of British Columbia, 1981–1990

1°N × 1°W block No.[a]	No. of transects[b]										
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total
1			2					29			31
2			8	7	23	15	5	49			107
3		39	26	60	364	266	166	429	99		1449
4		45	20	49	76	128	41	269	58	3	689
5			9	8	9			47	18		91
6		2	30	3				4			39
7		19	25	6							50
8		24	34	8					2		68
9		2	8						12		22
10		4		2				2	1		9
11		113	10	46	20	1		91	29	32	342
12		58	32	10				102	5	27	234
13		5	8					28			41
14		16	14						10		40
15				2					13		15
16		3	3	6					13		25
17		2	11	5					6		24
18		10	9								19
19		4	2	7				16			29
20		16	85	8				18			127
21		4		3							7
22		15	75								90
23		5	3								8
24		2	16	4							22
25		74	104	2							180
26		33	29	2						7	71
27		36	19	13						13	81
28		14	26	16							56
29			16	2							18
30		2	3								5
31		1	3	2							6
32		4	6	3							13
33		2	3	1							6
34		30									30
35		17	13	11							41
36		3	102	15							120
37		7	85	21							113
38			45	3							48
39			7	3							10
40				4							4
41		2	107	48							157
42		4	122	23							149
43			4	28							32
44			93	42							135
45			20	8							28
46			12	101							113
47	13		65	109							187
48	89		12	73							174
Total	102	617	1326	764	492	410	212	1084	266	82	5355

[a] For locations of block numbers, see Figure A1.
[b] Months with survey data:
1981 — May, June, July
1982 — March, May, June, July, September, November
1983 — March, May, June, July, August, September, October
1984 — January, April, May, July, August, October
1985 — March, May, June, November
1986 — June, July, August, September, October
1987 — September, October
1988 — May, June, August, September, October
1989 — May, June, August
1990 — January, February

Figure A1
Map showing locations of block numbers in Appendix 1



Appendix 2
Locations and dates of observations of accidental and rare bird species on the west coast of British Columbia, 1982–1990[a]

Species	No. on figure	Date	Latitude[b]	Longitude[b]
Lysan Albatross (Fig. 29)	1	23/1/84	52° 45′	133° 10′
	2	2/2/90	49° 28′	127° 22′
	3	22/4/84	53° 21′	133° 26′
	4	28/4/84	50° 43′	143° 50′
	5	1/5/84	49° 33′	138° 10′
	6	5/5/82	48° 52′	129° 34′
	7	7/5/82	49° 27′	137° 05′
	8	8/5/82	49° 48′	142° 15′
	9	10/5/82	51° 10′	138° 23′
	10	25/5/88	48° 00′	125° 40′
	11	25/5/88	48° 20′	126° 25′
	12	22/6/88	48° 57′	126° 38′
	13	14/8/88	49° 37′	127° 16′
	14	28/8/84	49° 53′	142° 57′
	15	10/9/83	52° 53′	133° 05′
	16	14/9/83	53° 58′	133° 31′
	17	19/9/82	49° 17′	134° 45′
	18	20/9/82	49° 46′	141° 39′
	19	21/9/82	50° 01′	144° 56′
	20	24/9/82	51° 14′	145° 43′
	21	25/9/82	50° 53′	145° 00′
	22	26/9/82	51° 01′	141° 05′
	23	27/9/82	51° 15′	136° 23′
	24	27/9/87	49° 36′	139° 12′
	25	27/9/82	51° 23′	133° 50′
	26	28/9/87	50° 00′	144° 00′
	27	3/10/87	47° 54′	141° 44′
	28	14/10/84	53° 38′	133° 11′
	29	14/10/87	49° 56′	129° 49′
	30	23/10/87	48° 25′	130° 05′
	31	24/10/87	48° 31′	134° 22′
	32	25/10/87	48° 36′	140° 00′
	33	27/10/87	47° 59′	140° 10′
	34	28/10/87	47° 48′	139° 20′
	35	30/10/87	48° 00′	139° 25′
	36	3/11/87	47° 49′	138° 47′
	37	4/11/87	47° 57′	134° 54′
Flesh-footed Shearwater (Fig. 30)	1	4/5/82	48° 41′	127° 00′
	2	13/5/83	52° 31′	130° 19′
	3	13/5/83	52° 28′	130° 28′
	4	19/5/83	48° 44′	127° 40′
	5	31/5/89	49° 10′	133° 51′
	6	10/6/83	53° 09′	130° 54′
	7	18/7/88	48° 37′	126° 28′
	8	19/7/88	48° 50′	126° 11′
	9	19/7/88	48° 52′	126° 01′
	10	9/8/88	49° 30′	127° 02′
	11	18/8/88	48° 20′	125° 32′
	12	19/8/89	48° 13′	125° 51′
	13	19/8/83	49° 29′	137° 32′
	14	23/8/89	48° 31′	126° 24′
	15	6/10/83	48° 30′	124° 44′
Black-vented Shearwater (Fig. 31)	1	9/8/88	50° 02′	127° 47′
	2	26/8/83	48° 55′	126° 17′
	3	17/9/82	48° 37′	126° 05′
	4	18/9/82	49° 06′	132° 24′
	5	23/9/82	50° 00′	145° 00′
	6	28/9/82	50° 34′	128° 48′
	7	29/9/82	49° 02′	126° 04′
	8	14/10/84	53° 03′	132° 36′
	9	26/10/88	48° 14′	125° 49′
Mottled Petrel (Fig. 32)	1	6/5/82	49° 30′	133° 46′
	2	7/5/82	49° 27′	137° 05′
	3	7/5/82	49° 36′	139° 24′
	4	8/5/82	49° 59′	144° 08′
	5	9/5/82	50° 41′	144° 00′
	6	16/6/86	49° 00′	126° 28′
	7	17/9/83	54° 11′	130° 20′
	8	22/9/82	50° 09′	144° 43′
	9	25/9/82	50° 53′	145° 00′
	10	27/10/87	47° 59′	140° 01′
	11	3/11/87	47° 45′	138° 37′
	12	4/11/87	47° 57′	134° 54′
	13	6/11/87	47° 53′	138° 32′
	14	7/11/87	47° 52′	138° 02′
South Polar Skua (Fig. 33)	1	9/6/83	52° 25′	130° 10′
	2	12/7/83	53° 29′	133° 41′
	3	15/7/83	49° 24′	127° 53′
	4	17/7/88	48° 20′	126° 15′
	5	18/7/88	48° 37′	125° 54′
	6	18/7/88	48° 35′	126° 29′
	7	19/7/88	48° 51′	126° 06′
	8	20/7/88	48° 54′	126° 44′
	9	12/8/88	49° 00′	128° 04′
	10	13/8/88	49° 27′	128° 03′
	11	13/8/88	49° 30′	128° 10′
	12	13/8/88	49° 24′	127° 48′
	13	13/8/88	49° 20′	127° 42′
	14	17/8/89	49° 07′	126° 55′
	15	18/8/89	48° 30′	126° 04′
	16	20/8/89	48° 04′	125° 36′
	17	21/8/83	50° 53′	144° 56′
	18	22/8/83	50° 58′	141° 10′
	19	25/8/83	49° 46′	129° 34′
	20	9/9/86	48° 26′	125° 12′
	21	15/9/83	53° 28′	133° 18′
	22	15/9/83	53° 35′	133° 32′
	23	1/10/88	48° 14′	125° 58′
	24	2/10/88	49° 16′	126° 35′
	25	3/10/88	48° 25′	125° 29′
	26	4/10/88	48° 20′	125° 35′
	27	15/10/88	48° 38′	126° 15′

Appendix 2 (*Continued*)
Locations and dates of observations of accidental and rare bird species on the west coast of British Columbia, 1982–1990[a]

Species	No. on figure	Date	Latitude[b]	Longitude[b]
Slaty-backed Gull (Fig. 34)	1	20/10/86	48° 30′	124° 41′
Iceland Gull (Fig. 34)	2	27/5/89	48° 47′	125° 52′
Glaucous Gull (Fig. 34)	3	23/1/84	53° 01′	132° 40′
	4	3/3/82	49° 02′	125° 53′
	5	13/3/82	52° 05′	129° 19′
	6	6/4/84	54° 29′	132° 03′
	7	14/4/84	54° 18′	131° 55′
	8	18/4/84	54° 32′	132° 04′
	9	18/4/84	53° 58′	133° 31′
	10	20/4/84	53° 44′	133° 14′
	11	20/4/84	54° 01′	133° 27′
	12	2/5/84	49° 03′	131° 53′
	13	10/5/83	53° 56′	131° 35′
	14	18/5/83	51° 15′	129° 19′
	15	19/5/83	48° 36′	126° 00′
	16	15/10/84	54° 22′	133° 00′
	17	21/10/84	54° 14′	131° 23′
Thick-billed Murre (Fig. 35)	1	13/1/84	52° 36′	129° 27′
	2	14/1/84	53° 14′	130° 51′
	3	17/1/84	53° 19′	130° 20′
	4	18/1/84	52° 27′	130° 29′
	5	18/1/84	52° 33′	130° 05′
	6	19/1/84	53° 56′	131° 03′
	7	21/5/82	53° 00′	131° 17′
	8	14/9/83	50° 55′	128° 20′
	9	30/10/84	53° 58′	130° 52′
	10	31/10/84	48° 45′	126° 01′
Horned Puffin (Fig. 36)	1	31/5/89	49° 11′	134° 07′
	2	2/7/89	50° 07′	127° 55′
	3	11/7/83	54° 19′	133° 39′
	4	14/7/82	50° 58′	129° 33′
Xantus' Murrelet (Fig. 36)	5	26/8/88	48° 06′	126° 50′
	6	31/10/88	48° 22′	125° 52′
Parakeet Auklet (Fig. 36)	7	29/5/89	49° 28′	136° 46′
	8	16/9/83	50° 47′	130° 23′
	9	27/9/82	51° 23′	133° 44′
	10	28/9/82	51° 46′	130° 57′
	11	14/10/84	53° 24′	132° 57′
	12	14/10/84	53° 43′	133° 17′
	13	14/10/84	53° 46′	133° 22′
	14	15/10/84	54° 21′	133° 01′
	15	27/10/88	48° 20′	127° 10′

[a] Observations are listed in calendar sequence for each species.
[b] Rounded to nearest minute.

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