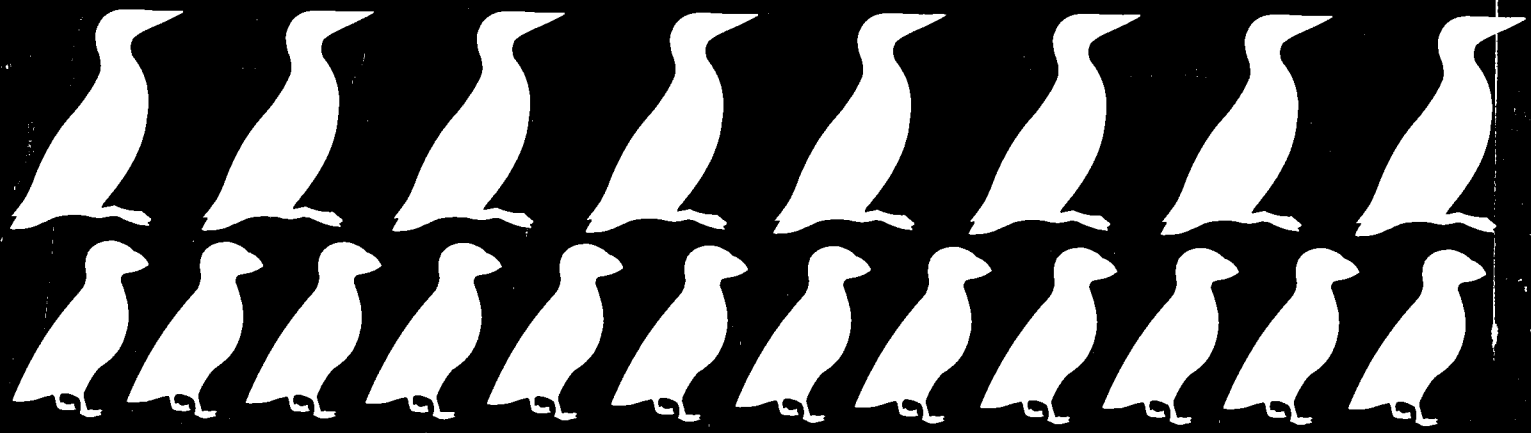
Atlas of eastern Canadian seabirds



by R. G. B. Brown, D. N. Nettleship, P. Germain, C. E. Tull and T. Davis

Canadian Wildlife Service

Environment Canada
Wildlife Service

Environnement Canada
Service de la Faune

Atlas of eastern Canadian seabirds

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This Atlas is dedicated to

Finn Salomonsen
Leslie M. Tuck
V.C. Wynne-Edwards

the pioneers of the study of the biology and ecology of marine birds in eastern Canada and west Greenland.

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Summary

The object of this Atlas is to bring together and summarize basic information on the ecology and pelagic and breeding distributions for the seabirds of the Gulf of St. Lawrence, the Atlantic Provinces and the eastern Canadian Arctic. This Atlas includes a review of the literature on the pelagic distributions of seabirds in the northwest Atlantic. However, we have based the distribution maps almost entirely on information collected during recent unpublished surveys supported or carried out by the Canadian Wildlife Service.

The pelagic maps summarize data collected between 31 March 1969 and 31 March 1973. They cover the eastern Canadian Arctic and the northwest Atlantic west of 40°W and north of 40°N. Data were recorded in a modified version of the Smithsonian Institution's Pacific Ocean Biological Survey Program recording scheme. A computer was programmed to process and print out the data in map form; we converted the print-outs into a more readable format for this Atlas.

The basic map format is quantitative. We divided the survey area into 1°N × 1°W (Atlantic) or 1°N × 2°W (Arctic) blocks. For the species and month in question, each map shows the average number of birds of a species seen in each block during a 10-minute watch from a moving ship. The effort maps show the number of watches on which these averages are based. We use a modification of this format to show the distribution of the colour phases of the Northern Fulmar (*Fulmarus glacialis*) and a non-quantitative ("rarebird") format for species infrequently seen at sea. Here, the symbol shows the existence of at least one sighting in a ¼°N × ¼°W (Atlantic) or ¼°N × ½°W (Arctic) block for the species and month in question. Finally, in some cases there are too few records to warrant plotting them in a map; these are listed in an appendix.

We collected information on breeding distributions between 1967 and 1974, and supplemented the information where necessary from the literature. We counted birds in the eastern Canadian Arctic, mostly from the air (fixed-wing aircraft and helicopter), and supplemented these counts wherever possible with aerial photographs and ground checks. Population estimates in the Gulf of St. Lawrence and the Atlantic Provinces are from intensive ground censuses and aerial surveys. For Northern Fulmar, Gannet (*Morus bassanus*), Great and Double-crested Cormorants (*Phalacrocorax carbo* and *P. auritus*), Black-legged Kittiwake (*Rissa tridactyla*), Razorbill (*Alca torda*), Common and Thick-billed Murres (*Uria aalge* and *U. lomvia*), Dovekie (*Plautus alle*) and Atlantic Puffin (*Fratercula arctica*), we plotted actual colony sites on the maps and listed them in tables. But for species which form many small colonies (*e.g.* Herring Gull (*Larus argentatus*)), which are usually non-colonial (*e.g.* Black Guillemot (*Cepphus grylle*)), or whose breeding sites are difficult to locate (*e.g.* Leach's Storm-Petrel (*Oceanodroma leucorhoa*)), we have given only a general indication of breeding range.

We discuss the factors controlling breeding distribution. Breeding seabirds must compromise between the availability of food and the presence of suitable places to nest. Thus the summer distributions of cliff-nesting species are confined to coasts with cliffs, a relatively small area in the Atlantic Provinces. We also discuss distortions in distribution arising from human interference, with particular reference to the extinction of breeding Gannets in the Bay of Fundy, and their near-extinction in the Gulf of St. Lawrence, during the late 19th century.

We summarize the oceanographic characteristics of the northwest Atlantic and the eastern Canadian Arctic. We divided these waters into four zones: *High Arctic*, *Low Arctic*, *Boreal* and *Cool Subtropical*. We show that, despite much overlap, each zone tends to have a distinctive plankton and fish fauna. We discuss seabird distributions, as shown by this survey, in terms of this biogeographic framework; it appears that, despite their greater mobility, seabirds are also surprisingly zone-specific.

We discuss the practical use of this Atlas in environmental impact studies. We use, as an example, the impact of oil pollution and show the areas where seabirds are most vulnerable to oil spills.

Résumé

Cet Atlas a pour objet de rassembler et résumer des renseignements fondamentaux sur l'écologie ainsi que sur la distribution, tant en haute mer que dans les aires de nidification, des oiseaux de mer du golfe du Saint-Laurent, des provinces de l'Atlantique et de l'est de l'Arctique canadien. Il inclut une critique des textes publiés sur la distribution pélagique des oiseaux de mer dans le nord-ouest de l'Atlantique. Néanmoins, les cartes qui en illustrent la distribution sont fondées presque entièrement sur les renseignements recueillis lors de relevés récents et inédits, menés par le Service canadien de la faune ou subventionnés par lui.

Les cartes pélagiques résument les données recueillies entre le 31 mars 1969 et le 31 mars 1973. Elles comprennent l'ensemble de l'Arctique canadien oriental ainsi que du nord-ouest de l'Atlantique à l'ouest de 40° O. et au nord de 40° N. Les données ont été enregistrées selon une variante du schéma d'enregistrement utilisé pour le Programme de relevé biologique de l'océan Pacifique mené sous les auspices de la Smithsonian Institution. On avait programmé un ordinateur de façon qu'il traite et imprime les données sous forme de cartes géographiques que nous avons réduites pour cet atlas à des dimensions se prêtant mieux à la lecture.

Le cadre de référence de base de ces cartes est quantitatif. Nous avons réparti l'aire étudiée en quadrilatères soit de 1° N. × 1° O. (Atlantique), soit de 1° N. × 2° O. (Arctique). Chaque carte montre, pour l'espèce et le mois en cause, le nombre moyen d'oiseaux d'une espèce donnée aperçus dans chaque quadrilatère par tour de garde de 10 minutes à partir d'un navire en en mouvement. Des cartes géographiques de travail indiquent le nombre de tours de garde sur lequel ces moyennes sont fondées. Nous nous servons d'une variante de ce cadre de référence pour montrer la distribution des phases de coloration du Fulmar boréal (*Fulmarus glacialis*). Pour ce qui est des espèces rarement aperçues en haute mer, nous avons eu recours à un cadre de référence non-quantitatif (pour "oiseaux rares"). En ce cas, le symbole montre que pour ce qui est de l'espèce et du mois en cause, on a aperçu un oiseau au moins par quadrilatère de ¼° N. × ¼° O. (Atlantique) ou de ¼° N. × ½° O. (Arctique). Il est enfin des cas où il y a eu trop peu d'enregistrements pour qu'il vaille la peine de les retracer sur cartes: on en trouvera la liste en appendice (Appendix 2).

Nous avons recueilli des renseignements sur la distribution de la nidification entre 1967 et 1974, à quoi nous avons ajouté aussi souvent que nécessaire des renseignements tirés d'autres textes. C'est surtout du haut des airs (d'aéronefs à ailes fixes et d'hélicoptères) que nous avons compté les oiseaux. Chaque fois que la chose a été possible, nous avons ajouté à ces décomptes tant des photographies aériennes que des vérifications au sol. L'estimation des populations dans le golfe du Saint-Laurent et les provinces de l'Atlantique résulte de recensements menés du sol et de relevés aériens, intensifs les uns et les autres. Pour ce qui est du Fulmar boréal, du Fou de Bassan (*Morus bassanus*), du Grand Cormoran (*Phalacrocorax carbo*), du Cormoran à aigrettes (*Phalacrocorax auritus*), de la Mouette tridactyle (*Rissa tridactyla*), du Gode (*Alca torda*), de la Marmette commune (*Uria aalge*), de la Marmette de Brünnich (*Uria lomvia*), du Mergule nain (*Plautus alle*) et du Macareux arctique (*Fratercula arctica*), nous avons marqué les sites de fait de leurs colonies sur les cartes et en avons dressé des listes sous forme de tableaux. Par contre, nous n'avons donné qu'une idée générale de l'aire de nidification d'espèces dont les sujets se groupent en un grand nombre de petites colonies (par ex., le Goéland argenté-*Larus argentatus*-), n'en forment généralement pas (par ex., le Guillemot noir -*Cepphus grylle*-) ou dont les sites de nidification sont difficilement repérables (par ex., le Pétrel cul-blanc -*Oceanodroma leucorhoa*-).

Nous discutons des facteurs qui régissent la distribution de la nidification. Les oiseaux de mer nicheurs doivent faire un compromis entre la disponibilité de nourriture et la présence d'endroits convenables où nicher. Ainsi, la distribution estivale des espèces qui nichent dans les falaises se confine-t-elle à des côtes qui comportent des falaises, soit à une aire relativement petite dans les provinces de l'Atlantique. Nous discutons aussi des distorsions qui surgissent dans la distribution du fait de l'intervention humaine, en nous référant tout particulièrement à l'extinction des Fous de Bassan nicheurs dans la baie de Fundy et à leur quasi-extinction dans le golfe du Saint-Laurent, au cours du 19e siècle.

Nous résumons les caractéristiques océanographiques du nord-ouest de l'Atlantique et de l'Arctique canadien oriental. Nous avons réparti ces eaux en quatre zones: du *Haut-Arctique*, du *Bas-Arctique*, *boréale* et *subtropicale fraîche*. Nous montrons que malgré beaucoup de chevauchement, chaque zone tend à avoir un peuplement distinct de zooplancton et de poissons. Nous discutons de la distribution des oiseaux de mer, telle que la montre ce relevé, en fonction de ce cadre de référence biogéographique: il appert que malgré leur mobilité supérieure, les oiseaux de mer sont eux aussi étonnamment spécifiques à une zone donnée.

Nous discutons de l'utilisation pratique de cet Atlas au cours des études d'effets écologiques. Nous prenons comme exemple l'effet de la pollution pétrolière et montrons en quelles régions les oiseaux de mer sont le plus vulnérables aux épanchements de pétrole.

1. Introduction

Until recently, North American wildlife biologists have had little incentive to study seabirds. Although seabirds are harvested in the USSR (*e.g.* Belopol'skii 1961) and elsewhere, they are almost completely protected in North America,[1] and so there has been no need for detailed studies of their ecology, of the kind used for the management of a harvested waterfowl stock. Their value as a resource was mainly an aesthetic one. Under the then-prevailing dollars-and-cents criteria, this could only be measured in the few areas where seabirds were a tourist attraction, as, for example, the gannetry on Bonaventure Island (Godfrey 1966).

Since the late 1960's, with the growing public concern over environmental issues, our perspectives have changed. It is now generally accepted that we must assess the impact of man-made changes in the environment and take into account as many facets as possible in doing so. Seabirds themselves have played an important role in this change in attitude; the effects of oil spills and of pesticides and other chemical pollutants on them have received widespread publicity. The seabird mortality incidental to the west Greenland salmon fishery (Tull *et al.* 1972) is another, less publicized, example of the unexpected side-effects of man's interference with the marine environment. Industrial expansion in the Arctic, where so many seabirds breed, and offshore mining and oil drilling both there and in the Atlantic will undoubtedly provide further examples. There is a clear need to minimize these risks by including information on seabirds in the impact studies required for advance planning of such projects.

For this, one needs to know where the birds are and how many of them there are. The difficulty is that information on seabird distributions is sparse and scattered through the literature, often in journals which are not readily available. Since many species breed in little-travelled parts of the Arctic, it has been hard enough to draw up a list of breeding sites, let alone to estimate the sizes of their populations. Moreover, seabirds spend much of their lives out of sight of land; yet, until the recent boom in oceanographic research, our knowledge of their pelagic distributions was largely confined to a few established shipping lanes. Observers seldom had the opportunity to make regular series of records. Their data were often also poorly quantified; the presence of a species might be noted, but not its absence, and counts were usually not related to a definite statistical base. Wynne-Edwards' (1935) pioneer study shows the importance of repeated, quantitative observation in recording the geographical and seasonal changes in the pelagic distributions and abundance of seabirds in the North Atlantic.

In 1969 Brown and Germain jointly organized and initiated systematic studies of the distribution of seabirds at sea in the Gulf of St. Lawrence, in the western North Atlantic and in Arctic waters. The program, entitled PIROP (Programme Intégré de Recherches sur les Oiseaux Pélagiques) and operated completely by the Canadian Wildlife Service (CWS) since 1972, used the relatively large oceanographic fleet based in eastern Canada to collect quantitative observations in the eastern Canadian Arctic and in the Atlantic north of 40°N and west of 40°W. At about the same time Nettleship initiated the CWS program "Studies on northern seabirds", which had as an immediate aim the cataloguing of seabird breeding sites in the same area. Together, the programs comprised a comprehensive investigation of the distributions and numbers of seabirds in eastern Canada (Nettleship 1973*a*).

This Atlas summarizes our results to date.[2] Coverage of certain areas and at certain seasons is clearly incomplete, especially for pelagic distributions, and we hope to bring it up-to-date in later editions or in supplementary publications. For the present, however, it seems adequate to demonstrate the distribution patterns of the seabirds of eastern Canada, and to provide the information needed for environmental impact studies which must take these patterns into account. From the point of view of pure research, we also hope to provide a basis for further research into the neglected field of pelagic ornithology, and wherever possible we have tried to suggest lines which this might follow.

1 Pre-Confederation Newfoundland was not a signatory to the Migratory Bird Treaty of 1916 between Canada and the United States, which set up this protective legislation. The traditional hunting of murres continues in that province, during a limited winter season. Hunting by Indians and Inuit is also permitted.

2 Our cut-off dates in preparing the maps were 31 March 1973 for pelagic distributions and 1 September 1974 for breeding distributions. In several cases more recent field work has significantly expanded our coverage. Where necessary this new information has been summarized in footnotes or in supplementary maps.

2. Quantitative observations of seabirds: the background to the Atlas maps

The Smithsonian Institution Pacific Ocean Biological Survey Program (POBSP) records the number of birds at every sighting, along with the time, ship's position, various aspects of the birds' plumage and behaviour, weather, and certain oceanographic parameters (King *et al.* 1967; King 1970). The data are then coded for computer analysis. We initially used this system for our quantitative observations, but modifications were necessary. King found seabirds so scarce in the tropical Pacific that he usually was able to log the time of each sighting. This is frequently quite impossible with the greater numbers of birds in the northwest Atlantic, so we adopted a system of 10-minute watches, recording the total numbers of each species seen during each watch. This interval was more convenient than Wynne-Edwards' (1935) 1-hour watches, especially in areas of rapid oceanographic change. It is not a major modification of the POBSP system; King used 5-minute totals when birds were exceptionally abundant, and his final analysis can be related to numbers seen per hour of observation. The codes which we finally adopted, incorporating this and other modifications, are listed in Appendix 1.

There are a number of unavoidable biases in this, as in any other recording system. We hope our method is sufficiently uniform to reduce to a minimum variability between observers. We have rejected obviously unrepresentative watches where fog or other factors affected observations. We have also rejected counts from stationary ships; many species are attracted to these, but the numbers depend on whether or not the ship is fishing, and are difficult to correlate with the numbers seen from moving ships. Birds which follow ships are another problem; we recorded these on each watch, even when it seemed that the same individual had been present during a previous watch, and this may have inflated our estimates. Bailey and Bourne (1972) discuss these and other possible biases in more detail. It is hard to say what the overall effect is; if the biases are constant, they ought not to be too serious for a study of relative changes in distribution, which is what we are attempting here. Finally, the Atlas format adds another possible bias: since the maps combine observations from several seasons, they conceal any differences in numbers or distributions which may occur between years. Comparisons between PIROP data and the literature (see Section 6) do not indicate any serious distortion, but we hope to analyse year-to-year variability in greater detail as observations accumulate.

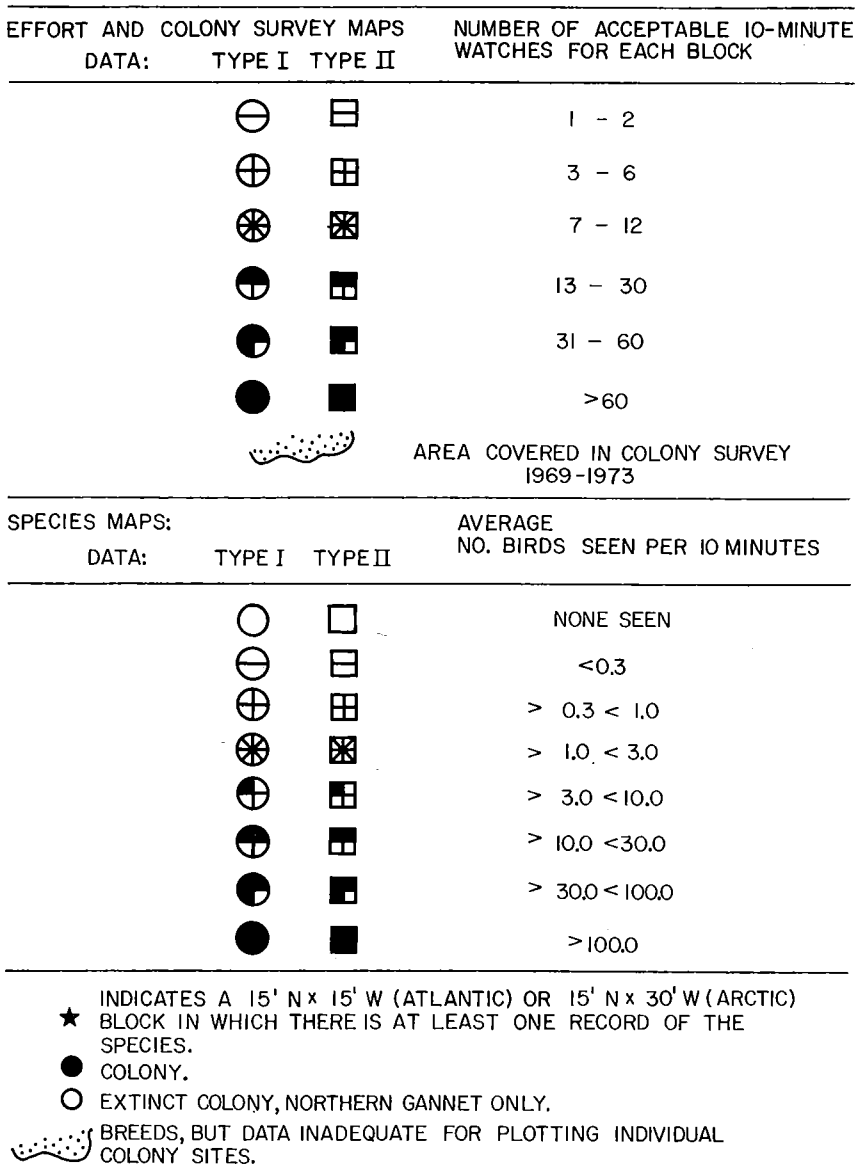
The observer usually coded the bird observations while at sea, and this was checked in the office for errors before it was punched onto computer cards. The cards were rechecked after being punched and machine-verified. We found this elaborate checking procedure (designed by Davis) essential in minimizing errors. We processed over 60,000 cards in this way, and the data were then transferred to a computer disc for greater accessibility.

The computer program (written by Tull) for the analysis set up a number of matrices for the region in question, with each entry corresponding to a 1°N × 2°W (Arctic region) or 1°N × 1°W (Atlantic region) block. We checked each observation card to see that it satisfied criteria for species, identification reliability, month and other factors specified at the start of the computer run. It was then placed in the appropriate location in the matrices. The effort (*i.e.* the number of acceptable 10-minute watches), the number of birds seen, the error estimates and the sums of squares were stored for the block in question. When we had checked all the observation cards, we calculated the average number of birds seen per 10 minutes in each block. Effort, numbers, errors, sums of squares and averages were then printed out. For mapping purposes we divided the averages into eight categories, ranging from "species absent" to "$\geqslant$ 100.0 birds per 10 minutes" and we gave each category a special symbol (Fig. 1).[3] We had previously programmed the computer to draw a simple map of the region; the category symbols for each block were superimposed on this map information, and the final map was printed out. These computer-drawn maps are adequate for working purposes, but were redrawn in a more readable form for this Atlas.

We must emphasize that the maps show only relative abundances, and do not provide any absolute estimates of seabird numbers. In theory a conversion is possible, given the ship's speed and the height of the observer above the sea. But it would also require estimates of the ranges at which the various species can be identified, their reactions to ships, and probably other factors as well. It seems unwise to attempt this for the present. However, these relative abundances show where most of the total population of a species is at any given season, and so they allow one to assess the likely impact on that species of various environmental modifications.

[3] Figure 1 also appears on page 220, facing the inside back cover of this Atlas.

Figure 1
The key to map symbols



The Atlas has three basic map formats: quantitative, "rarebird" and colony maps.

Quantitative maps

Quantitative maps show the average numbers of birds per 10-minute watch which were seen under good conditions from a ship moving at a minimum speed of 4 knots. The effort maps (Maps 1a–h) show the number of acceptable watches on which the averages were based.[4] Note that there are symbols to indicate the absence of birds; a blank indicates the absence of coverage for the block in question.

Full-time observers, following the PIROP instruction manual (Appendix 1), collected most of the data plotted on these maps. These data, which we labelled "Type 1", are shown as circles. For those blocks in which no Type I data were available, we used data collected by part-time observers (usually working oceanographers), who did not necessarily follow all the PIROP instructions. These "Type II" observations, some of which antedate the PIROP system, were based on 10-minute watches and are shown on the maps as squares.

The quantitative maps for the Northern Fulmar (*Fulmarus glacialis*) have been slightly modified to show the distributions of the colour phases of the species. On these maps the symbols plot the average percentage of "dark-phase" birds (Fisher (1952), types L, D and DD) in every block in which the colour phase of at least 25 birds was identified. We used observations from both stationary and moving ships for these averages. The maps cover only April–May and August–October; too few data are available for other periods.

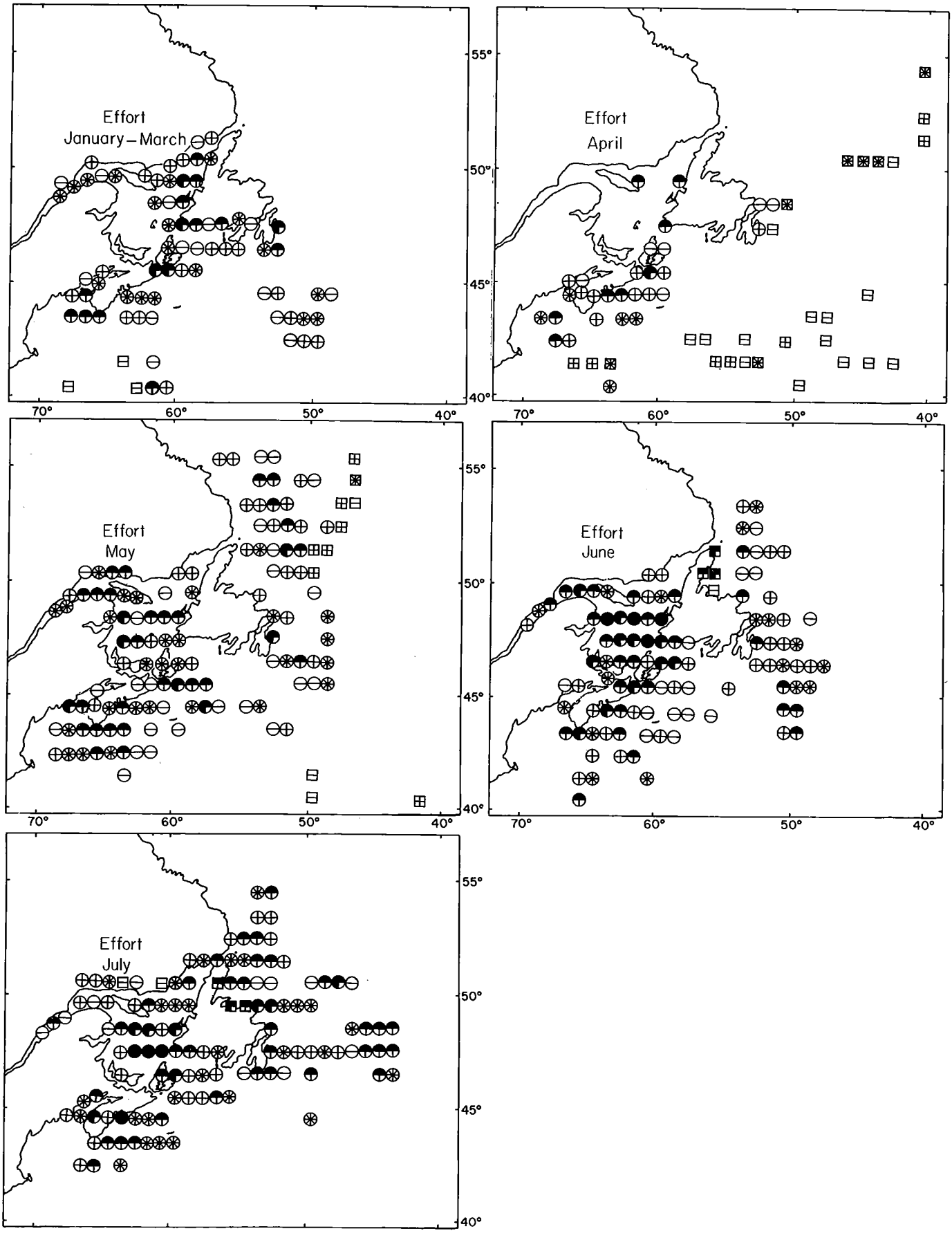
"Rarebird" maps

Plotting the data in quantitative form is not very meaningful for rarer species. For these we have plotted only positive sightings (from stationary and moving ships), shown on the maps as stars. These indicate every ¼°N × ¼°W (Atlantic) and ¼°N × ½°W (Arctic) block in which there is at least one record of the species in question. Unlike the quantitative maps, a blank area on a "rarebird" map can mean either the absence of birds or the absence of coverage. The effort maps give the extent of coverage. Note that "rare" refers to the frequency of sighting rather than to the size of the population. For example, the Atlantic Puffin (*Fratercula arctica*) is a common breeder in Atlantic Canada but is seldom seen at sea; plotting the data in "rarebird" form gives the most informative picture of its distribution. This format is also useful for plotting positive identifications of species which are hard to separate at sea, such as Thick-billed and Common Murres (*Uria lomvia* and *U. aalge*) and Red and Northern Phalaropes (*Phalaropus fulicarius* and *Lobipes lobatus*).

Colony maps

All breeding stations known to us are listed in Tables 1–10 and plotted on the colony maps; each number on the map refers to a colony labelled with the corresponding number in the tables. Wherever possible the maps are based on Nettleship's surveys during 1967–1974; the scope of these is indicated on the colony survey map (see Map 1i). We counted most of the birds in the eastern Canadian Arctic from the air (fixed-wing aircraft and helicopter), and supplemented these counts, where possible, by analyses of aerial photographs and ground checks. Population estimates in the Gulf of St. Lawrence and Atlantic Canada are from intensive ground censuses and aerial surveys. We used the ground census techniques described by Nettleship (1972*a*, 1975*a*), and calculated aerial counts according to procedures outlined by Nettleship (1974*a*, *b*, *c*, 1975*a*). The numbers of birds are usually given as the number of pairs in the tables. However, some counts in the literature refer to numbers of individuals and it seems best to quote them as such, rather than to risk errors by trying to convert them to numbers of pairs. We have not plotted colony sites for common species which breed in many small colonies, such as most of the gulls; in such cases the information is filed with the Canadian Wildlife Service, Ottawa.

4 The effort maps only show the number of watches in which all species were being counted (see Map 1a–h). Where the count was restricted to certain species (see Appendix 1), the averages may be based on more watches than the effort maps indicate. Murres and Dovekies are the species mainly affected; note that the November and December maps for these species have several extra symbols. The numbers of watches in those blocks were: 54°N/53°W = 10; 53°N/55°W = 2; 52°N/52°W = 11; 52°N/54°W = 6; 51°N/55°W = 4; 50°N/63°W = 6; 53°N/40°W = 9.


Effort
January – March
Effort
April
Effort
May
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June
Effort
July
55°
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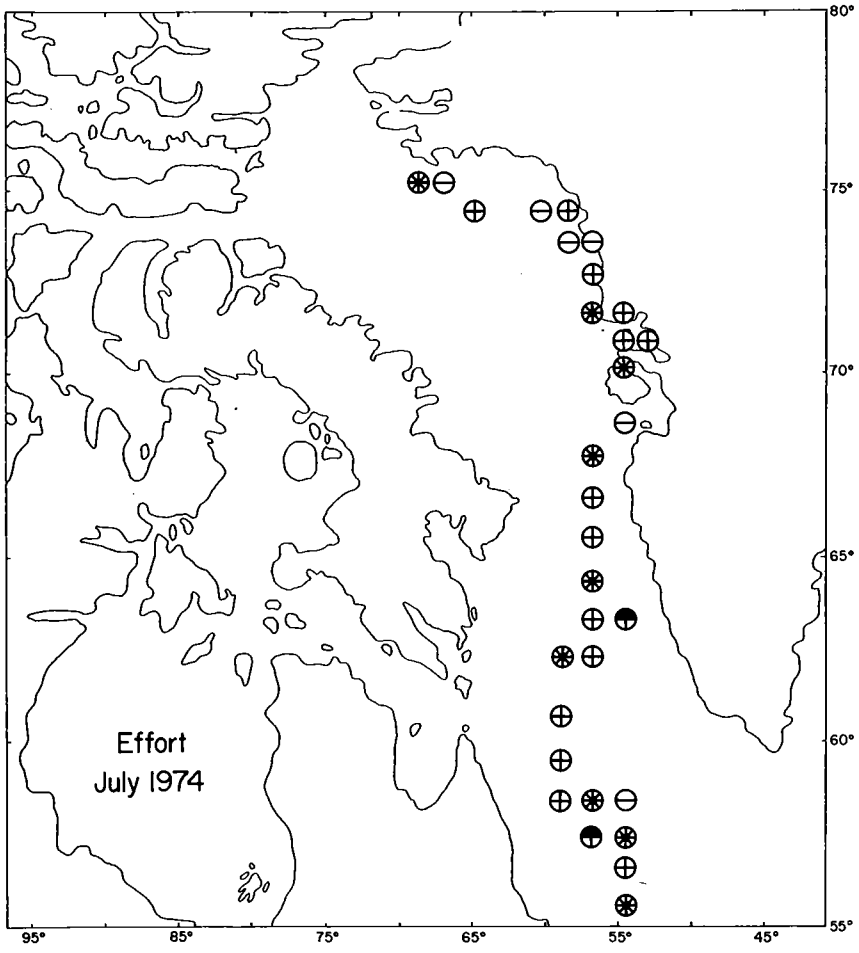
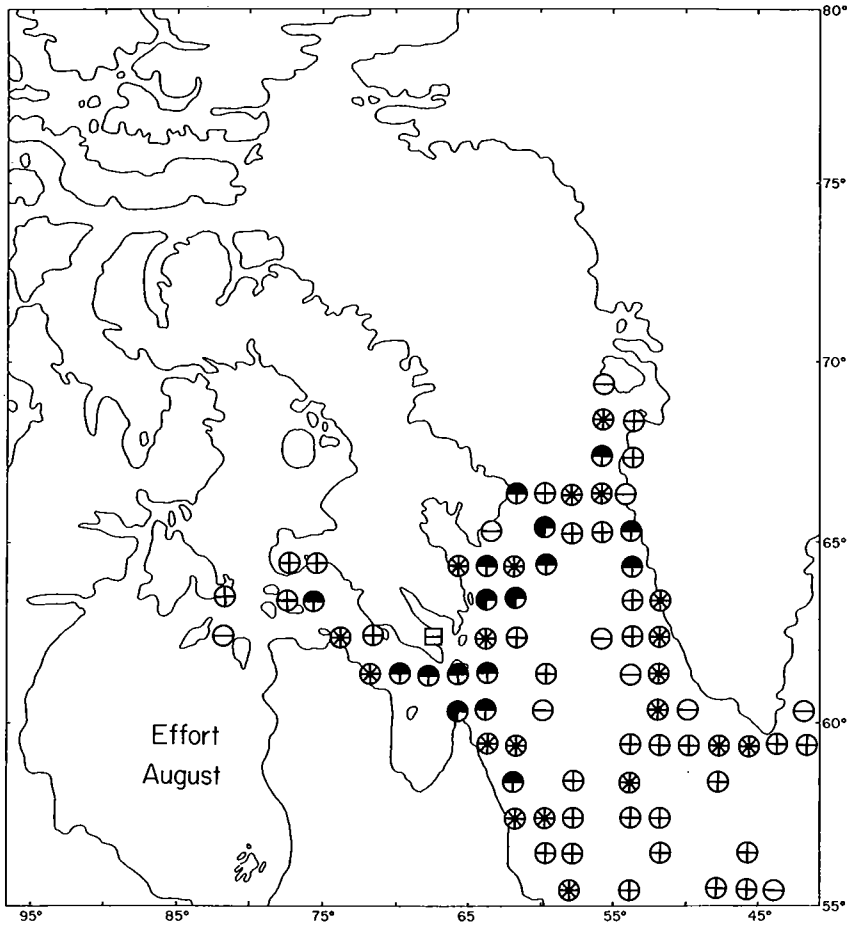
40°

Map 1b
Effort

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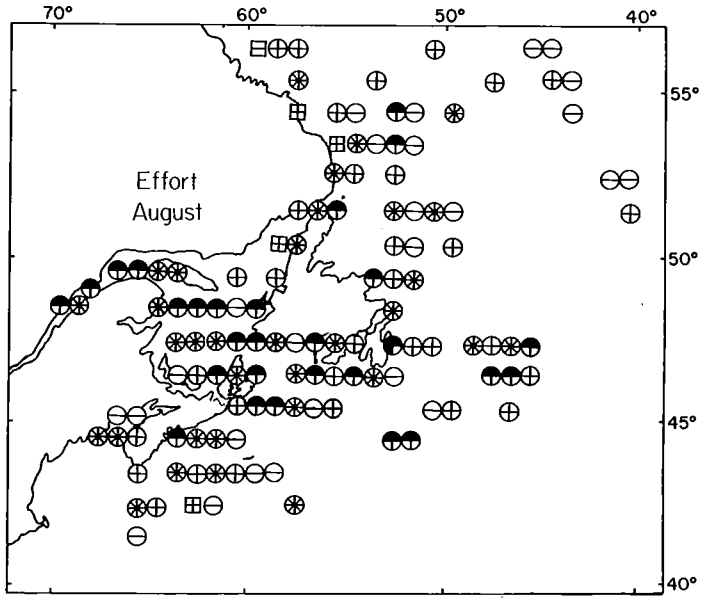
95°
85°
75°
65
55°
45°
Effort
August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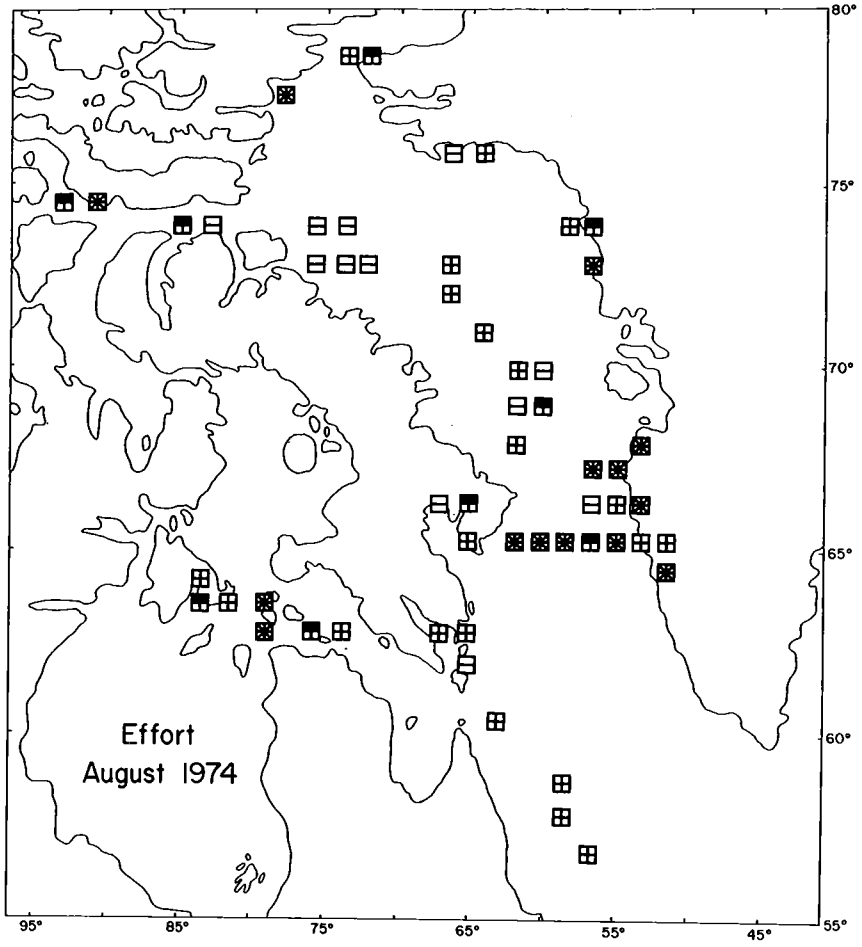
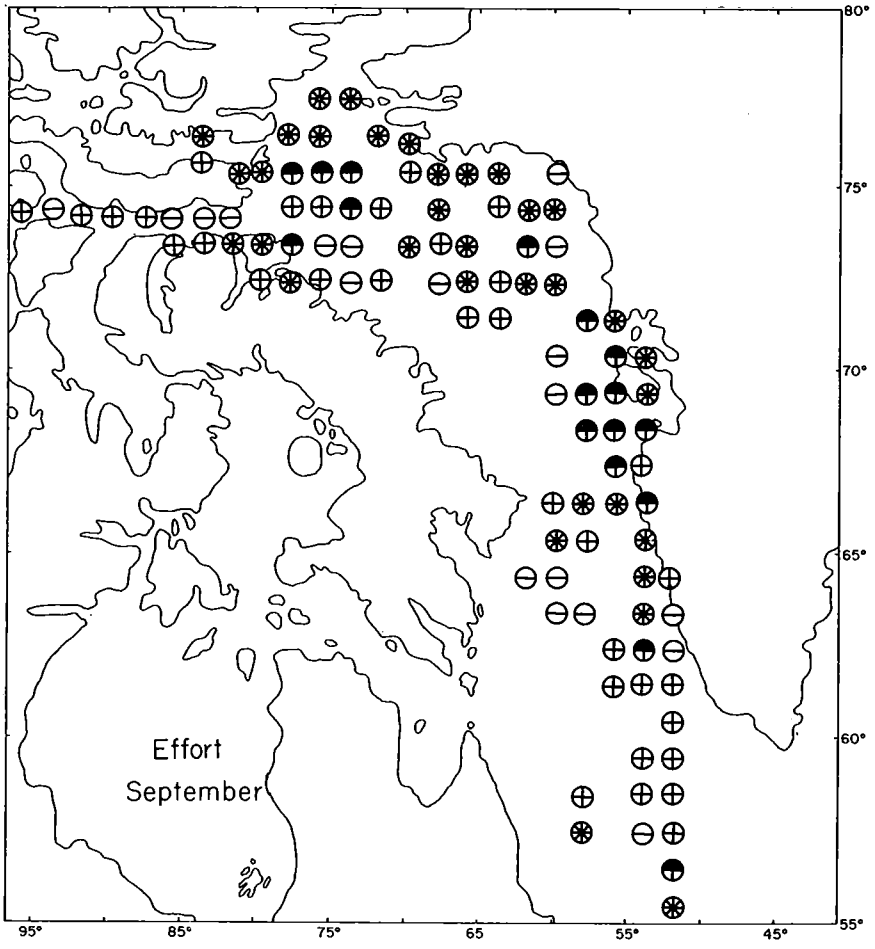
August

Map 1d
Effort




Effort
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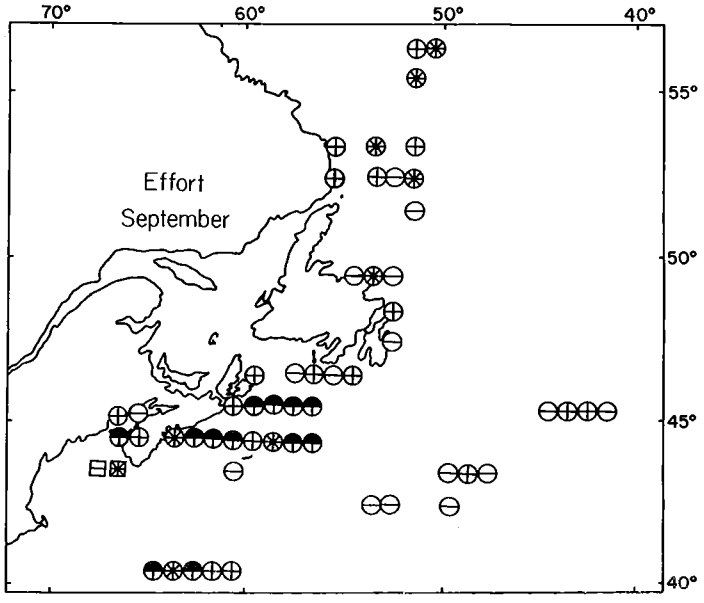
Effort
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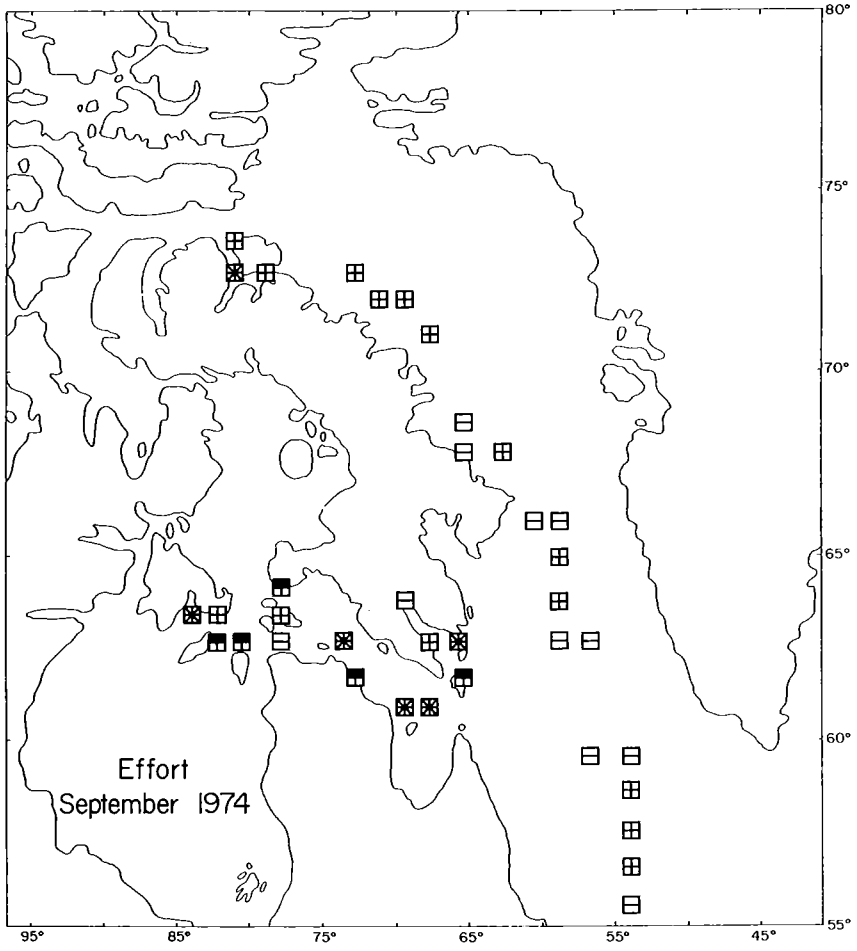
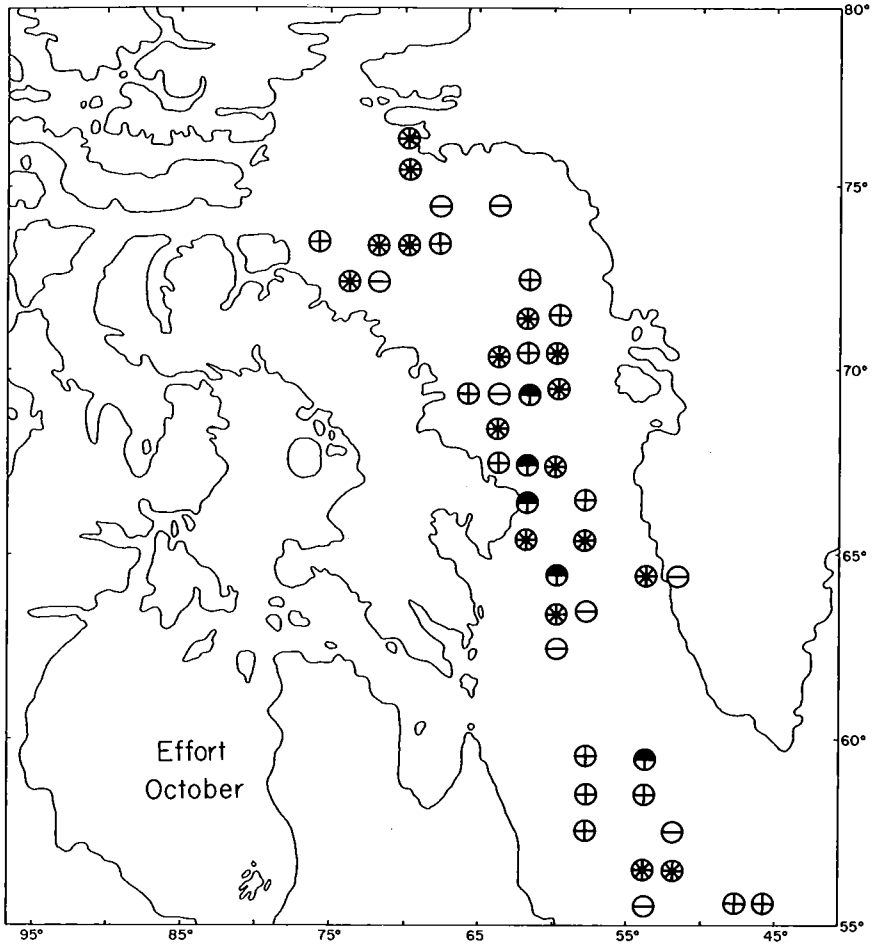
Map 1f
Effort

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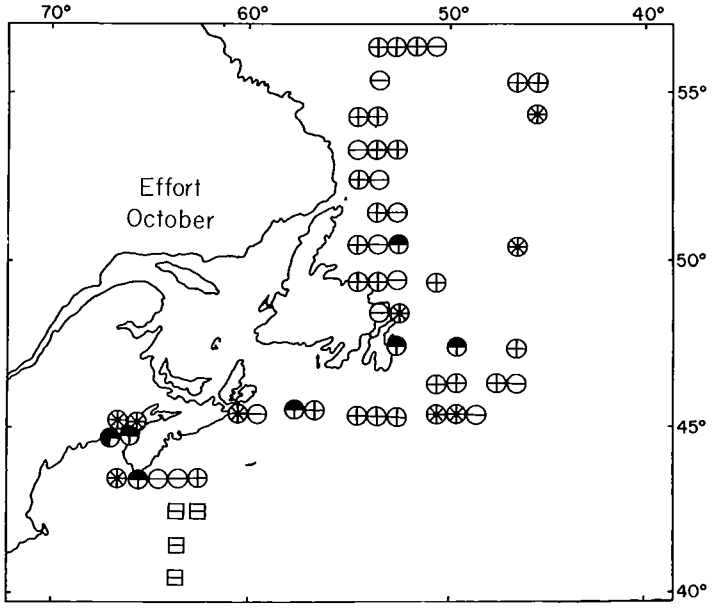
Effort
October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October

Map 1h
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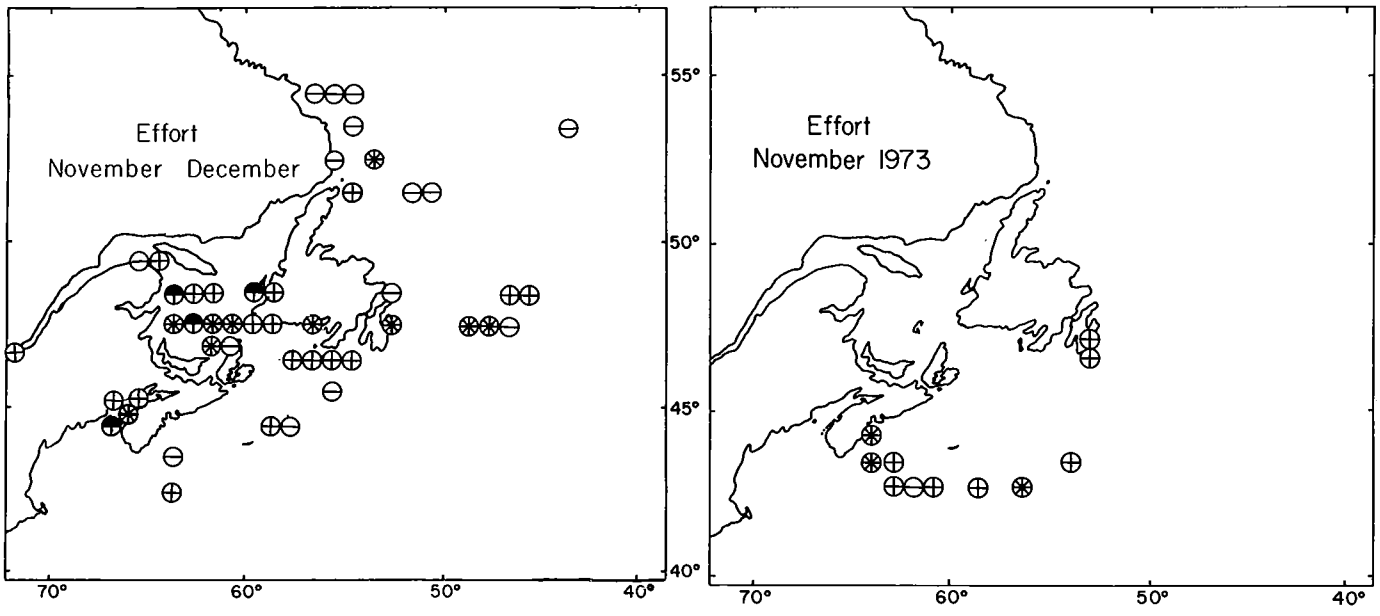

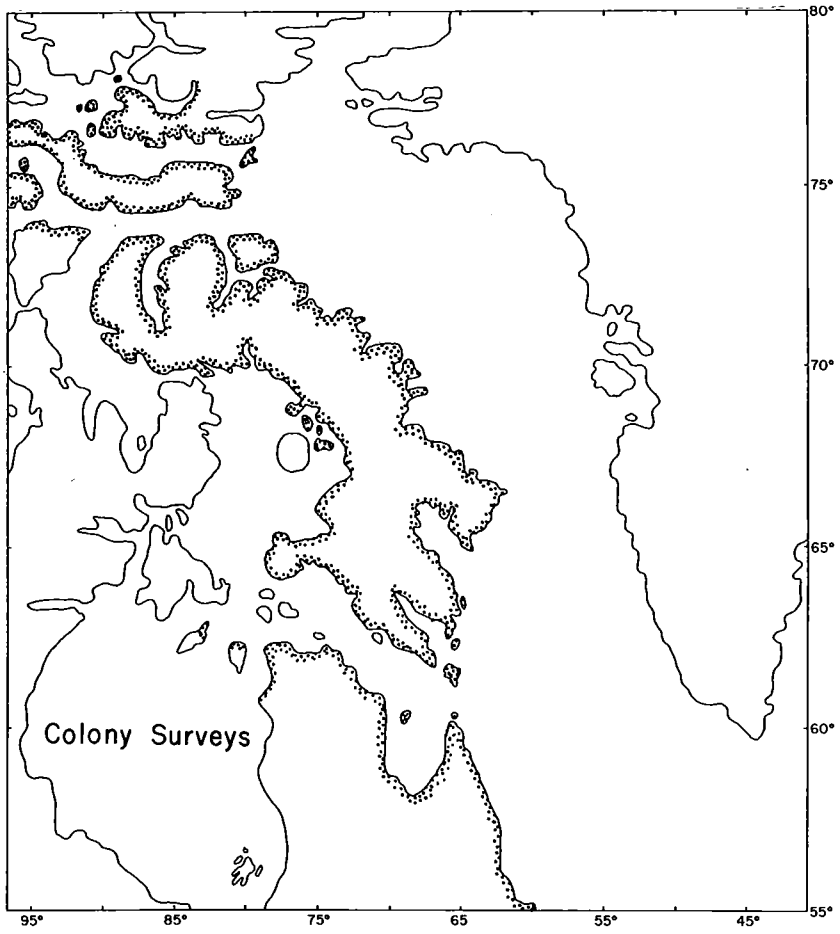
Colony Surveys
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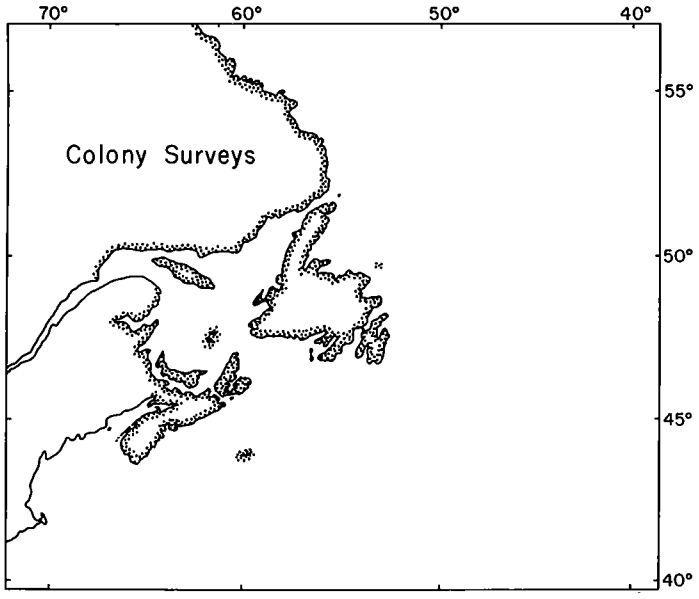
Colony Surveys
70°
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50°
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3. The oceanography of the northwest Atlantic and the eastern Canadian Arctic

The oceanographic characteristics of the waters off eastern Canada depend on the interactions of two water masses: *Polar* water from the Arctic Ocean and *Atlantic* water from the central North Atlantic. The summary which follows is based on Bailey *et al.* (1954), Collin and Dunbar (1964), Hachey (1961), and Huntsman *et al.* (1954) (see also Fig. 2).

(a) Cold polar water of low salinity enters Baffin Bay from the Arctic Ocean and flows down the east coast of Baffin Island as the *Baffin Land Current.*

(b) The warmer *West Greenland Current* (made up of mixed Polar and Atlantic water) flows north up the west coast of Greenland. Water from it branches off, crosses Davis Strait, and mixes with the Baffin Land Current and water flowing out of Hudson Strait to form the *Labrador Current*, which moves down the Labrador coast. This current is coldest inshore, and relatively unmodified Polar water persists as far south as 55°N. A variable but small amount of Labrador Current water enters the Gulf of St. Lawrence through the north side of the Strait of Belle Isle. The main current continues down the east coast of Newfoundland and splits. An easterly branch moves across the eastern Grand Bank and turns eastward where it meets and mixes with the North Atlantic Current (see below). A westerly branch turns along the south and west coasts of Newfoundland, and this cold water eventually reaches the north shore of the Gulf of St. Lawrence.

(c) The warm, highly saline *North Atlantic Current* moves northward along the American coast, out across the southern Grand Bank, and fans out northeastwards towards Britain and Iceland. (The term "Gulf Stream" applies to the section between the Florida straits and the Grand Bank.) The position of its northern boundary off eastern Canada can vary by as much as 200 miles. The North Atlantic Current mixes with the Polar water of the East Greenland Current in the Irminger Sea, and with the Labrador Current on the Grand Bank.

(d) The water in the Gulf of St. Lawrence is strongly influenced by the discharge of fresh water from the St. Lawrence River, originating in the Great Lakes watershed. Water of low salinity flows through the southern part of the Gulf, out of the southern side of Cabot Strait, and southwest along the Atlantic coast of Nova Scotia, where it interacts with modified North Atlantic Current water. The waters of the Scotian Shelf are thus markedly less saline than those of the Grand Bank farther east.

Ice cover (Figs. 3 and 4) is greatly influenced by these current systems. In winter the relatively warm Irminger Sea and much of the West Greenland Current are ice-free, but in the cold Labrador Current pack-ice occurs as far south as eastern Newfoundland, and drifts even farther south in spring. Most of the survey area is ice-free in summer, but ice persists in Polar water, such as off central Baffin Island and among the Canadian Arctic islands.

Figure 2
The principal current systems in the northwest Atlantic and the eastern Canadian Arctic (after Hachey 1961). Key: 1, Baffin Land Current; 2, West Greenland Current; 3, Labrador Current; 4, North Atlantic Current; 5, Gulf Stream

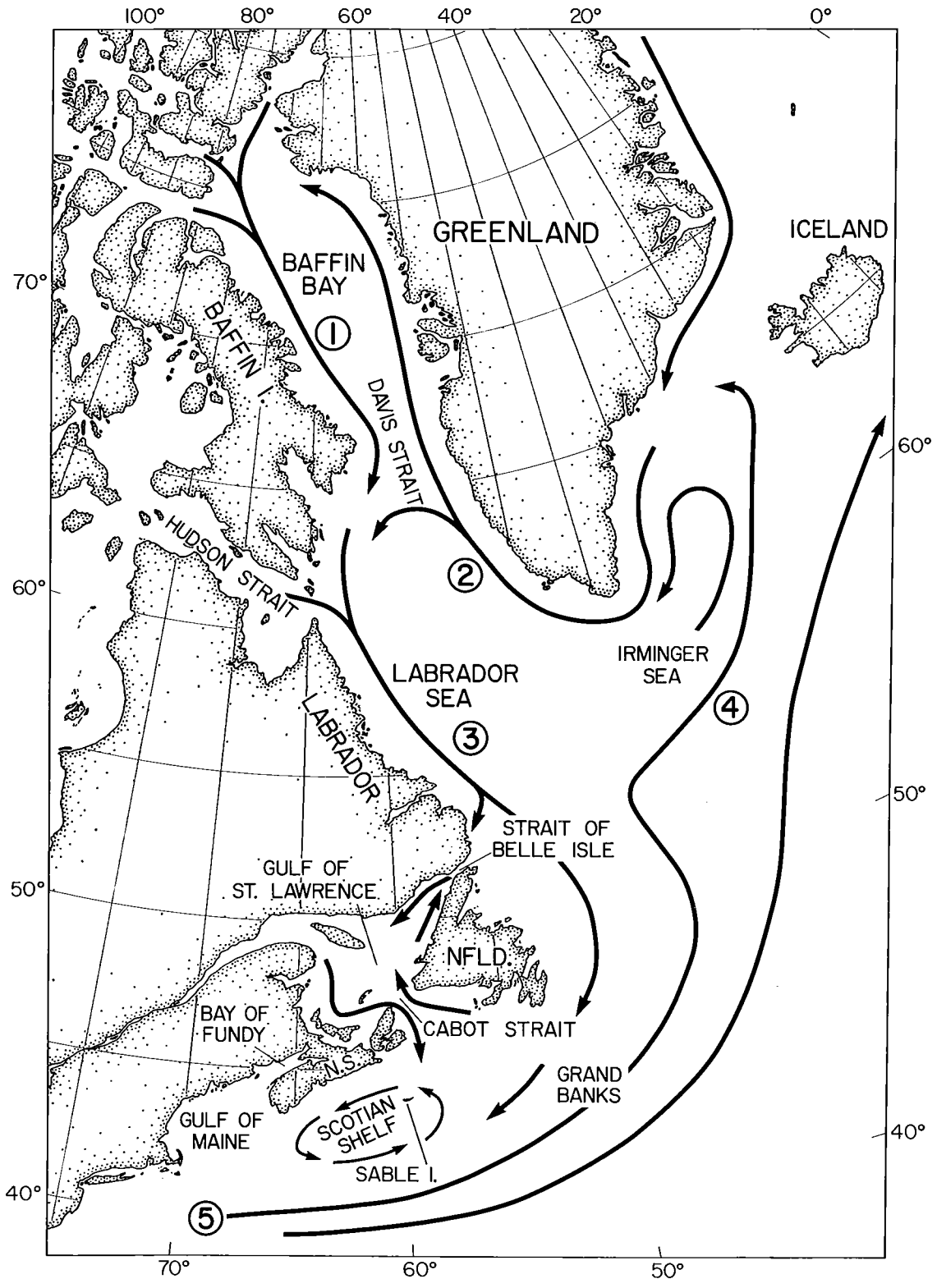


Figure 3
The average extent of ice cover on 13 August 1969–73, north of 54°N. From the Ice Summary Analyses published by Canada Department of Transport, Meteorological Branch, Toronto, and, for southeast Greenland, from Anon. (1958)

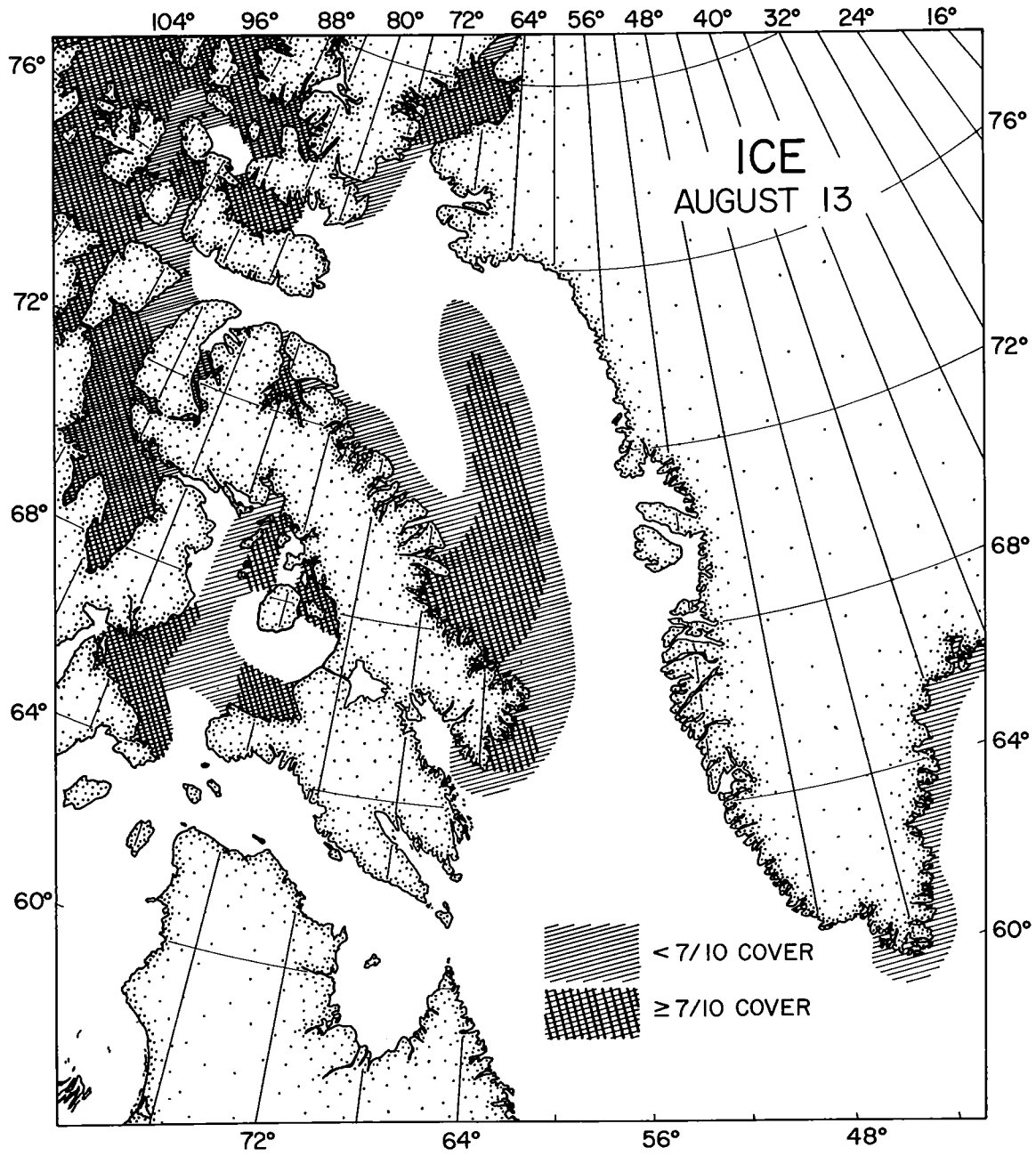
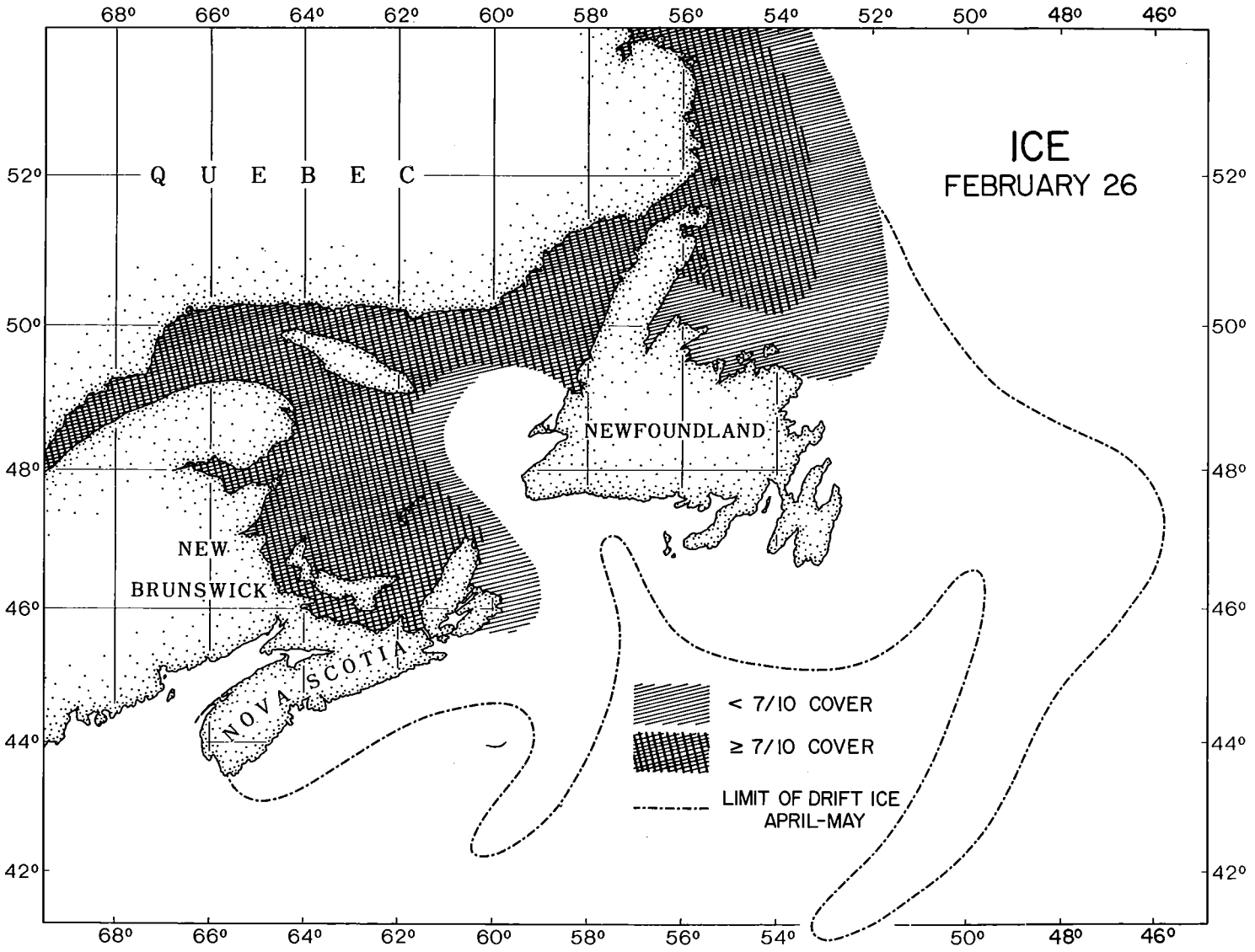


Figure 4
The average extent of ice cover on 26 February 1969–73 and the limit of drift ice in April–May, south of 54°N. From the Ice Summary Analyses published by Canada Department of Transport, Meteorological Branch, Toronto, and the southern limit of drift ice from Hachey (1961:75)



Ashmole (1971), Dunbar (1968) and Salomonsen (1965, 1972) have combined physical characteristics such as the temperature–salinity relationships used by oceanographers to define water types, along with biogeographical data, to divide eastern Canadian waters into four zones (Fig. 5):

(a) *High Arctic* (Dunbar's "arctic"): most of the polar region belongs to this zone, but the only High Arctic sector in our area is the Baffin Land Current water off northern and western Baffin Bay and in the adjacent channels. The surface layers of this zone are close to freezing even in August, the warmest month, and salinity is usually below $31^{\circ}/_{\circ\circ}$.

(b) *Low Arctic* (Dunbar's "subarctic"): areas influenced by the West Greenland and Labrador Currents. August surface temperatures are about 4°–10°C, and salinities about $31–34^{\circ}/_{\circ\circ}$.

(c) *Boreal:* the North Atlantic Current and areas strongly influenced by it, such as the Irminger Sea and the Scotian Shelf. August surface temperatures are between about 10°–19°C; salinities are about $31–35^{\circ}/_{\circ\circ}$ (less on the Scotian Shelf and in the southern Gulf of St. Lawrence), overlapping with those of the Low Arctic zone.

(d) *Cool Subtropical* (Ashmole's "subtropical", a term which seems incongruous in a Canadian context): the waters south of the North Atlantic Current. August surface temperatures are about 19°–23°C and salinity is over $35^{\circ}/_{\circ\circ}$.

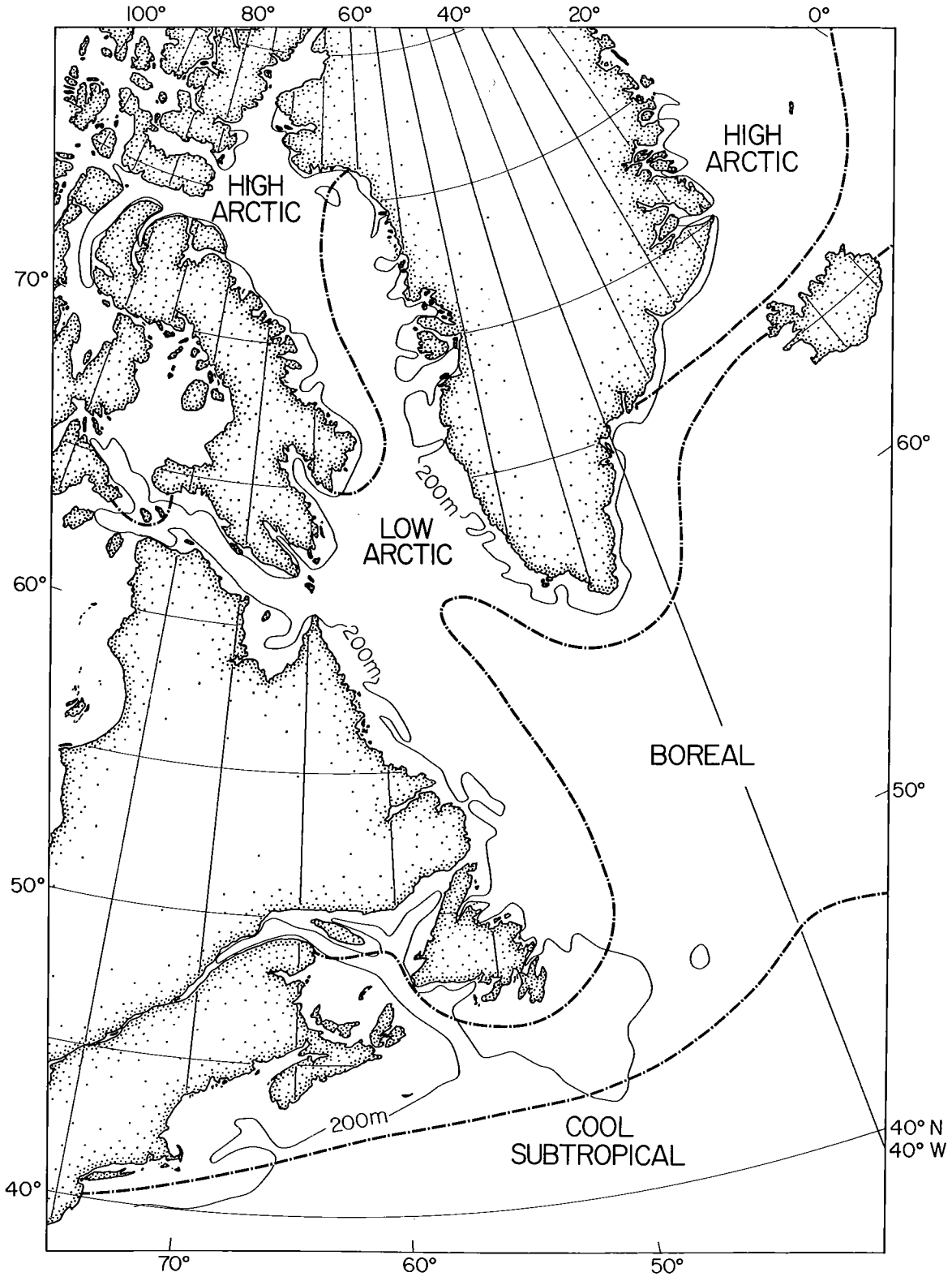
The boundaries of these zones are, of course, very far from being exact, and even fluctuate seasonally; the southern Gulf of St. Lawrence, for example, changes from an Arctic, ice-covered area in winter to one with Boreal surface waters of 16°C or more in summer. Nor are these the only boundaries which can be drawn. Briggs (1974), for example, combines the Boreal zone with the northern Cool Subtropical and the southern Low Arctic and names this "cold temperate"; everything farther north is "cold". But this seems too broad for present purposes. Our aim here is to provide a convenient framework within which to summarize the biological oceanography of the survey area.

The surface waters off Atlantic Canada are rich in nitrates, phosphates and other nutrients, which promote the production of phytoplankton. This is particularly true of the Low Arctic waters off eastern Newfoundland, Labrador and west Greenland, and also in the Boreal zone off Nova Scotia (Dunbar 1968; Koblentz-Mishke *et al.* 1970). Zooplankton at the next trophic levels is also abundant in Low Arctic and Boreal waters (*e.g.* Bainbridge and Corlett 1968, Edinburgh Oceanographic Laboratory, 1973); the zooplankton biomass in the Low Arctic waters southeast of Newfoundland is four to five times higher than in the adjacent, warmer North Atlantic Current (Vladimirskaya 1965). Pavshtiks *et al.* (1962) give a similar ratio for zooplankton plus phytoplankton in comparing the Boreal with the Cool Subtropical waters south and east of Nova Scotia. Data for more northerly latitudes are sparse, but Pavshtiks' (1968) estimates for the Labrador Sea and the southern coasts of Greenland show biomasses higher than those in warm-water areas, though not as high as on the Grand Bank. The abundance of plankton in these areas is reflected higher up the food web in the productive fisheries on the continental shelves off eastern Canada and west Greenland (*e.g.* ICNAF 1952–74).

These abundances are seasonal. The timing of the "biological spring", when zooplankton rises into the surface layers and starts to reproduce, varies with the influence of the different current systems. Generally speaking, if the water is cold and the ice breaks up late, the "spring" is also late (Matthews 1969, Pavshtiks 1968). The longest season of abundance is on the central Grand Bank. The copepod *Calanus finmarchicus* first becomes abundant there in late February, and zooplankton is still abundant as late as October (Vladimirskaya 1965). The *Calanus* "spring" begins in early March on the Scotian Shelf and in the southern Labrador Sea, in late March in the Gulf of Maine and the deep waters south of the Grand Bank, and in April–May off southwest Greenland and in the rest of the Labrador Sea. The *Calanus* "spring" is later farther north: in June in southern Davis Strait, July off west Greenland, August in Central Davis Strait and September off southern Baffin Island. The change in biomass during these Arctic "springs" is dramatic; Pavshtiks reports a tenfold increase in zooplankton off southwest Greenland.

These oceanographic zones have different species associated with them. For example, of the *Calanus* copepods, *C. helgolandicus* is largely confined to Cool Subtropical waters in the western North Atlantic (though it extends into the Boreal zone off the European coast); *C. finmarchicus finmarchicus* is found in Boreal and Low Arctic waters, while *C. f. glacialis* and *C. hyperboreus*

Figure 5
Oceanographic zonation in the northwest Atlantic and eastern Canadian Arctic, after Ashmole (1971), Dunbar (1968), and Salomonsen (1965, 1972). (Note that Dunbar differs in putting Hudson Bay in the High Arctic, and the whole of the Gulf of St. Lawrence in the Low Arctic.)



are the forms found in the Low and High Arctic (Grainger 1963, Matthews 1969, Pavshtiks 1968). More generally, many warm-water plankton species extend only a little way up into the Low Arctic waters east of Newfoundland, while many cold-water species just reach the edge of the Boreal zone there (Bainbridge and Jones 1962, Vladimirskaya 1965). There are similar effects in the Gulf of Maine and Bay of Fundy (Fish and Johnson 1937). Colebrook (1972) recognizes five distribution groupings of the commoner plankton species in the northwest Atlantic; these can broadly be linked with the zones described here, though more than one grouping can occur within a given zone.

Higher organisms often show a similar zonation. The boundary between the Cool Subtropical and Boreal zones roughly marks the northern limit of chub mackerel (*Scomber colias*) and offshore hake (*Merluccius albidus*) and the southern limit of the silver hake (*Merluccius bilinearis*). Atlantic mackerel (*Scomber scombrus*) and cusk (*Brosme brosme*) extend up to the Boreal–Low Arctic boundary. This also marks the southern boundary of such Arctic fish as the arctic char (*Salvelinus alpinus*), arctic cod (*Boreogadus saida*) and Greenland cod (*Gadus ogac*); these occur in the Gulf of St. Lawrence, but only in the cold-water area along the north shore. Such Boreal and Low Arctic species as the Atlantic salmon (*Salmo salar*) and Atlantic cod (*Gadus morhua*) are found only on the Low Arctic, Greenland side of Baffin Bay; the typically High Arctic narwhal (*Monodon monoceros*) is found on the High Arctic, Baffin Island side (Bigelow and Schroeder 1953, Dunbar 1951, Leim and Scott 1966).

These are, of course, only some of the simpler examples. In many cases distributions cannot be fitted so neatly into a simple scheme of zonation, based mainly on temperature–salinity relationships. It must be borne in mind that although these relationships provide convenient labels for water types, it is probable that temperature and salinity are often not the only, or even the most important, characteristics of the water to which the animals are reacting. Thus Bary (1963), analysing plankton distributions in the northeast Atlantic, found that temperature and salinity alone could not provide a satisfactory explanation of these distributions; he postulates control by hypothetical "properties" of an unknown nature, specific to each water type. Some such effect might underlie the anomalies in the distributions of many North Atlantic crustaceans, described by Dunbar (1954, 1964); species with purely Arctic distributions in the waters off eastern North America often extend well south into the Boreal zone in the seas east of Iceland. Similar southward extensions occur in the ranges of such seabirds as the Northern Fulmar, Parasitic Jaeger (*Stercorarius parasiticus*), Black-legged Kittiwake (*Rissa tridactyla*), Arctic Tern (*Sterna paradisaea*), and Atlantic Puffin (Brown 1970, Salomonsen 1972); they coincide with a discontinuity in plankton distribution patterns at about 25°W (Colebrook 1972). Both Dunbar and Salomonsen suggest that the extensions may represent populations originally established during colder climatic conditions, perhaps soon after the last glaciation period. But this does not explain what controls the animals' distributions today; why, for example, should fulmars from British colonies breed in Boreal waters, yet winter in Low Arctic waters off eastern Canada? Clearly, some unknown factor is influencing the distribution of a whole food web, from plankton up to birds.

But at the simplest level the oceanographic zonation outlined here provides operational descriptions of the ecological preferences of many species of plankton and higher organisms in the northwest Atlantic. Although seabirds are more mobile than other marine organisms, our maps suggest that these descriptions can be extended to cover many seabird species as well.

4. Factors influencing the breeding ranges of seabirds

Seabirds differ from most marine organisms in that they breed on land. Their distributions during the breeding season are therefore compromises between the oceanographic conditions which provide a suitable food supply, and the existence of a suitable breeding site within range of this supply. The Herring Gull (*Larus argentatus*) is a good illustration. Most of the colonies in eastern North America have expanded spectacularly within the last 50 years and breeding success is high, largely because the birds exploit human garbage as a food supply (Hunt 1972, Kadlec and Drury 1968). By contrast breeding success on Sable Island, Nova Scotia, is extremely poor, apparently because that isolated offshore colony is out of range of a suitable garbage supply (Lock 1973). The Gannet (*Morus bassanus*) illustrates a less artificial situation; its North American colonies are all in areas into which Atlantic mackerel, an important food, migrate in July and August (see Section 6). More generally, Cody (1973) discusses some of the long-term evolutionary effects which the distance between the colony and the food supply can have on the breeding biology of seabirds.

Oceanographic conditions can also affect the suitability of a breeding site through their influence on the climate. Breeding seasons cannot be compressed indefinitely; there must be a sufficiently long summer in the colony area for the birds to breed successfully. For example, the whole eastern coastline of Baffin Island is precipitous, and apparently suitable for breeding Thick-billed Murres, yet the only colonies are at the north and south ends. Tuck (1961) suggests that the birds do not breed on the central coast because the sea-ice there breaks up too late to allow them to fit in a breeding season (Fig. 3), a hypothesis strongly supported by Nettleship's recent studies of breeding distributions in the eastern Canadian Arctic.

The suitability of a colony site also depends on terrestrial factors. A seabird colony is an obvious mark for potential predators. To minimize the risks ground-nesting seabirds nest on offshore islands which usually lack ground predators. The extinction of the Great Auk (*Alca impennis*) is a classic example of what happens when this strategy breaks down, but it can be matched by many local extinctions of Leach's Storm-Petrels (*Oceanodroma leucorhoa*) from islands off Nova Scotia following the introduction of rats. Cliff-nesting is a way of avoiding aerial as well as ground predators (Cullen 1957), and the distributions of seabirds which nest on cliffs are obviously limited by the availability of cliffs, which are not universal in our survey area. There are apparently suitable cliffs on both sides of Baffin Bay, along the Labrador coast and on the north shore of the Gulf of St. Lawrence, on the Gaspé Peninsula and in southern and eastern Newfoundland, but only in limited areas of western Newfoundland, the Magdalen Islands and northern Nova Scotia. The remaining shores are either rocky but low-lying (the Atlantic coast of Nova Scotia, and the rest of Newfoundland), or are sandy beaches combined with low, eroding cliffs (the Bay of Fundy, and the rest of the Gulf of St. Lawrence). Therefore the fact that kittiwakes and murres, for example, breed in the north but not the south part of the Gulf of St. Lawrence may reflect the influence of Labrador Current water along that coast (see Section 3). But it is also true that there is nowhere suitable for them to breed along the southern shores.

These are the natural factors which influence breeding ranges; predation by man and his associated animals add artificial distortions. The best documented case of man's predation on seabird populations in our survey area is that of the Gannet (Nettleship 1974c). The approximate colony sizes listed in Table 2 suggest that, although more Gannets breed in the Gulf of St. Lawrence than outside it, the difference is not so very great. Actually, the Gannet was, until comparatively recently, overwhelmingly more abundant in the Gulf, which seems to have been the centre of its distribution in the northwest Atlantic. Before the lighthouse was built a hundred years ago on Bird Rocks, Magdalen Islands, the Gannet colony probably numbered 75,000 pairs (Bent 1922, Gurney 1913); the resulting disturbance was so great that by the turn of the century the colony was almost extinct and though there has been a recovery, it has been slow and very limited. The very large colony on Perroquet Island, on the north shore of the Gulf, actually did become extinct because eggs were taken for food and young birds for bait. These artificial effects, just as much as the availability of suitable breeding sites, must be taken into account in interpreting seabird distributions.

5. Seabird vulnerabilities: the use of the Atlas in environmental impact studies

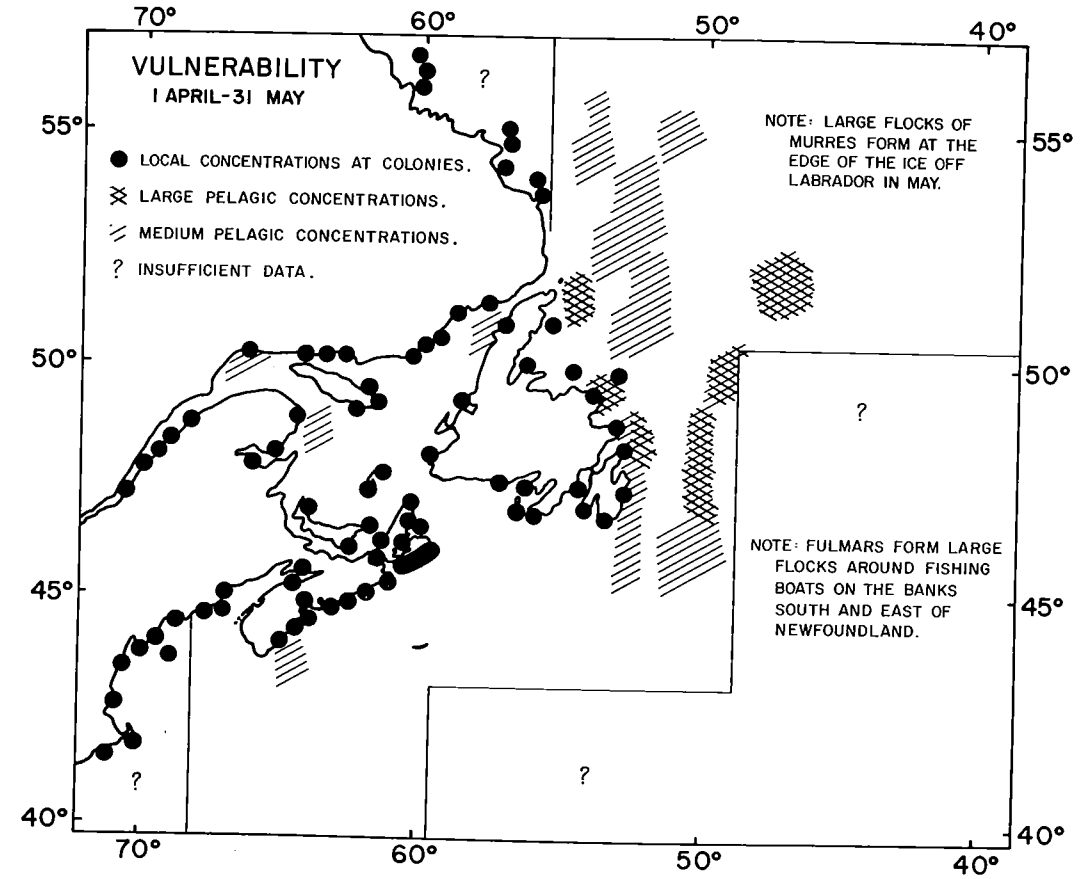
The distribution maps in Section 6 are rather numerous, and it may at first be difficult to extract the information needed for an environmental impact assessment. The object of this section is to suggest procedures which may simplify this process.

Generally seabirds are most concentrated at their breeding sites. Any impact assessment should take into account the positions of the nearest seabird colonies, and consider whether pollutants would be carried towards them by currents, tidal flow or (especially in the case of spilled oil) prevailing winds. Colonies are, of course, most vulnerable during the breeding season (March through September in Atlantic Canada, May through September in the Arctic), especially towards the end when there may be large numbers of adults and flightless young on the water. It must be remembered, however, that chemical wastes, by killing off prey species, could affect a colony no matter when they are released, and their transport by currents could also affect non-breeding birds at a considerable distance from the point of release. An impact study of such long-distance effects would require input from the whole spectrum of oceanography, taking into account current systems, dilution rates, food webs, fishing zones and much else that is beyond the scope of this Atlas.

In the open ocean seabirds are most vulnerable to oil spills. The species most affected are those which spend much time sitting on the water, mainly diving birds: Common and Thick-billed Murres, Dovekies (*Plautus alle*), Atlantic Puffins and Razorbills (*Alca torda*), and to a lesser extent Gannets and Great and Double-crested Cormorants (*Phalacrocorax carbo* and *P. auritus*), (Bourne *et al.* 1967, Greenwood *et al.* 1971, Hope-Jones *et al.* 1970). (Loons, grebes and diving ducks are also highly vulnerable to coastal oil spills; however, these are not covered by this Atlas.) Local flocks of other species may also be vulnerable; for example, Red and Northern Phalaropes and Greater Shearwaters (*Puffinus gravis*) in the fall in the Bay of Fundy, or Northern Fulmars, Greater Shearwaters and Black-legged Kittiwakes behind fishing boats. An impact study of an actual or potential spill should take into account the distribution maps of these species, and in particular those of the murres and Dovekies. The drift of oil across areas where seabirds concentrate should also be taken into account. As a rule, oil drifts with the wind at a rate of about 3.1–3.3% of the surface wind speed, though these commonly accepted constant values are based upon only a few measurements and tidal flows may complicate matters in inshore areas (see Brown 1973*a*, Brown *et al.* 1973, Harrison 1974, McTaggart-Cowan *et al.* 1970, Smith 1968).

Figures 6–9 may be useful for quick reference. They summarize the areas where seabirds are concentrated at different times of year. The figures are based on the murre and Dovekie pelagic distribution maps and observations of birds at sea by Nettleship (1974*b*), with the addition of important areas for other species and, during breeding seasons, the colonies listed in Tables 1–10. The absence of a colony or a reported concentration in a given area as shown in Figures 6–9 and the distribution maps cannot be taken as a guarantee that an oil spill there would have a negligible effect on seabirds.

Figure 6
Areas in the northwest Atlantic where seabird concentrations are most vulnerable to oil spills from 1 April to 14 September



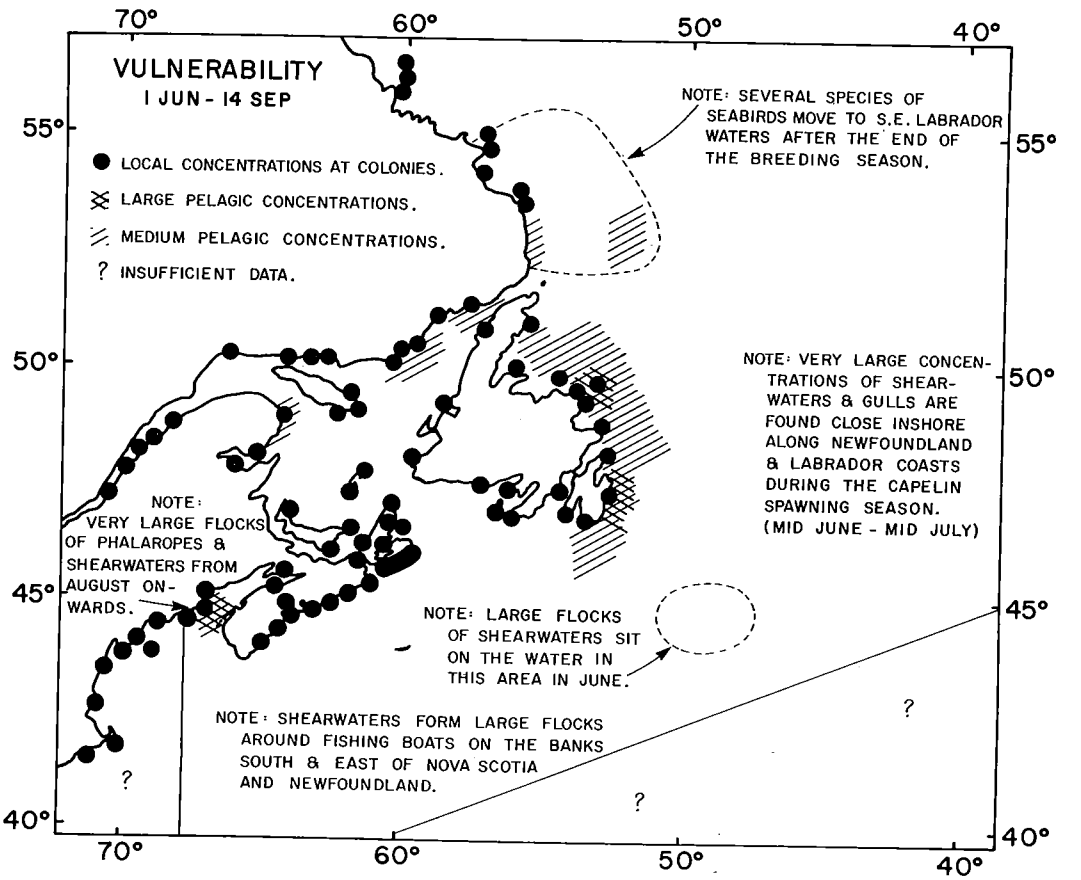


Figure 7
Areas in the northwest Atlantic where seabird concentrations are most vulnerable to oil spills from 15 September to 31 March

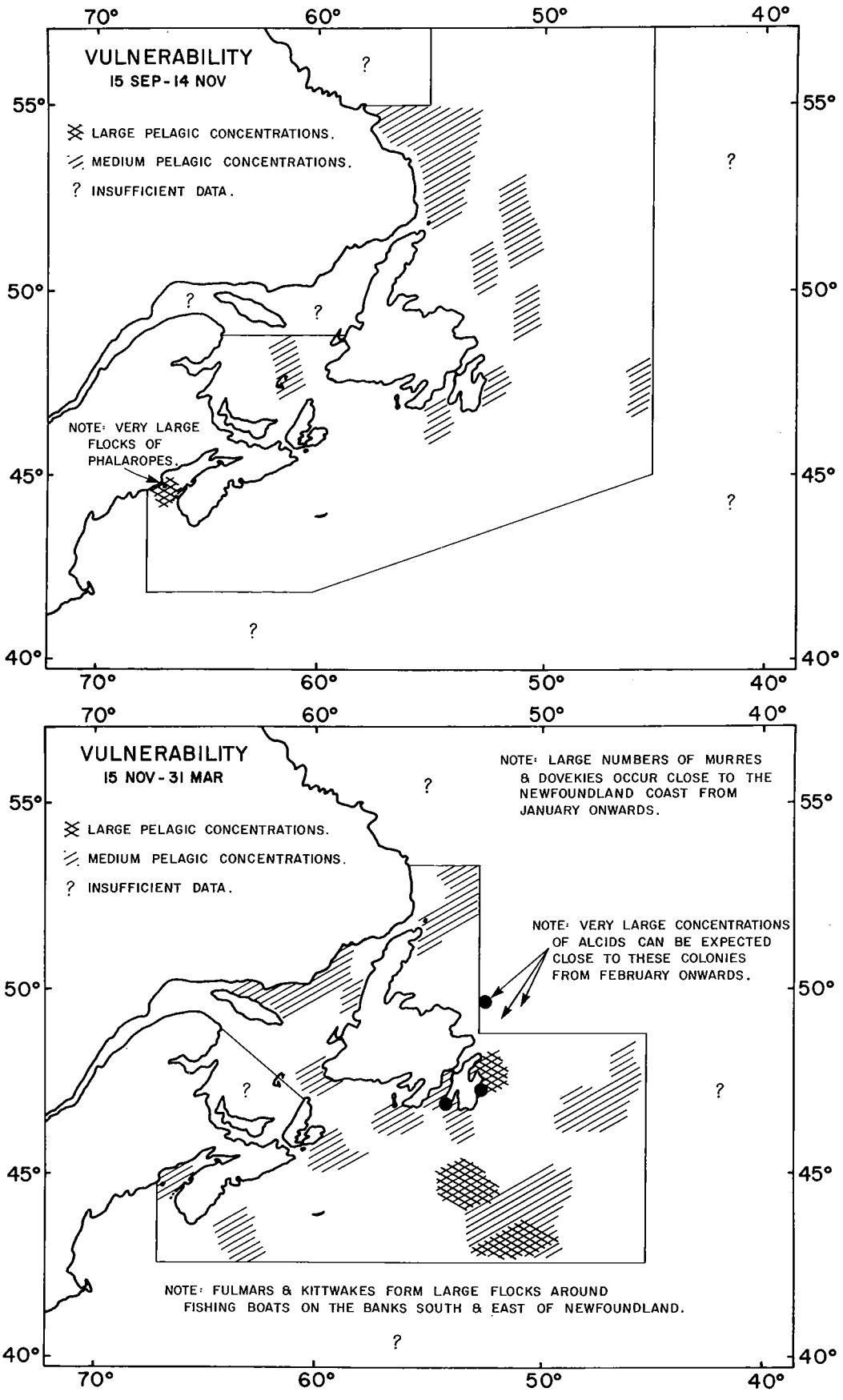


Figure 8
Areas in the eastern Canadian Arctic where seabird concentrations are most vulnerable to oil spills in July and August

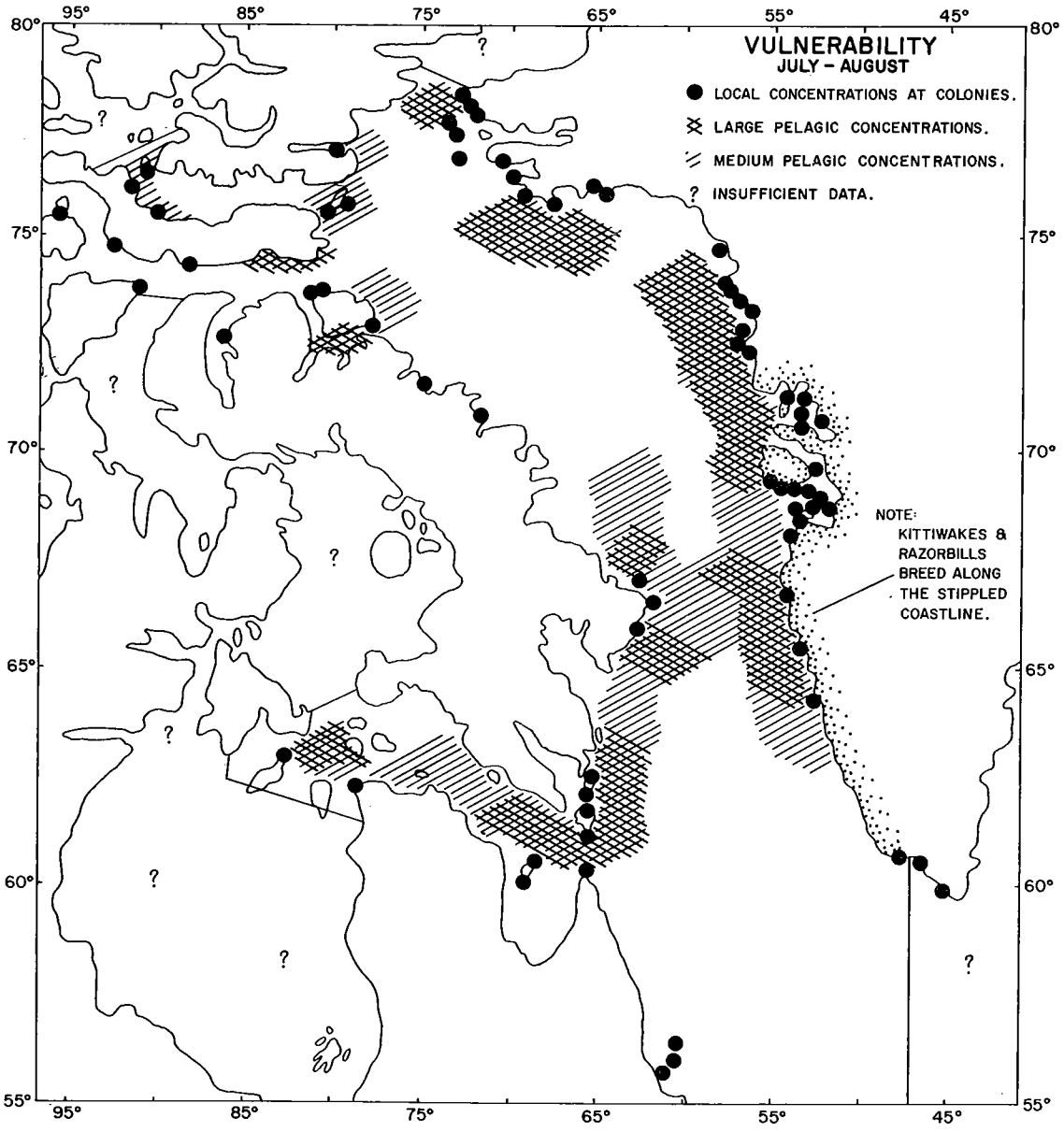
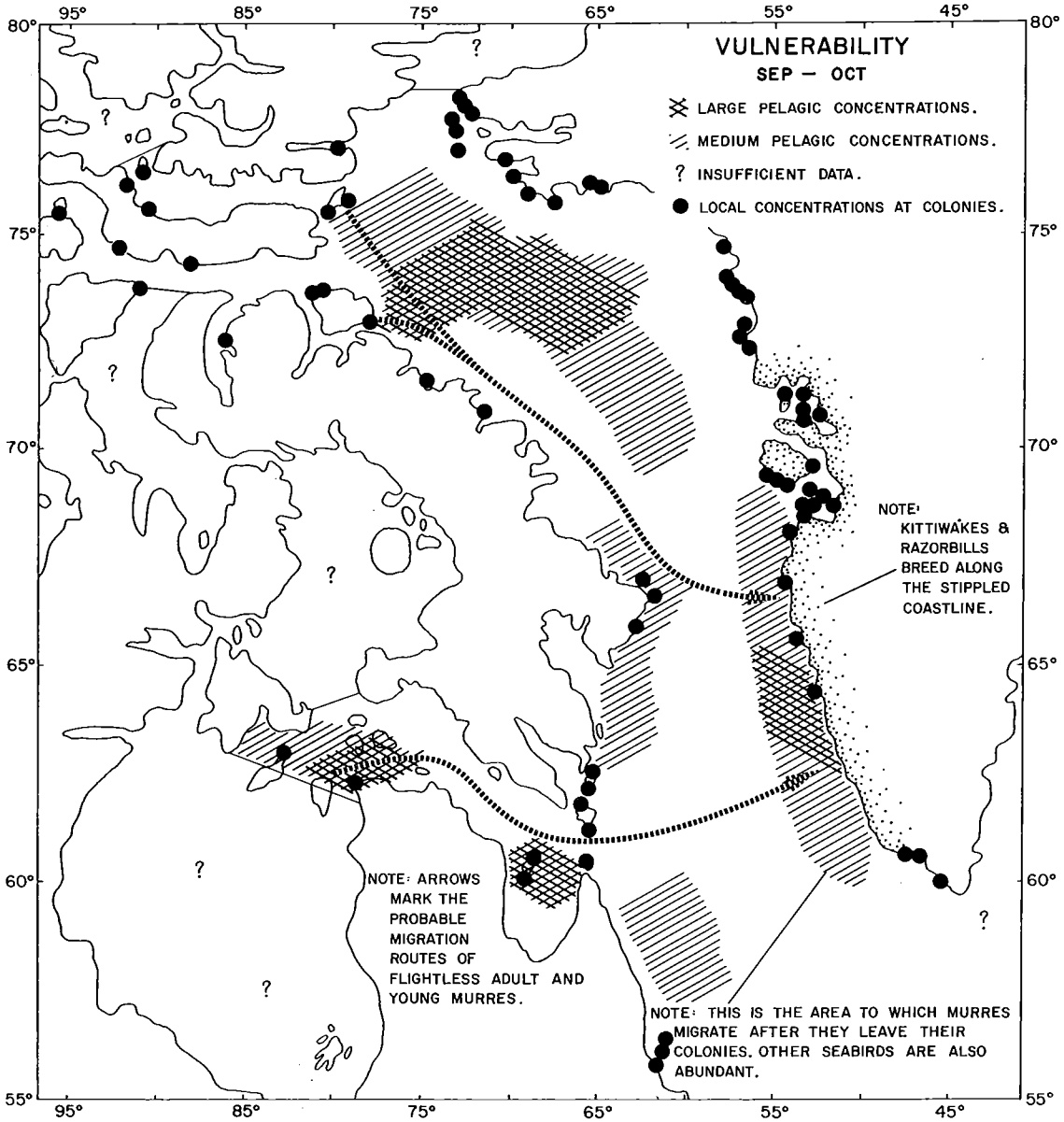


Figure 9
Areas in the eastern Canadian Arctic where seabird concentrations are most vulnerable to oil spills in September and October



6. Seabird distributions: species summaries

This Atlas presents quantitative information on seabird distributions in the northwest Atlantic. More detailed analyses are beyond its scope, but it is useful to summarize the main features of the maps, and to suggest some links with oceanographic factors. These distributions may be compared with those described in the literature; our aim here has been to provide background information, rather than a complete review for each species. Further information can be obtained from Bagenal (1951), Baker (1947), Brown (1967, 1968, 1970), Browne (1958), Cusa (1949), Dorval (1969), Drury and Drury (1959), Elgmork (1961, 1966), Fisher (1952), Gordon (1955), Gräfe (1973), Grayce (1950, 1955), Lambert (1973), Manikowski (1971), Nettleship (1974*b*), Nettleship and Tull (1970), Olivier (1950), Phillips (1963), Phillips (1947), Post (1967), Rankin and Duffey (1948), Rees (1961*a*, 1963), Reinsch (1967), Richards *et al.* (1960), Roberts (1940), Sage (1968), Salomonsen (1965), Stresemann and Stresemann (1970), Thorn (1956), Tuck (1961), van Oordt (1959), Voous and Wattel (1963), Wiley (1959), and Wynne-Edwards (1935); from the literature reviewed by Rankin and Duffey and by Wynne-Edwards; from data published or summarized in *Sea Swallow, Audubon Field Notes* and *American Birds;* and from the handbooks or atlases of Butcher *et al.* (1968), Fisher and Lockley (1954), Murphy (1967) and Palmer (1962).

Breeding distribution

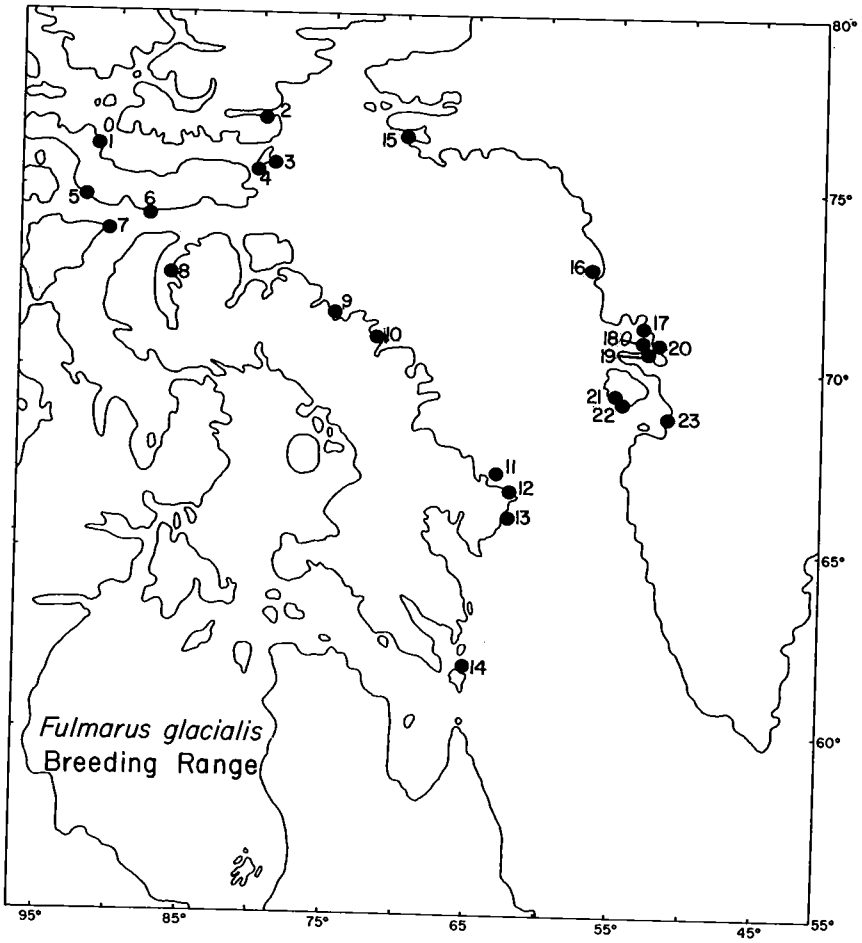
The Northern Fulmar breeds abundantly in the High Arctic and in the northern part of the Low Arctic in west Greenland. Its well-documented spread in breeding range in the eastern Atlantic (Fisher 1952, 1966) has recently extended to Newfoundland (Nettleship and Montgomerie 1974) and probably also to Labrador (Nettleship and Lock 1973*a*).

Pelagic distribution

Like most seabirds, fulmars were scarce in the low-salinity waters of the Gulf of St. Lawrence. They were common in both the High and Low Arctic, but scarce in the Boreal zone. (They are, however, abundant in the Boreal zone in the eastern Atlantic: see Section 3.) Most birds seen off Atlantic Canada are in the light plumage phase (Fisher (1952), type LL), and banding returns show that these are from colonies in Britain, Iceland and west Greenland (Brown 1970 and unpublished; Tuck 1971) though no fulmars have been banded in the eastern Canadian Arctic. Light birds are found up to the northern limit of the Low Arctic zone off west Greenland, and in the High Arctic zone in Jones Sound, Lancaster Sound and the northeast coast of Baffin Island south to Scott Inlet. Intermediate and dark-phase birds (Fisher (1952), types L, D and DD) predominate on the southeast side of Baffin Island, especially near the very large dark-phase colony at Cape Searle. It is not clear where the dark birds winter, but a few are found in early spring in cold waters close to the Labrador coast; some of these seem to come from the European Arctic (Brown 1973*b*).

The northerly withdrawal of fulmars in summer from eastern Newfoundland waters coincides with a seasonal warming of the surface layers. As an index, the 10°C isotherm, which lies well south of Newfoundland for most of the year, moves up to 50°–52°N between July and October (Anon. 1967). There is a similar northerly shift in the transition zone between cold- and warm-water plankton species (Vladimirskaya 1965); the fulmars may be reacting to seasonal movements of some cold-water prey species. The withdrawal might also reflect possible competition for food with the Greater Shearwaters which invade this area in summer (see below), but the large overlap in the ranges of the two birds in the Low Arctic makes this seem unlikely.

Map 2a
Northern Fulmar
Breeding range



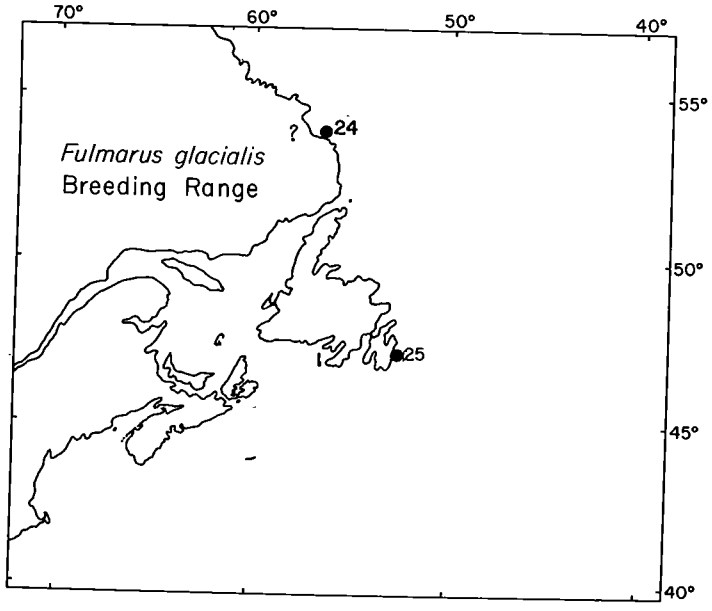


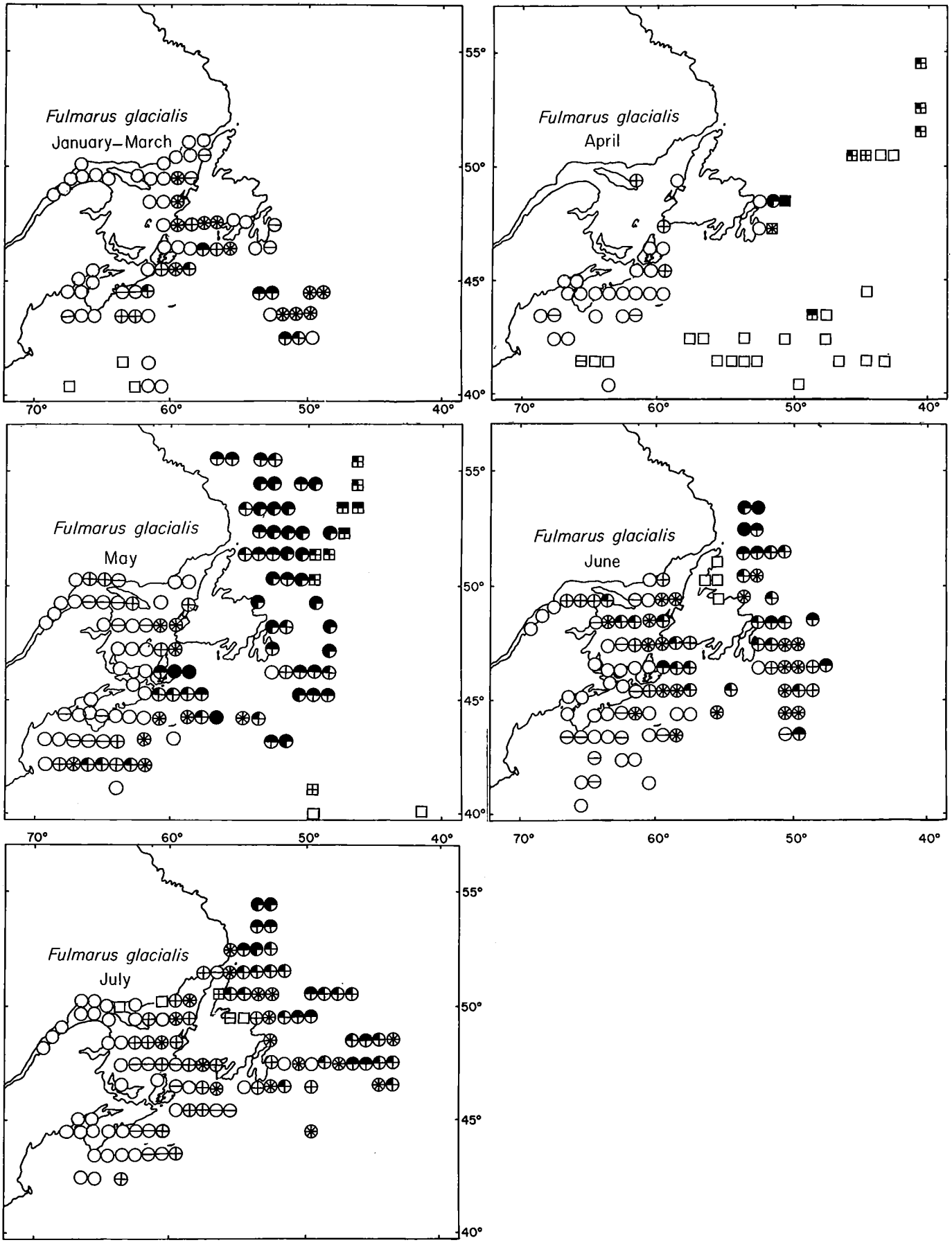
Table 1
Location and size of Northern Fulmar (*Fulmarus glacialis*) colonies. Symbols: p, pairs; i, individuals; +, a colony for which no numerical data are available; ±, a survey where an informed estimate is possible, but where complete data are not yet available (orders of magnitude have sometimes been added: order 3, 101–1,000p; order 4, 1,001–10,000p; order 5, 10,001–100,000p); ?, suspected breeding. "Nettleship" or "Nettleship *et al.*" indicates an unpublished CWS survey

	Colony location	Position	Colony size	Census year	Authority
	Eastern Canadian Arctic:				
1.	Cape Vera, Devon I.	76°14′N, 89°12′W	±25,000p (order 5)	1972	Nettleship 1974*a*,*b*
2.	Smith Island, SE Ellesmere I.	76°10′N, 81°20′W	0[1]	1973	Nettleship
3.	Princess Charlotte Monument, Coburg I.	75°50′N, 78°50′W	?	1973	Nettleship
4.	Cambridge Point, Coburg I.	75°48′N, 79°25′W	?	1973	Nettleship
5.	Cape Liddon, Devon I.	74°37′N, 91°13′W	±10,000p (order 4)	1972	Nettleship 1974*a*,*b*
6.	Hobhouse Inlet, Devon I.	74°27′N, 86°53′W	±75,000p (order 5)	1972	Nettleship 1974*a*,*b*
7.	Prince Leopold I.	74°02′N, 90°00′W	±50,000p (order 5)	1972	Nettleship
8.	Baillarge Bay, Baffin I.	73°25′N, 84°30′W	±25,000p (order 5)	1972	Nettleship
9.	Buchan Gulf, Baffin I.:				
	east colony (The Bastions)	71°50′N, 74°13′W			
	mid colony	71°47′N, 74°38′W	±25,000p (order 5)	1973	Nettleship
	west colony (The Mitres)	71°45′N, 74°42′W			
10.	Scott Inlet, Baffin I.	71°02′N, 71°08′W	±25,000p (order 5)	1973	Nettleship
11.	Cape Searle, Baffin I.	67°14′N, 62°28′W	±100,000p (order 5)	1973	Nettleship

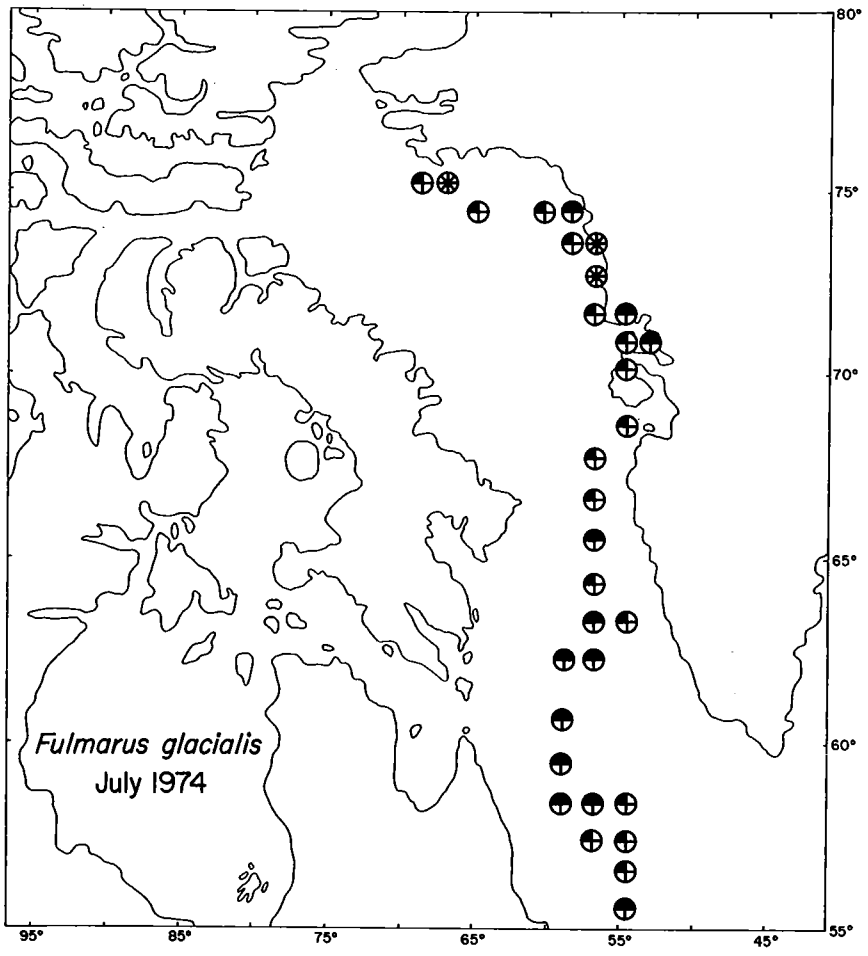
	Colony location	Position	Colony size	Census year	Authority
12.	Reid Bay, Baffin I.	66°53′N, 61°47′W	±10,000p[2] (order 4)	1973	Nettleship
13.	Island at mouth of Exeter Sound, Baffin I.	66°13′N, 62°11′W	±2,000p (order 4)	1973	Nettleship
14.	'Hantzch' I., NE of Edgell I.	61°55′N, 65°00′W	?	1973	Nettleship
	West Greenland:				
15.	Saunders I.	76°34′N, 70°00′W	<10,000p	1936	Salomonsen in Fisher 1952
16.	Tingmiakulugssuit	72°39′N, 55°49′W	30,000–40,000p[3]	1936	Salomonsen in Fisher 1952
17.	Ivnarssuaq	69°17′N, 53°22′W	10,000p	1949	Salomonsen in Fisher 1952
18.	Qaqugdlugssuit Halvø	c.71°10′N, 52°30′W	8,000p	1949	Salomonsen in Fisher 1952
19.	Sagdleg	70°57′N, 52°20′W	10,000–20,000p	1949	Salomonsen in Fisher 1952
20.	Agpatsiait	70°55′N, 52°00′W	25,000p	1949	Salomonsen in Fisher 1952
21.	Qeqertaq	69°31′N, 54°15′W	75,000p	1946	Salomonsen in Fisher 1952
22.	Blåfjaeld	69°22′N, 54°10′W	11,000p	1946	Salomonsen in Fisher 1952
23.	Seqineqarajugtoq	68°43′N,c.50°15′W	+	?	Salomonsen in Fisher 1952
	Atlantic Canada:				
24.	Outer Gannet I.	54°00′N, 56°31′W	?	1972	Nettleship and Lock 1973*a*
25.	Great I., Witless Bay	47°11′N, 52°49′W	6p	1973	Nettleship and Montgomerie 1974

1 Apparently a colony in 1894: Peary in Fisher (1952).
2 Total for 3 colonies.
3 1,000–1,500i recorded in incomplete census in 1965: Joensen and Preuss (1972).

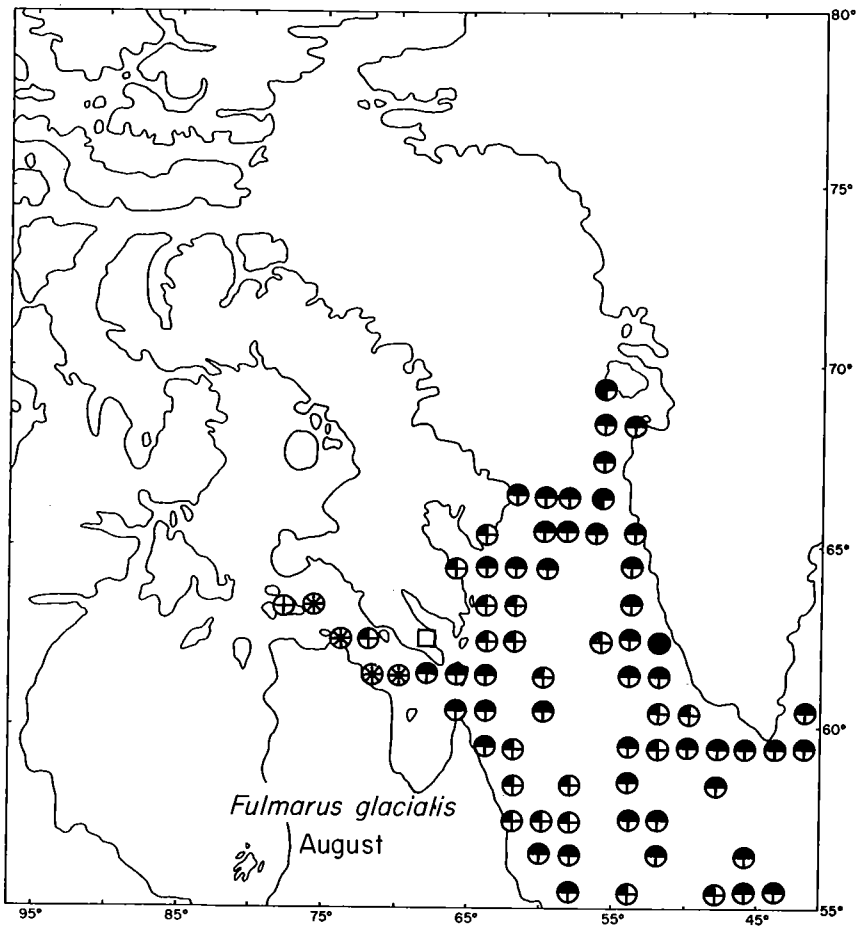
Map 2b
Northern Fulmar

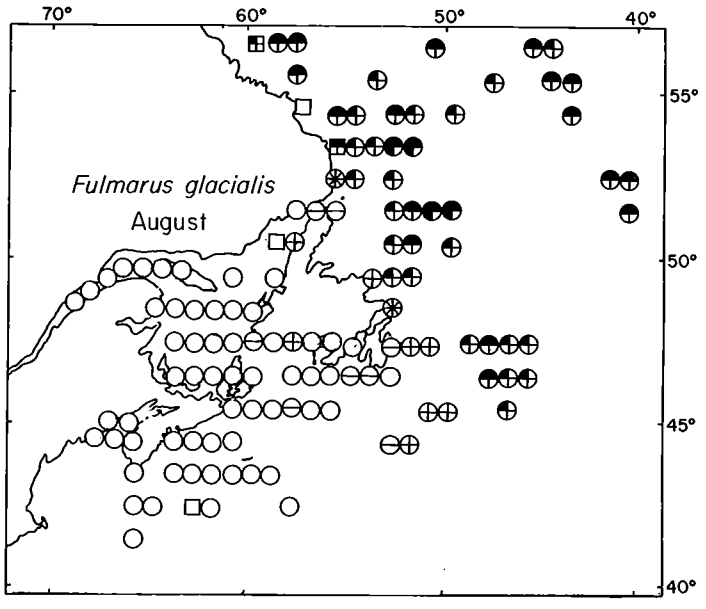


Map 2c
Northern Fulmar

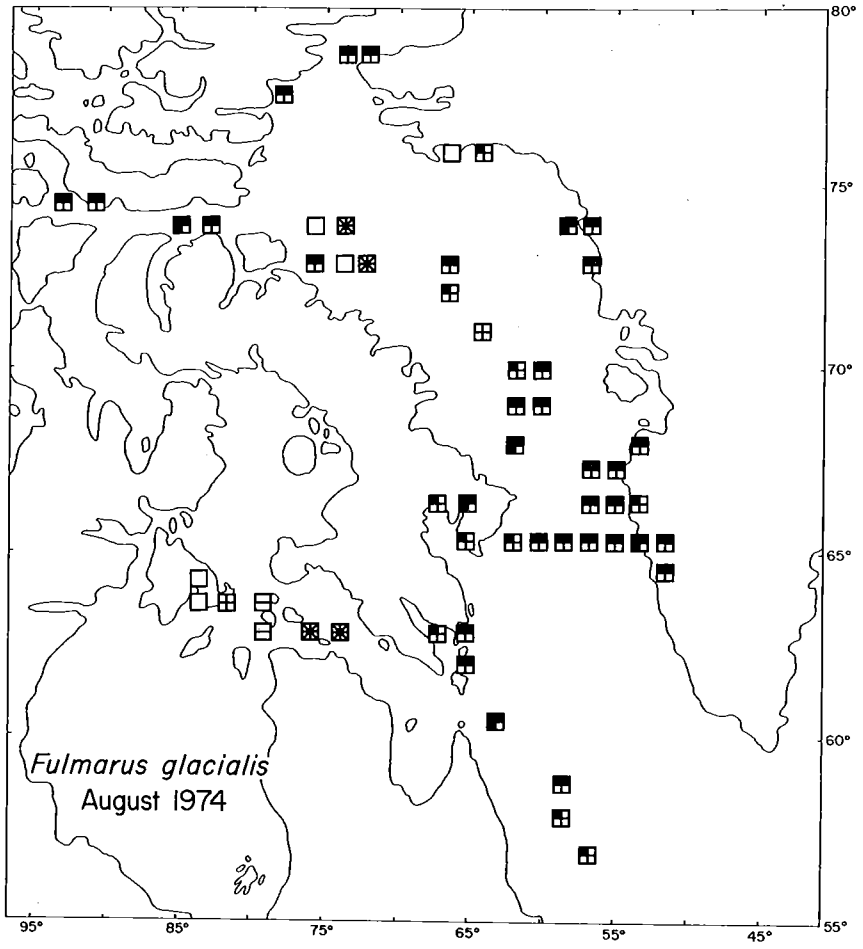


Map 2d
Northern Fulmar

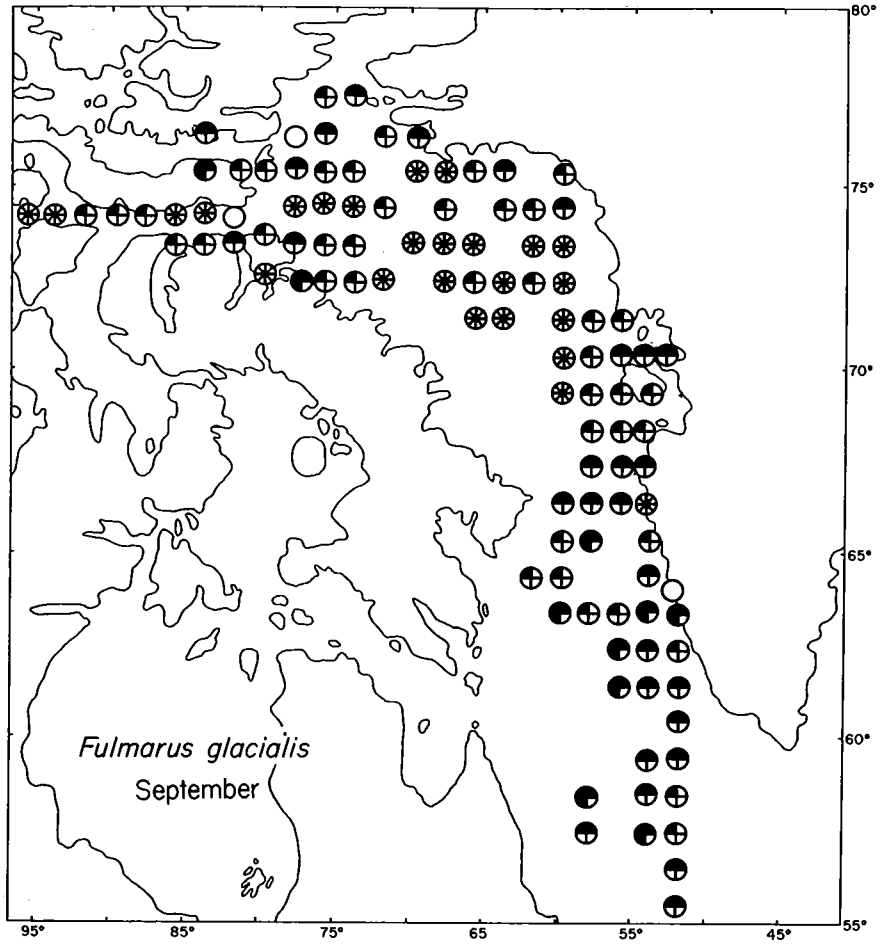


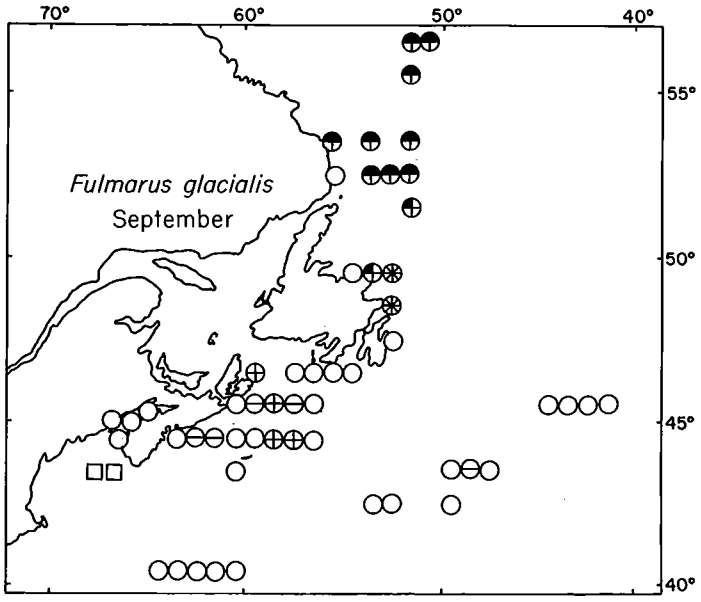


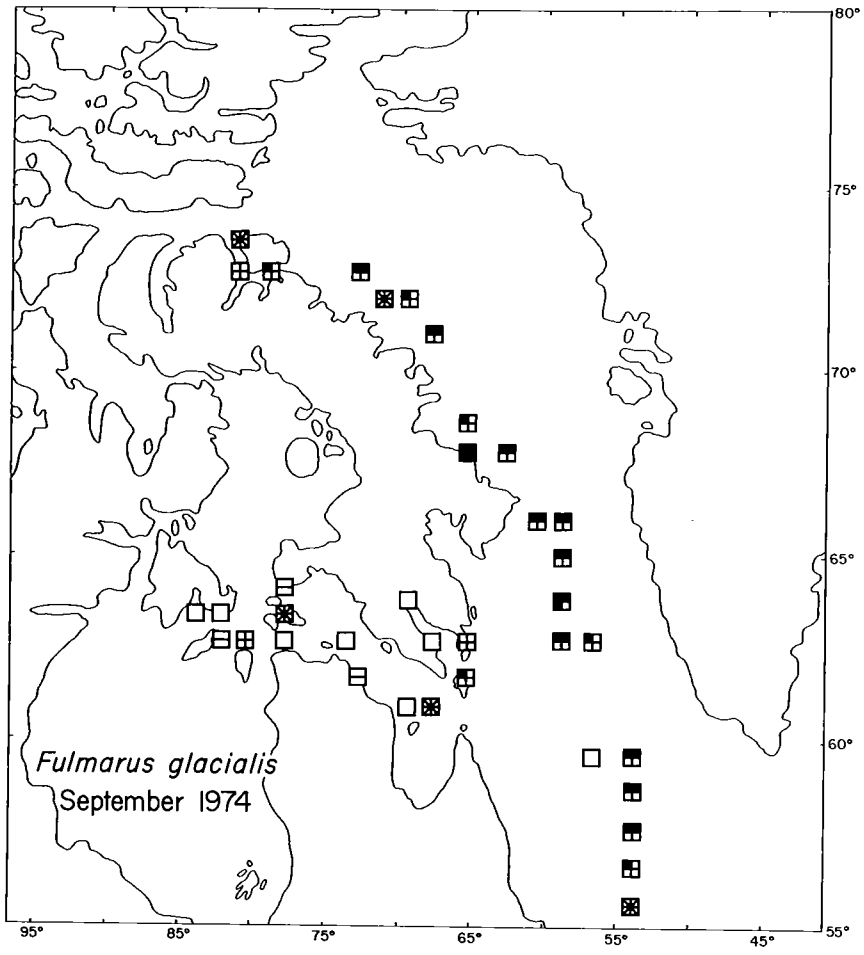
Map 2e
Northern Fulmar



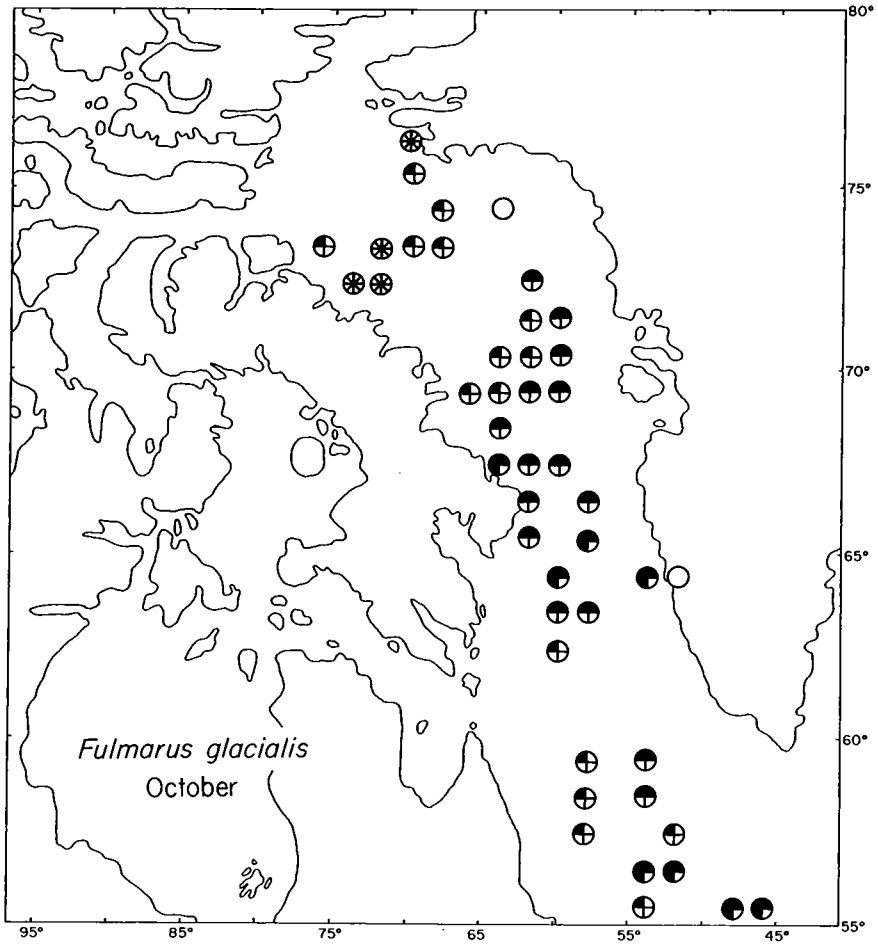
Map 2f
Northern Fulmar

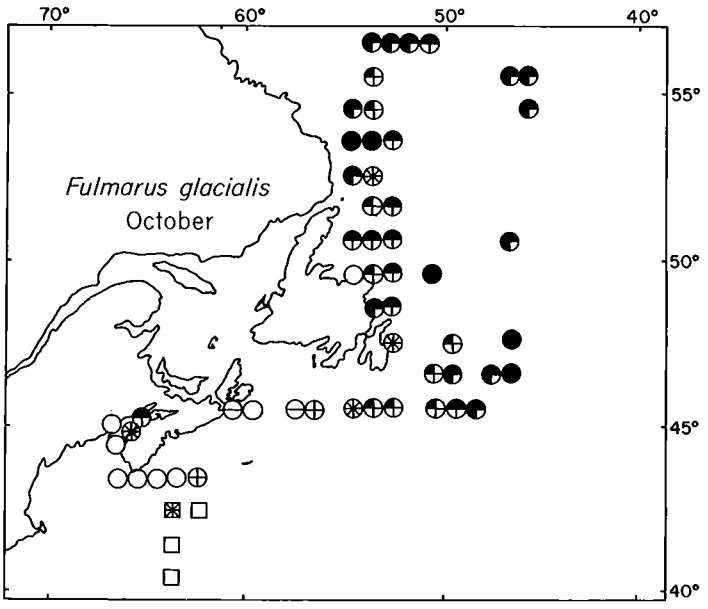




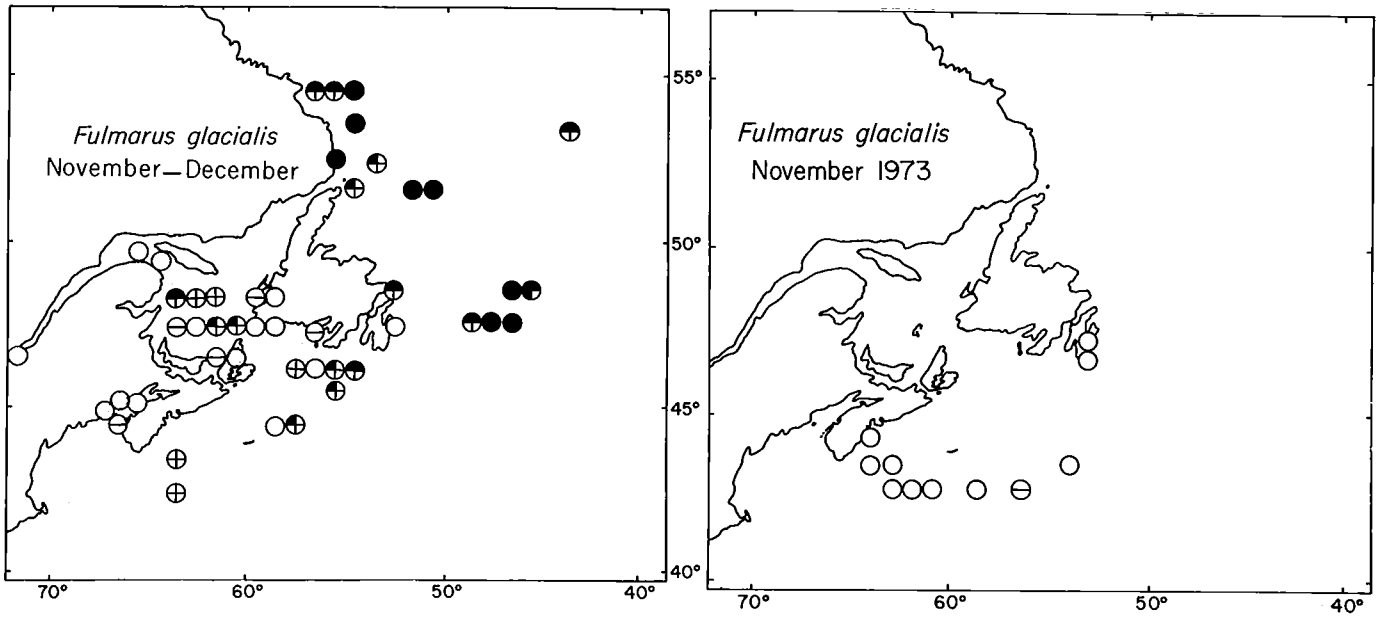

80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Fulmarus glacialis
September 1974

Map 2h
Northern Fulmar

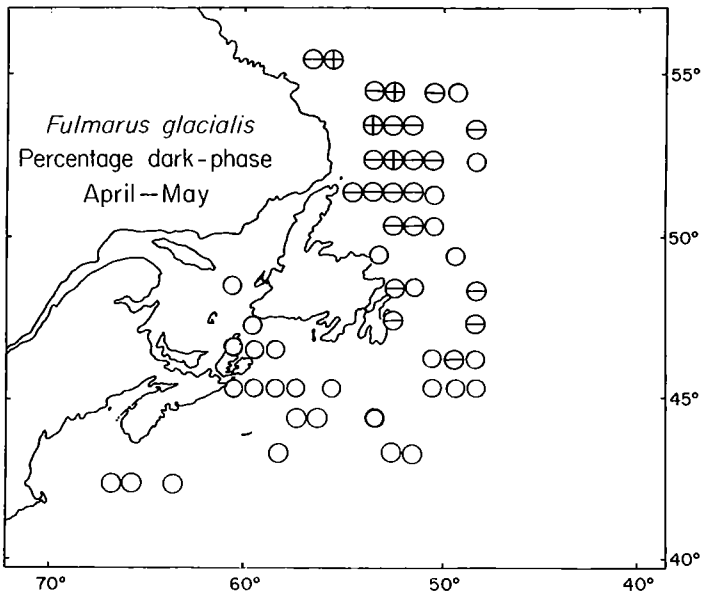




Map 2i
Northern Fulmar

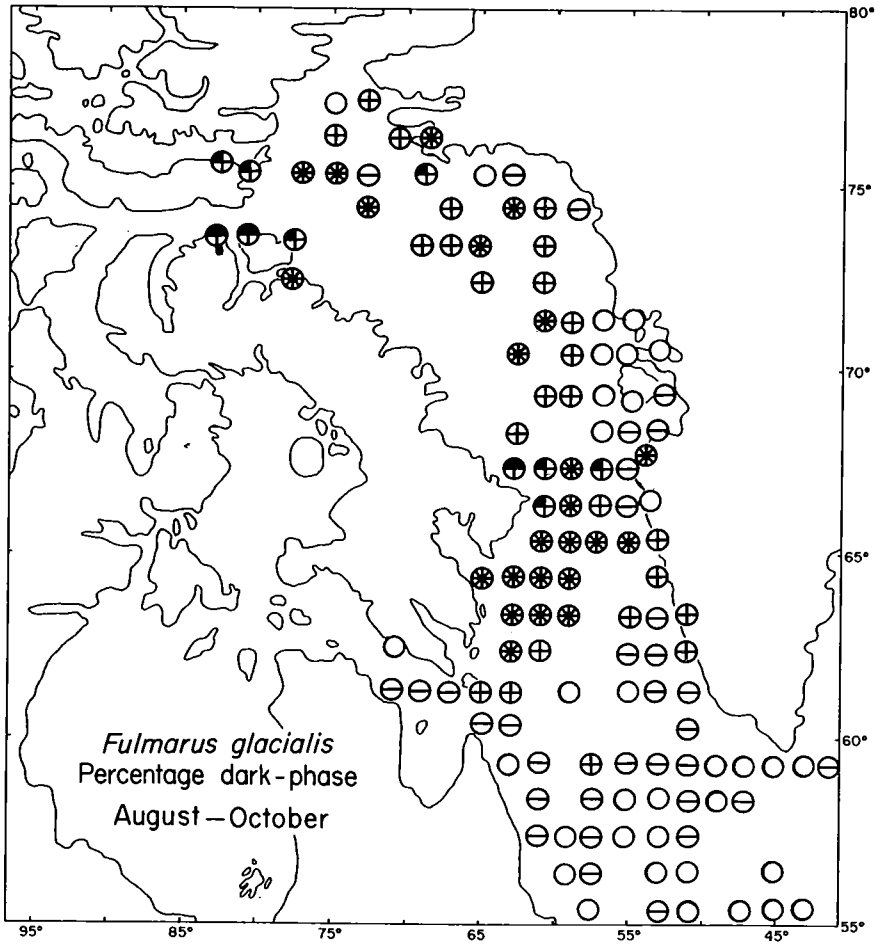


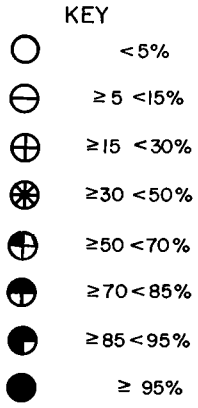
Map 2j
Northern Fulmar

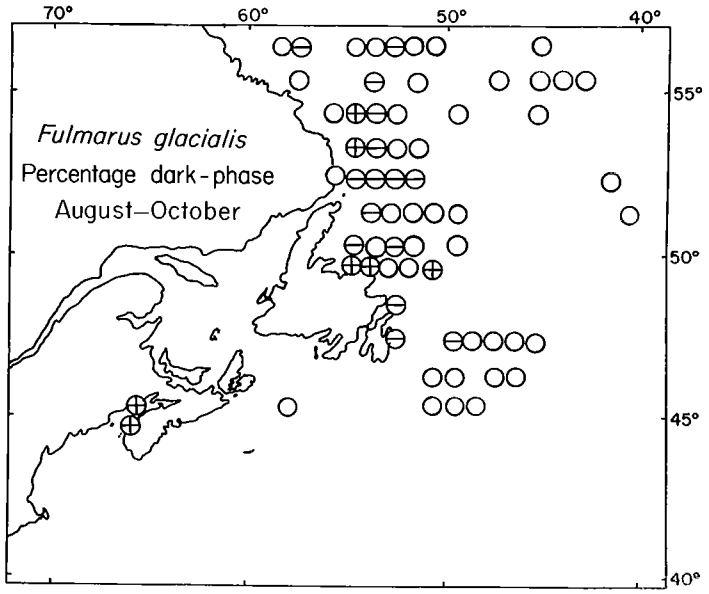


KEY

- <5%
- ≥5 <15%
- ≥15 <30%
- ≥30 <50%
- ≥50 <70%
- ≥70 <85%
- ≥85 <95%
- ≥ 95%


80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Fulmarus glacialis
Percentage dark-phase
August–October


KEY
<5%
≥5 <15%
≥15 <30%
≥30 <50%
≥50 <70%
≥70<85%
≥85<95%
≥ 95%


70°
60°
50°
40°
55°
50°
45°
40°
Fulmarus glacialis
Percentage dark-phase
August–October

Cory's Shearwater	*Calonectris diomedea*
Greater Shearwater	*Puffinus gravis*
Sooty Shearwater	*Puffinus griseus*
Manx Shearwater	*Puffinus puffinus*
Audubon's Shearwater	*Puffinus lherminieri*

Breeding distributions

The Greater and Sooty Shearwaters are migrants from the Southern Hemisphere, where they are found in the southern equivalent to the Boreal and Low Arctic zones (Brown *et al.* in press; Palmer 1962). Cory's Shearwater breeds in the Azores, the Mediterranean and off northwest Africa. The centre of Manx Shearwater breeding range in the Atlantic is at present in the east, where it is found from Iceland to the Azores and Canaries, but it formerly bred in Bermuda, and has recently been found breeding off Cape Cod (Finch 1973). Audubon's Shearwater is a tropical species whose nearest colonies are in Bermuda and in the West Indies.

Pelagic distributions

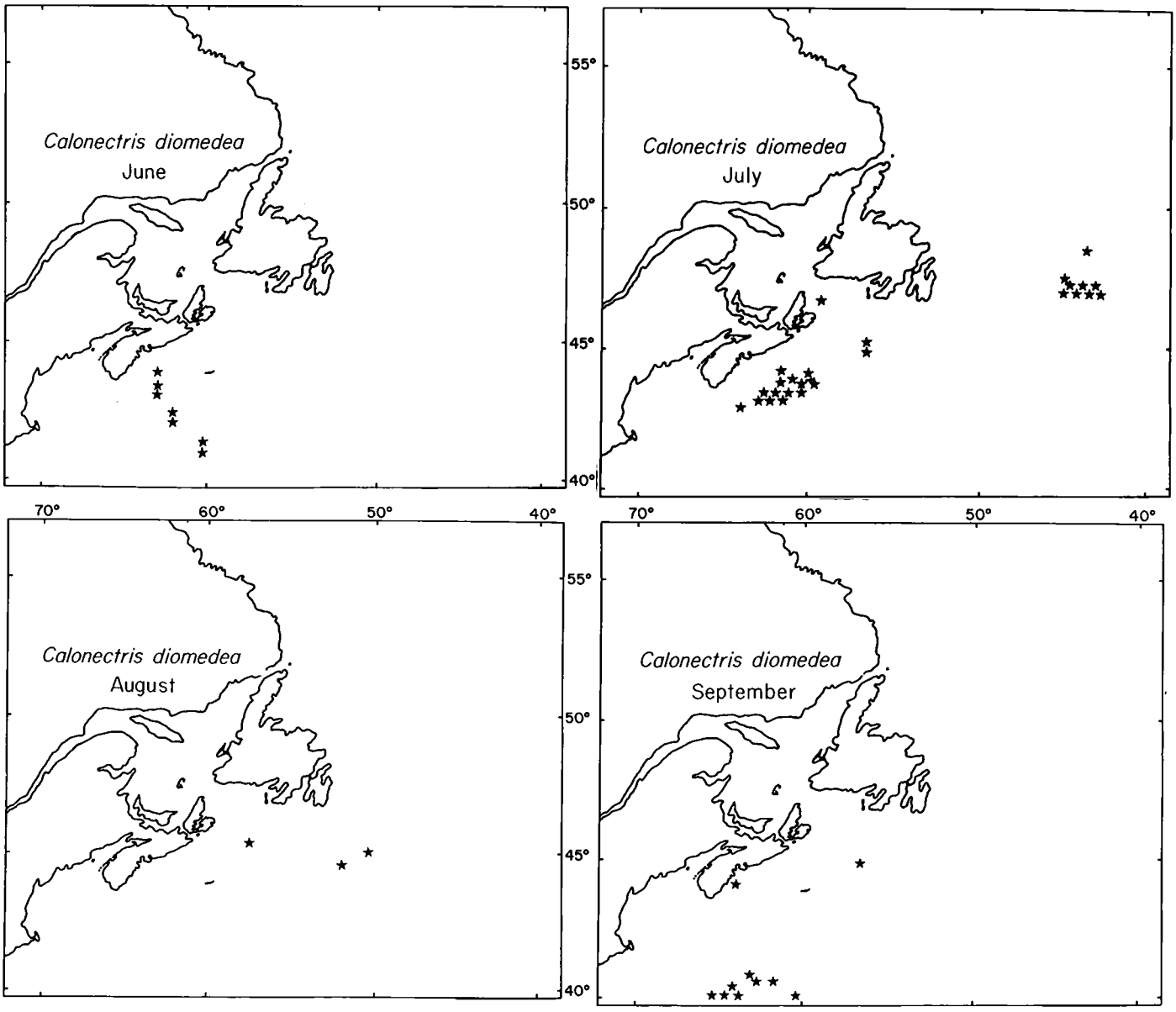
These five shearwaters show distinct zone preferences. Cory's and Audubon's are Cool Subtropical birds (see also Palmer 1962, Post 1967). Cory's reaches New England waters in August; our frequent July sightings may be of birds en route from the eastern Atlantic. Our sightings of Audubon's in September fit in with a similar late summer influx of that species along the American coast. Manx Shearwaters occur as far south as New York, but their distribution off eastern North America is more Boreal than that of the other two, and off eastern Newfoundland they cross the southern edge of the Low Arctic zone. The arrival of these three migrant shearwaters off New England coincides with the main Atlantic herring (*Clupea harengus*) fishery there, from August to October (ICNAF 1952–74). The birds may be exploiting the abundance either of herring or of some associated prey.

The total world populations of Greater and Sooty Shearwaters are not known, but are probably very large. The principal Greater Shearwater colony on Tristan da Cunha has been conservatively estimated at two million pairs (Rowan 1952). Allowing for other colonies, and for immature birds at sea, the total population must be of the order of 5–10 million individuals, almost all of which spend the northern summer in the North Atlantic. On the other hand, the majority of the Sooty Shearwater population winters off Peru and in the North Pacific (*e.g.* Palmer 1962). The proportion which migrates to the North Atlantic may well be no greater than that which stays behind and winters off the Argentine coast (Jehl 1974).

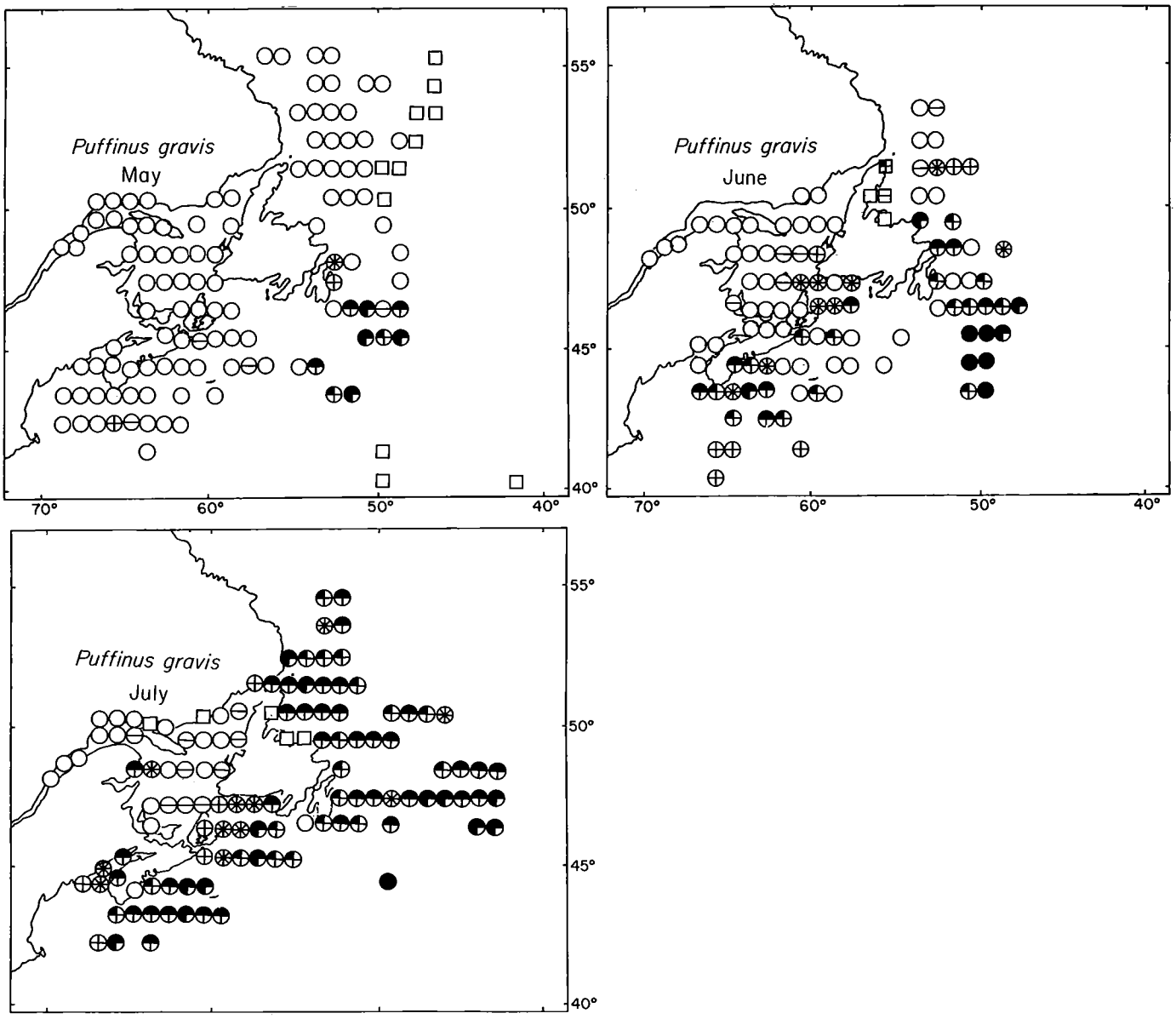
The great majority of Greater and Sooty Shearwaters reach eastern North American waters in May (Phillips 1963, Voous and Wattel 1963, Wynne-Edwards 1935), though birds have been reported as early as the end of February (L.M. Tuck pers. comm.). Sooty Shearwaters are commonest early in the season, but Greaters predominate from July onwards, when the species ratio in mixed flocks is usually of the order of 10 or more Greaters to one Sooty. The departure of the birds from the Southern Hemisphere coincides with a seasonal decline in the abundance of potential prey, and their arrival here coincides with an increase (Brown, in press). Capelin (*Mallotus villosus*) and the squid *Illex illecebrosus* are abundant inshore off eastern Newfoundland from May to July, and the squid remain offshore until October (Jangaard 1974, Rees 1961*b*, 1964, Pitt 1958, Squires 1957). Farther south, the main fishery for squid off Atlantic Nova Scotia is from May to July; surface swarms of euphausiids occur in the Gulf of Maine and Bay of Fundy from July to September and the fishery for "sardines" (young *Clupea harengus*) in the same area peaks in August and September (Fish and Johnson 1937, Graham 1936, ICNAF 1952–74).

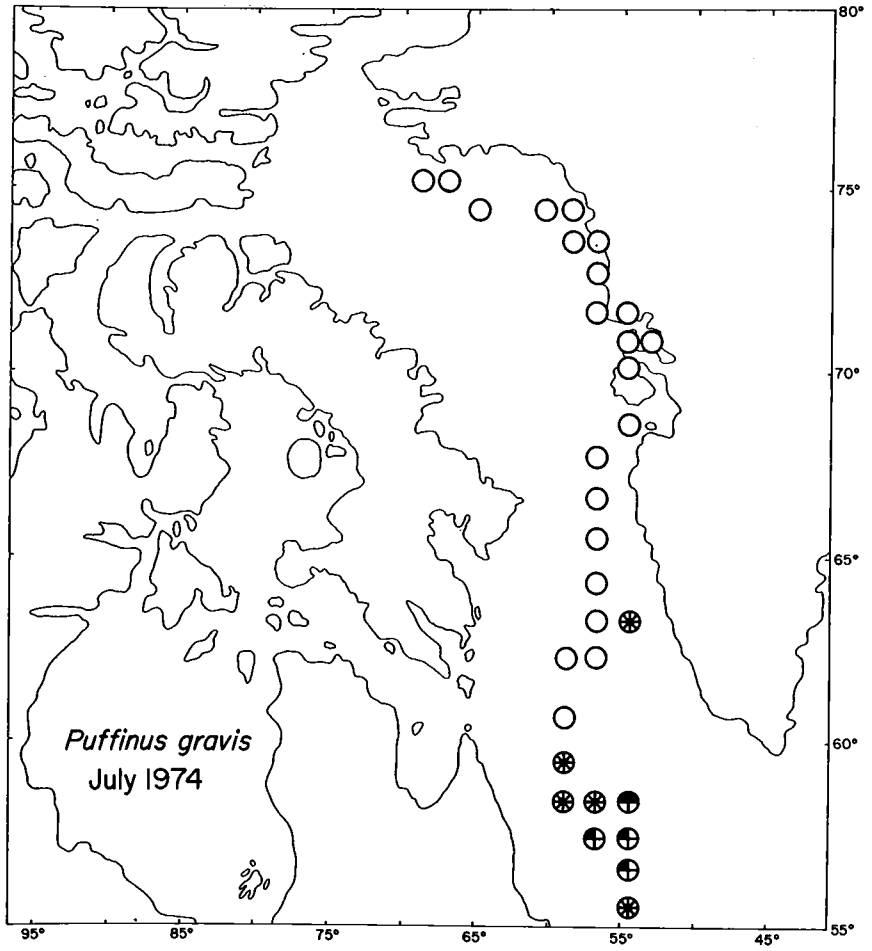
Both of these shearwaters spread through the Boreal and much of the Low Arctic zones, with the Greater having the more northerly range. Sooty Shearwaters move progressively northeast during the summer, and most have left Nova Scotian waters by August. Greater Shearwaters also spread northeast, but remain longer off eastern Canada; part of the population stays on the Newfoundland Banks and in the Bay of Fundy at least until November.

Map 3
Cory's Shearwater

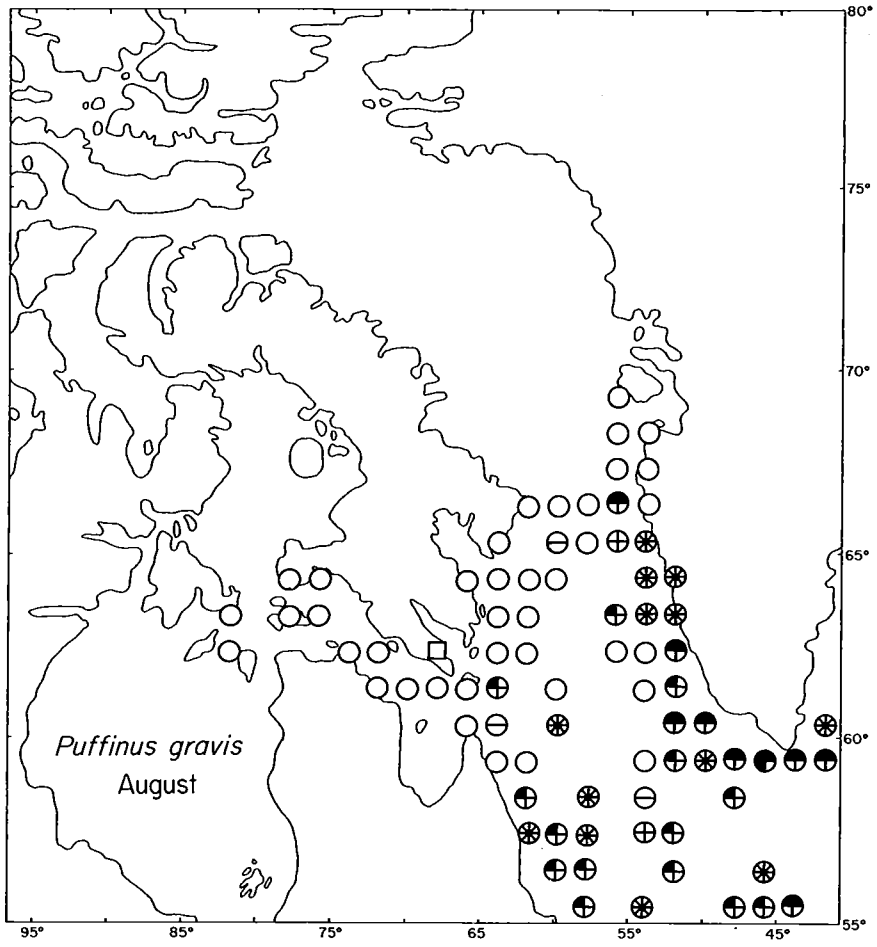


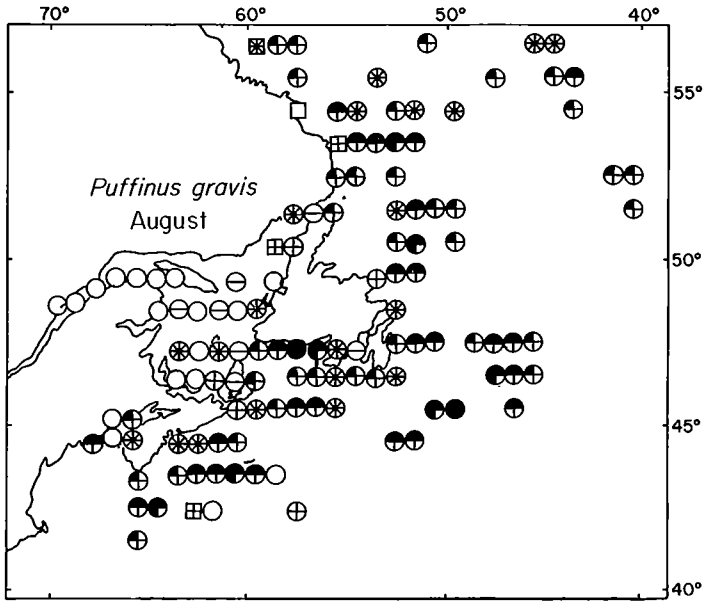
Map 4a
Greater Shearwater

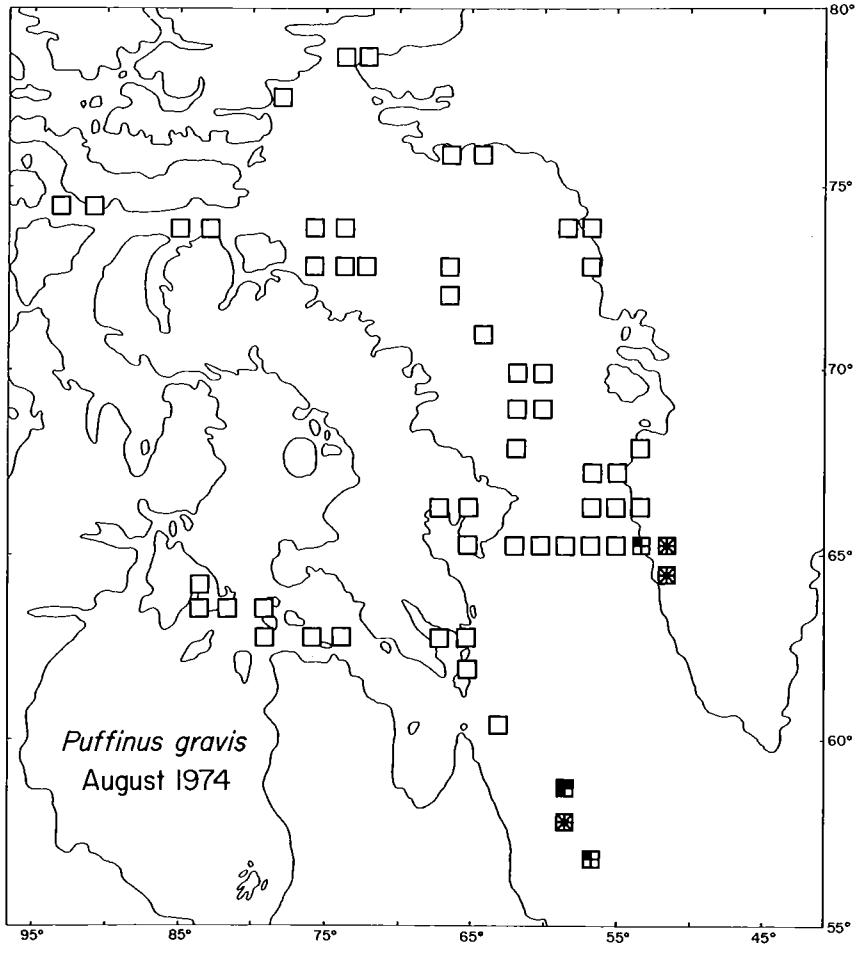



80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Puffinus gravis
July 1974

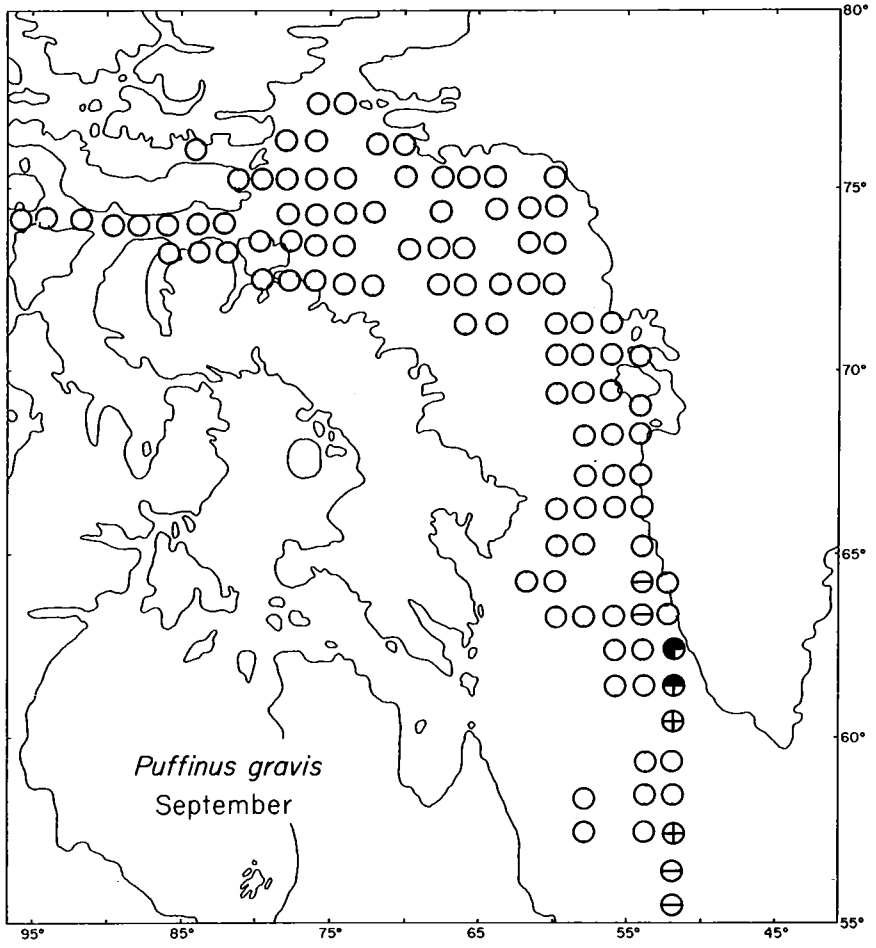
Map 4c
Greater Shearwater

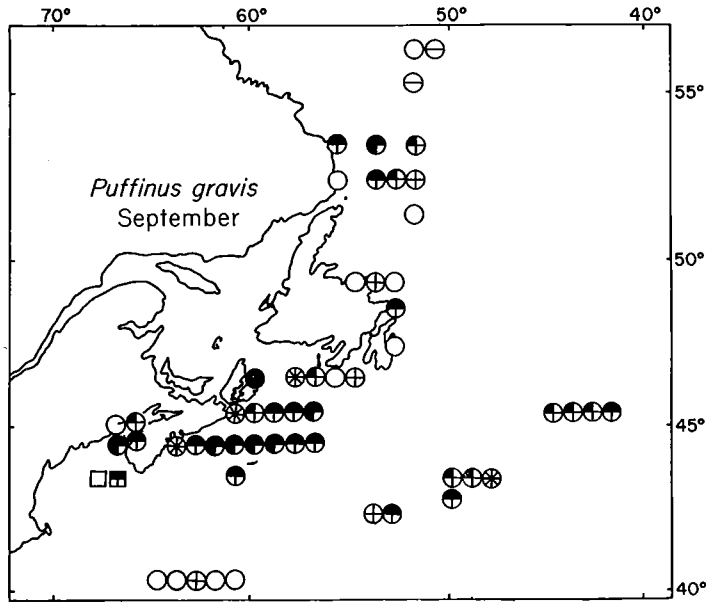


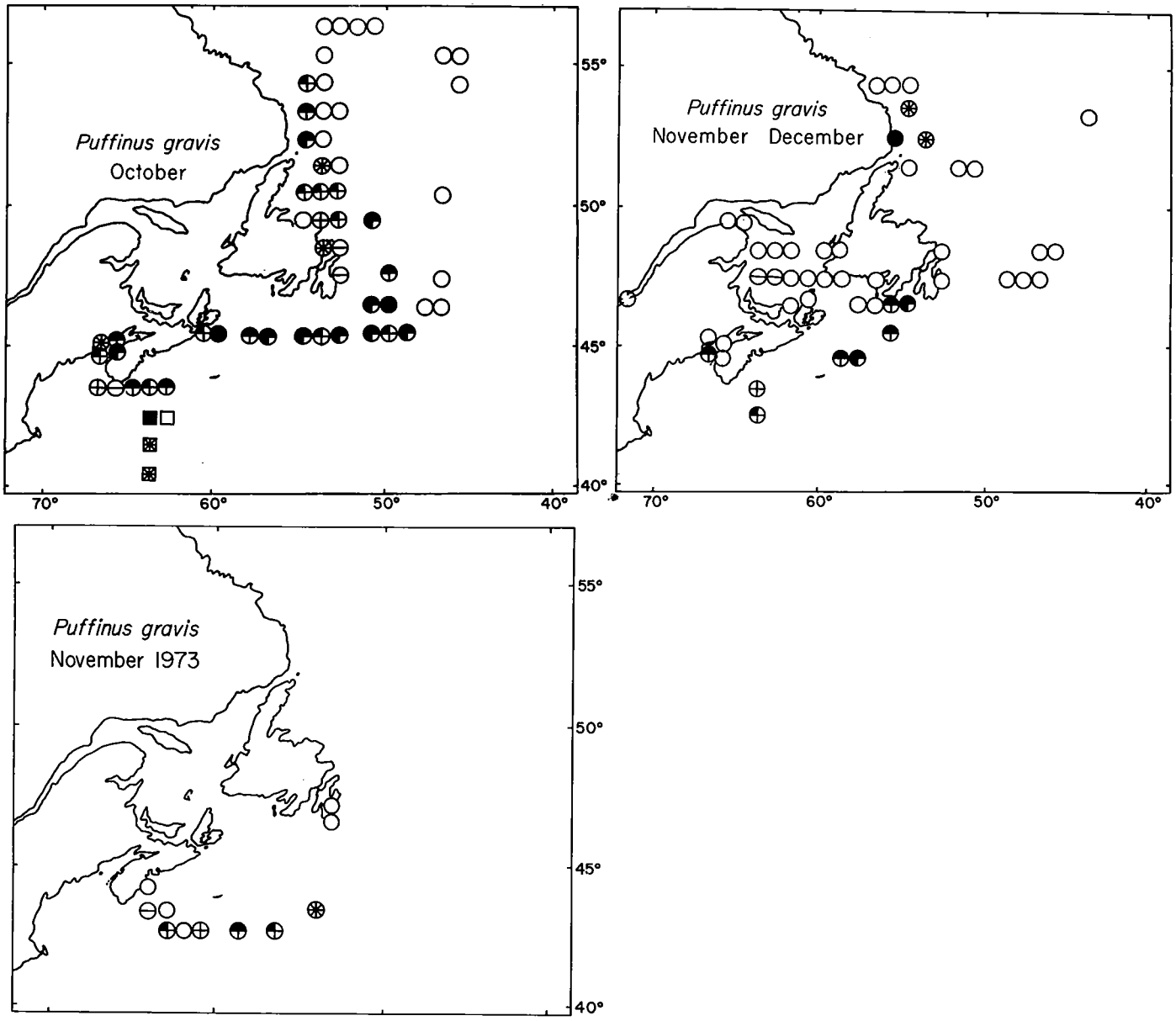



80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Puffinus gravis
August 1974

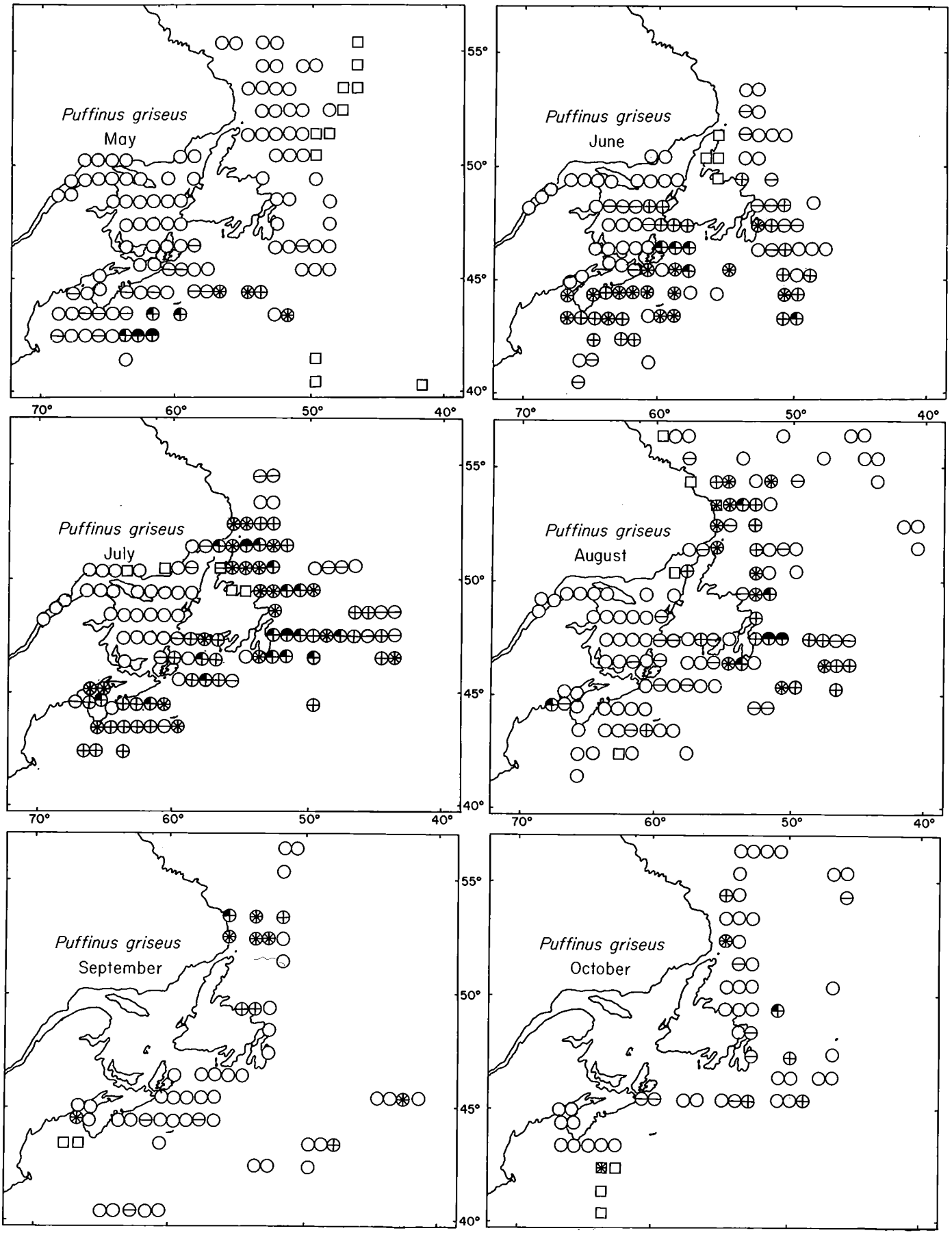
Map 4e
Greater Shearwater



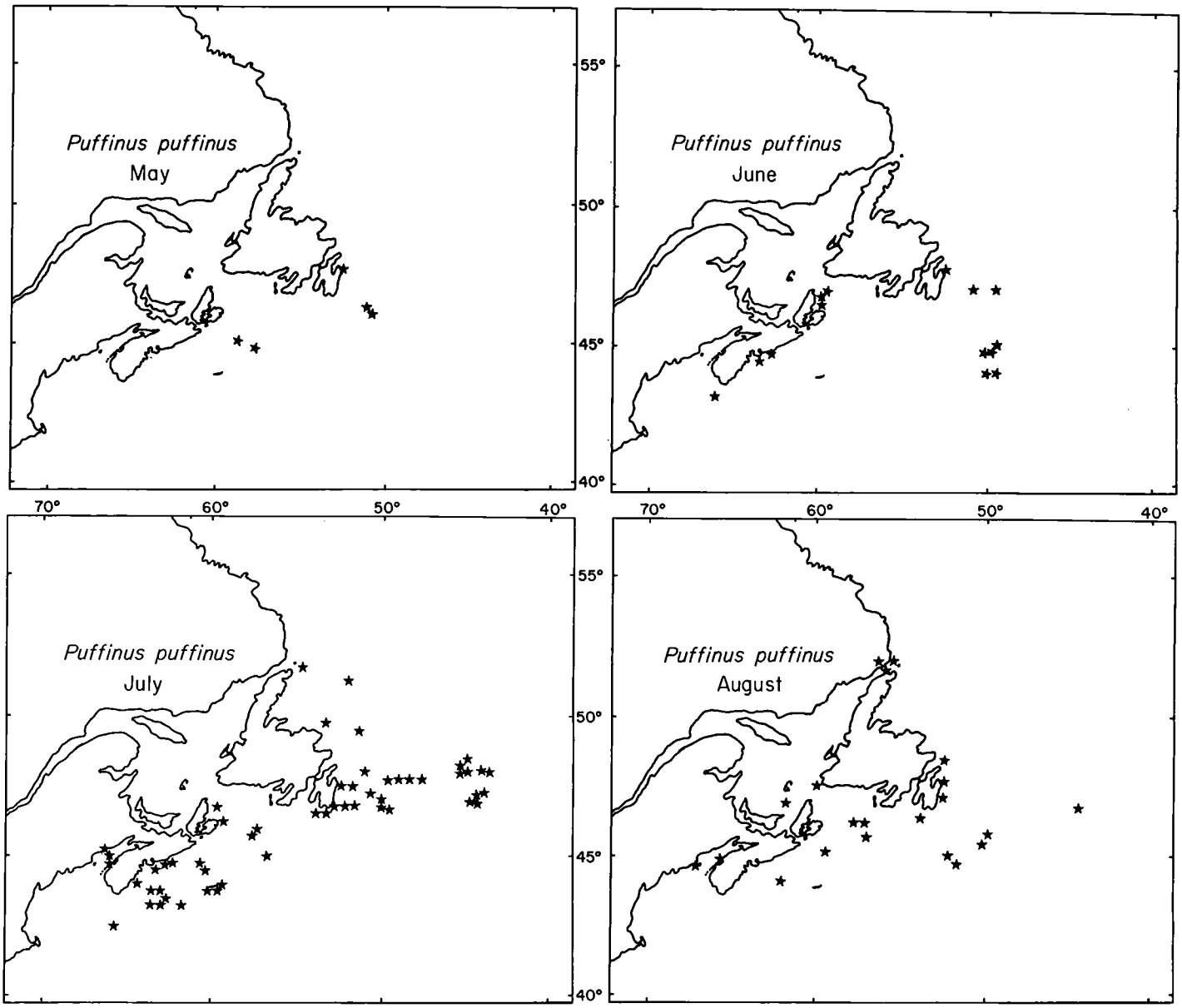



Puffinus gravis
October
Puffinus gravis
November December
Puffinus gravis
November 1973
55°
50°
45°
40°
70°
60°
50°
40°

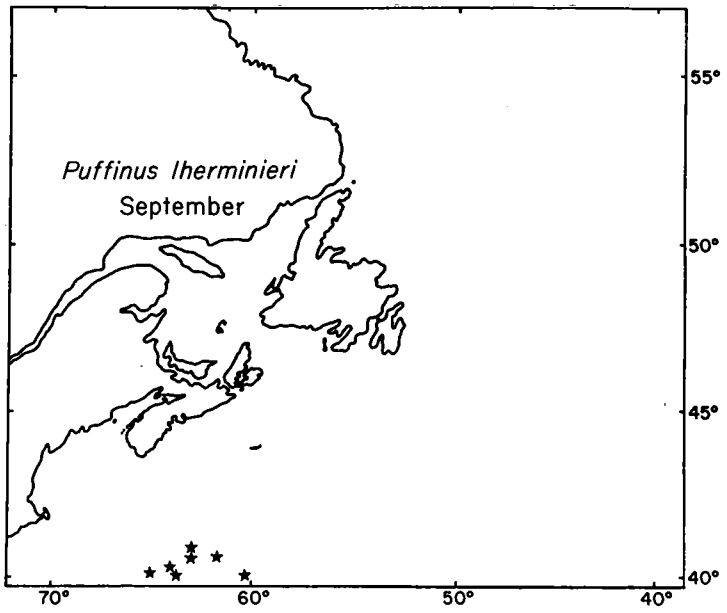
Map 5
Sooty Shearwater



Map 6
Manx Shearwater



Map 7
Audubon's Shearwater



Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Wilson's Storm-Petrel	*Oceanites oceanicus*

Breeding distributions

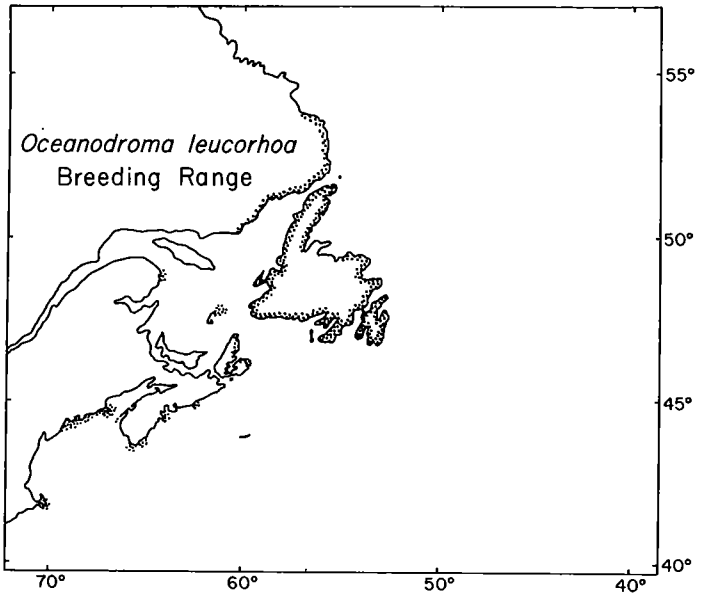
Wilson's Storm-Petrel breeds in the Antarctic and the colder sub-Antarctic (Roberts 1940). Leach's is known to breed at a number of sites between northern New England and southern Labrador (see Map 8a; data from Godfrey 1966; Nettleship and Lock 1973*b*, 1973c, Nettleship unpublished; W.H. Drury pers. comm.), though the colonies are hard to locate. The centre of distribution in the northwest Atlantic is in eastern Newfoundland, where Nettleship's unpublished surveys show that the largest colonies are on Gull Island, Witless Bay (47°16′N, 52°46′W: 210,000 pairs in 1973) and Great Island, Witless Bay (47°11′N, 52°49′W: 170,000 pairs in 1973). Baccalieu Island (48°07′N, 52°47′W) is also the site of a large colony.

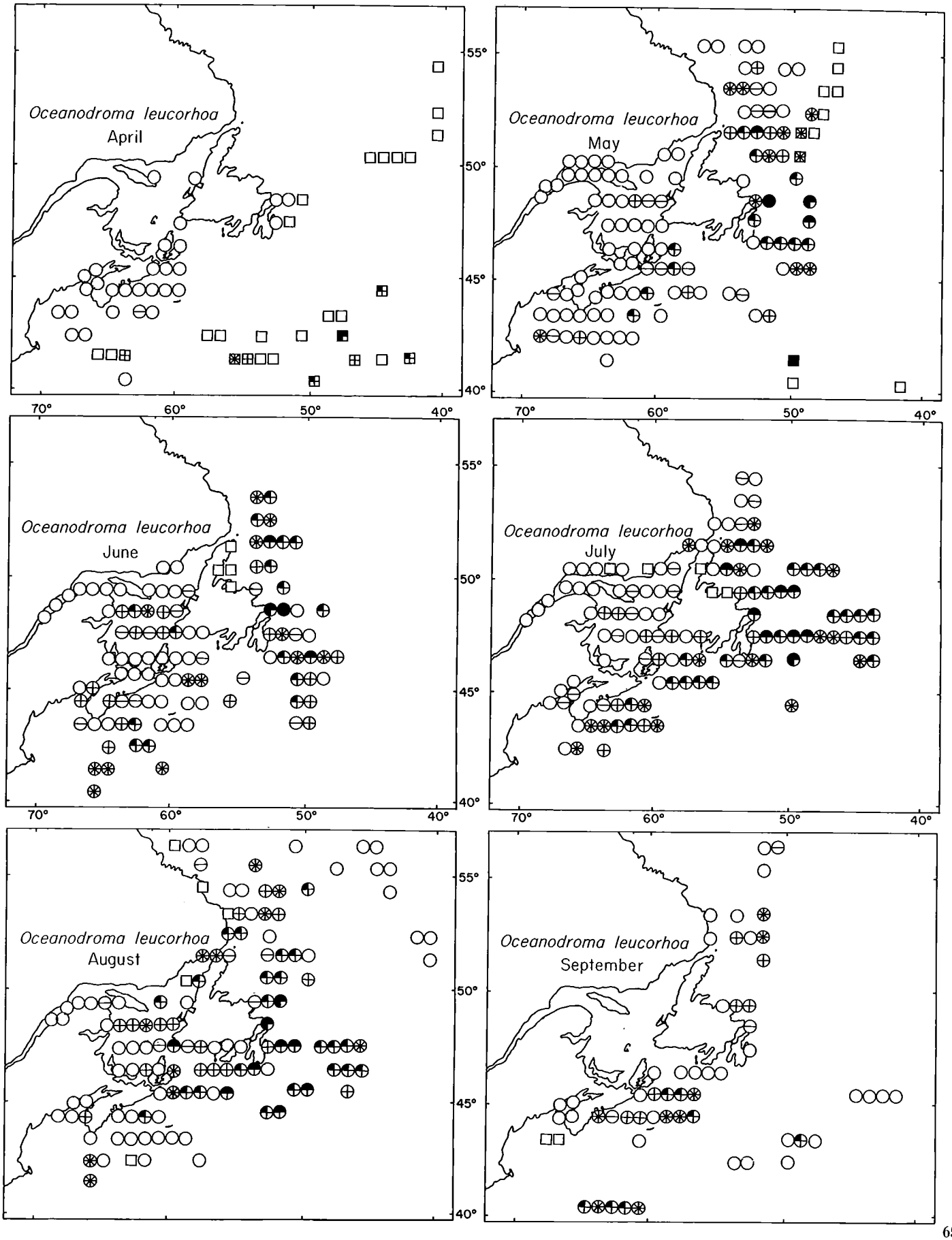
Pelagic distributions

Wilson's Storm-Petrel reaches eastern North American waters in May and remains there until September (Palmer 1962, Roberts 1940). It is extremely abundant off the New England coast and farther south. Our own observations show that it is also fairly common in the Boreal zone; Redfield's (1941) observations suggest that it may move into Nova Scotian waters when zooplankton abundance increases there in August. In view of its breeding distribution it seems strange that Wilson's Storm-Petrel should be absent from the productive Low Arctic waters off west Greenland. As it is, the "winter" pelagic range overlaps with the summer range of Leach's, its closest potential food competitor. However, Leach's Storm-Petrel is more a bird of the southern Low Arctic. Both species feed on small organisms at or close to the surface (Palmer 1962). Not enough is known of their precise feeding habits to say whether they do in fact compete for food.

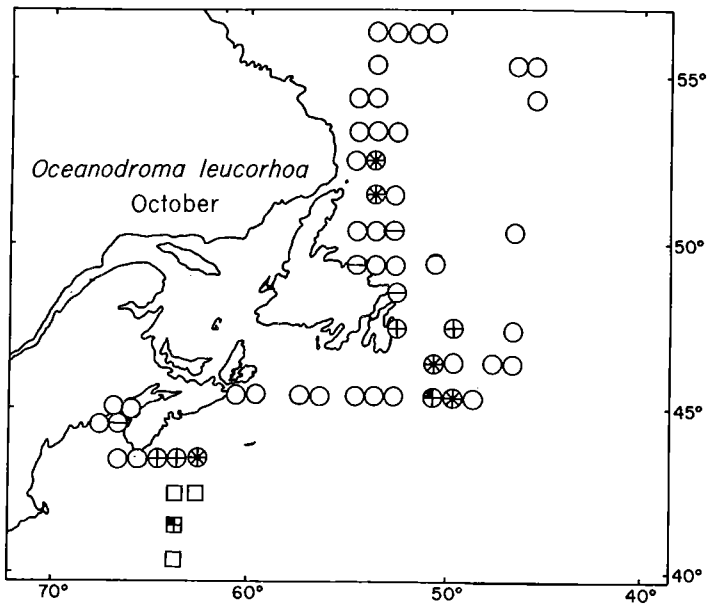
It is possible that the April and May sightings of birds identified as Leach's Storm-Petrels, from Cool Subtropical waters in the southeast corner of the survey area, could have been of Harcourt's Storm-Petrel (*Oceanodroma castro*), which breeds in the Azores and farther south (Palmer 1962).

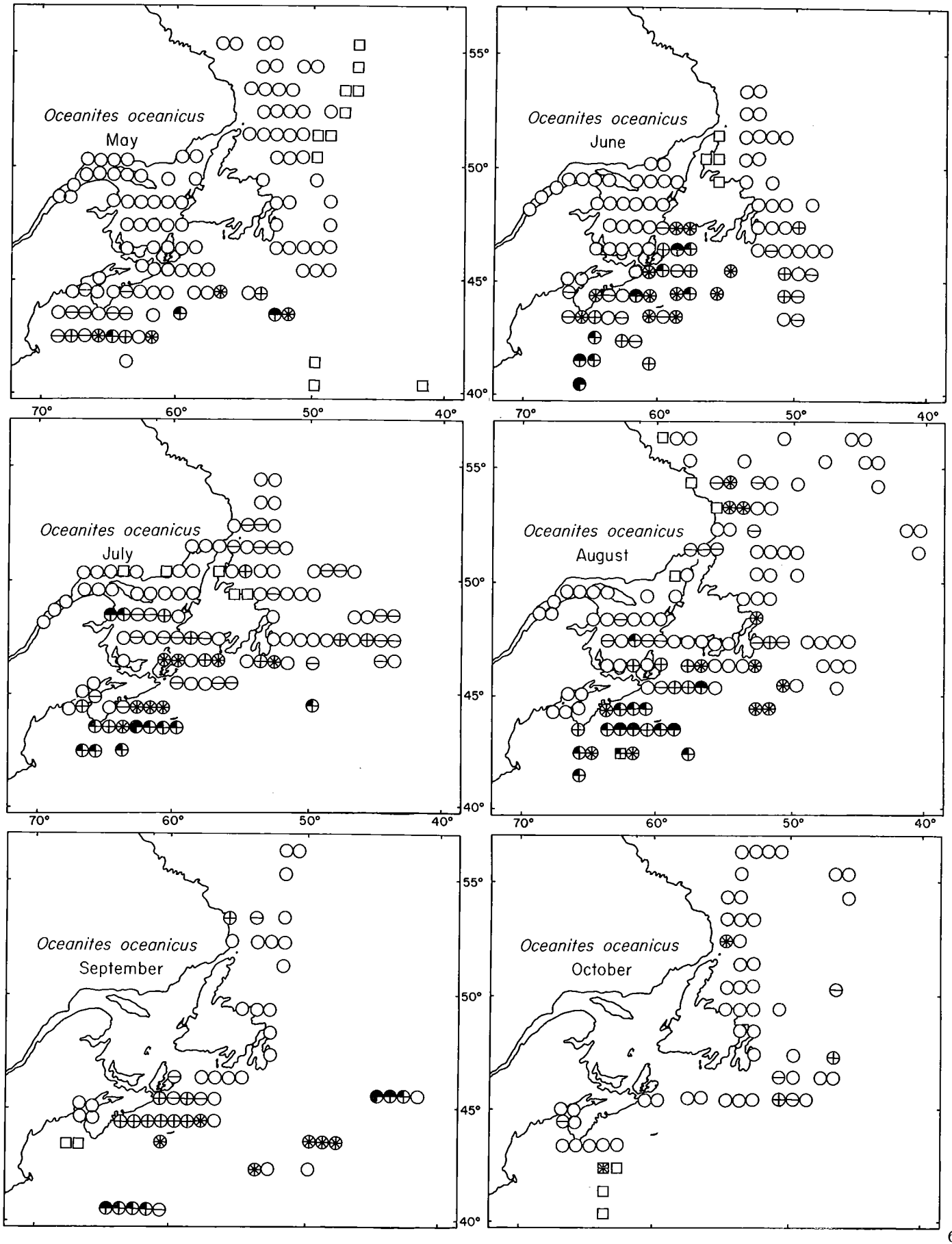
Map 8a
Leach's Storm-Petrel
Breeding range




Oceanodroma leucorhoa
April
Oceanodroma leucorhoa
May
Oceanodroma leucorhoa
June
Oceanodroma leucorhoa
July
Oceanodroma leucorhoa
August
Oceanodroma leucorhoa
September
55°
50°
45°
40°
70°
60°
50°
40°

Map 8c
Leach's Storm-Petrel




Oceanites oceanicus
May
Oceanites oceanicus
June
Oceanites oceanicus
July
Oceanites oceanicus
August
Oceanites oceanicus
September
Oceanites oceanicus
October
55°
50°
45°
40°
70°
60°
50°
40°

Breeding distribution

In eastern North America Gannets at present breed only off eastern Newfoundland and in the Gulf of St. Lawrence. The Gulf is the centre of their breeding range here, and was even more important before the drastic reduction in the Gannet population which resulted from human interference in the mid nineteenth century (Bent 1922, Gurney 1913; see also Section 4). At that time one colony in the Gulf and two in the Bay of Fundy were exterminated; these have been included in Map 10a and Table 2 because of their relevance to the discussion on the relations between Gannet and mackerel distributions in the next section.

The results of 1972 and 1973 surveys indicate a total North American Gannet population of about 32,731 pairs, of which 22,747 (69.5%) nest in the Gulf of St. Lawrence and 9,984 (30.5%) on the Atlantic coast of Newfoundland (Nettleship 1974*c*). Gannet numbers have decreased considerably at two of the three colonies (Bonaventure Island and Gullcliff Bay, Anticosti Island) in the Gulf since 1969 (Nettleship 1974*c*, 1975*b*). Reasons for these declines are obscure, though contamination by toxic chemicals seems a likely prime cause (Nettleship 1975*b*). Colonies in Newfoundland have remained somewhat stable (Cape St. Mary's and Baccalieu) or increased slightly (Funk) in recent times (Nettleship 1974*c*).

Pelagic distribution[5]

Gannets are summer visitors to the Boreal zone and to the extreme south of the Low Arctic; they are one of the few seabirds commonly seen in the southern part of the Gulf of St. Lawrence (Moisan and Scherrer 1973).

Gannets feed mainly on fish which school close to the surface. Herring are available all summer, and are important early in the season, but Atlantic mackerel are the principal prey during the period of maximum chick growth in July and early August (Nelson 1970, Nettleship unpublished, Poulin 1968). All the North American colonies are in areas which often barely support a commercial mackerel fishery, but these are also the areas into which mackerel migrate in July and August: the northern and western Gulf of St. Lawrence, eastern Newfoundland, and the Bay of Fundy (ICNAF 1952–74, Sette and Needler 1934). Tuck (1961: 201) suggests that the recent re-establishment and expansion of the colony on Funk Island is linked to a northerly extension of the mackerel's range off eastern Newfoundland. On the other hand, Gannets have apparently never bred on the Atlantic coast of Nova Scotia, despite the presence of apparently suitable nesting islands; here the main mackerel fishery is in June and few fish are caught in July and August. The late Canadian spring probably makes it impossible for Gannets to hatch chicks early enough to take advantage of a June mackerel run (Nelson 1970).

5 In November 1973 small numbers of Gannets were moving southwest on the Scotian Shelf at c. 44°N, 63°W.

Map 10a
Gannet
Breeding range

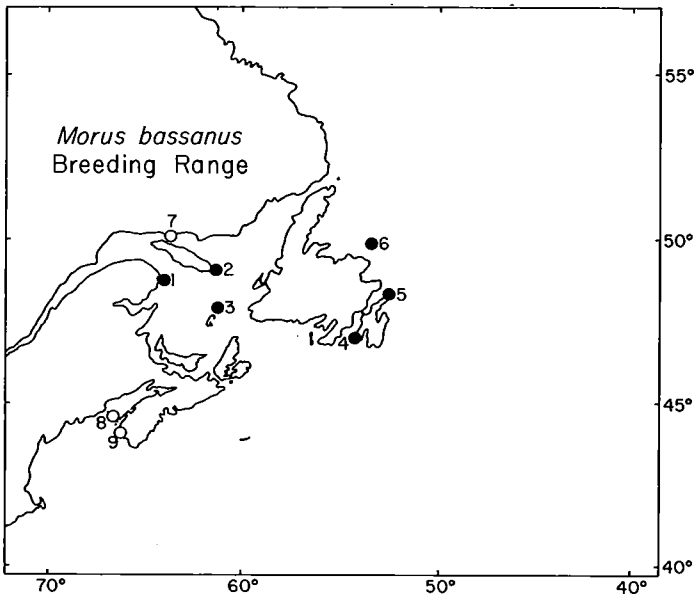
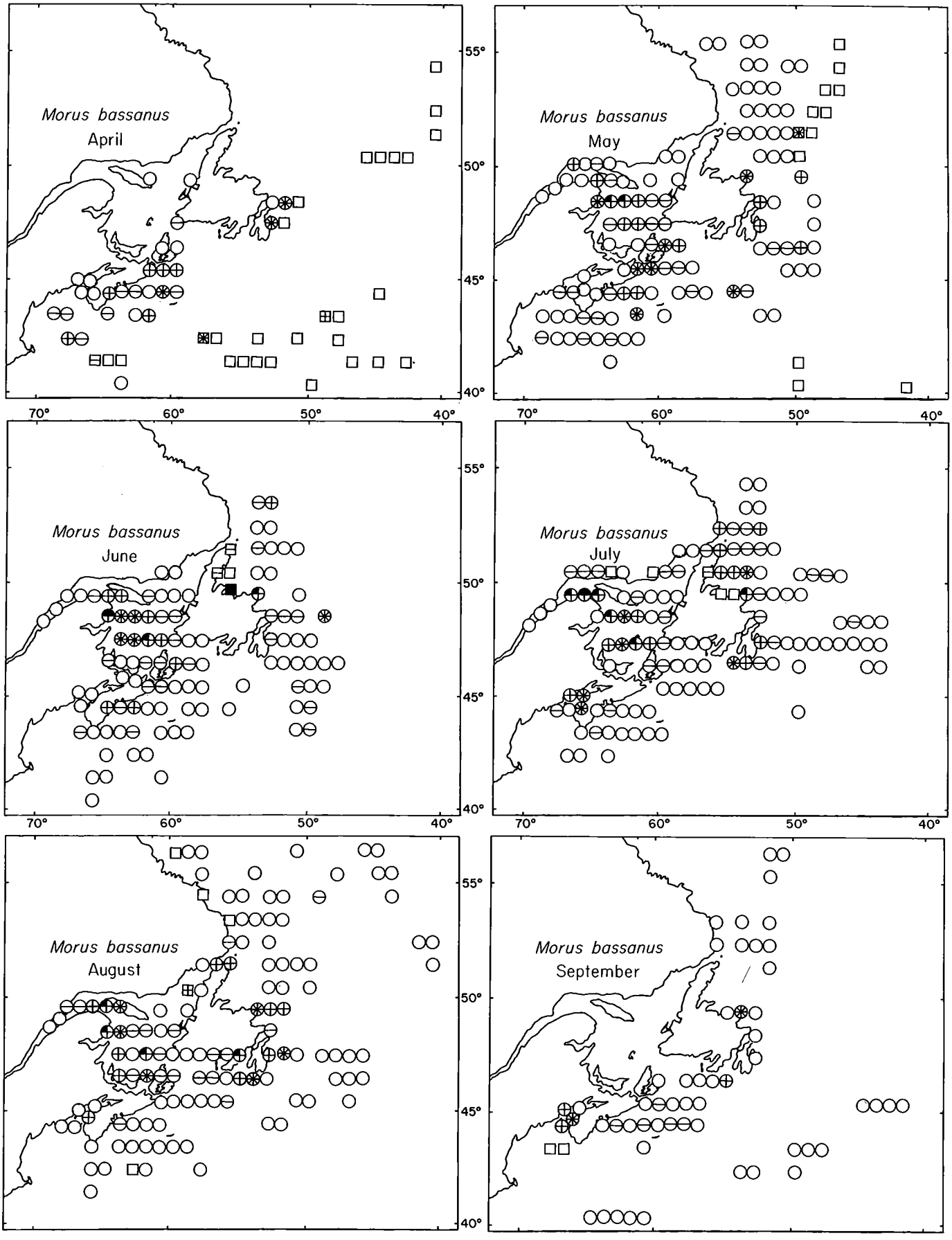
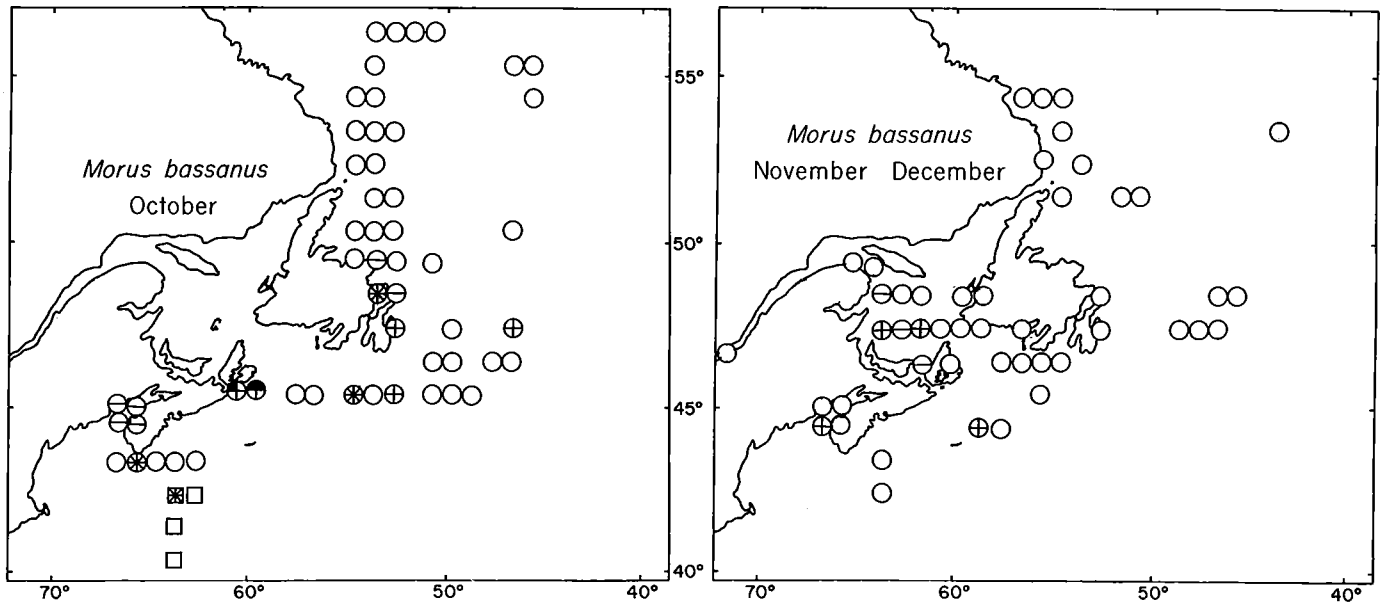


Table 2
Location and size of Gannet (*Morus bassanus*) colonies. For further details, see Table 1

	Colony location	Position	Colony size	Census year	Authority
	Atlantic Canada:				
1.	Bonaventure I.	48°30′N, 64°09′W	17,281p	1973	Nettleship 1974*c*, 1975*b*
2.	Gullcliff Bay, Anticosti I.	49°09′N, 61°42′W	135p	1972	Nettleship 1974*c*
3.	Bird Rocks, Magdalen I.:	47°50′N, 61°09′W			
	Great Bird Rock		4,527p	1973	Nettleship 1974*c*
	North Bird Rock		804p	1973	Nettleship 1974*c*
4.	Cape St. Mary's	46°50′N, 54°12′W	5,260p	1972	Nettleship 1974*c*
5.	Baccalieu I.	48°07′N, 52°47′W	673p	1973	Nettleship 1974*c*
6.	Funk I.	49°46′N, 53°11′W	4,051p	1972	Nettleship 1974*c*
7.	Perroquet I.	50°14′N, 64°13′W	extinct	1887	Fisher and Lockley 1954
8.	Gannet Rock, N.B.	44°31′N, 66°47′W	extinct	1871	Fisher and Lockley 1954
9.	Gannet Rock, N.S.	43°38′N, 66°09′W	extinct	1883	Fisher and Lockley 1954


Morus bassanus
April
Morus bassanus
May
Morus bassanus
June
Morus bassanus
July
Morus bassanus
August
Morus bassanus
September
55°
50°
45°
40°
70°
60°
50°
40°

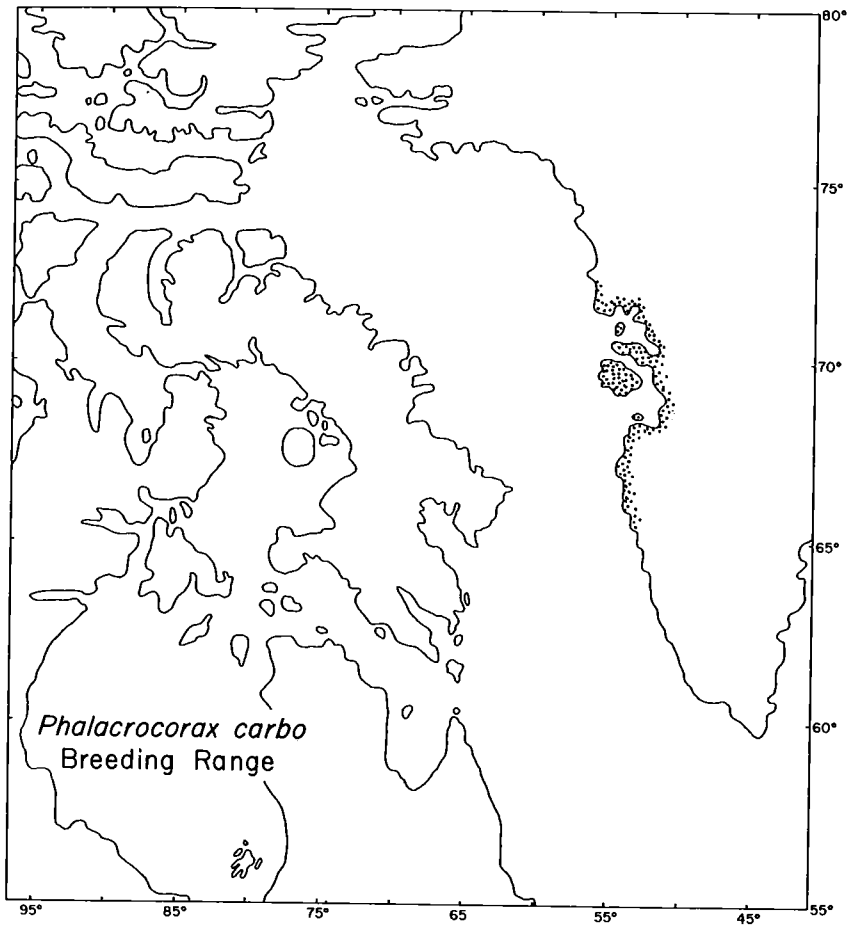
Map 10c
Gannet



Great Cormorant	*Phalacrocorax carbo*
Double-crested Cormorant	*Phalacrocorax auritus*

Cormorants are strictly coastal birds. We have so few observations from ships that there seems no point in mapping them, or even in listing them in Appendix 2. Their distributions are best shown by the colony sites. Both species are mainly Boreal in Atlantic Canada. The Double-crested extends up the St. Lawrence and is widespread in inland waters in central North America (Palmer 1962); a separate sub-species breeds along subtropical and tropical Atlantic coasts. A disjunct population of Great Cormorants breeds in west Greenland at the extreme northern edge of the Low Arctic (Salomonsen 1950).

Map 11
Great Cormorant
Breeding range



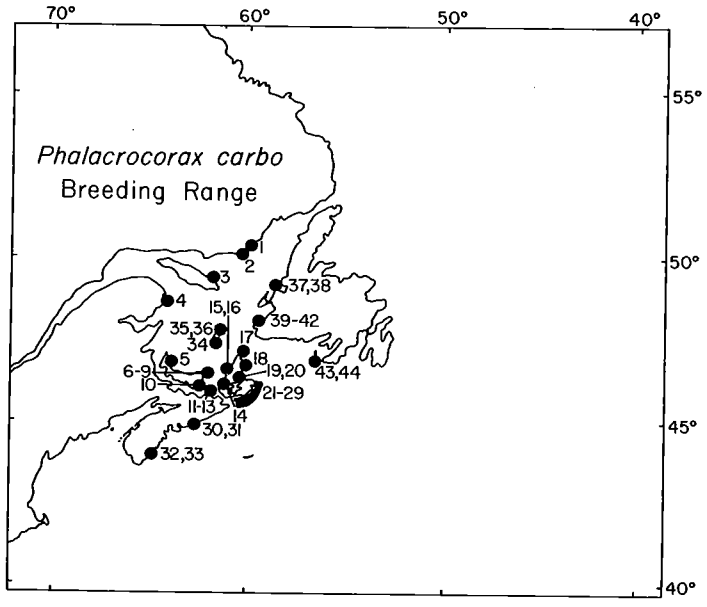


Table 3
Location and size of Great Cormorant (*Phalacrocorax carbo*) colonies. For further details see Table 1

	Colony location	Position	Colony size	Census year	Authority
	Atlantic Canada, St. Pierre-Miquelon:				
1.	St. Mary Is.	50°19′N, 59°39′W	440i	1972	Nettleship and Lock 1973*b*
2.	Wolf Bay	50°10′N, 60°17′W	24i	1972	Nettleship and Lock 1973*b*
3.	S of Table Head, Anticosti I.	49°19′N, 61°52′W	16p[1]	1972	Nettleship and Lock 1973*b*
4.	Percé Rock	48°31′N, 64°12′W	18p[2]	1974	Nettleship and Taylor
5.	C. Tryon, P.E.I.	46°32′N, 64°30′W	±30p	1973	Nettleship and Lock
6.	East Point, P.E.I.	46°26′N, 61°59′W	±50p	1973	Nettleship and Lock
7.	Deane Point, P.E.I. (=McKinnon Pt.?)	46°21′N, 62°10′W	±15p	1973	Nettleship and Lock
8.	Souris Head, P.E.I.	46°20′N, 62°17′W	9p	1973	Nettleship and Lock
9.	Durrel Pt., P.E.I.	46°16′N, 62°22′W	0[3]	1973	Nettleship and Lock
10.	E of Little Sands, P.E.I.	45°57′N, 62°35′W	+	1973	Nettleship and Lock
11.	Cape George	45°53′N, 61°54′W	12p	1971	Lock and Ross 1973
12.	Lakevale	45°47′N, 61°54′W	2p	1971	Lock and Ross 1973
13.	Crystal Cliffs	45°43′N, 61°54′W	33p	1971	Lock and Ross 1973
14.	Coalmine Pt.	46°07′N, 61°29′W	>80p	1971	Lock and Ross 1973
15.	Margaree I.	46°22′N, 61°16′W	75–85p	1971	Lock and Ross 1973
16.	Cheticamp I.	46°36′N, 61°04′W	45–55p	1971	Lock and Ross 1973
17.	Money Pt.	47°02′N, 60°23′W	12–20i	1971	Lock and Ross 1973
18.	Ingonish I.	46°41′N, 60°20′W	99p	1971	Lock and Ross 1973
19.	Ciboux I.	46°23′N, 60°23′W	88p	1971	Lock and Ross 1973
20.	Hertford I.	46°22′N, 60°24′W	310p	1971	Lock and Ross 1973
21.	C. Percé	46°10′N, 59°49′W	94p	1971	Lock and Ross 1973
22.	C. Morien	46°08′N, 59°48′W	65–75p	1971	Lock and Ross 1973
23.	Hay I.	46°02′N, 59°42′W	94p	1971	Lock and Ross 1973

	Colony location	Position	Colony size	Census year	Authority
24.	Portnova I.	45°56′N, 59°48′W	507i	1971	Lock and Ross 1973
25.	Kennington Rocks	45°52′N, 60°04′W	84p	1971	Lock and Ross 1973
26.	Green I.	45°49′N, 60°04′W	27p	1971	Lock and Ross 1973
27.	Sugarloaf I.	45°48′N, 60°05′W	160–180p	1971	Lock and Ross 1973
28.	Rock NE of Forchu Head	45°43′N, 60°13′W	30–50p	1971	Lock and Ross 1973
29.	Eastern Basque I.	45°35′N, 60°39′W	95–100p	1971	Lock and Ross 1973
30.	West Brother I.	44°49′N, 62°22′W	227p	1971	Lock and Ross 1973
31.	Islet off Guildford I.	44°48′N, 62°32′W	17p	1971	Lock and Ross 1973
32.	Green I.	43°45′N, 64°56′W	30–35p	1971	Lock and Ross 1973
33.	Blue Gull Rock	43°40′N, 65°13′W	20–30p	1971	Lock and Ross 1973
34.	Entry I., Magdalen Is.	47°16′N, 61°41′W	>86p	1972	W.B. Hughson, P.A. Pearce and A.D. Smith, pers. comm.
35.	Shag Rock, Magdalen Is.	47°29′N, 61°42′W	>40p	1972	W.B. Hughson, P.A. Pearce and A.D. Smith, pers. comm.
36.	Brion I., Magdalen Is.	47°48′N, 61°29′W	+	1967	R.W. Fyfe, pers. comm. (10i in 1940: Lewis 1941)
37.	Saddle I.	49°15′N, 58°18′W	14p	1973	Nettleship and Lock
38.	Guernsey I.	49°11′N, 58°22′W	19p	1973	Nettleship and Lock
39.	Ship Cove	48°07′N, 59°00′W	1p	1973	Nettleship and Lock
40.	Lewis Pt.	48°06′N, 59°04′W	25p	1973	Nettleship and Lock
41.	S of Little Friars Cove	48°04′N, 59°08′W	9p	1973	Nettleship and Lock
42.	N of Grebes Head	47°56′N, 59°22′W	41p	1973	Nettleship and Lock
43.	Anse aux Cormorans, Langlade I. (= Petite Miquelon I.)	46°52′N, 56°15′W	>20p	1964	Cameron 1967
44.	NW St. Pierre I.	c.46°48′N, 56°09′W	16p	1963 or 1964	Cameron 1967

[1] Note: other colonies on Anticosti I. reported by Ouellet (1969) and Erskine (1972) were not occupied in 1972.

[2] ± 200p in 1968: H.R. Ouellet (pers. comm.).

[3] 64p in 1966: Erskine (1972).

Map 12
Double-crested Cormorant
Breeding range

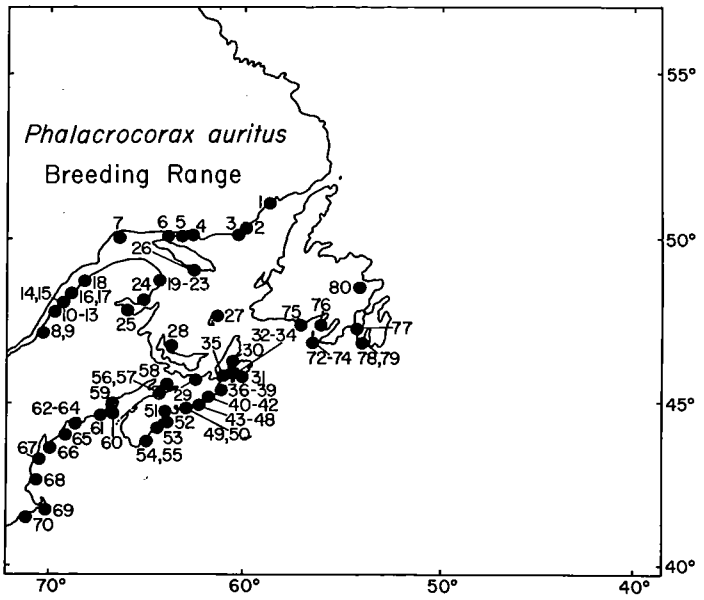


Table 4
Location and size of Double-crested Cormorant (*Phalacrocorax auritus*) colonies. For further details see Table 1. An asterisk indicates that the colony was not plotted on the map

	Colony location	Position	Colony size	Census year	Authority
	Atlantic Canada, New England, St. Pierre-Miquelon:				
1.	St. Augustin Sanctuary	51°07′N, 58°33′W	3i	1972	Nettleship and Lock 1973*b*
2.	St. Mary Is.	50°19′N, 59°39′W	320i	1972	Nettleship and Lock 1973*b*
3.	Wolf Bay	50°10′N, 60°17′W	120i	1972	Nettleship and Lock 1973*b*
4.	Watshishu	50°16′N, 62°38′W	155i	1972	Nettleship and Lock 1973*b*
5.	Betchouane	50°12′N, 63°13′W	3i	1972	Nettleship and Lock 1973*b*
6.	Birch Is.	50°14′N, 63°59′W	0[1]	1972	Nettleship and Lock 1973*b*
7.	Carrousel I.	50°05′N, 66°23′W	330i	1972	Nettleship and Lock 1973*b*
8.	Burnt Cape Ledges	47°07′N, 70°39′W	50p	1971	Reed 1973
9.	Wood Pillar Islet	47°12′N, 70°24′W	150p	1971	Reed 1973
10.	Kamouraska Is.	47°36′N, 69°53′W	15p	1966	Reed 1973
11.	Pilgrim Is.	47°44′N, 69°44′W	1,100p	1969	Reed 1973
12.	Ile Blanche	47°56′N, 69°40′W	840p	1967	Reed 1973
13.	Ile-aux-Pommes	48°06′N, 69°19′W	351p	1972	Reed 1973
14.	Southwest Razade	48°11′N, 69°09′W	7p	1972	Reed 1973
15.	Northeast Razade	48°12′N, 69°08′W	0[2]	1972	Reed 1973
16.	Ile Bicqnette and reefs	48°25′N, 68°53′W	150p	1972	Reed 1973
17.	Cap Caribou	48°24′N, 68°41′W	100p	1971	Reed 1973
18.	Les Boules	48°40′N, 68°00′W	100p	1970	G. Arsenault, pers. comm.
19.	Cape Bon Ami (= Cape-des-Rosiers)	48°51′N, 64°12′W	>220p	1967	H.R. Ouellet, pers. comm.
20.	Cape Gaspé	48°45′N, 64°10′W	>375p	1968	H.R. Ouellet, pers. comm.
21.	N side Gaspé Bay	c.48°49′N, 64°17′W	60i	1923	Lewis 1929

	Colony location	Position	Colony size	Census year	Authority
22.	S side Gaspé Bay	c.48°40′N, 64°12′W	872i	1923	Lewis 1929
23.	Percé Rock	48°31′N, 64°12′W	341p	1974	Nettleship and Taylor
*	Cap d'Espoir	48°25′N, 64°19′W	20p	1974	Nettleship and Taylor
*	Ile Plate	48°09′N, 64°37′W	5p	1973	G. Arsenault and A. Bourget, pers. comm.
24.	Paspébiac	48°01′N, 65°14′W	>125p	1967	H.R. Ouellet, pers. comm.
25.	Heron I.	48°00′N, 66°08′W	±300p	1973	Nettleship and Lock
26.	Point Dauphiné, Anticosti I.	49°07′N, 62°30′W	79p	1972	Nettleship and Lock
27.	Seal I., Magdalen Is.	47°36′N, 61°29′W	396p	1972	W.B. Hughson, P.A. Pearce and A.D. Smith, pers. comm.
28.	C. Tryon, P.E.I.	46°32′N, 63°30′W	87p	1952	Godfrey 1954
29.	Pictou wharf	45°38′N, 62°43′W	88p	1971	Lock and Ross 1973
30.	Double I. (= Spectacle or Toothbrush I.)	46°04′N, 60°44′W	225p	1971	Lock and Ross 1973
31.	Sugarloaf I.	45°48′N, 60°05′W	15–20p	1971	Lock and Ross 1973
32.	Rock NE of Forchu Head	45°43′N, 60°13′W	65–85p	1971	Lock and Ross 1973
33.	Eastern Basque I.	45°35′N, 60°39′W	20–25p	1971	Lock and Ross 1973
34.	Red I.	45°48′N, 60°46′W	315p	1971	Lock and Ross 1973
35.	Campbell I.	45°33′N, 61°09′W	305p	1971	Lock and Ross 1973
36.	Crow I.	45°31′N, 60°57′W	172p	1971	Lock and Ross 1973
37.	Millstone I.	45°12′N, 61°07′W	23p	1971	Lock and Ross 1973
38.	Island SW of Port Felix	45°14′N, 61°14′W	10p	1971	Lock and Ross 1973
39.	W Sugar I.	45°13′N, 61°17′W	470–500p	1971	Lock and Ross 1973
40.	Islet NE of Coddle I.	45°09′N, 61°31′W	10p	1971	Lock and Ross 1973
41.	Goose I.	45°07′N, 61°34′W	185p	1971	Lock and Ross 1973

	Colony location	Position	Colony size	Census year	Authority
42.	Tobacco I.	45°01′N, 61°55′W	180–200p	1971	Lock and Ross 1973
43.	Little White I.	44°54′N, 62°06′W	121i	1971	Lock and Ross 1973
44.	Middle Halibut I.	44°54′N, 62°12′W	200–250p	1971	Lock and Ross 1973
45.	Long I.	44°54′N, 62°18′W	68p	1971	Lock and Ross 1973
46.	Horse I.	44°50′N, 62°22′W	213p	1971	Lock and Ross 1973
47.	Speck I.	44°51′N, 62°24′W	8p	1971	Lock and Ross 1973
48.	Horse I.	44°51′N, 62°32′W	33p	1971	Lock and Ross 1973
49.	Bald I.	44°42′N, 62°48′W	170–180p	1971	Lock and Ross 1973
50.	Barren I.	44°42′N, 62°58′W	140–150p	1971	Lock and Ross 1973
51.	Southwest I.	44°30′N, 64°00′W	170–180p	1971	Lock and Ross 1973
52.	Little Duck I.	44°22′N, 64°11′W	150–190p	1971	Lock and Ross 1973
53.	Indian I.	44°10′N, 64°24′W	>172p	1971	Lock and Ross 1973
54.	Green I.	43°45′N, 64°56′W	240–250p	1971	Lock and Ross 1973
55.	Blue Gull Rock	43°40′N, 65°13′W	400–430p	1971	Lock and Ross 1973
56.	Boot I.	45°08′N, 64°16′W	40–45p	1971	Lock and Ross 1973
57.	Cape Split	45°20′N, 64°30′W	26p	1971	Lock and Ross 1973
58.	Egg I.	45°23′N, 64°08′W	79p	1971	Lock and Ross 1973
59.	Quoddy region, N.B.	c.44°45′N, 66°45′W	335p	1972	Drury 1973–74
60.	Grand Manan I.	c.44°35′N, 66°40′W	36p	1972	Drury 1973–74
61.	Machias Bay and Petit Manan, Me.	c.44°30′N, 67°30′W	2,295p	1972	Drury 1973–74
62.	Jericho–Blue Hill Bay region, Me.	c.44°15′N, 68°28′W	2,060p	1972	Drury 1973–74
63.	Outer Islands region, Me.	c.44°10′N, 68°39′W	1,323p	1972	Drury 1973–74

	Colony location	Position	Colony size	Census year	Authority
64.	Penobscot Bay region, Me.	c.44°15′N, 68°58′W	3,255p	1972	Drury 1973–74
65.	Seguin to Monhegan region, Me.	c.43°55′N, 69°30′W	2,340p	1972	Drury 1973–74
66.	Portland area, Me.	c.43°48′N, 70°00′W	2,075p	1972	Drury 1973–74
67.	Isles of Shoals region, Me.	c.43°00′N, 70°30′W	325p	1972	Drury 1973–74
68.	Massachusetts Bay region, Mass.	c.42°30′N, 70°45′W	325p	1972	Drury 1973–74
69.	Cape and Islands, Mass.	c.42°30′N, 70°30′W	175p	1972	Drury 1973–74
70.	Block I. Sound, Conn.	c.41°15′N, 71°40′W	35p	1972	Drury 1973–74
71.*	Long I. Sound region, Conn.	c.41°10′N, 72°50′W	±30p?	1972	Drury 1973–74, and pers. comm.
72.	NE St. Pierre I.	c.46°47′N, 56°12′W	11p	1963 or 1964	Cameron 1967
73.	NW St. Pierre I.	c.46°48′N, 56°09′W	+	1963 or 1964	Cameron 1967
74.	Anse aux Cormorans, Langlade I. (= Petite Miquelon I.)	46°52′N, 56°15′W	8p	1964	Cameron 1967
75.	Islet SW of Dorton Head	47°34′N, 57°01′W	27i	1973	Nettleship and Lock
76.	Islet SW of Bird I.	47°14′N, 55°57′W	55–60i	1973	Nettleship and Lock
77.	Cliff N of Great Barasway	47°08′N, 54°04′W	15i	1973	Nettleship and Lock
78.	Gull Cove	46°50′N, 54°01′W	>20p	1973	Nettleship and Lock
79.	Red Cove	46°51′N, 53°58′W	22i	1973	Nettleship and Lock
80.	Islet in Pitts Pond	48°27′N, 54°10′W	28p	1973	Nettleship and Lock

[1] 14i in 1965: Moisan and Fyfe (1967).
[2] 60p in 1971: Reed (1973).

Red Phalarope	*Phalaropus fulicarius*
Northern Phalarope	*Lobipes lobatus*

Breeding distributions

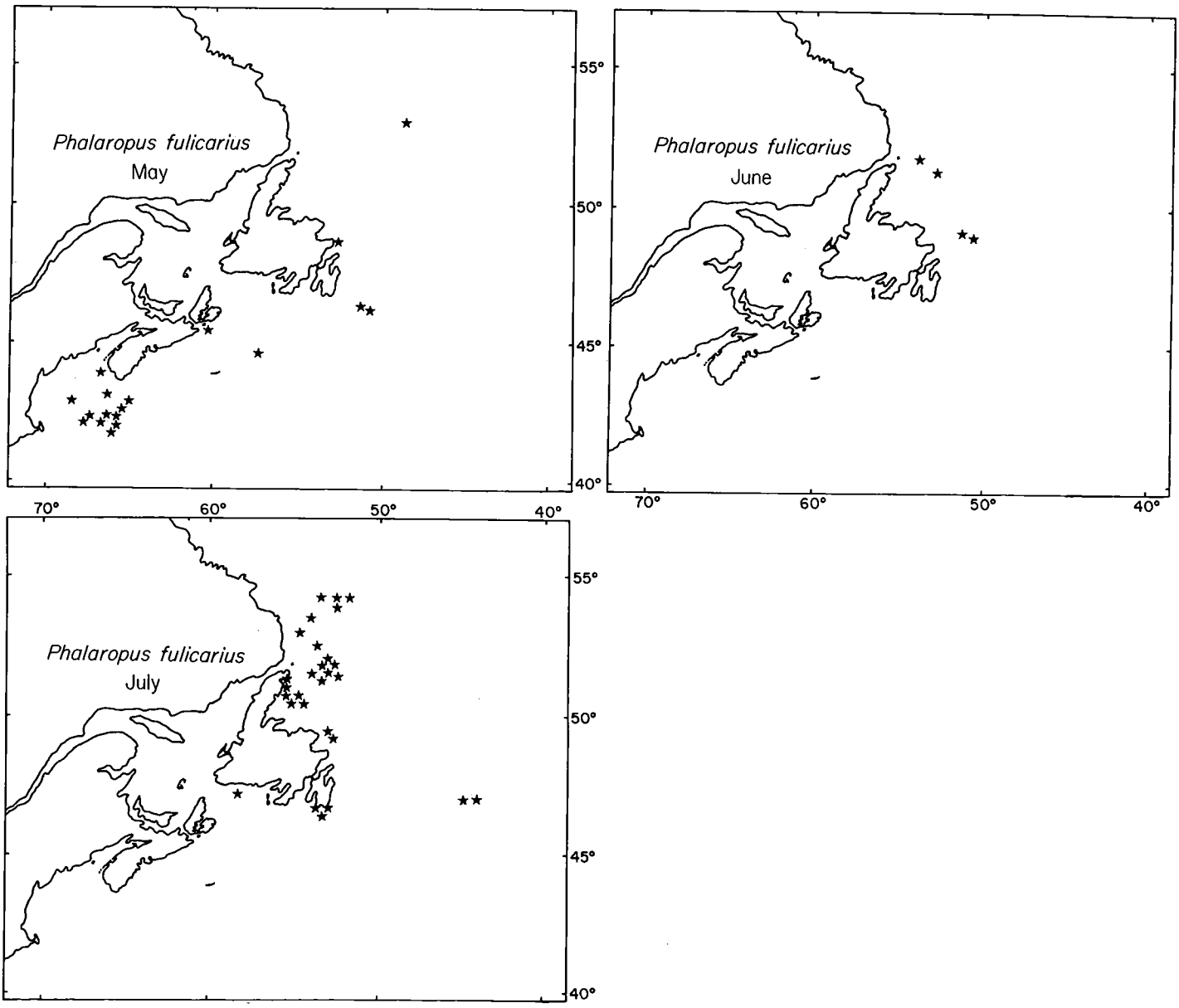
These shorebirds breed in the Arctic and have circumpolar distributions. In the survey area, the Red Phalarope's range extends south only to c. 69°N in west Greenland and c. 60°N in Canada (Godfrey 1966, Salomonsen 1950); it is a High Arctic species whose range, according to Salomonsen, retreated north during the recent climatic amelioration which peaked around 1950. Northern Phalaropes are birds of the northern Low Arctic, extending from c. 54°–65°N in Canada, and up to c. 71°N in west Greenland.

Pelagic distributions[6]

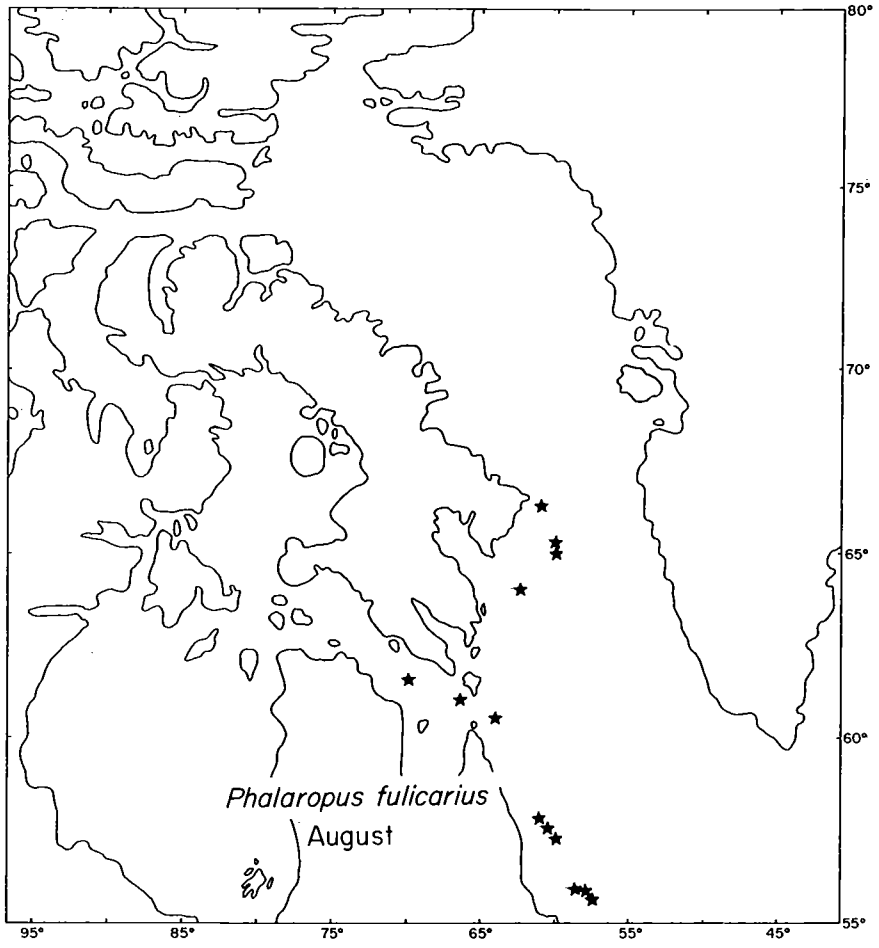
Phalaropes move north through Canadian Atlantic waters to arctic regions in May and the first migrants return in July. Migration out of the Arctic is complete by mid September, but large flocks remain in the Bay of Fundy at least until the end of October.

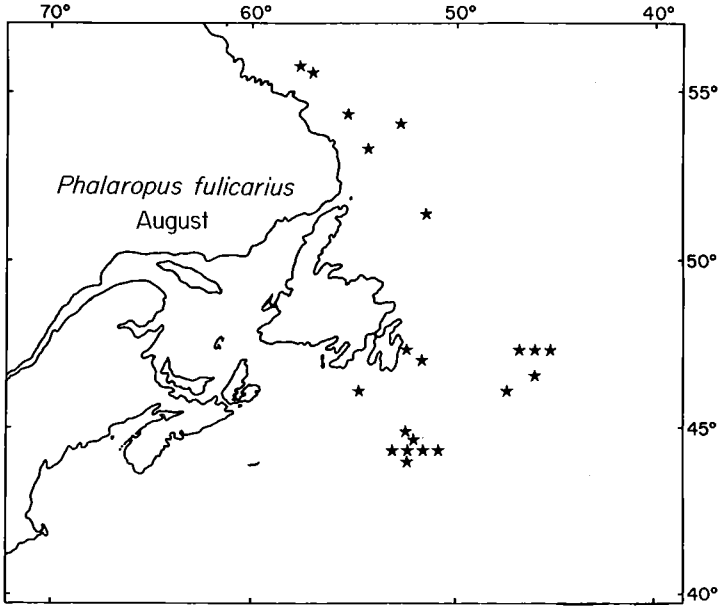
Phalarope species in winter plumage are difficult to separate at sea; we have only plotted positive identifications on the maps. Red Phalaropes seem to prefer colder waters; they migrate down the High Arctic zone, but Northerns go down the Low Arctic side of Baffin Bay. Red Phalaropes predominate in most of the Bay of Fundy in the fall; however, Northerns are overwhelmingly dominant at the entrance to Passamaquoddy Bay on the New Brunswick side (D.S. Christie pers. comm.). The oceanographic basis for this separation is not clear.

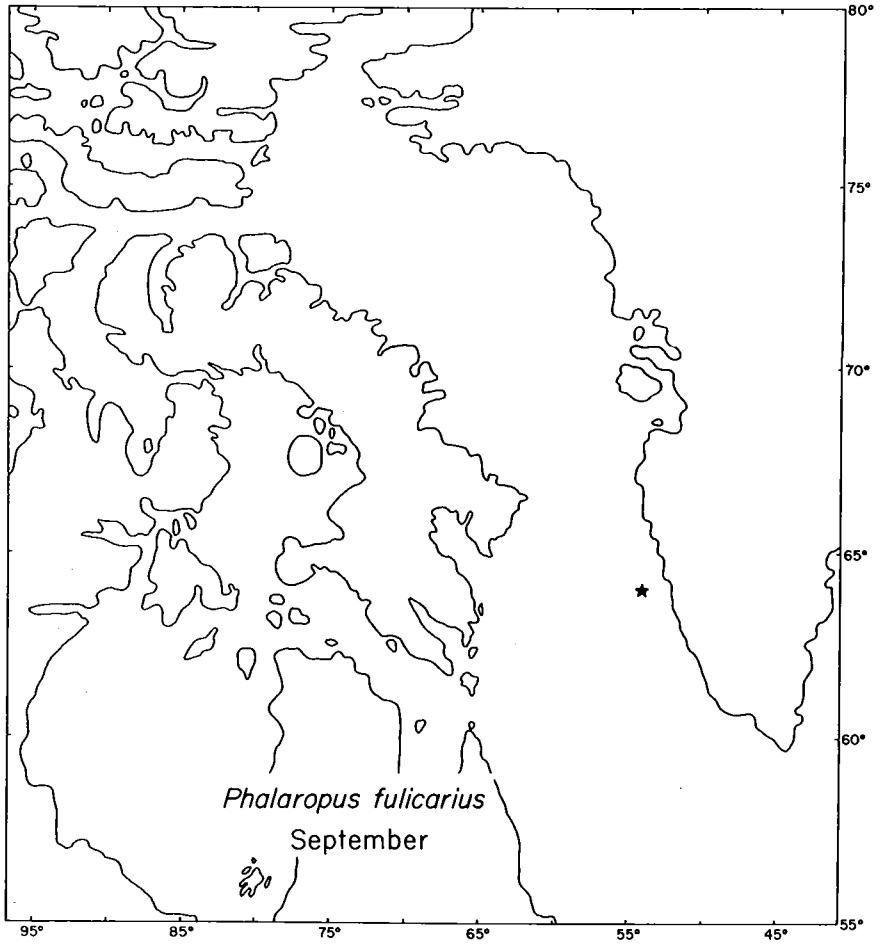
6 In late October 1973 there were large flocks of Red Phalaropes and rather fewer Northerns in the Strait of Belle Isle at 51°20′N, 56°50′W.

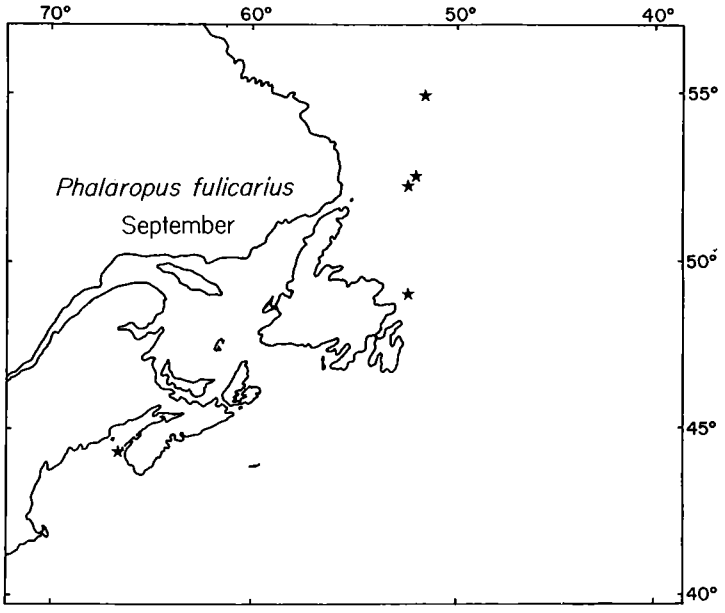

Phalaropus fulicarius
May
Phalaropus fulicarius
June
Phalaropus fulicarius
July
55°
50°
45°
40°
70°
60°
50°
40°

Map 13b
Red Phalarope

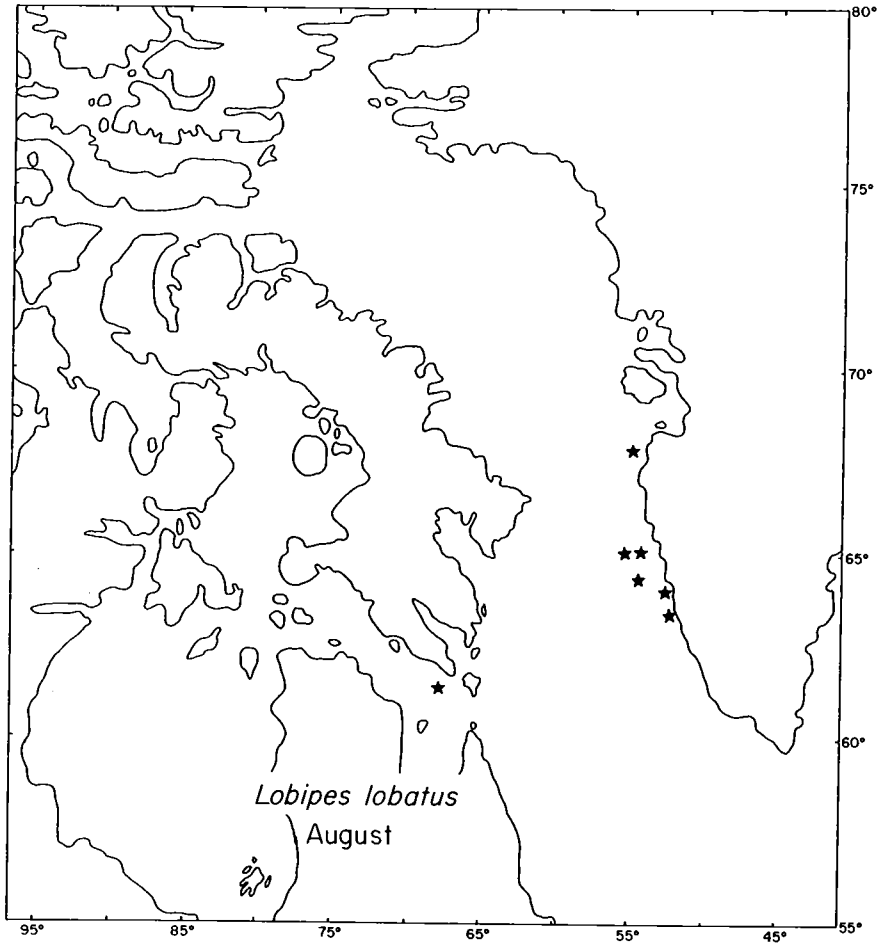


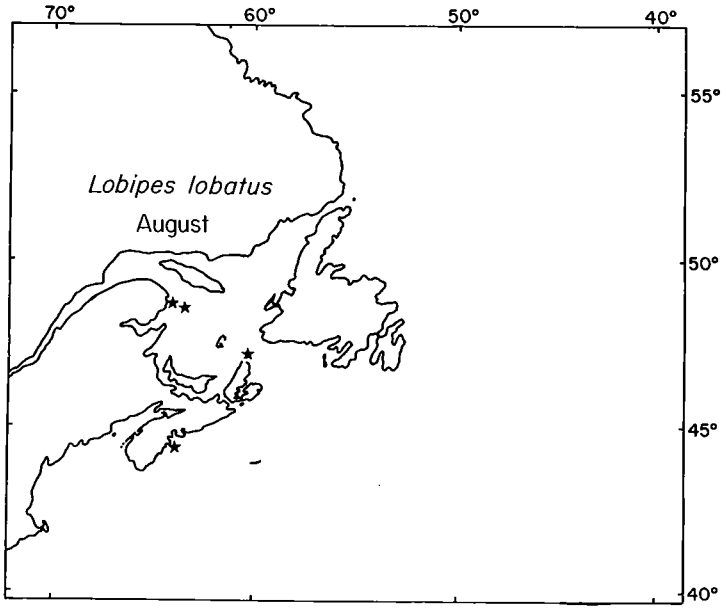


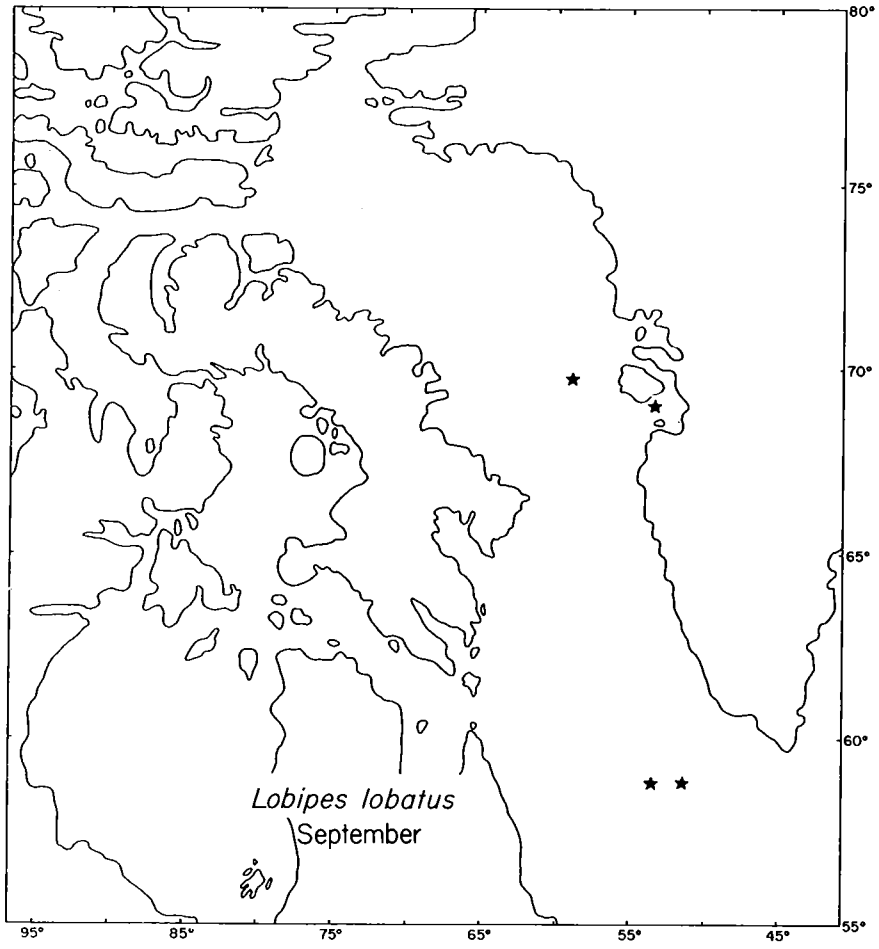

80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Phalaropus fulicarius
September

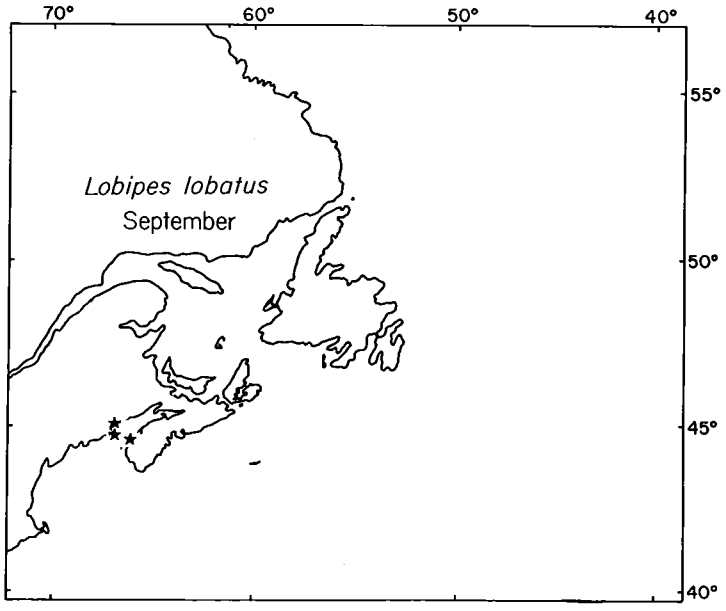

70°
60°
50°
40°
55°
50°
45°
40°
Phalaropus fulicarius
September

Map 14a
Northern Phalarope






80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Lobipes lobatus
September


70°
60°
50°
40°
55°
50°
45°
40°
Lobipes lobatus
September

Pomarine Jaeger	*Stercorarius pomarinus*
Parasitic Jaeger	*Stercorarius parasiticus*
Long-tailed Jaeger	*Stercorarius longicaudus*
Skua	*Catharacta skua*

Breeding distributions

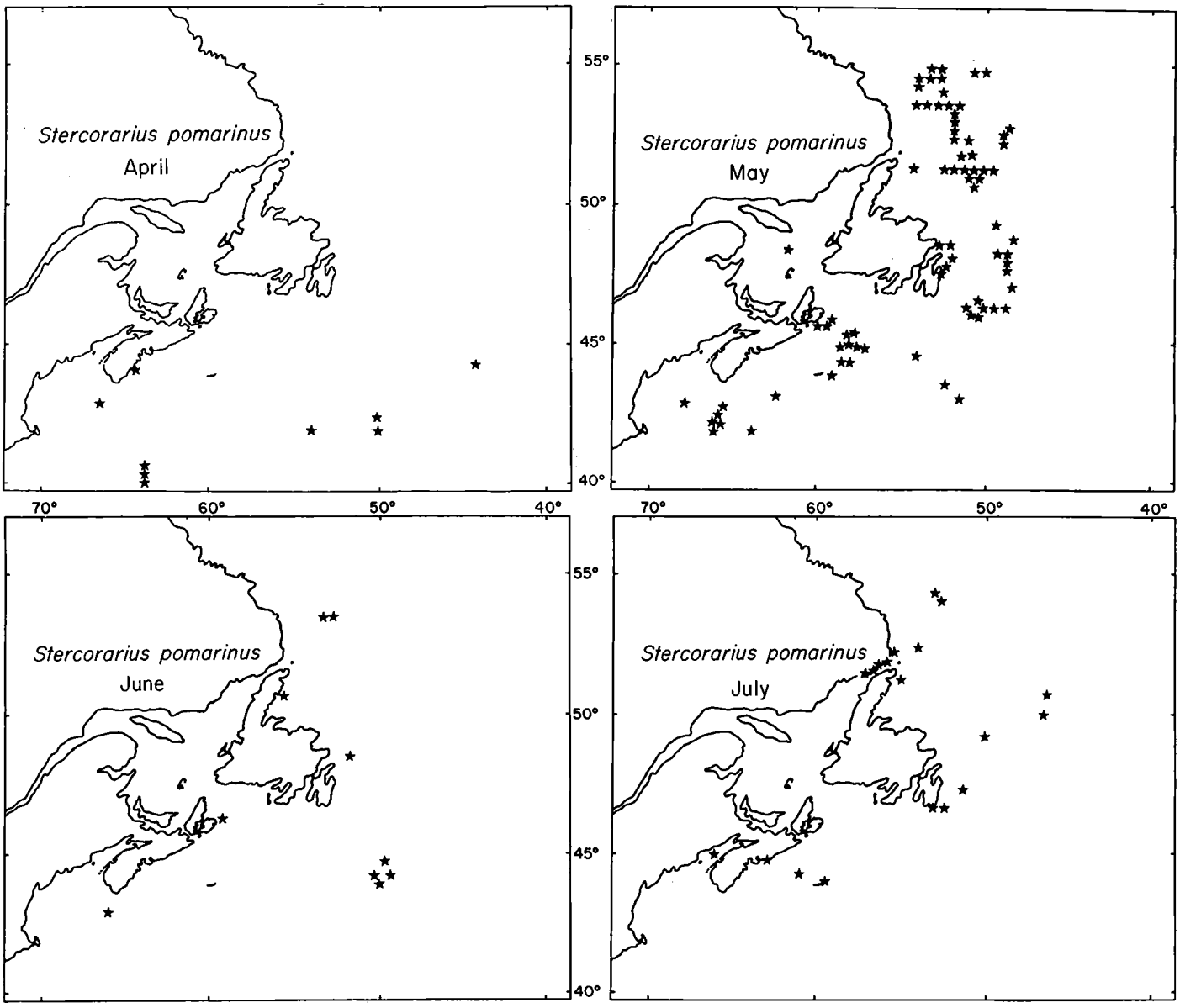
The three jaegers are circumpolar Arctic species. The Pomarine and Parasitic are birds of the southern High Arctic and northern Low Arctic zones. They range between c. 75°–60°N in Canada, and from c. 73° to c. 65°N (Pomarine) and to c. 60°N (Parasitic) in west Greenland (Godfrey 1966, Salomonsen 1950). The Long-tailed Jaeger is a High Arctic bird, breeding north of c. 60°N in Canada and of c. 75°N in west Greenland. Skuas have a bipolar distribution; in the Northern Hemisphere they breed only in Scotland, Faeroe and Iceland, at the northern edge of the Boreal zone (Fisher and Lockley 1954).

Pelagic distributions[7]

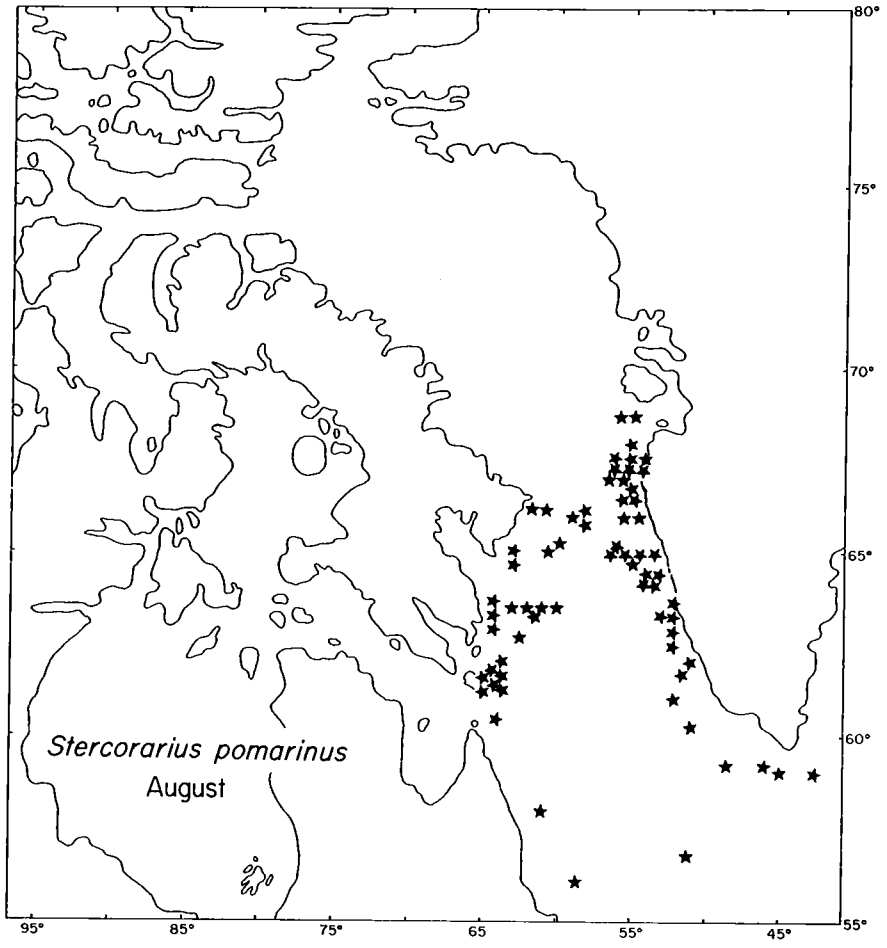
Jaegers are hard to identify at sea. We have found it easiest to identify Pomarines, and the greater number of sightings of that species may reflect this, rather than any overall greater abundance. Pomarine Jaegers arrive off eastern Canada in April, and the other two species in May. They all begin to return south in August, the Long-tailed leaving first. The Pomarine and Parasitic Jaegers are regularly seen off west Greenland in August and September. Plotting their distributions in "rarebird" form obscures their abundance there at that time; we have regularly recorded flocks of up to 75 Pomarines on the fishing banks. These two jaegers leave the Arctic by the beginning of October, and are rare in Atlantic waters after the end of that month.

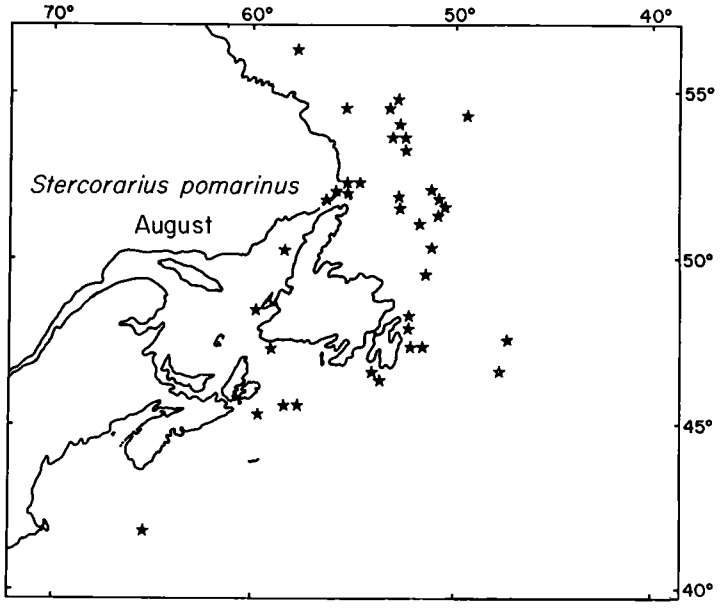
Skuas are regularly seen in ones and twos in Boreal and Low Arctic waters at almost any time of year. The banding returns suggest that these are subadult birds from the colonies in the eastern Atlantic (Landsborough-Thomson 1966, Tuck 1971).

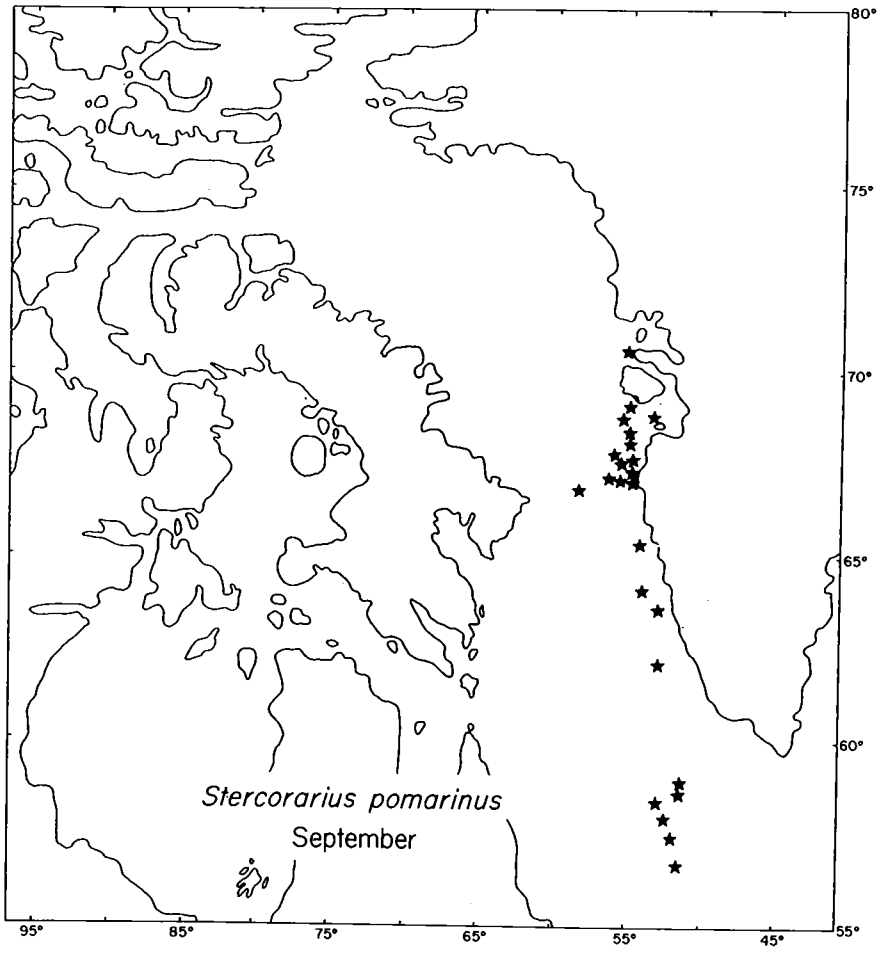
7 All three jaegers were seen in northern Baffin Bay in July and August 1974.

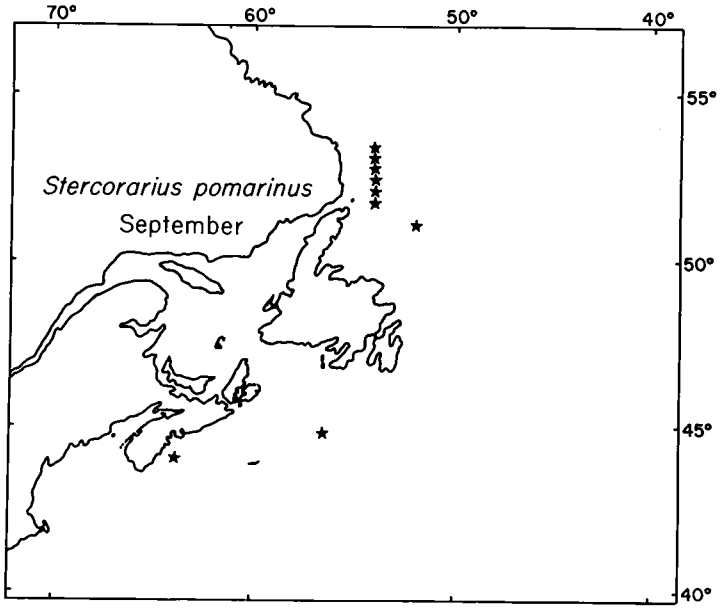

Stercorarius pomarinus
April
Stercorarius pomarinus
May
Stercorarius pomarinus
June
Stercorarius pomarinus
July
55°
50°
45°
40°
70°
60°
50°
40°

Map 15b
Pomarine Jaeger

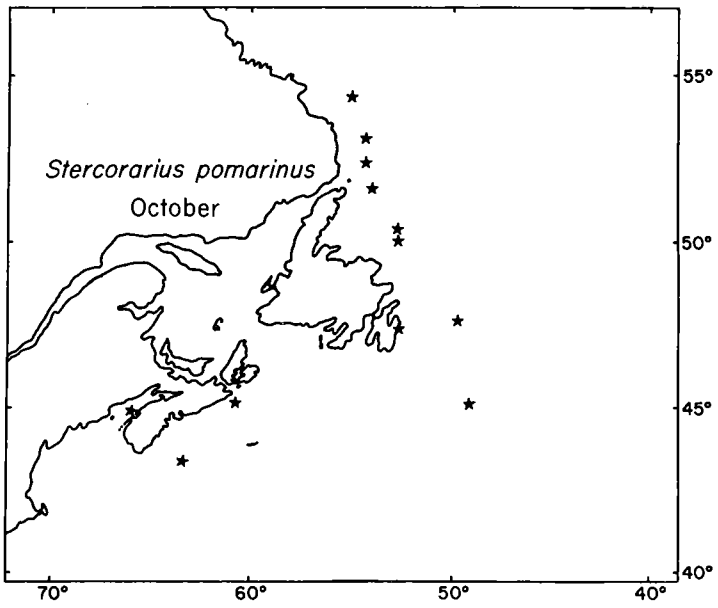


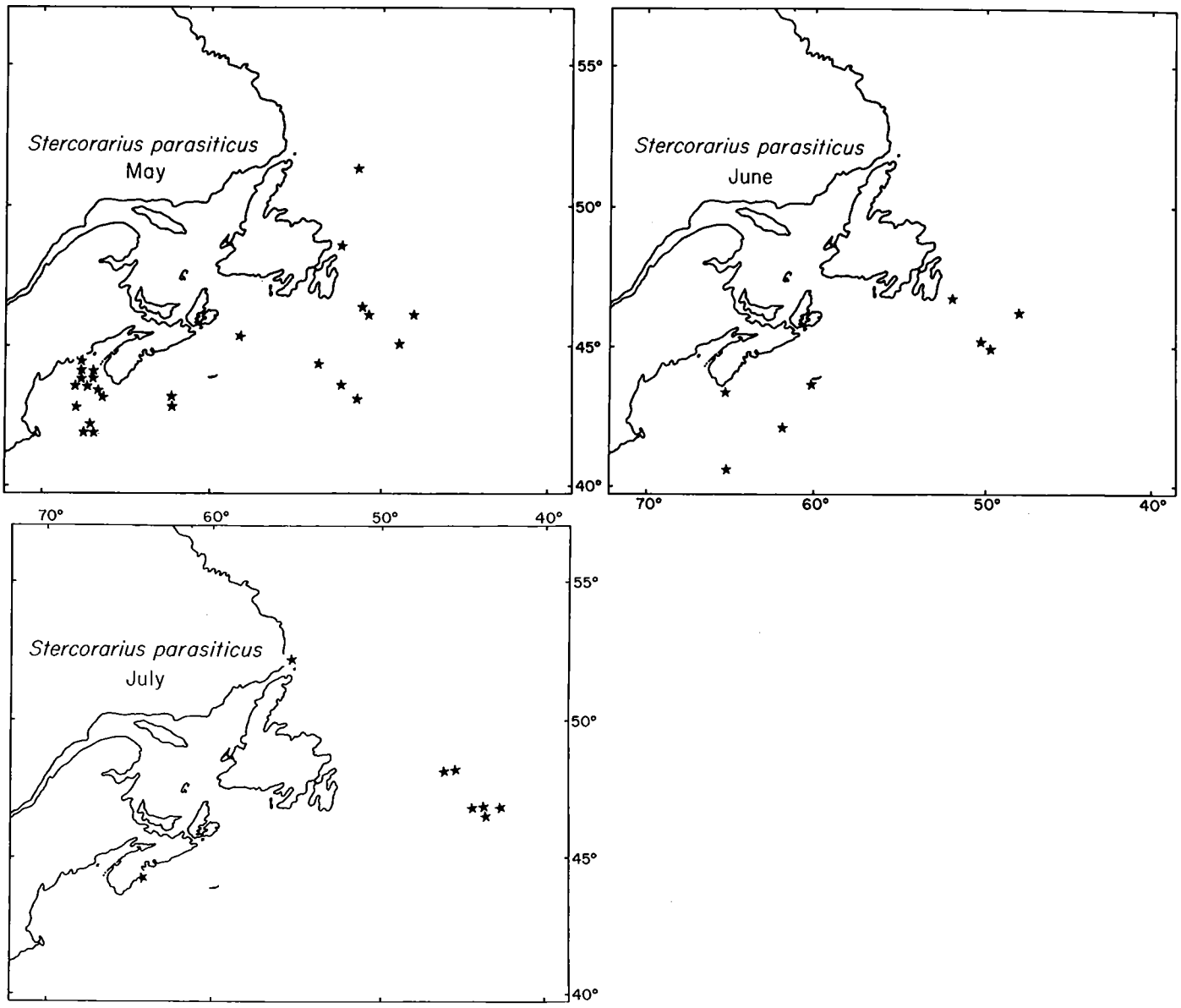



80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Stercorarius pomarinus
September

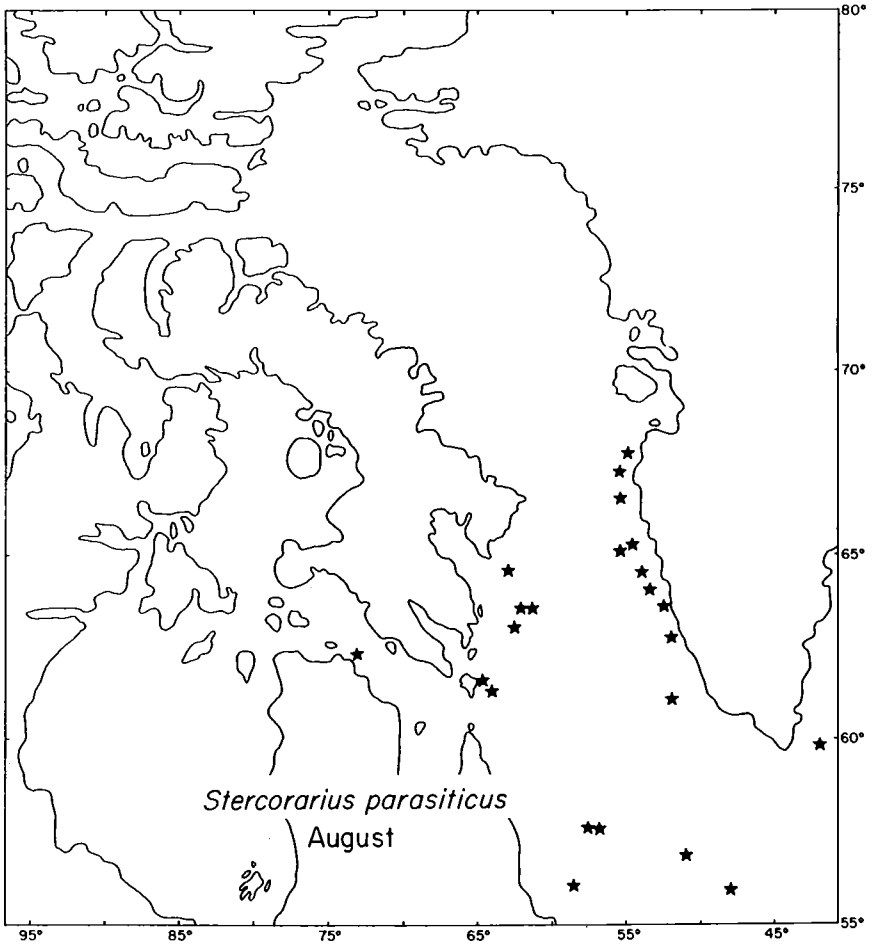

70°
60°
50°
40°
55°
50°
45°
40°
Stercorarius pomarinus
September

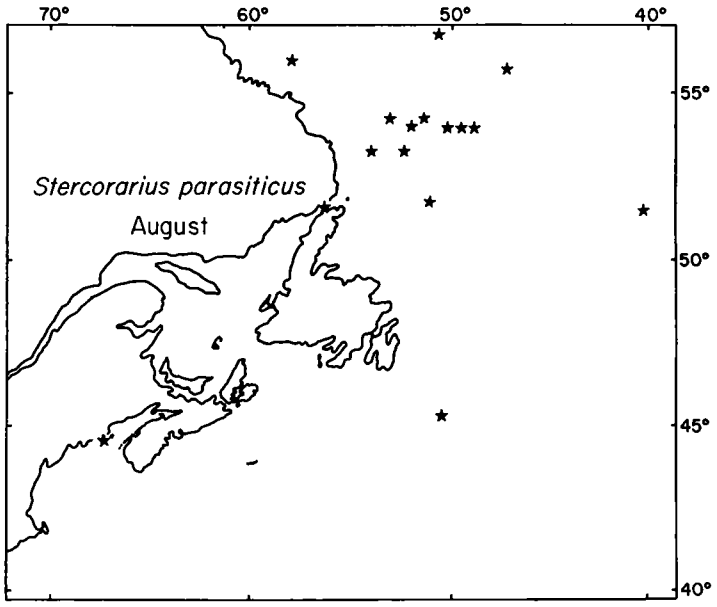
Map 15d
Pomarine Jaeger

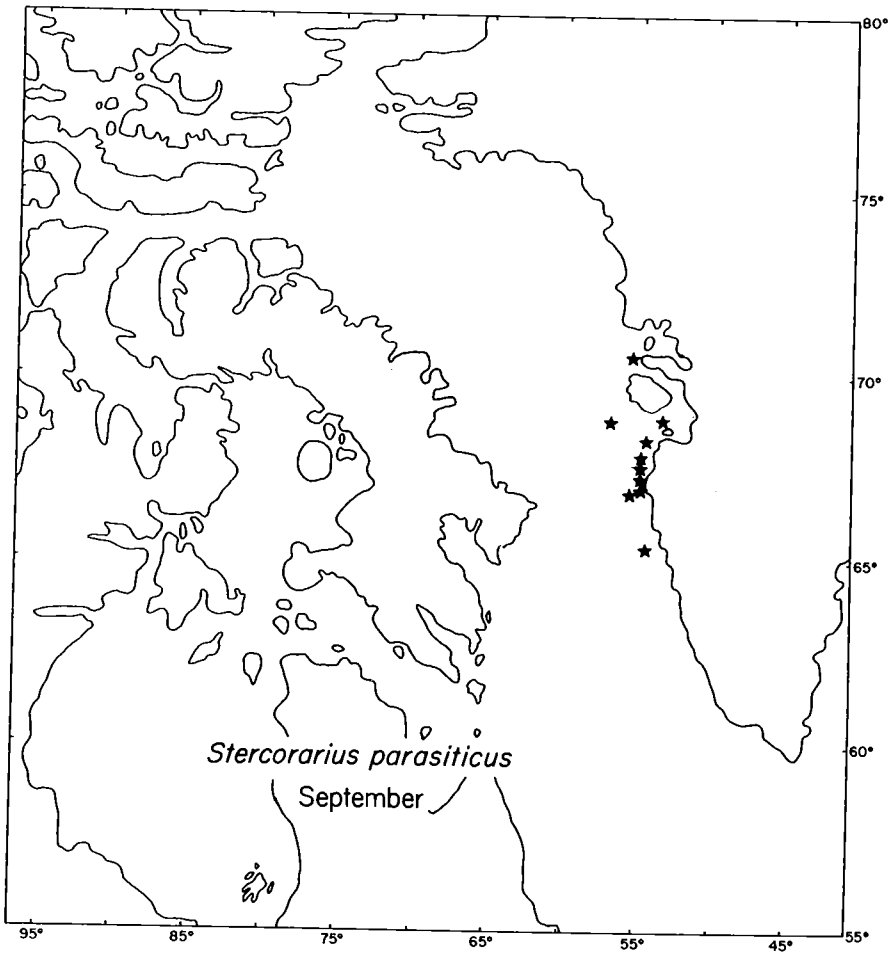


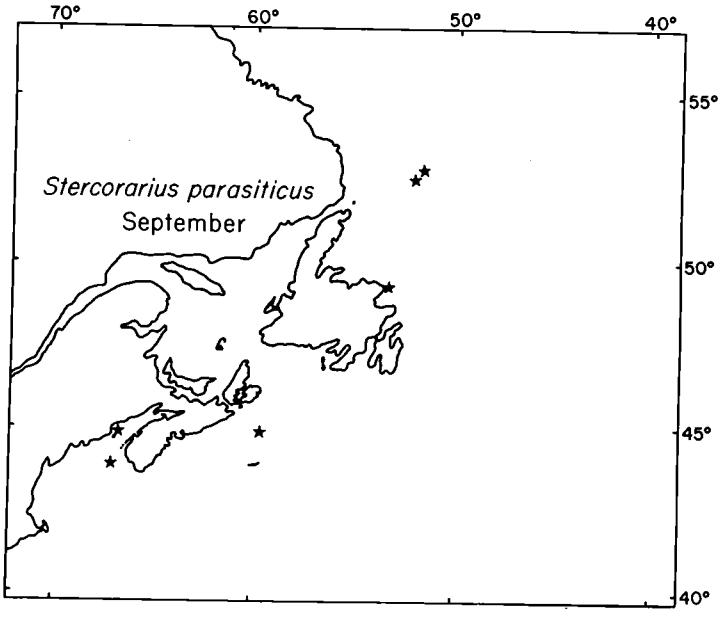

Stercorarius parasiticus
May
Stercorarius parasiticus
June
Stercorarius parasiticus
July
55°
50°
45°
40°
70°
60°
50°
40°

Map 16b
Parasitic Jaeger

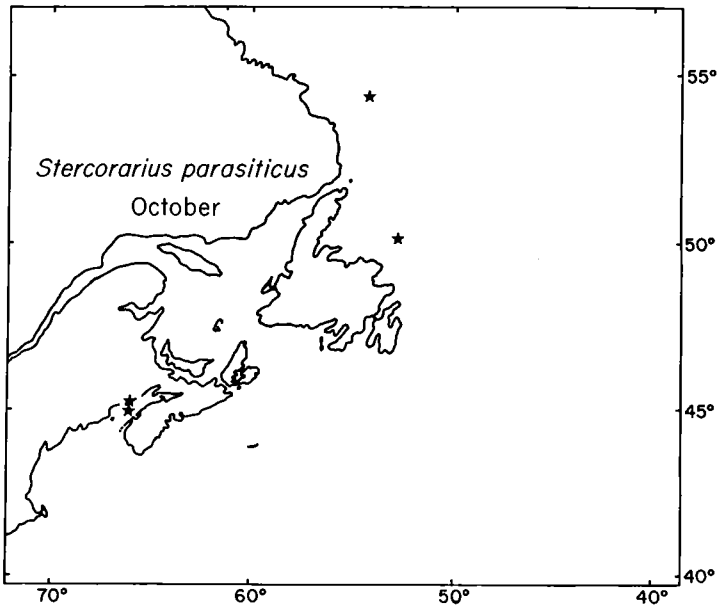




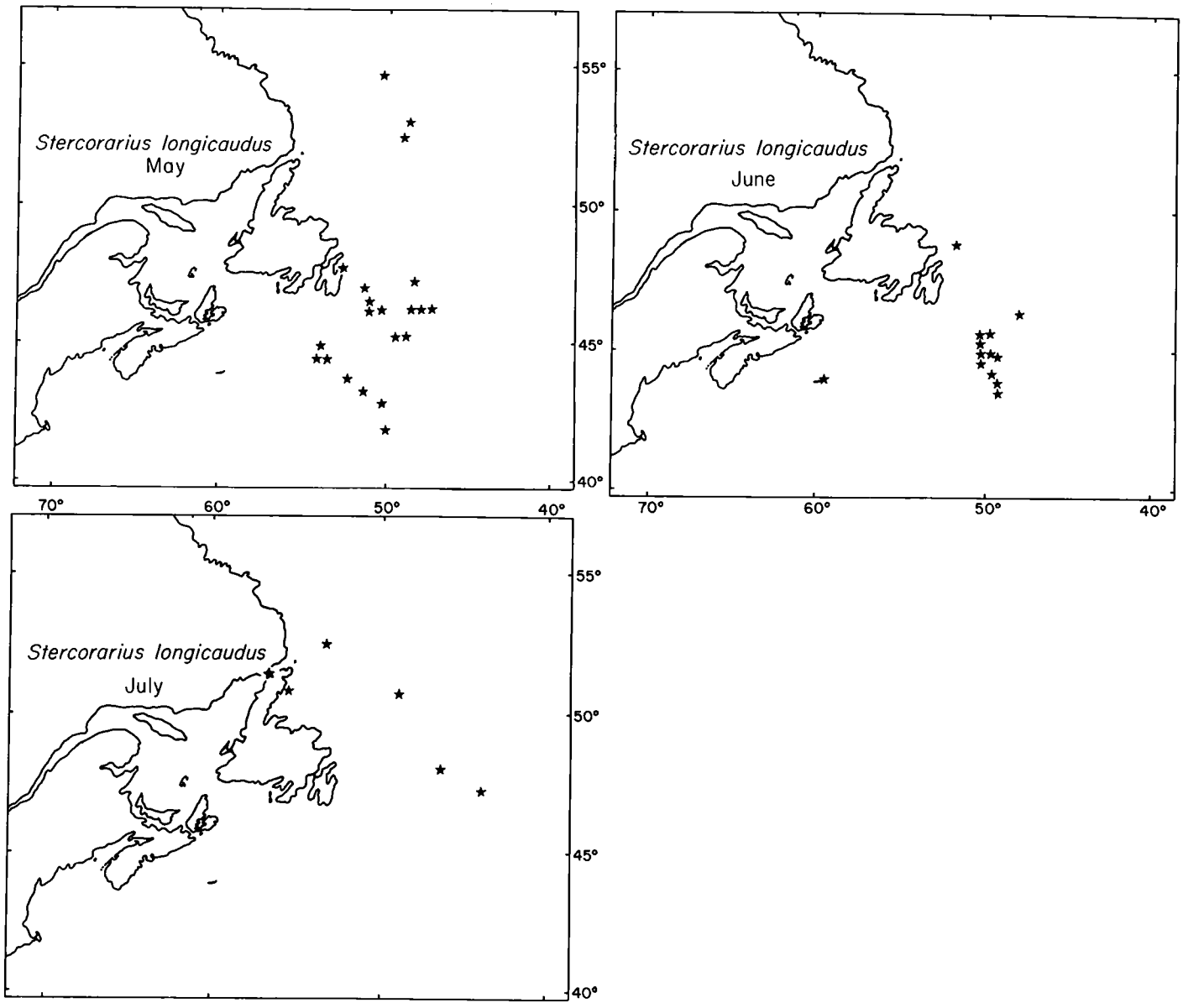

80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Stercorarius parasiticus
September


70°
60°
50°
40°
55°
50°
45°
40°
Stercorarius parasiticus
September

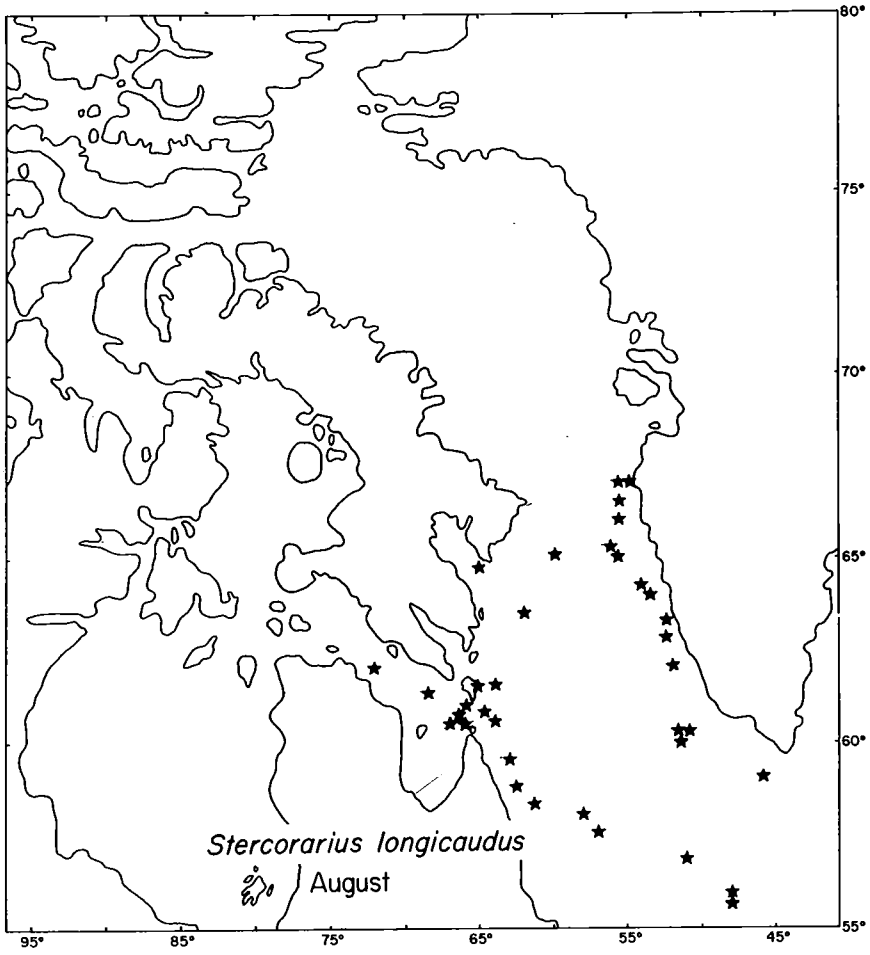
Map 16d
Parasitic Jaeger

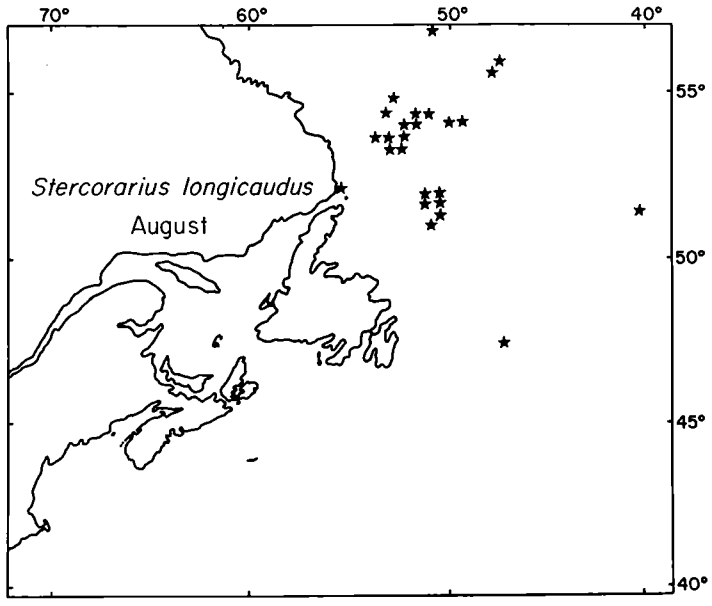


Map 17a
Long-tailed Jaeger

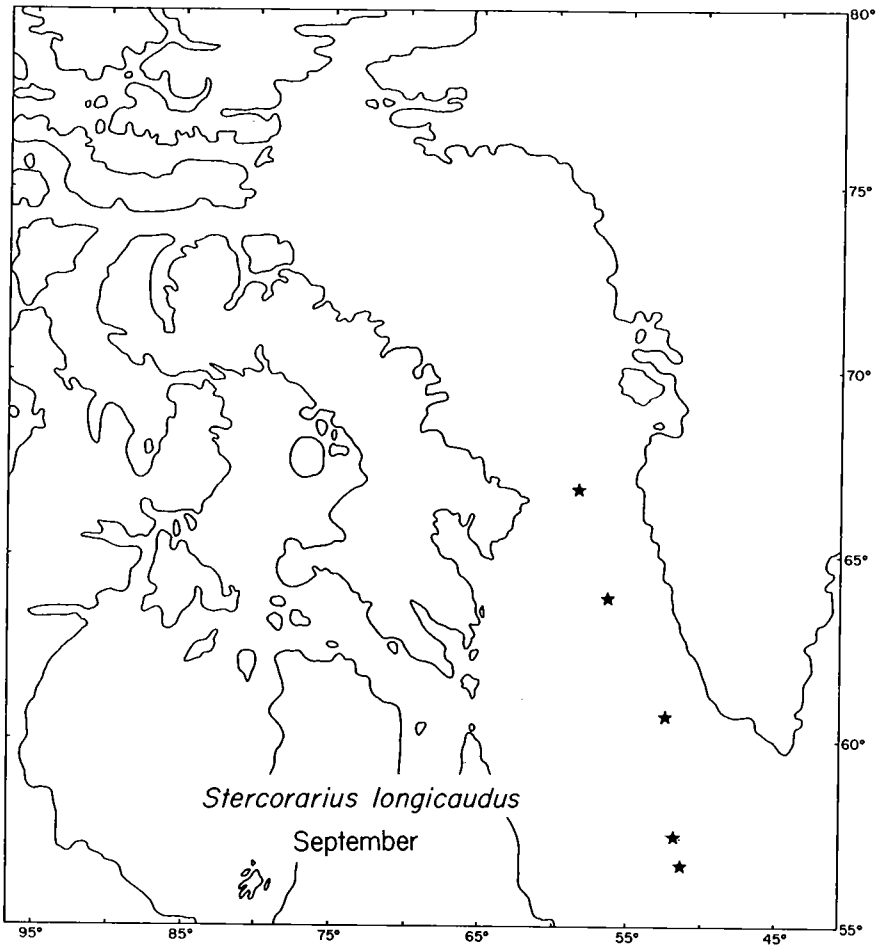


Map 17b
Long-tailed Jaeger

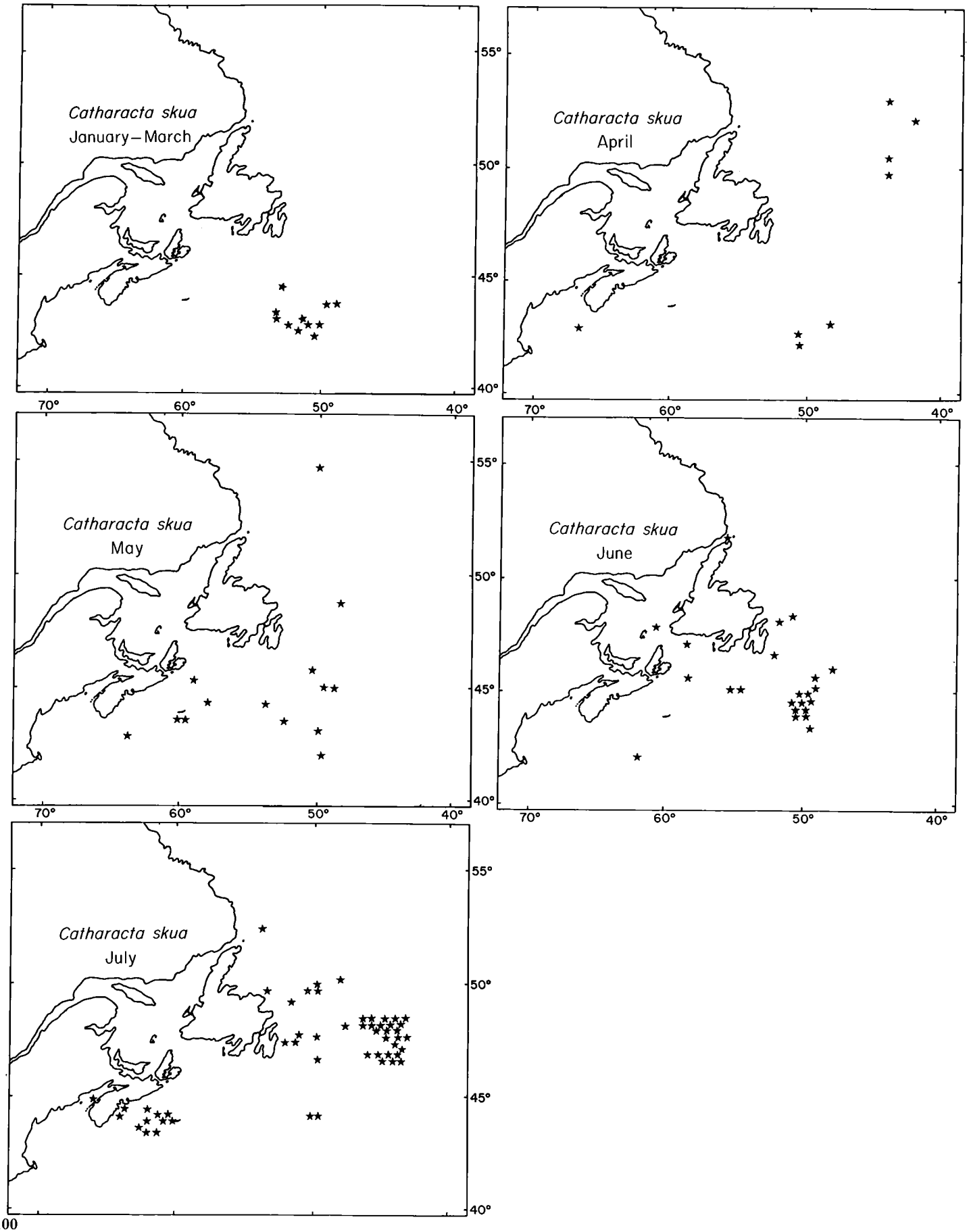


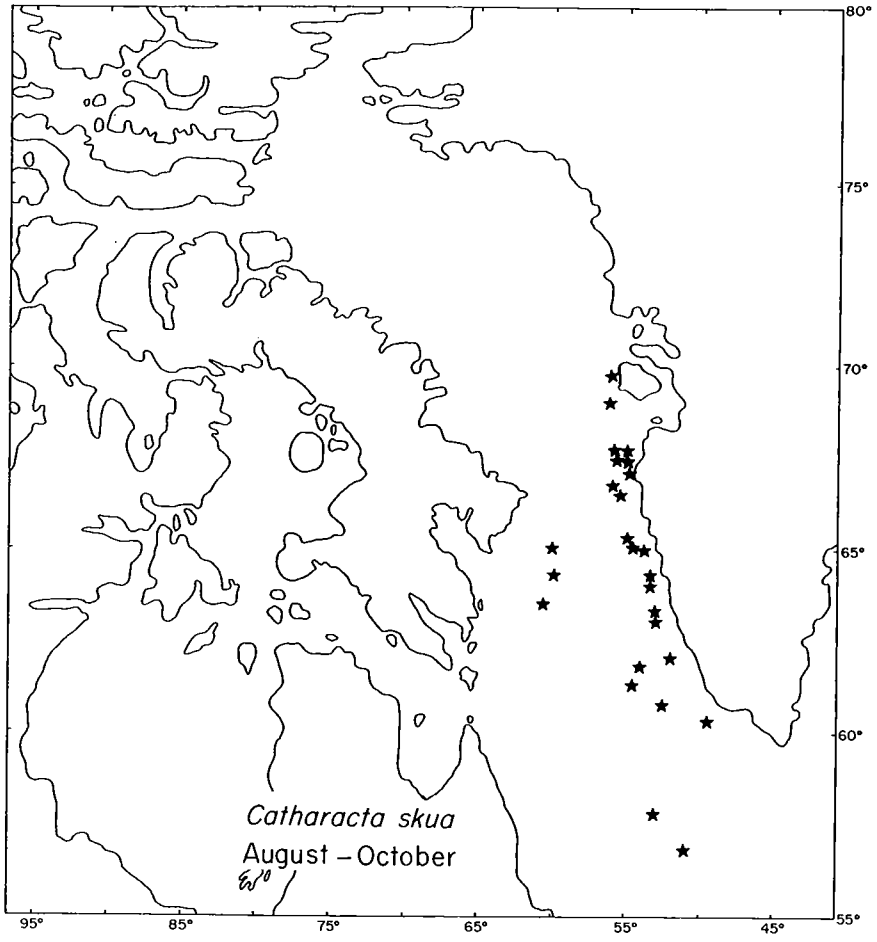


Map 17c
Long-tailed Jaeger

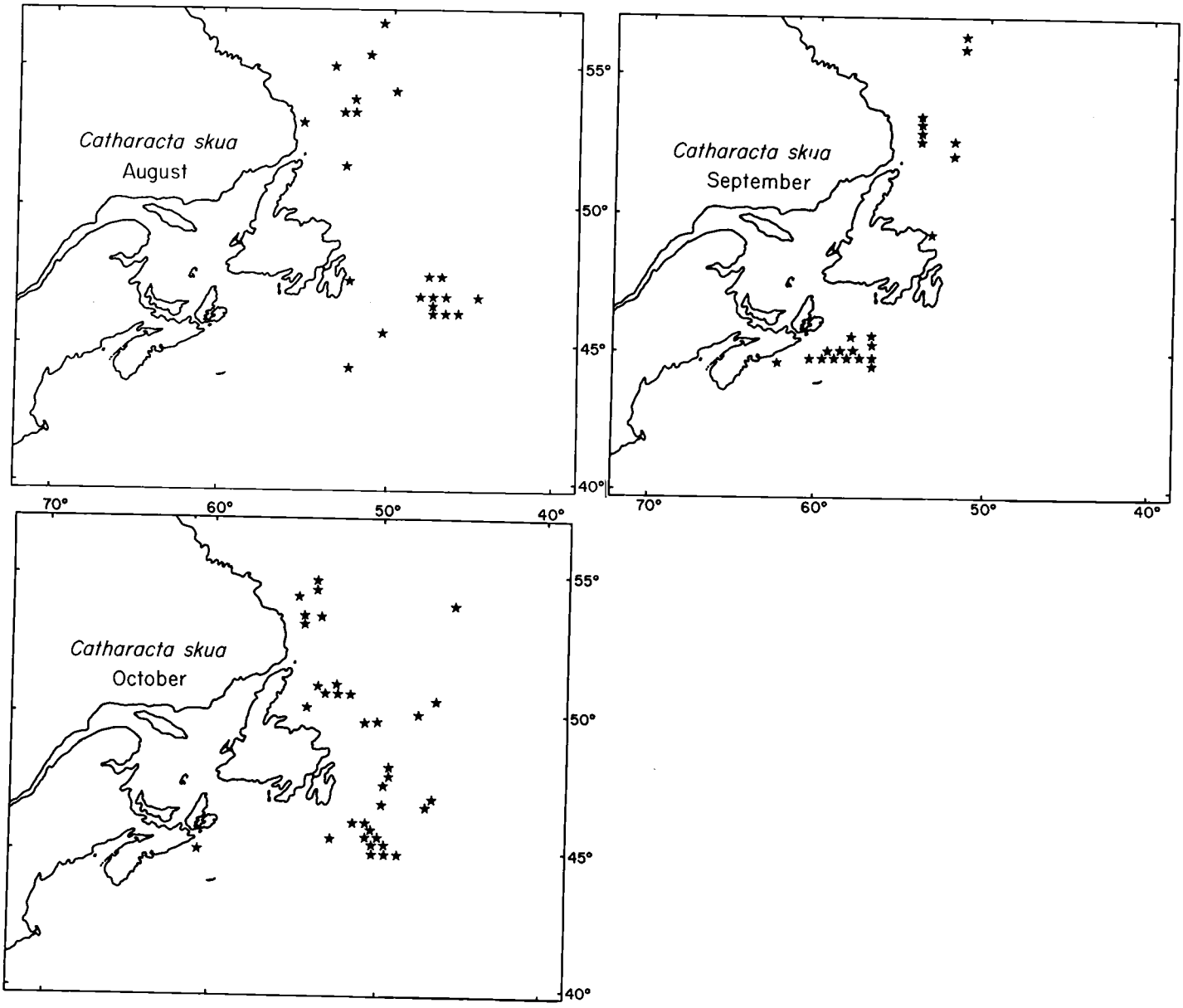


Map 18a
Skua


Catharacta skua
January–March
Catharacta skua
April
Catharacta skua
May
Catharacta skua
June
Catharacta skua
July
55°
50°
45°
40°
70°
60°
50°
40°


80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Catharacta skua
August – October

Map 18c
Skua


Catharacta skua
August
Catharacta skua
September
Catharacta skua
October
55°
50°
45°
40°
70°
60°
50°
40°

Glaucous Gull	*Larus hyperboreus*
Iceland Gull	*Larus glaucoides glaucoides*
Kumlien's Gull	*Larus glaucoides kumlieni*
Great Black-backed Gull	*Larus marinus*
Herring Gull	*Larus argentatus*
Thayer's Gull	*Larus thayeri*

Breeding distributions

The data on the colony maps for these species are from Freeman (1970), Godfrey (1966), Gross (1937), Joensen and Preuss (1972), Macpherson (1961), Nettleship (1974*b*, unpublished), Salomonsen (1950), Smith (1966*a*,*b*), Sutton (1932), and Todd (1963).

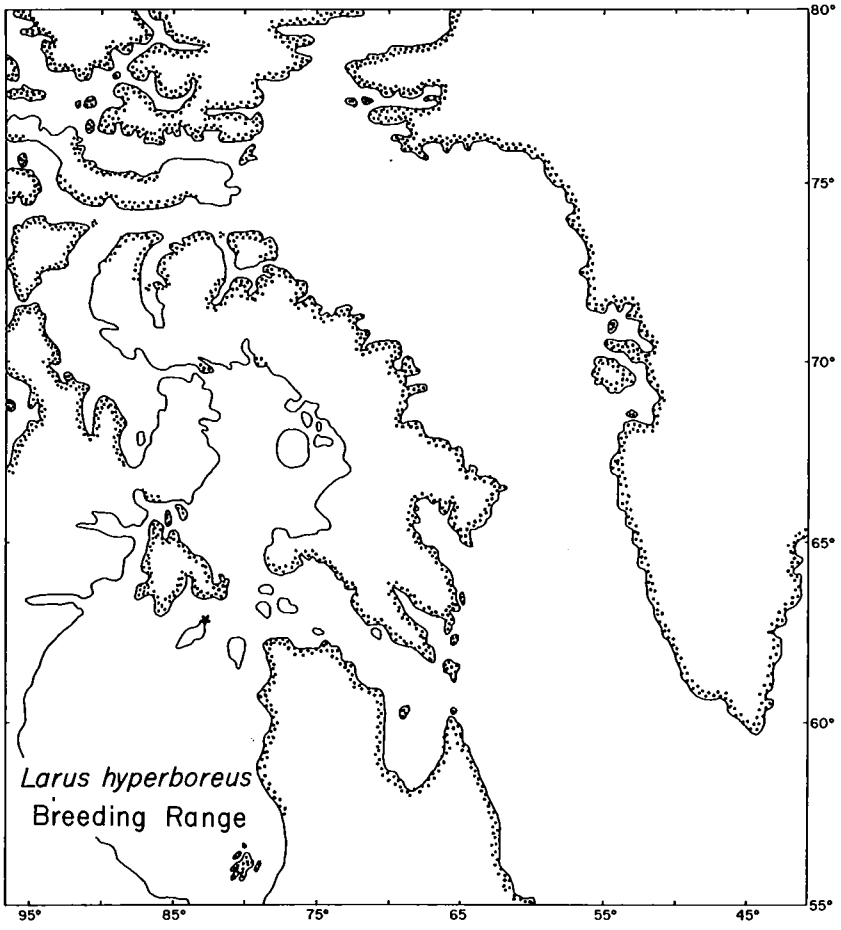
Herring Gulls breed in the Boreal and Low Arctic zones of North America; they are replaced by Iceland Gulls in west Greenland, by Kumlien's in southeast Baffin Island, and by Thayer's farther north in the Canadian Arctic. Great Black-backed Gulls are also Boreal and Low Arctic. Glaucous Gulls breed through most of the High Arctic, and extend down to c. 55°N on the Labrador coast, no doubt influenced by the very cold waters of that area.

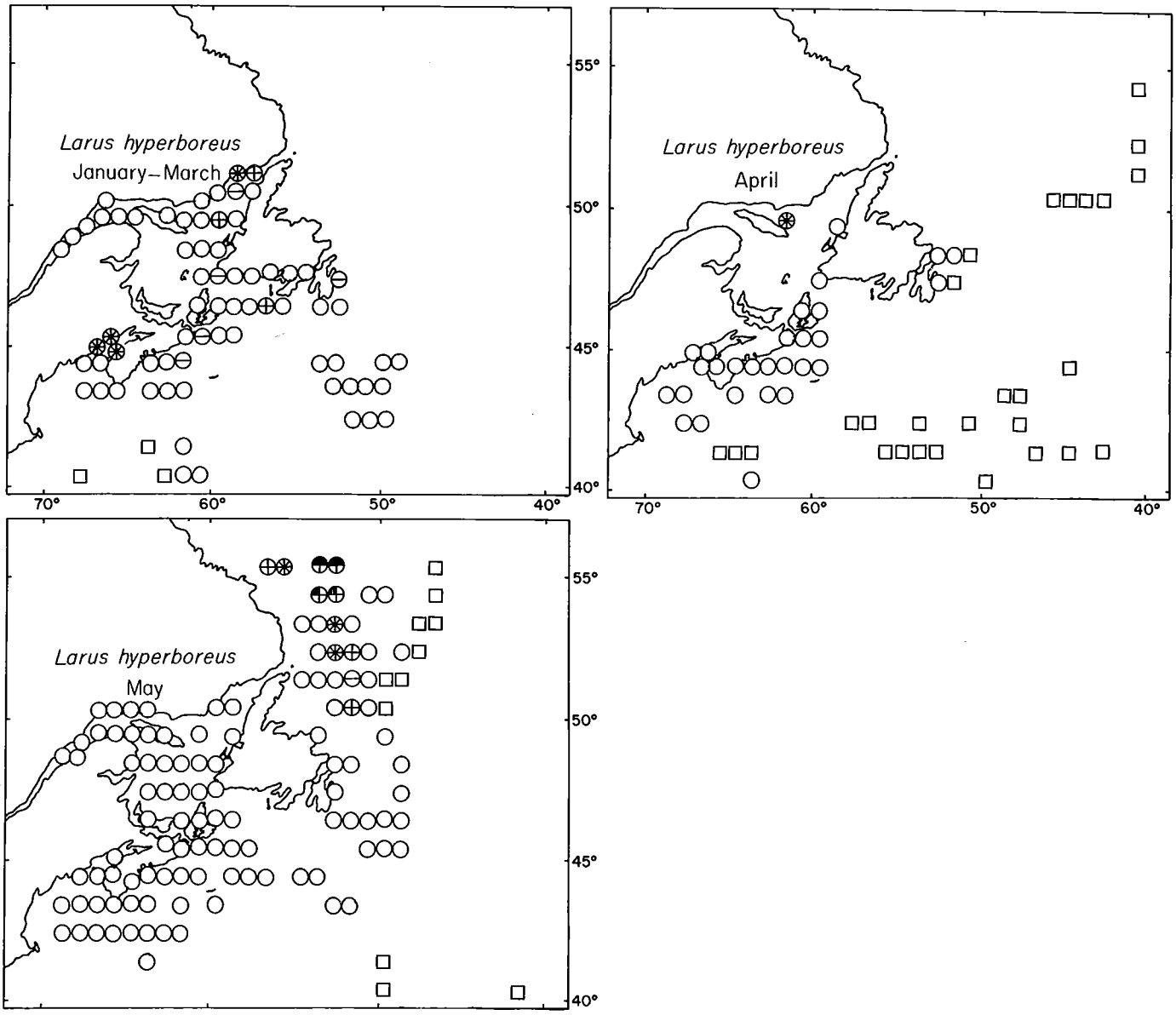
Pelagic distributions

Our only definite sightings of Thayer's Gull were made in August and early September 1974; the species was regularly seen in northern Hudson Bay west of 80°W, in Lancaster Sound, and along the east Baffin Island coast south to c. 66°N. It winters on the Pacific coast, so its migrations would take it away from our Atlantic area (Godfrey 1966). (Several winter identifications off western Newfoundland (Brown 1972*b*) are now thought to be doubtful.) The southward movement of Glaucous and Iceland/Kumlien's Gulls seems to start in October, when Glaucous Gulls are seen in Davis Strait and Iceland/Kumlien's in the Labrador Sea.[8] They reach Newfoundland and Nova Scotian waters in November, and return north in May. During the winter Kumlien's Gulls are particularly common around the Newfoundland coast. Great Black-backed Gulls stay in Atlantic Boreal and Low Arctic waters all winter. So do many Herring Gulls, but others move south into warmer waters off the eastern United States (Drury and Nisbet 1972).

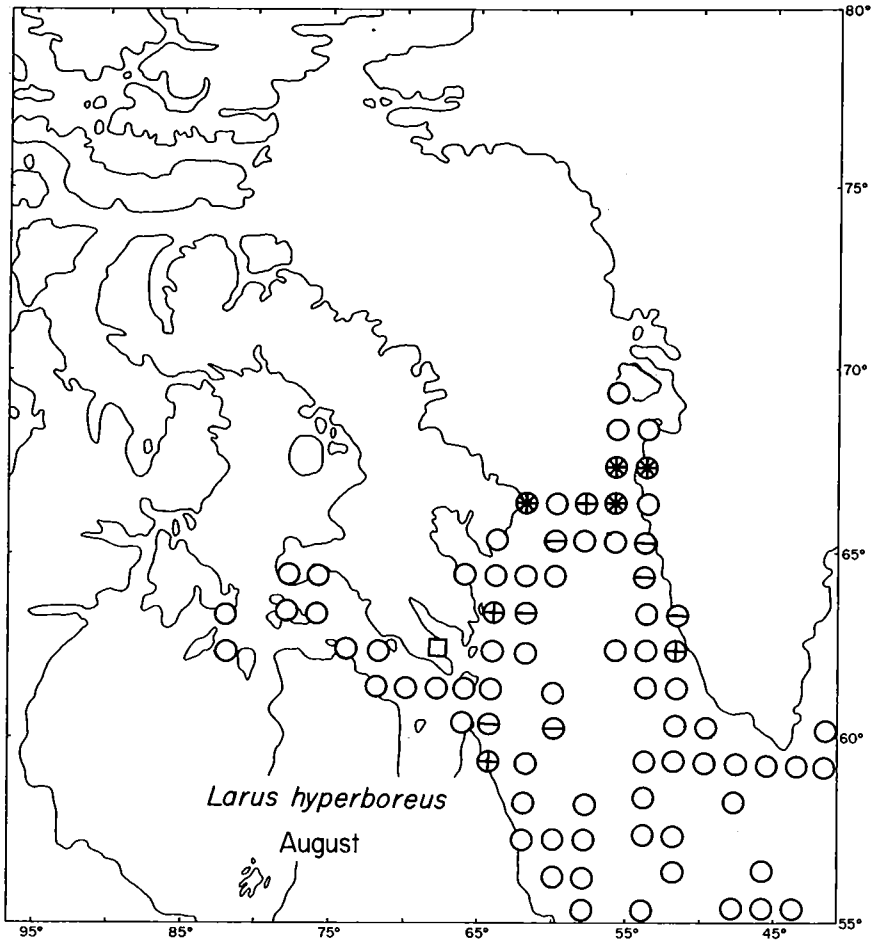
8 In October 1973 small numbers of Glaucous Gulls and rather fewer Iceland/Kumlien's were seen close to the Labrador coast at c. 55°N.

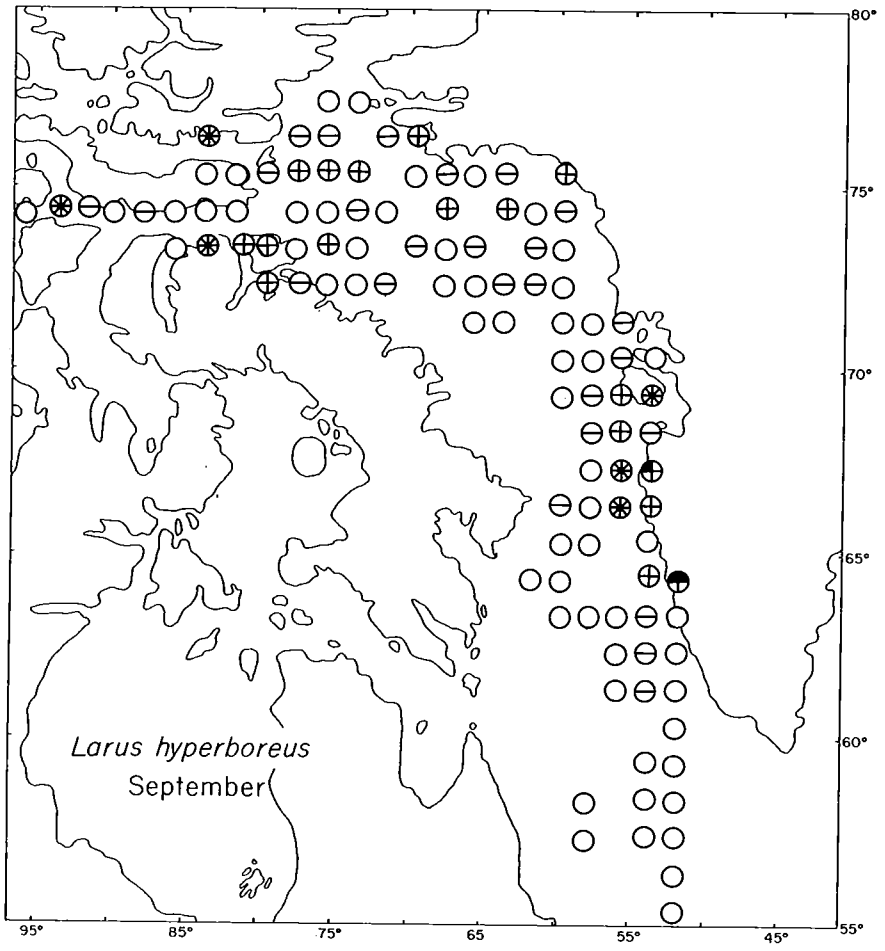
Map 19a
Glaucous Gull
Breeding range



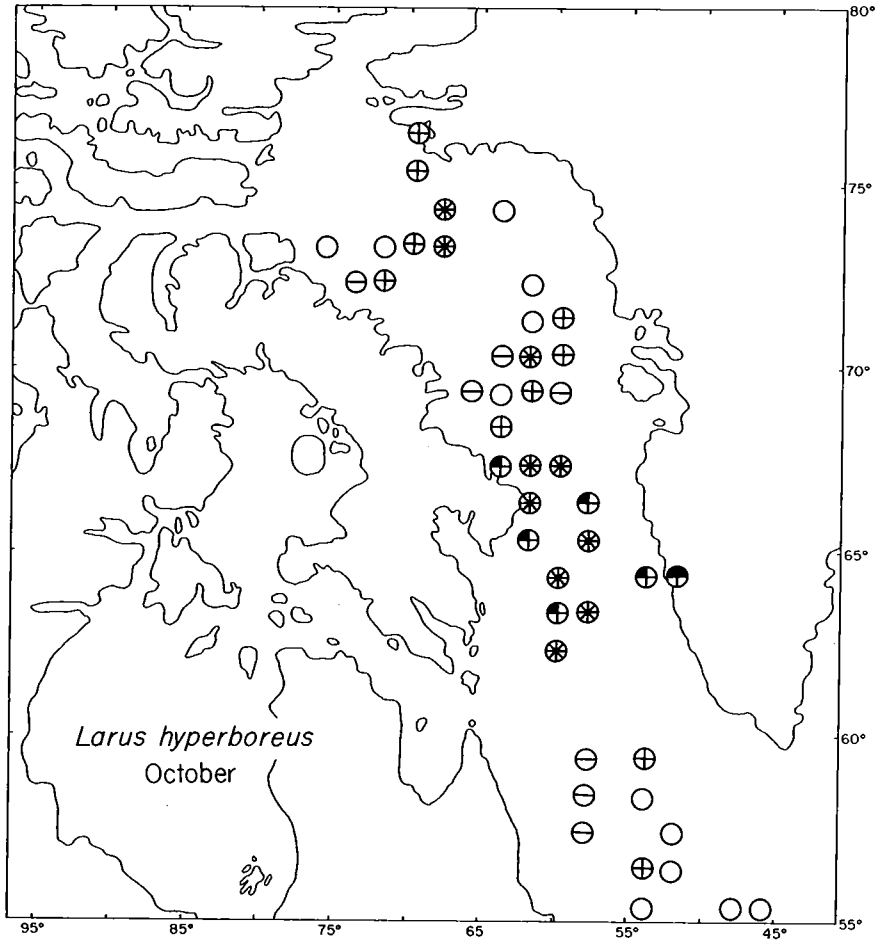

Larus hyperboreus
January–March
Larus hyperboreus
April
Larus hyperboreus
May
55°
50°
45°
40°
70°
60°
50°
40°

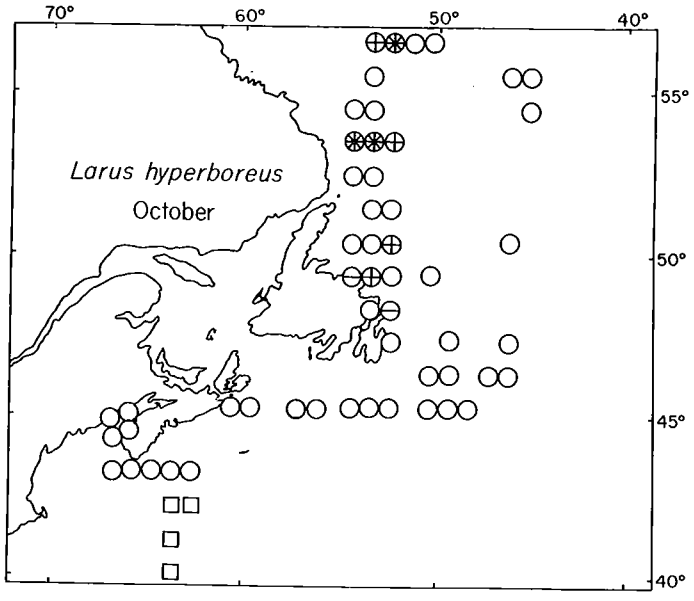
Map 19c
Glaucous Gull

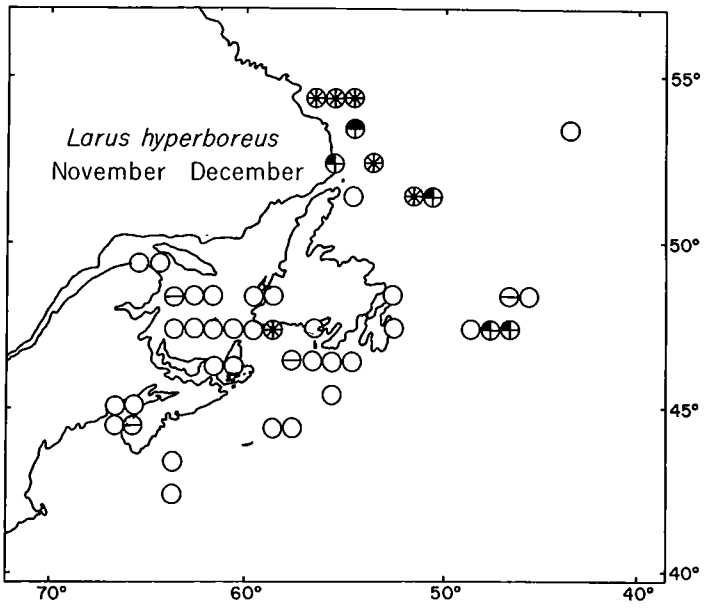



80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Larus hyperboreus
September

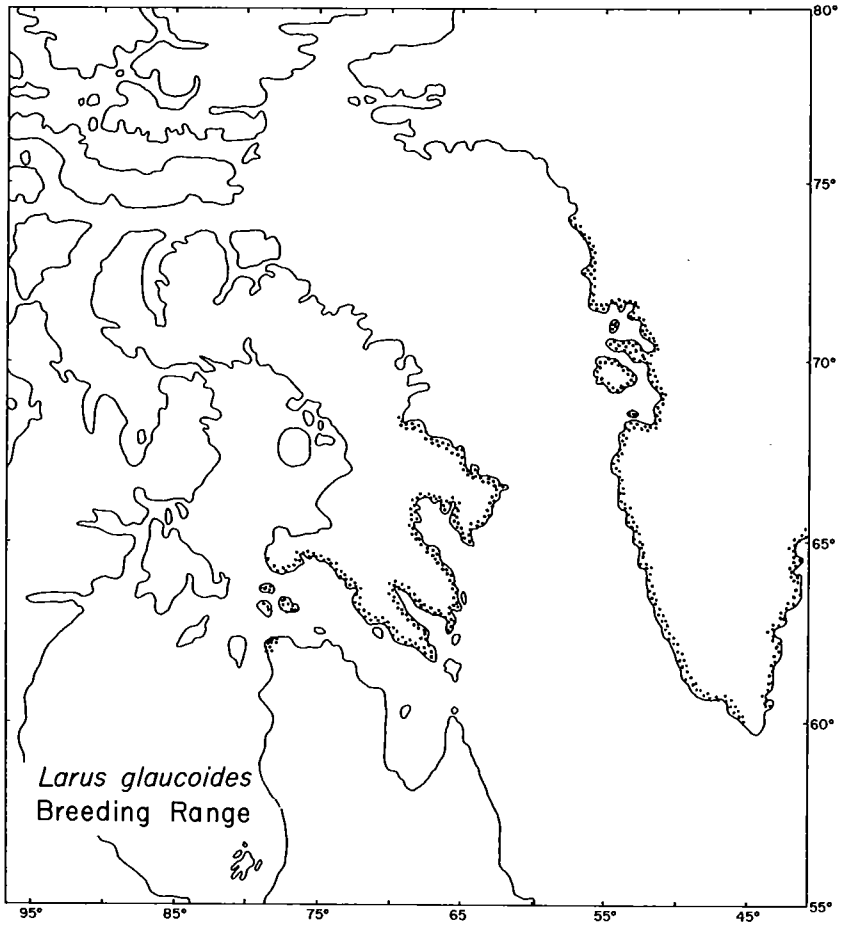
Map 19e
Glaucous Gull

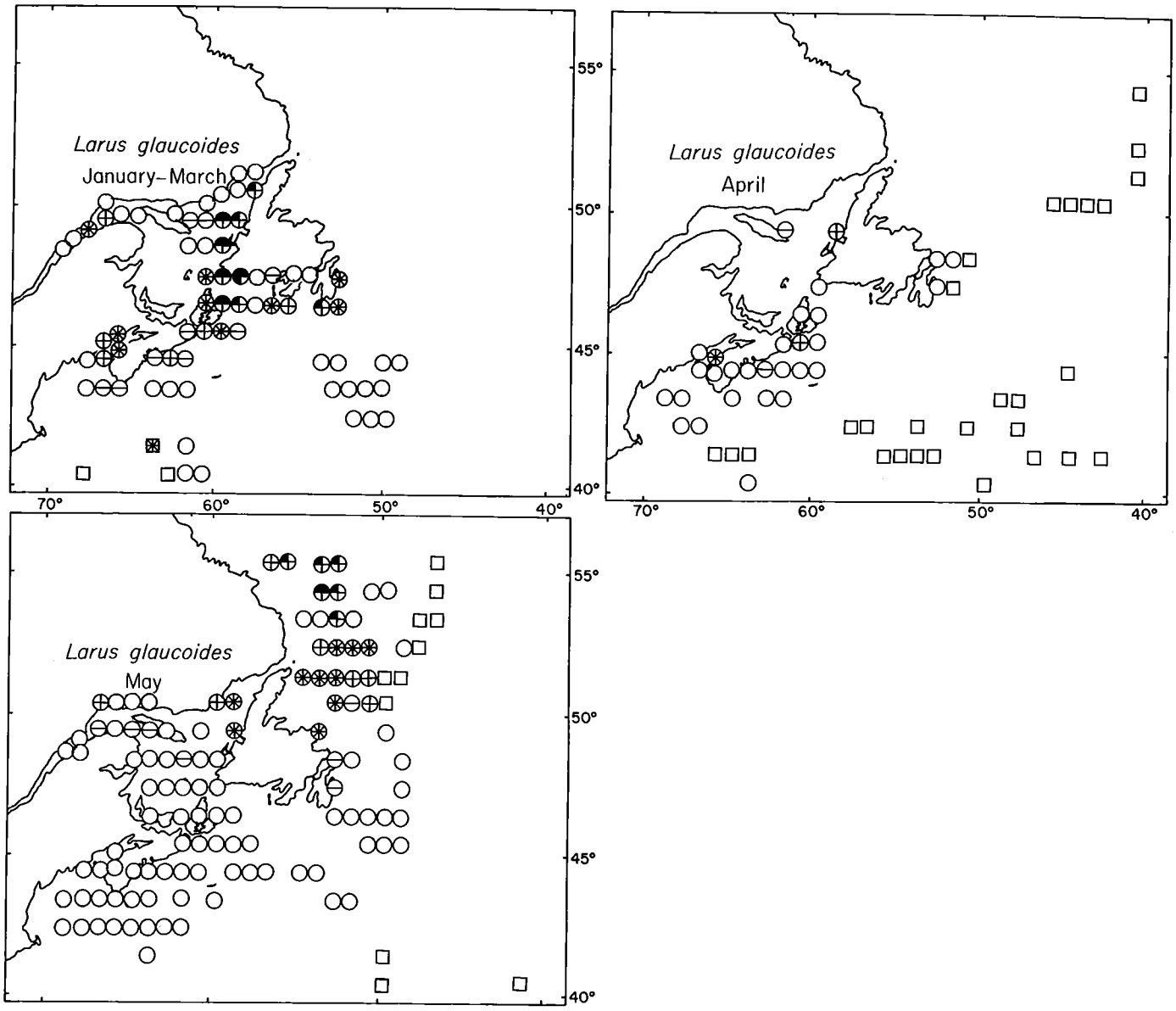




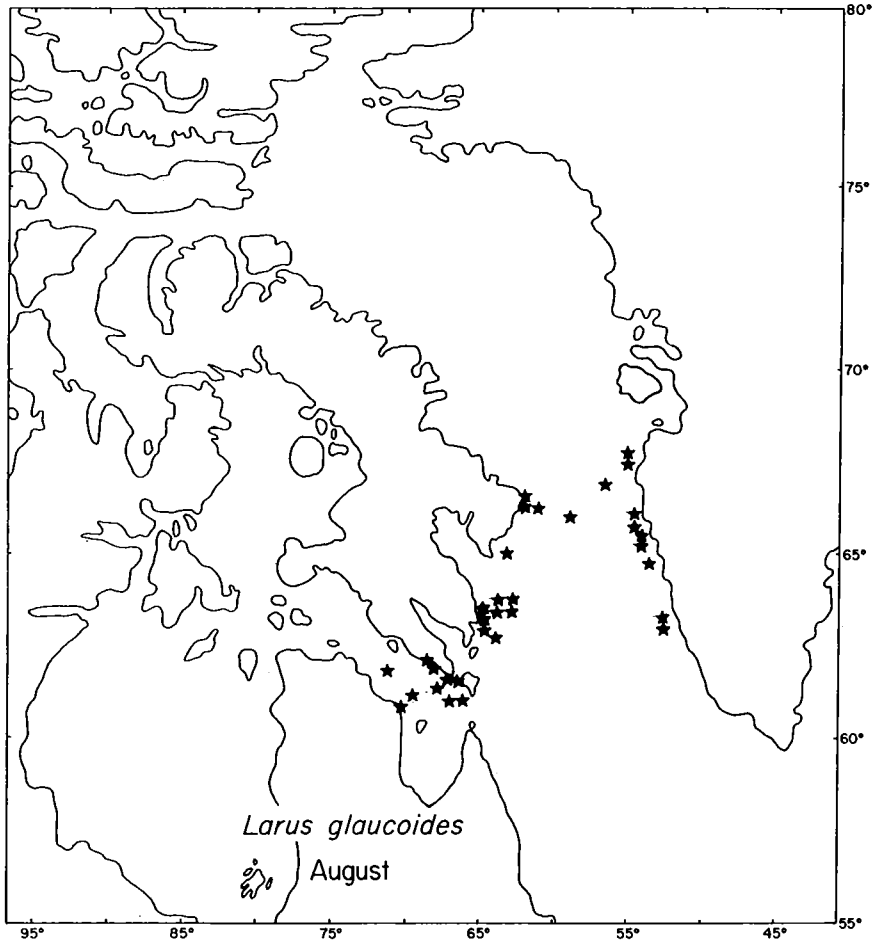

Larus hyperboreus
November December
55°
50°
45°
40°
70°
60°
50°
40°

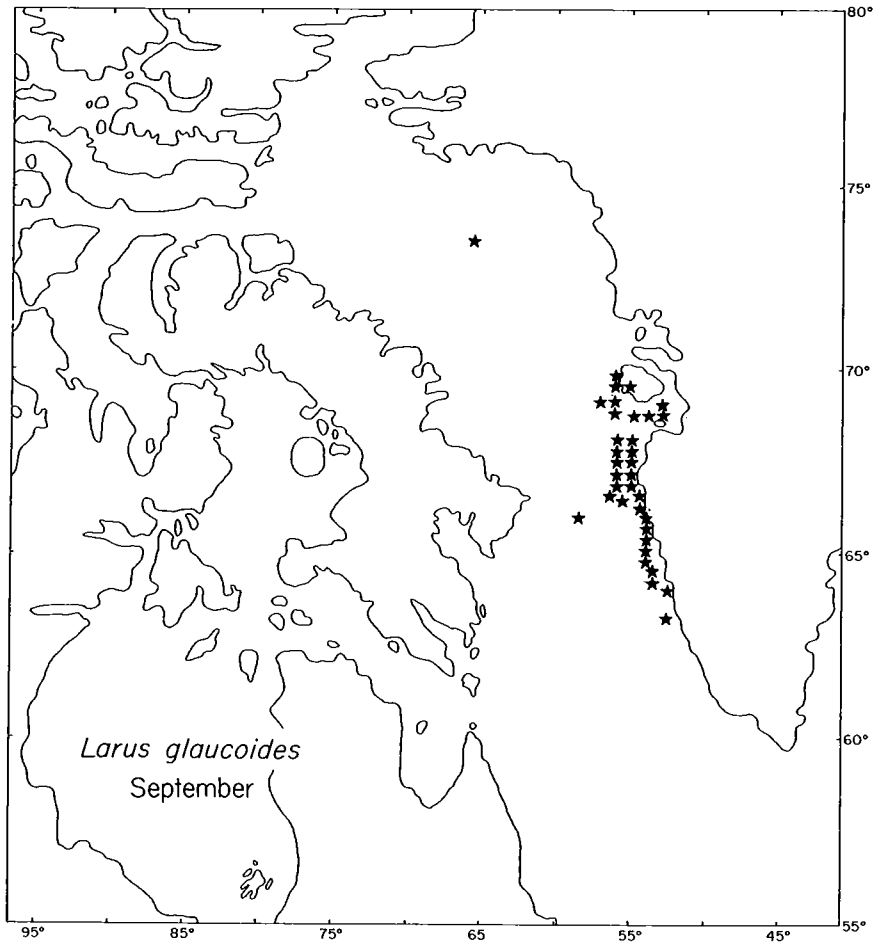
Map 20a
Iceland/Kumlien's Gull
Breeding range



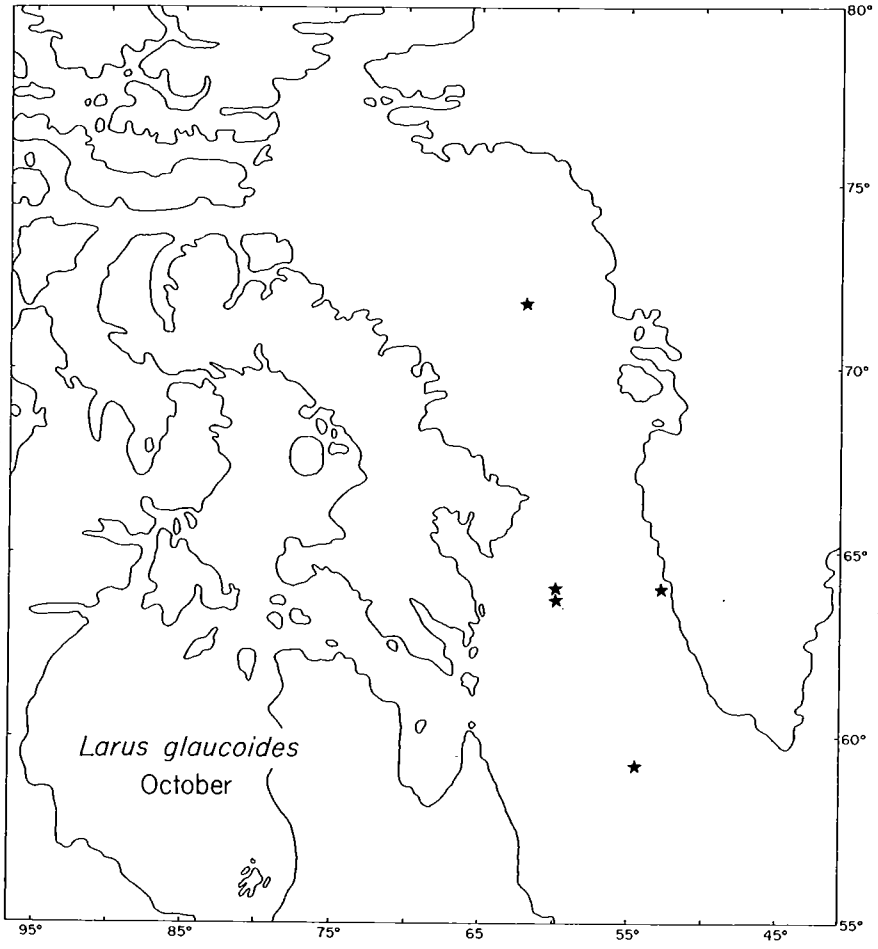

Larus glaucoides
January–March
Larus glaucoides
April
Larus glaucoides
May
55°
50°
45°
40°
70°
60°
50°
40°

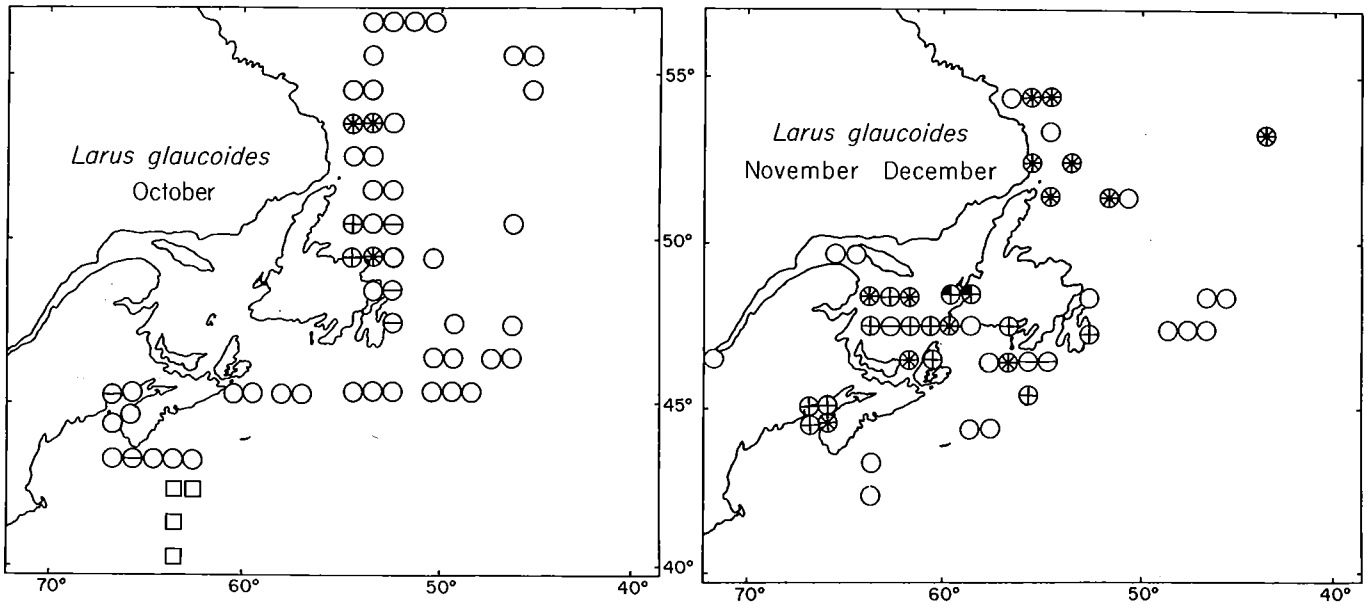
Map 20c
Iceland/Kumlien's Gull



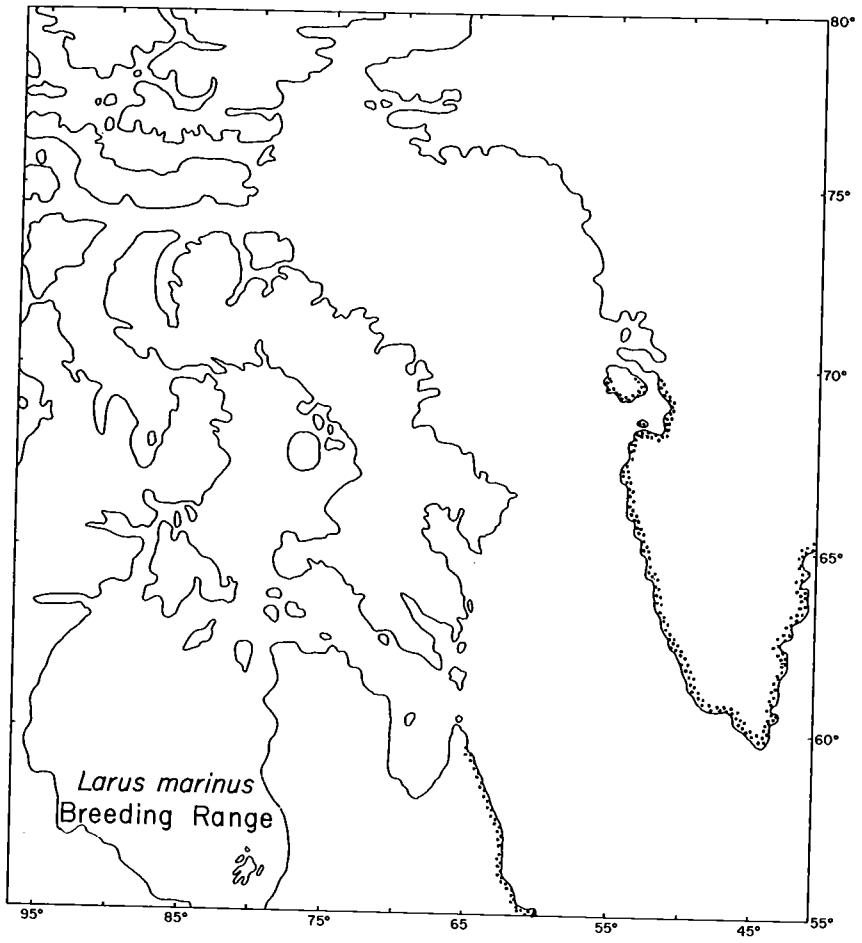

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Larus glaucoides
September

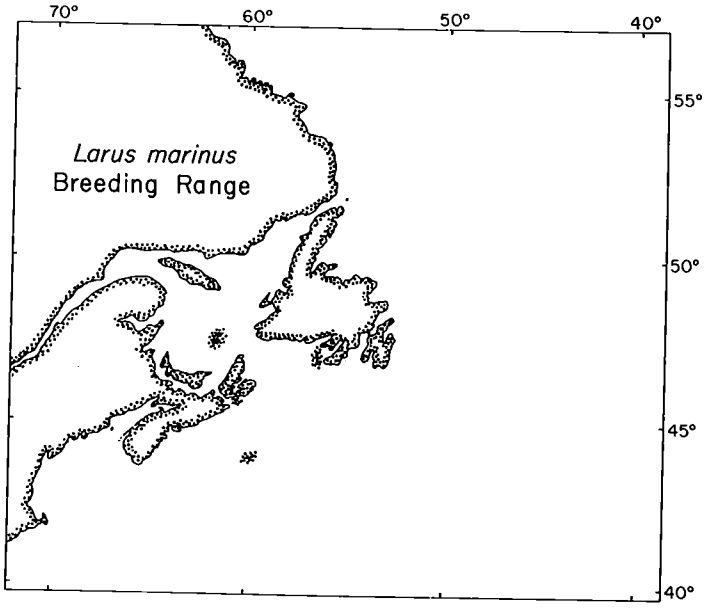
Map 20e
Iceland/Kumlien's Gull

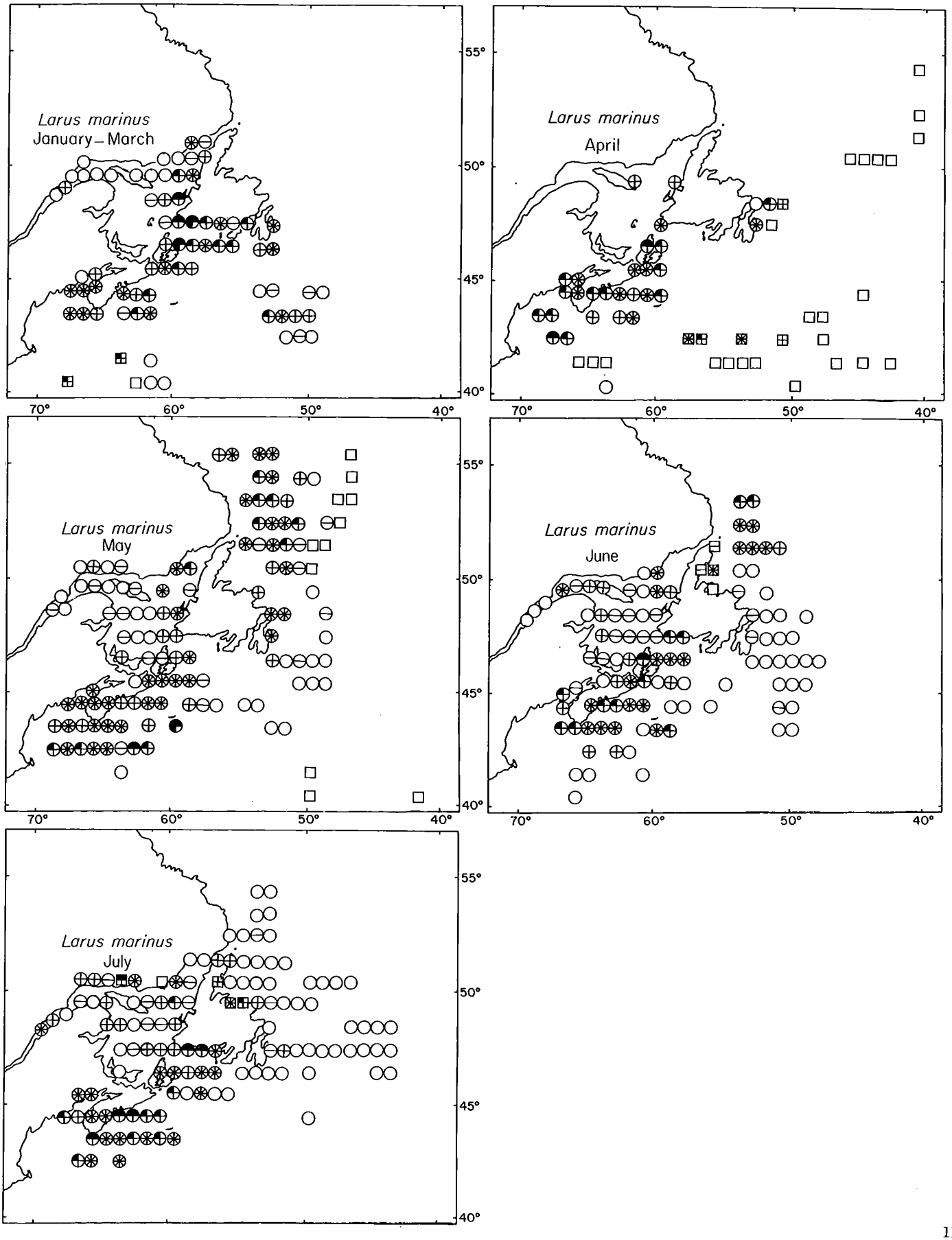



Larus glaucoides
October
Larus glaucoides
November December
55°
50°
45°
40°
70°
60°
50°
40°

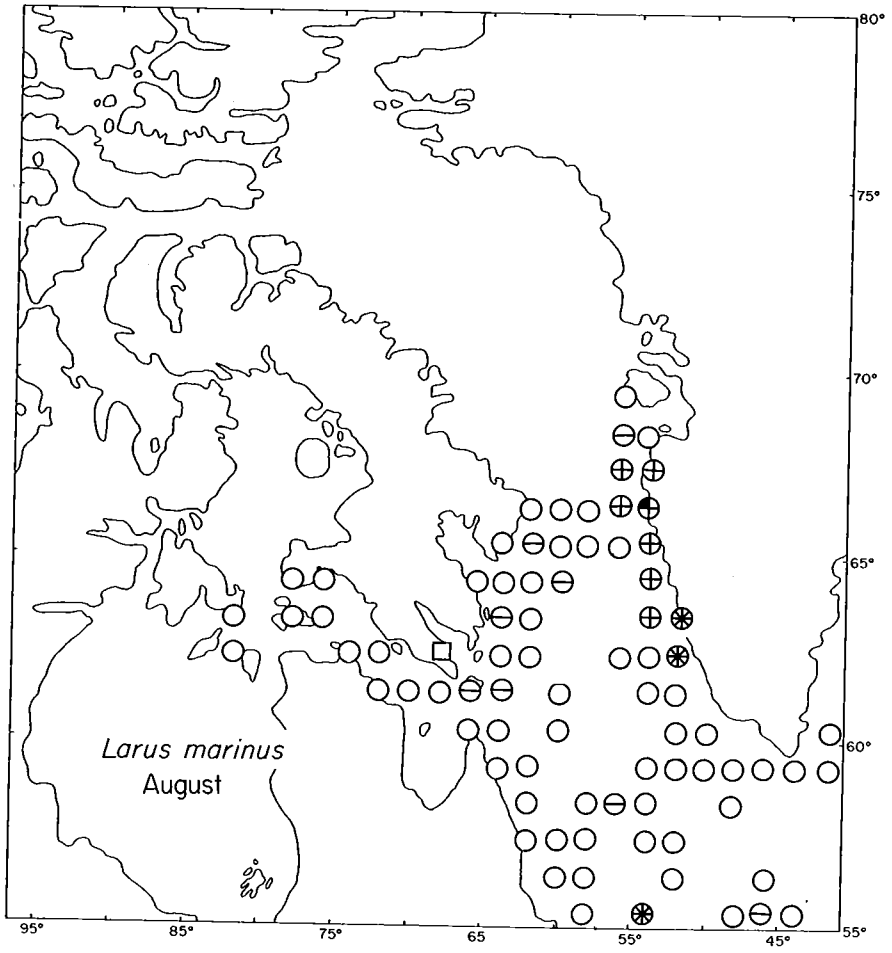
Map 21a
Great Black-backed Gull
Breeding range

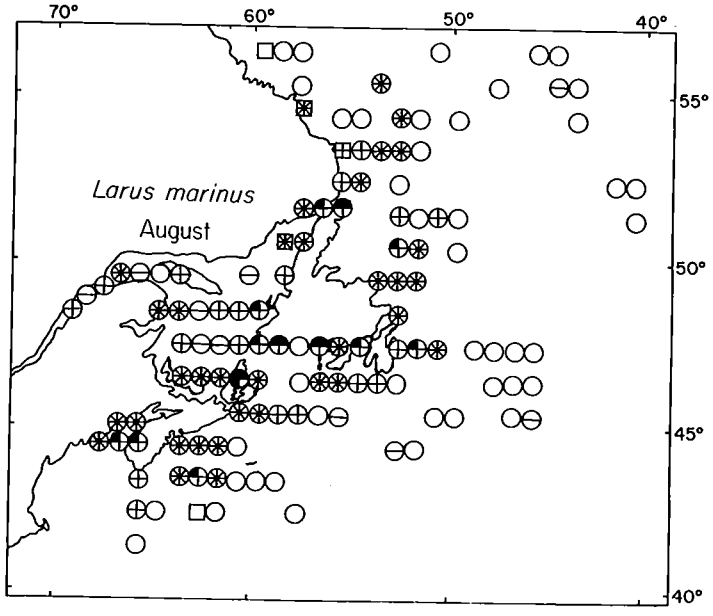


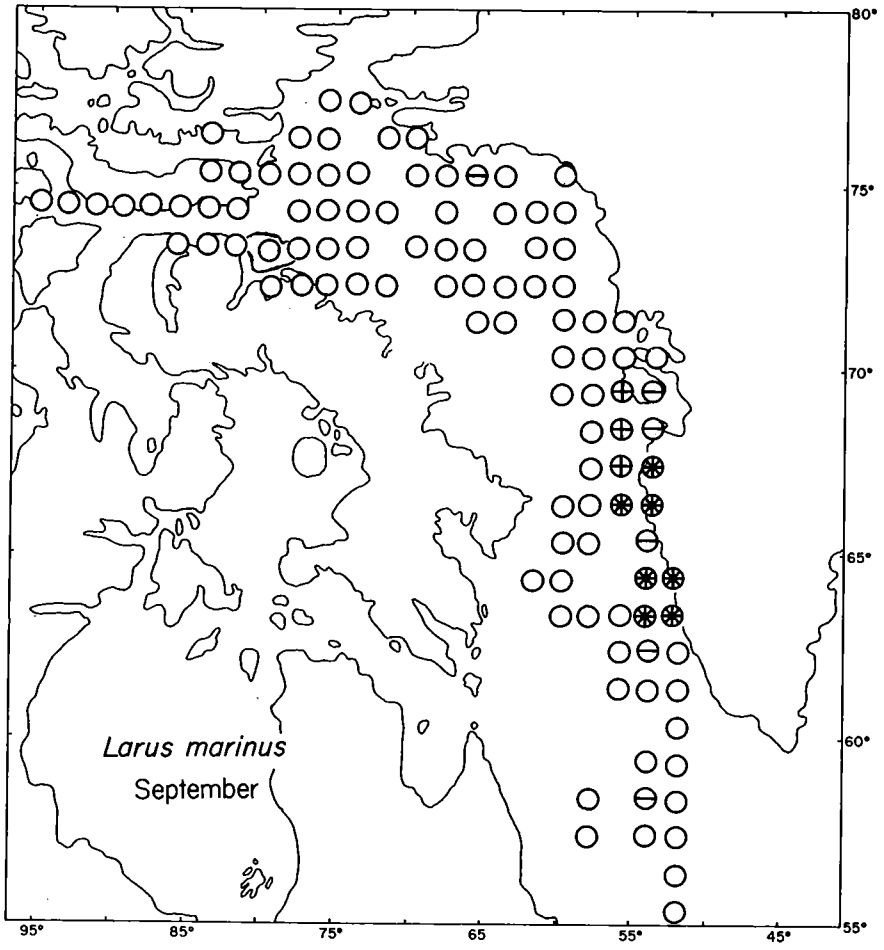


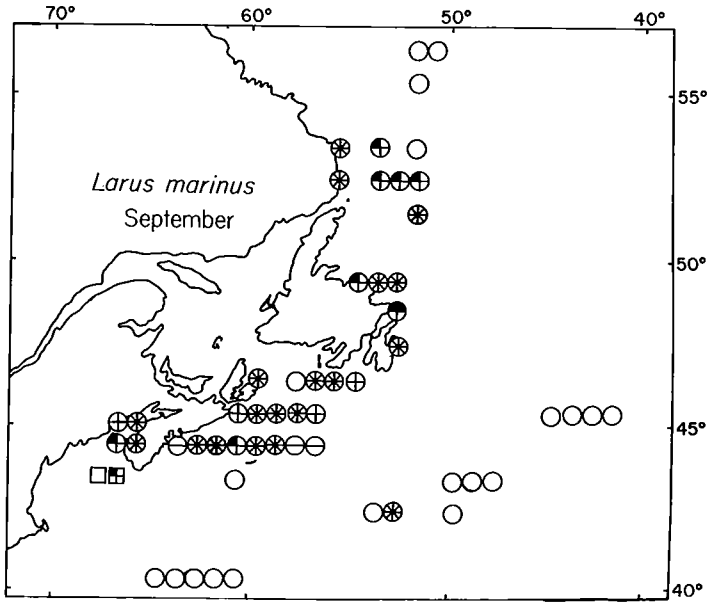

Larus marinus
January – March
Larus marinus
April
Larus marinus
May
Larus marinus
June
Larus marinus
July
55°
50°
45°
40°
70°
60°
50°
40°

Map 21c
Great Black-backed Gull

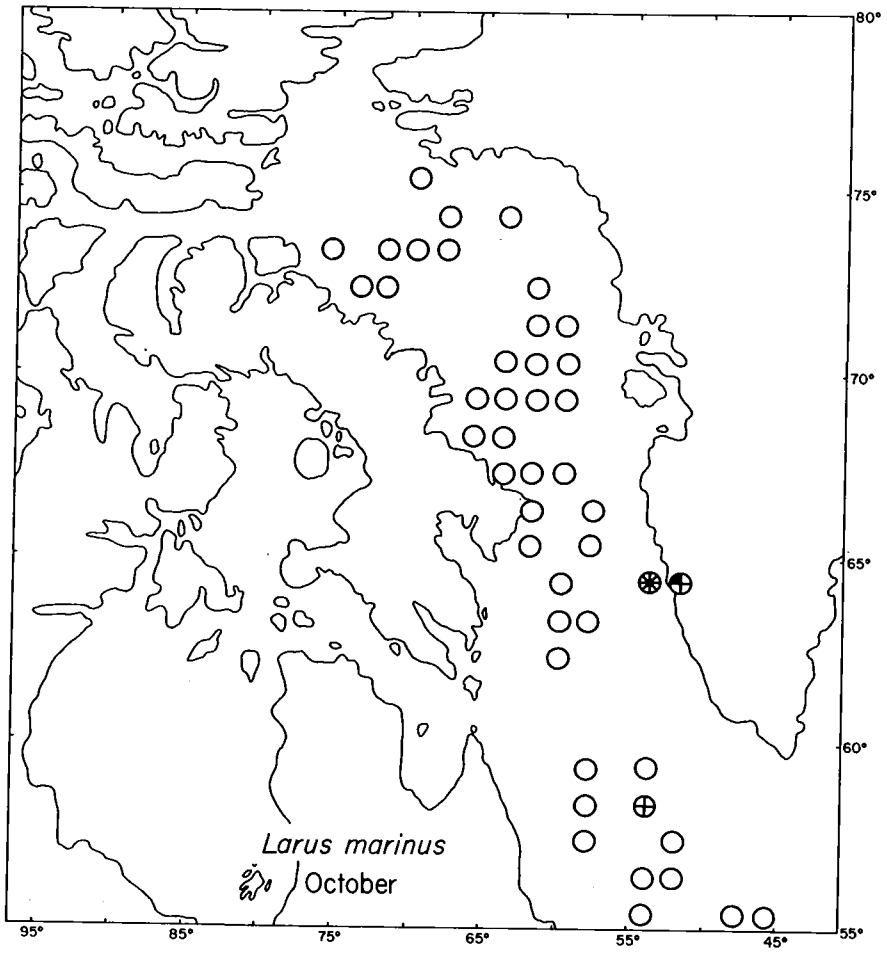


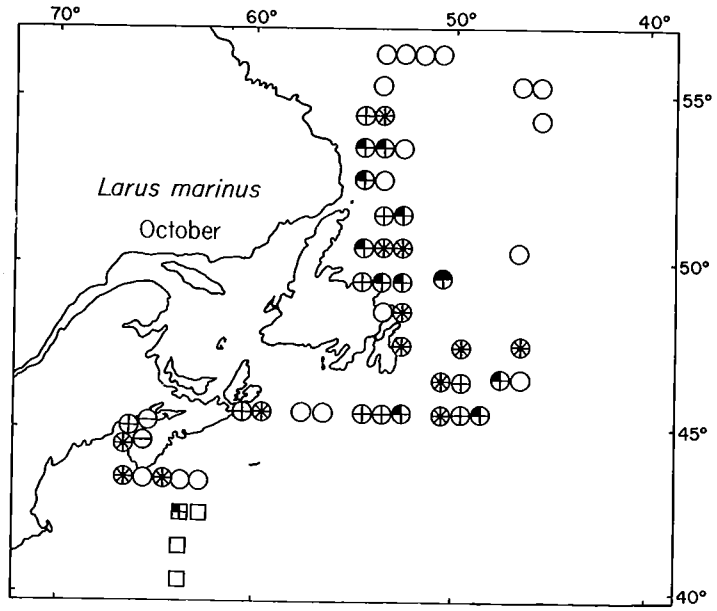



80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Larus marinus
September

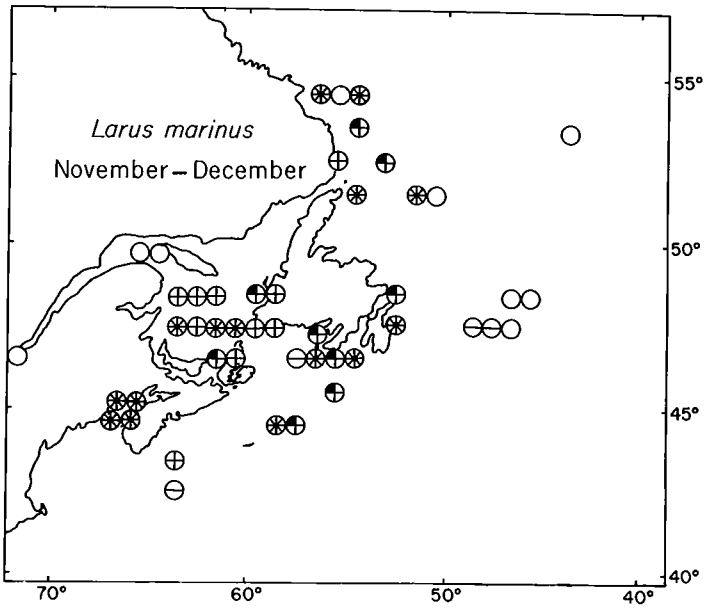

70°
60°
50°
40°
55°
50°
45°
40°
Larus marinus
September

Map 21e
Great Black-backed Gull

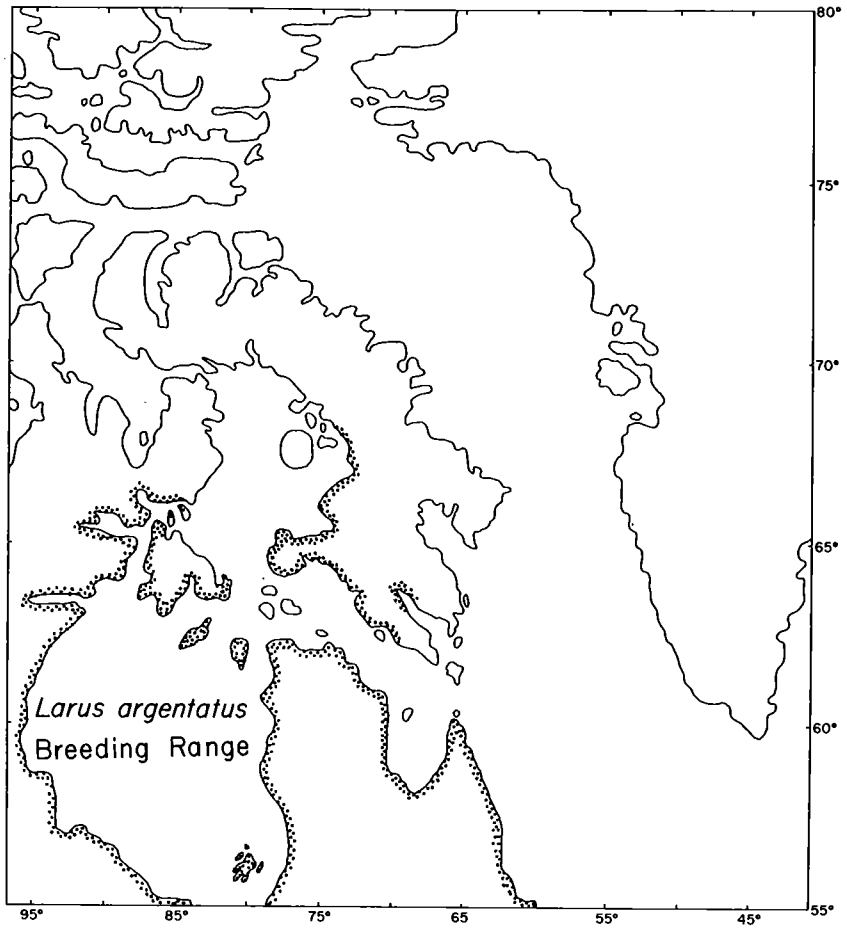


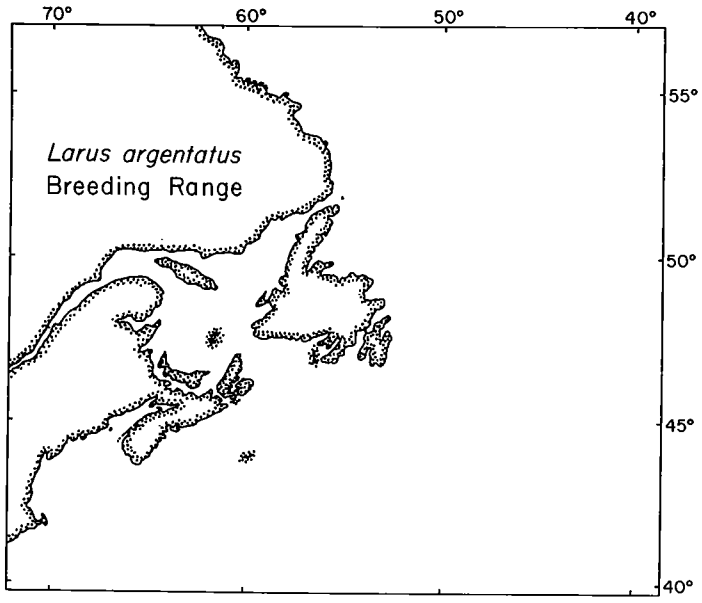


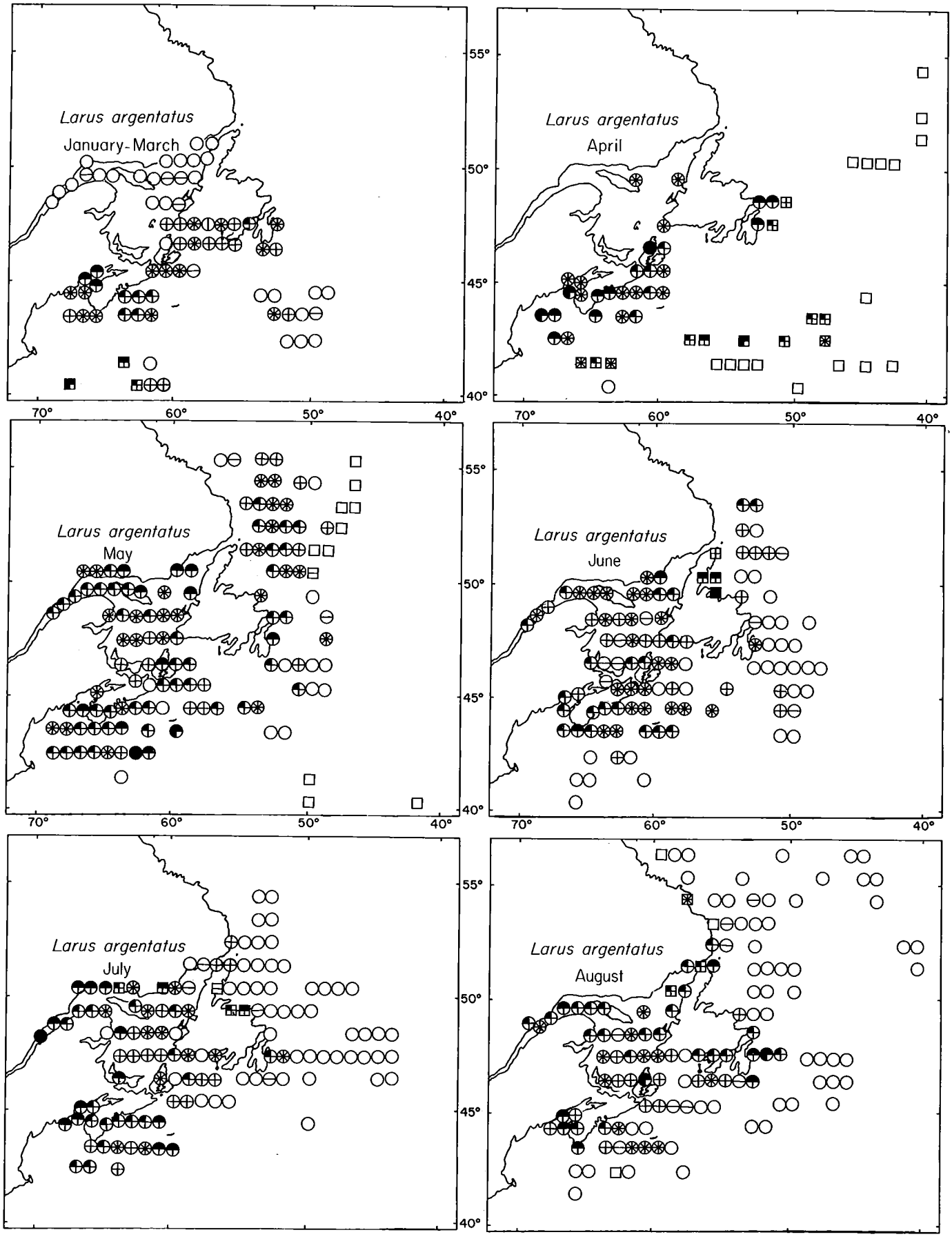
Map 21f
Great Black-backed Gull



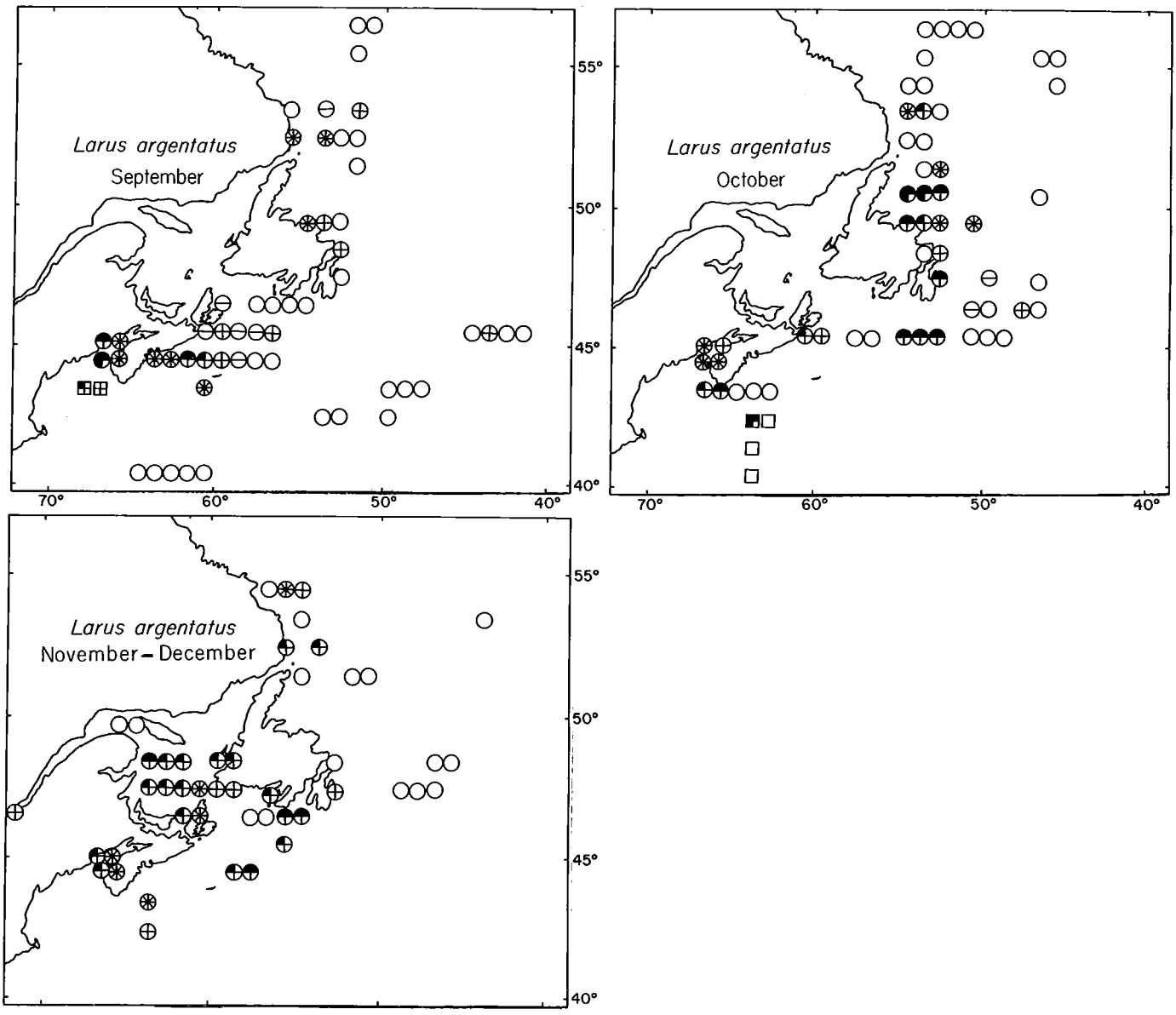
Map 22a
Herring Gull
Breeding range



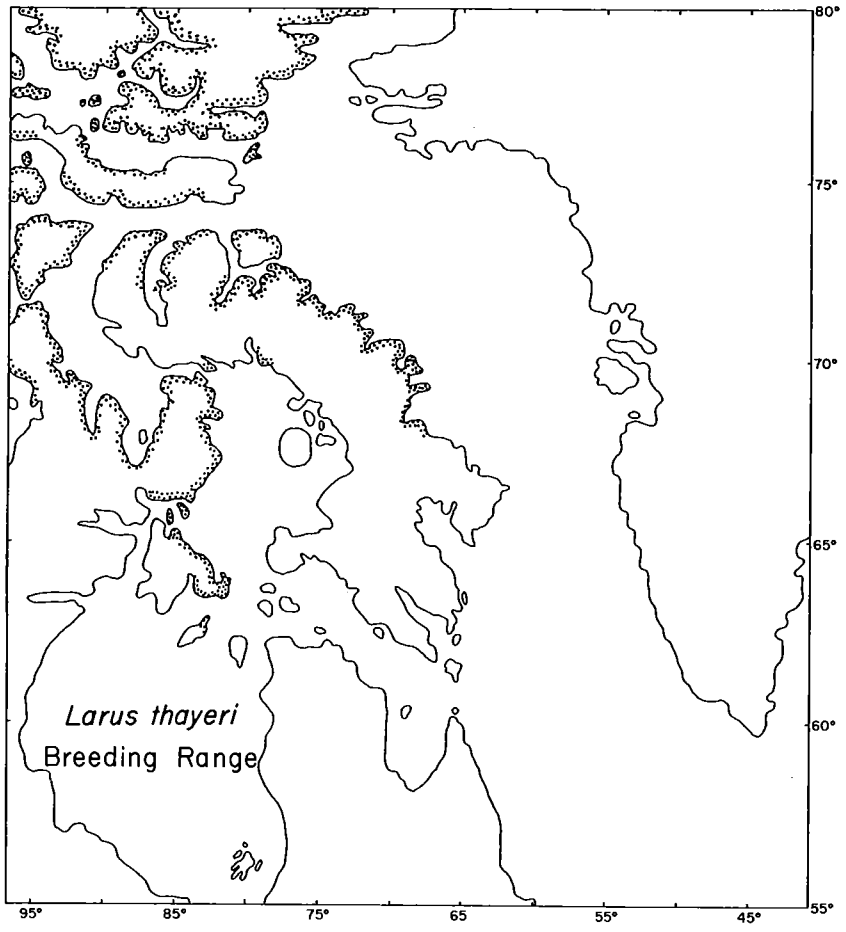



Larus argentatus
January-March
Larus argentatus
April
Larus argentatus
May
Larus argentatus
June
Larus argentatus
July
Larus argentatus
August
55°
50°
45°
40°
70°
60°
50°
40°

Map 22c
Herring Gull



Map 23
Thayer's Gull
Breeding range

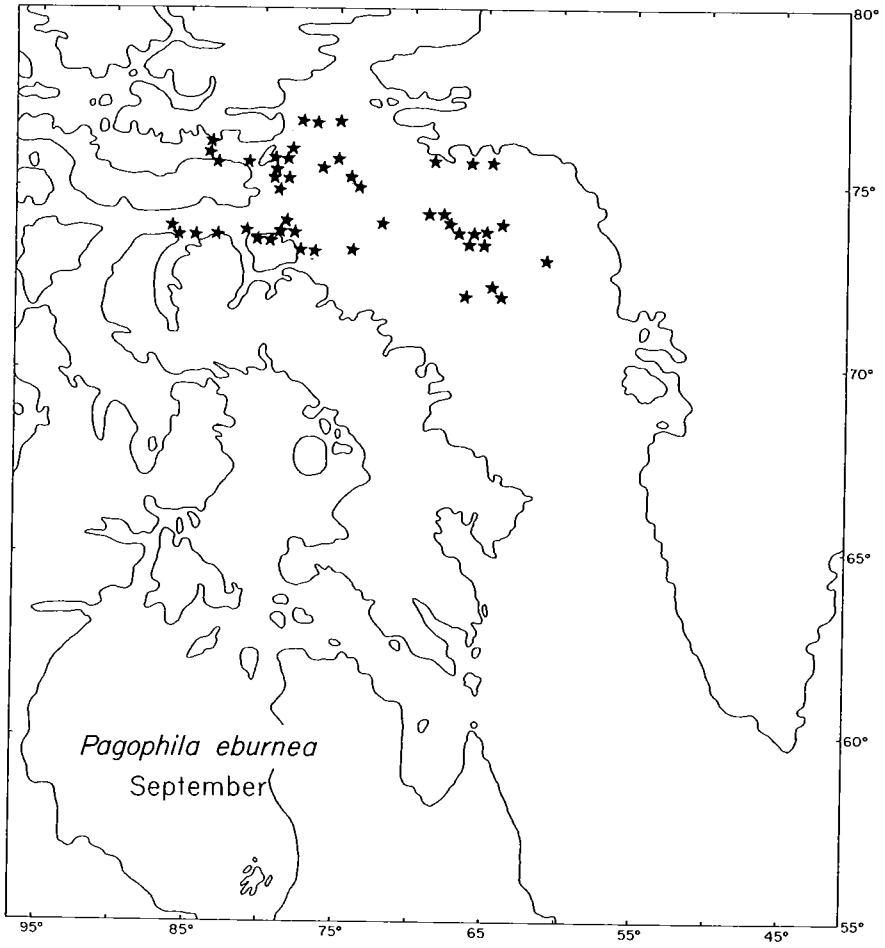


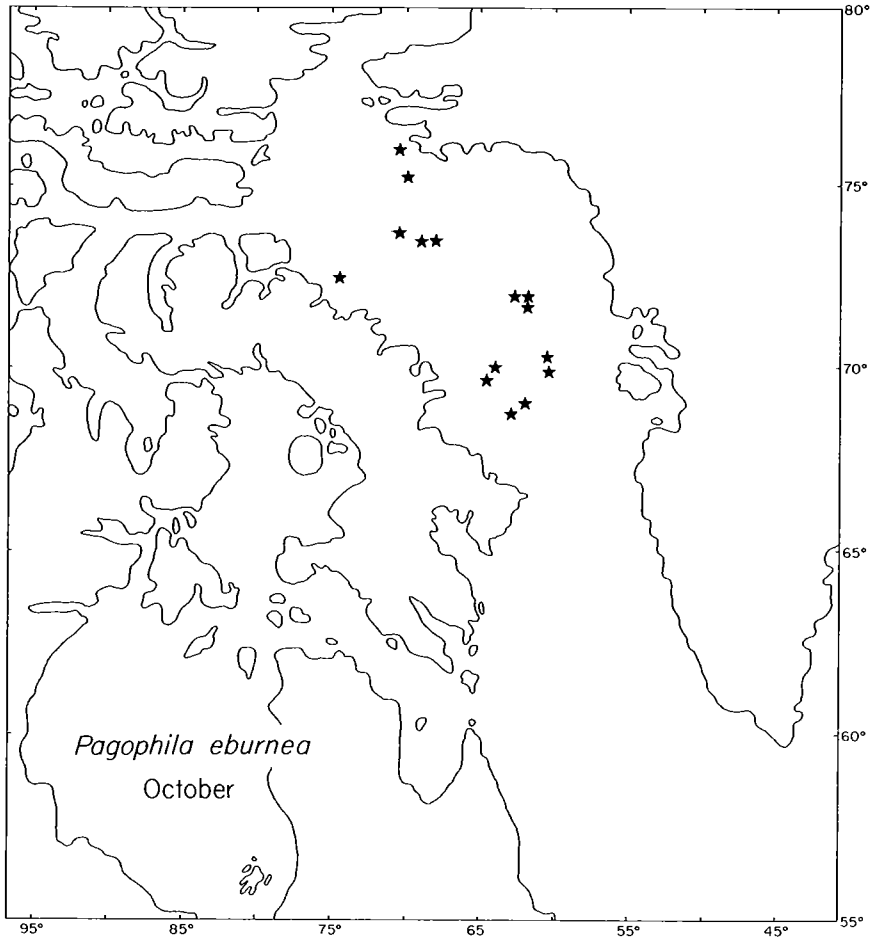
Ring-billed Gull	*Larus delawarensis*
Laughing Gull	*Larus atricilla*
Bonaparte's Gull	*Larus philadelphia*

The Ring-billed Gull breeds in southern and southeastern Labrador, the northern Gulf of St. Lawrence, southern Quebec, northeastern New Brunswick and Newfoundland in the area covered by this Atlas, and south to New York and also over a wide inland area in central North America. It has recently increased in numbers, especially in Newfoundland. Laughing Gulls formerly bred in New England and very locally in southern Nova Scotia and New Brunswick, but are now rare north of New Jersey. Bonaparte's Gull is a bird of inland waters in the boreal forest zones of western Canada. (Data from Drury 1973–74, Godfrey 1966, Nettleship unpublished.) Appendix 2 lists our few sightings of these gulls.

The Ivory Gull is a circumpolar breeder in the High Arctic; its colonies are outside the limits of our survey area (Godfrey 1966, MacDonald and Macpherson 1960–61, Salomonsen 1950). Seymour Island (76°48′N, 101°16′W) is the only proven breeding ground in the entire Canadian Arctic (S.D. MacDonald pers. comm., Nettleship and Smith 1975), although the existence of others is suspected. The birds seen in small numbers in northern Baffin Bay in September (and also in July and August 1974) were presumably either nonbreeders or from colonies along the north coast of Greenland. They appear to move south to reach Davis Strait by late October. Our only Atlantic records are from the edge of the pack-ice off Newfoundland and Labrador in May (see Appendix 2), presumably of birds scavenging among the seal herds (*e.g.* Peters and Burleigh 1951).

Map 24a
Ivory Gull




80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Pagophila eburnea
October

Breeding distribution

Kittiwakes breed on both the High and Low Arctic sides of Baffin Bay; in Atlantic Canada they are commonest on the Low Arctic coasts of Newfoundland and the northern Gulf of St. Lawrence. The exact positions of colonies south of 72°N in west Greenland are not recorded; according to Salomonsen (1950) the greatest population density is in the Umanaq, Disko Bay and Egedesminde districts, between c. 72° and 68°N.

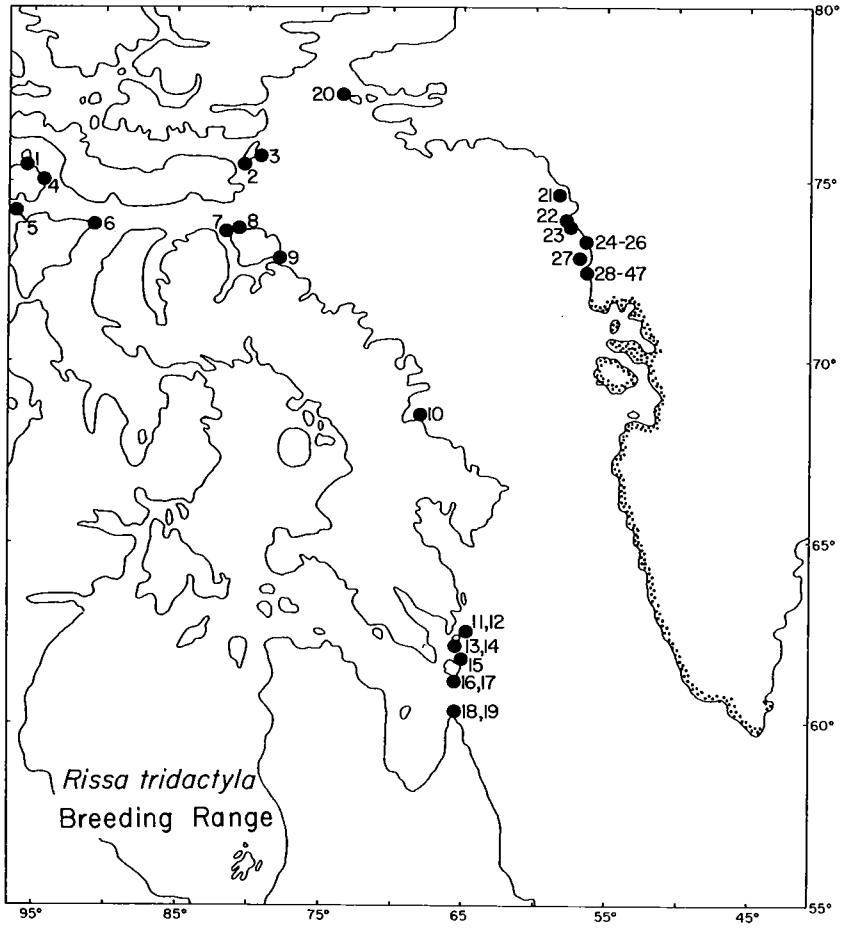
Pelagic distribution[9]

Kittiwakes are common in both High and Low Arctic waters in summer, and in Boreal and Low Arctic Atlantic waters at most times of year. The banding returns show that Newfoundland is an important wintering area for kittiwakes from Greenland, the northeast Atlantic and the European Arctic (Tuck 1971). The species also winters in Cool Subtropical waters (Baker 1947, Butcher *et al.* 1968, Jespersen 1930, Rankin and Duffey 1948). In fact, the pelagic range outside the breeding season is so wide that it is at present impossible to speculate about potential controlling oceanographic factors.

The abundance of birds off southeast Labrador between August and October suggests that Newfoundland birds may migrate to that area after breeding as do Common Murres (see below). Since kittiwakes are common throughout Baffin Bay during this period, it seems unlikely that these Labrador birds are the vanguard of migrants from the Arctic.

9 Kittiwakes were present but scarce on the Scotian Shelf in January 1974, along a transect between 44°30′N, 63°30′W and 42°20′N, 61°15′W. They were common close to the Labrador coast at c. 55°N during a cruise in late October 1973, and during an aerial survey in late October 1970.

Map 25a
Black-legged Kittiwake
Breeding range



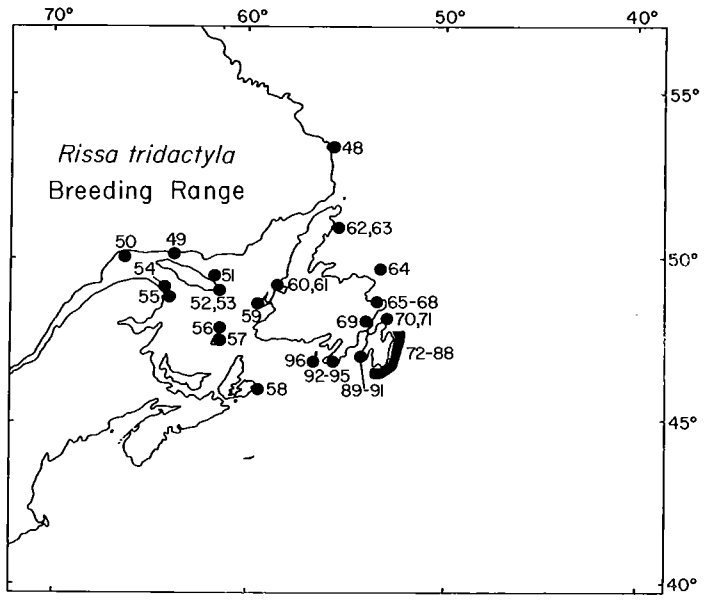


Table 5
Location and size of Black-legged Kittiwake (*Rissa tridactyla*) colonies. For further details see Table 1. An asterisk indicates that the colony was not plotted on the map

	Colony location	Position	Colony size	Census year	Authority
	Eastern Canadian Arctic:				
1.	Washington Pt., Baillie-Hamilton I.	75°46′N, 94°17′W	±3,000p	1973	Nettleship 1974*b*
2.	Cambridge Pt., Coburg I.	75°48′N, 79°25′W	+ (order 4)	1973	Nettleship
3.	Princess Charlotte Monument, Coburg I.	75°50′N, 78°50′W	+ (order 4)	1973	Nettleship
4.	Separation Point, Cornwallis I.	75°07′N, 93°29′W	125p	1972	Nettleship 1974*b*
5.	Browne I.	74°49′N, 96°22′W	±1,000p	1972	S.D. MacDonald, pers. comm.
6.	Prince Leopold I.	74°02′N, 90°00′W	±50,000p	1972	Nettleship
7.	Wollaston I.	73°43′N, 80°57′W	+ (order 3)	1973	Nettleship
8.	W of Cape Hay, Bylot I.	73°46′N, 80°23′W	50,000p	1957	Tuck and Lemieux 1959
9.	Cape Graham Moore, Bylot I.	72°56′N, 76°02′W	3,000p	1957	Tuck and Lemieux 1959
10.	SE of Kekertal I.	68°33′N, 67°28′W	140p	1973	Nettleship
11.	Lady Franklin I.	62°56′N, 63°41′W	+[1]	1973	Nettleship
12.	Monumental I.	62°45′N, 63°51′W	+[2]	1973	Nettleship
13.	Islet off Queen Elizabeth Foreland, Loks Land	62°20′N, 64°26′W	75p	1973	Nettleship
14.	Harper I.	62°21′N, 64°45′W	250p	1973	Nettleship
15.	'Hantzsch' I.	61°55′N, 65°00′W	±3,000p	1973	Nettleship
16.	Hatton Headland, Resolution I.	61°20′N, 64°44′W	125p	1973	Nettleship
17.	Acadia Cove, Resolution I.	61°19′N, 64°54′W	100p	1973	Nettleship
18.	Goodwin I., Button Is.	c.60°41′N, 64°39′W	+	1934	Gross 1937

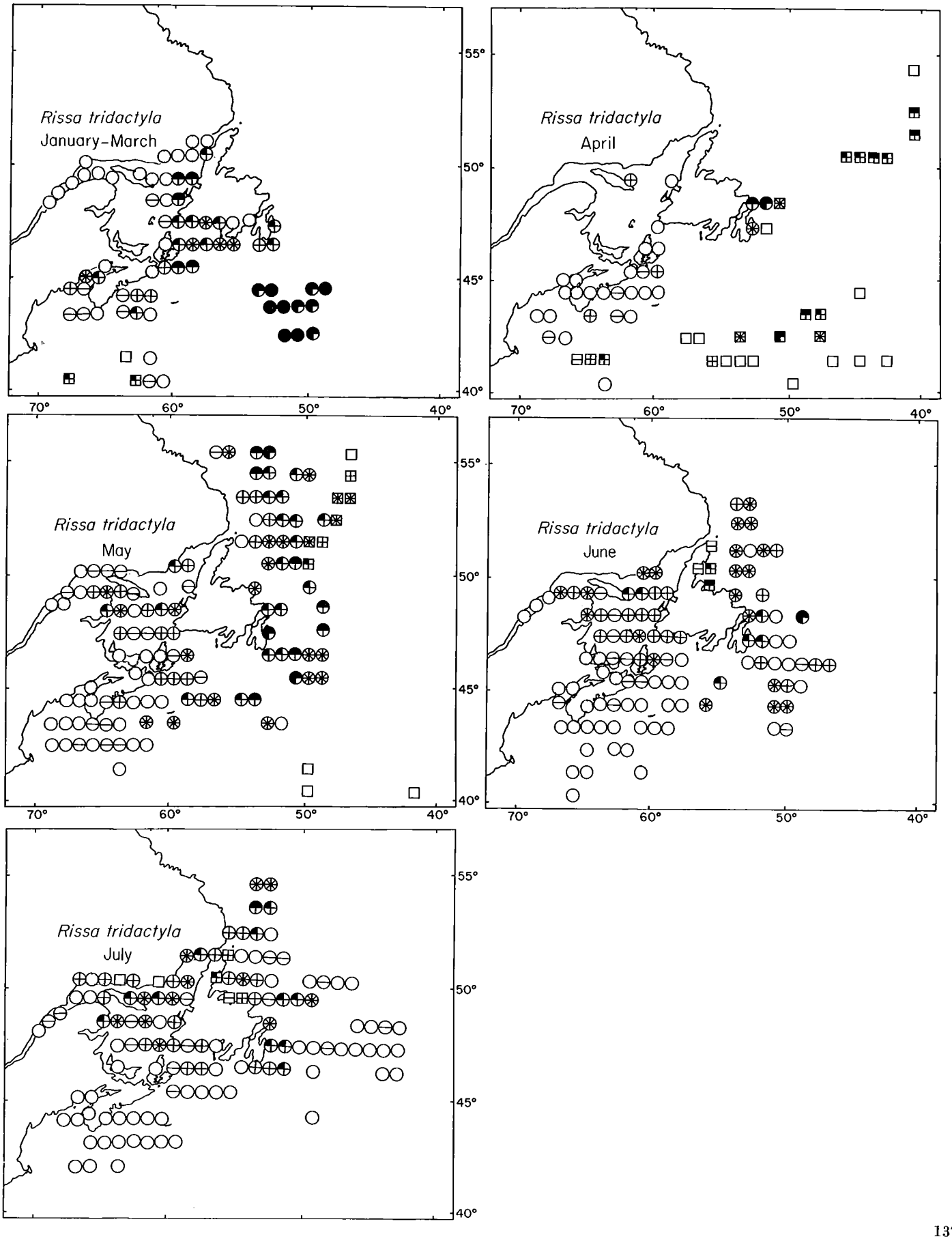
	Colony location	Position	Colony size	Census year	Authority
19.	Knight I., Button Is.	c.60°35′N, 64°35′W	+	1934	Gross 1937
	West Greenland:				
20.	Hakluyt I.	77°25′N, 72°38′W	+	1936	Salomonsen 1950
21.	Garde I., Melville Bay	74°48′N, 57°05′W	+	1936	Salomonsen 1950
22.	Agparssuit (= K. Shackleton)	c.73°49′N, 56°50′W	6,000–7,000p	1965	Joensen and Preuss 1972
23.	Qiparko (= Kipako)	73°43′N, 56°38′W	1,750–1,850p	1965	Joensen and Preuss 1972
24.	Quadlunât	73°33′N, 56°22′W	150–200p	1965	Joensen and Preuss 1972
25.	Matângassut	73°32′N, 56°40′W	450p	1965	Joensen and Preuss 1972
26.	Torqussâq	73°26′N, 56°38′W	535–585p[3]	1965	Joensen and Preuss 1972
27.	Kingigtuarssuk II (= K. Middle)	72°56′N, 56°40′W	925–1,025p	1965	Joensen and Preuss 1972
28.	Akinaq	72°49′N, 55°20′W	73–76p	1965	Joensen and Preuss 1972
29.	Angmaussarssuaq	72°49′N, 55°42′W	41p	1965	Joensen and Preuss 1972
30.	Nûna	72°46′N, 55°33′W	9p	1965	Joensen and Preuss 1972
31.	Nutârmiut	72°46′N, 55°03′W	30–40p	1965	Joensen and Preuss 1972
32.	Qardlît Qeqertât	72°42′N, 55°10′W	100p	1965	Joensen and Preuss 1972
33.	Agpatsiait	72°41′N, 55°49′W	1,500p	1965	Joensen and Preuss 1972
34.	Qaersorssuaq (= Sanderson's Hope)	72°41′N, 56°11′W	600–700p	1965	Joensen and Preuss 1972
35.	Qâmutit	72°41′N, 54°53′W	115–140p	1965	Joensen and Preuss 1972
36.	Nako (NW side of W Peninsula)	72°40′N, 55°12′W	250–260p	1965	Joensen and Preuss 1972
37.	Kingigtoq Agparssuit	72°39′N, 55°53′W	1,625–1,950p	1965	Joensen and Preuss 1972
38.	Tingmiakulugssuit	72°39′N, 55°50′W	1,000p	1965	Joensen and Preuss 1972
39.	Nako (SW side of W Peninsula)	72°39′N, 53°13′W	230p	1965	Joensen and Preuss 1972

	Colony location	Position	Colony size	Census year	Authority
40.	Niaqornarssuaq	72°39′N, 54°50′W	43p	1965	Joensen and Preuss 1972
41.	Pâq	72°38′N, 54°58′W	100p	1965	Joensen and Preuss 1972
42.	Islet SW of Pâq	72°37′N, 55°02′W	150–165p	1965	Joensen and Preuss 1972
43.	Manîtsunguaq	72°34′N, 55°43′W	200p	1965	Joensen and Preuss 1972
44.	Nutârmiut (SE side of S Peninsula)	72°33′N, 55°32′W	80p	1965	Joensen and Preuss 1972
45.	Pûgutâ	72°31′N, 55°04′W	100p	1965	Joensen and Preuss 1972
46.	Iperaq	72°28′N, 55°47′W	2i [4]	1965	Joensen and Preuss 1972
47.	Oqaitsut	72°17′N, 55°07′W	?	1965	Joensen and Preuss 1972
	Atlantic Canada, St. Pierre-Miquelon:				
48.	Outer Gannet I.	54°00′N, 56°31′W	16p	1972	Nettleship and Lock 1974
49.	Birch Is.	50°14′N, 63°59′W	465p	1972	Nettleship and Lock 1973*b*
50.	Carrousel I.	50°05′N, 66°23′W	915p	1972	Nettleship and Lock 1973*b*
51.	Fox Pt., Anticosti I.	49°18′N, 61°50′W	478p	1972	Nettleship
52.	Gullcliff Bay, Anticosti I.	49°09′N, 61°42′W	18,468p	1972	Nettleship
53.	Heath Pt., Anticosti I.	49°05′N, 61°42′W	1,218p	1972	Nettleship
54.	Cap Gaspé	48°45′N, 64°10′W	75p	1968	H.R. Ouellet, pers. comm.
*	The Three Sisters	48°32′N, 64°13′W	171p	1974	Nettleship and Taylor
55.	Bonaventure I.	48°29′N, 64°07′W	14,849p	1974	Nettleship and Taylor
*	Cap d'Espoir	48°25′N, 64°19′W	+	1974	Nettleship and Taylor
56.	Bird Rocks, Magdalen Is.	47°51′N, 61°12′W	5,000p	1973	Nettleship
57.	Entry I., Magdalen Is.	47°16′N, 61°42′W	+	1973	A.D. Smith, pers. comm.
58.	Green I., N.S.	45°49′N, 60°04′W	60p	1971	Lock 1972

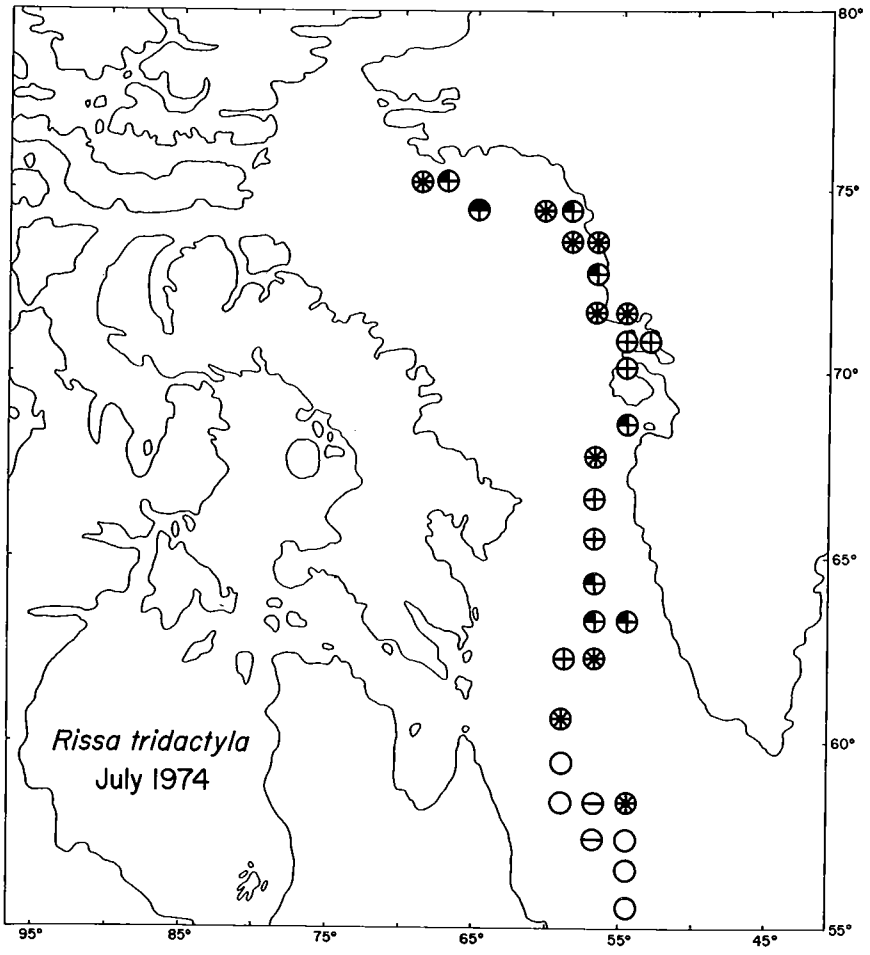
	Colony location	Position	Colony size	Census year	Authority
59.	Big Cove	48°30′N, 59°14′W	+	1973	Nettleship
60.	Hen I.	49°14′N, 58°20′W	+	1973	Nettleship
61.	Gregory I.	49°17′N, 58°18′W	500p	1973	Nettleship
62.	The Sister Rocks (NE of Groais I.)	50°59′N, 55°31′W	400p	1973	Nettleship
63.	Island NW of Groais I.	50°59′N, 55°37′W	2,000p	1973	Nettleship
64.	Funk I.	49°45′N, 53°51′W	<100p	1969	Nettleship
65.	Spillars Point	48°40′N, 53°03′W	+	1973	Nettleship
66.	Island off Elliston Pt.	48°38′N, 53°01′W	+	1973	Nettleship
67.	Sherwink Head	48°22′N, 53°20′W	+	1973	Nettleship
68.	Island off Maiden Pt.	48°16′N, 53°26′W	500p	1973	Nettleship
69.	Islet off St. Jones Harbour	47°55′N, 53°40′W	100p	1973	Nettleship
70.	Baccalieu I.	48°08′N, 52°48′W	±10,000p	1969	Nettleship
71.	Harbour Grace I.	47°42′N, 53°09′W	+	1973	Nettleship
72.	Pouch Cove	47°46′N, 52°45′W	±100p	1973	Nettleship
73.	Black Head North	45°45′N, 52°43′W	50p	1973	Nettleship
74.	Torbay Point	47°39′N, 52°41′W	50p	1973	Nettleship
75.	Spriggs Point	47°32′N, 52°41′W	80p	1973	Nettleship
76.	Vizard Hill	47°24′N, 52°42′W	+	1973	Nettleship
77.	Long Point	47°22′N, 52°44′W	+[5]	1973	Nettleship
78.	Gull I., Witless Bay	47°16′N, 52°46′W	8,306p	1970	Maunder and Threlfall 1972
79.	Green I., Witless Bay	47°15′N, 52°47′W	±10,000p	1973	Nettleship

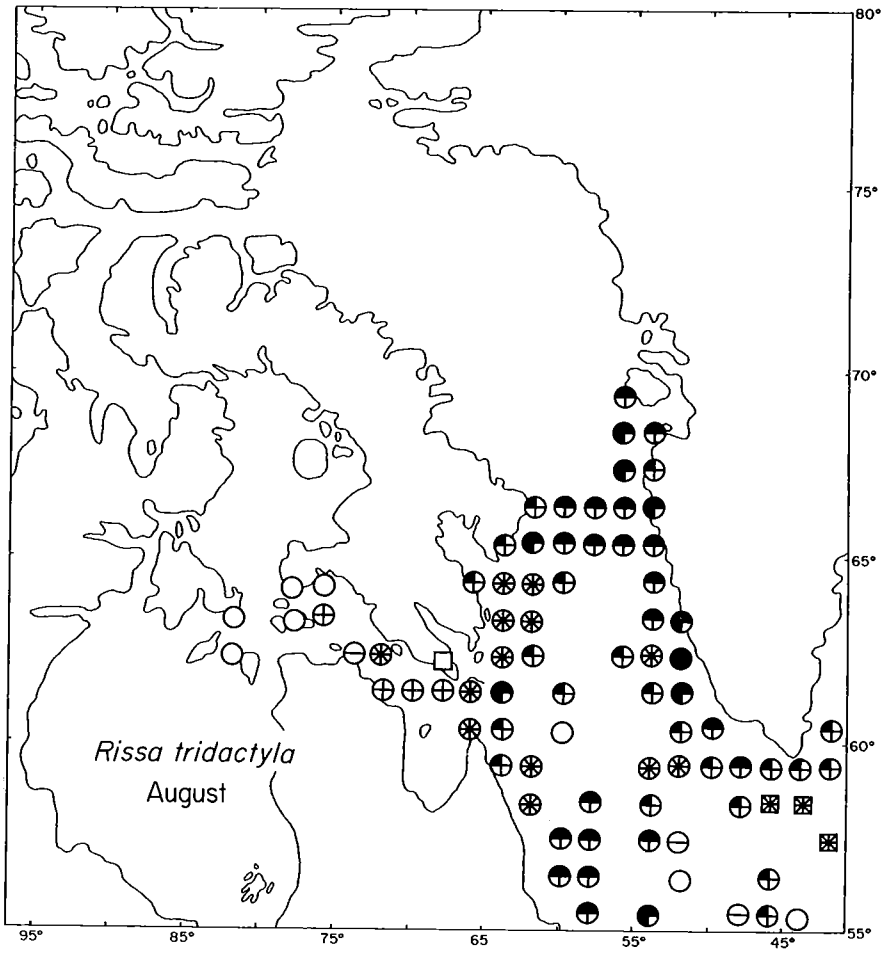
	Colony location	Position	Colony size	Census year	Authority
80.	Great I., Witless Bay	47°11′N, 52°49′W	23,229p	1968	Nettleship
81.	Cape Neddick	47°09′N, 52°51′W	+[6]	1973	Nettleship
82.	Cape Ballard	46°47′N, 52°58′W	20p	1973	Nettleship
83.	Calm Cove	46°43′N, 53°02′W	+	1973	Nettleship
84.	Drook Point	46°40′N, 53°15′W	+[7]	1973	Nettleship
85.	Cape Mutton	46°41′N, 53°20′W	+	1973	Nettleship
86.	N of Cape Pine	46°37′N, 53°32′W	+	1973	Nettleship
87.	Western Head	46°38′N, 53°37′W	+	1973	Nettleship
88.	Gull Island Point	46°42′N, 53°39′W	100p[8]	1973	Nettleship
89.	Bull Island Point	46°48′N, 56°06′W	+	1973	Nettleship
90.	Cape St. Mary's	46°50′N, 54°12′W	+ (order 4)	1972	Nettleship
91.	Island Head	46°53′N, 54°12′W	50p	1973	Nettleship
92.	Island at mouth of Mortier Bay	47°08′N, 55°05′W	+	1973	Nettleship
93.	Tides Cove Point	47°06′N, 55°04′W	200p	1973	Nettleship
94.	Colombier I.	46°53′N, 55°34′W	1,000p	1973	Nettleship
95.	Offer I. (= Lawn I.)	46°51′N, 55°38′W	200p	1973	Nettleship
96.	Anse aux Cormorans, Langlade I. (= Petite Miquelon I.)	46°52′N, 56°15′W	22p	1963 or 1964	Cameron 1967

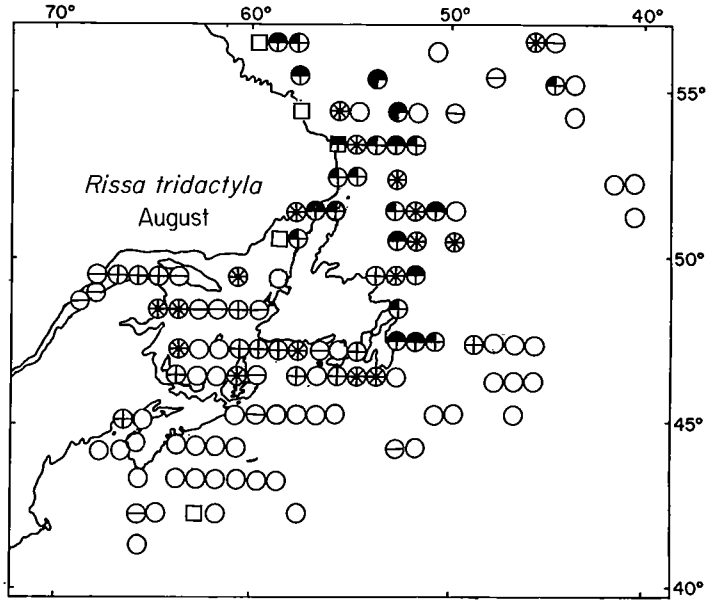
1 450i seen flying at sea.
2 1,600i seen flying at sea.
3 Total for 3 colonies.
4 Not breeding: Joensen and Preuss (1972).
5 Large colony.
6 Two colonies.
7 Large colony.
8 Total for 2 colonies.


Rissa tridactyla
January–March
Rissa tridactyla
April
Rissa tridactyla
May
Rissa tridactyla
June
Rissa tridactyla
July
55°
50°
45°
40°
70°
60°
50°
40°

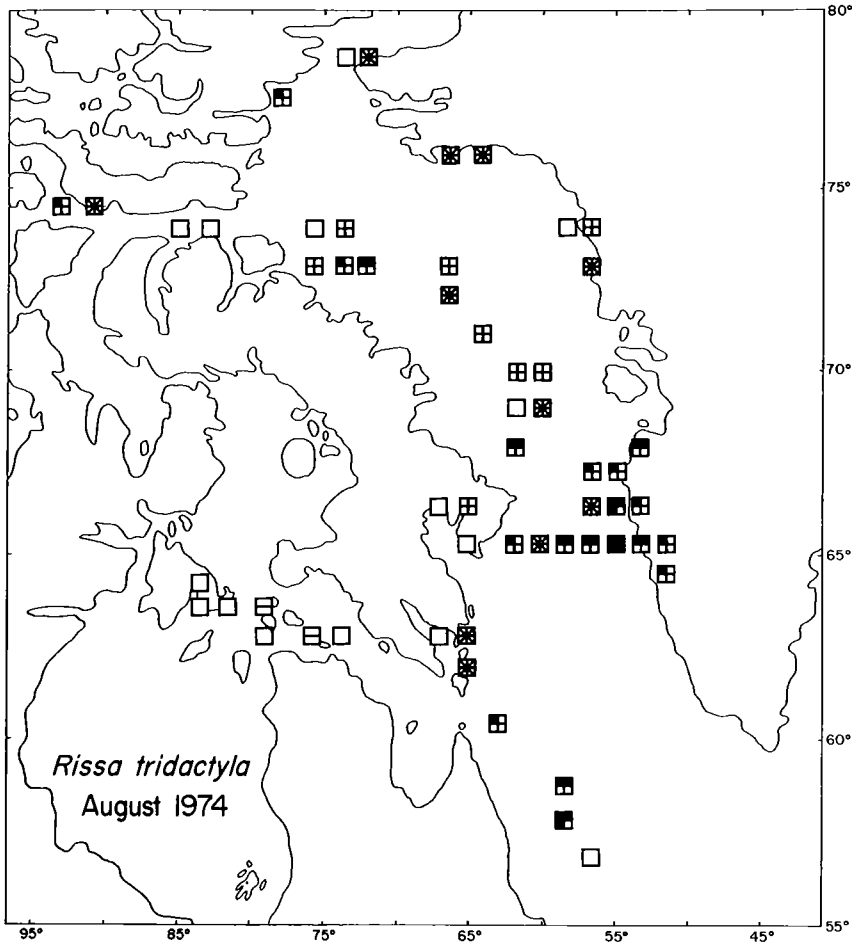
Map 25c
Black-legged Kittiwake

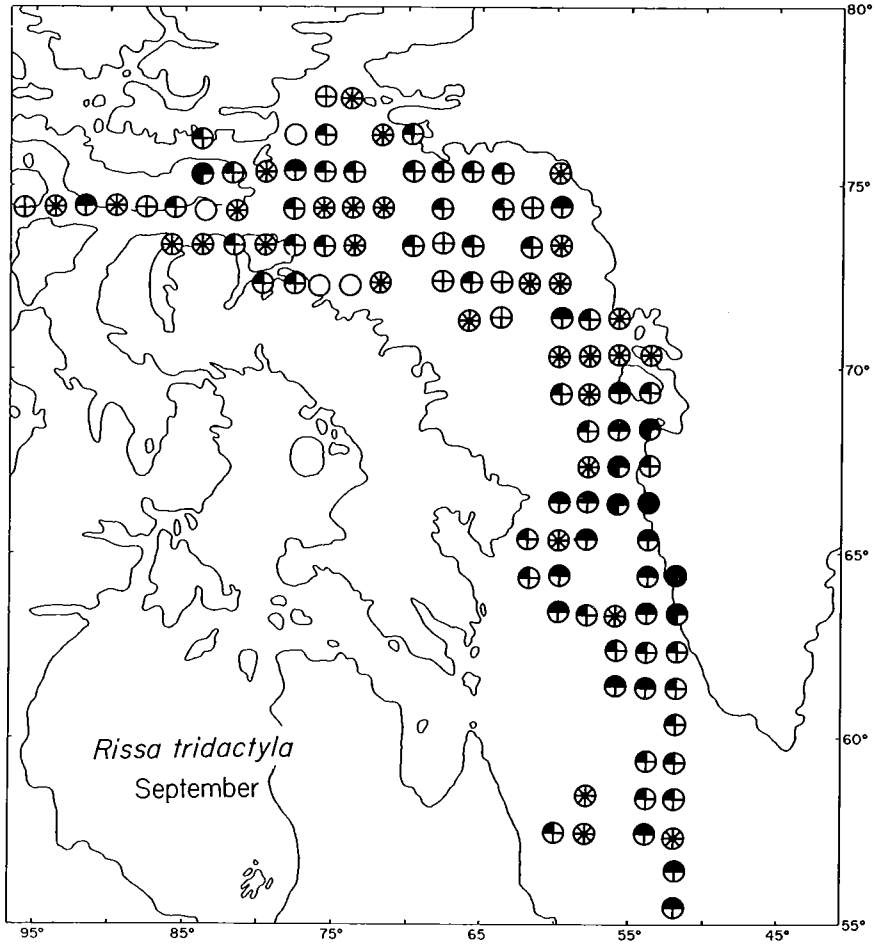


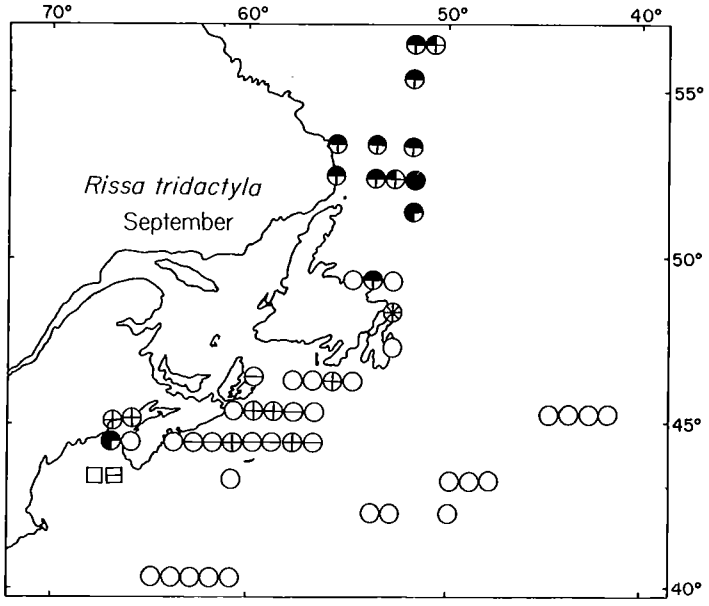

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Rissa tridactyla
August


70°
60°
50°
40°
55°
50°
45°
40°
Rissa tridactyla
August

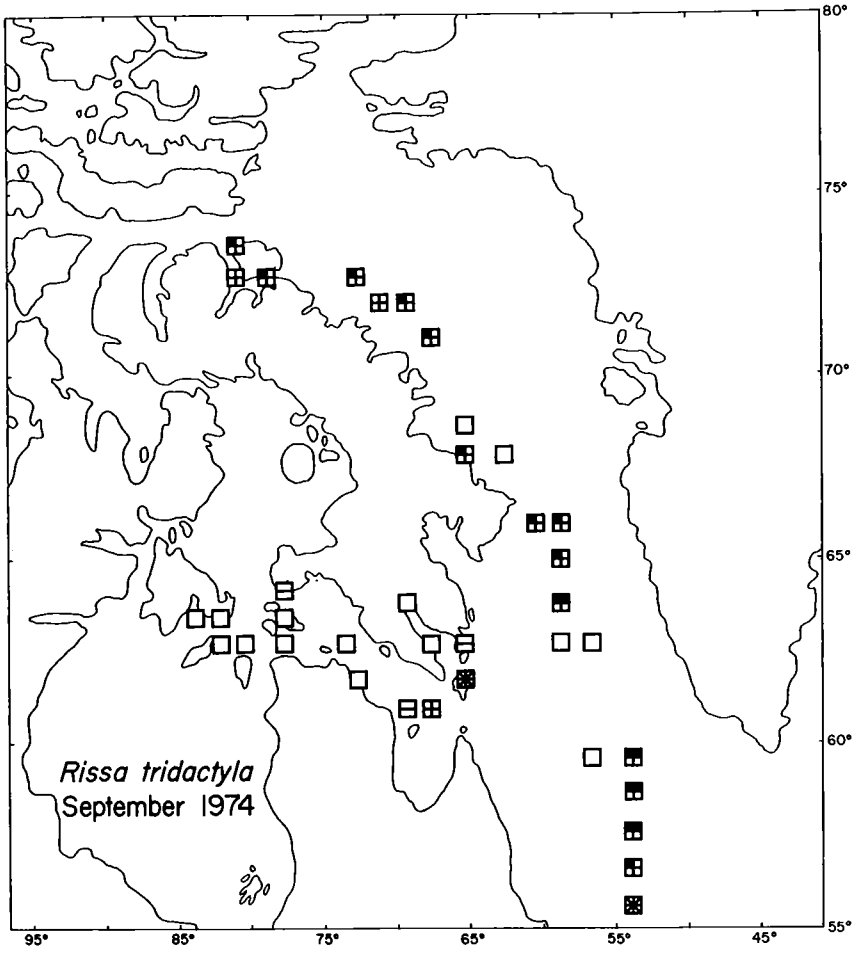
Map 25e
Black-legged Kittiwake

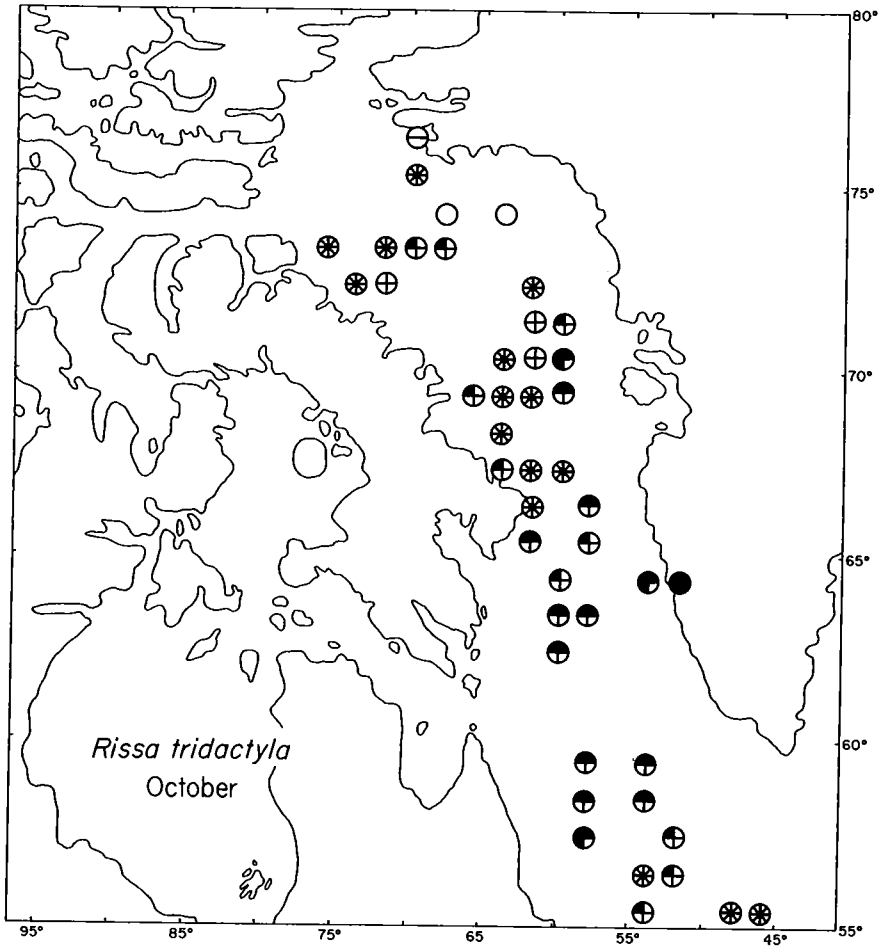


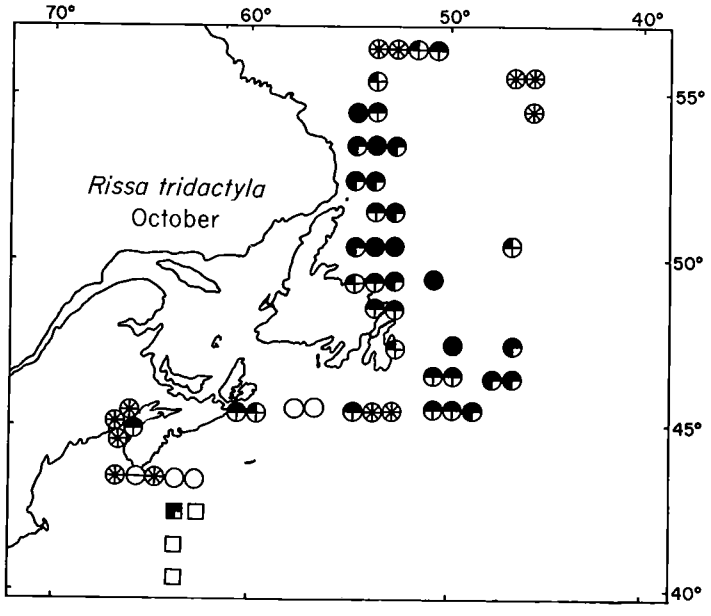

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Rissa tridactyla
September


70°
60°
50°
40°
55°
50°
45°
40°
Rissa tridactyla
September

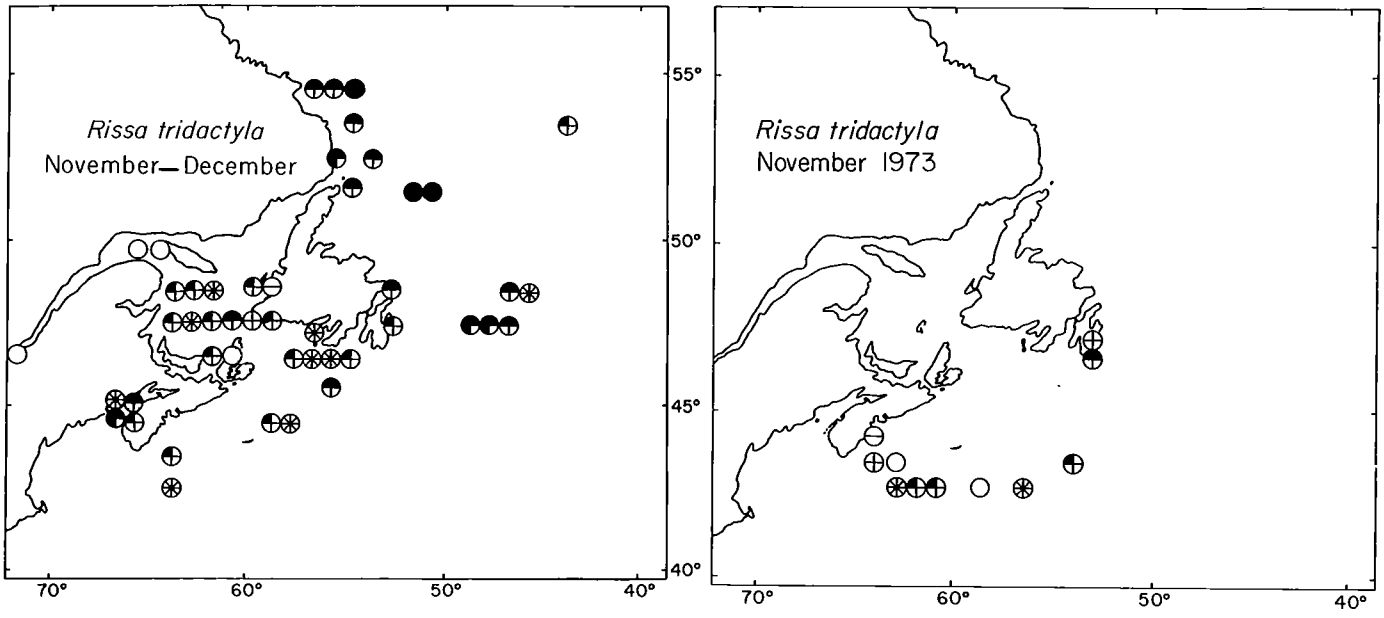
Map 25g
Black-legged Kittiwake




80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Rissa tridactyla
October

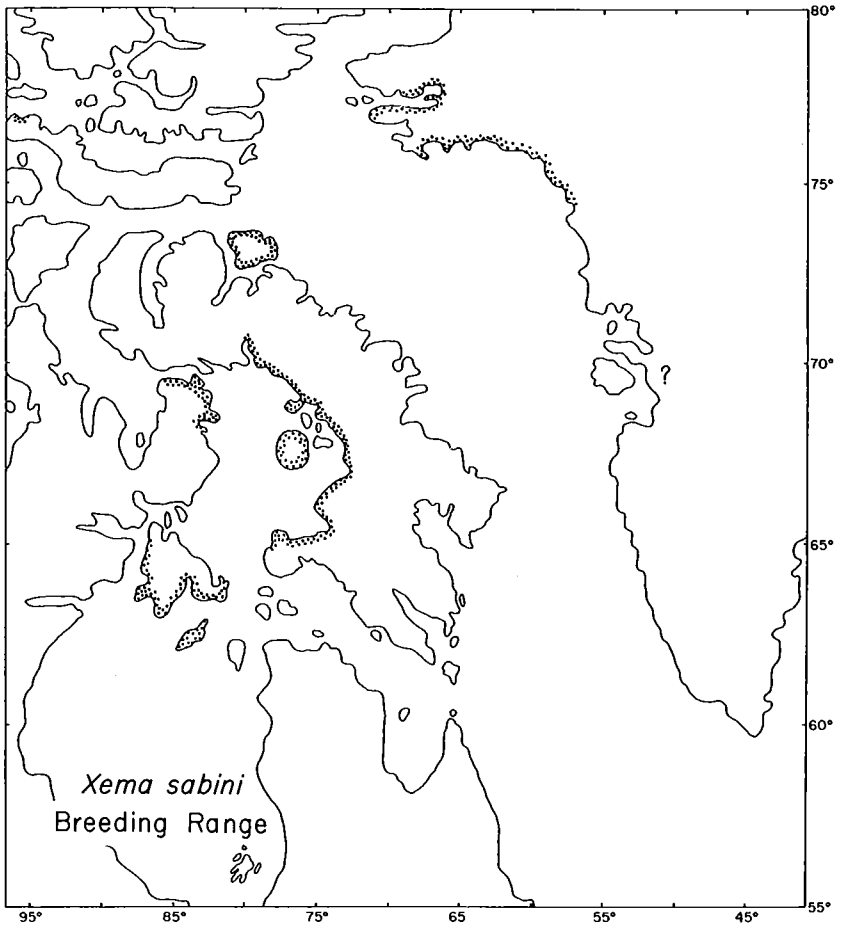

70°
60°
50°
40°
55°
50°
45°
40°
Rissa tridactyla
October

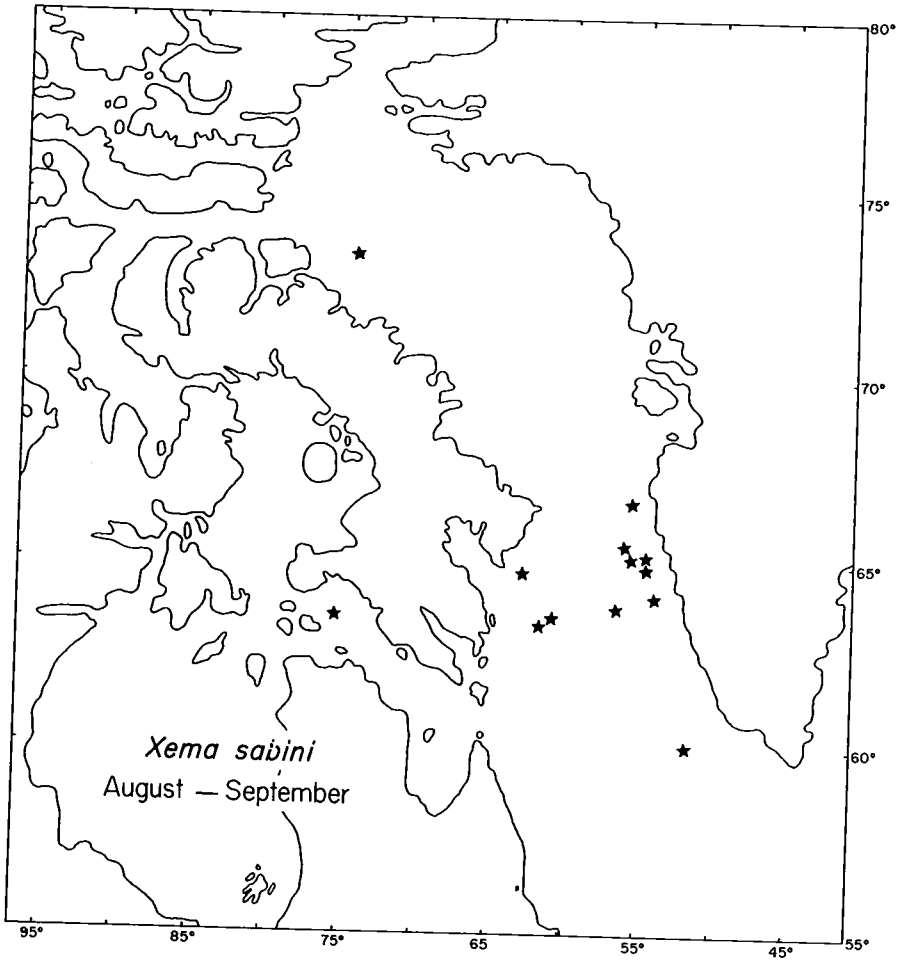
Map 25i
Black-legged Kittiwake

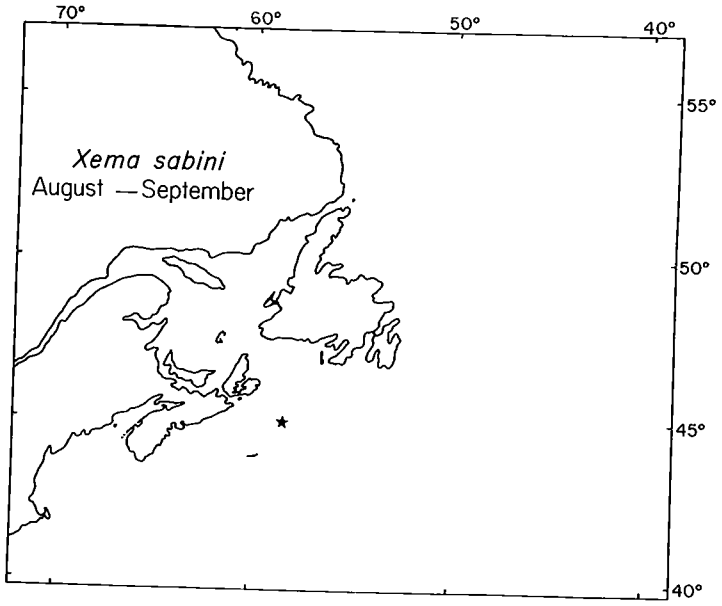


In the survey area Sabine's Gull breeds in scattered parts of northwest Greenland and the Canadian Arctic (Godfrey 1966, Nettleship 1974*b*, Salomonsen 1950, Tuck and Lemieux 1959). This population apparently winters off southwest Africa (Lambert 1973). Lambert shows that spring migrants reach eastern Canadian waters in May. Fall migration takes place in August, and the birds have left the Arctic by mid September. The scarcity of Atlantic records at this time supports Lambert's suggestion of a direct movement across to southwest Europe. But, as he points out, the occurrence of birds in the fall off New Brunswick, Nova Scotia and Maine may indicate another, overland migration route from the Arctic to the Atlantic.

Map 26a
Sabine's Gull
Breeding range




80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Xema sabini
August — September


70°
60°
50°
40°
55°
50°
45°
40°
Xema sabini
August — September

Common Tern	*Sterna hirundo*
Arctic Tern	*Sterna paradisaea*
Roseate Tern	*Sterna dougallii*
Caspian Tern	*Hydroprogne caspia*

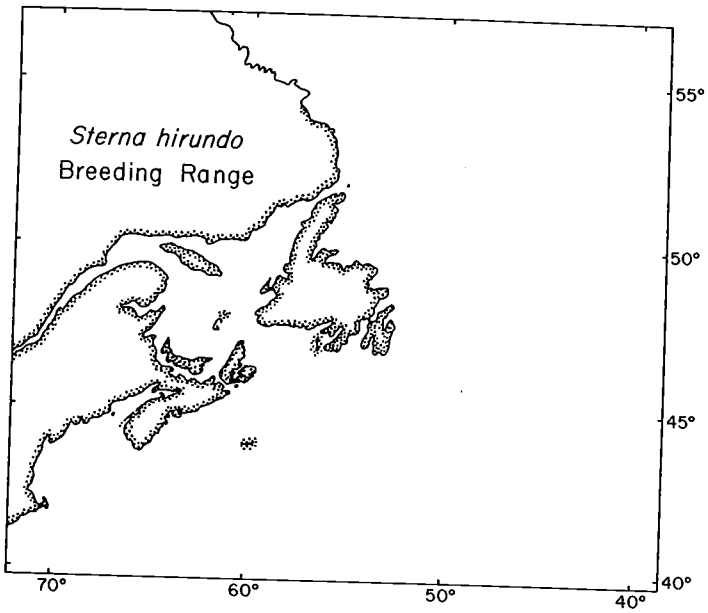
Breeding distributions

The Common Tern breeds in the Boreal and Cool Subtropical zone, and the Arctic Tern in the Low and High Arctic, though their ranges overlap in eastern Canada. In the western North Atlantic the Roseate Tern is a tropical and subtropical species which barely enters the Boreal zone; it breeds in very small numbers in Atlantic Nova Scotia, and on Wolf Island in the Magdalens (47°32′N, 61°42′W), but is otherwise not found north of New England. The Caspian Tern breeds mainly on inland waters in North America, but there is a small population breeding on the north shore of the Gulf of St. Lawrence and in Newfoundland. (Data from Drury 1973–74, Godfrey 1966, Lock 1971, Nettleship 1973*b*, Nettleship and Lock 1973*b*, Nettleship unpublished, Nisbet 1973, Salomonsen 1950, A.D. Smith pers. comm., Tuck 1967 and pers. comm.).

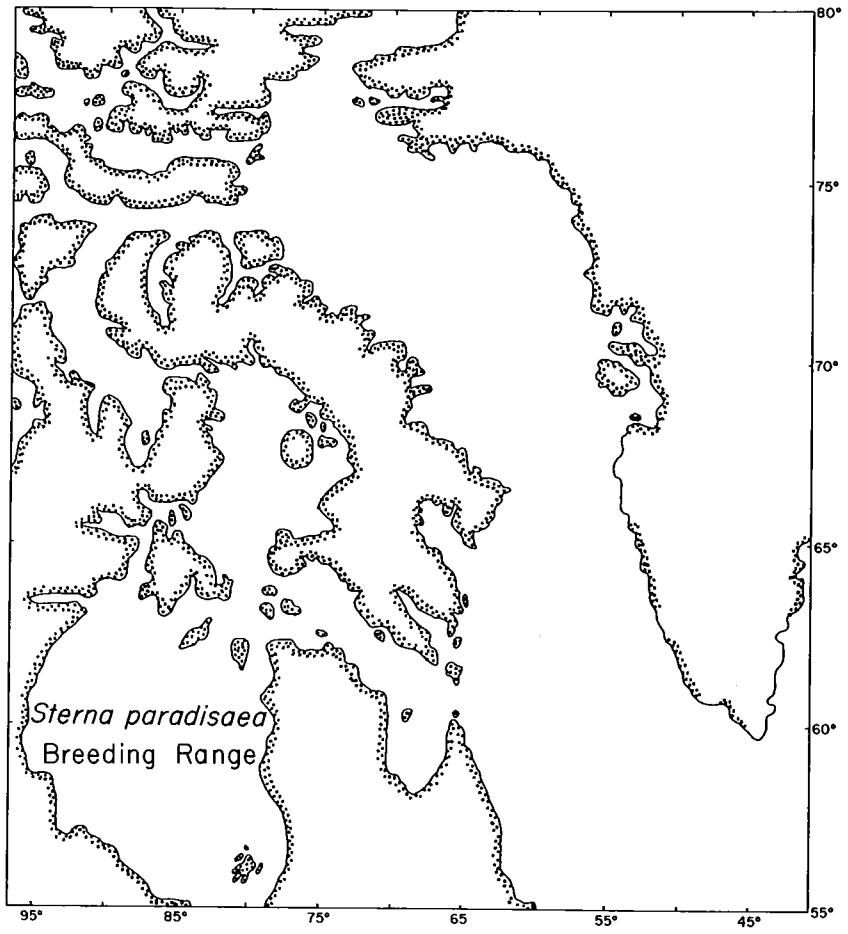
Pelagic distributions

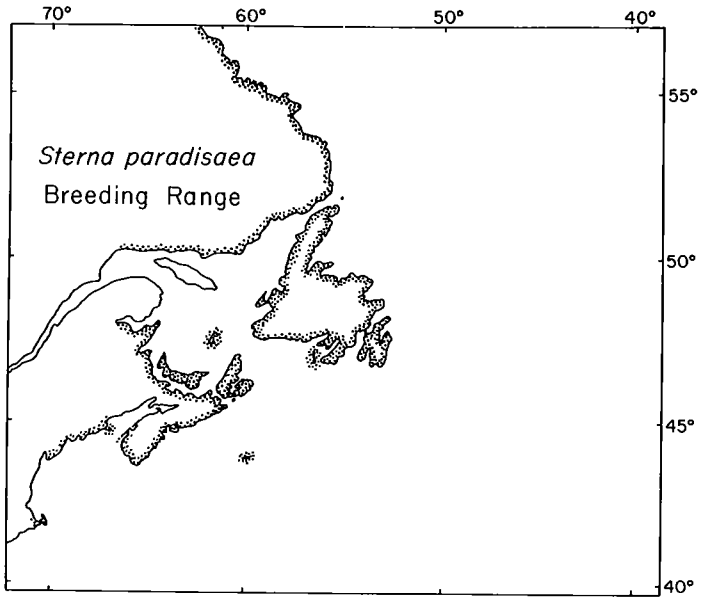
The pelagic maps combine the *Sterna* species, which are difficult to separate at sea; the Atlantic birds were probably Common or Arctic, and the Arctic area birds were Arctics. Appendix 2 gives the positive identifications in which we have most confidence. In general, terns reach the Atlantic waters off eastern Canada in May; most of them have left the survey area by early September.

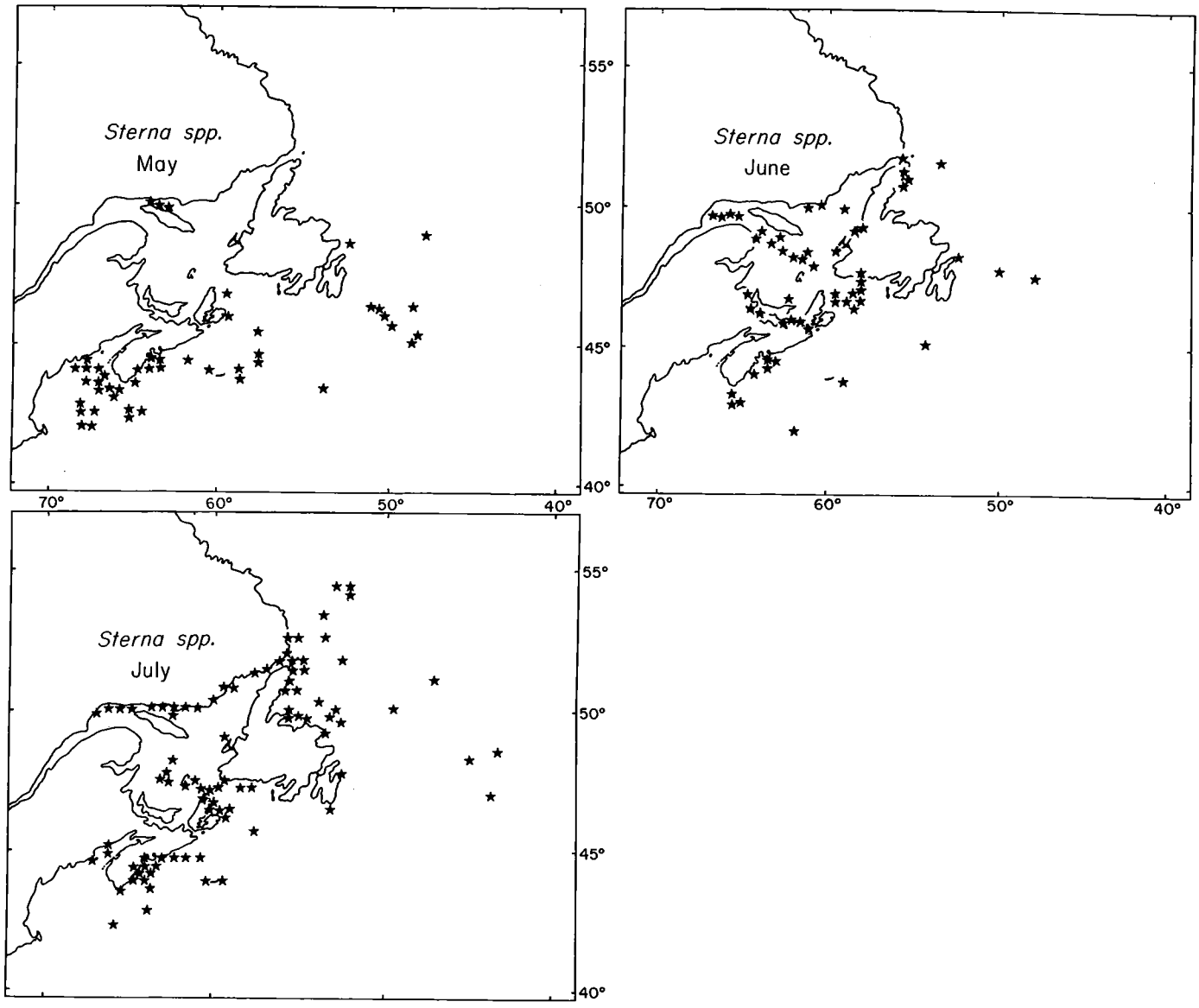
Map 27
Common Tern
Breeding range



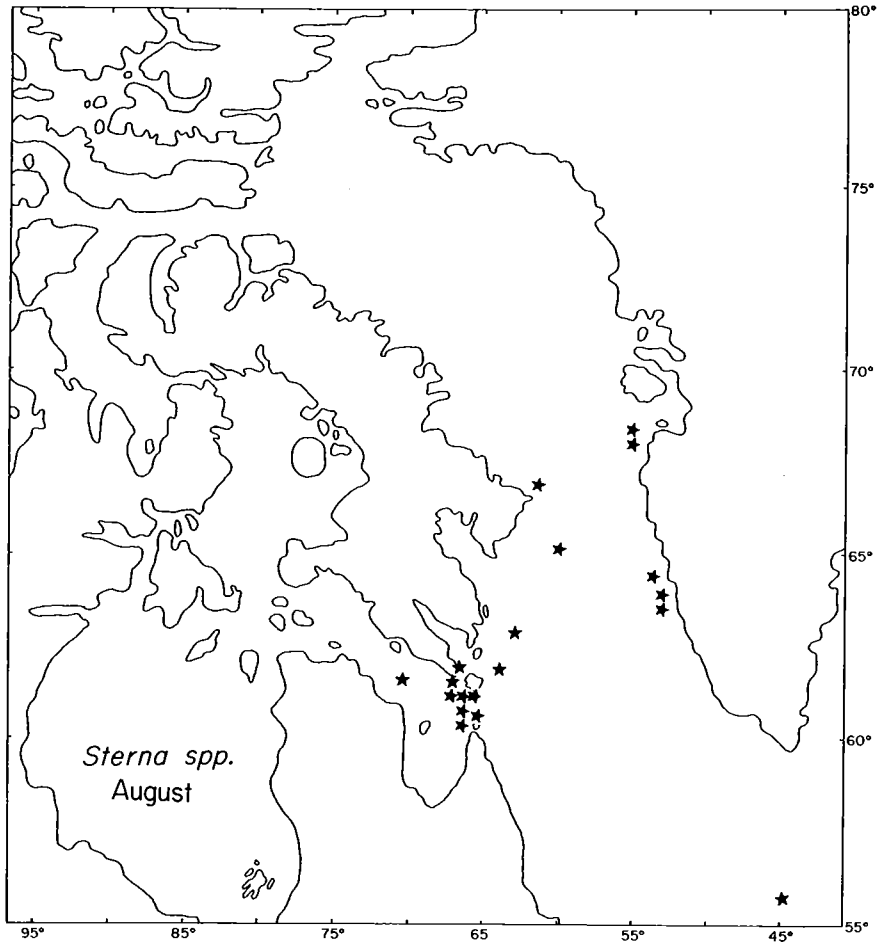
Map 28
Arctic Tern
Breeding range

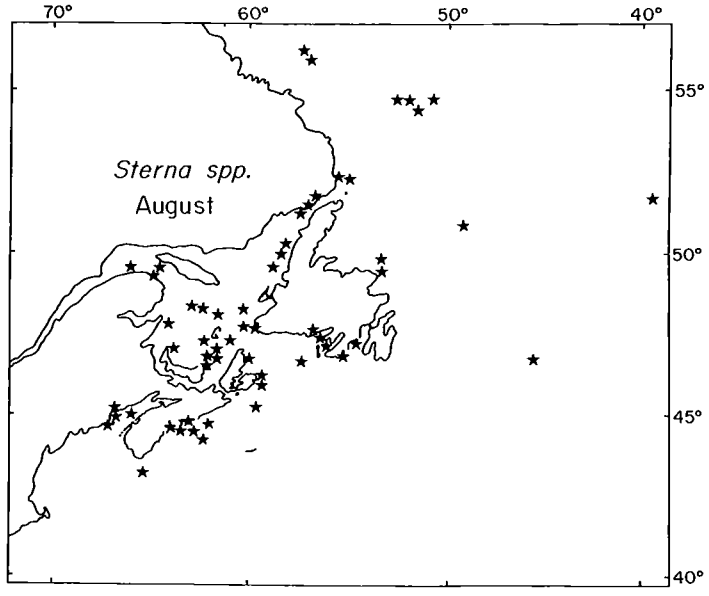


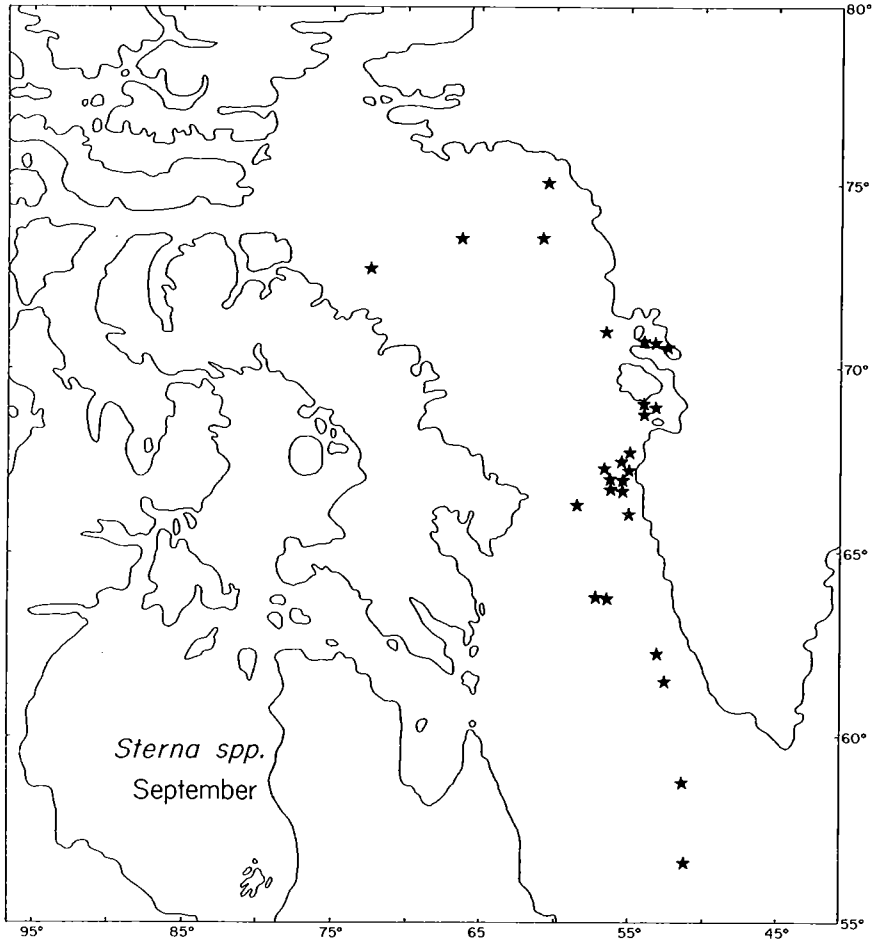


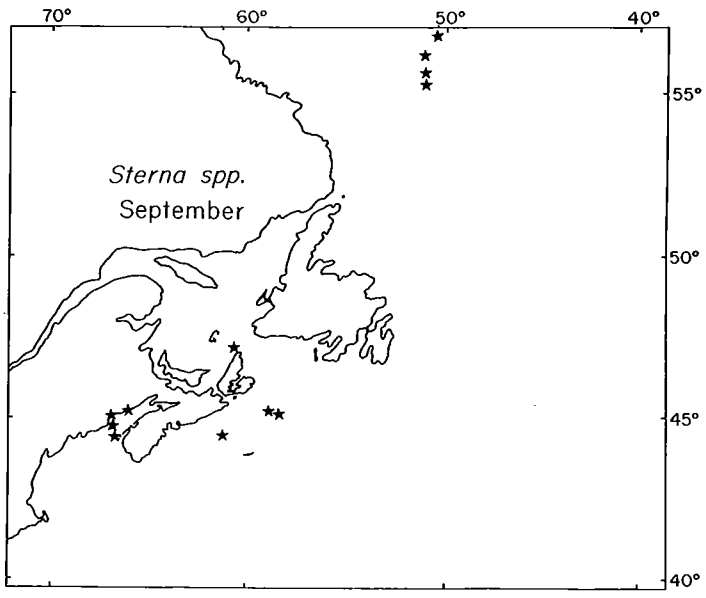

Sterna spp.
May
Sterna spp.
June
Sterna spp.
July
55°
50°
45°
40°
70°
60°
50°
40°

Map 29b
Terns





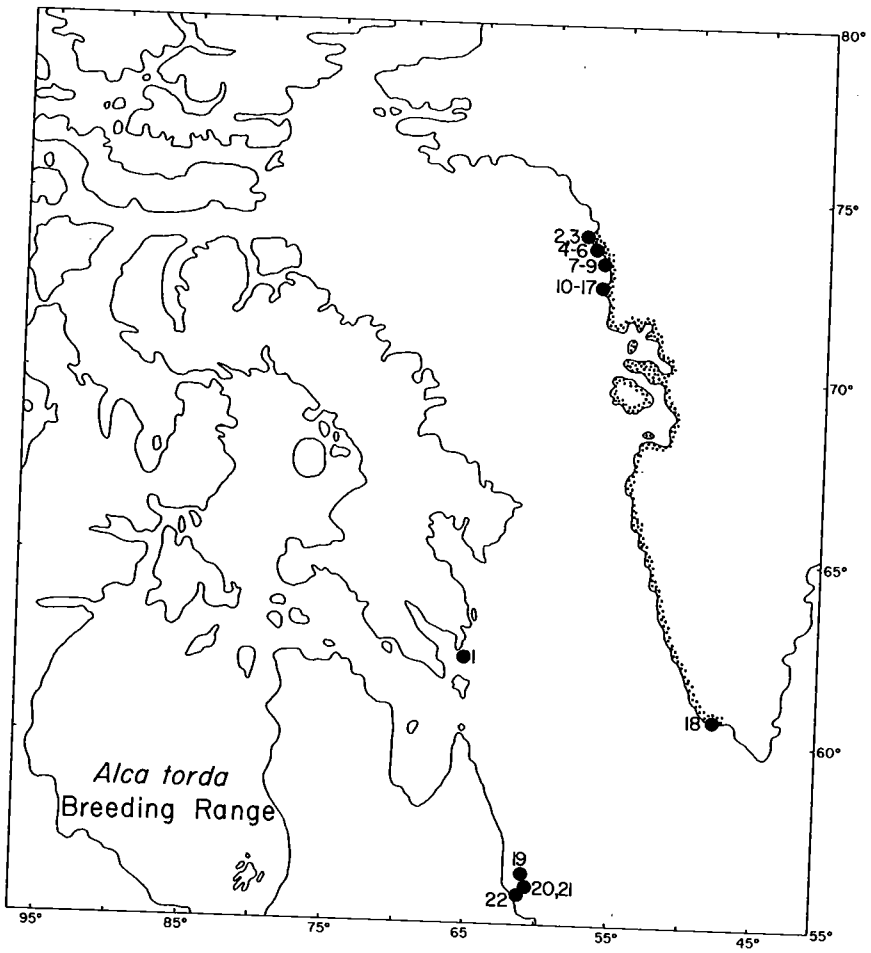

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Sterna spp.
September


70°
60°
50°
40°
55°
50°
45°
40°
Sterna spp.
September

The Razorbill breeds, usually in small colonies, throughout Atlantic Canada and up the Low Arctic coast of west Greenland. Only the positions of the northernmost Greenland colonies have been reported. Farther south Razorbills are commonest between c. 68° and 64°N; there are widely scattered colonies to the south of this, but the birds are absent from the southernmost tip of Greenland (Salomonsen 1950).

At sea, Razorbills are easily confused with the much more numerous murres; the pelagic maps therefore give only an incomplete picture of their distribution.

Map 30a
Razorbill
Breeding range



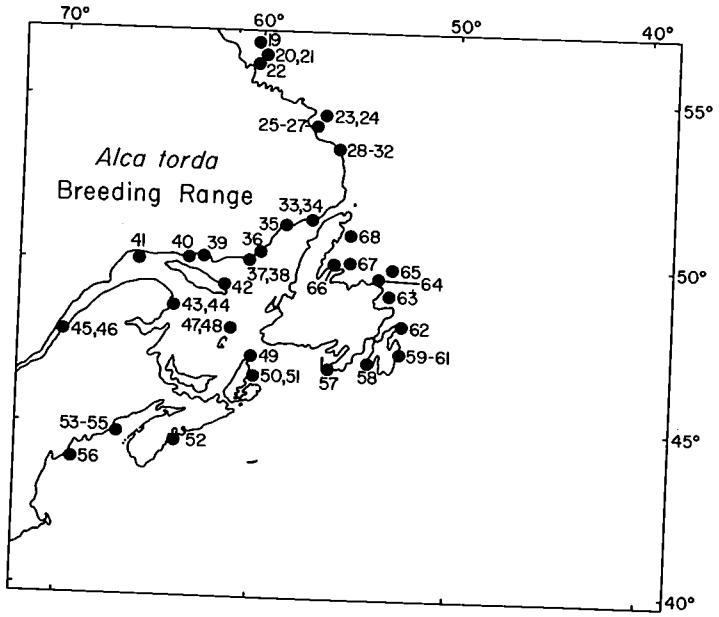


Table 6
Location and size of Razorbill (*Alca torda*) colonies. For further details see Table 1. An asterisk indicates that the colony was not plotted on the map

	Colony location	Position	Colony size	Census year	Authority
	Eastern Canadian Arctic:				
1.	Loks Land	62°21′N, 64°45′W	50p	1953	Wynne-Edwards in Godfrey 1966
	West Greenland:				
2.	Kitsigsorssuit (= Ederfugleoer)	74°02′N, 57°47′W	0[1]	1965	Joensen and Preuss 1972
3.	Agparssuit (= K. Shackleton)	73°49′N, 56°50′W	>50i	1965	Joensen and Preuss 1972
4.	Qiparqo (= Kipako)	73°43′N, 56°38′W	50–100i	1965	Joensen and Preuss 1972
5.	Tugtokortoq	73°40′N, 56°30′W	150p[2]	1936	Salomonsen 1950
6.	Agapalersalik (= Horse Head)	73°38′N, 57°00′W	50–75i	1965	Joensen and Preuss 1972
7.	Islet NE of Nutarmiut	73°33′N, 56°36′W	±40i	1965	Joensen and Preuss 1972
8.	Torqussârssuk	73°22′N, 56°36′W	150i	1965	Joensen and Preuss 1972
9.	Kingigtuarsuk III (= K. North)	73°15′N, 56°52′W	25i	1965	Joensen and Preuss 1972
10.	Nutarmiut	72°46′N, 55°03′W	>50i	1965	Joensen and Preuss 1972
11.	Nordø	72°44′N, 56°24′W	10–50i	1965	Joensen and Preuss 1972
12.	Umiasugssuk	72°46′N, 55°57′W	10–50i	1965	Joensen and Preuss 1972
13.	Qaersorssuaq (= Sanderson's Hope)	72°41′N, 56°11′W	10–50i	1965	Joensen and Preuss 1972
14.	Hvalø	72°41′N, 56°18′W	±15i	1965	Joensen and Preuss 1972
15.	Qôrnoq Kitdleq	72°41′N, 55°45′W	20i	1965	Joensen and Preuss 1972
16.	Umanaq	72°38′N, 55°17′W	>30i	1965	Joensen and Preuss 1972
17.	Ipernaq	72°28′N, 55°47′W	40i	1965	Joensen and Preuss 1972
18.	Qioqê I.	60°42′N, c.46°30′W	+[3]	1949	Salomonsen 1950

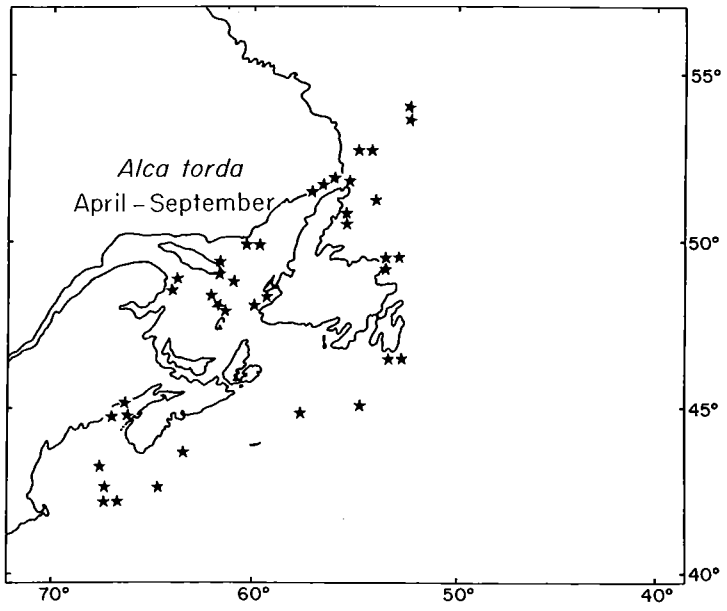
	Colony location	Position	Colony size	Census year	Authority
	Atlantic Canada, St. Pierre-Miquelon, and New England:				
19.	Negro I.	56°20′N, 60°32′W	10i	1928	Austin 1932
20.	Kidlit I.	56°11′N, 60°28′W	500i	1928	Austin 1932
21.	Nunarsuk I.	56°03′N, 60°27′W	150i	1953	Tuck in Bédard 1969
22.	Tinker I.	55°53′N, 60°35′W	100i	1952	Tuck in Bédard 1969
23.	Quaker Hat	54°44′N, 57°20′W	1,000i	1952	Tuck in Bédard 1969
24.	Tinker I.	54°42′N, 57°28′W	100i	1952	Tuck in Bédard 1969
25.	Green I.	54°23′N, 57°19′W	200i	1952	Tuck in Bédard 1969
26.	Herring I.	54°20′N, 57°06′W	4,000–5,000i	1952	Tuck in Bédard 1969
27.	Puffin I.	54°24′N, 57°22′W	20i	1928	Austin 1932
28.	Outer Gannet I.	54°00′N, 56°31′W	1,275p	1972	Nettleship and Lock
29.	Gannet Clusters	53°56′N, 56°31′W	5,460p	1972	Nettleship and Lock
30.	Wester Bird I.	53°44′N, 56°18′W	5,000i	1953	Tuck in Bédard 1969
31.	Little Bird I.	53°43′N, 56°15′W	300p	1972	Nettleship and Lock
32.	Bird I.	53°43′N, 56°15′W	900p	1972	Nettleship and Lock
33.	Greenly I.	51°23′N, 57°12′W	+	1972	Nettleship 1973, and Nettleship and Lock 1973*b*
34.	Perroquet I.	51°26′N, 57°15′W	±500p	1972	Nettleship 1973, and Nettleship and Lock 1973*b*
35.	St. Augustin Sanctuary	51°07′N, 58°33′W	5i	1972	Nettleship and Lock 1973*b*
36.	St. Mary Is.	50°19′N, 59°39′W	1,765i	1972	Nettleship and Lock 1973*b*
37.	Wolf Bay	50°10′N, 60°17′W	2,295i	1972	Nettleship and Lock 1973*b*
38.	Fog I.	50°10′N, 60°31′W	4i	1972	Nettleship and Lock 1973*b*
39.	Watshishu	50°16′N, 62°38′W	21i	1972	Nettleship and Lock 1973*b*

	Colony location	Position	Colony size	Census year	Authority
40.	Betchouane	50°12′N, 63°13′W	100i	1972	Nettleship and Lock 1973*b*
41.	Carrousel I.	50°05′N, 66°23′W	130i	1972	Nettleship and Lock 1973*b*
42.	Anticosti I., NE coast and Fox Bay	c.49°20′N, 61°40′W	+[4]	1937	Braund and McCullagh 1940
*	The Three Sisters	48°32′N, 64°13′W	1p	1974	Nettleship and Taylor
*	Percé Rock	48°30′N, 64°12′W	45p	1974	Nettleship and Taylor
43.	Bonaventure I.	48°29′N, 64°07′W	512p	1974	Nettleship and Taylor
44.	Cape Bon-Ami (= Cap-des-Rosiers)	48°57′N, 64°12′W	?	1938	Bédard 1969
45.	Brandy Pot Islets	47°52′N, 69°41′W	45p	1967	Reed 1973
46.	Pilgrim Is.	47°43′N, 69°45′W	500p	1970	Reed 1973
47.	Brion I., Magdalen Is.	47°48′N, 61°29′W	+	1958	Gaboriault 1961
48.	Bird Rocks, Magdalen Is.	47°51′N, 61°12′W	300i	1961	Audubon Field Notes 15(5): 451
49.	St. Paul I.	44°12′N, 64°09′W	+	1971	Lock 1971
50.	Ciboux I.	46°23′N, 60°22′W	50p	1971	Lock 1971
51.	Hertford I.	46°22′N, 60°23′W	?	1971	Lock 1971
52.	Pearl I.	44°23′N, 64°03′W	1p	1971	Lock 1971
53.	Yellow Murr Ledge	44°31′N, 66°52′W	100p	1935	Pettingill 1939

	Colony location	Position	Colony size	Census year	Authority
54.	Machias Seal I.	44°30′N, 67°06′W	47p	1974	Nettleship and Parker
55.	Old Man I., Machias Bay	44°29′N, 67°05′W	40i	1973	Drury 1973–74
56.	Matinicus Rock, Me.	43°47′N, 60°51′W	10i	1971	Buchheister in Drury 1973–74
57.	Grand Colombier I., St. Pierre I.	46°49′N, 56°10′W	+[5]	1964	Cameron 1967
58.	Cape St. Mary's	46°50′N, 54°12′W	100i	1959	Tuck in Bédard 1969
59.	Great I., Witless Bay	47°11′N, 52°49′W	120p	1973	Nettleship
60.	Green I., Witless Bay	47°15′N, 52°47′W	170p	1973	Nettleship
61.	Gull I., Witless Bay	47°16′N, 52°46′W	30p	1973	Nettleship
62.	Baccalieu I.	48°08′N, 52°48′W	500i	1960	Tuck in Bédard 1969
63.	South Cabot I. (= Little Cabot)	49°10′N, 53°22′W	?[6]	1973	Nettleship
64.	Wadham Is.	49°33′N, 53°51′W	?[7]	1973	Nettleship
65.	Funk I.	49°45′N, 53°51′W	±200p	1969	Nettleship
66.	Gull I., Cape St. John	50°00′N, 55°22′W	25p	1943	Peters and Burleigh 1951
67.	Tin Pot I., Coachman's Cove	50°03′N, 56°05′W	25p	1943	Peters and Burleigh 1951
68.	The Sisters, NE of Groais I.	50°59′N, 55°32′W	25p	1943	Peters and Burleigh 1951

1 A few pairs present in 1936: Salomonsen (1950).
2 Total for 2 colonies.
3 A few pairs present.
4 A common breeder.
5 Small numbers present.
6 None seen in 1973; 35p in 1945: Peters and Burleigh (1951).
7 None seen in 1973; 500i in 1959: Tuck in Bédard (1969).

Map 30b
Razorbill



Common Murre	*Uria aalge*
Thick-billed Murre	*Uria lomvia*

Breeding distributions

The Common Murre is a bird of the Boreal and Low Arctic zones (Tuck 1961), whose centre of distribution in the northwest Atlantic is in eastern Newfoundland. Small numbers of Thick-billed Murres also breed in Atlantic Canada, mainly in areas influenced by the Labrador Current, but the species is primarily High Arctic, with large colonies in the eastern Canadian Arctic and in west Greenland north of c. 70°N.

Pelagic distributions

We found it hard to distinguish between the two murre species at sea. For the purposes of this Atlas we have plotted positive identifications as "rarebirds", and have plotted all murres seen during 10-minute watches, irrespective of whether or not the species was identified, in the *Uria* spp. quantitative maps. It may be assumed that almost all the murres on the Arctic maps are Thick-billed (*e.g.* Tuck 1961, Tull *et al.* 1972).

Murres appear to leave their High Arctic colonies in Baffin Bay by the middle of September; judging from the banding returns (Tuck 1961, 1971), they cross to the Low Arctic waters off west Greenland. Tuck notes that Common Murres from eastern Newfoundland have a comparable post-breeding movement to southeast Labrador. The High Arctic birds presumably go to feed in the highly productive (and late-freezing) waters of the West Greenland Shelf; the existence of a developing capelin fishery off Labrador from September to November suggests that those waters too are productive (ICNAF 1952–74). Both migrations are of adults swimming in company with flightless young; the Baffin Bay birds presumably take advantage of the strong, southward-flowing Baffin Land Current (Fig. 2), and the Newfoundland birds would be helped by a northward-flowing eddy in the Labrador Current off northeast Newfoundland (Hachey 1961:50).

Tuck's banding returns show that Thick-billed Murres from colonies in Hudson Strait winter mainly off eastern Newfoundland, though some remain off west Greenland. West Greenland birds tend to winter off southern Newfoundland. By contrast many birds from the High Arctic colonies in the Lancaster Sound area (and also from the European Arctic (Salomonsen 1972)) winter off west Greenland. Since west Greenland is, so to speak, a focal point for a large proportion of the Atlantic population of Thick-billed Murres, it is particularly unfortunate that the birds there have recently been subjected to a massive mortality; Tull *et al.* (1972) estimate that of the order of 500,000 birds a year are drowned in the fall in gill nets set for salmon.

Thick-billed Murres reach eastern Newfoundland in November. Their distributions from January onwards are influenced by the southward drift of pack ice off the Newfoundland coast (Fig. 4). Our maps suggest that the birds stay clear of this, but nonetheless tend to remain in areas influenced by the Labrador Current. Thick-billed Murres move north again in May, when a spectacular northwestward migration can be seen in the Labrador Sea (Brown 1968).

Map 31a
Common Murre
Breeding range

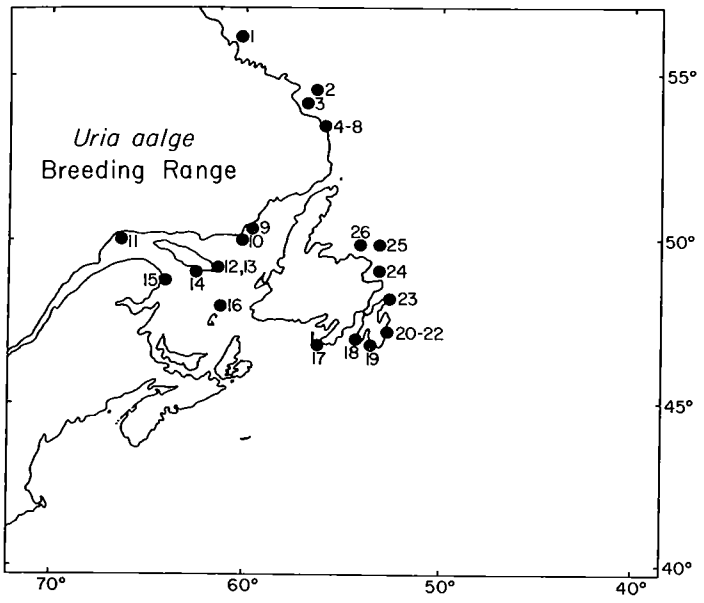
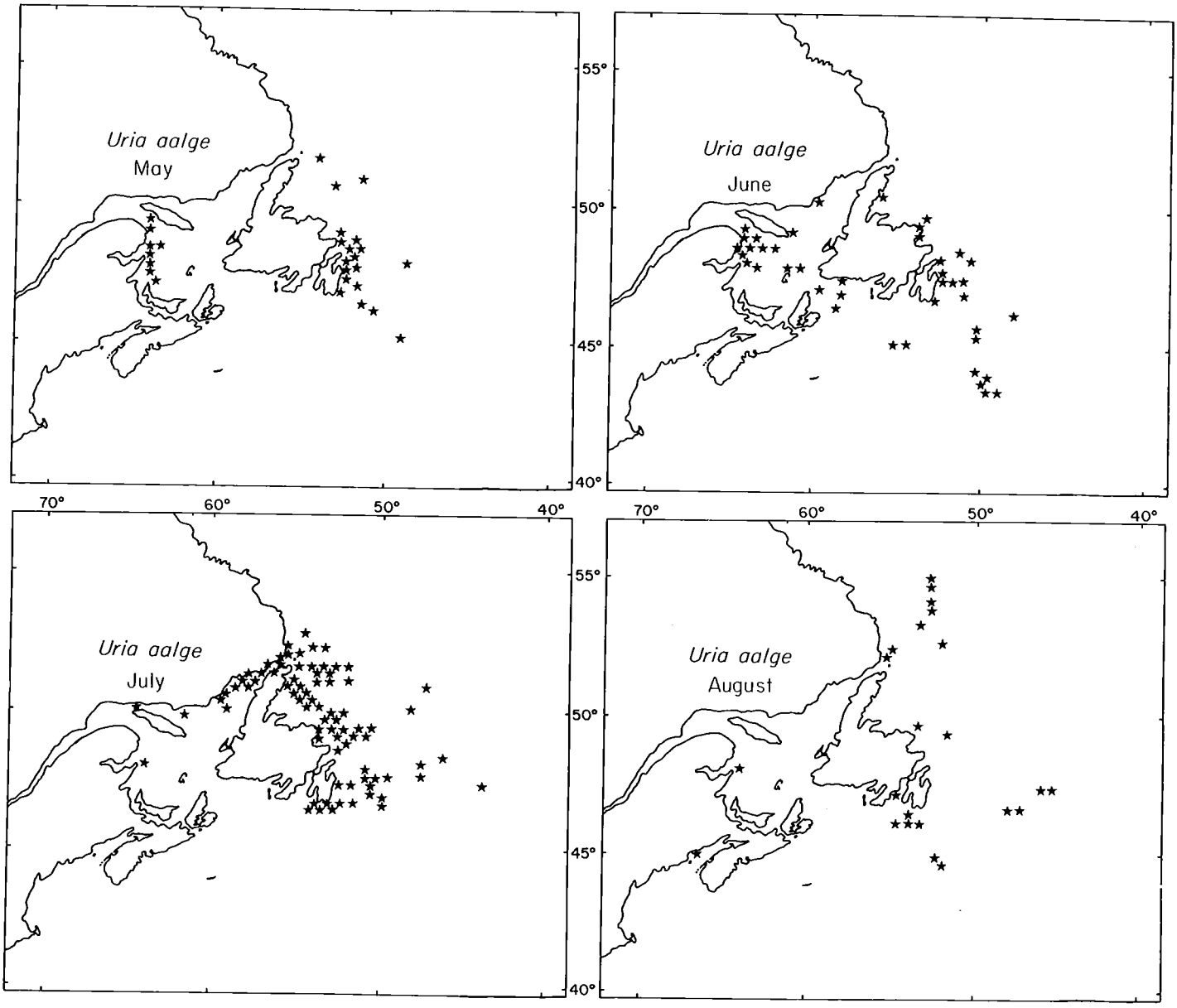


Table 7
Location and size of Common Murre (*Uria aalge*) colonies. For further details see Table 1

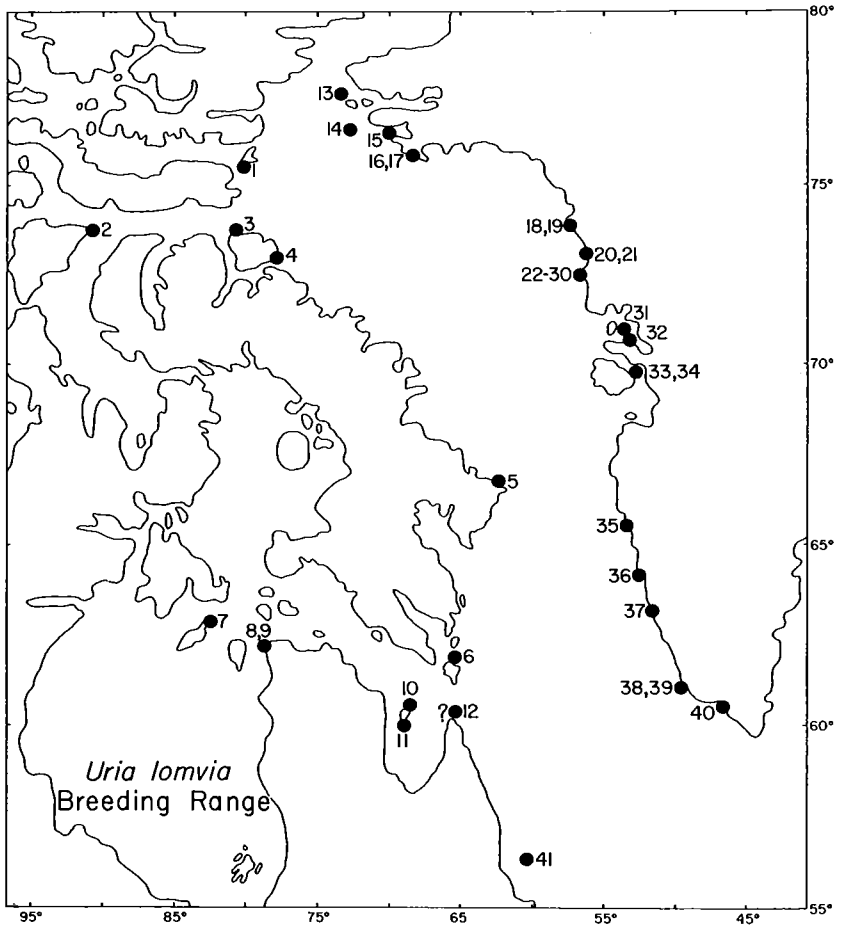
	Colony location	Position	Colony size	Census year	Authority
	Atlantic Canada and St. Pierre-Miquelon:				
1.	Nunarsuk I.	56°03′N, 60°27′W	150p	1953	Tuck 1961
2.	Quaker Hat	54°44′N, 57°20′W	30p	1952	Tuck 1961
3.	Herring I.	54°20′N, 57°06′W	475p	1952	Tuck 1961
4.	Outer Gannet I.	54°00′N, 56°31′W	17,700p	1972	Nettleship and Lock
5.	Gannet Clusters	53°56′N, 56°31′W	17,500p	1972	Nettleship and Lock
6.	Wester Bird I.	53°44′N, 56°18′W	50p	1953	Tuck 1961
7.	Little Bird I.	53°43′N, 56°15′W	725p	1972	Nettleship and Lock
8.	Bird I.	53°43′N, 56°15′W	250p	1972	Nettleship and Lock
9.	St. Mary Is.	50°19′N, 59°39′W	4,120i	1972	Nettleship and Lock 1973*b*
10.	Wolf Bay	50°10′N, 60°17′W	1,510i	1972	Nettleship and Lock 1973*b*
11	Carrousel I.	50°05′N, 66°23′W	4i	1972	Nettleship and Lock 1973*b*
12.	Gullcliff Bay, Anticosti I.	49°09′N, 61°42′W	?[1]	1972	Nettleship
13.	Heath Point, Anticosti I.	49°05′N, 61°42′W	2i	1972	Nettleship
14.	Shallop R., Anticosti I.	49°08′N, 62°32′W	?[2]	1972	Nettleship
15.	Bonaventure I.	48°29′N, 64°07′W	17,162p	1974	Nettleship and Taylor
16.	Bird Rocks, Magdalen Is.	47°51′N, 61°12′W	500–1,000i	1973	Nettleship
17.	Grand Colombier I., St. Pierre I.	46°49′N, 56°10′W	40i	1964	Cameron 1967
18.	Cape St. Mary's	46°50′N, 54°12′W	2,500p	1959	Tuck 1961
19.	Western Head, St. Mary's Bay	46°38′N, 53°37′W	>100i	1973	Nettleship
20.	Great I., Witless Bay	47°11′N, 52°49′W	2,800p	1973	Nettleship

	Colony location	Position	Colony size	Census year	Authority
21.	Green I., Witless Bay	47°15′N, 52°47′W	74,000p	1973	Nettleship
22.	Gull I., Witless Bay	47°16′N, 52°46′W	680p	1973	Nettleship
23.	Baccalieu I.	48°08′N, 52°48′W	2,500p	1959	Tuck 1961
24.	South Cabot I. (= Little Cabot)	49°10′N, 53°22′W	2,000p	1973	Nettleship
25.	Funk I.	49°45′N, 53°51′W	500,000p	1959	Tuck 1961
26.	Guppy Islets	49°47′N, 54°17′W	25i	1973	Nettleship

1 100p in 1937: Braund and McCullagh (1940).
2 75p in 1937: Braund and McCullagh (1940).


Uria aalge
May
Uria aalge
June
Uria aalge
July
Uria aalge
August
55°
50°
45°
40°
70°
60°
50°
40°

Map 32a
Thick-billed Murre
Breeding range



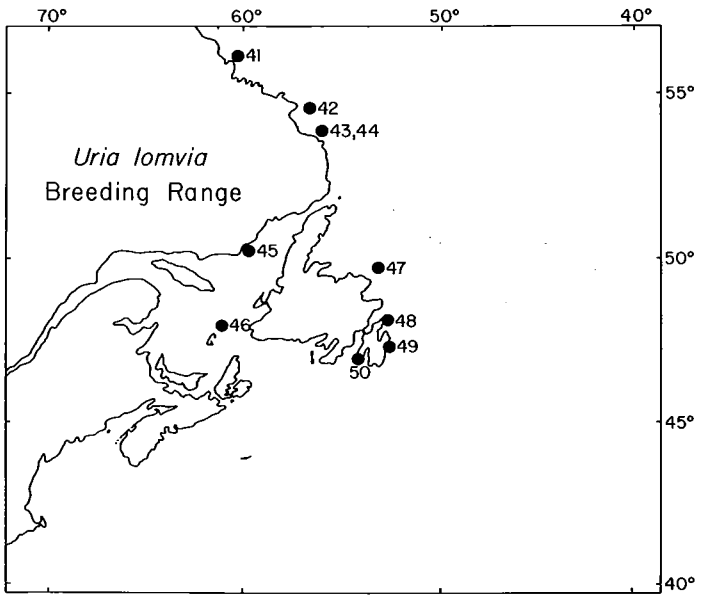


Table 8
Location and size of Thick-billed Murre (*Uria lomvia*) colonies.
For further details see Table 1

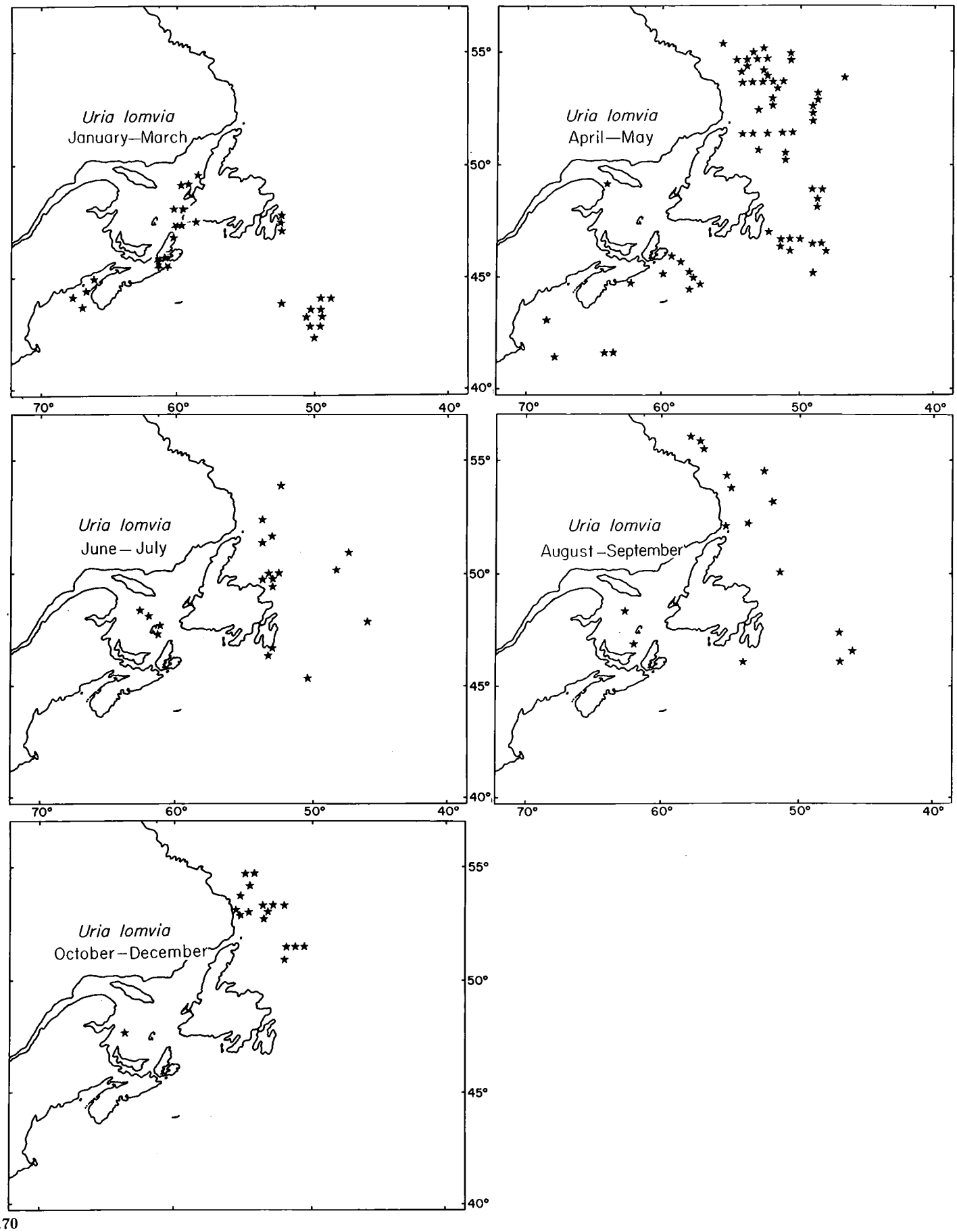
	Colony location	Position	Colony size	Census year	Authority
	Eastern Canadian Arctic:				
1.	Cambridge Pt., Coburg I.	75°48′N, 79°25′W	±200,000p	1973	Nettleship
2.	Prince Leopold I.	74°02′N, 90°00′W	±75,000p	1972	Nettleship
3.	W of Cape Hay, Bylot I.	73°46′N, 80°23′W	400,000p[1]	1957	Tuck 1961
4.	Cape Graham Moore, Bylot I.	72°56′N, 76°02′W	±20,000p (order 5)	1972	Nettleship
5.	Reid Bay, Baffin I.	66°56′N, 61°46′W	±200,000p[2] (order 6)	1973	Nettleship
6.	'Hantzsch' I.	61°55′N, 65°00′W	±50,000p (order 5)	1973	Nettleship
7.	Cape Pembroke, Coats I.	62°57′N, c.82°00′W	±15,000p[3] (order 5)	1972	Nettleship
8.	Digges I., Digges Sound	62°33′N, 77°43′W	600,000p[4]	1955	Tuck 1961 and pers. comm.
9.	Cape Wolstenholme, Digges Sound	62°32′N, 77°31′W	400,000p[4]	1955	Tuck 1961 and pers. comm.
10.	North Colony, Akpatok I.	60°34′N, 68°00′W	450,000p[4]	1954	Tuck 1961
11.	South Colony, Akpatok I.	60°15′N, 68°15′W	150,000p[4]	1954	Tuck 1961
12.	Button Is.	c.60°40′N, 64°40′W	?[5]	1934	Gross 1937
	West Greenland:				
13.	Hakluyt I.	77°25′N, 72°38′W	+[6]	1936	Salomonsen 1950
14.	Breaks, Carey Is.	c.76°35′N, 72°40′W	20,000p[7]	1936	Salomonsen 1950
15.	Saunders' I.	76°33′N, 69°50′W	200,000p	1936	Salomonsen 1950
16.	Igsivigsoq, Parker Snow Bay	c.76°09′N, 68°40′W	+[8]	1936	Salomonsen 1950
17.	Agpat	76°05′N, 68°20′W	100,000p	1936	Salomonsen 1950
18.	Agparssuit (= Kap Shackleton)	73°49′N, 56°50′W	970,000i [9]	1965	Joensen and Preuss 1972
19.	Qiparqo (= Kipako)	73°43′N, 56°38′W	17,500i [9]	1965	Joensen and Preuss 1972

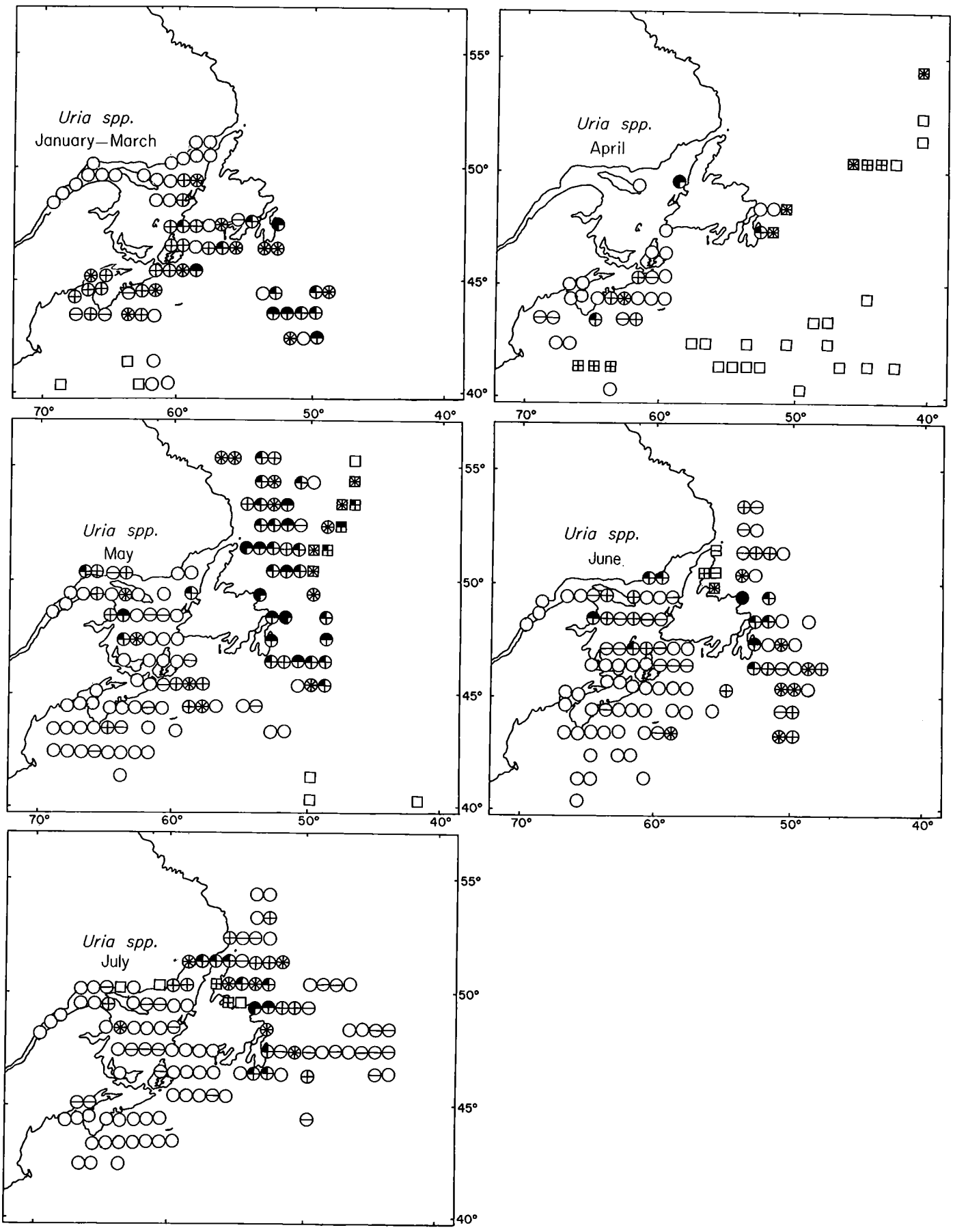
	Colony location	Position	Colony size	Census year	Authority
20.	Torqussâq	73°26′N, 56°35′W	2,150i [9]	1965	Joensen and Preuss 1972
21.	Kingigtaurssuk III (= K. North)	73°15′N, 56°52′W	1,000i [9]	1965	Joensen and Preuss 1972
22.	Kingigtaurssuk II (= K. Middle)	72°56′N, 56°40′W	3,500i [9]	1965	Joensen and Preuss 1972
23.	Angissoq	72°54′N, 56°23′W	200i [9]	1965	Joensen and Preuss 1972
24.	Umiasugssuk	72°46′N, 55°57′W	0[10]	1965	Joensen and Preuss 1972
25.	Agpatsiat	72°42′N, 55°51′W	8,700i [9]	1965	Joensen and Preuss 1972
26.	Qôrnoq Kitdleq	72°41′N, 55°45′W	525i	1965	Joensen and Preuss 1972
27.	Qaersorssuaq (= Sanderson's Hope)	72°41′N, 56°11′W	27,200i [9]	1965	Joensen and Preuss 1972
28.	Agparssuit at Kingigtoq	72°40′N, 55°53′W	6,350i [9]	1965	Joensen and Preuss 1972
29.	Tingmiakulugssuit, Nutarmiut	72°39′N, 55°47′W	6,800i [9]	1965	Joensen and Preuss 1972
30.	Umanaq	72°38′N, 55°17′W	50i	1965	Joensen and Preuss 1972
31.	Colonies near Umanaq		14,000p[11]	1936	Salomonsen 1950
32.	Sagdleq I.	70°56′N, 52°18′W	>150,000p[12]	1949	Salomonsen 1950
33.	Ivnaq, Arveprinsens I.	c.69°48′N, 51°15′W	50,000p	1946	Salomonsen 1950
34.	Colonies near Arveprinsens I.		+[13]	1936	Salomonsen 1950
35.	Sermilinguaq Fjord	c.65°37′N, 52°45′W	5,000p	1946	Salomonsen 1950

	Colony location	Position	Colony size	Census year	Authority
36.	North of Utorqarmiut	c.63°40′N, 51°28′W	30p	1949	Møller in Salomonsen 1950
37.	Kingigtuarssuk I., off Fiskenaesset	63°05′N, 50°40′W	+	1949	Salomonsen 1950
38.	Kangeq South	61°25′N, 48°58′W	4,000p	1949	Salomonsen 1950
39.	Islet off Sermersût I.	61°18′N, 48°50′W	1,000p	1949	Salomonsen 1950
40.	Qioqê I.	60°42′N, c.46°30′W	1,000p	1949	Salomonsen 1950
	Atlantic Canada:				
41.	Nunarsuk I.	56°03′N, 60°27′W	175p	1953	Tuck 1961
42.	Quaker Hat	54°44′N, 57°20′W	75p	1952	Tuck 1961
43.	Outer Gannet I.	54°00′N, 56°31′W	±475p	1972	Nettleship and Lock
44.	Gannet Clusters	53°56′N, 56°31′W	0[14]	1972	Nettleship and Lock
45.	St. Mary Is.	50°19′N, 59°39′W	0[15]	1972	Nettleship and Lock
46.	Bird Rocks, Magdalen Is.	47°51′N, 61°12′W	500–1,000i	1973	Nettleship
47.	Funk I.	49°45′N, 53°51′W	250p	1959	Tuck 1961
48.	Baccalieu I.	48°08′N, 52°48′W	+	1959	Tuck 1961
49.	Green I., Witless Bay	47°15′N, 52°47′W	600p	1973	Nettleship
50.	Cape St. Mary's	46°50′N, 54°12′W	285p	1959	Tuck 1961

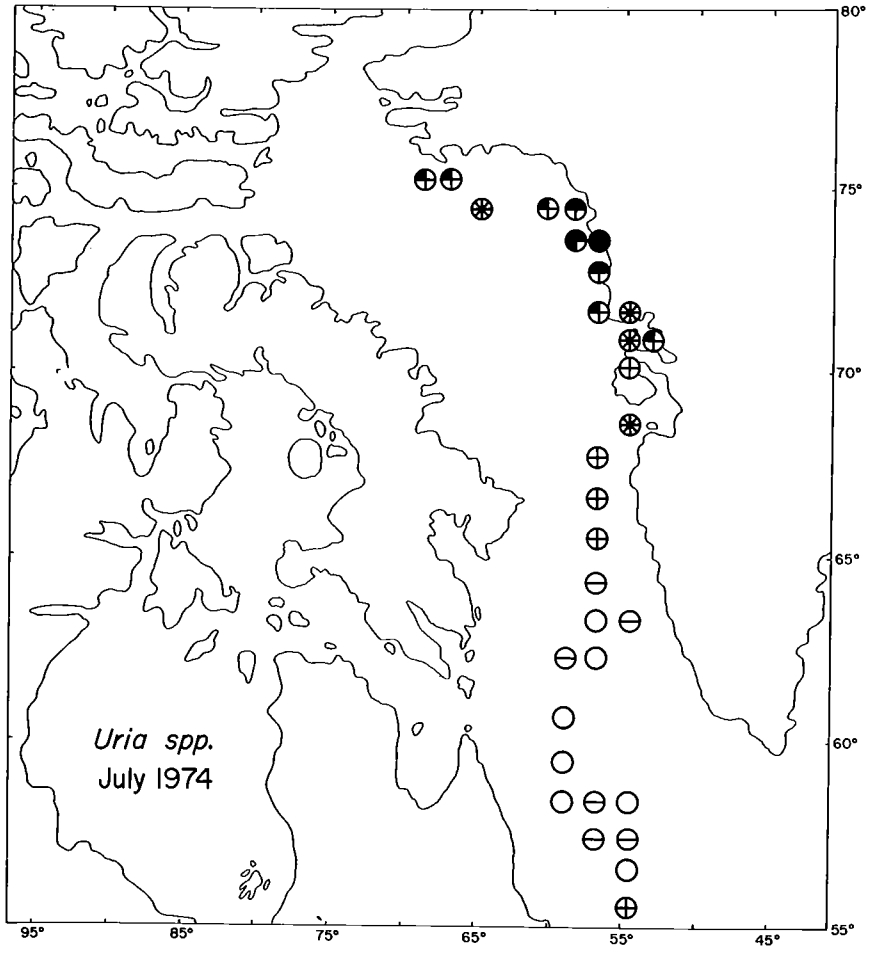
[1] Preliminary analysis of Nettleship's 1972 and 1973 surveys suggests a population decline since Tuck's count.
[2] Total for 2 colonies.
[3] Total for 2 colonies.
[4] Preliminary analysis of Nettleship's 1972 surveys suggests a population decline since Tuck's count.
[5] Small numbers suspected breeding in 1934: Gross (1934).
[6] Fairly large numbers.
[7] Total for 5–9 colonies.
[8] Small colonies present.
[9] Salomonsen's 1936 survey showed substantially greater numbers.
[10] 100–1,500p in 1936: Salomonsen (1950).
[11] Total for 7 colonies.
[12] Probably close to 250,000p.
[13] 5 small colonies ranging from 10–200p.
[14] 15p in 1952: Tuck (1961).
[15] 2i in 1947: Gabrielson (1952).

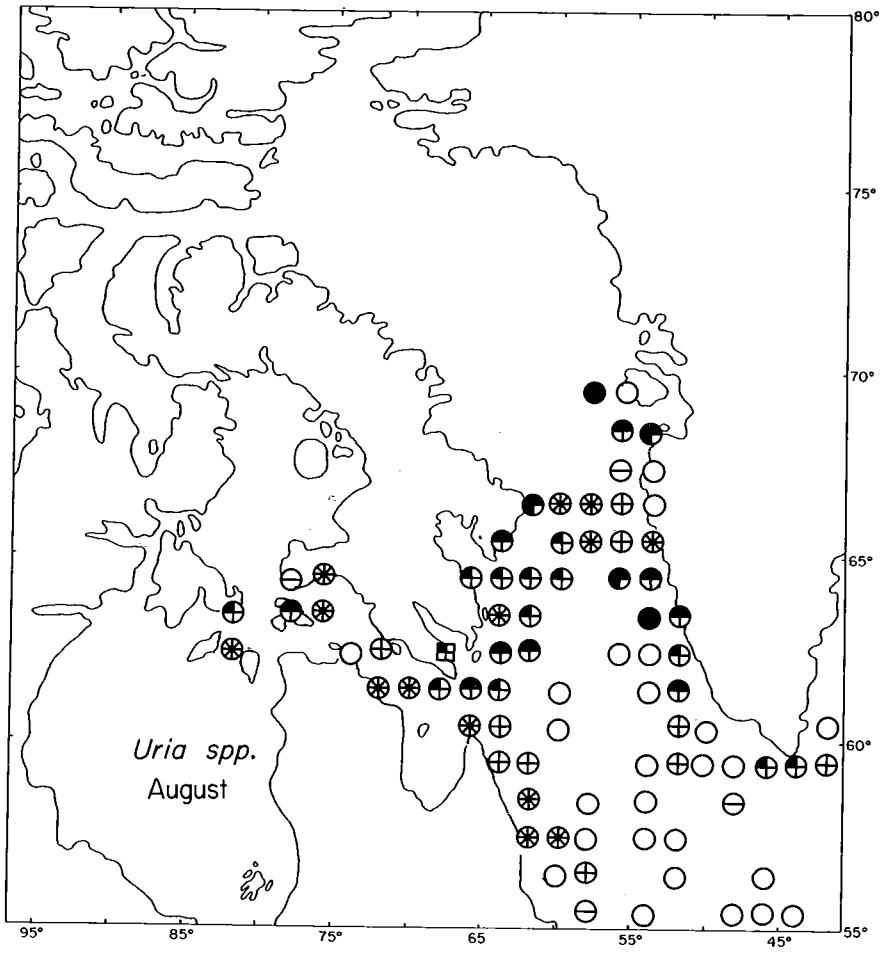
Map 32b
Thick-billed Murre

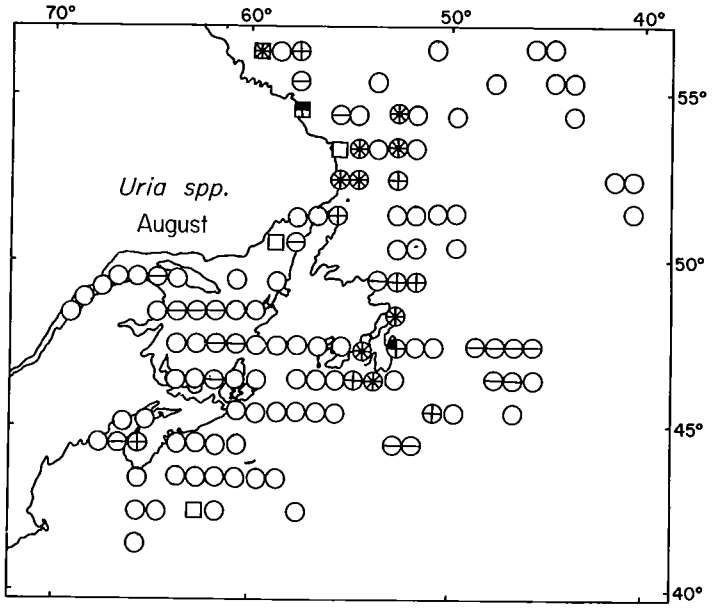



Uria spp.
January—March
Uria spp.
April
Uria spp.
May
Uria spp.
June
Uria spp.
July
55°
50°
45°
40°
70°
60°
50°
40°

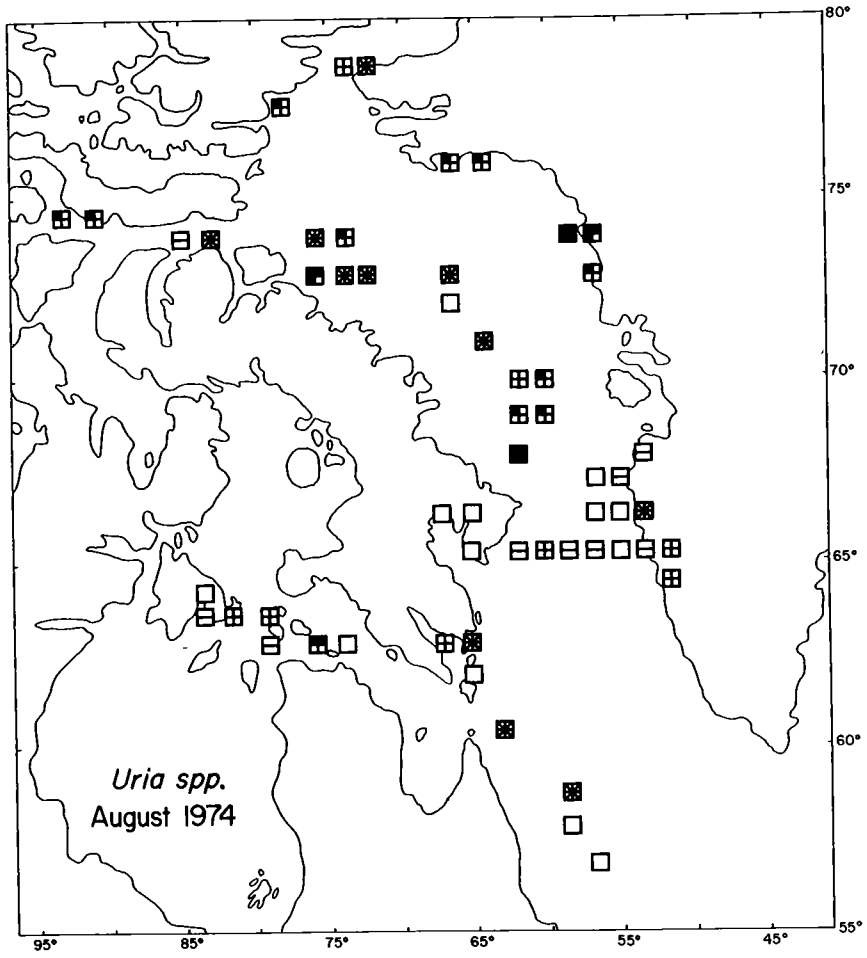
Map 33b
Murres

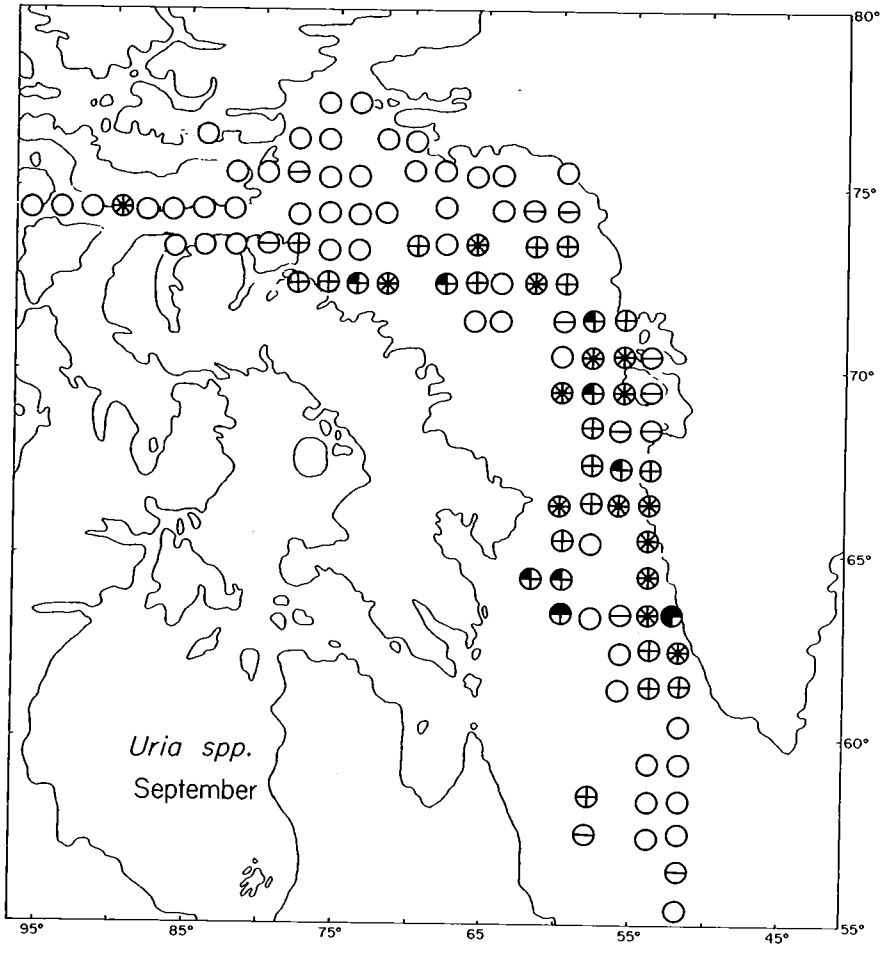


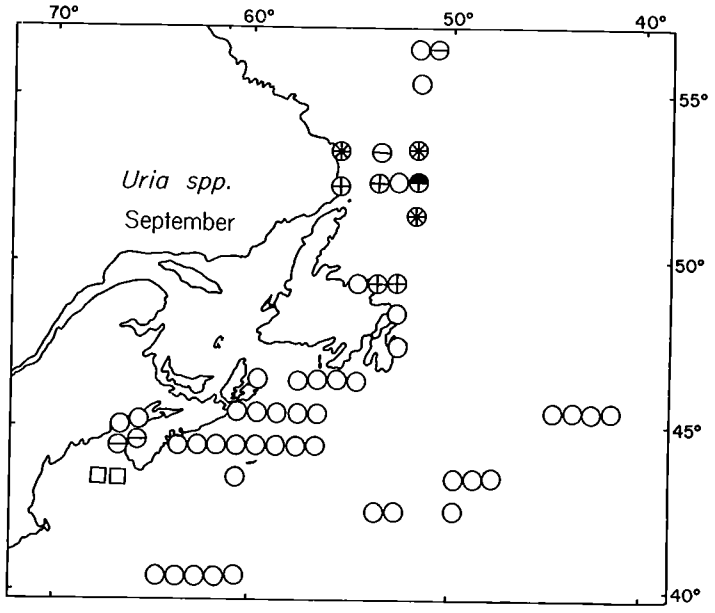

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Uria spp.
August


70°
60°
50°
40°
55°
50°
45°
40°
Uria spp.
August

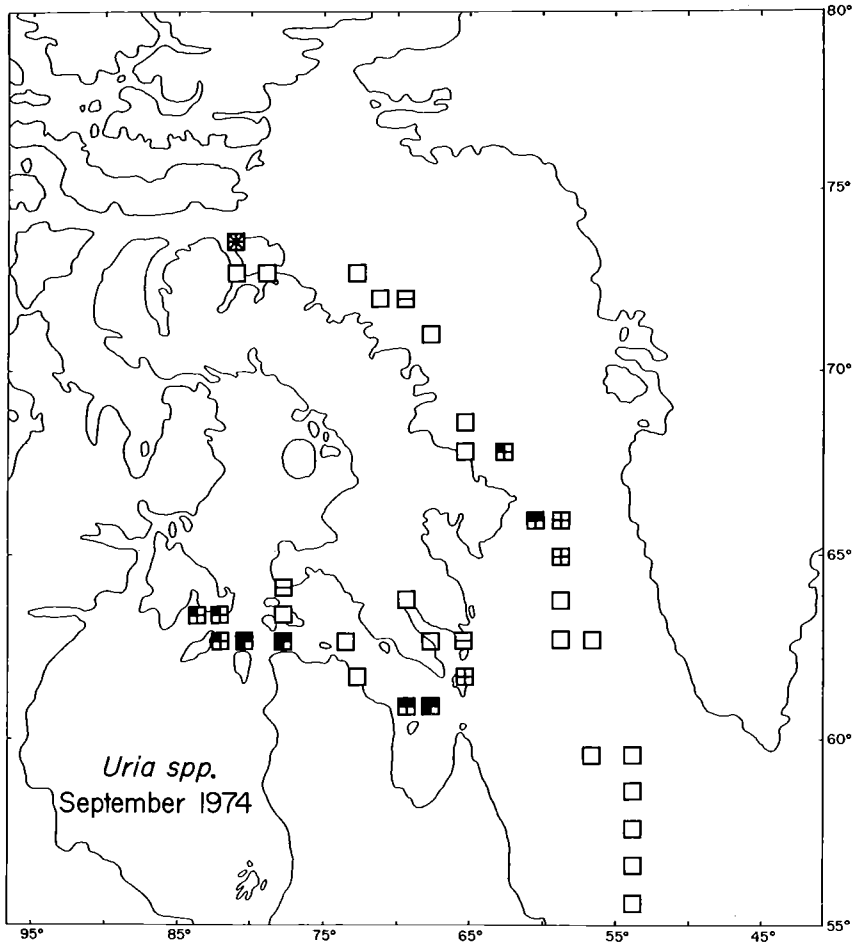
Map 33d
Murres

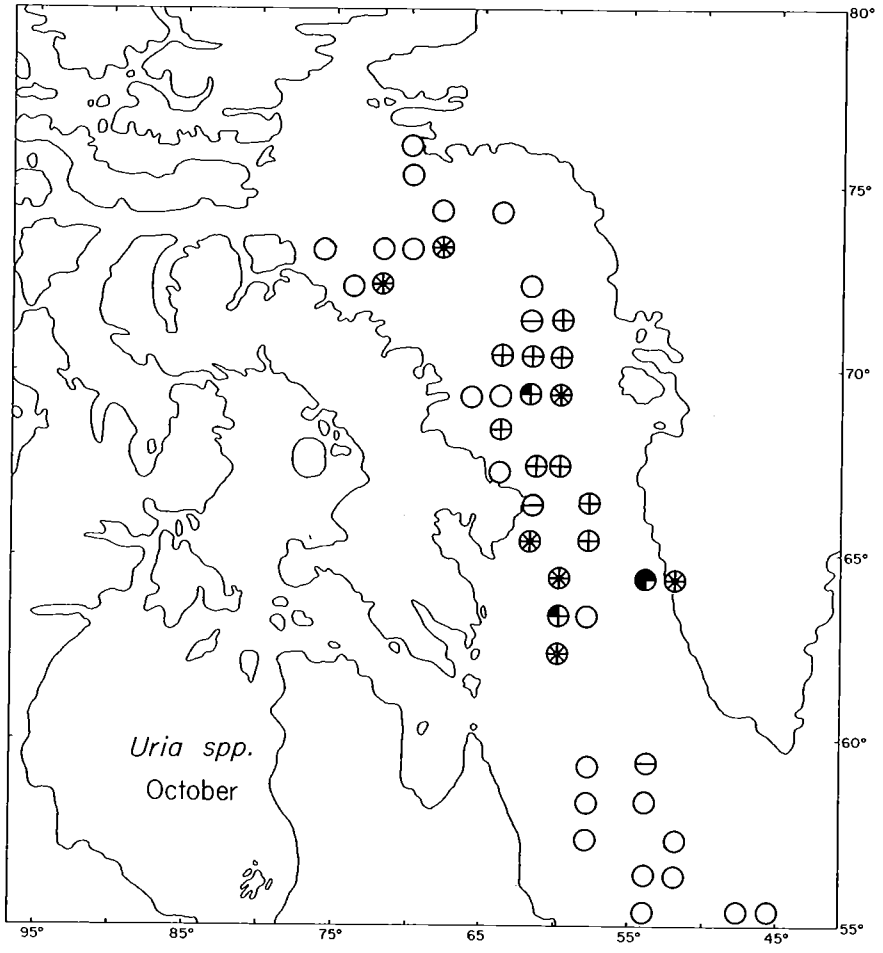


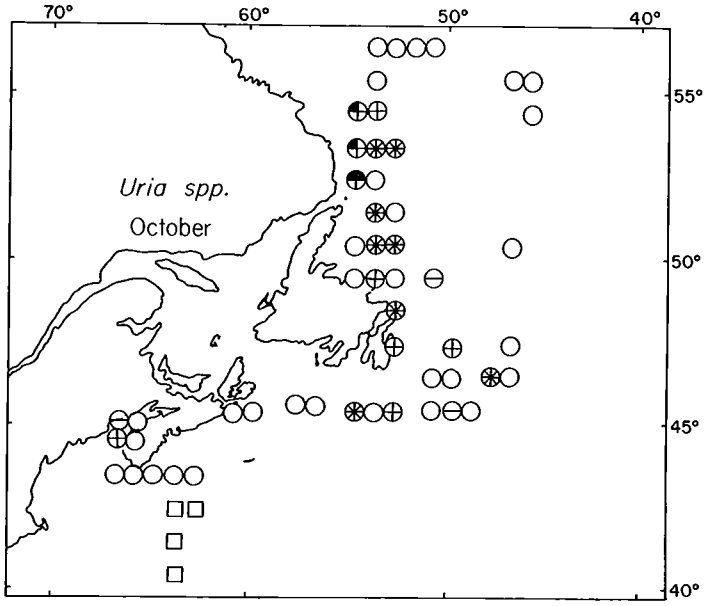

80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Uria spp.
September


70°
60°
50°
40°
55°
50°
45°
40°
Uria spp.
September

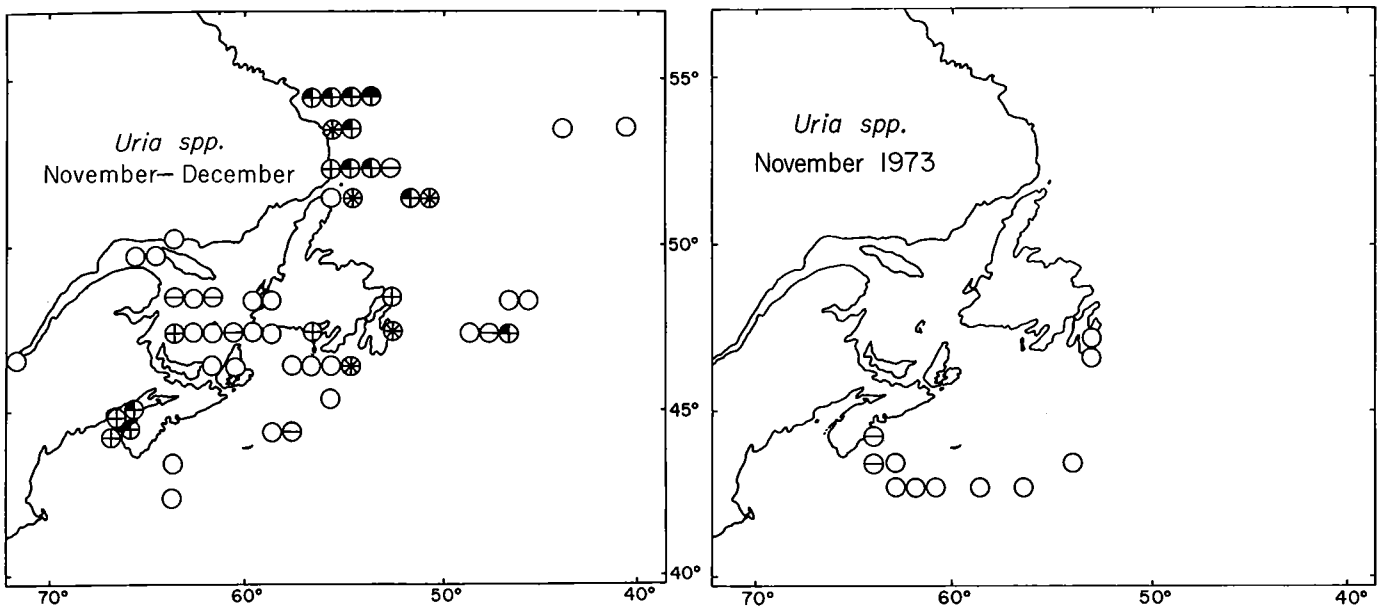
Map 33f
Murres




80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Uria spp.
October


70°
60°
50°
40°
55°
50°
45°
40°
Uria spp.
October

Map 33h
Murres



Breeding distribution

Dovekies are High Arctic birds which in our survey area breed only in west Greenland. Few colony counts are available, but it would seem that the bulk of the population breeds north of c. 76°N (Salomonsen 1950).

Pelagic distribution

As one would expect from their breeding distribution, Dovekies are largely confined to the High Arctic during the breeding season. Our sightings in Davis Strait in August are presumably of nonbreeding birds, as opposed to those from the very small colonies in Greenland at those latitudes. The Greenland birds winter in the Low Arctic and Boreal zones of the northwest Atlantic, though storm-driven birds are often found much farther south (Fisher and Lockley 1954, Salomonsen 1972). Our maps suggest that after they leave their colonies, Dovekies from northwest Greenland enter northern Baffin Bay during September, move south down the High Arctic side of the Bay avoiding the West Greenland Shelf (see also Salomonsen 1967) and reach the Labrador Sea in October. Dovekies remain in the northwest Atlantic until May.

Map 34a
Dovekie
Breeding range

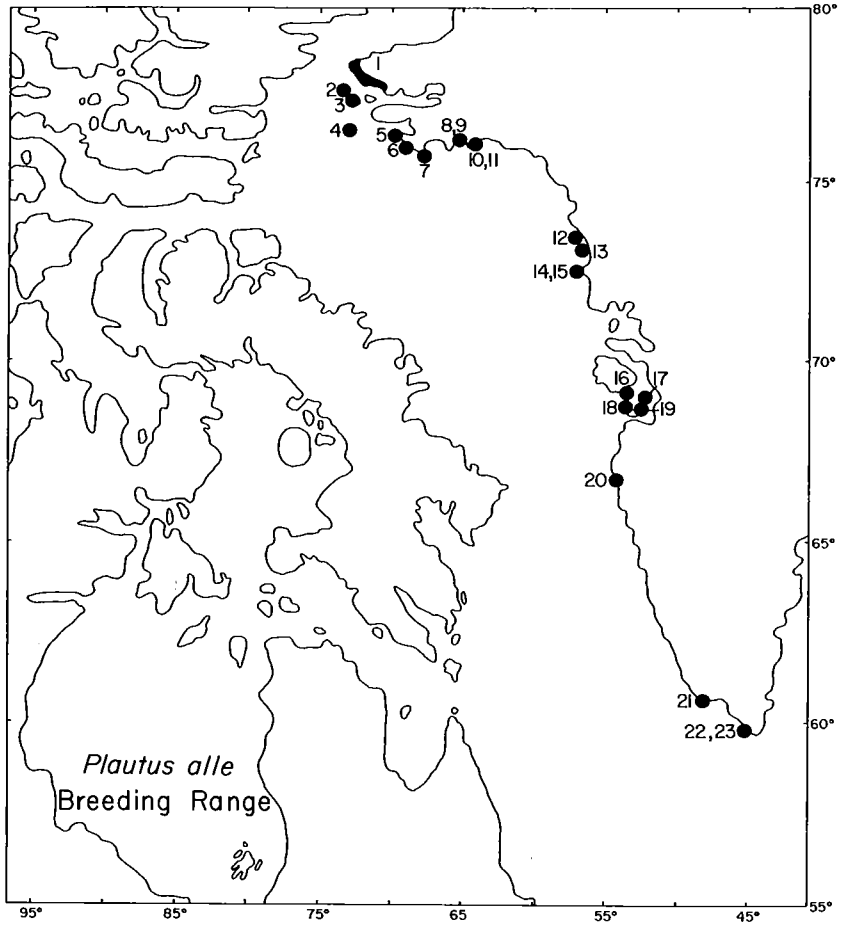
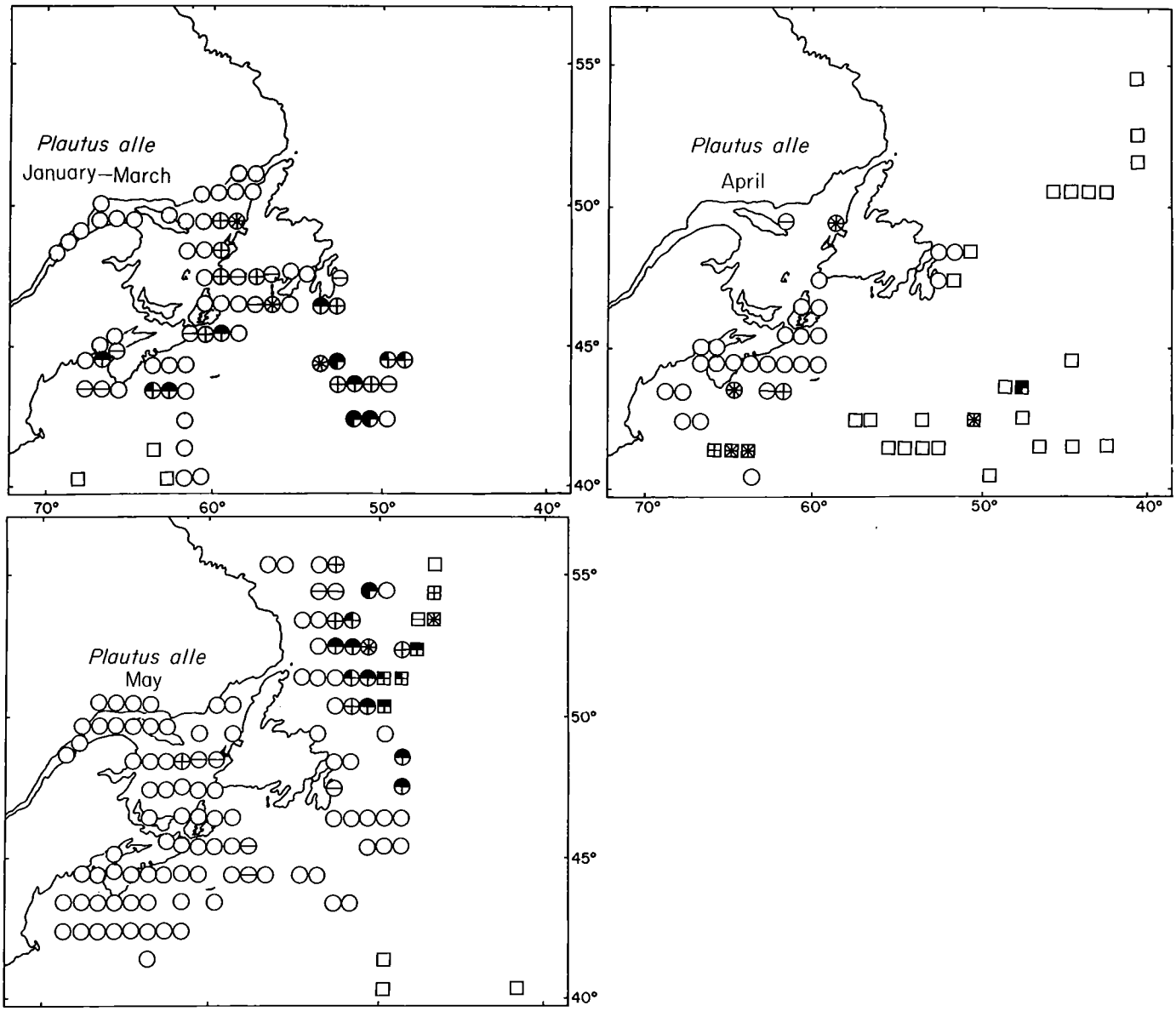


Table 9
Location and size of Dovekie (*Plautus alle*) colonies. For further details see Table 1

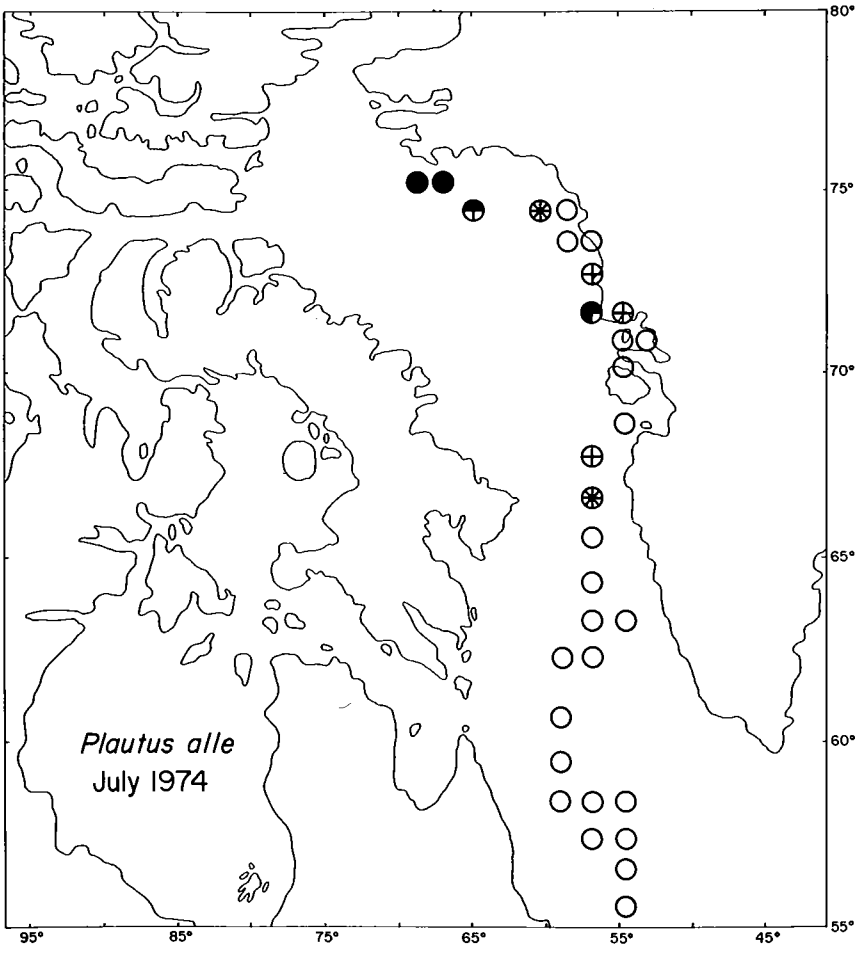
	Colony location	Position	Colony size	Census year	Authority
	West Greenland:				
1.	Etah south to Robertson Bay	c.78°17′N to c.77°45′N	+[1]	?	Salomonsen 1950
2.	Hakluyt I.	77°25′N, 72°38′W	+	?	Salomonsen 1950
3.	Northumberland I.	77°23′N, 72°00′W	+	?	Salomonsen 1950
4.	Carey Is.	76°35′N, 72°40′W	?	?	Salomonsen 1950
5.	Cape Atholl south to Pitugfik Glacier	c.76°22′N to c.76°11′N	+	?	Salomonsen 1950
6.	Parker Snow Bay	c.76°10′N, 67°30′W	+	?	Salomonsen 1950
7.	Agpat to Cape York	c.76°05′N, c.66°30′W	+	?	Salomonsen 1950
8.	Savik Peninsula	c.76°07′N, 65°00′W	+	?	Salomonsen 1950
9.	Meteorite I.	76°03′N, 65°00′W	+	?	Salomonsen 1950
10.	Cape Melville Peninsula	76°04′N, 64°02′W	+	?	Salomonsen 1950
11.	Agpaliarssuit I.	76°10′N, 63°40′W	+	?	Salomonsen 1950
12.	Agpalersalik I. (= Horse Head)	73°38′N, 57°00′W	5,000p	1936	Salomonsen 1950
13.	Kingigtuarssuk III (= K. North)	73°15′N, 56°52′W	0[2]	1965	Joensen and Preuss 1972
14.	Nordø	72°44′N, 56°24′W	+[3]	1965	Joensen and Preuss 1972
15.	Hvalø	72°41′N, 56°18′W	0[4]	1965	Joensen and Preuss 1972
16.	Asigsut Skerry	69°04′N, 53°30′W	10p	?	Salomonsen 1950
17.	Sâtuarssunguit Skerries	68°52′N, 52°05′W	50p	?	Salomonsen 1950
18.	Rotten I. (= Nunatsiaq I.)	68°52′N, 53°25′W	15p	?	Salomonsen 1950
19.	Sâtuarssuit Skerries	68°46′N, 52°30′W	50p	?	Salomonsen 1950

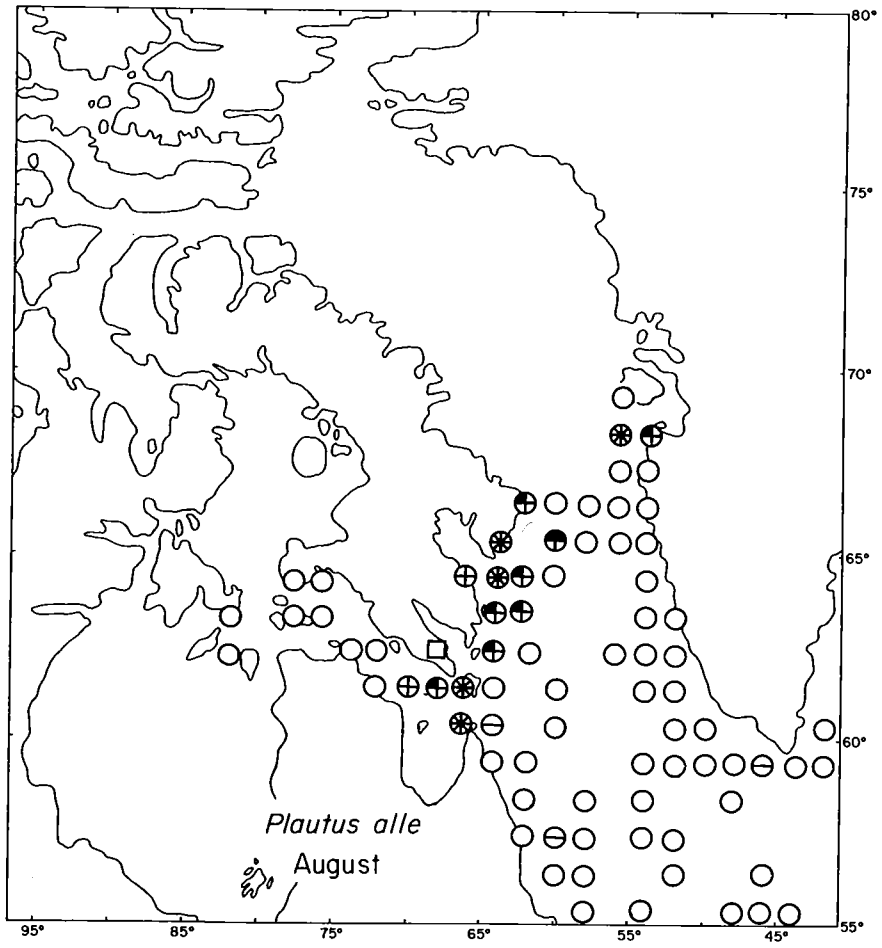
	Colony location	Position	Colony size	Census year	Authority
20.	Kangerdluarssuk Fjord	66°48′N, 53°15′W	1p	1949?	Rosing in Salomonsen 1950
21.	Outer Kitsigsut I.	c.60°45′N, 48°25′W	1p	1949	Salomonsen 1950
22.	Ujaragtarfitkunugdleq I.	c.59°55′N, 45°00′W	1p	1949	Salomonsen 1950
23.	Klapmyds I. (= Kitsigsut)	59°50′N, 45°00′W	<10p	1949	Salomonsen 1950

1 Large numbers present.
2 A few pairs in 1936: Salomonsen (1950).
3 A few pairs suspected breeding.
4 50p in 1936: Salomonsen (1950).

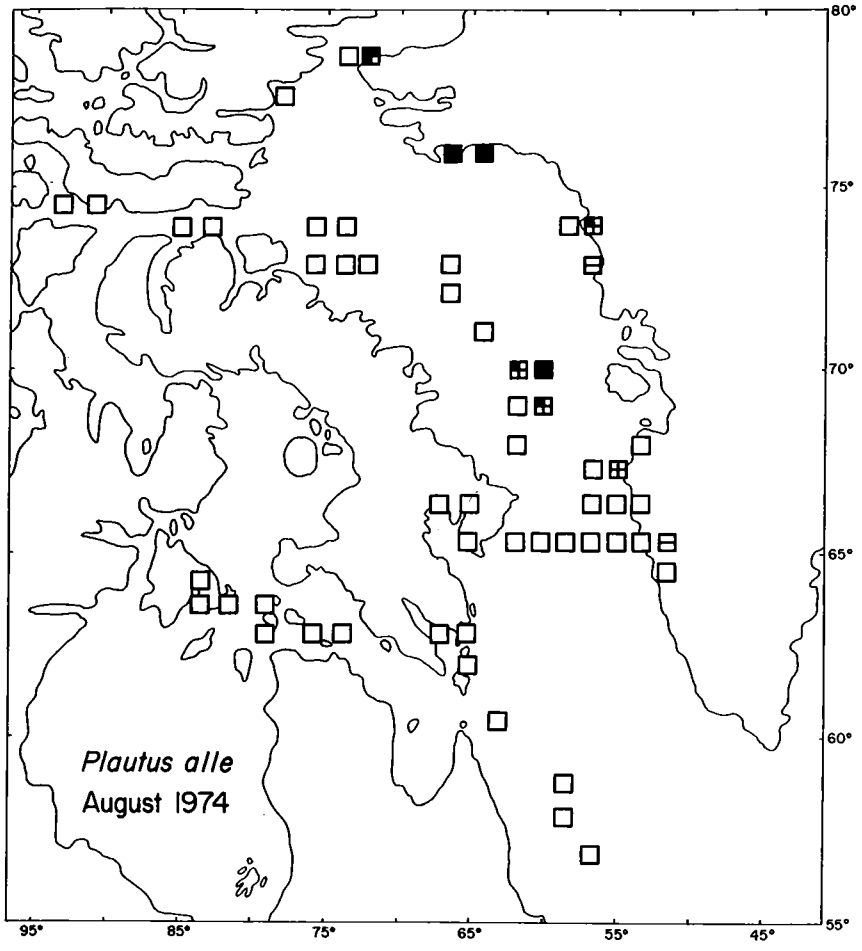

Plautus alle
January—March
Plautus alle
April
Plautus alle
May
55°
50°
45°
40°
70°
60°
50°
40°

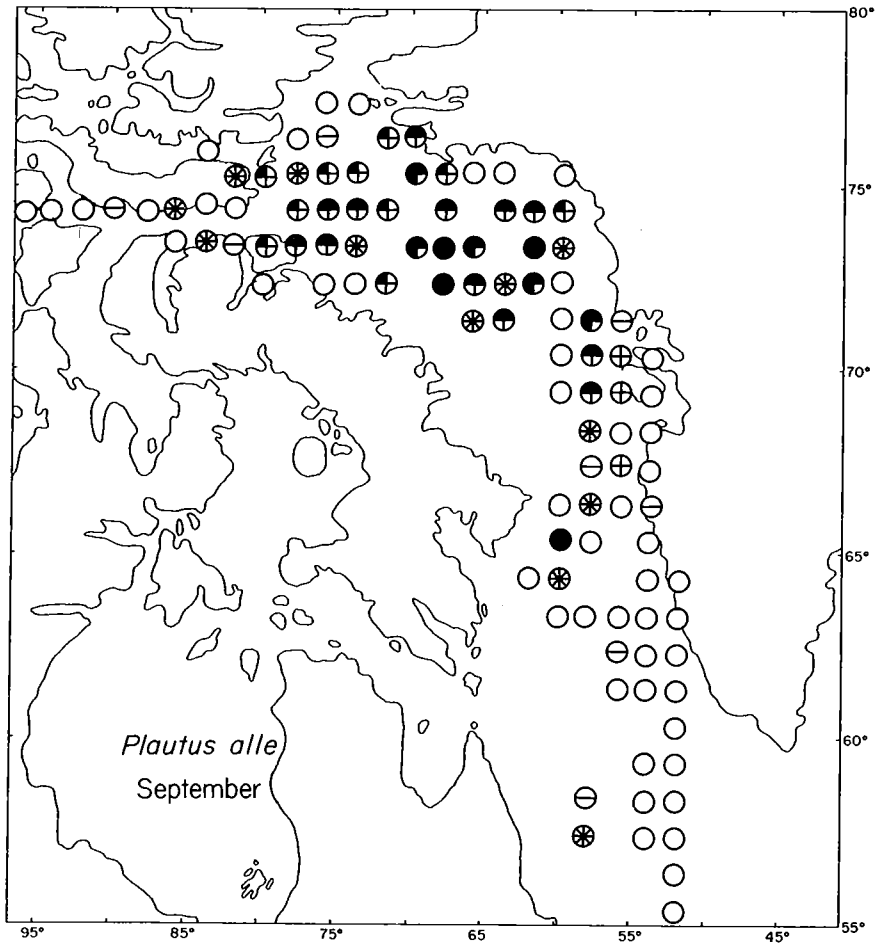
Map 34c
Dovekie



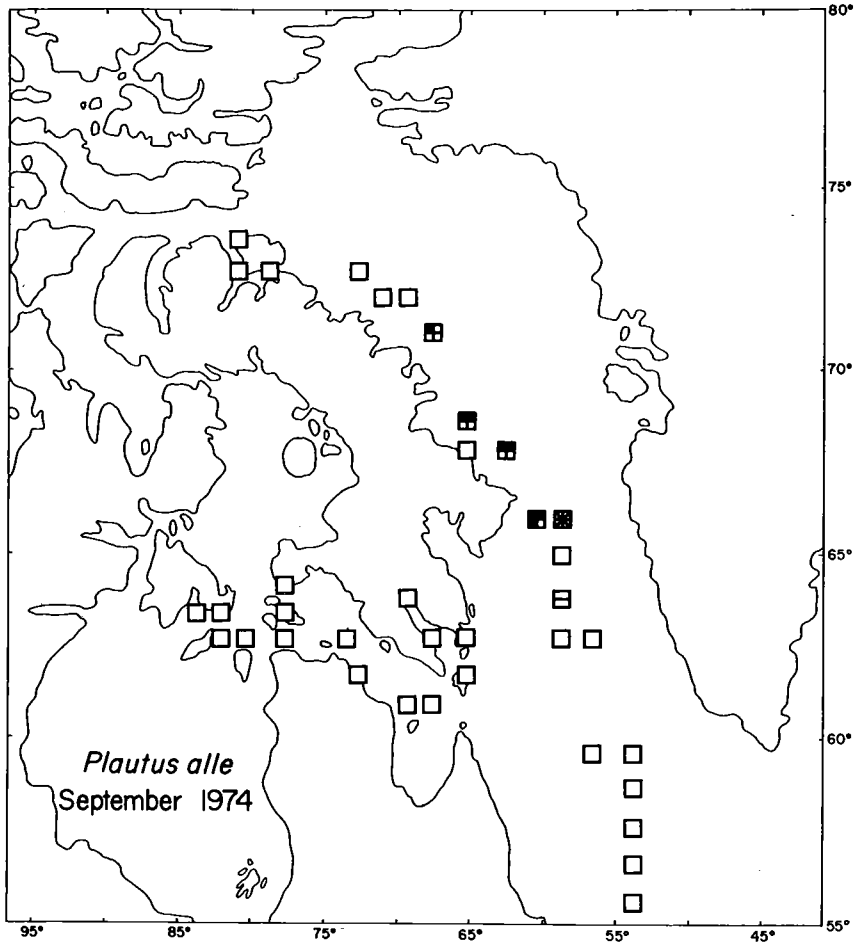

80°
75°
70°
65°
60°
55°
95°
85°
75°
65°
55°
45°
Plautus alle
August

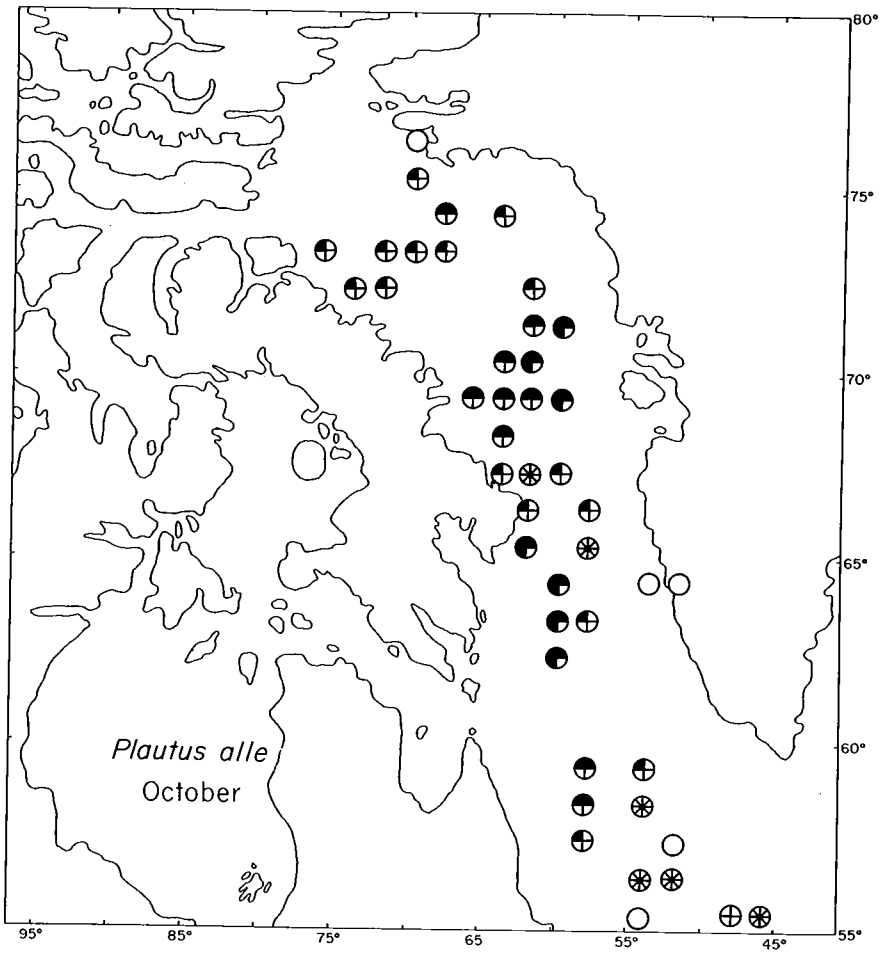
Map 34e
Dovekie

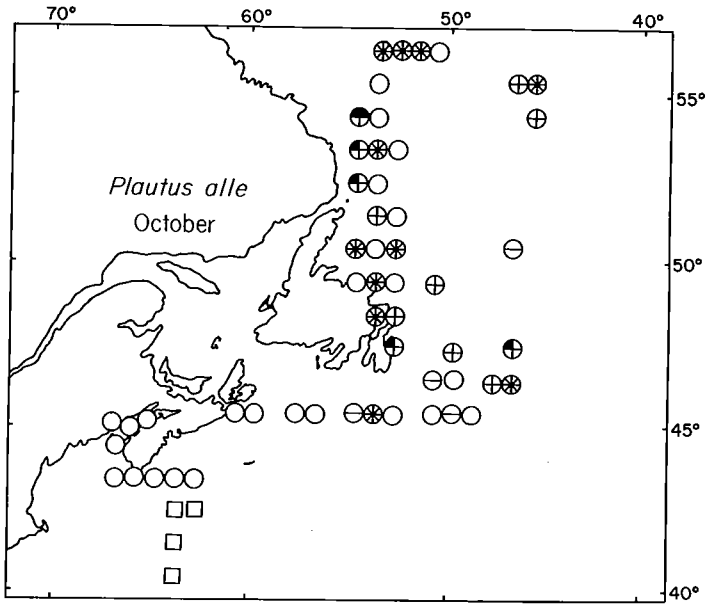



80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Plautus alle
September

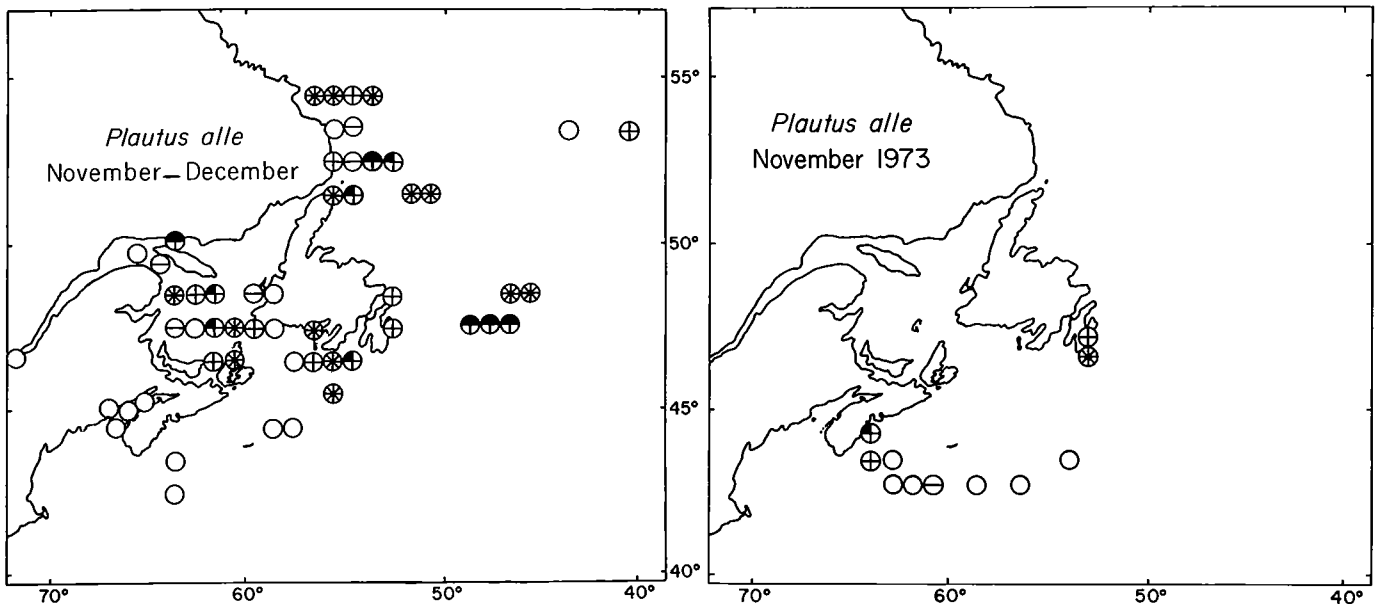
Map 34g
Dovekie




80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Plautus alle
October


70°
60°
50°
40°
55°
50°
45°
40°
Plautus alle
October

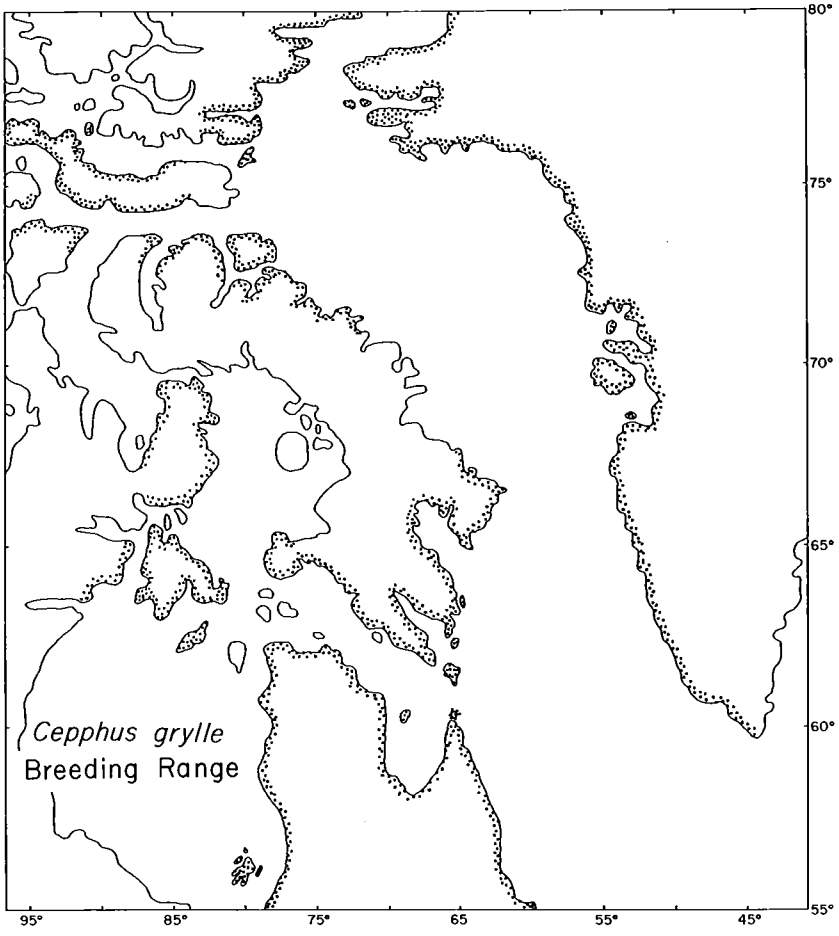
Map 34i
Dovekie

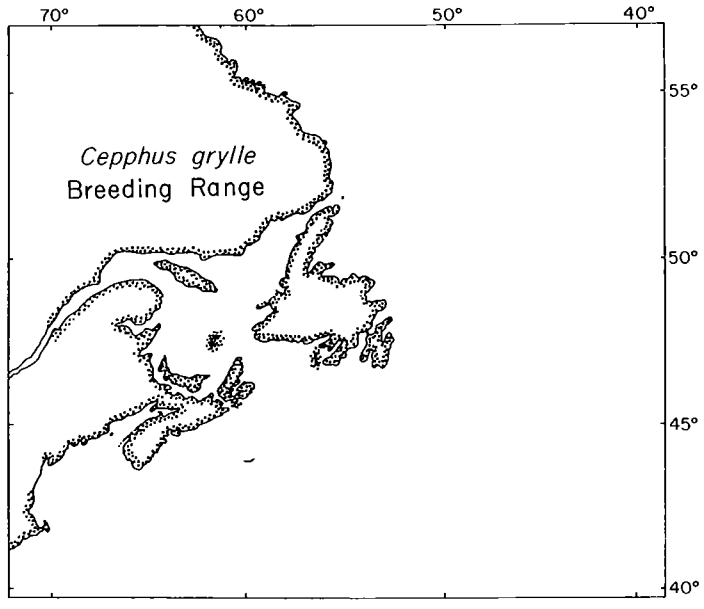


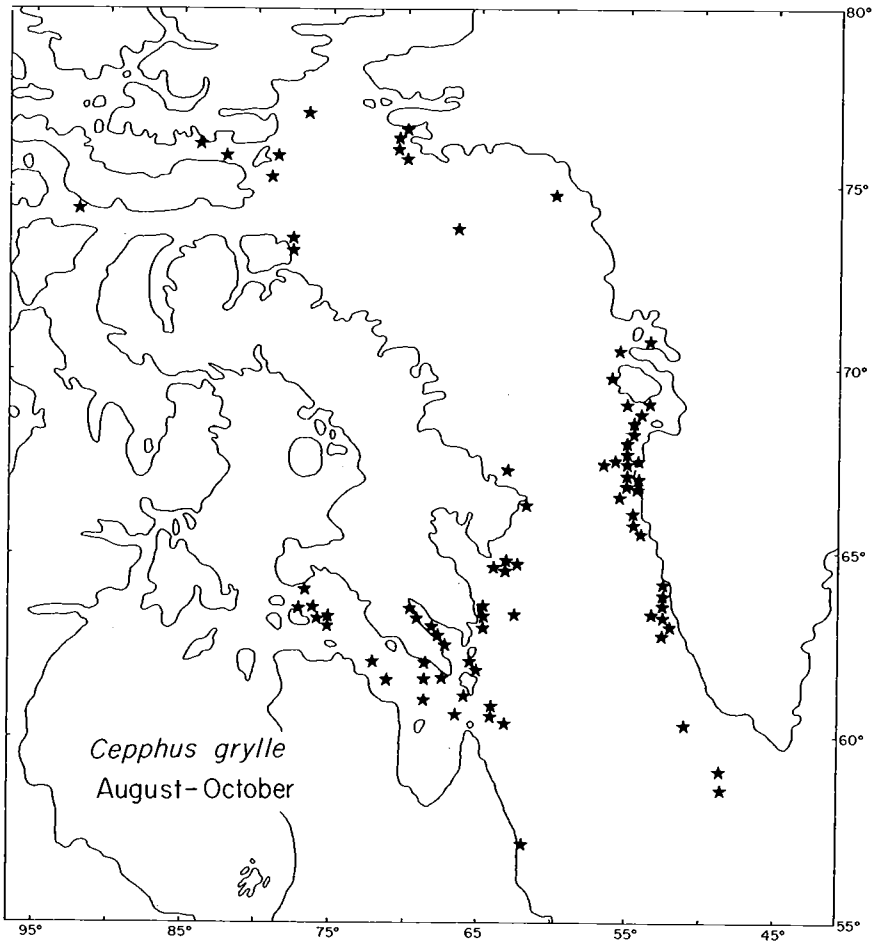
Black Guillemots breed through most of the survey area (Godfrey 1966, Nettleship 1974*b*, Nettleship unpublished, Salomonsen 1950). The pelagic maps show that they are seldom seen at any distance from land.

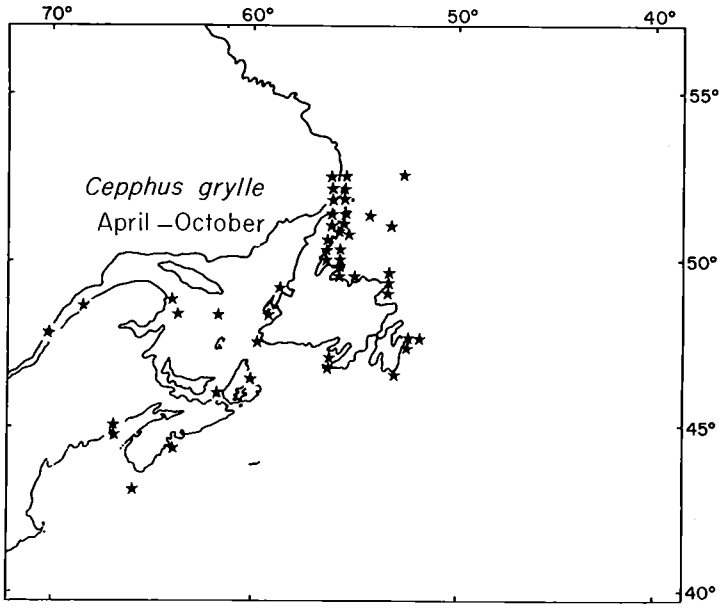
The species is usually non-colonial, but Nettleship's (1974*b*) surveys in 1973 showed that there are several large breeding concentrations on the north coast of Devon Island and vicinity: three colonies at the southeast tip of North Kent Island (c. 76°30′N, 89°42′W), totalling 2000–3000 pairs; c. 5000 pairs on Calf Island (76°27′N, 89°32′W); c. 10,000 pairs southeast of Skruis Point, Devon Island (76°39′N, 88°46′W). Barry (1961) reports c. 4000 individuals on Prince Leopold Island (74°02′N, 90°00′W) in 1958. There were also Large numbers (<1000 individuals) on the West Foxe Islands (64°17′N, 75°48′W) in 1973.

Map 35a
Black Guillemot
Breeding range






80°
75°
70°
65°
60°
55°
95°
85°
75°
65
55°
45°
Cepphus grylle
August–October


70°
60°
50°
40°
55°
50°
45°
40°
Cepphus grylle
April–October

Breeding distribution

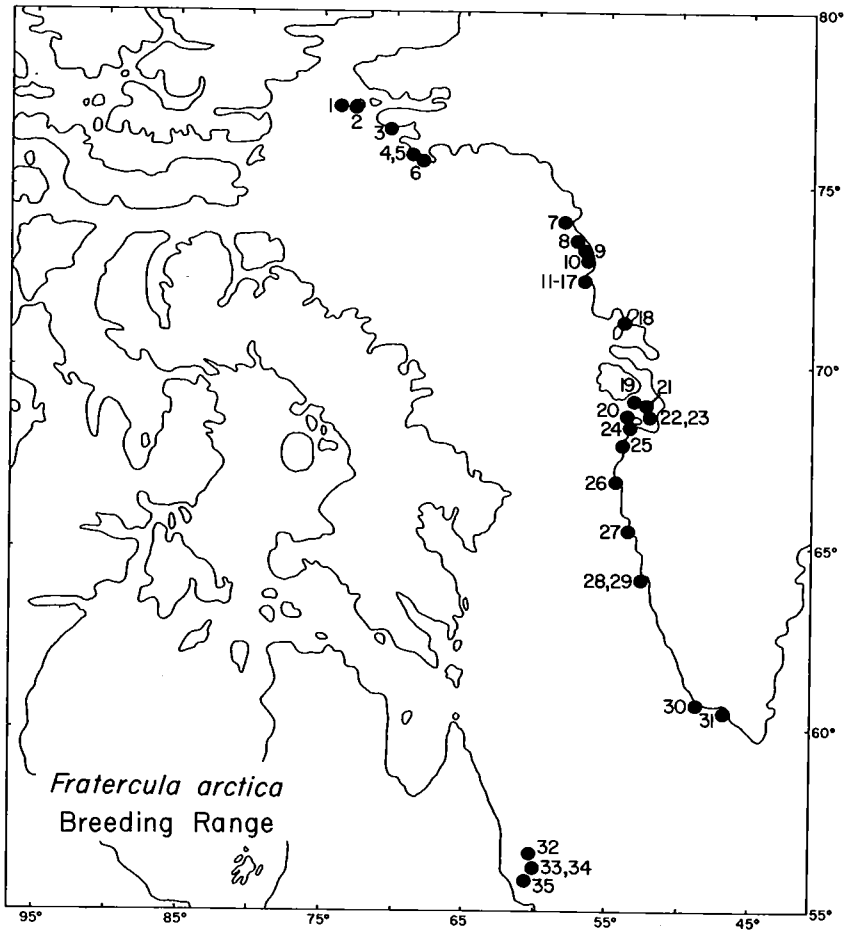
The centre of the Atlantic Puffin's breeding range in North America is in eastern Newfoundland and southeast Labrador, though smaller numbers are found elsewhere in eastern Canada and up the west Greenland coast (Nettleship 1972*b*, unpublished). The birds breeding in northwest Greenland are of the High Arctic subspecies *F. a. naumanni* (Salomonsen 1950).

Pelagic distribution[10]

Apart from *F. a. naumanni*, puffins are Low Arctic birds during the summer. Later, they are most commonly seen in the Labrador Sea and off southeast Labrador. The birds in the latter area may, like the Common Murres, have moved up from the Newfoundland colonies; they might also be the vanguard of migration from the Arctic, which is almost complete by October. It is not clear where the birds go after that. Our own records, and the winter Newfoundland recoveries of birds banded in Greenland and the northeast Atlantic (Tuck 1971) show that at least some birds winter in Canadian Atlantic waters.

[10] Small numbers of puffins were seen in the Strait of Belle Isle in October 1973; two birds were seen at the edge of the Scotian Shelf (42°50′N, 61°44′W) in January 1974.

Map 36a
Atlantic Puffin
Breeding range



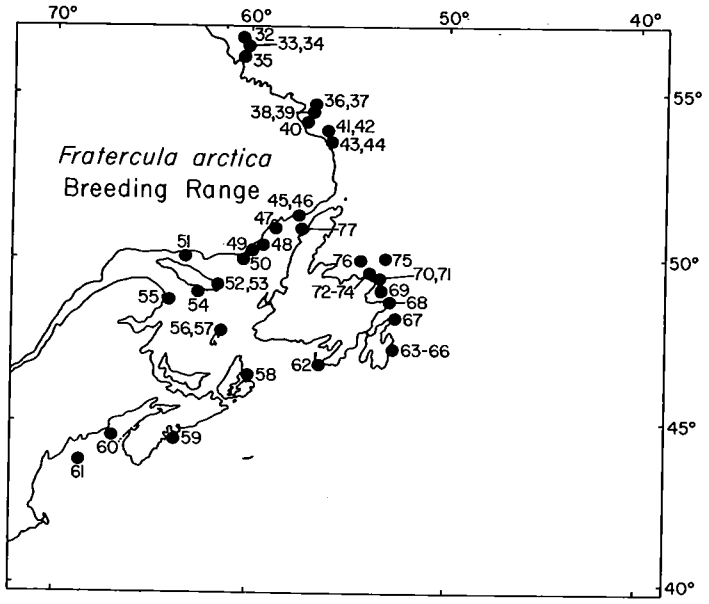


Table 10
Location and size of Atlantic Puffin (*Fratercula arctica*) colonies.
For further details see Table 1

	Colony location	Position	Colony size	Census year	Authority
	West Greenland:				
1.	Hakluyt I.	77°25′N, 72°38′W	+[1]	c.1915?	Ekblaw in Bent 1919
2.	Northumberland I.	77°23′N, 72°00′W	+[1]	c.1915?	Ekblaw in Bent 1919
3.	Saunders I.	76°34′N, 70°00′W	+[1]	c.1915?	Ekblaw in Bent 1919
4.	C. Dudley Digges	76°08′N, 68°35′W	+[1]	c.1915?	Ekblaw in Bent 1919
5.	Parker Snow Point	76°05′N, 68°24′W	+[1]	c.1915?	Ekblaw in Bent 1919
6.	W part of Crimson Cliffs	76°03′N, 67°30′W	+[1]	c.1915?	Ekblaw in Bent 1919
7.	Kitsigsurssuit (= Ederfugleoer)	74°02′N, 57°47′W	4i [2]	1965	Joensen and Preuss 1972
8.	Agpalersalik (= Horse Head)	73°38′N, 57°00′W	40–50i	1965	Joensen and Preuss 1972
9.	Torqussôrssuk	73°22′N, 56°36′W	250i	1965	Joensen and Preuss 1972
10.	Kingigtuarssuk III (= K. North)	73°15′N, 56°52′W	100i [3]	1965	Joensen and Preuss 1972
11.	Kingigtuarssuk II (= K. Middle)	72°56′N, 56°40′W	1i	1965	Joensen and Preuss 1972
12.	Angissoq	72°54′N, 56°23′W	50–75i	1965	Joensen and Preuss 1972
13.	Islets W of Upernavik	72°46′N, 56°35′W	50p	1936	Salomonsen 1950
14.	Idglutalik Islet	72°47′N, 56°36′W	10i	1965	Joensen and Preuss 1972
15.	Nordø	72°44′N, 56°24′W	9i	1965	Joensen and Preuss 1972
16.	Kingigtuarssuk I. (= K. South)	72°45′N, 56°32′W	57i	1965	Joensen and Preuss 1972
17.	Hvalø	72°41′N, 56°18′W	175i	1965	Joensen and Preuss 1972
18.	Schade's Is.	71°23′N, 53°47′W	2–3p	?	Salomonsen 1950
19.	Asigsut Skerry	69°02′N, 53°30′W	20p	?	Salomonsen 1950
20.	Rotten I. (= Nunatsiaq I.)	68°52′N, 53°25′W	>100p	?	Salomonsen 1950
21.	Agpalilik	68°46′N, 53°07′W	20p	?	Salomonsen 1950

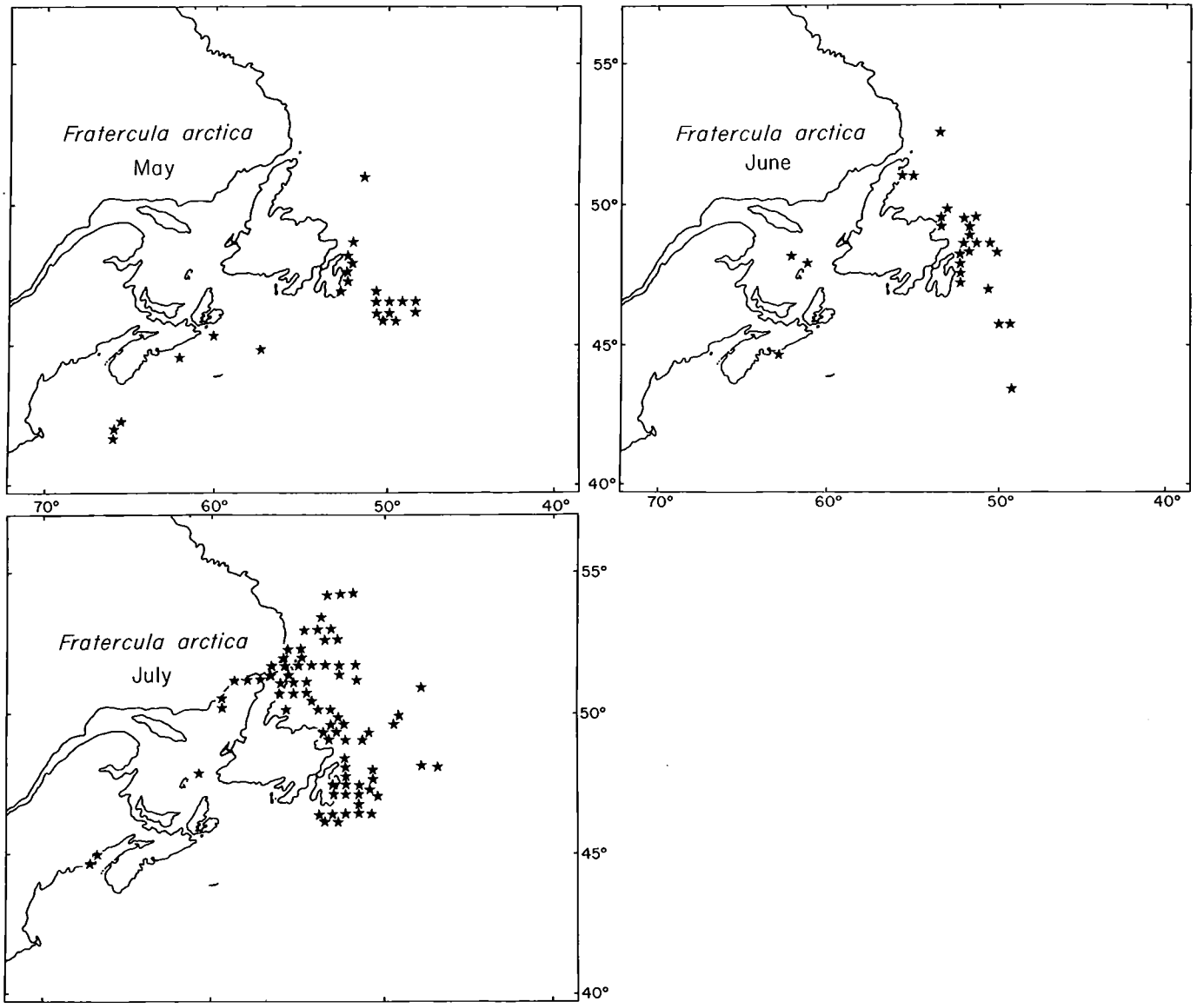
	Colony location	Position	Colony size	Census year	Authority
22.	Sâtuarssuit Skerries	68°46′N, 52°30′W	2p	?	Salomonsen 1950
23.	Grønne I.	68°50′N, 51°53′W	50p	?	Salomonsen 1950
24.	Ivnalinguaq I.	68°31′N, 53°35′W	+4	?	Salomonsen 1950
25.	Rifkel I. (at Agto Outpost)	67°58′N, 53°47′W	+5	?	Salomonsen 1950
26.	Qagssit I.	67°01′N, 54°03′W	+6	?	Salomonsen 1950
27.	Naujarssuit Islet (N of Sukkertoppen settlement)	65°26′N, 53°09′W	+5	?	Salomonsen 1950
28.	Satsigsunguit Skerries	64°14′N, 52°09′W	+5	?	Salomonsen 1950
29.	Narssaq (S to Mt. Skinderhvalen)	63°58′N, 51°36′W	+6	?	Salomonsen 1950
30.	Outer Kitsigsut I.	60°45′N, 48°25′W	+6	?	Salomonsen 1950
31.	Qioqê I.	60°42′N, c.46°30′W	2p	1949	Salomonsen 1950
	Atlantic Canada, St. Pierre-Miquelon, and New England:				
32.	Negro I.	56°20′N, 60°32′W	20i	1928	Austin 1932
33.	Kidlit I.	56°11′N, 60°28′W	1,000i	1928	Austin 1932
34.	Nunarsuk I.	56°03′N, 60°27′W	2,500i	1928	Austin 1932
35.	Tinker I.	55°53′N, 60°35′W	20i	1928	Austin 1932
36.	Quaker Hat	54°44′N, 57°20′W	2,500p	1952	L.M. Tuck, pers. comm.
37.	Tinker I.	54°42′N, 57°28′W	?	1952	L.M. Tuck, pers. comm.
38.	Green I.	54°23′N, 57°19′W	500p	1952	L.M. Tuck, pers. comm.
39.	Herring I.	54°20′N, 57°06′W	10,000p	1952	L.M. Tuck, pers. comm.
40.	Puffin I.	54°24′N, 57°22′W	200p	1952	L.M. Tuck, pers. comm.
41.	Outer Gannet I.	54°00′N, 56°31′W	4,950p	1972	Nettleship and Lock
42.	Gannet Clusters	53°56′N, 56°31′W	37,425p	1972	Nettleship and Lock

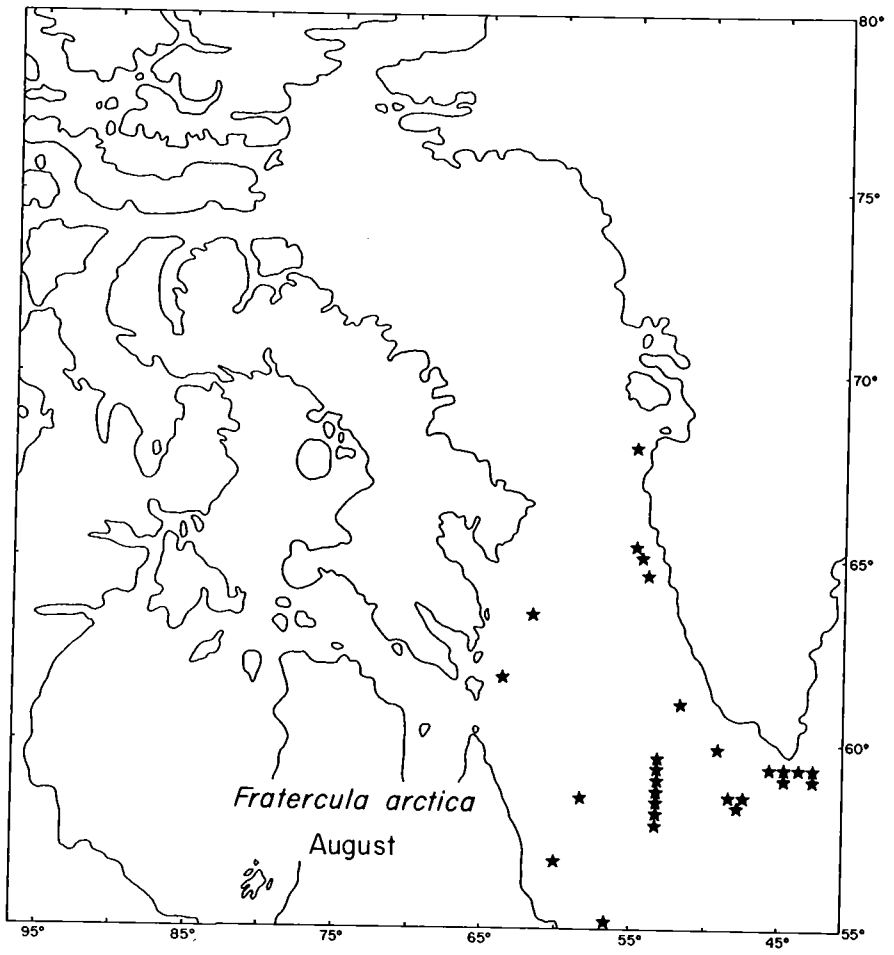
	Colony location	Position	Colony size	Census year	Authority
43.	Wester Bird I.	53°44′N, 56°18′W	1,500p	1953	L.M. Tuck, pers. comm.
44.	Bird I.	53°43′N, 56°15′W	4,500p	1972	Nettleship and Lock
45.	Greenly I.	51°23′N, 57°12′W	2,645p	1972	Nettleship and Lock 1973*b*
46.	Perroquet I.	51°26′N, 57°15′W	4,625p	1972	Nettleship and Lock 1973*b*
47.	St. Augustin Sanctuary	51°07′N, 58°33′W	9i	1972	Nettleship and Lock 1973*b*
48.	Mecatina Sanctuary	c.50°44′N, 59°01′W	2i	1972	Nettleship and Lock 1973*b*
49.	St. Mary Is.	50°19′N, 59°39′W	600i	1972	Nettleship and Lock 1973*b*
50.	Wolf Bay	50°10′N, 60°17′W	9,510i	1972	Nettleship and Lock 1973*b*
51.	Betchouane	50°12′N, 63°13′W	190i	1972	Nettleship and Lock 1973*b*
52.	Table Head, Anticosti I.	49°21′N, 61°54′W	2i	1963	Ouellet 1969
53.	Gullcliff Bay and East Point, Anticosti I.	49°09′N, 61°42′W	3i	1963	Ouellet 1969
54.	Shallop R., Anticosti I.	49°08′N, 62°33′W	6i	1963	Ouellet 1969
55.	Bonaventure I.	48°29′N, 64°07′W	6p	1974	Nettleship and Taylor
56.	Brion I., Magdalen Is.	47°28′N, 61°29′W	+[4]	1958	Gaboriault 1961
57.	Bird Rocks, Magdalen Is.	47°51′N, 61°12′W	+[4]	1956	Gaboriault 1961
58.	Hertford and Ciboux Is., N.S.	c.46°22′N, 60°22′W	50–70p	1971	Lock 1971
59.	Pearl I., N.S.	44°23′N, 64°03′W	2p	1971	Lock 1971
60.	Machias Seal I., N.B.	44°30′N, 67°06′W	900p	1974	Nettleship and Parker
61.	Matinicus Rock, Me.	43°47′N, 68°51′W	170i	1971	Drury 1973–74
62.	Grand Colombier I., St. Pierre I.	46°49′N, 56°10′W	+[4]	1964	Cameron 1967
63.	Great I., Witless Bay	47°11′N, 52°49′W	148,000p	1973	Nettleship

	Colony location	Position	Colony size	Census year	Authority
64.	Pebble I., Witless Bay	47°11′N, 52°50′W	420p	1973	Nettleship
65.	Green I., Witless Bay	47°15′N, 52°47′W	17,000p	1973	Nettleship
66.	Gull I., Witless Bay	47°16′N, 52°46′W	60,000p	1973	Nettleship
67.	Baccalieu I.	48°08′N, 52°48′W	±3,000p	1969	Nettleship
68.	Bird I., Cape Bonavista	c.48°42′N, 53°05′W	500p	1942	Peters and Burleigh 1951
69.	South Cabot I. (= Little Cabot)	49°10′N, 53°22′W	0[7]	1973	Nettleship
70.	Gull I., Cape Freels	49°16′N, 53°26′W	100p	1945	Peters and Burleigh 1951
71.	South Penguin I.	49°26′N, 53°48′W	1,200p	1973	Nettleship
72.	Small I., Wadham Is.	49°35′N, 53°47′W	5,600p	1973	Nettleship
73.	Pigeon I., Wadham Is.	49°32′N, 53°52′W	20p	1973	Nettleship
74.	Coleman I., Wadham Is.	49°33′N, 53°49′W	±3,000	1973	Nettleship
75.	Funk I.	49°45′N, 53°51′W	±1,000p	1969	Nettleship 1972
76.	Islet N of Little Fogo I.	49°49′N, 54°06′W	+[4]	1973	Nettleship
77.	St. John Bay	c.50°53′N, 57°10′W	10p	1944	Peters and Burleigh 1951

1 Small colonies.
2 Suspected breeding.
3 Several hundred burrows present.
4 Small numbers present.
5 Large colony.
6 A few pairs present.
7 50p in 1945: Peters and Burleigh (1951).

Map 36b
Atlantic Puffin

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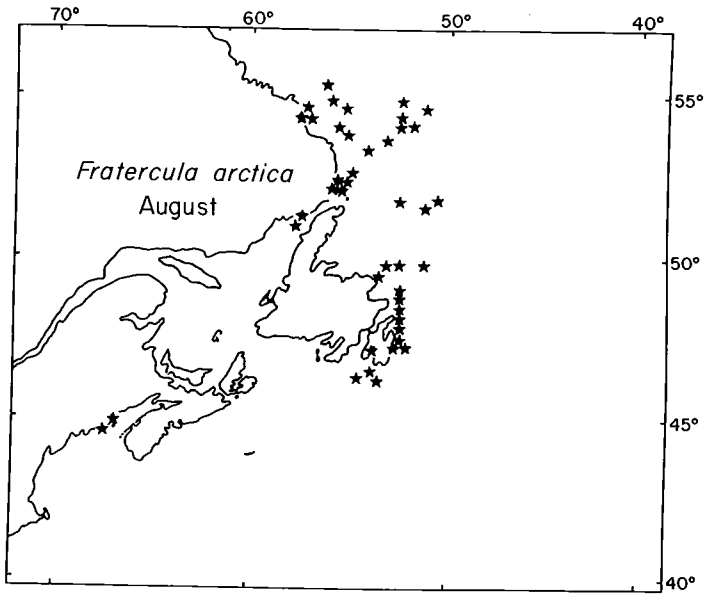
Fratercula arctica
August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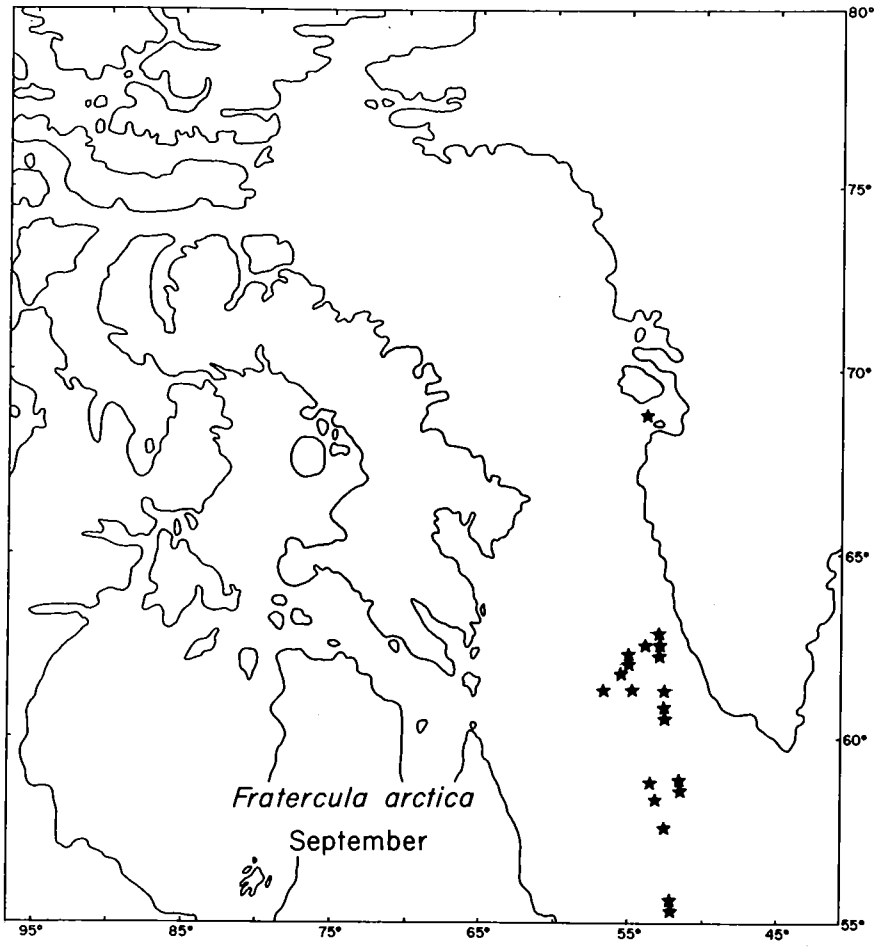
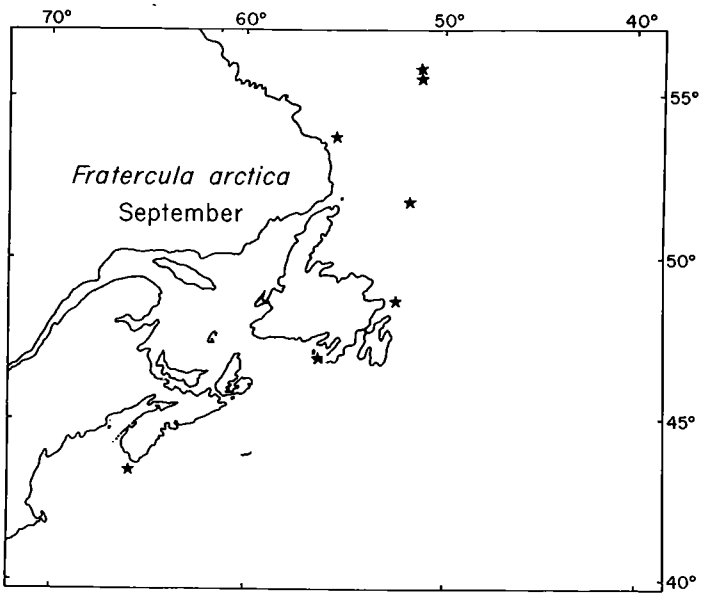
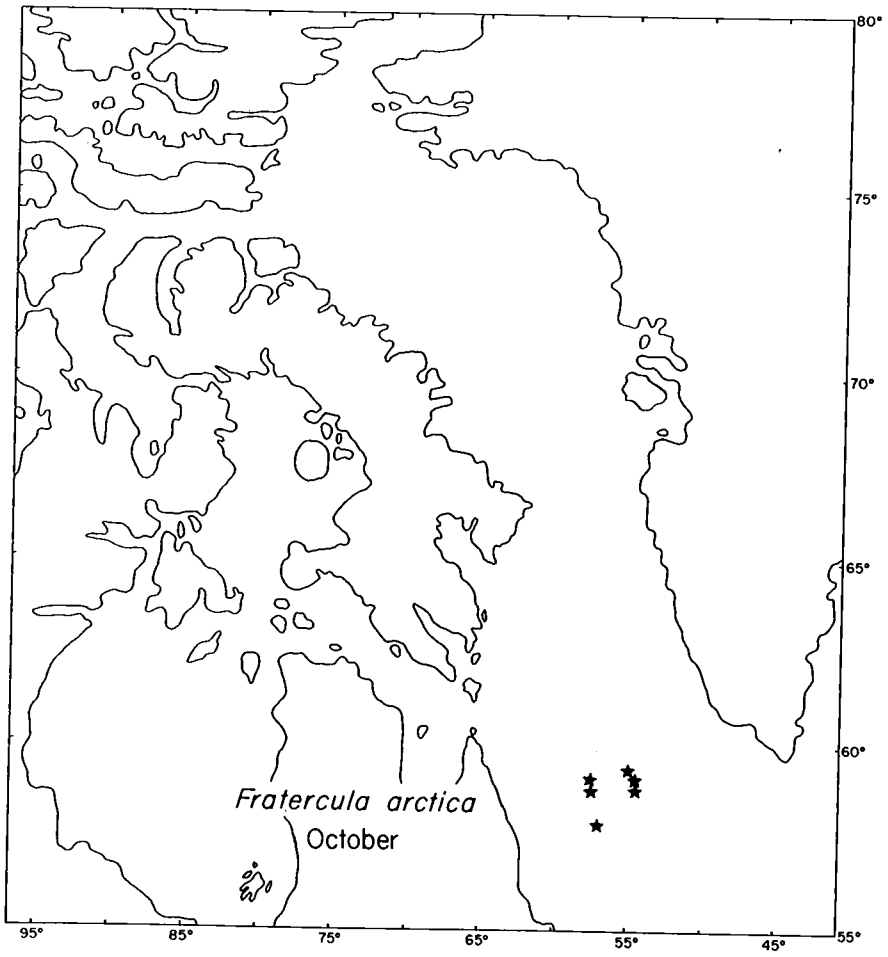
Fratercula arctica
August

Map 36d
Atlantic Puffin



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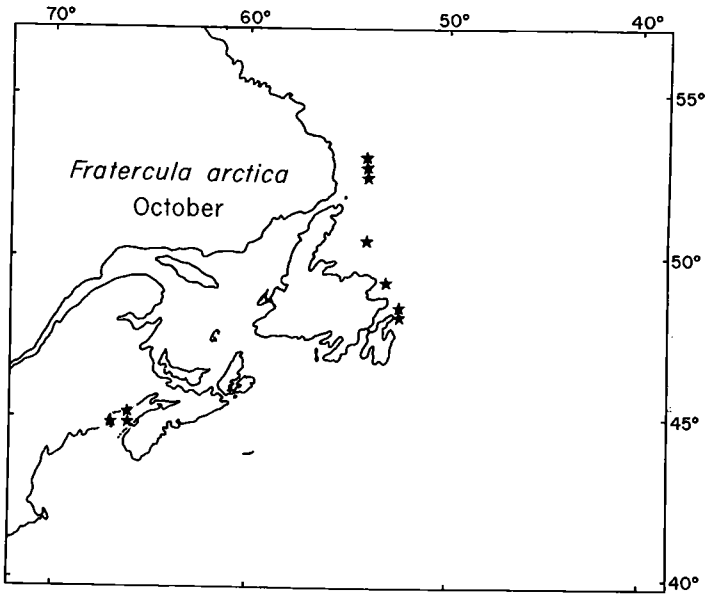
Fratercula arctica
October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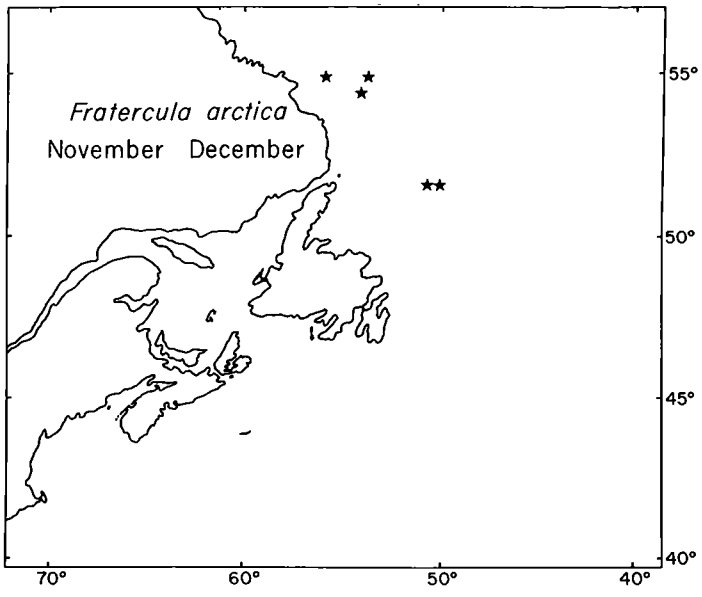
Fratercula arctica
October

Map 36f
Atlantic Puffin



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Panama: MV *Lindblad Explorer*

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Appendices

Appendix 1
The PIROP coding scheme

Each seabird observation was coded numerically and punched into the first 76 columns of a standard 80-column computer card. These numerical codes are derived from those of King *et al.* (1967)

Columns	Codes
1– 2	Format code, indicating type of information on the card; here 97 indicates a seabird observation.
3–11	Administrative identification codes for ship, cruise and observer.
12–17	Month, day and year (e.g. 050172 = May 1, 1972).
18–21	Time of observation (GMT).
22–30	Position of observation: 22 Octant: 0,1,2,3 = N. Hemisphere 5,6,7,8 = S. Hemisphere 0 = 0° – 90°W 5 = 0° – 90°W 1 = 90° – 180°W 6 = 90° – 180°W 2 = 180° – 90°E 7 = 180° – 90°E 3 = 90° – 0°E 8 = 90° – 0°E 23–26 Latitude in degrees and minutes. 27–30 Longitude in degrees and minutes. (The initial figure is omitted from longitudes greater than 99°; thus 6015 = 160°15′.)
31–32	Type of watch: 00 = diurnal watch, with all species recorded during a 10-minute observation period. 01 = sightings of individual species outside a 10-minute observation period. 02 = nocturnal watch, all species recorded. 03 = sample count to show the ratio of species in a mixed flock. 04 = sample count to show the ratios of ages or plumage phases within a flock of a single species. These two columns may also be coded to indicate: a. 10-minute periods where only selected species' groups were being recorded, and all others ignored: 20 = only tubenoses 45 = only gulls 22 = only fulmars, shearwaters 48 = only alcids 23 = only storm-petrels 99 = only non-seabirds b. 10-minute periods from which certain species groups were excluded, but in which all others were recorded: 72 = shearwaters and fulmars not recorded 95 = gulls not recorded (The codes for (a) are taken from the second and third figures of the species identification code number (see below). Those for (b) are obtained by adding 50 to these two figures.)

Columns	Codes
33	Reliability of watch: 0 = observer feels that data from the watch are quantitatively comparable with those obtained in good conditions. 1 = observer feels that data from the watch are not representative, due to adverse weather conditions, poor visibility or for reasons of personal health.
34	Visibility during watch: 0 = not recorded. 1 = good; efficiency of watch is not reduced. 2– 4 = fog, snow or rain are limiting factors: 2 = visibility 1 mile to ¼ mile 3 = visibility ¼ mile to 100 yards 4 = visibility less than 100 yards 5– 7 = glare or poor light are limiting factors: 5 = good light but glare 6 = poor light plus glare 7 = poor light but no glare
35	Weather during watch: 0 = no data (or none of the following): 1 = drizzle 5 = very calm, no wind 2 = rain at ship 6 = fog 3 = birds at edge of rain 7 = snow 4 = high winds 8 = hail 9 = other conditions (code as a Special Note in col. 74–76)
36	State of sea during watch: 0 = no data 5 = rough sea (over 20 ft) 1 = flat calm 6 = no waves but considerable swell 2 = light sea (4 ft or less) 7 = little sea but considerable swell 3 = medium sea (5–10 ft) 4 = heavy sea (10–20 ft)
37–38	Floating matter: 00 = no data 01 = no floating matter observable 02 = floating debris, type unidentified 03 = tree-trunks, branches or driftwood 04 = floating matter of human origin 05 = seaweed (may be identified further in a Special Note – see col. 74–76) 06 = sargassum 07 = fucus 08 = long line of foam 09 = offal – any source 10–12 = other ships: 10 = other ship, type not identified 11 = other ship, nonfishing type 12 = other ship, fishing type

Columns	Codes
20–22	= oil slicks: 20 = oil slick, type not identified 21 = oil slick, made by whale when breathing 22 = oil slick – petroleum
29	= other floating matter apart from ice (code as a Special Note in col. 74–76)
30–49	= ice 30 = icebergs and/or bergy bits, in range of bird observations 31 = icebergs and/or bergy bits, out of range of bird observations (not used if ice is over 5 miles away) 32 = growlers and/or brash ice, in range of bird observations 33 = fast ice, out of range of bird observations 34 = ship at edge of fast ice 35 = ship breaking through fast ice 36 = consolidated pack ice, out of range of bird observations 37 = ship at edge of consolidated pack ice 38 = ship breaking through consolidated pack ice 39 = close or very close pack ice, out of range of bird observations 40 = ship at edge of close or very close pack ice 41 = ship breaking through close or very close pack ice 42 = open or very open pack ice, out of range of bird observations 43 = ship at edge of open or very open pack ice 44 = ship passing through open or very open pack ice 45 = ship at edge of pancake ice 46 = ship breaking through pancake ice 47 = ice type not known, and out of range of bird observations 48 = ship at edge of ice, type not known 49 = other ice type (code as a Special Note in col. 74–76)
	(Codes 52–99 are used for the same things as 02–49, when a bird is associated with the floating matter in question; add 50 to the code to obtain the new number.)
39–40	Ship's speed in knots (99 = no information).
41–42	Ship's direction (true compass) in tens of degrees (e.g. 36 = 360°, or North). Additional codes: 00 = ship stopped 40 = ship circling 41 = ship zigzagging 99 = no information

Columns	Codes
43	Ship's activity: 0 = no information 1 = nonfishing activity 2 = major fishing activity 3 = steaming between fishing stations 7 = anchored offshore 8 = moored at dock 9 = other (code as a Special Note in col. 74–76)
44	Approximate angle of view: 1 = 360° continuously 2 = 360° intermittently 3 = roughly front 180° 4 = roughly 180° astern 5 = 180° on one side 6 = all but 45° forward 7 = all but 45° astern 9 = other (code as a Special Note in col. 74–76)
45	Height of eye above the water: 1 = under 15 ft 2 = 15–30 ft 3 = 30–60 ft 4 = over 60 ft
46	Number of observers.
47–52	Species identification code (see separate list): 900.000 = no birds seen during the 10-minute watch in question
53	Reliability of identification: 0 = sighting as a whole reliable 2 = this or next most similar form 3 = this or any similar form 4 = genus reliable, species unreliable 5 = genus unreliable 6 = sighting as a whole unreliable
54	Age: 0 = not determined 1 = adult 2 = subadult 3 = immature (1st year) 4 = unfledged young 7 = adult or subadult 8 = subadult or immature 9 = other (code as a Special Note in col. 74–76)
55	Plumage (colour phase): 0 = no information 1 = light phase 2 = intermediate phase 3 = dark phase 6 = special type (has a specific meaning for each applicable species; e.g. "bridled" plumage of Common Murre)
56	Moult: 0 = not determined 1 = moult not present 2 = moult present (changing) 6 = summer plumage 7 = winter plumage 8 = mixed moults in birds observed

Columns	Codes
57	Sex: 0 = not determined 1 = male 2 = female
58–62	Number of birds (e.g. 00001 = 1 bird)
63	Reliability of count: 0 = actual count 1 = ± 5% 2 = ±10% 3 = ±15% 4 = ±20% 5 = ±25% 6 = ±30% (or 33%) 7 = ±40% 8 = ±50% 9 = present, but no count possible (Note: Code 9 should be accompanied by a rough estimate in col. 58–62.)
64	Type of flock (within a species): 0 = no information 1 = birds mainly as individuals 2 = birds mainly as pairs 3 = birds mainly in small groups of 5 or less 4 = birds mainly in groups of 5–25 5 = birds mainly in groups of 25–100 6 = birds mainly in groups of over 100 7 = birds entirely in one group (size of group = number of birds) 9 = other (code as a Special Note in col. 74–76)
65	Associations with other species: 0 = no information, or bird was not associated with other species 1 = species associated with each other (e.g. a jaeger chasing a gull; both birds would have code 1 in their column 65) 2 = a second, independent interspecific association within the same 10-minute watch (Note: A mixed flock of birds following a ship is not regarded as an association in this sense.)
66	Direction of bird movement: 0 = no data 2 = north 3 = northeast 4 = east 5 = southeast 6 = south 7 = southwest 8 = west 9 = northwest
67–68	Behaviour: 00 = no information 10 = travelling 20 = sitting on water 21 = sitting on water and diving 22 = sitting on water and flying off 23 = sitting on water and feeding 24 = sitting on water and bathing 25 = sitting on water and calling 30 = sitting on floating matter (identified in col. 37–38) 31 = sitting on shore 35 = sitting on ship 40 = feeding from air – diving into water 41 = feeding from air – in the air 42 = feeding from air – coming down to surface without landing 43 = feeding from air – landing briefly on surface 49 = feeding – method not noted 50 = following ship 51 = following ship – birds continuously in sight with no apparent turnover during present string of 10-minute watches 52 = following ship – birds continuously in sight but with apparent turnover 53 = following ship – appearing and disappearing but presumably the same birds during present string of 10-minute watches 54 = following ship – appearing and disappearing but presumably not the same birds 55 = bird positively recognized as same during string of 10-minute watches (Note: Codes 51 to 55 are used for a string of 10-minute watches, not for turnover within a single watch.) 60 = flying with no apparent direction 61 = circling ship 65 = flying and calling 70 = parasitism 80 = breeding display 99 = other (code as a Special Note in col. 74–76)
69	Food association: 0 = not determined 1 = flying fish 2 = predatory fish or mammal 3 = squid 4 = plankton 5 = food fish 6 = scavenging 7 = larger whales 9 = other (code as a Special Note in col. 74–76)
70–71	Status of bird: 00 = no information 01 = bird is seen to be banded 51 = bird photographed 52 = bird tape-recorded 61 = bird captured and released 62 = bird captured, banded and released 63 = bird captured, banded, colour-marked and released 64 = bird captured, colour-marked and released 65 = bird collected 66 = banded bird recaptured 70 = bird oiled – no details 71 = bird slightly oiled – one or two streaks or spots 72 = bird moderately oiled – a number of streaks or patches 73 = bird heavily oiled – most of breast and belly covered 80 = bird injured 98 = some combination of these 99 = other (Note: Codes 98 and 99 should be accompanied by a Special Note in col. 74–76.)
72–73	Duration of sighting in minutes: 00 = no information, or pointless to record

Columns	Codes
74–76	Special Notes

74 Subject-matter of Special Note:

0 = no Special Note	5 = location of sighting
1 = identification, appearance	6 = direction of bird movement
2 = association, flocking	
3 = behaviour	7 = food association
4 = abundance	8 = watch characteristics
	9 = other

75–76
Special Note reference number (00 = no Special Note):

- the various Special Notes are numbered successively within each day, starting with 01; if necessary this number can be used for several sightings which have a common Special Note.
- these numbers refer to the Special Note form for that day; on this the ship, cruise and observer codes, the date and the Special Note reference number are repeated in columns 3–19. The Special Note is written in columns 22–76, one letter to a column and with a one-column space between each word. It may occupy up to 9 lines; the lines are numbered sequentially in column 21, and the total number of lines in the Note is given in column 20.

Environmental data were coded in the identical way to that described by King *et al.* (1967), using the Environmental Data Sheet which they devised.

Species identification codes:

The identification codes are those prepared by the Smithsonian Institution for the POBSP program, with one exception; a PIROP 10-minute watch in which no birds were seen is coded 900.000. The following species codes are those most commonly required for Canadian Atlantic and eastern Arctic waters:

122.000	Procellariidae	
	122.100 *Fulmarus* sp.	
	122.101 *F. glacialis*	Northern Fulmar
	122.400 *Calonectris* sp.	
	122.401 *C. diomedea*	Cory's Shearwater
	122.500 *Puffinus* sp.	
	122.505 *P. gravis*	Greater Shearwater
	122.519 *P. griseus*	Sooty Shearwater
	122.522 *P. puffinus*	Manx Shearwater
	122.534 *P. lherminieri*	Audubon's Shearwater
	122.545 *P. assimilis*	Little Shearwater
123.000	Hydrobatidae	
	123.100 *Oceanites* sp.	
	123.101 *O. oceanicus*	Wilson's Storm-Petrel
	123.400 *Oceanodroma* sp.	
	123.409 *O. leucorhoa*	Leach's Storm-Petrel
133.000	Sulidae	
	133.100 *Morus* sp.	
	133.101 *Morus bassanus*	Gannet
134.000	Phalacrocoracidae	
	134.100 *Phalacrocorax* sp.	
	134.101 *P. auritus*	Double-crested Cormorant
	134.115 *P. carbo*	Great Cormorant
143.000	Phalaropodidae	
	143.100 *Phalaropus* sp.	
	143.101 *P. fulicarius*	Red Phalarope
	143.300 *Lobipes* sp.	
	143.301 *L. lobatus*	Northern Phalarope
144.000	Stercorariidae	
	144.100 *Stercorarius* sp.	
	144.101 *S. pomarinus*	Pomarine Jaeger
	144.102 *S. parasiticus*	Parasitic Jaeger
	144.103 *S. longicaudus*	Long-tailed Jaeger
	144.200 *Catharacta* sp.	
	144.201 *C. skua*	Skua
145.000	Laridae	
	145.100 *Larus* sp.	
	145.101 *L. atricilla*	Laughing Gull
	145.110 *L. (Rissa) tridactyla*	Black-legged Kittiwake
	145.115 *L. philadelphia*	Bonaparte's Gull
	145.116 *L. ridibundus*	Black-headed Gull
	145.135 *L. (Xema) sabini*	Sabine's Gull
	145.139 *L. (Pagophila) eburnea*	Ivory Gull
	145.145 *L. delawarensis*	Ring-billed Gull
	145.152 *L. argentatus*	Herring Gull
	145.153 *L. thayeri*	Thayer's Gull
	145.168 *L. glaucoides*	Iceland Gull
	145.169 *L. g. glaucoides*	Iceland Gull
	145.170 *L. g. kumlieni*	Kumlien's Gull
	145.171 *L. fuscus*	Lesser Black-backed Gull
	145.183 *L. marinus*	Great Black-backed Gull
	145.185 *L. hyperboreus*	Glaucous Gull
146.000	Sternidae	
	146.800 *Sterna* sp.	
	146.829 *S. hirundo*	Common Tern
	146.835 *S. paradisaea*	Arctic Tern
	146.846 *S. dougallii*	Roseate Tern
148.000	Alcidae	
	148.100 *Plautus* sp.	
	148.101 *P. alle*	Dovekie
	148.200 *Alca* sp.	
	148.201 *A. torda*	Razorbill
	148.300 *Uria* sp.	
	148.301 *U. lomvia*	Thick-billed Murre
	148.304 *U. aalge*	Common Murre
	148.400 *Cepphus* sp.	
	148.401 *C. grylle*	Black Guillemot
	148.700 *Fratercula* sp.	
	148.701 *F. arctica*	Atlantic Puffin

Appendix 2
List of seabird records omitted from the maps

For some species, regions or months there are too few records for it to be worth plotting them in maps. These sightings are instead listed in this Appendix. Note that the omitted fulmar and kittiwake records refer to half-hour watches (see Brown 1968). Only definite identifications have been listed for the other species.

Northern Fulmar			*Fulmarus glacialis* (Type II data in half-hour watches)
v: 1: 1966	57°35′N, 40°55′W	25	(1 Dark bird)
v: 6: 1966	59°30′N, 40°50′W	25	(no Dark birds)
v: 7: 1966	60°07′N, 41°45′W	25	(no Dark birds)
	59°24′N, 42°49′W	45	(no Dark birds)
	58°35′N, 43°50′W	35	(1 Dark bird)
	58°10′N, 44°20′W	20	(1 Dark bird)

Cory's Shearwater			*Calonectris diomedea*		
iv: 9: 1967	41°35′N, 46°54′W	4	v: 1: 1972	40°02′N, 41°40′W	1
iv: 17: 1972	42°30′N, 50°00′W	1	x: 24: 1972	42°40′N, 63°00′W	2
iv: 26: 1972	41°10′N, 42°30′W	1	xi: 27: 1970	47°33′N, 48°39′W	2

Sooty Shearwater			*Puffinus griseus*		
iv: 6: 1967	41°31′N, 63°52′W	2	viii: 23: 1971	58°02′N, 60°07′W	1
iv: 13: 1972	42°00′N, 53°45′W	1		57°40′N, 59°40′W	1
iv: 14: 1972	40°53′N, 49°55′W	1	viii: 30: 1970	58°10′N, 52°37′W	1
iv: 19: 1969	43°22′N, 62°49′W	1	xi: 4: 1970	46°34′N, 54°32′W	1
iv: 20: 1972	43°00′N, 48°15′W	1	xi: 5: 1971	52°51′N, 55°13′W	1
iv: 26: 1966	54°45′N, 41°13′W	1	xi: 9: 1972	43°19′N, 63°31′W	1
viii: 22: 1971	61°29′N, 63°37′W	1			

Manx Shearwater			*Puffinus puffinus*		
ix: 2: 1972	44°48′N, 65°51′W	1	ix: 5: 1971	44°51′N, 66°45′W	5
ix: 3: 1972	44°19′N, 66°23′W	1		44°49′N, 66°45′W	30
ix: 5: 1971	44°59′N, 66°48′W	1		44°47′N, 66°44′W	2
	44°58′N, 66°47′W	1	ix: 20: 1971	45°00′N, 66°48′W	1
	44°55′N, 66°46′W	1		44°58′N, 66°47′W	1
	44°53′N, 66°46′W	10	x: 25: 1971	44°58′N, 65°54′W	1

Audubon's Shearwater			*Puffinus lherminieri*
(Note: Identification was by size, flight type and, in the case of many of the birds on the September map, by the dark under tail coverts as well.)			
v: 21: 1969	42°23′N, 66°11′W	1	

Little Shearwater			*Puffinus assimilis*		
(Note: for identification details, see Brown (1972a).)					
ii: 28: 1971	42°56′N, 50°47′W	1	iii: 1: 1971	43°26′N, 50°07′W	1
	42°57′N, 50°46′W	1		43°37′N, 49°57′W	1
iii: 1: 1971	43°05′N, 50°47′W	1	iii: 5: 1971	43°21′N, 51°27′W	2

Leach's Storm-Petrel			*Oceanodroma leucorhoa*		
viii: 28: 1970	59°43′N, 48°54′W	2	xi: 9: 1972	42°35′N, 63°36′W	1
viii: 31: 1970	57°56′N, 52°37′W	1		42°37′N, 63°36′W	1

Wilson's Storm-Petrel			*Oceanites oceanicus*		
iv: 19: 1969	43°21′N, 62°48′W	2	iv: 26: 1972	41°17′N, 42°51′W	1
	43°23′N, 62°44′W	1	iv: 27: 1969	42°28′N, 67°25′W	1
	43°28′N, 62°47′W	1	iv: 29: 1969	43°13′N, 67°32′W	1
	43°34′N, 62°50′W	1	viii: 22: 1971	61°27′N, 63°24′W	1
iv: 21: 1972	42°30′N, 46°50′W	80	viii: 23: 1971	61°34′N, 63°36′W	1
iv: 24: 1969	43°10′N, 66°55′W	1		57°29′N, 59°25′W	2
	40°11′N, 63°28′W	2		57°22′N, 59°16′W	2
iv: 25: 1969	42°08′N, 66°58′W	32			
White-tailed Tropicbird			*Phaëthon lepturus*		
ix: 5: 1969	40°06′N, 60°06′W	1	ix: 7: 1969	40°40′N, 61°21′W	1
ix: 6: 1969	40°03′N, 63°20′W	1			
Gannet			*Morus bassanus*		
iv: 29: 1966	59°20′N, 43°09′W	1	viii: 9: 1971	61°43′N, 64°12′W	1
viii: 8: 1971	58°59′N, 61°37′W	1	viii: 14: 1971	63°42′N, 62°02′W	1
	60°04′N, 62°55′W	1			
Red Phalarope			*Phalaropus fulicarius*		
x: 9: 1972	44°49′N, 66°15′W	3	x: 9: 1972	44°58′N, 66°47′W	8
	44°53′N, 66°46′W	1	x: 25: 1971	45°01′N, 65°56′W	40
	44°55′N, 66°47′W	5	xi: 1: 1971	44°56′N, 66°46′W	1
Northern Phalarope			*Lobipes lobatus*		
v: 15: 1971	43°20′N, 66°30′W	9	vii: 23: 1969	50°40′N, 55°04′W	1
v: 16: 1971	44°00′N, 66°37′W	3	vii: 29: 1971	49°56′N, 61°54′W	6
v: 18: 1971	44°05′N, 66°29′W	4	vii: 30: 1971	50°06′N, 64°21′W	2
v: 19: 1971	47°30′N, 63°55′W	2		50°04′N, 64°56′W	2
v: 26: 1969	44°10′N, 66°52′W	1	x: 9: 1972	45°00′N, 66°48′W	1
v: 26: 1971	48°35′N, 52°18′W	2	x: 13: 1972	45°00′N, 66°48′W	1
	43°19′N, 66°54′W	5		44°58′N, 66°47′W	1
vii: 18: 1970	48°06′N, 61°34′W	1	x: 28: 1971	45°01′N, 65°56′W	1
Pomarine Jaeger			*Stercorarius pomarinus*		
iv: 28: 1966	57°31′N, 42°27′W	1	x: 10: 1970	64°15′N, 59°30′W	3
x: 2: 1970	59°17′N, 54°10′W	2	xi: 9: 1971	48°24′N, 52°49′W	1
Skua			*Catharacta skua*		
iv: 29: 1966	59°06′N, 43°20′W	2	v: 7: 1966	59°58′N, 41°35′W	1
	59°20′N, 43°09′W	1		59°24′N, 42°49′W	1
iv: 30: 1966	59°11′N, 42°09′W	1	xi: 5: 1970	44°34′N, 57°38′W	1
v: 6: 1966	59°17′N, 40°25′W	1	xi: 9: 1972	43°13′N, 63°31′W	1
v: 7: 1966	60°08′N, 42°01′W	1		42°29′N, 63°36′W	1
Glaucous Gull			*Larus hyperboreus*		
iv: 30: 1966	59°11′N, 42°09′W	1	vii: 1: 1969	51°38′N, 55°34′W	1
v: 7: 1966	60°08′N, 42°01′W	1			
Iceland Gull			*Larus glaucoides*		
iv: 29: 1966	59°06′N, 43°20′W	1	vi: 8: 1969	51°54′N, 53°54′W	1
	59°15′N, 43°07′W	2	viii: 4: 1972	52°43′N, 55°10′W	1
v: 7: 1966	60°08′N, 42°01′W	5			

Great Black-backed Gull			*Larus marinus*		
iv: 29: 1966	58°47′N, 43°06′W	1	iv: 30: 1966	57°30′N, 40°48′W	1
	59°06′N, 43°20′W	2	v: 7: 1966	59°58′N, 41°35′W	1
	59°20′N, 43°09′W	3			
Herring Gull			*Larus argentatus*		
viii: 19: 1972	61°52′N, 67°05′W	1	viii: 25: 1971	63°24′N, 74°34′W	1
	61°54′N, 67°15′W	1		63°25′N, 74°37′W	1
viii: 20: 1972	60°59′N, 70°05′W	1	viii: 26: 1971	62°50′N, 81°08′W	2
viii: 24: 1971	61°48′N, 70°08′W	1	viii: 28: 1971	62°01′N, 71°14′W	3
	61°49′N, 70°12′W	1		62°05′N, 71°20′W	1
	61°38′N, 69°04′W	1	ix: 3: 1971	57°59′N, 51°59′W	1
	61°39′N, 69°10′W	1			
Lesser Black-backed Gull			*Larus fuscus*		
(Note: Birds identified by the combination of black back and wings, and yellow feet; see also Brown (1968).)					
iv: 26: 1966	54°25′N, 41°13′W	2	iv: 29: 1966	59°20′N, 43°09′W	2
	53°42′N, 40°48′W	1	v: 6: 1966	59°17′N, 40°25′W	1
iv: 27: 1966	56°27′N, 42°12′W	1	v: 7: 1966	60°08′N, 42°01′W	1
iv: 28: 1966	57°31′N, 42°27′W	1	vi: 1: 1969	45°10′N, 50°00′W	1
iv: 29: 1966	59°06′N, 43°20′W	1	vi: 9: 1971	46°35′N, 50°15′W	2
	59°15′N, 43°07′W	1	vi: 12: 1971	44°30′N, 49°24′W	1
Ring-billed Gull			*Larus delawarensis*		
i: 2: 1971	44°56′N, 65°24′W	1	vi: 15: 1970	47°35′N, 58°08′W	1
v: 29: 1969	47°35′N, 52°40′W	3			
Laughing Gull			*Larus atricilla*		
iv: 24: 1969	40°36′N, 63°25′W	2	v: 24: 1969	43°25′N, 67°45′W	1
	40°32′N, 63°27′W	1	vi: 14: 1970	41°05′N, 65°07′W	1
Bonaparte's Gull			*Larus philadelphia*		
iv: 28: 1969	43°21′N, 67°40′W	1	viii: 19: 1972	46°23′N, 62°01′W	1
v: 26: 1969	44°10′N, 67°14′W	1	viii: 21: 1971	46°54′N, 60°27′W	1
vii: 28: 1970	47°23′N, 62°52′W	1			
Little Gull			*Larus minutus*		
ix: 20: 1971	44°51′N, 66°45′W	1			
Ivory Gull			*Pagophila eburnea*		
v: 2: 1970	53°30′N, 52°25′W	1	v: 9: 1969	49°13′N, 53°03′W	2
v: 3: 1969	54°43′N, 53°40′W	4		49°07′N, 53°03′W	2
	55°39′N, 55°31′W	2	v: 16: 1969	54°45′N, 53°14′W	1
	55°46′N, 56°12′W	1	viii: 8: 1971	60°45′N, 63°24′W	4
v: 9: 1969	49°11′N, 53°05′W	1	viii: 24: 1971	60°36′N, 65°57′W	1
Black-legged Kittiwake			*Rissa tridactyla* (Type II data in half-hour watches)		
v: 1: 1966	57°35′N, 40°55′W	1	v: 7: 1966	59°24′N, 42°49′W	5
v: 6: 1966	59°30′N, 40°50′W	0		58°35′N, 43°50′W	3
v: 7: 1966	60°07′N, 41°45′W	3		58°10′N, 44°20′W	4
Sabine's Gull			*Xema sabini*		
v: 24: 1970	43°02′N, 51°11′W	1	vi: 7: 1971	48°29′N, 61°29′W	1

Terns			*Sterna* spp.		
iv: 26: 1972	44°10′N, 42°30′W	2			
Common Tern			*Sterna hirundo*	= C	
Arctic Tern			*Sterna paradisaea*	= A	
Roseate Tern			*Sterna dougallii*	= R	
v: 20: 1971	44°00′N, 67°22′W	4C	vii: 16: 1971	44°31′N, 67°07′W	12A
v: 21: 1969	45°13′N, 48°45′W	1A		44°33′N, 67°08′W	2A
	45°05′N, 48°46′W	4A	vii: 17: 1970	46°04′N, 59°36′W	2A
v: 23: 1970	43°39′N, 52°05′W	1C	vii: 17: 1970	46°09′N, 59°35′W	1A
v: 24: 1969	43°31′N, 67°39′W	2C	vii: 20: 1971	48°10′N, 45°07′W	1A
v: 24: 1971	48°51′N, 48°18′W	1A	vii: 23: 1971	47°09′N, 58°00′W	1A
v: 28: 1969	44°06′N, 64°07′W	1C	vii: 24: 1969	51°39′N, 52°27′W	2C
v: 30: 1969	46°13′N, 50°39′W	2A	vii: 28: 1970	47°23′N, 62°52′W	1A
v: 31: 1969	45°40′N, 50°00′W	4A	vii: 30: 1970	46°03′N, 59°37′W	2A
	46°10′N, 50°25′W	2A	vii: 31: 1969	47°39′N, 62°24′W	1A
vi: 2: 1969	44°31′N, 63°00′W	7C	viii: 6: 1971	44°27′N, 63°00′W	1C
vi: 6: 1971	49°07′N, 58°20′W	1A	viii: 9: 1970	46°44′N, 57°01′W	1C
vi: 12: 1969	48°12′N, 52°54′W	1A	viii: 11: 1969	54°22′N, 51°00′W	1A
vi: 12: 1970	46°35′N, 59°29′W	6C	viii: 14: 1971	45°01′N, 65°56′W	1C
vi: 15: 1970	47°35′N, 58°08′W	4C	viii: 19: 1970	44°50′N, 66°45′W	1C
	47°28′N, 58°12′W	2C		44°58′N, 66°47′W	1R
	47°28′N, 58°11′W	2C	viii: 20: 1971	47°00′N, 62°19′W	2C
vi: 22: 1970	46°41′N, 58°09′W	1A	viii: 21: 1969	47°32′N, 56°23′W	2A
vi: 27: 1969	44°28′N, 63°26′W	1R		47°12′N, 55°58′W	1A
vii: 2: 1969	44°21′N, 63°53′W	1R	viii: 21: 1971	44°32′N, 67°08′W	1A
vii: 4: 1969	43°57′N, 63°52′W	1C		44°32′N, 67°06′W	1A
	44°12′N, 63°44′W	1C	viii: 31: 1971	46°49′N, 63°34′W	1C
	43°57′N, 63°55′W	1C	ix: 2: 1970	47°03′N, 60°28′W	1C
	44°24′N, 63°57′W	2C	ix: 3: 1972	44°17′N, 66°21′W	3C
	44°22′N, 63°56′W	1A	ix: 5: 1971	45°01′N, 66°48′W	1C
			ix: 6: 1969	40°13′N, 64°59′W	1C
Caspian Tern			*Hydroprogne caspia*		
vi: 11: 1970	46°28′N, 59°34′W	1			
Razorbill			*Alca torda*		
i: 1: 1972	45°02′N, 65°57′W	1	xi: 11: 1970	48°09′N, 46°04′W	3
	45°51′N, 65°51′W	1		47°56′N, 47°02′W	1
	44°48′N, 65°50′W	3	xi: 29: 1971	45°04′N, 65°58′W	1
	44°45′N, 65°48′W	7		45°01′N, 65°56′W	1
i: 2: 1971	45°06′N, 65°59′W	1	xii: 21: 1970	44°54′N, 65°53′W	1
x: 25: 1971	45°04′N, 65°58′W	5		44°48′N, 65°50′W	1
x: 28: 1971	45°10′N, 66°01′W	1		44°58′N, 65°54′W	1
	44°48′N, 65°50′W	1		44°55′N, 66°47′W	3
xi: 1: 1971	44°49′N, 66°44′W	1		44°54′N, 66°46′W	1
	44°48′N, 65°50′W	1			
Murres			*Uria* spp.		
iv: 28: 1966	57°02′N, 42°21′W	1	v: 6: 1966	59°17′N, 40°25′W	1
iv: 29: 1966	59°06′N, 43°20′W	4			

Common Murre			*Uria aalge*		
i: 1: 1972	44°54′N, 65°48′W	1	iv: 23: 1970	49°22′N, 58°25′W	59
ii: 15: 1973	45°25′N, 61°02′W	2		49°23′N, 58°23′W	12
ii: 20: 1973	45°23′N, 61°07′W	1		49°33′N, 58°25′W	10
ii: 26: 1971	47°18′N, 52°37′W	1		49°34′N, 58°19′W	40
	47°14′N, 52°37′W	3	iv: 30: 1970	47°47′N, 52°22′W	1
ii: 27: 1971	44°23′N, 52°49′W	1	ix: 2: 1972	44°48′N, 65°51′W	1
iii: 1: 1971	43°14′N, 50°25′W	3	ix: 20: 1971	44°55′N, 66°46′W	1
	42°28′N, 49°48′W	2	ix: 27: 1972	49°02′N, 53°08′W	3
iii: 9: 1971	47°02′N, 52°02′W	1	x: 9: 1972	44°49′N, 66°45′W	2
iv: 23: 1970	49°07′N, 58°30′W	1		44°55′N, 66°47′W	1
	49°08′N, 58°29′W	5	x: 28: 1971	53°17′N, 53°57′W	1
	49°09′N, 58°28′W	3	xi: 4: 1971	53°44′N, 54°47′W	1
	49°14′N, 58°34′W	32		52°59′N, 54°48′W	1
Black Guillemot			*Cepphus grylle*		
i: 26: 1971	49°06′N, 58°50′W	1	iii: 2: 1973	49°44′N, 62°15′W	11
ii: 4: 1972	46°36′N, 53°09′W	8		49°48′N, 62°00′W	13
	46°46′N, 53°07′W	4		49°49′N, 61°56′W	12
	46°43′N, 52°55′W	4		49°53′N, 61°42′W	3
ii: 15: 1973	45°28′N, 61°11′W	1		49°54′N, 61°35′W	71
ii: 16: 1973	46°56′N, 60°10′W	1	iii: 3: 1973	49°37′N, 60°52′W	30
	46°55′N, 60°11′W	2		49°54′N, 60°52′W	46
ii: 20: 1973	45°25′N, 61°05′W	5		49°57′N, 60°52′W	18
	45°27′N, 61°04′W	3	iii: 5: 1973	51°06′N, 57°24′W	1
	45°26′N, 61°02′W	1		50°35′N, 58°13′W	8
	45°24′N, 61°03′W	4		50°34′N, 58°14′W	29
	45°27′N, 60°59′W	1	iii: 6: 1973	50°15′N, 58°32′W	1
ii: 24: 1973	49°16′N, 64°41′W	10		50°14′N, 58°33′W	3
	49°17′N, 64°43′W	3		50°14′N, 58°34′W	1
ii: 26: 1971	47°33′N, 52°35′W	1		50°08′N, 58°50′W	1
	47°18′N, 52°37′W	1		50°01′N, 59°05′W	1
ii: 28: 1973	49°00′N, 68°00′W	1		50°01′N, 59°06′W	14
	49°02′N, 67°57′W	1		50°00′N, 59°08′W	1
	49°12′N, 67°34′W	1	iii: 8: 1973	48°27′N, 59°47′W	3
	49°15′N, 67°28′W	1		48°24′N, 59°46′W	4
	49°31′N, 66°57′W	3		48°10′N, 59°42′W	2
iii: 1: 1973	50°03′N, 66°03′W	7	iii: 9: 1973	44°47′N, 61°44′W	1
			xi: 1: 1971	44°59′N, 66°47′W	3
			xi: 5: 1971	52°45′N, 55°44′W	3
			xi: 15: 1970	47°58′N, 59°21′W	2
Dovekie			*Plautus alle*		
vi: 7: 1969	49°29′N, 52°10′W	1	vi: 17: 1969	48°15′N, 60°22′W	3
vi: 8: 1969	48°29′N, 59°33′W	6	vii: 11: 1971	49°25′N, 53°21′W	1
	48°29′N, 59°34′W	3	vii: 14: 1969	47°47′N, 60°10′W	1
	48°29′N, 59°39′W	2	vii: 16: 1969	46°30′N, 52°56′W	1
vi: 10: 1969	53°25′N, 52°19′W	1	vii: 19: 1969	51°13′N, 53°22′W	1
	53°20′N, 52°19′W	3		51°14′N, 53°19′W	1
	53°18′N, 52°23′W	11		51°54′N, 54°47′W	4
	53°16′N, 52°25′W	16	viii: 3: 1972	49°45′N, 58°27′W	1
	53°14′N, 52°27′W	6	viii: 7: 1972	51°56′N, 52°19′W	1
vi: 11: 1969	51°28′N, 50°20′W	3	viii: 13: 1969	51°30′N, 56°23′W	1
vi: 16: 1969	48°00′N, 61°15′W	1			
Atlantic Puffin			*Fratercula arctica*		
i: 2: 1971	44°46′N, 65°49′W	1	iv: 24: 1969	40°22′N, 63°28′W	4
iii: 1: 1971	43°04′N, 50°37′W	1			

Figure 1
The key to map symbols

EFFORT AND COLONY SURVEY MAPS DATA: TYPE I	TYPE II	NUMBER OF ACCEPTABLE 10-MINUTE WATCHES FOR EACH BLOCK
⊖	⊟	1 – 2
⊕	⊞	3 – 6
✳	✳	7 – 12
◓	◧	13 – 30
◕	◧	31 – 60
●	■	>60
		AREA COVERED IN COLONY SURVEY 1969-1973

SPECIES MAPS: DATA: TYPE I	TYPE II	AVERAGE NO. BIRDS SEEN PER 10 MINUTES
○	□	NONE SEEN
⊖	⊟	<0.3
⊕	⊞	> 0.3 < 1.0
✳	✳	> 1.0 < 3.0
◓	◧	> 3.0 < 10.0
◓	◧	> 10.0 < 30.0
◕	◧	> 30.0 < 100.0
●	■	> 100.0

★ INDICATES A 15' N x 15' W (ATLANTIC) OR 15' N x 30' W (ARCTIC) BLOCK IN WHICH THERE IS AT LEAST ONE RECORD OF THE SPECIES.

● COLONY.

○ EXTINCT COLONY, NORTHERN GANNET ONLY.

BREEDS, BUT DATA INADEQUATE FOR PLOTTING INDIVIDUAL COLONY SITES.