Seabirds of the Russian Far East

Special Publication
Canadian Wildlife Service

Alexander Ya. Kondratyev
Natalia M. Litvinenko
Gary W. Kaiser
(Editors)

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Foreword by Hugh Boyd
Canadian Wildlife Service

A member of the Environmental Conservation family

Cover photo: Horned Puffins on Talan Island
(A. Ya. Kondratyev)

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Foreword

In North America we have become increasingly aware of a growing body of work by Russian seabird specialists. But the English summaries attached to lengthy papers in Russian, a language that few of us have learned to read fluently, are often insufficient. We need the details, not just the outlines, of their findings. Consequently, when biologists in the Pacific and Yukon Region of the Canadian Wildlife Service were approached by their Russian colleagues for assistance in publishing a selection of their work in full in English, it was very clear that we should do whatever we could to help them. This collection of reports offers the first fruits of what we hope will be continuing collaboration.

Dealing with the unfamiliar is rarely easy. Here we in Canada were confronted by papers about a region full of place names that we could not at once fit on to a map, and using Russian technical terms that do not always have exact English-language equivalents. To arrive at the translated results presented here took a lot of hard work by many people. One must be singled out: if Gary Kaiser had been less of a believer in the value of this work and had not devoted a great deal of time and effort to ensure its completion, these reports would never have appeared. Our debt to him is great. He deserves warm thanks and congratulations.

The chapter on the history of seabird studies in the Russian Far East is admirably thorough, with the unexpected consequence that what we in North America may previously have thought of as the least-known circumpolar region is now the best-documented for seabirds. The five following chapters are equally authoritative; and the Appendices — supplying maps, place names and acronyms of organizations — provide an effective gazetteer and guide.

The detailed account of the incidental mortality of seabirds in the Japanese drift net fishery for salmon in the Russian Economic Zone provides a valuable, and sad, addition to earlier evidence of the harmful effects on birds of drift net fisheries in other parts of the Pacific Ocean. Showing how this fishery developed following the closure by the United States of drift netting in its Economic Zone, it provides an awkward example of the necessity of unified action by all range states if nuisances of this magnitude are to be ended.

Thanks to the studies summarized in considerable detail in these reports, we now know not only where seabirds are to be found in the Russian Far East, but when and why they are there. Though, as the authors repeatedly remind us, much is still to be learned, here is proof that a great deal has been accomplished in recent years by them and a few colleagues, despite administrative upheavals and funding shortages that would have defeated less resolute scientists. They too deserve our sincere congratulations and thanks.

Hugh Boyd
Scientist emeritus
Canadian Wildlife Service

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Contents

Introduction

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In this book, we present an overview of the available information on the scale and character of seabird communities in the Russian Far East. Ranging along the vast eastern end of the Asian continent from the edge of Yakutia in the northwest to the boundary with Korea and China in the southeast, these communities represent one of the world's greatest and least known (in the west, at least) seabird resources. Forty species of alcids, procellariids, gulls, terns, and cormorants breed in the Russian Far East and are the central subjects of this book. Many of these breeding species are shared with North America, but others, such as Swinhoe's Storm-Petrel, Japanese (Temminck's) Cormorant, Japanese Murrelet, and Ross' Gull, are effectively local endemics, breeding only in the Russian Far East and the adjacent parts of Asia. These endemics are among the least known seabirds in the world. In addition, we have included nonbreeding and postbreeding birds that use the area as seasonal habitat. Large numbers of these birds arrive from the Arctic interior of Asia and the South Pacific.

The coast of the Russian Far East is more than 4000 km long and is washed by two oceans and five seas. In the north, the Russian Far East includes the East Siberian and Chukchi seas of the Arctic Ocean, whereas the Bering Sea, Sea of Okhotsk, and Sea of Japan lie south of Bering Strait on the western edge of the North Pacific. It is an extremely complex coast, divided by large peninsulas such as Chukotka and Kamchatka, big islands such as Sakhalin and Hokkaido, and chains of small volcanic islands such as the Kurils and Aleutians. It includes some of the richest and most productive seas in the world. The Russian Far East offers a geographic, ecological, and cultural link between intensive seabird research in Japan and equally intensive efforts in Canada and the United States. The goal of these chapters is to present a broad overview of very large subregions, and we have therefore not discussed the finer biogeographic and natural divisions of the Russian Far East in detail. Similarly, we have confined ourselves to the eastern coast of Asia and have not included the heroic explorations to study the Arctic biota that have generated a great mass of information.

For many readers, the details of the geography will be unfamiliar, and few atlases cover the area in detail (but see Anon. 1998).[1] We provide maps of the regions of interest in Appendix 1 and a list of the Russian place names and locations mentioned in the text in Appendix 2. We have avoided the use of Russian acronyms, but readers of this book will undoubtedly come across them in other literature. Appendix 3 contains a short list of acronyms and names of the more important Russian agencies and institutes in the Far East.

Only a handful of scientists have studied the seabirds of the Russian Far East in the past few decades, but most appear as authors of one chapter or another of this book. Their participation has created an opportunity for an overview of the most current information on the region's seabirds, putting distribution and abundance in the context of oceanic and climatic conditions and identifying management and conservation problems at the end of the 20th century. Unlike the American North Pacific, the ecosystems of the Russian coast are constrained by pack ice for much of the year, the seabird phenologies are driven by snow cover and permafrost, and huge tracts are intensively exploited and modified for human use in the form of subsistence hunting, reindeer grazing, commercial fishing, or fur farming. In the 21st century, we can expect a great increase in petrochemical development and seafloor mining.

The book is divided into six chapters. The first sets the historical context, touching on the activities of the early explorers, the museum collectors, and the descriptive naturalists, as well as the relatively recent development of large scientific institutes devoted to natural resources. The second chapter sets the marine context, with a description of the oceanography and climate of the region. Chapter 3 focuses on the status, abundance, and distribution of the 40 breeding species; wherever possible, we have also included pertinent information on habitat requirements, breeding phenology, and success. Chapter 4 discusses birds at sea, dealing with the annual migrations from the southern hemisphere and the Asian interior. Chapter 5 deals with fishery interactions and the scale of by-catch of seabirds, particularly near their breeding colonies. Chapter 6 outlines the habitat preservation and wildlife management programs that affect seabird conservation in the Russian Far East.

We hope that this book will be useful to both Russian and foreign scientists who have only a most general concept

[1] This atlas actually shows some of the major seabird colonies as "Ptits'i Bazary."

of the seabird resource in the Russian Far East. We stress the problems of the near future, proposing both regional and international cooperative protection efforts. Such efforts require integration of Russian information and approaches with those of our Pacific neighbours. Elsewhere in the North Pacific, the past few decades have been marked by a general increase in seabird research effort and report production. Important gaps have been filled, and conservation planning is well advanced. Generally, however, the seabirds of the Russian Far East are poorly represented in discussions of the North Pacific. Just as the Russian Far East is isolated from the rest of the North Pacific by distance and geographic barriers, linguistic barriers isolate it intellectually. Much useful material is unknown to western scientists simply because it exists only in Russian or in poorly circulated translations. Although the Russian Far East is still plagued by information gaps and fragmentary knowledge, there is much more information available than has appeared in other English-language material.

Literature cited

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Chapter 1. Seabird studies in the Russian Far East

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Summary

Although analysis of the population biology of seabirds in the Russian Far East is a very recent development, their study and description have a long history and have involved many of the early explorers in the North Pacific Ocean, including Bering, Cook, Kotzebue, Wrangel, and many less familiar names. The crews on most of those early voyages included naturalists like Krasheninnikov and Steller, whose responsibilities were to record and assess the natural resources of unknown regions. Their voucher specimens, journals, and reports became the backbone of the great 19th-century monograph by Pallas, which, in turn, provided the foundation for Portenko and Dement'ev in their 20th-century reviews of the Russian avifauna. Descriptive and taxonomic biology remained the major feature of ornithology in the Russian Far East throughout the 19th and early 20th centuries, but the establishment of the Far East Branch of the USSR Academy of Sciences and the Kronotskiy Zapovednik (Nature Reserve) in the 1930s marked the beginning of a systematic and scientific approach to conservation and management of the region's avifauna. The later 20th century has seen many detailed ecological and biological analyses of the seabird colonies in the Russian Far East, and these are the basis of the following chapters.

Résumé

Même si l'analyse de la biologie des populations d'oiseaux de mer de l'Extrême-Orient russe n'a été entreprise que très récemment, leur étude et leur description ont commencé voilà longtemps déjà et nombre des premiers explorateurs du Pacifique Nord, dont Béring, Cook, Kotzebue, Wrangel et bien d'autres moins connus y ont contribué. Les équipages de la majeure partie de ces premières expéditions comprenaient des naturalistes comme Krasheninnikov et Steller, qui étaient chargés de répertorier et d'évaluer les ressources naturelles des régions inconnues. Leurs collections de spécimens, leurs récits et leurs rapports ont servi de charpente à l'excellente monographie réalisée au 19ᵉ siècle par Pallas qui a elle-même fourni les fondements des études de l'avifaune russe réalisées au 20ᵉ siècle par Portenko et Dement'ev. Les études biologiques descriptives et taxonomiques sont demeurées la tendance dominante de l'ornithologie de l'Extrême-Orient russe durant le 19ᵉ siècle et au début du 20ᵉ siècle, mais la création du département d'études Extrême-orientales de l'Académie des sciences de l'URSS ainsi que d'une Kronotskiy Zapovednik (réserve naturelle) dans les années 1930 ont marqué le début d'une approche systématique et scientifique de la conservation et de la gestion de la avifaune de la région. Un grand nombre d'analyses écologiques et biologiques détaillées des colonies d'oiseaux de mer de l'Extrême-Orient russe ont été effectuées vers la fin du 20ᵉ siècle et ce sont celles-ci qui constituent la base des chapitres qui suivent.

Общее изложение

Хотя анализ биологии популяций морских птиц Дальнего Востока России стал проводиться недавно, их изучение и описание насчитывают уже длительную историю. Ими занимались многие первооткрыватели Северного Тихого океана, включая Беринга, Кука, Коцебу, Врангеля и множество других менее знаменитых. Экспедиции большинства первопроходцев включали таких природоведов, как Крашенинников и Стеллер, в обязанности которых входила регистрация и оценка природных ресурсов неизведанных районов. Собранные ими образцы, дневники и отчеты легли в основу крупнейшей монографии 19-го века П.С.Палласа, которая в свою очередь дала материал для обзоров орнитофауны России, составленных в 20-м веке Л.А.Портенко и Г.П.Дементьевым. В течение 19-го и начале 20-го веков основной характеристикой орнитологии Дальнего Востока России оставалась описательная и таксономическая биология, однако образование Дальневосточного отделения Академии наук СССР и Кроноцкого заповедника в 1930-х годах положило начало систематическому и научному подходу к вопросам сохранения и управления использованием орнитофауны региона. Позднее в 20-м веке были опубликованы многочисленные подробные отчеты о проведенных экологических и биологических анализах колоний морских птиц Дальнего Востока России и именно эти публикации легли в основу следующих глав.

Introduction

Our knowledge of the seabirds of the Russian Far East (Appendix 1) extends back more than two centuries to the heroic expeditions of explorers and naturalists in the 18th century. The beginning of scientific research on seabirds (and also generally on all of the Russian animal kingdom) is closely connected with the name of the scholar Peter Simon Pallas (1741–1811), who directed the expeditions program of the Russian Academy of Sciences (founded in 1725) from 1768 to 1775 and carried out other expeditions and research in Russia until 1810. His general monograph in three volumes, *Zoographia Rosso-Asiatica* (Pallas 1811–1831), has been the primary guide for many generations of Russian zoologists and naturalists. The field conditions that constrained Pallas's investigations have not changed greatly in the intervening centuries. The enormous expanse of territory, with its many different biotic and climatic zones, continues to prevent the uniform collection and analysis of information from the various parts of the Russian Far East. For instance, the 4000-km maritime coastline includes climatic regions ranging from Arctic deserts in northern Chukotka to deciduous woodlands in Primorye, where subtropical species play a great role in the avifauna. To help clarify the history and current state of seabird studies of the Russian Far East, we have divided the area into three subregions and dealt with them independently: the North Region, Kamchatka Region, and South Region. The boundaries of these divisions are necessarily subjective, and each could be divided into a series of many smaller biogeographical areas; however, three divisions capture the major features of climate and geography in large units with roughly similar natural conditions and a distinctive seabird fauna.

The North Region

The North Region of the Russian Far East (Appendix 1) includes the Arctic coast as far west as the Kolyma Lowlands on the East Siberian Sea, Wrangel and Gerald islands, the Chukot Peninsula, and the coast of the Bering Sea as far south as Cape Navarin at the northern boundary of the Koryak Highlands. It also contains the northern Sea of Okhotsk from Penzhinskaya Bay to the Ayan-Okhotsk area.

Until the 1930s, seabird studies in the northern maritime areas, as in other regions of the Russian Far East, concentrated on descriptive natural history. During that phase, ornithological observations and collections were taken episodically, often not by professional zoologists but by members of scientific expeditions whose expertise was far from biological or by professional hunters and employees of trading companies acting incidentally during their performance of other duties.

Correspondence and unofficial reports were the only material available to Captain James Cook for his third expedition of 1778–1779 (King 1785). In 1779, after the death of that great navigator, the expedition, now under the command of Charles Clerke, visited the Russian Far East while investigating the potential of a northern route for the return to Europe. The voyage report includes brief descriptions and drawings of some seabird species from Bering Strait and coastal waters of the Chukot Peninsula (Stresemann 1949). Subsequent marine and coastal expeditions by Otto von Kotsebu (or Kotzebue) (1821), F.P. Wrangel (1841), and I.G. Voznesensky (Gil'zen 1915) added a little more to the biological information. An American expedition under the command of Captain John Rodgers of the *Vincennes*, 1853–1855, through Senyavina Strait to Wrangel and Gerald islands contributed to a catalogue of North Pacific birds by Cassin (1862). Unfortunately, the specimens were lost when Chicago burned in 1871 (Mearns and Mearns 1998).

The first scientific seabird investigations on the Chukot Peninsula were conducted during the A.I. Nordensheld expedition on the *Vega* in 1878–1879 (Palmen 1887), but other explorers who made smaller contributions should also be mentioned, if only because of the heroism inherent in these early voyages. The Arctic expeditions of the *Jeannette* in 1879 (Newcomb 1888) and the *Corwin* in 1881 with Edward W. Nelson as naturalist (Nelson 1883) produced scant ornithology. K.I. Bogdanovitch made more significant observations on the northern coast of the Sea of Okhotsk in 1896–1897, and ornithological materials from oceanographic expeditions have been analyzed and included in subsequent reviews of Russian avifauna (Menzbier 1900; Buturlin and Dement'ev 1934–1941; Dement'ev 1940; Dement'ev and Gladkov 1951–1954; Kozlova 1957). The Norwegian explorer I. Koren made considerable additions to our knowledge of the avifauna of Arctic Chukotka and Yakutia as well as the Bering Strait region through bird collections from 1909 to 1915 (Koren 1910; Thayer and Bangs 1914; Schaanning 1954). Most recently, Konyukhov et al. (1998) summarized the available data and added their own observations made between 1983 and 1991.

Many of the expedition reports and the specimen collections gathered in the first two centuries of exploration were housed in various museums of Europe and America, only to be lost or destroyed in social upheavals and catastrophes of the early 20th century. However, in spite of the losses, a considerable body of descriptive and preserved materials representing the biota of the northern Far East had been accumulated by the 1930s, when the descriptive-naturalist phase of environmental study came to a close. That material became the basis of a great body of work by Leonid Alexandrovich Portenko, who collected and analyzed the dispersed scraps of information thoroughly and carefully, augmenting them with his own long-term observations. With encyclopedic erudition, he produced a monumental series of monographs that are the foundation of modern Russian ornithology (Portenko 1939, 1972–1973).

The inventory of regional biological resources was carried on by numerous land management and subsistence harvest expeditions beginning in the 1930s. These led to the first thorough investigations of the Arctic island fauna (Portenko 1937; Bannikov 1941). The increased volume of knowledge permitted not only the publication of local faunistic descriptions, but also the construction of large-scale zoogeographic analyses (Dement'ev 1940; Volkov and Dement'ev 1948). Alexei Petrovich Vaskovski, an ardent naturalist who worked for many years in the region beginning in the 1930s, made numerous significant observations of the seabirds and composed the first list of birds for the northern Far East (Vaskovski 1956a,b, 1966).

Basic changes came when strategies for the protection and study of the animals and plants in the Far East demonstrated the need for a series of reserves to protect the unique natural areas and a regional scientific institution to support them. Ambitious goals for the protection and conservation of the Russian Far East's unique nature and environment set technical requirements that governed development of institutional research. The establishment of regional organizations followed the pattern of human settlement. The first scientific research institute was founded in Vladivostok in 1932 and later became the Far East Branch of the USSR Academy of Sciences. Then, in November 1934, the Kronotskiy Zapovednik (Nature Reserve) was officially established in Kamchatka, although the decision for its creation had been made in 1926. An institute devoted to the northern areas waited until 1972, when the USSR Academy of Sciences opened the Institute for Biological Problems of the North in Magadan. It was an important step in promoting the study and protection of the animal life of the northern region. Wrangel Island became the first zapovednik in Arctic Asia in 1976.

Even after the establishment of scientific and nature protection agencies in the northern Far East, the role of expeditions and short-term scientific studies remained significant. Until recently, scientists from the European part of Russia, particularly Moscow and St. Petersburg, initiated many such short-term projects. At the end of the 1980s, international cooperation supporting observation and protection of biological resources began to play a big role in initiating ornithological expeditions. One important aspect of this cooperation has been an increased emphasis on the publication of scientific literature.

Historically, scientific literature has been very important in the Russian Far East. The 19th century saw the publication of more than 100 minor articles, short reports, and a few monographs, all of which were reviewed and summarized by L.A. Portenko (1972–1973). Subsequently, a considerable number were devoted to the special observations of seabirds, if only to one-time local observations or reports about some singular event. Until recently, most of the important publications were based on the observations of special scientific expeditions (Kondratyev 1986; Pridatko and Lutsyuk 1986; Bogoslovskaja and Konyukhov 1987; Bogoslovskaja et al. 1988), observations at temporary field stations (Kondratyev et al. 1987), or longer-term observations at permanent sites on the Wrangel Island Zapovednik (Pridatko 1986a,b). Many of those publications included only incidental observations of seabirds as part of ornithological analyses (Kondratyev 1978; Tomkovich and Sorokin 1983; Stishov et al. 1991).

Seabird observations tend to be extremely sparse in those maritime areas of the northern Far East not covered in the works of L.A. Portenko (1972–1973). However, there are important exceptions, such as the long-term investigations by the famous Russian zoologist and biogeographer A.A. Kishchinski, who also reported on unusual wrecks of seabirds in the northern part of the Sea of Okhotsk (Kishchinski 1968) and on the coast of the Koryak Highlands (Kishchinski 1980). Similarly, A.G. Velizhanin played a significant role in maritime areas with observations he made while working on expeditions of the Pacific Research Institute of Fisheries and Oceanography for many years. He collected and summarized a large mass of information about seabird species composition, abundance, and distribution (Velizhanin 1977, 1978; Smirnov and Velizhanin 1986).

The bulk of the recent material on the abundance and distribution of seabirds in the northern Sea of Okhotsk is the product of V.D. Yakhontov. Although a medical doctor, as opposed to a zoologist, he explored and described many new seabird colonies in the northern Sea of Okhotsk (Yakhontov 1973, 1975a,b, 1977, 1979). Unfortunately, many of his observations remain unpublished. The Estonian Scientific Expedition in 1987 made a significant contribution when it mapped and described seabird colonies on the Koni Peninsula in the northern part of the Sea of Okhotsk (Leito and Mand 1991).

The creation of the regional system of research institutes and reserves in the Far East, as well as the changes in the Russian political and economic situation during the 1960s, generated a very important reorganization of protection and investigation in the north. It was recognized that the future development of effective management for bioresources through environmental protection would require a more sophisticated approach at a variety of scales, one that required understanding of the function of animal populations at different trophic levels within ecosystems, of reproductive biology, and of how population dynamics and demographic structure of populations affect the interpretation of long-term monitoring. Essentially, there was a shift from regional studies towards detailed ecological observations of single species and particularly of large populations and communities. This shift in emphasis marked the initiation of the “ecological” approach to studies of the northern Far East. Unfortunately, this process did not at first include seabirds, a predictable omission, considering the remote character of the Russian Far East and the difficulty of carrying out scientific studies there. For many years, ornithologists could not get access to boats and ships or to the special equipment necessary for maritime investigations. All such boats and equipment were concentrated in local departments of the Ministry of Fisheries, whose resource management activities and research were focused on fishery fleet management, inspections, and annual catch statistics. Such goals did not always coincide with effective scientific development in the Far East. By the beginning of the 1980s, our lack of progress in seabird study in comparison with neighbouring countries in the Pacific region became evident through contact with specialists from those countries and increases in the exchange of scientific information. There was a clear need for special studies of seabird communities as important components of marine and coastal ecosystems. At the same time, there was a more general acceptance that seabird studies had broad complementary scientific and practical value. Many maritime nations had begun to apply information, gained from understanding the role of seabirds as indicators of marine ecological conditions, to practical problems. Both conservation agencies and environmental activists were using this information to interpret long-term monitoring efforts at seabird colonies and to comment on the health of marine ecosystems.

Seabird study, as a special scientific program in Magadan, began in the middle 1980s and continues with staff of the Laboratory of Coastal Ecology and Resources under the leadership of A.Ya. Kondratyev at the Institute for Biological Problems of the North. This group has followed several major directions. First, the laboratory maintains a comprehensive seabird inventory based on all of the accumulated data and analyses (published and unpublished) dealing with the abundance, distribution, and status of seabirds and seabird communities of the Far East region (Kondratyev 1991; Byrd et al. 1993; Springer et al. 1993). This activity includes periodic expeditions to seabird colonies, especially in areas with high bioproductivity. Secondly, the laboratory tries to eliminate blank spots on the ornithological maps by visiting the still-numerous coastal sites that have never before been seen by professional zoologists (Kondratyev et al. 1991; Kondratyev 1994). The inventory remains far from complete because of the vastness of the northern Far East and ongoing shortages of specialists and resources. Even where research has been possible, much remains unpublished.

One important aspect of the laboratory's scientific activity is the detailed long-term monitoring of the status and productivity of seabird populations and their role in marine ecosystems. In 1992 and 1993, observations were made on the Komandorskiye Islands (Vyatkin and Zelenskaya 1993; Zelenskaya 1994a,b). Today, activity is restricted to the northern part of the Sea of Okhotsk, particularly on Talan Island, which supports one of the largest aggregations of breeding seabirds in the Russian Far East (Kondratyev 1992, 1993; Kondratyev et al. 1995). Contacts with Alaskan specialists of the U.S. Fish and Wildlife Service and the U.S. National Biological Service have been essential in carrying out this work, particularly through two cooperative projects: *The seabird colony catalogue of the North Pacific* with K.D. Wohl and V.M. Mendenhall and *The demographic status of the seabird populations in the Gulf of Alaska and the northern part of the Sea of Okhotsk* with S.A. Hatch (Hatch et al. 1994a,b; Kondratyev et al. 1994).

In the extreme north of the Far East, seabird nesting habitats have been studied on the Wrangel Island Zapovednik, which holds the largest colonies in the Arctic sector of the Far East (Stishov et al. 1991). In the northern part of the Sea of Okhotsk, the Yamskiye Islands are the centrepiece of the Magadansky Zapovednik (Velizhanin 1977; Kondratyev et al. 1993), but we have been unable to establish a regular pattern of seabird observation there.

Marine observations of seabirds have not been linked to colony studies, primarily because such studies continue to be opportunistic. Typically, they have depended on the enthusiasm of members of marine fisheries expeditions whose time was usually required for other tasks. The first seabird observations in seas of the northern Far East were made by M.M. Sleptzov (1959). During the next 10 years, observations by V.P. Shuntov (e.g., 1972, 1985, 1988, 1992) and later by his colleagues contributed significantly to our understanding of seasonal seabird distribution at sea and the main trophic relationships of the birds (Kosygin 1985; Trukhin and Kosygin 1986, 1987).

The Kamchatka Region

For the purposes of this report, the Kamchatka Region includes both coasts of the Kamchat Peninsula and the Koryak Highlands south of Cape Navarin (see Appendix 1). It also includes Karaginsky Island and the Komandorskiye Islands.

Seabird study on the Kamchat Peninsula has proceeded independently of work in other parts of the Far East. In part, this is due to its unique environment and fauna. The first detailed information about seabirds anywhere in the Russian Far East was collected by surgeon-naturalists S.P. Krasheninnikov and Georg Wilhelm Steller during the expedition of Vitus Bering on the *St. Peter* from 1725 to 1743. These included the discovery of the Spectacled Cormorant *Phalacrocorax perspicillatus*, endemic to the Komandorskiye Islands, in 1741. Steller was the only naturalist to see this species alive, and it was probably extinct by 1850. In 1839, Governor Kuprianof of Sitka gave a skin to Edward Belcher of the *Sulphur* (1836–1842), which John Gould used for his illustration in the trip report (Hinds 1843–1844), an illustration that has been widely copied (Mearns and Mearns 1998). The first written reports about the birds of Kamchatka were comments on 14 species by S.P. Krasheninnikov, who led the second Kamchatka expedition (1733–1743) under the command of Vitus Bering (Krasheninnikov 1786). Pallas (1811–1831) incorporated this report and others by Georg Steller and Carl Merck in his *Zoographia Rosso-Asiatica*. Steller worked periodically in Kamchatka from 1740 to 1744, and Carl Merck was the naturalist-physician of the Joseph Billings–G.A. Sarjichev expedition of 1785–1794. The collections of Merck have been reexamined by Stresemann (1949). The curator of the Russian Academy of Sciences, I.G. Vosnesenski, collected birds in Kamchatka from 1846 to 1848. His collecting expeditions were followed by those of B.I. Dybowski and Leonard H. Stejneger, an employee of the U.S. National Museum from 1879 to 1883. Their historic material became the basis for a series of publications by Dybowski (1883), Dybowski and Taczanowski (1884), and Taczanowski (1891). Stejneger's (1885) monograph is still in use. Two centuries of ornithological observations in the Kamchatka area have been summarized by G.K. Ioganzen (1934) [see also Johansen (1934) for an English version — eds.], S. Bergman (1935), L.O. Belopolski and E.N. Rogova (1947), and, most recently, Yu.V. Averin (1957, 1958).

The second half of the 20th century has seen many years devoted to studies of faunal composition, abundance, and ecology of seabirds by S.V. Marakov (1963, 1966, 1972, 1977), who set the stage for protection of the natural communities on the Komandorskiye Islands. N.N. Kartashev (1961, 1979), N.N. Gerasimov (1970, 1975), and P.S. Vyatkin (1981, 1986) began their seabird investigations in the 1960s, and Yu.B. Artyukhin (1991) began more recently. These scientists continue their studies as staff of the Kamchatka Institute of Ecology and have recently been investigating seabird population dynamics and the factors limiting reproductive success. In the last two years, P.S. Vyatkin and Yu.B. Artyukhin (see Chapter 5) have been observing seabird mortality in commercial fisheries through the initiative and financial support of Kamchatribvod (Kamchat Department of the Federal Fisheries Committee).

Although active ornithological investigations continue in Kronotskiy Zapovednik, the oldest in the Russian Far East, the priority has not been on seabirds (Lobkov 1986).

The South Region

The South Region (Appendix 1) of the Russian Far East is the most diverse and includes the southern portion of the Sea of Okhotsk, the Primorye coast, Sakhalin Island, and the Kuril Islands.

Continental areas

Ornithological observation, including seabirds, began in the southern part of the Russian Far East with the first colonization by ethnic Russians in the middle of the 19th century. However, the great size of the region, the sparseness of its human habitations, its remoteness from cultural centres, its poor transportation or inaccessibility, and many other factors have all contributed to the delayed completion of a basic inventory of natural resources for the region. The Russian Academy of Sciences, the Russian Geographic Society, and even private foundations have organized special expeditions, with some zoological objectives, from their bases in western scientific centres. Most attention was paid to terrestrial birds, and information about seabirds was collected incidentally or not at all. From 1854 to1856, L. Schrenk (1860), who worked mainly along the Amur River and its estuary, as well as on Sakhalin Island, contributed some information about seabirds. Nicholas Michailovitch Prjevalsky (also spelled Przevalskiy), who was assigned to Irkutsk in 1867, spent two years surveying the catchment of the Ussuri River and mentions some seabirds in his first bird list (Prjevalsky 1870). As a general of the army, he later led four famous expeditions into the interior: 1871–1873, 1876–1877, 1879–1889, and 1884–1885 (Mearns and Mearns 1998).

In the second half of the 19th century, when Poland was part of the Russian Empire, several Polish deportees energetically and productively collected birds in the Far East. B. Dybowski worked in Kamchatka and on the Komandorskiye Islands (Dybowski 1883; Dybowski and Taczanowski 1884), while V. Godlevski, M. Jankowski, and Jean Kalinowski worked in southern Ussuriland and North Korea. Much of their work appears in the monumental monograph *Fauna ornithologique de la Sibérie Orientale* (Taczanowski 1891). The eminent Polish ornithologist Ladislas Taczanowski, curator of the Zoology Museum of the University of Warsaw from 1855 to 1890, accumulated zoological material from around the world through the financial support of K. and A. Branicki-Maecenases. Count Branicki, an avid bird collector, also donated about 12 000 specimens. As a result, Taczanowski's (1891) list of seabirds is very close to the modern one. The species descriptions usually focus on taxonomy and morphology, offering only fragmentary, occasional, and poor notes on biology. Sometimes there is a subjective estimate of abundance. Later editions were supplemented by the inclusion of rare local species, oceanic migrants, and revisions of the taxonomic status of several species.

In 1884, the Society for the Study of Amur Land, later the Primorskiye Department of the Russian Geographic Society, was formed in Vladivostok. This society, as well as the newly formed Museum of Regional Study, coordinated the activity of local naturalists. From 1908 to 1915, A.I. Cherski was the museum's curator of ornithology from southern Ussuriland, while S.A. Buturlin was curator of ornithology at the Vladivostok and Habarovsk Museums of Regional Study.

In 1924, M.A. Firsov (1928) discovered a colony of Swinhoe's Storm-Petrel *Oceanodroma monorhis* on a small island near Vladivostok, the northern limit of the breeding range for the species. From 1926 to 1928, a young and active zoologist, L.M. Shulpin, worked in Ussuriland. He was unable to devote much time to the sea coast, but he did include seabirds in his main publication (Shulpin 1936). The same can be said of Konstantin A. Vorobyov, who worked in the catchment of the Ussuri River in 1932 and from 1945 to 1950. His monograph, *Birds of the catchment of the Ussuri River* (Vorobyov 1954), contains little beyond lists of species.

In the 1960s, bird studies in the southern Far East underwent a fundamental change. Local ornithologists formed a collaborative working group through the Regional Centre of the Academy of Sciences and some biological institutes. At first, the group was made up of ornithologists from Vladivostok, but it soon included members from Magadan and Petropavlovsk-Kamchatsky. Membership extended beyond the major academic establishments to ornithologists working in the zapovedniks and in the University of the Far East at Vladivostok. In this larger collective, a subgroup of seabird biologists was able to generate a rapid flow of new information. Meanwhile, a group of zoologists, mostly marine mammalogists, was established in the Pacific Research Institute of Fisheries and Oceanography, which worked throughout the ocean basins of the Russian Far East. This group of specialists had the opportunity to collect information about seabirds while working in coastal areas, on offshore islands, and on the open sea, and Viacheslav P. Shuntov made seabirds, in relation to the biological structure of the sea, the main object of his scientific interests (see Chapter 4).

Recent years have seen many parts of the coast included in biological inventories (Labzyuk 1975; Elsukov 1984; Roslyakov 1986a,b; Shibaev 1987) or reports on various aspects of seabird biology (Nazarov and Labzyuk 1972; Litvinenko 1975, 1976; Litvinenko and Shibaev 1987; Babenko 1996). There have also been interpretations of the role of seabirds in marine ecosystems (Vishkvartzev and Lebedev 1986) and assessments of seasonal abundance and population dynamics (Lebedev 1986). Detailed studies of Black-tailed Gull *Larus crassirostris* have produced meaningful population estimates (Shibaev and Litvinenko 1975) and a comprehensive analysis of their biology (Litvinenko 1980). Banding studies of Japanese Cormorant *Phalacrocorax filamentosus* (= *capillatus*) (Litvinenko and Shibaev 1992) have begun. The first results of long-term population monitoring have also been analyzed, and problems of seabird preservation have been discussed (Shibaev 1987, 1996; Shibaev and Litvinenko 1996). The broad spectrum of seabird studies is reflected by two volumes of collected papers published by the Institute of Biology and Soil Sciences in Vladivostok (Litvinenko 1986) and by the USSR Academy of Sciences (Litvinenko 1987). Both books have been translated to English by the Canadian Wildlife Service of Environment Canada. The 49 articles in these books include articles completely or partially devoted to seabirds, published by the Institute of Biology and Soil Sciences from 1971 to 1996, and some materials originally published outside Russia (Litvinenko and Shibaev 1991; Byrd et al. 1993; Ewins et al. 1993; Litvinenko 1993; Siegel-Causey and Litvinenko 1993; Springer et al. 1993).

Much of the information, particularly that connected with the southern part of Primorye, remains unpublished. Even the overview series, *Birds of the USSR*, begun in 1982, is not yet complete, although many ornithologists from the Russian Far East contributed to the volumes containing accounts of the tube-nosed swimmers, gulls, and alcids.

Shantar Islands

In the last century, this archipelago in the southwestern Sea of Okhotsk was rarely visited by explorers because it lies outside the main sea lanes and is often difficult to reach because of ice conditions. The earliest report about the birds (including seabirds) of the Shantars is by A.Th. Middendorff (1851), who visited these islands in August 1844 during an expedition to eastern Siberia. Zoologist G.D. Dulkeit worked on the islands from 1924 to 1926 as a staff member of the expedition, assessing populations of fur-bearing animals. His collection of 214 specimens was the basis for the first list of the birds of the Shantar Islands (Dulkeit and Shulpin 1937), which included 172 species (19 seabird species). Unfortunately, he was unable to pay much attention to the seabird colonies. In the summer–autumn periods of 1959, 1971, and 1972, V.D. Yakhontov made ornithological collections and observations that supplemented his earlier list. He recorded 205 species of birds, including four tube-nosed swimmers, two phalaropes, 10 gulls, and nine alcids (Yakhontov 1977). The ornithologist G.E. Roslyakov (1986a,b, 1991, 1994; Roslyakov and Roslyakov 1996) worked on the islands in the summers of 1978, 1982, 1986, 1991, and 1992 to complete an ornithological assessment for the creation of a national park on the archipelago.

Sakhalin Island

In spite of its large size, the shores of Sakhalin Island offer few places suitable for nesting colonies of seabirds. Most of the colonies are on two modestly sized islands, Moneron and Tyuleniy, or small offshore rocks. A few other small colonies occur on the capes that jut out into the sea on the northern, southern, and eastern coasts of the island.

Ornithological observations of Sakhalin Island have accumulated very slowly since their beginning in the middle of the 19th century. The first reports of seabirds on Sakhalin are from L. Schrenk (1860) and S.S. Rosset (1888), who worked on Tyuleniy Island. The first faunal summary of Sakhalin contains information on Aleutian Tern *Sterna aleutica*, Black-tailed Gull, Long-billed Murrelet *Brachyramphus perdix* (recently separated from the North American Marbled Murrelet *B. marmoratus*; see Chapter 3), and others (Nikolski 1889).

Japan held southern Sakhalin Island from 1905 to 1945, and during this period there was considerable bird collecting by zoologists from Japan and other countries. Russian zoologists were active on the northern part of the island. Seabirds became a primary subject of faunistic observations, and the first description of seabirds on Moneron Island was made in 1914 (Munsterhjelm 1922). A series of brief articles (Takahashi 1939) and annotated lists (Ornithological Society of Japan 1942) of the birds of Sakhalin Island contained 282 and 285 species, respectively. In the postwar years (1947–1949), the majority of the seabird work was produced by A.I. Gizenko, an ornithologist on the staff of the Sakhalin Branch of the USSR Academy of Sciences. He focused on seabirds, especially in the Kuril Islands, but included generalized observations of the fauna of Sakhalin Island and the coast of China. He visited seabird colonies on both Moneron and Tyuleniy islands to observe nesting biology. Unfortunately, in the 1950s and 1960s, the zoologists working on Sakhalin did not take any special interest in the seabirds.

From 1968 to 1989, V.A. Nechaev observed the avifauna on Sakhalin Island and gave seabirds significant coverage in his *Birds of Sakhalin Island* (Nechaev 1991). Besides Moneron and Tyuleniy islands (Nechaev 1975; Nechaev and Timofeeva 1980), traditional sites for zoologists, Nechaev visited and described seabird colonies on Terpeniya and Shmidta peninsulas. He also described the nesting biology of the Aleutian Tern and proved the nesting by the Long-billed Murrelet on Sakhalin Island. At the same time, E.A. Mikhtar'yantz began her work on the nesting biology of alcids, which included very detailed observations of the feeding biology of murres on Tyuleniy Island (Mikhtar'yantz 1984, 1986). Monitoring of seabird colonies on Moneron and Tyuleniy islands continued through the 1970s and into the 1990s (Shibaev and Litvinenko 1996; Trukhin and Kuzin 1996).

The Kuril Islands

The observation of seabirds on this important archipelago (Appendix 1) began with the expeditions of Vitus Bering from 1725 to 1743. He had two naturalists aboard the *St. Peter*, G.V. Steller (1709–1746) and S.P. Krasheninnikov (1713–1755). Steller's description of the northern Kurils was included in *Zoographia Rosso-Asiatica* (Pallas 1811–1831). Steller's travels were largely restricted to the northern Kurils, and it was not until the 1780s that G.I. Shelikhov (1971) observed and described the seabird colonies on some islands of the middle Kurils.

The curator of the Russian Academy of Sciences, I.G. Vosnesenski, collected birds in the northern and middle Kurils in 1844 and 1845. His collection remains in the Zoological Institute, Russian Academy of Sciences, in St. Petersburg. From 1873 to 1881, Captain S. Snow hunted sea mammals off the Kurils but made a collection of about 160 bird species (Blakiston and Pryer 1882; Seebohm 1890). L. Stejneger worked on the middle Kurils in 1897 (Stejneger 1899) and included some seabird material in his list of 146 species.

After the Russo-Japan War of 1905, all of the Kurils were ceded to Japan and remained part of the Japanese Empire until 1945, providing an opportunity for Japanese ornithologists and collectors. S. Uchida (1912) published a fairly comprehensive list of birds, which was updated and expanded by Y. Yamashina (1931). From 1929 to 1930, the Swedish zoologist S. Bergman (1935) worked on the middle and southern Kurils and published essays devoted to seabirds, including taxonomic notes and impressions of distribution and biology. Typically, the focus of bird investigations in the first half of the 20th century was concentrated on the compilation of faunal inventories, with other information collected as an aside.

Once the Kuril Islands were returned to Russian jurisdiction, in 1945, they became a place of great interest to Russian zoologists, who had a very practical mandate related to the profoundly difficult economic conditions after the Second World War. The economic stress created an intense interest in the exploitation of natural biological resources, in which colonial seabirds were seen either as a source of protein (albumin) or as food for fur-bearing mammals. B.A. Kuznetzov (1949) worked on the Kuril Islands in 1947 with that perspective, but he was also interested in the distribution and rational use of seabird colonies. A.I. Gizenko (1955), who worked on some of the Kuril Islands in 1947 and 1948, devoted special attention to colonial seabirds, completing a catalogue of the important colonies of the Kuril Islands and Sakhalin, recording locality, species composition, estimates of abundance, and potential for harvesting. Besides considering plans for intensive exploitation of the seabird resource, he made significant observations on the biology of the Common Murre *Uria aalge*, Tufted Puffin *Fratercula cirrhata*, Rhinoceros Auklet *Cerorhinca monocerata*, and some gulls. In 1951 and from 1955 to 1956, S.K. Klumov included observations of some seabird colonies while he studied marine mammals (Klumov 1960). Near the end of the decade, S.M. Uspenski collected much of the published material in a catalogue of seabird information for the seas of the Russian North and the Russian Far East (Uspenski 1959). A later publication, *Birds of the southern Kuril Islands* (Nechaev 1969), is devoted to terrestrial birds and gives little information on seabirds.

From 1963 to 1974, A.G. Velizhanin made several visits to the Kuril Islands, observing colonies on the majority of islands and collecting new information on species composition, distribution, and abundance. He also worked on islands and coasts in other parts of the Russian Far East and, in 1978, published a new catalogue of seabird breeding areas, which included much new information on nesting habits (Velizhanin 1978). Unfortunately, the effort to keep this seabird catalogue up to date has ceased. The great size of the Kuril Archipelago and its inaccessibility have precluded most recent activity, and our knowledge of seabirds in the area has not increased significantly over the past 20 years.

Observations of birds at sea

The first studies of seabird distribution across the seas of the Far East began in the 1950s. Initially, these were connected to expeditions related to the needs of fishery development and provided only incidental opportunities for the observation of seabirds. Systematic studies of birds at sea began with staff of the Pacific Research Institute of Fisheries and Oceanography (Sleptzov 1959, 1960; Gudkov 1962; Kurotchkin 1963). Subsequently, V.P. Shuntov of the same institute was able to make important contributions to our knowledge of birds at sea during oceanographic cruises. The main thrust of his work was to link observations of species composition, abundance, distribution, and the nature of seabird migration to oceanographic and hydrobiological features. Between 1959 and 1968, he published about 10 articles on seabirds, which led to his monograph *Sea birds and the biological structure of the ocean* (Shuntov 1972), which included some comparative material from the southern hemisphere. From 1984 to 1997, he was involved in seven expeditions during the summer–autumn seasons, which covered regions from the Bering Sea to Tsushima and Sangarsky straits, producing 15 articles about seabirds (e.g., Shuntov 1985, 1988, 1992, 1995).

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Chapter 2. Far East seas as habitat for seabirds

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Summary

The seas of the Russian Far East are strongly influenced by the intense winter cold carried from the Asian continental land mass by the prevailing winds. Much of the nearshore habitat is covered by ice for more than half the year, and this strongly affects the distribution of an abundance of seabirds and constrains their migration schedule. The dominance of ice is reflected by the many pagophilic (ice-loving) species in the region and the dependence of some species on polynyas and other predictably open areas. Surprisingly, the cold Arctic air has little effect on water temperature in the seas. This is controlled by warm and cold currents, which combine with very complex geography to divide the region's water bodies into large domains with varying hydrologic characteristics, in terms of nutrient availability and primary productivity, creating a complex mosaic of habitats exploited by a variety of breeding and migrant birds.

Oceanic conditions are subject to interannual variation, which may affect seabird breeding success in the short term; however, there are also cycles with decade-long periods, which have long-term consequences for seabird ranges and abundance. Unfortunately, current studies of marine resources are dominated by analyses of commercially important species, so that any relationship between food availability and seabird abundance remains unclear and poorly understood, except in the most extreme cases.

Résumé

Les mers de l'Extrême-Orient russe subissent fortement l'influence du froid hivernal intense que les vents dominants apportent de la masse continentale asiatique. Une bonne partie du littoral est couvert de glace plus de la moitié de l'année, ce qui exerce un effet marqué sur la répartition d'un grand nombre d'oiseaux de mer et restreint leurs périodes migratoires. Cette dominance de la glace est reflétée par la présence de nombreuses espèces pagophiles (aimant la glace) dans la région et par la dépendance de certaines d'entre elles à l'égard des polynies et d'autres zones d'eau libre. Curieusement, l'air froid de l'Arctique a peu d'effet sur la température de l'eau dans ces mers. Celle-ci dépend plutôt des courants chauds et froids qui, en combinaison avec la configuration très complexe de la région, divisent les étendues d'eau en grands domaines dont les caractéristiques hydrologiques varient aussi bien du point de vue de la disponibilité des nutriments que de la productivité primaire, ce qui donne naissance à une grande diversité d'habitats exploités par toute une variété d'oiseaux nicheurs et migrateurs.

Les conditions océaniques sont assujetties à des variations interannuelles qui ont parfois des répercussions à court terme sur la réussite de la reproduction des oiseaux de mer; certains cycles décennaux ont également des conséquences à long terme sur les aires de répartition des oiseaux de mer et leur abondance dans celles-ci. Malheureusement, les études actuelles des ressources marines sont dominées par des analyses portant sur des espèces commercialement importantes, ce qui fait que les relations entre la disponibilité des ressources alimentaires et l'abondance des oiseaux de mer demeurent obscures et mal comprises, sauf dans les cas les plus extrêmes.

Общее изложение

Моря Дальнего Востока России находятся под сильным влиянием интенсивных зимних холодов, приносимых преобладающими ветрами с материка Азиатского континента. Большинство прибрежных мест обитания в течение более полугода находятся под покровом льда, что оказывает огромное влияние на распределение и количество морских птиц, а также накладывает ограничения на сроки их перелётов. Властвование льда отражается в наличии в этом регионе многих пагофилических (любящих лёд) видов, а также в зависимости других видов от наличия полыней и иных открытых ото льда пространств. Вызывает удивление тот факт, что холодный воздух Арктики незначительно влияет на температуру морской воды. На температуру здесь влияет комплекс теплых и холодных течений, которые в комбинации с очень сложной географией региона разделяют водные массы на обширные области с изменяющимися гидрологическими характеристиками доступности и производительности питательных элементов, что в свою очередь создает сложную мозаику мест обитания гнездящихся и пролетных птиц.

Состояние океана варьирует в течение года, что в краткосрочной перспективе может оказывать влияние на процесс размножения птиц. Однако, отмечены также циклы продолжительностью в десять лет, которые вызывают долгосрочные последствия для областей распространения и влияют на количественные

показатели присутствия птиц. К сожалению, среди имеющихся исследований морских ресурсов доминируют анализы коммерчески значимых видов, поэтому связь между наличием корма и количеством морских птиц остается неясной и не понятой до конца, за исключением весьма крайних случаев.

The oceanic regimes

The Russian portion of the North Pacific Ocean and the adjacent seas of the Russian Far East lie within the Subarctic Oceanic Zone. This zone is delineated by the edges of the Subarctic Water Mass revolving in a system of cyclonic gyres that occupy the whole space above 45°N latitude between Asia and North America. The northern and southern boundaries of the Subarctic Oceanic Zone are sometimes called the North and South Subarctic Fronts (Bulgakov et al. 1972). The south boundary forms the Subarctic Front between 40°N and 45°N, where cold subarctic water of low salinity mixes with warmer and more saline subtropical water (Favorite et al. 1976; Ohtani 1991; Okuda et al. 1991). It is contiguous with the continuation of the Kuroshio – North Pacific Current. The North Subarctic Front lies on the edge of the Subarctic Current.

Although the Subarctic Pacific is considered to be a single climatic region, it is not homogeneous in its physical or hydrobiological characteristics. Within it, a number of discrete domains, such as the large, second-order cyclonic gyres in the Sea of Okhotsk, the Bering Sea, the Western Subarctic Sea, the Gulf of Alaska, and the Sea of Japan, create environmental complexities at different hierarchical levels. The Sea of Japan has its own special features. There, the cold South Primorsky Current, a branch of the main Primorsky Current, interacts with the subtropical East Korean Current, drawing the local subarctic front (analogous to the Subarctic Front of the North Pacific) southward so that it lies between latitudes 38°N and 40°N throughout the year (Yarichin 1980; Yurasov and Yarichin 1991).

The Russian Economic Zone is basically situated within the Okhotsk–Kuril currents, the Bering currents, and the northern Sea of Japan current systems. The eastern outskirts are contiguous with the Subarctic and Alaskan currents.

Ice formation

Because most of the seas on the continental shelf are shallow, with limited intrusion by oceanic waters, their environmental conditions are controlled by their proximity to the Arctic Air Mass of central East Siberia. Its intense low temperatures in winter contribute to the formation of ice fields over much of Russia's coastal waters. Typically, shallow gulfs and bays, especially those with low salinity, are the first to be covered by ice. The waters over the continental shelf soon follow. The shallow Sea of Okhotsk, which extends far into the continent, receives oceanic water only through Chetvertyi–Kurilskiy, Severgina, and Kruzensterna straits in the Kuril Archipelago, and often up to 97% of the surface is frozen in winter. Oceanic waters can enter the Sea of Okhotsk only through the northern and central straits of the Kuril Range, allowing conditions there to become very severe and much of the basin to become covered by ice (Khen, in press). Great masses of ice from the north and northwest are carried by the East Sakhalin Current into the southern part of the Sea of Okhotsk and southern Kurils. In the last weeks of winter, ice fields form even adjacent to the central straits of the Kurils, covering areas of abyssal plain and extending along the continental slope of western Kamchatka. Abyssal areas, strongly influenced by oceanic conditions, usually remain open. In spite of its higher latitude, the Bering Sea also remains clear of ice in most years because the influence of oceanic water limits the formation of ice fields to areas over the continental slope. Ice fields in the Sea of Japan are limited to the Tatarsky Strait area, because large masses of subtropical oceanic water intrude from the south (Fig. 1).

Seabirds and ice

Broad expanses of ice make life difficult for most seabirds; consequently, conditions in the Russian Far East are much less favourable for seabirds than are conditions in American waters of the North Pacific. By late winter, ice fields extend approximately 1500 km farther south than those along American shores. These ice fields form too late in the year to have an important effect on seasonal seabird migrations, which begin by September in the autumn and sometimes as early as August (Shuntov 1972). Movements may continue through October and November, but ice coverage does not reach its maximum until the second half of winter. Ice usually does not recede until late April, and, once ice cover is complete, it simply excludes seabirds and limits winter distribution.

Zooplankton

With the approach of winter, the distribution of zooplankton changes, as a majority of the nekton and larvae sink to deeper levels. The scale and range of such seasonal vertical migrations tend to be most substantial within the abyssal areas, where major concentrations of zooplankton, fish, and squid become mesopelagic in winter (Table 1). This change effectively moves them beyond the reach of even the most capable of the diving seabirds. Over the continental shelves, however, vertical migration is limited by the sea bottom, and plankton and nekton merely concentrate at lower levels, where they are more likely to remain accessible to birds, at least until ice covers the surface. Similarly, benthic organisms are also an important source of food for seabirds before ice covers the inner half of the shelf and the shallow seas.

This combination of ice cover and seasonal migration by plankton helps explain why some seabirds, including some sea ducks, gulls, and cormorants, but especially murres (Fig. 2), remain at the edges of the ice fields or near patches of open water. Most seabirds of the Far East are not limited by climate and tolerate a broad range of air and water temperatures. However, temperature may affect food supply or accessibility and force the birds to move. Generally, seabirds are opportunistic and will migrate northward, even in the middle of winter, if the wind causes the ice to retreat.

Temporary leads are not the only open water available to birds. In certain areas, persistent, vast polynyas (special areas that remain open or open regularly and more or less predictably) are an important ocean feature that can occur even among the most dense ice packs of the rigorous polar

Figure 1
Seasonal changes in the extent of sea ice in the Russian Far East during the winter months (updated from Bulgakov 1968)

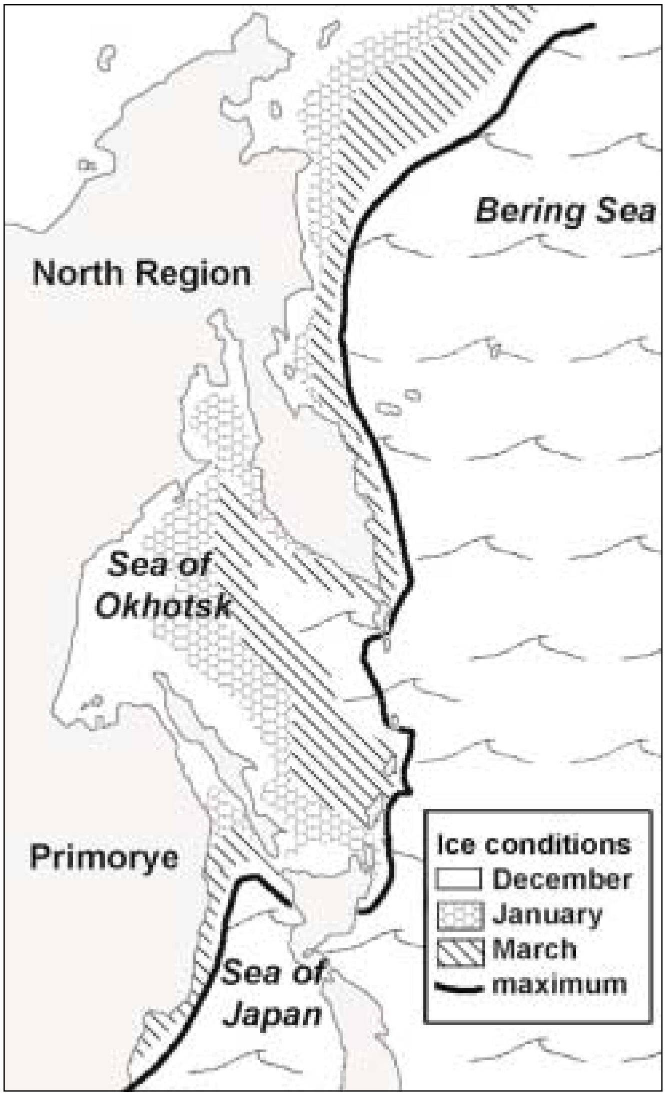
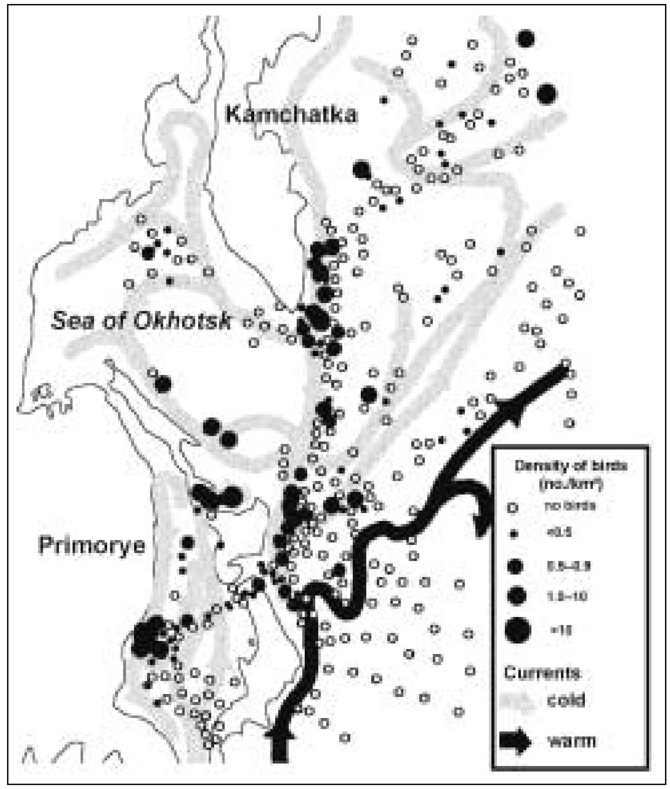


Table 1
Seasonal vertical distribution of zooplankton and nekton in abyssal areas of the Sea of Okhotsk (Gorbatenko 1996)

	Summer		Winter	
Stratum (m)	Zooplankton (g/m^3)	Nekton (g/m^3)	Zooplankton (g/m^3)	Nekton (g/m^3)
0–199	227.2	7.5	62.1	1.9
200–499	252.4	16.3	137.7	11.9
500–999	126.4	8.6	484.5	29.2

regions. Polynyas form over strong vertical water movements and where currents adjust to sudden changes in depth or complex bottom relief. In the Sea of Okhotsk, they form in the Iona–Kashevarov area, the mouth of Shelikhov Gulf, and the Tyuleniy Island area. In the Bering Sea, polynyas occur near the Chukot Peninsula and Saint Lawrence Island, Alaska, as well as some areas in the western part of the basin over the continental slope. Although there have been few opportunities to observe

Figure 2
The distribution of murres in the Russian Far East during winter months of the 1960s in relation to warm currents and cold currents (Shuntov, in press)



seabirds on polynyas or other patches of open water in the ice-covered regions, it is clear that many spend the winter on polynyas and other areas of infrequent ice (Fay and Cade 1959; Voronov 1972b; Bogoslovskaya and Votrogov 1981; Kosygin 1985; Trukhin and Kosygin 1986, 1987; Konyukhov 1990). Konyukhov (1990) found 10 species wintering on the Syrenikovskaja polynya near the coast of Chukotka, and some birds even attempt to spend the winter in the Arctic Ocean (Uspenski 1969). Not only seabirds but also other marine animals, including interzonal, neritic, nerito-oceanic, and oceanic species, adapt to these zones. In the nerito-oceanic group, the ice-neritic species are a distinct group of pagophiles (ice-lovers) (Shuntov 1972).

Climate and oceanography

The frozen parts of Far East seas are, indeed, very cold. The average air temperature in winter months is −15°C to −20°C in the northern parts of the Bering Sea and Sea of Japan and −20°C to −25°C in the Sea of Okhotsk, where minimum temperatures may be −40°C or −50°C (Dobrovolsky and Zalogin 1982). Such low temperatures exclude at least some species, and the majority of all seabirds leave the coldest regions before the most extreme cold arrives.

In spite of its great size, the Asian continental air mass generally has little effect on water temperature, because the major currents run parallel to the northwest by southeast alignment of the coast. As a result, surface water isotherms lie along the same axis in winter, and sea surface tempera-tures in the southern Kurils are similar to those in the southwest Bering Sea. Conditions around Hokkaido are much like those in the Gulf of Alaska. However, in summer, climate normals on the coast of the Russian Far East are shifted some 1600 km south of their American counterparts. At any given latitude, the climate and oceanic conditions of the western North Pacific are more rigorous than those in the east (Fig. 3), and there is a much sharper contrast between seasons. These differences affect the seabirds' behaviour and contribute to later nesting dates and more extended seasonal migrations. Continental influence gradually declines with distance from shore, but it drives the zonation on the shelf. Oceanic influences are much more important on the American shore, because the prevailing westerly winds travel through the moderating effects of the North Pacific (Falleev and Dyomin 1974).

Ocean and climate conditions are not the only factors contributing to the Russian Far East being less favourable seabird habitat than the North American coast. The moderate environmental conditions in the eastern North Pacific are enhanced by geographic factors such as abundant nesting habitat in the form of small offshore islands and a more indented coastline. Consequently, preliminary estimates suggest that Russian seabirds (excluding southern migrants) comprise only 28% of the roughly 90 million individuals in the whole Subarctic Pacific (Table 2). Most are concentrated in American waters, where their number is 2.6 times larger than in the Russian regions.

The distribution of oceanic and modified water masses in each sea basin or ocean area depends on the bottom relief and currents, whereas the arrangement of currents depends upon both shore configuration and bottom relief. Shallow waters (>200 m) occupy 45% of the continental shelf of the Bering Sea and 40% of the Sea of Okhotsk, but only 24% of the Sea of Japan (Larina 1968). The upper Tatarsky Strait and Peter the Great Bay are the only wide shallows within the Russian region of the Sea of Japan, and both the Kamchat Peninsula and Kuril Islands have only a narrow continental shelf. The wide shelves in the Sea of Okhotsk and the northern Bering Sea are poorly connected to oceanic circulation. Water from the Bering Sea is carried into the Chukchi Sea through Bering Strait by the Navarinskiy and Western Alaskan currents. The southern part of the Chukchi Sea (especially near the Alaskan coast) does not differ much from the northern part of the Bering Sea in climate or oceanographic conditions because of the warming influence of that water (Dobrovolsky and Zalogin 1982). The southern Bering Sea receives such large volumes of oceanic water that it functions like a large embayment of the Pacific Ocean.

The water exchange between the Sea of Okhotsk and the ocean is less varied than that in the Bering Sea, because oceanic waters intrude through narrow straits in the northern and middle Kurils. The Sea of Japan is even further removed from oceanic effects. The subtropical Tsushima and East Korean currents, which are modified Kuroshio waters, enter the Sea of Japan through the Korean Strait from the East China Sea (Yarichin 1980; Yurasov and Yarichin 1991). Unlike the other seas of the Russian Far East, the Sea of Japan contains two natural zones, subarctic and subtropical. They are separated by a local subarctic front, which crosses the sea approximately from the Korean Gulf to Sangarsky Strait. Primorye is situated comparatively close to the local subarctic front, and its coastal waters are subarctic.

Productivity

The composition of the water masses and the position of the major currents create the general environmental character of marine and oceanic areas. These, in turn, determine the distribution of seabirds and other organisms, defining the general biogeography of large areas through the abundance and accessibility of food (Shuntov 1972). This phenomenon is partially connected with the intrinsic biological productivity of ecosystems in an area and partially determined by the peculiarities of the vertical and horizontal distributions of marine organisms as set by a variety of oceanographic factors, primarily second-order fronts, water stratification, and meso- or macro-circulation.[1]

The seas of the Far East and the adjacent oceanic waters have always been considered areas of exceptionally high biological productivity, with stable long-term nutrient supplies. Generally, mineral nutrients are concentrated in the Kuril, Kamchatka, and Aleutian waters, as well as the waters of the Gulf of Alaska and the North American coast. The Bering Sea is somewhat less rich than those regions, whereas nutrient concentrations in the Sea of Okhotsk are lower still (Kun 1975; Sapozhnikov et al. 1986; Gershanovich et al. 1990). Highly productive areas occur where abyssal oceanic waters carry their load of nutrients into the euphotic zone. The Sea of Japan has lower productivity, because shallow straits isolate it from the deep waters of the North Pacific, reducing nutrient concentrations to half those in the Bering Sea and Sea of Okhotsk (Mokievskaja 1961; Volkov and Chuchukalov 1985). In coastal waters, only the estuaries of major rivers, which contribute quantities of terrestrial nutrients, can produce local areas of such high productivity.

The supply and accessibility of mineral nutrients in the euphotic layers of the sea are the limiting factor in bioproductivity at lower trophic levels, but they do not act alone. Light, temperature, and vertical water stratification are also of great importance. Bioproductivity is generally based on the abundance of bacteria and protozoa, which are the primary consumers of elementary organic substances (Shuntov and Dulepova 1995, 1996; Sorokin et al. 1995).

Traditionally, only comparative analyses have been used to describe the relative productivity of the North Pacific and Far East seas. However, such analyses underestimate the actual values of biomass production at all trophic levels by several orders of magnitude. This became evident during a wide-ranging bioresources study, conducted by the Pacific Research Institute of Fisheries and Oceanography in the 1980s (Shuntov 1985; Markina 1986; Shuntov et al. 1990, 1993, 1997; Shuntov and Dulepova 1995, 1996). At middle and high latitudes, the reservoir of mineral nutrients builds

[1] The fertilization of coastal waters by excrement from very large seabird colonies appears significant, and the high nutrient value of the mineral and organic substances made available to the phytoplankton has been demonstrated by Golovkin (1982, 1991). However, this source for increasing seawater fertility is too local, and its influence is generally imperceptible at the scale of the sea basins or portions of basins.

Figure 3
Average temperature differences (°C) between air and sea surface in the North Pacific in February 1966

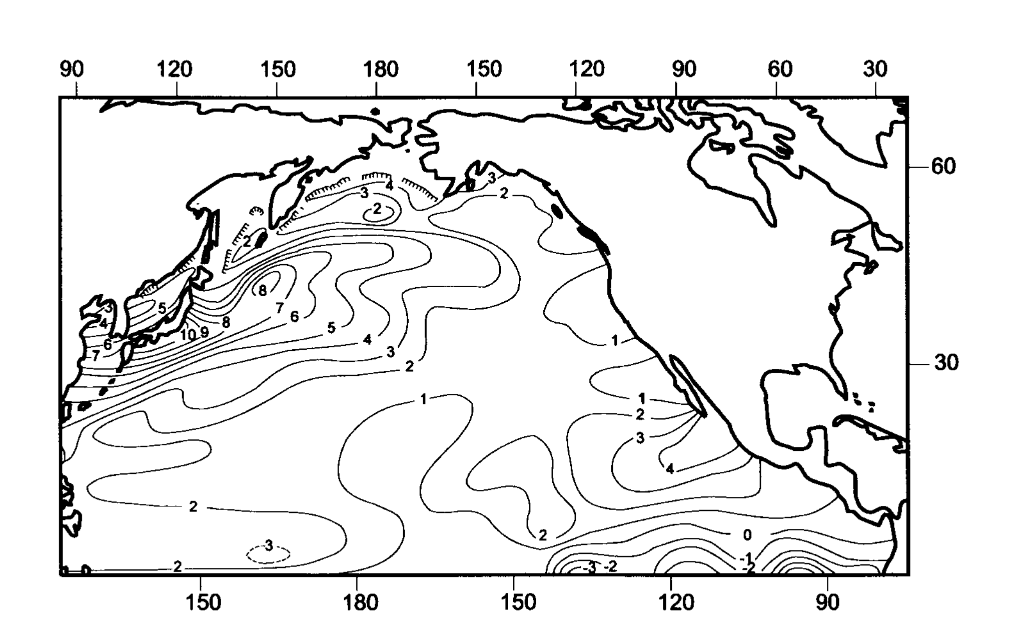


Table 2
Numbers of seabirds nesting in the Russian Far East and the Subarctic Pacific (Shuntov, in press)

	Russian Far East		Subarctic Pacific	
Family	Number (000s)	%	Number (000s)	%
Procellariids	3 419	13.7	22 500	25.0
Cormorants	266	1.1	600	0.7
Phalaropes	275	1.1	3 000	3.3
Jaegers	235	1.0	750	0.8
Gulls	3 731	15.0	7 860	8.7
Terns	265	1.1	655	0.7
Alcids	16 702	67.0	54 738	60.8
Total	24 893	100.0	90 103	100.0

up in the euphotic layer when shallow and deeper layers mix in autumn and winter. This supply is quickly consumed during a burst of phytoplankton development in the spring, when there is a sudden reappearance of productivity after the dark of winter (Sapozhnikov et al. 1986). This rapid transformation of organic materials and the regeneration of nutrients have been clarified in recent hydrochemical and productivity studies. Once the spring store of nutrients is exhausted in summer, the products of organic decomposition are drawn into the process of primary production and share in productivity by biogenic recycling, which reaches 70% or 80% efficiency (Sapozhnikov 1995; Sapozhnikov and Naletova 1995; Agatova and Lapina 1996; Leonov et al. 1997). Perhaps the most important effect of recycling is the extension of the photosynthetic season into the late summer.

The role of local upwellings in enriching the euphotic layer with nutrients has been underrated in the seas of the Far East. It is especially important in summer, when the water becomes stratified and the euphotic layer tends to become isolated from nutrients in deep water. Some important vertical mixing often takes place in straits when the flow becomes turbulent over sudden changes in bottom relief. More often, however, upwellings are connected with mesoscale eddies over the continental slope, in the lee of capes, or at the interzonal fronts. The most powerful upwellings are in the Kashevarovskiy, Yamskiye, Kuril, and Navarinskiy areas (Chernyavsky et al. 1981; Kotenev 1995; Sapozhnikov 1995; Karpushin et al. 1996; Shuntov and Dulepova 1996).

Higher rates of primary production sustain a higher biomass of zooplankton, benthic organisms, squid, and fish, the important seabird foods, but the relationship between plankton, nekton, fish, and seabirds is too complex for simple comparisons. The effect of plankton on other members of the ecosystem is strongly modified by vertical and horizontal distribution, size and composition, the stability of concentrations, etc. (Shuntov 1993a,b; Shuntov et al. 1993). Seabird distribution may also be strongly affected by extrinsic factors, such as the distribution of convenient nesting areas. We can only say that regions with high concentrations of aquatic organisms provide greater opportunities for foraging seabirds.

Recently, some dozen expeditions have created an opportunity for an unprecedented reassessment of the bioresources in the Russian Far East and new estimates of the scale of those resources within trophic levels from zooplankton up. In part, the results differ strongly from previous calculations because we applied specific capture coefficients to the biomass estimates. Capture techniques are far from perfect, and catch rates are affected by the targets' size and mobility; in the past, however, the correction factor for small fish (e.g., anchovy) in trawling surveys and euphausiids in plankton tows was arbitrarily set at 10 (i.e., assuming that we captured a constant 10% of the animals present). The new correction coefficient incorporates the effects of time of day to avoid underestimating the mass of pelagic animals, the majority of which migrate to lower strata in daylight

(Shuntov et al. 1993; Volkov 1996). Such elementary adjustments make the calculations of the biomass of marine organisms more precise and estimates of species composition more reliable. Most importantly, we are able to show that 70–85% of plankton communities are composed of macroplankton (>3.5 mm), the type taken by planktivorous seabirds such as small alcids and storm-petrels. Previously, mesoplankton was considered to be the most abundant.

Within the deep-water strata, the total summer zooplanktonic biomass reaches 400–460 t/km² in the Sea of Okhotsk and in the oceanic waters near the Kurils and 230–260 t/km² in the Bering Sea, Sea of Japan, and Kamchatka–Komandorskiye oceanic area (Shuntov et al. 1993).

The absence of a correlation between the quantity of nutrients and plankton abundance or between bird density and potential prey biomass deserves further consideration. In the Russian Far East, the highest seabird densities occur in the Bering Sea, and the lowest in the Sea of Japan. The above-mentioned regional differences in plankton communities are apparently further subdivided (Table 3) so that within each of the bigger regions there are areas that are significantly richer or poorer in zooplankton. Although plankton density is much lower over the shelf in the Bering Sea and more homogeneous in the Sea of Okhotsk, planktivorous birds are equally abundant on the shelf in both seas (Shuntov 1972; Hunt et al. 1981a,b; Gould et al. 1982). This discrepancy occurs partially because there are intrusions of cold, nutrient-rich waters onto the continental slope and partially because there are abyssal areas within the shelf. Shelf areas appear even more significant in terms of higher plankton concentrations when we calculate density on the basis of total water volume, even in the Bering Sea.

The horizontal patchiness and vertical stratification of zooplankton are well-known. Vertical stratification is largely dependent on water movement, which redistributes nutrients and drives the formation of plankton accumulations and, secondarily, concentrations of nekton. The maintenance of many layers in a stratified but dynamic structure is dependent upon low bottom relief and simple coastline configuration.

On the wide shelf of the eastern Bering Sea, there are three areas: coastal, middle, and outer. These areas are separated by corresponding coastal, middle, and outer secondary fronts over the 50-, 100-, and 170-m isobaths, respectively, and have a width of 10, 50, and 150 km, respectively (Coachman et al. 1980; Kinder and Schumacher 1981). Prey accessibility and feeding conditions are not equal across these areas for the different seabird groups. Murres, in spring, and shearwaters, in summer, are predominant over the inner shelf areas, and nondiving species such as fulmars, kittiwakes, and storm-petrels are predominant on the outer shelf (Schneider and Hunt 1982; Schneider et al. 1986; Shuntov 1995b).

Ecologically based clustering of seabirds can also be seen in the western part of the Bering Sea (Shuntov 1993a), but there, local anomalies affect the distribution of feeding areas. Currents along the continental slope affect the shelf waters, whereas the narrow coastal shallows force the middle front to intrude on the outer. Occasionally, there is room for only two shelf zones, one coastal and one outer (Fig. 4). Water movement, parallel to the Kamchatskiy Current, occurs over the outer shelf, whereas a countercurrent moves along the shore, over the inner shelf (Verkhunov 1995). The overall result is a mosaic structure, which characterizes much of the western Bering Sea. In the Gulf of Anadyr, with its vast, gently sloping shelf (Fig. 4), another type of mosaic forms in response to seasonal changes in the gyre in the gulf, rather than variations in the topography of the sea bottom or coast (Sapozhnikov 1995). In the waters of the Gulf of Anadyr, we can find effects from the Navarinskiy Current, near-bottom cold-water areas, and also coastal shallows (Verkhunov 1995). (The edge of the coastal shallows is marked by the Kresta Bay Front.)

The oceanographic situation over the continental slope and in the Bering Sea has long been the subject of study, but early notions about the complicated structure of coastal currents were confirmed only recently (Kotenev 1995; Sapozhnikov 1995), and it has become evident that the role of dynamic processes in the water masses over the continental slope was underrated in the past. The currents passing along the continental slope give rise to various meanders and

Table 3
Mean zooplankton biomass in the 0- to 199-m stratum of different portions of the seas of the Russian Far East and adjacent oceanic waters in summers from the 1980s and 1990s (Shuntov, in press)

	Biomass (g/m^3)	
Area	1980s	1990s
Bering Sea		
Bering Strait	53	–
Western Gulf of Anadyr	48	–
Southeastern Gulf of Anadyr	56	–
Northeastern Gulf of Anadyr	86	–
Navarinskiy area	187	–
Korjasky shelf	89	–
Korjasky continental slope	177	–
Western Aleut Abyss	185	157
Olyutorskiy continental slope	77	185
Karaginsky and Olyutorskiy shelves	19	80
Karaginsky continental slope	167	185
Komandorskiye Abyss	174	201
Oceanic waters		
Kamchatka shelf and slope	–	199
Offshore Kamchatka-Komandorskiye	–	120
Nearshore northern and middle Kurils	–	232
Offshore northern and middle Kurils	–	202
Nearshore southern Kurils	–	256
Offshore southern Kurils	–	243
Sea of Okhotsk		
Shelikhov Gulf	181	181
Yamskiye-Tauyskaya	195	191
Okhotsk-Lisjansky	212	–
Ayan-Shantarsky	208	–
Iona-Kashevarovsky	181	–
TINRO Abyss	201	191
North Kamchatka	351	179
South Kamchatka	196	200
Central Abyss	297	253
Eastern Sakhalin Shelf	149	309
Terpeniya-Aniva	122	158
Southern Abyss	234	247
Kuril Islands	232	224
Sea of Japan		
Tatarsky Strait	73	–
Primorskiye	95	–

Figure 4
Schematic representation of the transverse water circulation across the Gulf of Anadyr (A) from the Chukchi Peninsula to the Navarinskiy area and (B) in the Bering Sea from the western Bering Sea to Korfa Bay (Verkhunov 1995)

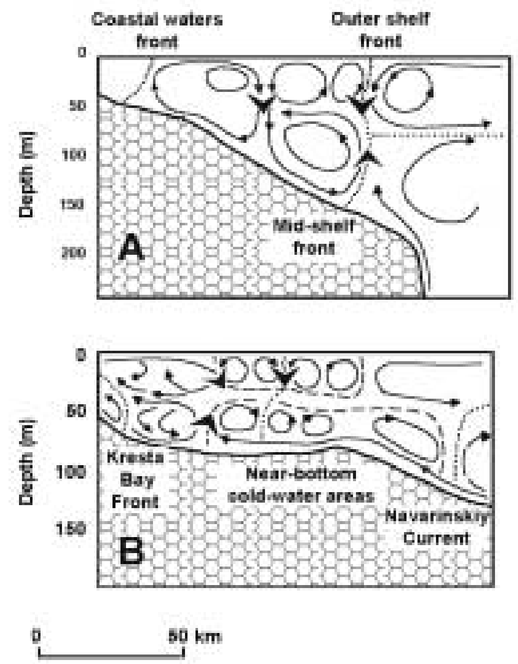
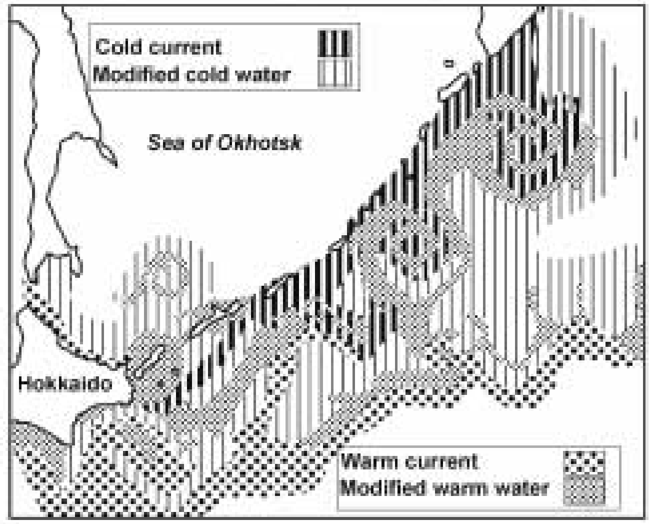


Figure 5
Turbulence created east of the Kuril Archipelago by the meeting of a cold current from the north (Oyashio) and a warm current from the south (Kamchatskiy) from satellite images for 29 September–2 October 1980 and 21–29 September 1981



eddies, especially in areas with complicated bottom relief (canyons, etc.), and are significant in the creation of seabird feeding areas. The influence of such formations on the concentration of marine birds is well recognized (Shuntov 1972, 1993a; Markina and Khen 1990; Springer et al. 1996).

In narrow straits, the complexity of the hydrodynamic process is enhanced by tidal phenomena. The application of satellite imagery has helped us to understand that not even basic currents are calm, regular streams, but instead appear as a ribbon of smaller eddies such as those from the Kuroshio Current, which pass northward along the Kuril Archipelago (Fig. 5) (Lobanov and Bulatov 1993). These temporary eddies are also influenced by air movement. For instance, in the Sea of Okhotsk, up to 28 of these mesoscale gyres (60–200 km in diameter) may form at one time (Darnitsky and Luchin 1993). Not all of these are stable structures, but seabirds appear to be able to find prey concentrations and determine which are the most stable. These are usually related to anomalies in the bottom relief, coastal configuration, and the effect of larger stable currents.

The feeding conditions for planktivorous seabirds, outside the exceptional situation with the eddies, depend upon the species composition of the plankton and its vertical distribution. Vertical plankton distribution is most evident in areas of greater than average depth. In the upper layers, as a rule, the plankton biomass declines in the daytime, but diurnal concentrations at greater depths may be within the reach of the more capable diving seabirds. At twilight, prey availability (plankton, squid, and fish) suddenly increases as prey species rise to the upper layers (Fig. 6). Prey availability apparently remains high during darkness. This phenomenon may be especially important in winter, when the period of darkness is greatly extended.[2]

The abundance of benthic organisms in the shallow part of the shelf is significant for some species such as the marine diving ducks (Mergini and Aythyini). As a rule, the broad sandy bottoms of Far East seas support a rich benthic fauna whose biomass exceeds that found in the oceanic waters of the North Pacific (Table 4). Where sandy bottoms occur with weakened surf, real underwater oases may form (Kussakin and Lukin 1995). Exceptionally high biomasses of benthic organisms also occur in the coldest northwestern waters of the Bering Sea and Sea of Okhotsk (Table 4). There, low temperatures contribute to smaller populations of bottom fishes. A mild hydrological regime, suitable for high densities of bottom fishes and large invertebrates, tends to have a low biomass of benthic fauna. Thus, we find a significant community of bottom fish (flounders, Pacific cod, sculpins, etc.) in the eastern Bering Sea, accompanied by the lowest benthic biomass in the whole basin. The benthic biomass on the shelf of the Chukchi Sea, where bottom fishes are scarce, is comparable with that of the North Pacific Ocean, whose average biomass is about 214 g/m^2. In southern areas adjacent to the Bering Strait, benthic biomass increases to 500 g/m^2 or more.

The destructive action of ice fields contributes to the paucity of benthic organisms in much of the littoral and

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[2] In spite of pointedly similar oceanographic features in the Okhotsk and Bering seas, plankton density in the former is approximately 1.5 times higher than in the latter. In addition, in the Sea of Okhotsk, the biomass of euphausiids is much greater than that of copepods and Chaetognatha (arrow worms). In the Bering Sea, copepods and Chaetognatha are abundant, but euphausiids are relatively abundant only in northern shelf areas (Shuntov et al. 1993; Volkov 1996).

Figure 6
The effect of daytime brightness on the vertical distribution of plankton biomass over abyssal regions of the Sea of Okhotsk in summer, autumn, and winter (Gorbtenko 1996). The shaded area is the intermediate cold-water layer.

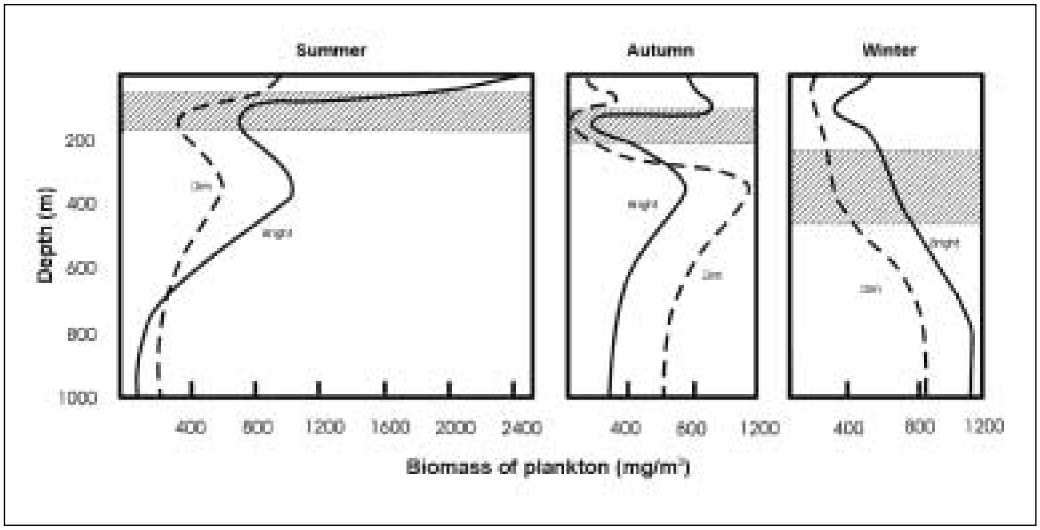


Table 4
Mean benthic biomass on different portions of the continental shelf of the seas of the Russian Far East and adjacent oceanic waters (Shuntov, in press)

Area	Biomass (g/m^3)
Bering Sea	
Chirikov Gulf	843
Gulf of Anadyr	401
Koryak shelf	314
St. Matthew-Pribiloff	228
Southeast port	62
Olyutorskiy Gulf	586
Karaginsky Gulf	349
Sea of Okhotsk	
Shelikhov Gulf	575
West Kamchatka shelf	375
Tauyskaya Bay	534
Shantarsky-Okhotsk	241
East Sakhalin	370
Terpeniya Gulf	488
Oceanic waters	
Kamchatskiy Gulf	157
Kronotskiy Gulf	247
Southeast Kamchatka shelf	280
Paramushir and Shumshu shelves	229
Sea of Japan	
Tatarsky Strait	123
Southwest Sakhalin shelf	152
North Primorskiye shelf	359
Peter the Great Bay	209

coastal shallows of the Chukchi Sea (Zenkevich 1963), but ice action is not the only problem in the littoral zone and on the upper part of the shelf. Open coastal areas swept by strong currents and intense wave activity do not encourage high concentrations of benthic organisms. However, the slight protection offered in bays or gulfs and the lees of capes and shoals may allow sharp increases in the benthic biomass. On the rocky substrate of reefs, kelp and other marine plants provide habitat for numerous epizoans. Along the Kurils and near the Shantars, there are areas of particularly high benthic biomass in Gizhiginskaya and Shelikhov gulfs. Although studies of benthic fauna have focused on the Sea of Okhotsk (Kussakin 1989; Kussakin and Lukin 1995), the conclusions are applicable to much of the region.

Nektonic organisms, such as fish and squid, drive the abundance of most seabirds by being the most important food for many species. Their eggs, larvae, and juveniles are also important. Unlike commercial fisheries, seabirds take small prey (15–20 cm). Consequently, resource calculations, without size composition analyses, from fishery-based studies may not describe seabird food supplies reliably. Usually, fishery analyses focus only on commercial species such as walleye pollock *Theragra chalcogramma*, Pacific herring *Clupea pallasi*, Pacific saury *Cololabis saira*, and Pacific sardine or ivasi *Sardinops sagax.* However, capelin *Mallotus villosus*, Pacific sand lance *Ammodytes hexapterus*, juvenile walleye pollock, Pacific herring, and arctic cod *Boreogadus saida* play a major role in seabird feeding in the north-boreal regions of the Pacific and Arctic oceans, and the Pacific sardine, Pacific saury, Japanese anchovy *Engraulis japonicus*, Pacific sand lance, herring, and juvenile walleye pollock are important in the south-boreal regions. Squid are usually most important for seabirds in the abyss-water regions, especially in the southern part of the Boreal Zone.

The waste from fishery operations offers some seabirds additional feeding opportunities. This waste may be especially important to gulls and fulmars excluded from other feeding opportunities by ice through much of the autumn, winter, and spring. At that time, hundreds to thousands of these birds concentrate near the fishing operations. Even in summer, however, it is difficult to find a fishing boat without an escort of birds.

Currently, most of the available information on seabird diet is connected to the nesting period, when feeding areas are limited to some dozens of kilometres from the nesting sites. During the nonnesting period, seabirds are more widely dispersed across marine regions, and there ought to be significant changes in their diet. Not only squid, but also the epipelagic oceanic fish, especially the numerous, small, mesopelagic fishes such as the Myctophidae and Bathylagidae, which rise to the surface at night, likely become a major component of the diet.

Oceanic regime shifts

Until the 1980s, walleye pollock was the prevalent species in the epipelagic fish communities of the Bering and Okhotsk seas, where the majority of Russia's seabird nesting populations are concentrated (Figs. 7 and 8; Tables 5 and 6). Pollock has since become less abundant on the shelf and in the abyssal areas. At first, the decline was attributed to competition from increases in the abundance of herring and capelin or some other species. Later, there were observations of increasing abundance of salmon and other mesopelagic fishes that prey on pollock. However, fishery stock assessments frequently underestimate the proportion of small species and individuals, especially in coastal waters, and consequently the estimated sizes of the fish resources near the largest seabird nesting colonies (Figs. 7 and 8) (Bering Strait, Gulf of Anadyr, Karaginsky area, Shelikhov and Terpeniya gulfs in the Shantarsky area and, to some extent, the area of the Kuril Islands) appeared much lower than in adjacent regions. Either the seabirds were able to compensate for the apparent lack of fish with plankton, benthic organisms, or squid, or they were able to use dispersed resources such as small fish and fry of little concern to the fishery stock assessment.

The major regions of the Russian Economic Zone, in order of fish abundance, are the Sea of Okhotsk, the Bering Sea, waters near the Kuril Islands, the Sea of Japan, and the Eastern Kamchatka region. In some periods, namely in summer and autumn during the irruptions of Pacific sardine, the prey base for fish-eating birds can also be very high in the Sea of Japan.

Like the planktonic biomass, the distribution of the nektonic biomass can also be described as a mosaic. Micro- and mesoscale circulations and the vertical structure of water play a significant role for fish; frequently, however, especially in moving water masses, the distribution of adult fish and fry can change rapidly, and the wide-ranging foraging efforts by seabirds result from this instability. Interannual variation and long-term changes in nektonic associations, including fish communities, are the major factors in determining the overall distribution and productivity of fish-eating birds. Important changes were observed in the 1990s, not only in the seas of the Far East, but also in much of the North Pacific. At that time, the number of walleye pollock declined significantly in the Bering Sea and in the Sea of Okhotsk. In spite of complementary increases in the quantity of herring and other fish, the total fish production declined in both seas, but especially in the Bering Sea (Table 7). A similar situation was observed in waters near the Kuril Islands (Table 8), where there were repeated declines in Pacific sardine and later in walleye pollock. Such reductions in the total biomass of the nekton could be only partially compensated by the increases in Pacific saury, Japanese anchovy, and squid. The reorganization in pelagic fish communities in the northern part of the Sea of Japan was even more dramatic (Table 9). From the 1970s and into the 1980s, the Pacific sardine had been the predominant species of pelagic fishes in the summer months, and the subsequent failure of its migration into the north of the basin dramatically changed the prey base available to piscivorous birds. However, there may have been other resources available to seabirds. The stock assessment data (Tables 7–9) do not include the coastal zone. That zone is often several kilometres wide and provides habitat for fry and some species of small fish, such as arctic smelt, stickleback, and others.

Climate history

These changes in the species composition of the fish communities in Far East seas reflect recent oceanic regime shifts brought on by global climate changes (Shuntov 1986b, 1993b, 1994, 1995a; Klyashtorin and Sidorenkov 1996; Shuntov et al. 1997). Interannual changes and, more significantly, changes in the long-term dynamics of the climate and oceanographic routine are the fundamental events or background against which the biota of the seas and ocean is reorganized. Recent events are particularly noteworthy. Much of the Earth's geological history, at least that recorded in sedimentary rocks, reflects alternating warm and cold epochs with different durations. Even in the history of the last few hundred years, we find the latest great cold spell from the 13th to the 18th century, which has become known as "the little glacial period." From the middle of the 19th century, the average global temperature has begun to increase (Fig. 9); at this point, the 20th century can be seen as the beginning of a warm period.[3]

Within these greater cycles, we can distinguish shorter rhythms lasting from two years to dozens of years, but it is the 40- to 60-year cycles that we ought to consider as a primary influence on biota as a whole (Klyashtorin and Sidorenkov 1996; Shuntov et al. 1997). It is these cycles that are connected to landscape-scale changes in the environment, century-long fluctuations in faunistic complexes, and long-term trends in population size of various species. Of course, the changes in climatic and oceanographic conditions during shorter cycles are also reflected in changes in the structure of associations and the dynamics of the animal populations, but the influence of these short-term changes is more local.

In the current century, the first warm period lasted about 30 years, from the 1920s to the 1940s. The famous warming in the Arctic, with its consequent redistribution of boreal fauna and flora to the high latitudes, occurred in these years (Uspenski 1969). It was also the period of the first powerful irruption of Pacific sardine in this century and the intrusion of many subtropical and even tropical marine organisms to the temperate waters in Far East seas (Shuntov 1986b). A second warm period began in the 1970s and continued into the first half of the 1990s. In this period, there was a second irruption of Pacific sardine, and, again, we saw the northern expansion of many southern marine organisms. But, in general, this warm period has had less impact in the scale of its biological consequences than the warm period of

[3] In the huge number of observations of increasing average global temperature as a result of the "greenhouse" effect, the natural climatic rhythm is usually ignored.

Figure 7
Fishery biostatistical areas in the Sea of Okhotsk (see Table 5)

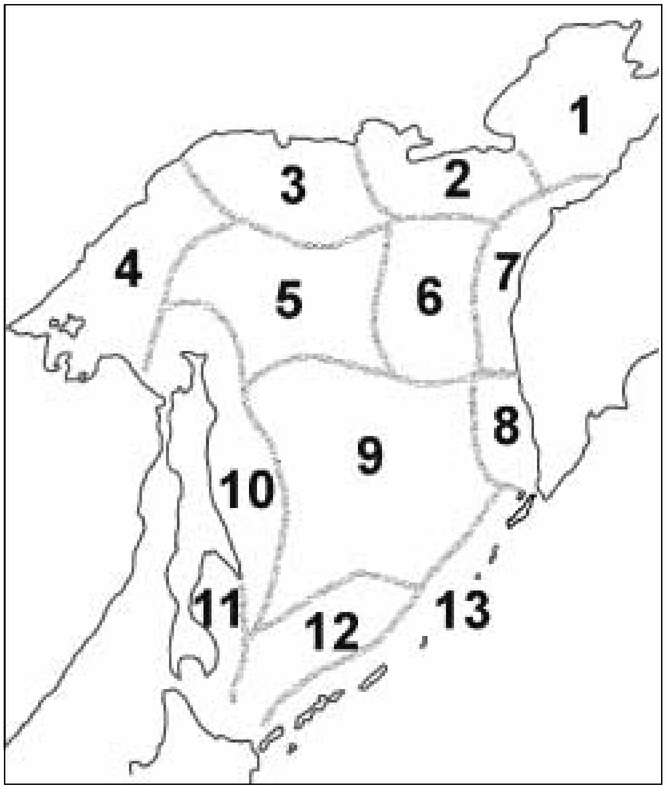


Table 5
Density and biomass of fish in the biostatistical areas (Fig. 7) of the Sea of Okhotsk in summer (1988) and autumn (1985) (Shuntov et al. 1993)

Fisheries Bio-statistical Area	June–August			September–November		
	Density class (t/km^2)	Biomass (million tonnes)	% walleye pollock	Density class (t/km^2)	Biomass (million tonnes)	% walleye pollock
1	<5	0.4	69.7	>20	1.9	74.4
2	>20	2.1	82.8	5–9	0.5	90.0
3	5–9	0.7	73.9	<5	0.9	31.7
4	<5	0.3	91.1	5–9	0.9	91.7
5	5–9	0.9	91.7	>20	1.7	90.3
6	>20	1.3	93.1	>20	1.3	91.9
7	10–19	0.8	94.4	>20	0.7	87.2
8	10–19	0.5	94.7	>20	0.7	86.9
9	5–9	3.0	37.5	5–9	1.9	33.1
10	10–19	1.4	91.9	<5	0.6	66.1
11	<5	0.1	86.8	5–9	0.3	9.2
12	<5	0.7	36.1	<5	0.7	36.4
13	5–9	0.6	62.3	5–9	1.0	27.8

Figure 8
Fishery biostatistical areas in the western Bering Sea (see Table 6)

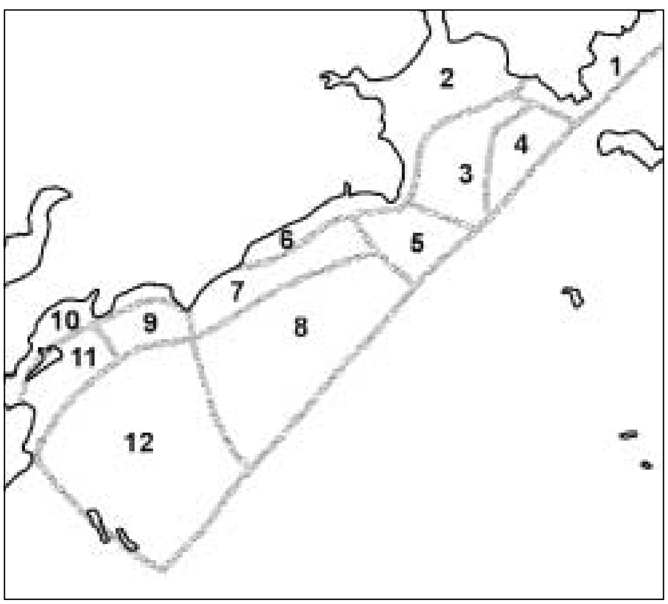


Table 6
Density and biomass of fish in the biostatistical areas (Fig. 8) of the western Bering Sea in summer (1989) and autumn (1987) (Shuntov et al. 1993)

Fisheries Bio-statistical Area	June–August			September–November		
	Density class (t/km^2)	Biomass (million tonnes)	% walleye pollock	Density class (t/km^2)	Biomass (million tonnes)	% walleye pollock
1	<1	0.001	9.7	<1	0.009	10.0
2	<1	0.008	50.0	1–4	0.120	26.4
3	<1	0.009	90.6	1–4	0.140	13.2
4	<1	0.002	96.8	1–4	0.050	81.1
5	>10	0.300	96.1	>10	0.970	96.8
6	<1	0.006	18.8	<1	0.005	19.4
7	1–4	0.040	89.7	>10	0.400	97.5
8	1–4	0.500	86.1	5–10	1.100	85.0
9	>10	0.330	97.2	>10	0.320	31.9
10	<1	0.003	24.4	1–4	0.003	75.0
11	1–4	0.040	77.2	5–10	0.040	83.1
12	1–4	0.920	87.5	5–10	0.920	89.2

Table 7
Biomass of nektonic fish groups in the epipelagic strata of the Sea of Okhotsk and the Bering Sea in the 1980s and 1990s (Shuntov et al. 1997)

	Sea of Okhotsk				Bering Sea			
	1980s		1990s		1980s		1990s	
Species or group	weight (kt)	%	weight (kt)	%	weight (kt)	%	weight (kt)	%
Walleye pollock	10 000	71.6	6 000	56.8	20 000	87.9	8 000	66.4
Pacific herring	500	3.6	2 500	23.7	700	3.1	1 500	12.4
Deep-sea smelts	2 500	17.9	1 200	11.4	125	0.5	140	1.2
Myctophids	10	0.1	30	0.3	790	3.5	900	7.5
Salmonids	150	1.1	480	4.6	315	1.4	500	4.1
Capelin	150	1.1	250	2.4	360	1.6	0	0
Pacific sardine	500	3.6	tr	0	0	0	540	4.5
Other fish	135	1.0	85	0.8	465	2.0	tr	0
Total	13 945	100.0	10 545	100.0	22 755	100.0	12 050	100.0
t/km^2	9.3		7.0		9.9		5.2	

Table 8
Biomass of nektonic fish in the epipelagic strata of the Kuril waters in the 1980s and 1990s

	1980s		1990s	
Species or group	Weight (kt)	%	Weight (kt)	%
Pacific sardine	2000	48.8	200	8.9
Walleye pollock	850	20.7	200	8.9
Salmonids	200	4.9	300	13.3
Myctophids	400	9.8	450	20.0
Pacific saury	400	9.8	600	26.7
Japanese anchovy	50	1.2	200	8.9
Other fish	100	2.4	100	4.4
Squid	100	2.4	200	8.9
Total	4100	100.0	2250	100.0
t/km^2	7.2		4.0	

Table 9
Biomass of nektonic fish in the upper epipelagic strata of the northern Sea of Japan (within the Russian Economic Zone) in 1985 and 1995

	July 1985		September 1995	
Species or group	Weight (kt)	%	Weight (kt)	%
Pacific sardine	2483	86.5	tr	0
Herring	34	1.2	0.2	0
Walleye pollock	162	5.6	0.5	0.1
Capelin	4	0.1	1.0	0.2
Mackerel	0.5	0	51	7.7
Japanese anchovy	tr	0	34	5.1
Boreal smelt	tr	0	2.3	0.3
Pacific saury	tr	0	3.1	0.5
Other fish	8.3	0.3	6	0.9
Squid	180	6.3	563	85.2
Total	2871	100.0	661	100.0
t/km^2	8.7		2.0	

the 1920s and1930s, in spite of the fact that the planetary background temperature in the last 25 years has been higher.

Since the beginning of the 1990s, characteristic reorganizations in pelagic fish communities and regular reductions in the number of Pacific sardine have coincided with maximum temperature anomalies (Fig. 9). This suggests that, within bounds, the change in temperature plays a more important role than the base temperature. However, these changes in temperature are driven by long-term climatic and oceanic events, influenced by changes in basic atmospheric circulation and contributing to a general deterioration of environmental condition in terms of bioproductivity. Significantly, the beginning and the end of the first warm epoch in the 20th century coincided with powerful and lasting El Niño phenomena from 1911 to 1913 and from 1939 to 1942. A powerful El Niño was also observed from 1991 to 1993. These events have led me to conclude that the 1990s could be the frontier, after which a decrease in global temperature will begin and the climatic oceanographic events will be similar to those that prevailed from the 1940s to the 1960s (Shuntov et al. 1997). The curve of the line reflecting the course of the global temperature anomalies may have begun to indicate such a change in the early 1990s (Fig. 9). In general, before the mid-1990s, the limited extent of ice in Far East seas suggests that the temperature range was high (Fig. 10).

Analogous conclusions were derived from the analysis of the correlation between global air temperature, the rate of atmospheric circulation, and the speed of the Earth's rotation (Klyashtorin and Sidorenkov 1996). In evaluating the global climatic changes and shifts in the oceanic regime, we ought to take into account the regional contribution to environmental processes. It is obvious that the development of atmospheric, hydrological, and biological phenomena in different regions proceeds on its own course, even with the considerable global fall or rise in temperature. Consequently, we should observe differences between seas frequently, and all the trends in seabird populations in the North Pacific should not be going in one direction.

In the northern part of the Pacific Ocean, we have identified five large, independent marine regions (Krovnin 1995): Eastern (waters of the American coast and the eastern Bering Sea); Central (open waters of the North Pacific); Northwestern (Kamchatka and oceanic waters of the northern

Figure 9
Differences (°C) between terrestrial air temperatures and sea surface temperatures from 1860 to 1993

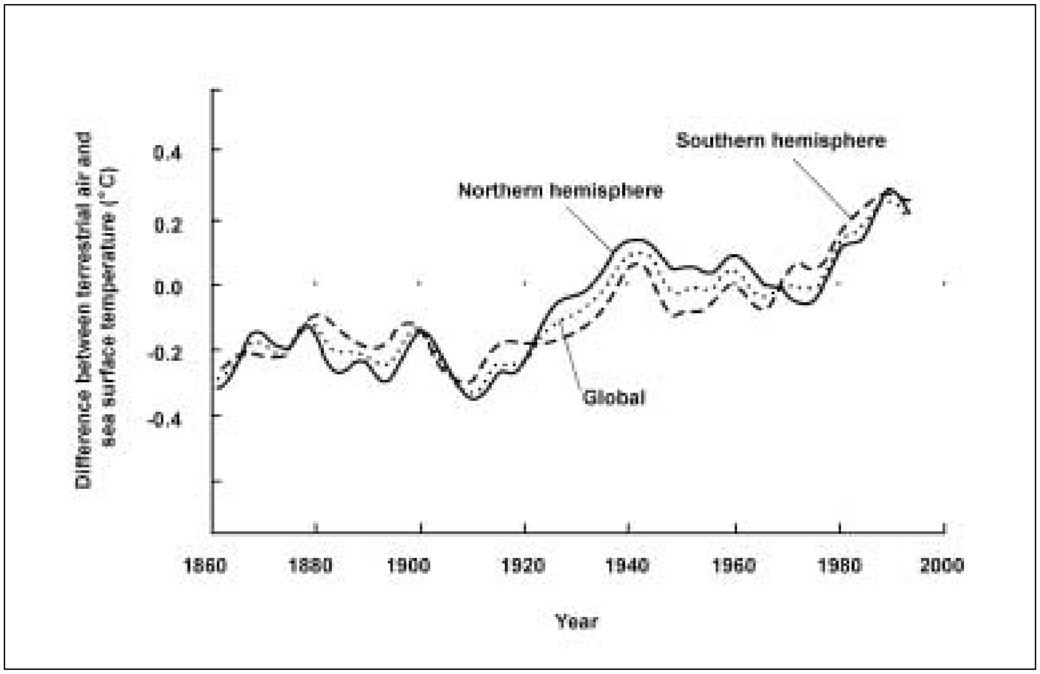
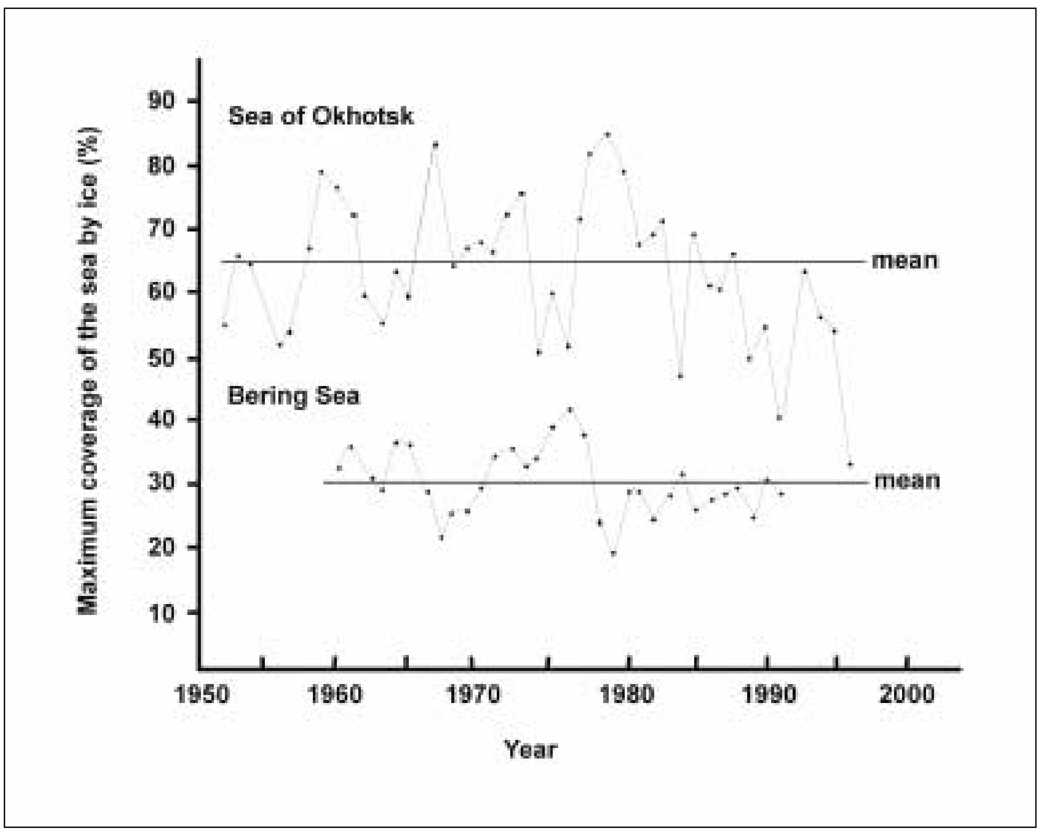


Figure 10
Variations in the winter ice coverage of the Sea of Okhotsk and Bering Sea



Kurils, the Sea of Okhotsk, the western Bering Sea, and the northern Sea of Japan); Southwestern (waters around Japan, including the southern Sea of Japan); and Southern (waters near Hawaii). Four of these regions are readily grouped in pairs: Eastern–Central and Northwestern–Southwestern. The temperature anomalies tend to be out of phase between these pairs (i.e., complementary). But the real picture of the climatic and oceanographic processes is more complex. For example, the increased icing in the adjacent Okhotsk and Bering seas may occur as often in phase as out of phase (Fig. 10).

Outside the global factors (solar activity, the Earth's rotation, the tidal cycle, or El Niño), the basic character of processes in different marine regions is strongly influenced by the position and power of the main regional climatic centres (Aleut minimum, Siberian and Hawaiian minima, and others). Much is dependent on the relation between climate events within zones and atmospheric movement along the north–south axis (meridional processes), especially in the colder part of the year. For instance, zonal events dominated climate for a long period beginning with the winter of 1972 and coincided with the harvest of year-class I Pacific sardines, which indicated the beginning of the next irruption. The same picture had occurred in the 1920s and 1930s. With the prevalence of meridional processes coincident with the incursion of cold air masses from the North, the situation in Far East seas became less stable and took on more continental features. A similar trend appears to have started again in the mid-1990s.

The cyclically recurring climatic and oceanographic processes and regime shifts, described above, drive the long-term changes in seabird abundance of at least some species and populations. However, it is frequently difficult or even impossible to see real changes in seabird abundance even with long-term observations. In some regions, human activity plays an important and perhaps critical role in the status of seabird populations through simple persecution, destruction of nesting habitat, water pollution, and introduction of predators. Occasionally, human activities enhance the status through protection initiatives or increases in the food base in the form of waste or offal. Often we cannot assess changes in bird numbers because of simple data shortages.

The total abundance of seabirds in both the Asian and American part of the North Pacific has shown a significant increase during the last 10–15 years. These numbers are in part the product of new exploration and the discovery of new nesting places and in part the result of the application of improved counting methods. However, we also have undeniable examples of population increases and northward expansion during the warm epoch of the 1970s and 1980s. The number of Least Auklets *Aethia pusilla* and Crested Auklets *A. cristatella* grew in the northern part of the Bering Sea (Konyukhov 1991; Springer et al. 1996). In the 1970s, Common Murre *Uria aalge* was scarce on the Chukotka coast of the Bering Sea and did not breed in the Chukchi Sea, in the region of Cape Serdtse-Kamen, or on Kolyuchin, Wrangel, and Gerald islands; in the 1980s, however, its number became comparable to that of the Thick-billed Murre *U. lomvia*, and it began to breed in those regions of the Chukchi Sea (Kondratyev 1991; Stishov et al. 1991). In the 1980s, the Tufted Puffin *Fratercula cirrhata* began to breed in small numbers on Wrangel and Gerald islands (Stishov et al. 1991). Evidently, it had nested there in the 1920s — i.e., during a previous warm period. There are also reasons to connect the range expansion of some terns in Eastern Asia with the climate of the 1970s and 1980s.

In the southern part of the Subarctic Zone (Peter the Great Bay, southern Sakhalin, southern Kurils, and Hokkaido), which has been greatly influenced by economic activity, a more complex picture of seabird number and dynamics was observed in the 1970s and 1980s (Abramov et al. 1973; Elsukov 1984). On one hand, in spite of the abundance of Pacific sardine, the overall numbers of seabirds declined, and some colonies of northern species have deteriorated along their southern frontier. In the Japan region, in particular, Spectacled Guillemot *Cepphus carbo*, Ancient Murrelet *Synthliboramphus antiquus*, Rhinoceros Auklet *Cerorhinca monocerata*, Common Murre, and Tufted Puffin declined (Hasegawa 1984; Fujimaki 1986; Watanuki et al. 1988; Ewins et al. 1993). Tufted Puffins stopped nesting during this period, even in Peter the Great Bay. These events appear closely related to climate and oceanographic factors. At the same time, the warm period may have led to an improvement in status for some seabird species in the southern part of the Russian Pacific: Japanese Cormorant *Phalacrocorax filamentosus*, Black-tailed Gull *Larus crassirostris*, Slaty-backed Gull *L. schistisagus*, Spectacled Guillemot, and Common Murre (Shibaev 1987; Litvinenko and Shibaev 1991; Shibaev and Litvinenko 1996). In this case, however, protective actions, including the organization of a Marine Reserve in Peter the Great Bay, played a positive role. The significant climate changes and series of oceanic regime shifts that began some years ago in the North Pacific have likely brought more negative consequences for seabirds than positive. One of the first effects of these changes appears to have been a reduction in the reproductive success of the Black-legged Kittiwake *Rissa tridactyla*, the most numerous gull species, which began in American waters and in the 1990s affected the Asian region (Hatch et al. 1993; Kondratyev 1993; Kondratyeva 1994, 1995). It was accompanied by declines in the productivity of other Far East seabirds in the 1990s. Only future observations will be able to show whether the real cause of these events is the long-term cyclical recurrence of environmental change or only interannual variability in local conditions.

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Chapter 3. The breeding seabirds of the Russian Far East

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Summary

The Russian Far East extends from subtropical waters in the south to ice-covered areas of the Arctic. This huge range provides nesting opportunities for 40 species of seabird: one fulmar, one shearwater, three storm-petrels, four cormorants, nine gulls, two kittiwakes, three terns, and 17 auks. Most of the storm-petrels and cormorants nest in the south, whereas the gulls and auks are more typical of northern areas. Many of these species nest in large colonies on offshore islands or inaccessible cliffs along the mainland, but terns and gulls nest on the mainland, particularly in river estuaries and on sandbars, where they are more readily accessible to people. Seabirds and their eggs have been an important food resource in the area since prehistoric times; since the 18th century, however, mammalian predators have been introduced to these islands for the fur trade. In the 20th century, some sites close to large cities were very heavily exploited for food, but such activity is now regulated; however, introduced mammals remain a problem at many sites (see Chapter 6).

In the Arctic portion of the North Region, many of the 200000 or so seabirds nest in 24 large colonies, but many gulls nest in small groups along the coastal lowlands. Farther south, 3.5 million seabirds nest along the Bering Sea coast of the Chukot Peninsula, with colonies becoming more numerous and larger as one moves south. On the south side of the peninsula, there are 80 large colonies. Diversity also increases southward largely because plankton-feeding auklets occur south of Big Diomede Island. The North Region also includes the northern Sea of Okhotsk, west of the Kamchat Peninsula. There are some 10 million seabirds in this area. Large colonies in Penzhinskaya Bay, which hold 250000–300000 birds, are well known; off the Koni Peninsula, Talan Island alone supports about 1.5 million seabirds of 12 species. Westward, the many small estuaries create local areas of high productivity that support birds nesting solitarily or in small groups.

The Kamchatka Region is bounded by the southern Bering Sea in the east and the eastern Sea of Okhotsk. It also includes the Komandorskiye Islands. Along the east coast of Kamchatka, there are more than 1300 colonies supporting nearly 2 million seabirds of 15 species. Most of these colonies are in protected reserves. In contrast, the west coast is poorly known, and its low-lying topography offers few nesting opportunities. Nonetheless, it has about 450000 nesting seabirds. The remote Komandorskiye Islands are a continuation of the Aleutian Islands and support about 1 million seabirds of 17 species.

The South Region is the most diverse region in the Russian Far East, supporting 30 species of seabird. There are about 30000 seabirds nesting on the Shantar Islands in the southern Sea of Okhotsk, and a similar number along the coast of Primorye. About 135000 nest in Peter the Great Bay, and more than 215000 around Sakhalin Island. However, most of the region's seabirds nest in the Kuril Islands, with more than 1.6 million scattered through the archipelago.

Résumé

L'Extrême-Orient russe s'étend des eaux subtropicales du sud aux étendues couvertes de glace de l'Arctique. L'énormité de cette aire de répartition offre des sites de nidification à quarante espèces d'oiseaux de mer : une de fulmar, une de puffin, trois d'océanite, quatre de cormorans, neuf de goélands et de mouettes, deux de Mouettes tridactyle et de Mouettes des brumes, trois de sternes et dix-sept espèces d'alcidés. La plupart des océanites et des cormorans nichent au sud alors que les goélands et les mouettes et les alcidés et les pingouins se rencontrent davantage dans les régions septentrionales. Nombre de ces espèces nichent en grandes colonies sur des îles ou dans des falaises inaccessibles de la côte, mais les sternes, les goélands et les mouettes fond leur nid à l'intérieur des terres, surtout dans les estuaires et sur les barres, où elles sont plus facilement accessibles. Dans cette région, les oiseaux de mer et leurs oeufs constituent une ressource alimentaire importante depuis la préhistoire mais des mammifères prédateurs ont aussi été introduits dans ces îles au 18e siècle dans le cadre du commerce de la fourrure. Au 20e siècle, certains sites proches des grandes villes ont été lourdement exploitées comme sources de nourriture, mais cette activité est maintenant réglementée. Les mammifères introduits demeurent cependant un problème dans bien des sites (voir chapitre 6).

Dans la partie arctique de la région nord, nombre des quelque 200 000 oiseaux de mer nichent dans 24 grandes colonies, mais un grand nombre de goélands et de mouettes vont nicher en petits groupes le long des plaines littorales. Plus au sud, 3,5 millions d'oiseaux de mer nichent sur les côtes de la péninsule Chukot dans la mer de Béring, et les colonies deviennent plus nombreuses et plus importantes à mesure que l'on descend vers le sud. Quatre-vingt grandes colonies sont installées du côté sud de la péninsule. La

diversité augmente également vers le sud, principalement parce que l'on trouve un grand nombre de stariques se nourrissant de plancton au sud de la grande île Diomède. La région nord comprend également le nord de la mer d'Okhotsk, à l'ouest de la péninsule du Kamtchatka. On y dénombre quelque 10 millions d'oiseaux de mer. Les grandes colonies de la baie Penzhinskaya, où vivent de 250 000 à 300 000 oiseaux, sont bien connues. Au large de la péninsule Koni, l'île Talan abrite à elle seule environ 1,5 million d'oiseaux de mer de douze espèces différentes. À l'ouest, de nombreux petits estuaires forment des poches de forte productivité où les oiseaux peuvent nicher à l'écart ou en petits groupes.

La région du Kamtchatka est bordée à l'est par le sud de la mer de Béring et la partie est de la mer d'Okhotsk. Elle englobe également les îles du Commandeur. Sur la côte est du Kamtchatka, on dénombre plus de 1 300 colonies regroupant près de 2 millions d'oiseaux de mer de quinze espèces différentes. La plupart de ces colonies sont protégées par des réserves. La côte ouest, par contre, est mal connue et, à cause de son faible relief, offre peu de lieux favorables à la nidification. Quelque 450 000 oiseaux de mer nicheurs y ont néanmoins été recensés. Les îles du Commandeur, très isolées, qui sont une prolongation de la chaîne des Aléoutiennes, abritent environ un million d'oiseaux de mer de dix-sept espèces différentes.

La région sud est la plus diversifiée de l'Extrême-Orient russe, puisque l'on y trouve trente espèces d'oiseaux de mer. Quelque 30 000 oiseaux de mer nichent sur les îles Santar, dans la partie sud de la mer d'Okhotsk, et presque autant sont installés le long de la côte de Primorye. Près de 135 000 nichent dans la Baie Pierre-le-Grand et plus de 215 000 autour de l'île Sakhaline. Toutefois, la majeure partie des oiseaux de mer de la région nichent dans les Kouriles, puisque plus de 1,6 million d'entre eux sont éparpillés dans cet archipel.

Общее изложение

Российский Дальний Восток простирается от субтропических водных пространств на юге до покрытых льдами районов Арктики. На этой огромной территории располагаются на гнездовье около 40 видов морских птиц: один вид глупышей, один вид буревестников, три вида малых качурок, четыре вида бакланов, девять видов чаек, два вида моёвок, три вида крачек и 17 видов чистиковых. Большинство видов малых качурок и бакланов гнездятся на юге, тогда как чайки и птицы семейства чистиковых более типичны для северных районов. Многие птицы гнездятся крупными колониями на островах или на неприступных утесах побережья материка, однако крачки и чайки гнездятся на материке, особенно в устьях рек и на отмелях, где они становятся доступны для людей. Морские птицы и их яйца были значительным источником продуктов питания в этом регионе ещё с доисторических времен. Однако, начиная с 18-го века на острова были завезены млекопитающие хищники для торговли мехами. В 20-м веке многие места гнездования вблизи крупных городов подверглись сильной эксплуатации с целью получения продуктов питания, но в настоящее время эта деятельность подвергнута регламентации. Однако, распространившиеся млекопитающие хищники продолжают представлять собой проблему во многих местах (см. Глава 6).

В арктической зоне северного региона гнездятся около 200000 морских птиц в 24 крупных колониях, но многие чайки гнездятся малыми группами в низовьях побережья. Южнее, на Чукотском полуострове по берегам Берингова моря гнездятся 3,5 миллиона морских птиц, причем их колонии становятся более многочисленными при продвижении на юг. На южной стороне полуострова насчитывается 80 крупных колоний. С продвижением на юг также увеличивается разнообразие птиц, что в большой степени объясняется тем, что к югу от острова Ратманова в большом количестве водятся мелкие виды планктоноядных чистиковых. Северный район также включает северную часть Охотского моря к западу от полуострова Камчатка. В этом районе имеется около 10 миллионов морских птиц. Широко известны крупные колонии в Пенжинском заливе с числом птиц от 250000 до 300000. Недалеко от полуострова Кони только на острове Талан проживают примерно 1,5 миллиона морских птиц 12 видов. Западнее, многочисленные небольшие эстуарии создают районы высокой плодовитости, которые представляют собой места для гнездования птиц-одиночек или птиц в небольших группах.

Район Камчатки омывается на востоке южными водами Берингова моря и восточными водами Охотского моря. Он также включает Командорские острова. Вдоль восточного берега Камчатки насчитывается более 1300 колоний с почти 2 миллионами морских птиц 15 видов. Большинство этих колоний находятся в заповедных зонах. Напротив, западное побережье изучено недостаточно и низинная топография сокращает возможности гнездования. Несмотря на это, там насчитывается около 450000 гнездящихся морских птиц. Удаленные Командорские острова являются продолжением Алеутских островов и там обитают примерно 1 миллион морских птиц 17 видов.

Южный район является самым разнообразным районом российского Дальнего Востока, где обитают 30 видов морских птиц. На Шантарских островах в южной части Охотского моря гнездятся примерно 30000 морских птиц и примерно столько же - вдоль побережья Приморья. Около 135000 гнездятся в заливе Петра Великого и более 215000 - на острове Сахалин. Однако, большинство морских птиц в этом районе гнездятся на Курильских островах, где их насчитывается более 1,6 миллиона особей по всему архипелагу.

Introduction

Seabird colonies are found along the entire coast of the Russian Far East. This is a huge area with many different habitats, so only a few of the 40 nesting species are found in any one area. Gulls are found at all latitudes, but the alcids and fulmars seem to prefer northern- and middle-latitude sites, whereas southern areas are preferred by cormorants and shearwaters.

In this chapter, we first discuss the breeding biology and distribution of each of these species. Then, we outline the characteristics of the major geographic areas. No single researcher has personal knowledge of the whole area, and we divided the tasks necessary to prepare this chapter. First, the published and unpublished information was compiled by A.Ya. Kondratyev and L.F. Kondratyeva. Then, the authors chose the area with which they were most familiar: A.Ya. Kondratyev and L.F. Kondratyeva reported on the North Region, P.S. Vyatkin, the Kamchatka Region, and N.M. Litvinenko with Yu.V. Shibaev, the South Region. The senior author was responsible for ensuring cohesion of the whole and uniformity in the species accounts.

A survey of the nesting seabirds

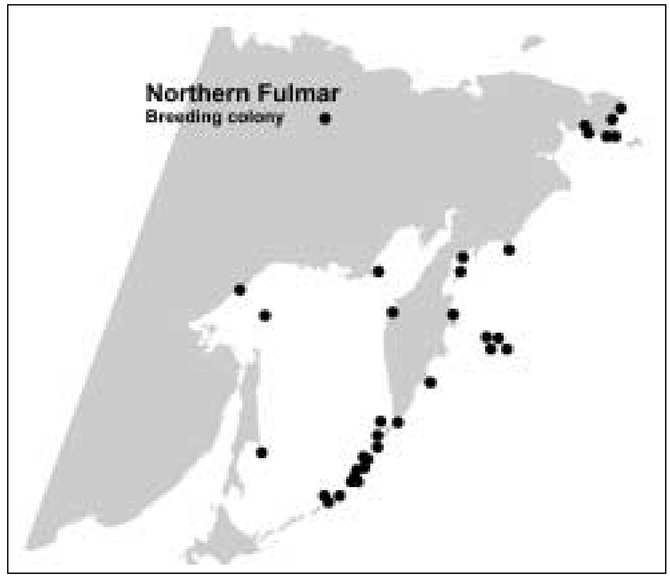
In the first part of this chapter, we summarize the nesting biology of 40 species of seabirds that nest in the Russian Far East. As the concept “seabird” does not have a specific definition and is rather freely interpreted by different scientists, we have selected species based on their degree of connection to marine ecosystems. All species with strong ecological or trophic connections with the sea, particularly in their reproductive phase, have been included. The list includes all of the alcids (Alcidae) and tube-nosed swimmers (Procellariidae), which spend their entire lives at sea and are generally highly adapted as marine predators and which come to shore only to breed on the extreme edges of the continent or offshore islands. Typically, their dependence on concentrations of marine prey that are mobile and patchily distributed obliges them to form colonies for nesting. Such colonies can sometimes reach gigantic sizes. Similarly, the cormorants (Phalacrocoracidae) and gulls (Laridae) have been included as seabirds, even though some species of gull exhibit a high degree of ecological radiation and their dependence on the sea varies greatly. Some, such as kittiwakes, are obligate seabirds; however, among the members of the genus *Larus*, there is a spectrum of “maritime” adaptations, running from typical sea species such as the Glaucous Gull *L. hyperboreus* to Mew Gull *L. canus* or Common Black-headed Gull *L. ridibundus*, which nest readily in both maritime and inland areas. For the more wide-ranging species, we have included only the coastal elements of the population, which depend on marine resources during their reproductive phase and migrate to the sea after the nesting period. Unless otherwise noted, the observations are those of the authors.

We have excluded those species that generally breed inland in association with terrestrial and aquatic ecosystems, even though many spend the winters at sea. Such criteria exclude the jaegers (Stercoraridae), even though they spend much time at sea, because they tend to nest far inland and depend on terrestrial resources during their breeding period. Jaegers also exhibit territoriality, as opposed to coloniality, at the nest and are widely dispersed across the interior of the continent during the breeding season. It is not until autumn that breeding jaegers and their young join the immatures and nonbreeding adults at sea. Only the Pomarine Jaeger *Stercorarius pomarinus* is occasionally coastal and associated with marine ecosystems year-round. Similarly, the criteria exclude loons (Gaviidae), grebes (Podicipedidae), waterfowl (Anatidae), which usually breed in freshwater areas, coming to the sea in winter, and all of the sandpipers (Scolopacidae), even the phalaropes, which have strong connections to marine ecosystems but breed inland. We have also excluded oystercatchers, which are associated with shoreline ecosystems rather than marine environments. Some migration movements of these species are discussed in Chapter 4.

NORTHERN FULMAR *Fulmarus glacialis*

Distribution and abundance

The Northern Fulmar is a widespread seabird in the Pacific basin of the Russian Far East, where it nests from the Terpeniya Gulf to the northeast of Sakhalin Island and Urup Island of the Kuril Archipelago (Gizenko 1955; Shuntov



1982) northward to Cape Enmelen on the southern coast of the Chukot Peninsula (Portenko 1972; Konyukhov 1986; Vyatkin 1992, 1993; Konyukhov et al. 1998). Wandering birds commonly enter the seas of the Arctic basin, where they can be found even in the Chukchi and East Siberian seas.

Without a doubt, the Northern Fulmar is one of the most numerous species of seabird in the Far East. At the same time, the record of the number of nesting birds on the colonies is far from complete and includes many approximations and extensions of data from years long past. On the Chukot Peninsula, near the northern limit of distribution for this species, the colonies contain 80 000–90 000 individuals (Bogoslovskaya and Konyukhov 1987; Bogoslovskaya et al. 1988). The most thorough and reliable observations of nesting fulmars come from the Kamchatka Region (Gerasimov 1970; Kharkevich and Vyatkin 1977; Lobkov 1980; Vyatkin 1986; Artyukhin 1991). Along the eastern coast, there are 18 colonies; the biggest, on the Olyutorskiy Peninsula, has about 110 000 individuals (Vyatkin, in press a). About 500 000 individuals nested on the Komandorskiye Islands 30 years ago (Marakov 1963). Recent estimates are closer to 400 000. More than 240 000 of those birds nest on Medniy Island (Vyatkin and Artyukhin 1994; Artyukhin, in press a). At present, fulmars appear to be increasing their numbers and their breeding range along the eastern coast of Kamchatka. According to surveys in 1995, there were 12 new colonies in previously unoccupied sites (P.S. Vyatkin, unpubl. data). However, such small colonies of fulmar are often temporary events (Shuntov 1982). On the western coast of Kamchatka, in the northern Sea of Okhotsk, the only known colony is on Ptichy Island. A report by V.D. Yakhontov (1975a) of nesting on the small islands in the Penzhinskaya Gulf region needs to be confirmed. On the northwestern coast of the Sea of Okhotsk, large fulmar colonies are known from the Yamskiye Islands archipelago. These colonies are significant, not only because of their huge size, but also because of poorly understood variations in population estimates for the colonies. A.G. Velizhanin (1975) estimated a total of 50 000 individuals on the five islands of the archipelago, with 16 000 of those on Matykil Island. In 1988, as a result of rather painstaking counts of fulmars on Matykil Island, the number was 100 000–110 000 individuals (Kondratyev 1991; Kondratyev et al. 1993). The numbers were reassessed on all of the Yamskiye Islands again in 1992 and 1993 (A.Ya. Kondratyev, unpubl. data). The numbers jumped to 900 000–1 100 000 individuals.

In the northern Sea of Okhotsk, there are known colonies on Nansikan Island, where there has been no population assessment (Yakhontov 1975b), and on Iona Island, which was last estimated at 50 000–70 000 birds (Kharitonov 1975; Velizhanin 1977a). Fulmars nest on the northern and middle islands of the Kurils and are among the most numerous seabirds in the southern Far East, with about 1.5 million individuals (Velizhanin 1978). The biggest colonies, on Broutona Island, hold 300 000–400 000 individuals. From 1947 to 1949, fulmars nested on Sakhalin Island at Cape Terpeniya and perhaps at Cape Aniva (Gizenko 1955). However, in 1981, V.A. Nechaev (1986) could not find any nesting fulmars on Cape Terpeniya. In 1991, solitary nesting pairs were first reported from Tyuleniy Island (Trukhin and Kuzin 1996).

Nesting habitat

The fulmar will nest on ledges of sheer precipices but more usually chooses grass-covered slopes of islands or the mainland sea coast at elevations from 15 or 20 m to 500 m above sea level (Velizhanin 1972). It usually settles with other species of seabirds. On the big colonies, such as those on the Yamskiye Islands, nest density can reach 0.7/m^2 (A.Ya. Kondratyev, unpubl. data).

Breeding biology

Early fulmars appear off the Komandorskiye Islands at the end of March and begin to visit land by the end of May. Egg laying occurs at the beginning of June, with fledglings reported on the water in September and October (Marakov 1972). A similar schedule is observed in the northern Sea of Okhotsk (Yakhontov 1975b; A.Ya. Kondratyev, unpubl. data). On the middle Kurils, the birds arrive at the end of March or in early April. In 1947, on the Shirinski and Raikoke islands, copulation was observed after 20 May, and egg laying began in the first days of June, reaching a peak of activity by the middle of the month (Gizenko 1955).

Diet

The main items in the diet of nestling fulmars are squid, crustaceans, and, when available, offal from fishery operations.

Threats and protection

In the northern part of the region and on Kamchatka, the fulmar population is generally doing rather well. The main threats near the colonies are pollution from petrochemicals and mortality associated with the commercial fishery. The success of reproduction can be limited by predators such as Eurasian Crow *Corvus corone*, Common Raven *C. corax*, red *Vulpes vulpes* or arctic *Alopex lagopus* fox, wolverine *Gulo gulo*, and large gulls, as well as by subsistence hunters and egg gatherers.

On the Kurils from 1916 to 1940, Japanese fur farmers repeatedly brought arctic and red foxes to the islands. Those foxes destroyed the majority of birds (Voronov 1982). In addition, the fur farmers collected tens of thousands of fulmar chicks to feed the foxes in the fur farms (Gizenko 1955; Bromley 1981). The proposal by A.I. Gizenko (1955) to regularly collect eggs and fulmar chicks on a commercial scale was not approved, but uncontrolled subsistence harvesting continues.

STREAKED SHEARWATER *Calonectris leucomelas*

Distribution and abundance

The only Russian colony for this species is on Karamzin Island in Peter the Great Bay near Vladivostok. The colony was discovered in 1967 (Litvinenko et al. 1972) and had not more than 150 pairs nesting in 1969 (Litvinenko

1976). A visit in June 1992 showed that little had changed in the intervening years. The Streaked Shearwater is an inhabitant of offshore waters, but, in contrast to its more oceanic relatives, it prefers the margins of the ocean (Shuntov 1982) and is frequently seen from land, especially after storms.

Nesting habitat

Like all Procellariids, the Streaked Shearwater comes to land only to reproduce on rocky marine islands. Karamzin Island is not big (maximum elevation is 107 m above sea level, and the length of the island is about 600 m), and the shores fall precipitously to the sea. The shearwaters nest mainly on the upper, comparatively flat part of the island, which is covered with grass and contains a large mixed-species colony. They nest in holes dug into the soil or in rock crevices.

Breeding biology

The reproductive period is very long compared with that of other seabirds of the Russian Far East. Egg laying takes place in the second half of June, and the single egg, incubated by both partners for about two months, hatches in August. Nestlings stay in the burrow for about another three months (90–95 days), not fledging until November. The adult birds come to the colony on Karamzin Island after sunset, leaving at dawn. During these visits, they may feed the chick once every 24 hours, but often less frequently. At the age of two months, the nestling reaches twice the weight of a parent, but it is not fed during its last 10–15 days before fledging; after the fast, the young bird's weight is similar to that of an adult bird, 500–600 g. In 1969, the overall nesting success was 56.5% (n = 69), and fledging success (survival from hatching to fledging) was 82% (n = 39). The main limit to productivity in the colony seems to be egg failure (Litvinenko 1976).

Threats and protection

With such low numbers of birds, any accident can lead to the loss of the colony and disappearance of the species in Russia. The situation is aggravated by the closeness of the colony to the large industrial centre at Vladivostok and to the densely populated industrial regions of Primorye. The species is included in the Red Data Book of Russia. Karamzin Island was declared a Natural Monument (in 1984) because it is the place of nesting of the Streaked Shearwater and other seabirds; however, status alone cannot protect the colony from plunder by tourists. It is an urgent necessity to include Karamzin Island in the Far East Marine Reserve, which includes many other islands in Peter the Great Bay (see Appendix 1).

LEACH'S STORM-PETREL *Oceanodroma leucorhoa*

Distribution and abundance

Being a typical oceanic Procellariiforme, the Leach's Storm-Petrel avoids the nearshore and shallow marine areas. It is not found in the northern parts of the Sea of Okhotsk or the Bering Sea. It nests in the Komandorskiye Islands on Medniy, Ari Kamen, and Toporkov (Ioganzen 1934; Johansen 1934; Kartashev 1961; Marakov 1963, 1972; Vyatkin and Artyukhin 1994; Artyukhin, in press a). The number breeding on the Komandorskiye Islands is perhaps some thousand pairs, but that needs to be confirmed (Vyatkin and Artyukhin 1994; Artyukhin, in press a). In the southern part of the region, the Leach's Storm-Petrel nests on the

Kuril Islands, Sakhalin Island, and Moneron Island. On the Kuril Islands, it is sporadically distributed from Onekotan Island in the north to Simushir Island in the south, as well as on Shikotan and Anuchina islands and perhaps other members of the Lesser Kurils. The total population on the Kuril Islands is about 350 000 birds (Velizhanin 1972). Only one colony, at Cape Terpeniya, is known on Sakhalin Island, but the number of nesting birds has not been ascertained (Nechaev 1986). On Moneron Island, not more than 20 pairs of nesting birds were found by Yu.V. Shibaev in 1976 (Litvinenko and Shibaev 1991).

Nesting habitat

The Leach's Storm-Petrel nests in colonies usually adjacent to Fork-tailed Storm-Petrel *Oceanodroma furcata* and other species of seabirds. The nests are built into terraces of bluffs and on gentle slopes where there are suitable crevices or soft soil for burrowing.

Nesting biology

There is little information about the nesting biology of storm-petrels in the Russian Far East. In spring, they appear near Matua Island in the first 10 days of April. Eggs were found in many nests by 11 June in 1947 (Gizenko 1955).

Threats and protection

In 1947, mass collecting of eggs and nestlings occurred on Matua Island in the Kurils (Gizenko 1955). On Cape Terpeniya, fresh remains of seven birds that were killed by fox were found between 14 and 30 June 1981, not far from the nesting colony (Nechaev 1986). The Norway rat *Rattus norvegicus*, which has been introduced to Moneron Island and the adjacent islets, is also a real threat for this storm-petrel (Litvinenko and Shibaev 1991).

SWINHOE'S STORM-PETREL *Oceanodroma monorhis*

Distribution and abundance

Swinhoe's Storm-Petrel is a rare species in the Russian Far East and is near the northern boundary of its nesting range. The Verhovsky Islands and Karamzin Island, rocky, uninhabited islands in Peter the Great Bay, hold the only colonies (Firsov 1928; Nechaev and Yudakov 1968). About 11 000 nesting pairs were counted on the larger of the Verhovsky Islands in 1966, making it one of the three largest colonies for this species in the world (Nechaev and Yudakov 1968). In 1985, there were 7500 pairs of birds, and in 1988, 8370 pairs (extrapolated from four sample plots of 5 m^2 each) (N.M. Litvinenko, unpubl. data). Not more than 100 pairs nest on each of the smaller of the Verhovsky Islands and Karamzin Island. This colony on the Verhovsky Islands is one of the three largest colonies of the species in the world. Two other large colonies are relatively nearby, along the southwest coast of the Korean Peninsula.

Nesting habitat

Swinhoe's Storm-Petrel comes ashore only to breed in nests on marine islands. In other seasons, it is dispersed across outlying areas of the ocean, far from shore (Shuntov 1982). The majority of nests on the larger of the Verhovsky Islands are on a slope covered with grass (mostly *Elymus mollis* and *Artemisia* sp.), occupying almost all of the available space. The island is shared with nesting Black-tailed Gull *Larus crassirostris*, Ancient Murrelet *Synthliboramphus antiquus*, Rhinoceros Auklet *Cerorhinca monocerata*, and Spectacled Guillemot *Cepphus carbo*.

Breeding biology

Storm-petrels make nests in shallow burrows dug into the layer of turf or in crevices among boulders. On the nesting colony, birds are active only after dark. The average density of nests in 1988 was 0.93/m^2. Occasionally, storm-petrels nest in burrows previously occupied by Rhinoceros Auklets or Ancient Murrelets. Nest preparation consists of covering the nest bottom with dry grass and fine gravel. Egg laying is in late June, and eggs are incubated by both parents. Hatching occurs in August, and nestlings stay in the burrows until the end of October or the beginning of November. At that time, there are light frosts and snowfalls in Primorye. In 1985, the survival, from mortality and emigration, by fledglings was about 61% (n = 46) (N.M. Litvinenko, unpubl. data).

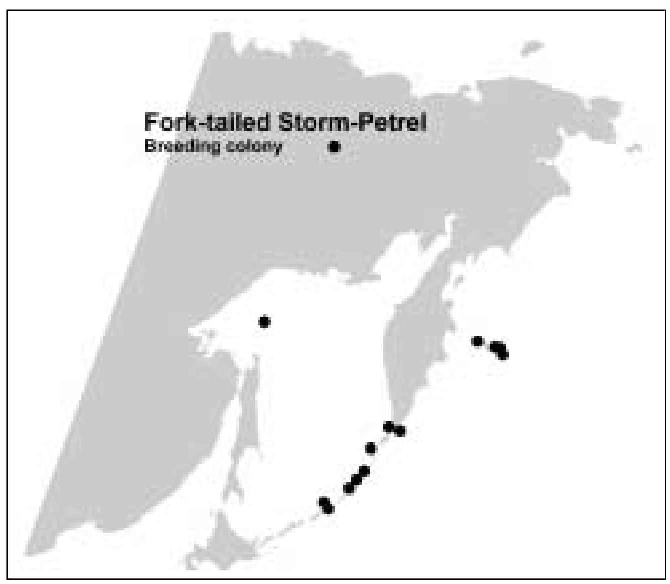
Threats and protection

In spite of a high and apparently stable population in these colonies, there is a real threat of destruction. The Verhovsky Islands are situated within the recreation area of Vladivostok and are visited by people during the warm periods of the year. Hundreds of nests are wrecked during these excursions, because the thin vaults of the burrows cannot bear the weight of a human being. In 1984, the Verhovsky Islands were declared a Natural Monument as the nesting place of a rare species; however, the islands are still visited frequently. For protection, it is necessary to include the Verhovsky and Karamzin islands in the Far East Marine Reserve.

FORK-TAILED STORM-PETREL *Oceanodroma furcata*

Distribution and abundance

The Fork-tailed Storm-Petrel breeds no farther north than the Komandorskiye Islands, where it usually shares colonies with Leach's Storm-Petrel (Artyukhin 1991; Vyatkin and Artyukhin 1994). However, the total population does not exceed some 1000 nesting pairs. Unlike Leach's Storm-Petrel, the Fork-tailed Storm-Petrel is common in nearshore maritime areas of the Sea of Okhotsk and of the Bering Sea in the breeding season and as far north as Bering Strait. In the South Region, it appears to nest only on the Kuril Islands, from the northern and middle parts of the



archipelago as far south as Broutona Island. The entire Kuril population is about 20 000 birds (Velizhanin 1972). In 1947, 1948, 1951, 1953, and 1954, colonies of these birds were observed at Cape Aniva, Cape Terpeniya, and Cape Elizaveta on Sakhalin Island (Sleptzov 1959); in June 1980 and 1981, however, there were none at Cape Aniva or Cape Terpeniya (Nechaev 1986). In the nearby Kuril waters, this bird occurs throughout the year (Velizhanin 1972).

Nesting habitat

On the Kuril Islands, the Fork-tailed Storm Petrel inhabits islands with soft soils and nests up to 200 or 300 m above sea level.

Nesting biology

There is little information about the nesting biology of this bird in the Russian Far East. The Fork-tailed Storm-Petrel builds nests in burrows or in the holes among talus rocks (Velizhanin 1972). On the Komandorskiye Islands, egg laying begins in the middle of June, about two weeks earlier than for Leach's Storm-Petrel (Marakov 1972). On Matua Island (Kurils), eggs have been found in the last 10 days of June (Gizenko 1955).

Threats and protection

This species shares many colonies with Leach's Storm-Petrel and is therefore subject to the same threats.

GREAT CORMORANT *Phalacrocorax carbo*

Distribution and abundance

The distribution of Great Cormorant is chiefly continental throughout Europe and Asia. In the southern Far East, there are many colonies on islands in the Ussuri and Amur rivers. The only marine population, however, is a small and isolated group on Furugelm and Butakov islands in Peter the Great Bay (see Appendix 1) (Shibaev 1987). A colony of 15 pairs was found on Furugelm Island in 1982, and numbers increased gradually to 33 pairs in 1983, 70 in 1984 (Shibaev 1987), and 413 in 1996 (Y.V. Shibaev, unpubl. data). On Butakov Island, 10–20 pairs breed irregularly. Nesting of the Great Cormorant on the Kuril Islands (Velizhanin 1977b) may occur irregularly and needs to be verified (Litvinenko and Shibaev 1991).

Nesting habitat

In Peter the Great Bay, the Great Cormorant breeds on wide shelves on cliffs among Japanese Cormorants *Phalacrocorax filamentosus* and Grey Herons *Ardea cinerea.* Many nest at inland sites not included in this study.

Breeding biology

Coastal populations have not been studied in detail.

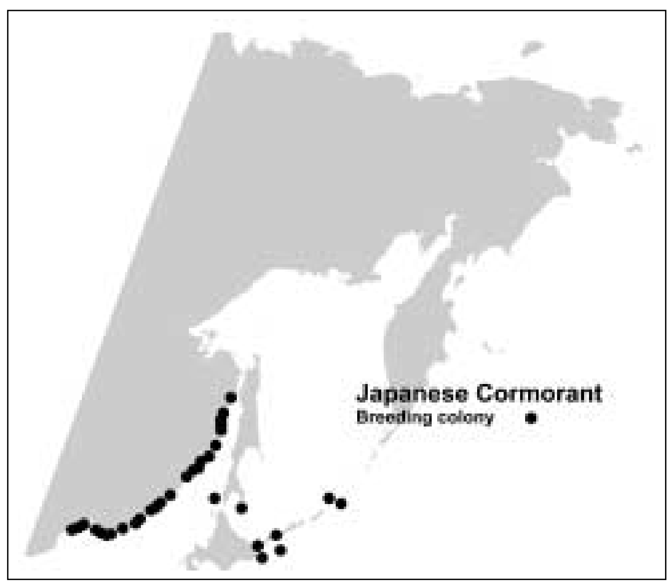
Threats and protection

The increasing number of birds is probably due to both reduced disturbance after the creation of the Far East Marine Reserve in Peter the Great Bay in 1978 and the occurrence of abundant food in the form of the Pacific sardine *Sardinops sagax* (Shibaev 1987).

JAPANESE CORMORANT *Phalacrocorax filamentosus*

Distribution and abundance

The Russian population of Japanese Cormorant was long considered a separate species and given the name Temminck's Cormorant. This name is still frequently used to describe the race that breeds along the mainland coast of the Sea of Japan from Tatarsky Strait to the Tumangan River, on Sakhalin, Moneron, and the southern Kuril islands. The



biggest Russian colony is situated on Furugelm Island (989 pairs in 1996) in Peter the Great Bay (Appendix 1). The other 38–40 colonies on the coast of the Sea of Japan are small, with 10–20 pairs in each (Elsukov 1984; N.M. Litvinenko and Y.V. Shibaev, unpubl. data). About 7000 birds breed on the Kuril Islands (see Appendix 1), from Kunashir Island in the north to Simushir Island in the south (Velizhanin 1978). There is a colony on Sakhalin of 100–120 pairs at Cape Aniva (Nechaev 1991), and about 170 pairs nested on Moneron Island in 1991 (Shibaev and Litvinenko 1996).

Wintering

Small numbers of these cormorants spend the winter in the southern Russian Far East. Banding studies show that young birds forage along the Primorye coast after leaving the colonies in Peter the Great Bay and stay there until late October; some stay until December. Most of the first-year birds from this region, however, migrate southwest to winter in the Korean Strait (Litvinenko and Shibaev 1992).

Population trends

The number of Japanese Cormorants has varied in Peter the Great Bay over the last 60 years. On Furugelm Island, the colony was completely destroyed by arctic foxes introduced in 1929–1930, but the cormorants returned, and their numbers increased through the 1950s. In 1967, most died from an unknown, but possibly natural, cause (Labzyuk et al. 1971). After 1977, the numbers again increased, and the colony held 1520 birds in 1985, 10 times more than in 1969. This probably reflects favourable conditions under the protection of the Far East Marine Reserve, created in 1978, and the occurrence of abundant food, particularly the Pacific sardine (Shibaev 1987). In 1996, there were about 2000 Japanese Cormorants in the Russian Far East (N.M. Litvinenko and Y.V. Shibaev, unpubl. data).

Nesting habitat

The Japanese Cormorant is strictly colonial and rarely breeds in isolated pairs. Most colonies are small (20–30 nests), but there is an exceptionally large colony on Furugelm Island. The Japanese Cormorant nests on broad ledges and shelves on open cliff faces, often in mixed colonies with Common Murres *Uria aalge* or Black-tailed Gulls.

Breeding biology

The earliest successful breeding was observed at three years of age. In Primorye, egg laying begins in late April and reaches a peak in early May. Clutch size (n = 45) is 2–4 eggs (average 3.35). The peak of hatching is from late May to early June (N.M. Litvinenko and Y.V. Shibaev, unpubl. data).

Diet

The Japanese Cormorant feeds in small flocks or individually in coastal and estuarine waters, often with large flocks of gulls. Food samples regurgitated by chicks at colonies in Peter the Great Bay in the 1970s contained mostly bottom-dwelling fish (e.g., Cottidae, Stichaeidae, Pholidae), but also herring. In 1984–1985, Pacific sardine was prevalent (Siegel-Causey and Litvinenko 1993).

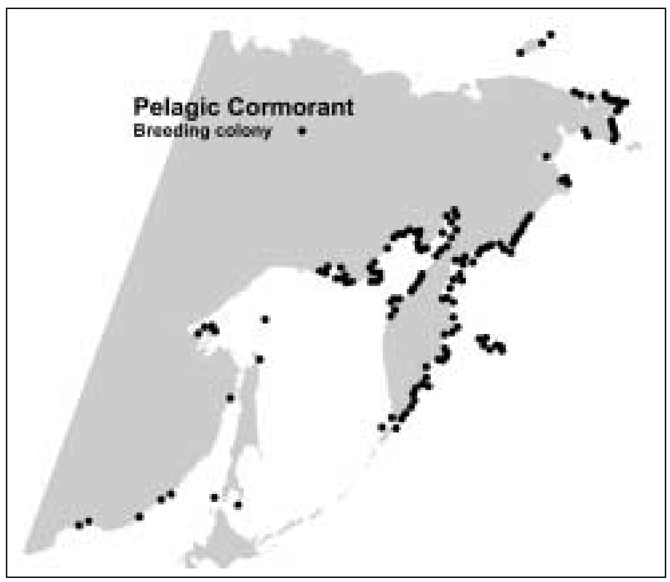
Threats and protection

The main threat to this species is human disturbance. On Sakhalin, Moneron, and the southern Kuril islands, crews of fishing boats have systematically destroyed the majority of colonies through egging and target shooting for many years (Gizenko 1955; Benkovsky 1968). The Carrion Crow *Corvus corone*, Large-billed Crow *C. macrorhynchos*, and Black-tailed Gull sometimes steal eggs and small chicks. Cormorants breeding on the continental coast are under pressure from predatory mammals, mainly red fox. At present, all large colonies of Japanese Cormorant in Peter the Great Bay are within protected areas.

PELAGIC CORMORANT *Phalacrocorax pelagicus*

Distribution and abundance

The Pelagic Cormorant is one of the most common and widespread seabird species in the Russian Far East, but it usually does not form big colonies. It nests in the Arctic seas of the Far East westward to Shelagskiy Cape and Chaun Bay



in the East Siberian Sea (Kondratyev 1986), as well as on Wrangel and Gerald islands (Portenko 1972). The total number of Pelagic Cormorants nesting in the Arctic basin is estimated at about 4000 birds (Kondratyev 1991), including 1000–1800 birds on Wrangel and Gerald islands (Pridatko 1986). The average nesting density of cormorants southward of Bering Strait is much higher. On Big Diomede in 1991, for instance, there were an estimated 250 nesting pairs (Kondratyev et al. 1995). The Pelagic Cormorant nests everywhere along the coastal cliffs in single pairs and small groups. Colonies of more than 100 pairs are very rare (Kishchinski 1980; A.Ya. Kondratyev, unpubl. data). The total number of cormorants in the northern part of the Bering Sea may be close to 50 000 birds (Kondratyev 1991).

In the Kamchatka Region, the numbers of this species seem depressed at present, about 14 000 pairs (Vyatkin 1986, in press b). On the eastern coast of Kamchatka, about 23 000 pairs nested from 1970 to 1983 (Vyatkin 1986); in 1994 and 1995, in contrast, only 12 000 pairs nested there. Along the southern coast of the Kamchat Peninsula in the 1970s, dozens of small Pelagic Cormorant colonies held up to 100 pairs. In 1983, observers found the majority of these colonies to be empty, and many of them were occupied by Red-faced Cormorants *Phalacrocorax urile*. By 1994 or 1995, many nests were empty of either species. About 3100 pairs nest on the Komandorskiye Islands (Artyukhin, in press b), but the population is variable. In the first half of the 1960s, there were about 9000 pairs; in the early 1970s, there were 10 000; in the 1980s, there were 3300; and in the early 1990s, there were 3500 (Artyukhin 1991). In the northern Sea of Okhotsk, the preliminary estimate of the total number of Pelagic Cormorants is 10 000 birds, but the real number may be higher because of underestimates at colonies on Nansikan Island and in the area of the Ayan Gulf (A.Ya. Kondratyev, unpubl. data). Overall, in the northern Sea of Okhotsk, the population of cormorants has slowly decreased during the last 10 years (Kondratyev et al. 1995).

The biggest colonies in the southern Far East are on the Kuril Islands (total 50 000–60 000 birds), where this species is widespread (Velizhanin 1978). Very small numbers nest on Sakhalin Island (25–30 pairs on Cape Aniva and maybe on the Shmidta Peninsula) and on Moneron Island (12 pairs in 1991) (Nechaev 1991; Shibaev and Litvinenko 1996). A small colony on Tyuleniy Island was destroyed by people and has never returned (Trukhin and Kuzin 1996). The Pelagic Cormorant also nests in small numbers on the Shantars (Yakhontov 1977; Roslyakov and Roslyakov 1996). There are relatively few Pelagic Cormorants in the Sea of Japan, with not more than 2000 birds nesting between the Tumangan and Amur rivers, 300 of those in Peter the Great Bay (Shibaev 1987).

Wintering

This species winters in waters around the Kuril Islands and along southern Primorye (Velizhanin 1972; Shibaev and Litvinenko 1996). Konyukhov et al. (1998) reported birds regularly wintering in the Sireniki polynya.

Nesting habitat

This species nests on ledges and crevices in cliffs. No specific requirements have been determined.

Breeding biology

In the Arctic basin, during 1985, the cormorants arrived at the Kolyuchin Island colony at the end of May, and egg laying began on 4 June (Kondratyev et al. 1987). The average clutch size was calculated to be 1.3 eggs on Big Diomede in 1991. On Verkhoturova Island in eastern Kamchatka, egg laying lasts from the beginning of May to the beginning of June (Kharkevich and Vyatkin 1977). On Talan Island in the northern Sea of Okhotsk, egg laying starts at the end of May and occasionally as late as the first few days of June; the average clutch size ranged from 2.17 (n = 18) in 1995 to 4.33 (n = 21) in 1993. On Talan Island, the number of fledglings per brood ranged from 2.06 (n = 38) in 1995 and 1989 to 3.41 (n = 29) in 1993.

In the southern Far East, egg laying on Moneron Island and in South Primorye (Peter the Great Bay) starts in the beginning of May. In South Primorye, hatching started in seven of 24 active nests on 30–31 May 1979; on Moneron, it occurred in the first 10 days of June (Gizenko 1955; Siegel-Causey and Litvinenko 1993).

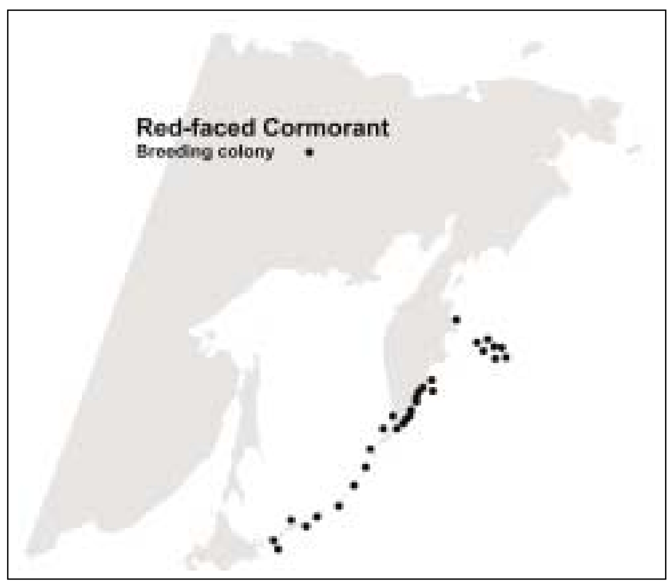
Diet

In the northern Sea of Okhotsk, nesting cormorants usually collect bottom fish and krill or, rarely, polychaetes to feed their nestlings. Small fish predominated in the stomachs of eight birds collected on Sakhalin: Eurasian smelt *Osmerus operlanus*, Japanese smelt *Hypomesus japonicus*, threespine stickleback *Gasterosteus aculeatus*, Pacific sand lance *Ammodytes hexapterus*, saffron cod *Eleginus gracilis*, and capelin *Mallotus villosus* (Nechaev 1991).

RED-FACED CORMORANT *Phalacrocorax urile*

Distribution and abundance

In the Russian Far East, the Red-faced Cormorant nests on the Komandorskiye Islands, along the southeastern Kamchatka coast, and on the Kuril Islands. At present, the population of Red-faced Cormorant is about 3000 pairs in the



Kamchatka Region and appears to be at a depressed level. In the early 1970s, about 2000 pairs were found on the Kamchat Peninsula; 6000 were found in 1983, and 2000 in 1995 (Vyatkin 1981, 1986, in press b). On the Komandorskiye Islands, about 1500–2000 were recorded in the 1950s, 12 000 in the early 1970s, but only 850–1100 pairs between 1986 and 1994 (Marakov 1963, 1972, 1977; Artyukhin 1991, in press b). These populations seem to vary on a very large scale. On the Kuril Islands, the population was estimated at

20 000–30 000 birds in 1963. Small numbers had first been observed in the early 20th century, but at present the population represents about 30% of all cormorants in the area (Gizenko 1955; Velizhanin 1977a).

Wintering

Most Red-faced Cormorants spend the winter on the southern Kurils.

Nesting habitat

The Red-faced Cormorant nests on wide shelves and also on the tops of pinnacles and rocks between 3–4 and 200 m in elevation. It will nest in a single pair, but more often it nests in small groups or colonies of up to several hundred pairs. Nests are constructed from seaweeds and stems of *Elymus* spp.

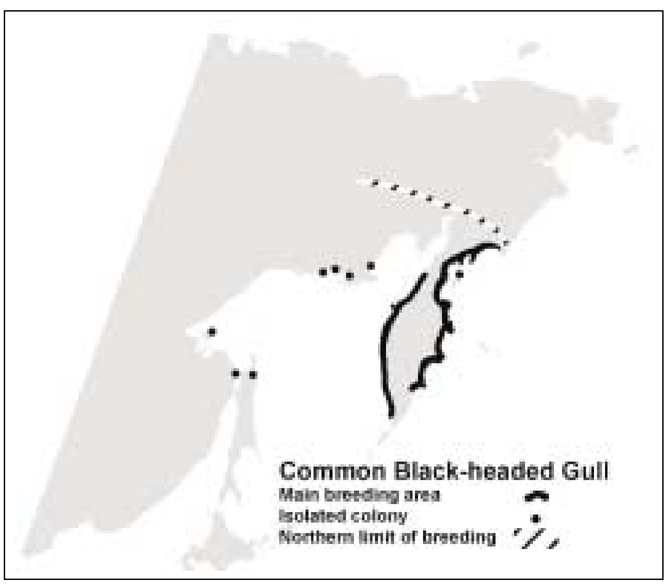
Breeding biology

The nesting schedule is very extended in the Kamchatka Region. On the Komandorskiye Islands, nest building begins in March and April, but the first eggs do not appear until the second half of April. The peak of egg laying is later, at the beginning of June. The chicks fledge from August to October (Marakov 1972). On the Kuril Islands, egg laying begins in late May (Velizhanin 1977a).

COMMON BLACK-HEADED GULL *Larus ridibundus*

Distribution and abundance

The nesting area for the Common Black-headed Gull in the northern part of the Russian Far East is still poorly known. It inhabits both coastal and inland lowlands from 68°N, along the Kolyma River to the southern Koryak



Highlands along the Bering Sea coast (Kishchinski 1980; Kondratyev 1996). In the Kamchatka Region, it is distributed in most coastal areas around the peninsula and on Karaginsky Island (Lobkov 1981). The size of colonies varies from a few birds to several thousand, and the colonies are usually shared with Mew Gulls and terns. Available information does not allow an accurate estimate of the Kamchatka population, but it could be close to 100 000 pairs. There is also little information about the number nesting farther inland. In the northern Sea of Okhotsk, the Common Black-headed Gull nests widely in coastal lowlands, but coastal colonies are never more than a few tens of birds, and the number nesting in those coastal areas is still unknown. On Talan Island, 10 500 flying Common Black-headed Gulls were counted during the spring migrations in 1991 (Kondratyev et al. 1992).

In the southern Far East, the Common Black-headed Gull is a common resident on mainland freshwater reservoirs and wetlands, but only three coastal breeding sites are known. One, on Sakhalin Island, at a small lake behind Piltun Bay, held 10–13 pairs on 4 June 1983 (Nechaev 1991). Another, on wetlands within islands of the Shantar Archipelago, held about 7000–8000 birds (Roslyakov 1986). A third colony has been reported on the mainland coast, near the mouth of the Amur River (Litvinenko and Shibaev 1991). This gull very likely nests on Mukhtel Lake, a brackish lagoon located on the coast of Aleksandra Bay, southeast of the Shantar Islands (Poyarkov and Budris 1991). One more small colony of approximately 30 pairs was found on fresh water at Doritzeni Lake in the southern Primorye, 12 km from the coast, on 18 June 1996 (Yu.V. Shibaev, unpubl. data).

Nesting habitat

In the northern and southern areas, the Common Black-headed Gull nests in small colonies or as single pairs in river deltas and coastal wetlands with other gulls and terns. In Kamchatka, it nests widely in both coastal and inland areas, almost always associated with a water body such as a lake or lagoon. It prefers wetter grassy lowlands throughout its range, often selecting sites with *Carex* sp. and mosses on the ground.

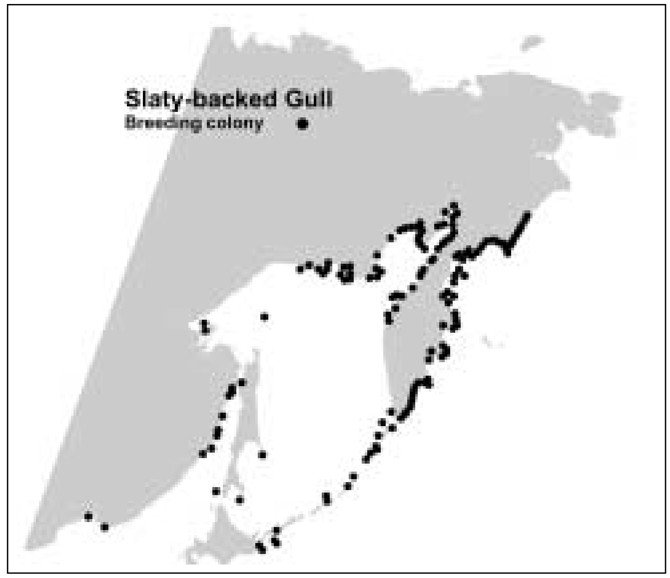
Breeding biology

No special investigations of Common Black-headed Gull breeding biology have been carried out in the Far East. In the Kamchat Peninsula, egg laying occurred at the end of May and in June, with chicks hatching at the end of June. Fledging occurred at the end of July or the beginning of August (Lobkov 1986). The clutch size in the Magadan area was 2.6 (n = 42) (A.Ya. Kondratyev, unpubl. data). Two nests found on Sakhalin Island on 4 June held fresh eggs (Nechaev 1991).

HERRING GULL *Larus argentatus*

Distribution and abundance

The Herring Gull is widely distributed in the northern Far East, including Wrangel Island. The southern limit of coastal nesting coincides with the northern boundary of the Kamchatka Region. Southward, it inhabits inland areas, but it is replaced on the sea coast by the Slaty-backed Gull *L.*



schistisagus (Kondratyev 1996). Colonial and individual nesting occur with about equal frequency. Colonies usually do not exceed 25–30 pairs. The “maritime” portion of the population in the Arctic is estimated to be 12 000 birds. On the Chukotka coast of the Bering Sea, the Herring Gull nests more rarely, and the total is probably not more than 2000 birds (Kondratyev 1991, 1993a).

Nesting habitat

Along sea coasts, the Herring Gull nests at the top of cliffs, above seabird colonies, and on coastal lowlands. It usually nests with the Glaucous Gull.

Breeding biology

The average clutch size in the coastal Chukot tundra ranges annually from 2.2 to 2.9 (n = 614) (Krechmar et al. 1991). Colonies and separate pairs may have different rates of breeding success. In Chaun Bay, in the early 1980s, success (fledglings/egg) on colonies was 71.4% (n = 91) (A.Ya. Kondratyev, unpubl. data); in isolated nests, however, the success rate is as low as 15.1% (n = 48) (Krechmar et al. 1991).

SLATY-BACKED GULL *Larus schistisagus*

Distribution and abundance

In the Russian Far East, the Slaty-backed Gull nests along most of the mainland coast from the Koryak Highlands in the north to the southern boundary of Russia with China. It is common on the Kamchat Peninsula but almost absent on the Komandorskiye Islands, where it is replaced by the Glaucous-winged Gull *L. glaucescens*. Shelikan Island in the northern Sea of Okhotsk holds one of the largest colonies known in the Russian Far East. In 1997, its population reached more than 3500 pairs (L.A. Zelenskaya, unpubl. data). About 90 000 are dispersed among breeding sites in the southern Far East (Velizhanin 1978). Several tens of pairs nested on Sakhalin in 1980 and 1981, on Cape Aniva, Cape Terpeniya, and the Tonino-Anivsky Peninsula (Nechaev 1991). It has never been numerous on Tyuleniy Island, where censuses from 1989 to 1994 report 8–24 nesting pairs (Trukhin and Kuzin 1996). On Moneron Island, numbers decreased in the 1940s as a result of direct destruction (Benkovsky 1968); in 1973, the population was about 230 pairs (Nechaev 1975), in 1976, 260–280 pairs, and in 1991, about 500 pairs (Shibaev and Litvinenko 1996). No fewer than 250 pairs nested on the Shantar Archipelago in 1991 and 1992 (Roslyakov and Roslyakov 1996). In 1993, some tens of nesting pairs were counted along the mainland coast of the Sea of Japan and on islands in Peter the Great Bay (the southern limit for the breeding range). On the coast of Tatarsky Strait, Yu.V. Shibaev counted 10–50 pairs at each of 10–15 nesting sites (Litvinenko and Shibaev 1991). On Talan Island, they made up between 32% (1996) and 74% (1991) of gulls breeding at the colony.

Wintering

This species winters around the Kurils (Velizhanin 1972), in the northern part of the Sea of Japan, and around Sakhalin (Shuntov 1965, 1972).

Nesting habitat

Most nesting habitats occur in a narrow band along the coast, but sometimes this gull will nest several dozen kilometres inland — for example, at Kurilskoye and Kronotskoye lakes on Kamchatka. This bird is a very rare nester in river estuaries.

Breeding biology

The Slaty-backed Gull may form single-species colonies, especially near rich foraging places, but more often it nests with other seabirds. The size of colonies ranges widely, from two or three pairs to over 1000 pairs. In the Kamchatka Region, egg laying begins in the second half of May (Firsova et al. 1981, 1982). In the northern Sea of Okhotsk, egg laying begins between 20 May and 1 June. On Sakhalin, egg laying began on 2 June 1980, and on Moneron

Island, it began in the second part of May in 1973 (Nechaev 1991). Clutch size was three and, rarely, two eggs (Nechaev 1975). On Talan Island, productivity ranges from 0.23 to 0.92 fledglings per pair.

Threats and protection

Slaty-backed Gull populations in the northern Sea of Okhotsk and Kamchatka are quite safe, and their numbers are increasing in many colonies, sometimes rapidly. On Verkhoturova Island in 1975, there were about 150 pairs, but in 1994, numbers reached 4800 (Kharkevich and Vyatkin 1977; Vyatkin, in press b).

GLAUCOUS-WINGED GULL *Larus glaucescens*

Distribution and abundance

Nesting by the Glaucous-winged Gull in the Russian Far East occurs only on the Komandorskiye Islands (see Appendix 1), 90% on Toporkov and Ari Kamen islands. There has been one report of a nest by a mixed pair with a

Slaty-backed Gull in Geka Gulf, Koryak Highlands (Yudin and Firsova 1988a). It is not rare to find these gulls on the eastern coast of the Chukot Peninsula, and a female with brood patches was found there in 1978 (Tomkovich and Morozov 1982). On the Komandorskiye Islands, the population is increasing. In the early 1970s, about 1000 pairs nested; in 1986, this number increased to 1900; in 1991, to 4300; and in 1993, to 5200 (Firsova 1978a; Vyatkin and Artyukhin 1994; Artyukhin, in press b).

Nesting habitat

The Glaucous-winged Gull is the only large gull nesting on the Komandorskiye Islands. It uses much the same habitat that the Slaty-backed Gull uses on the Asian mainland.

Breeding biology

Egg laying begins in May or June, with chicks hatching in July. The first fledglings appear at the end of July or the beginning of August (Firsova 1978a, 1983). Incubation success varied on Toporkov Island in 1993, ranging from 31% to 59% in different parts of the colony. In 1971 and 1973, productivity was between 0.5 and 0.6 fledglings per breeding pair (Yudin and Firsova 1988a; Zelenskaya 1994).

Threats and protection

The main threat to this species comes from subsistence egg collecting and human disturbance on the colonies.

GLAUCOUS GULL *Larus hyperboreus*

Distribution and abundance

In the Russian Far East, the Glaucous Gull is distributed along the Arctic coast from the western boundary of the region to Bering Strait. It nests on Wrangel and Gerald islands. Along the Bering coast, it inhabits coastal lowlands

and cliffs in the northern part of the Koryak Highlands on the south. Nonbreeding birds are common in the summer along the Kamchatka Peninsula and the Sea of Okhotsk. The Glaucous Gull is a marine gull, almost absent 15 or 20 km inland. The total number on the Arctic colonies was estimated at 3000 birds (Kondratyev 1991, 1993a). The largest colony is on Big Diomede in the northern Bering Sea. It held about 1140 birds in 1991 (Kondratyev et al. 1995). According to some local observations, the number of Glaucous Gulls is increasing, especially in the Bering Strait area; a preliminary estimate that put their number in the northern Bering Sea at 2000 is probably too low (Kondratyev 1991).

Nesting habitat

The Glaucous Gull is quite a common breeder in big seabird colonies, where it prefers to nest on grassy flats at the top of cliffs or on pinnacles with wide shelves.

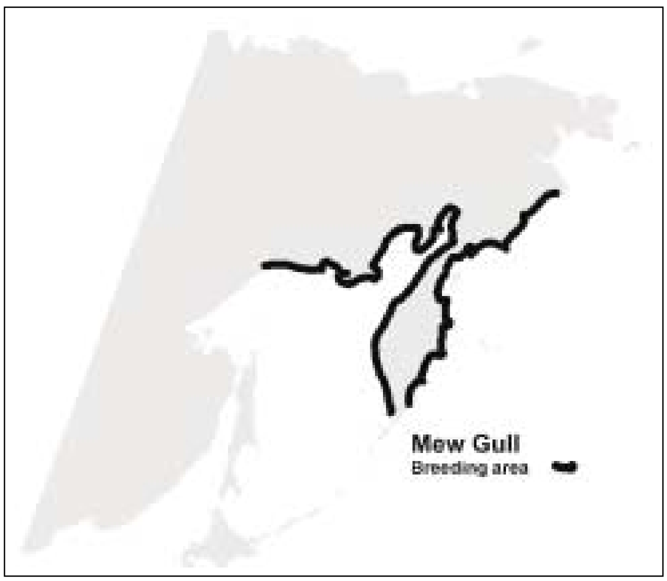
Breeding biology

The Glaucous Gull nests in separate pairs, not in large colonies. It is usually found nesting with Herring Gulls. It arrives at the nesting colonies at the end of April or the beginning of May, before other Arctic seabirds (Kondratyev 1978). Egg laying begins in the first days of June. On Big Diomede, nests with eggs coincided with chicks of 1.5 weeks between 3 and 14 July 1991 (Kondratyev et al. 1995).

MEW GULL *Larus canus*

Distribution and abundance

Along the Far East coast, the Mew Gull nests in the Kamchatka Region and the northern Sea of Okhotsk. The population in Kamchatka is quite stable (Lobkov 1983, 1986), and a preliminary estimate puts the population near



50 000 pairs, with most colonies situated in coastal areas. In the northwest Sea of Okhotsk, the Mew Gull nests in small groups and colonies of fewer than 25–35 pairs. It is much rarer there than the Common Black-headed Gull, but the total population is undetermined.

Breeding biology

The Mew Gull inhabits coastal wetlands and islets on lakes and in river deltas. It often nests in isolated pairs, but colonies can reach thousands of pairs.

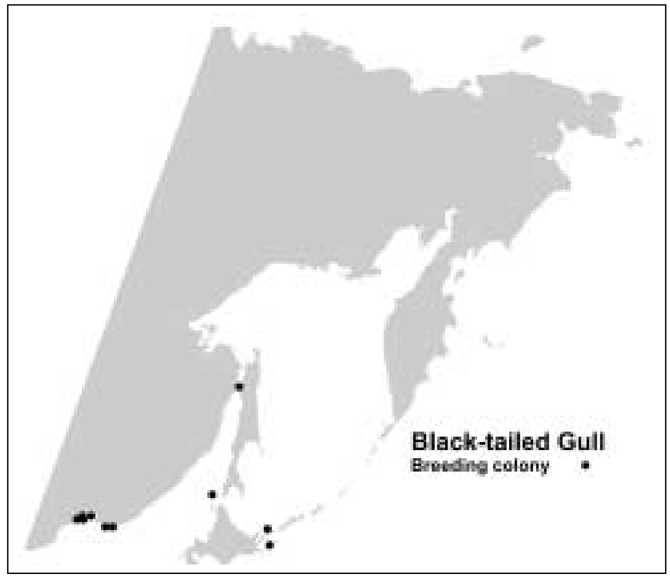
Threats and protection

The colonies are situated along rivers and are sometimes destroyed by the spring freshet. Most damage comes from cattle grazing and predation by Slaty-backed Gulls, crows, and dogs.

BLACK-TAILED GULL *Larus crassirostris*

Distribution and abundance

This species nests only in the southern portion of the Russian Far East, mainly around the Sea of Japan. The largest colony, on Furugelm Island in Peter the Great Bay, held 40 000–45 000 individuals in 1973, 85 000 in 1983,



73 440 in 1993, and 40 520 in 1996 (Shibaev 1987; Litvinenko 1988; N.M. Litvinenko and Y.V. Shibaev, unpubl. data). Such variations in nesting activity probably reflect changes in the availability of prey fish, especially Pacific sardines, whose abundance is linked to hydrological conditions (Shuntov 1986).

On the mainland coast of the Sea of Japan, this gull nests at only two sites: Popov Island in Tatarsky Strait and a small islet in Kievka Bay (Litvinenko and Shibaev 1991). The Black-tailed Gull does not nest on Sakhalin, but it is very common on Moneron Island, where 2000 birds were observed in 1949 and 1973 (Gizenko 1955; Nechaev 1975), 3000 birds were observed in 1976, and 8000 in 1991 (Shibaev and Litvinenko 1996). On the Kurils, it breeds only in the very south. The largest colony of about 700 individuals is on the Dyomin Islands (Velizhanin 1977b).

Nesting habitat

Black-tailed Gulls nest on maritime islands, preferring slopes covered with grass (e.g., *Senecio* sp., *Elymus mollis*), rocky outcrops, or broad ledges on cliff faces.

Breeding biology

The average nesting density in Peter the Great Bay is $0.29/m^2$. Egg laying begins in early May. Clutch size is 2–3 eggs, rarely four (n = 800). Hatching occurs from the end of May to the beginning of June. Fledging success on Furugelm

Island was 63% in 1976 (1.2 fledglings per breeding pair at 55 nests). Most chick mortality arises from pursuit and attack by adult gulls, but bad weather at the time of hatching can be important. Mass mortality of chicks, observed from 1993 to 1997, was caused by a decrease in the availability of sardines (Litvinenko 1980, 1988; N.M. Litvinenko and Y.V. Shibaev, unpubl. data).

Diet

The diet includes crustaceans, insects, and garbage, but fish predominate. The most common prey in the breeding seasons of 1968–1977 in Peter the Great Bay was Pacific saury *Cololabis saira* and Pacific herring *Clupea pallasi*. From 1982 to 1990, sardines were the most important (Litvinenko 1988; N.M. Litvinenko and Y.V. Shibaev, unpubl. data).

Threats and protection

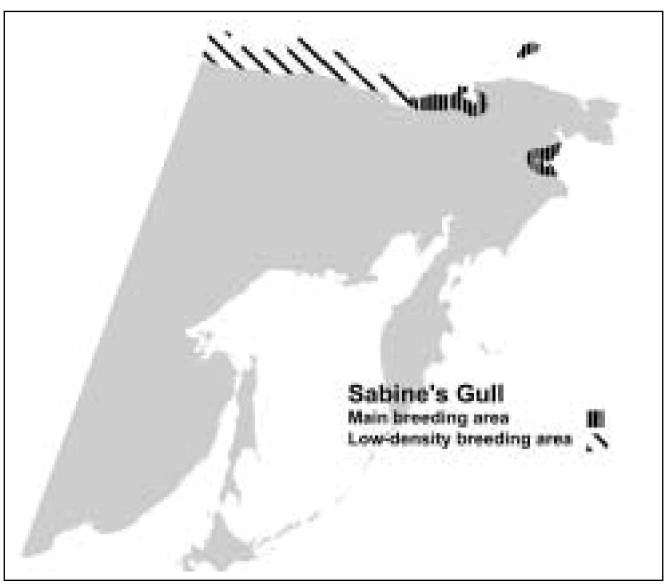
In Peter the Great Bay, remains of Black-tailed Gulls occurred in 3.4% of Peregrine Falcon *Falco peregrinus* pellets (n = 1120) and 4% of Northern Eagle-Owl *Bubo bubo* pellets (n = 399) (Nazarov and Trukhin 1985). At Lazo Reserve (South Primorye), this gull was found in 7.5% of the eagle-owl pellets (n = 67) (Kolomijtsev and Poddubnaya 1985). Other predators, mostly of eggs, are Eurasian Crow, Large-billed Crow, and Black-billed Magpie *Pica pica*. On Moneron Island, Slaty-backed Gulls eat fledglings of Black-tailed Gull (Litvinenko 1988).

More than 90% of Black-tailed Gulls nesting in Russia are protected in the Far East Marine Reserve and two Natural Monuments in Peter the Great Bay.

SABINE'S GULL *Xema sabini*

Distribution and abundance

In the Russian Far East, there are a number of separate nesting areas of Sabine's Gull on the Arctic coast (including Wrangel Island) and coastal wetlands of the Gulf of Anadyr (Portenko 1939, 1973; Lebedev and Filin 1959; Kondratyev and Kondratyeva 1987; Stishov et al. 1991). No complete survey of its population has been made. It nests in small groups as opposed to large colonies and is comparatively rare in all of the nesting localities. The total breeding population in the Far East is not more than 1000 pairs (Kondratyev 1991).



Nesting habitat

Sabine's Gull is restricted to the tundra of coastal lowlands and wetlands along lakes, rivers, and estuaries. Generally, it does not nest inland farther than 30 or 50 km. The nest is much like that of Common Black-headed Gull in areas with grass, moss, *Carex* sp., and small hummocks. The bottom of the nest may be wet.

Breeding biology

This gull has been comparatively thoroughly investigated in the Wrangel Island Zapovednik (Stishov et al. 1991) and along the Chaun Bay coast (Kondratyev and Kondratyeva 1984, 1987). About 45% of the population nests in single pairs. The clutch size ranges annually from 2.1 to 2.6 eggs (n = 182). Egg loss in Chaun Bay was 35% (n = 78) on average, but 60–80% (n = 44) of the hatched chicks were successfully fledged (Kondratyev and Kondratyeva 1987).

Wintering

Trukhin and Kosygin (1987) believed this species to winter in the Gulf of Anadyr.

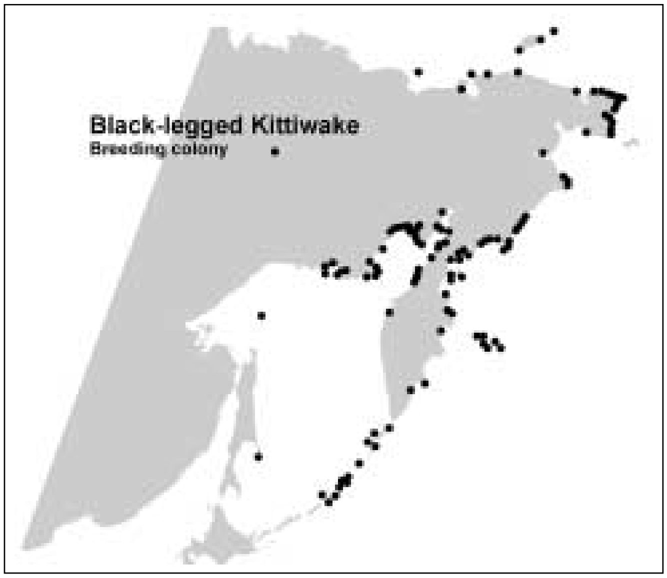
Threats and protection

The main threat to Sabine's Gull is human impact on the coastal ecosystems. Egg and chick mortality occur because of domestic reindeer grazing, and there is predation by arctic fox, dogs, other gulls, and jaegers.

BLACK-LEGGED KITTIWAKE *Rissa tridactyla*

Distribution and abundance

The Black-legged Kittiwake is the most numerous gull species in the Russian Far East and is the most numerous gull in the world. In the Arctic Far East seas, the western boundary of the kittiwakes' nesting range is Chetrekhstolbovoy Island near the Kolyma River delta. Closer to the mainland coast, it does not breed west of Kittiwarken Rock in Chaun Bay (Kondratyev 1986). This bird never nests in single pairs; colonies can be as large as tens of thousands of birds, even in the Arctic Ocean. Preliminary estimates of kittiwake abundance were too low (e.g., Portenko 1973; Kondratyev 1975), and estimates have been significantly improved by more recent information. The total number of kittiwakes nesting on Wrangel and Gerald islands ranges from 70 000 to 175 000 birds annually (Stishov et al. 1991). The total nesting population in the Far East Arctic basin as a whole could reach 250 000 or 300 000 (A.Ya. Kondratyev, unpubl. data). On Big Diomede, 3400 kittiwakes were counted on cliffs in 1991, but not more than



1500 pairs nested there. In that same year, the population of the northern part of the Bering Sea was estimated to be about 900 000–1 100 000 birds (Kondratyev 1993b). In the Kamchatka Region, about 202 000 pairs nest along the eastern coast of the peninsula, and perhaps another 80 000 pairs nest along the western coast (Vyatkin, in press b). Some 40 000 pairs nest on the Komandorskiye Islands (Vyatkin and Artyukhin 1994; Artyukhin, in press b). In the northern Sea of Okhotsk, the largest kittiwake colony is on Talan Island, which holds 30 000–35 000 pairs (A.Ya. Kondratyev, unpubl. data). About 90 000 nest on the Kuril Islands, with the largest colonies on Ptichy, Antziferov, Raikoke, Matua, and some other islands. The most southern colonies on the Kurils are on Urup Island (Velizhanin 1978). The only nesting area on Sakhalin is Cape Terpeniya, which had 5000 birds in 1981 (Nechaev 1991). A colony on Tyuleniy Island, decimated by uncontrolled exploitation in the 1950s, has recently recovered its status. In 1947–1948, it held 1500 birds (Gizenko 1955), but by 1963 there were not more than 200 birds (Benkovsky 1968). From 1974 to 1976, it held about 300 birds (Nechaev and Timofeeva 1980), but numbers increased to 1680 in 1991, 1800 in 1992, 1900 in 1993, and 2200 in 1994 (Trukhin and Kuzin 1996). It is also a common breeding bird on some islands of the Shantars (Yakhontov 1977).

Nesting habitat

This species nests widely on the ledges of sea cliffs.

Breeding biology

This bird rarely forms single-species colonies; more often, it nests together with other seabirds, especially murres. Because of its circumpolar distribution, abundance, and behaviour, the Black-legged Kittiwake has become the most popular choice as an ecological indicator of the health of marine ecosystems. Consequently, its breeding biology and population dynamics are better known than those of other seabirds. During the last dozen years, the reproductive success of kittiwakes has continuously decreased in many areas of the North Pacific, including some of the Russian-Pacific regions. Unfortunately, we are uncertain of the reproductive situation or the population dynamics at kittiwake colonies because of a shortage of opportunities for observation. We can say only that there is poor reproductive success in the northern Bering Sea, near Bering Strait. On Big Diomede from 3 to 14 July 1991, only two chicks were found in a check of 203 occupied nests (Kondratyev et al. 1995); other nests were empty or contained unincubated eggs. In the Kamchatka Region, the Black-legged Kittiwake's reproductive situation looks more successful so far (Firsova 1978b; Artukhin, in press b; Vyatkin, in press b). However, in the northern Sea of Okhotsk, reproduction has dramatically decreased in the last 10 years (Kondratyeva 1993, 1994; Kondratyev et al. 1995). On the Talan Island colony, Black-legged Kittiwakes' productivity was observed to be 0.71–1.18 fledglings per nest with eggs in 1987–1989; in 1997, this parameter fell to 0.22 (L.F. Kondratyeva, unpubl. data). The clutch size was observed to be between 1.70 and 1.90 (n = 287) in 1987–1989 and 1.24 (n = 158) in 1997.

In the southern Far East, intensive nest building on Black-legged Kittiwake colonies was observed on Sakhalin Island at Cape Terpeniya on 12–17 June 1981; mass egg laying was observed from 15 to 27 June. Clutch size is two, rarely three, eggs (Nechaev 1991).

RED-LEGGED KITTIWAKE *Rissa brevirostris*

Distribution and abundance

In the Russian Far East, the Red-legged Kittiwake nests only on the Komandorskiye Islands. That population has been accurately measured at 16 172 pairs (Vyatkin and Artyukhin 1994; Byrd et al. 1997). There are 15 303 pairs

nesting on Bering Island, 440 on Ari Kamen, 29 on Toporkov Island, and 400 on Medniy Island. The trends in the population are unknown.

Nesting habitat

The Red-legged Kittiwake frequently nests with the Black-legged Kittiwake but uses much narrower ledges.

Breeding biology

Nest building and egg laying occur in June. Chicks are hatched in July and fledge in August–September (Firsova 1978a,b). No clutches with two eggs or second clutches have been found. Egg mortality ranged from 29% to 36%. On average, 47% of chicks fledged successfully (Yudin and Firsova 1988b; Artyukhin 1991; Vyatkin and Zelenskaya 1993).

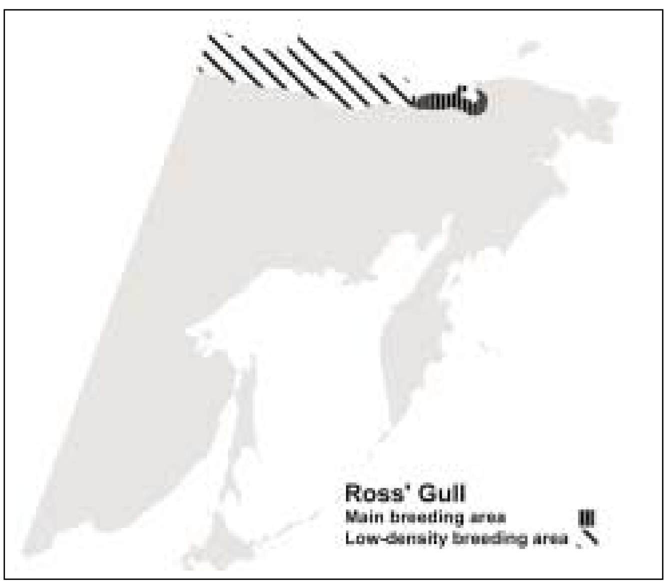
Threats and protection

Birds and nests may be destroyed by rock falls, and strong winds contribute to chicks falling out of the nests. The main predators are arctic fox, Glaucous-winged Gull, and Peregrine Falcon.

ROSS' GULL *Rhodostethia rosea*

Distribution and abundance

The Ross' Gull is endemic to Arctic Russia. The only regularly used nesting sites are in the Yano-Indigirskaya and Kolymskaya lowlands of Yakutia and the northwestern edge of the Russian Far East. Small numbers nest, incidentally,



eastward to the Chaun coastal lowlands. Elsewhere in the Arctic, single pairs nest occasionally in widely separated areas from Greenland (Hjort 1980; Kampp and Kristensen 1980) to Hudson Bay, Canada (Chartier and Cooke 1980), but no populations have become established. The total population in the Russian Far East is not more than 1000 individuals (Kondratyev 1991). Migrating and wintering gulls occur in all of the Far East seas southward to Japan (Nechaev 1969, 1991; Bogoslovskaya and Votrogov 1981; Kosygin 1985).[1]

Nesting habitat

Ross' Gull will nest farther inland than Sabine's Gull, occasionally up to 100 km inland. It uses two basic types of habitat: low shores and islets of large tundra lakes or very wet lowlands with large numbers of small ponds (no big lakes). The habitat includes wetlands with plants such as relatives of the bearberry (*Arctostaphylla* spp.), *Comarum* spp. (or *Potentilla* spp.), and the mare's tail or ginseng group (*Hippuris* spp.). In contrast, the solitarily nesting birds in Greenland often use areas of gravel (Hjort 1980).

Breeding biology

Most of the observations of nesting habits and productivity have been made in the Kolymskaya and Chaunskaya lowlands (Andreev and Kondratyev 1981; Andreev 1985; Kondratyev and Kondratyeva 1987). The Ross' Gull nests in small and very scattered colonies. It arrives on the nesting grounds in the Kolyma delta at the end of May, but not until the beginning of June in Chaun Bay. The peak of egg laying ranges from 1 to 15 June, and the first hatch ranges from 21 June to 6 July. Annual average clutch size ranges from 2.2 to 2.7. In extremely bad weather, the normal incubation period of 19–20 days can be prolonged (Andreev and Kondratyev 1981). At 18–20 days of age, the young gulls are already flying. Beginning about 20 July, adult birds leave the nesting areas and move to sea. Young gulls stay on the colonies about half a month more. Usually, productivity (fledglings per laid egg) is close to 20%.

Threats and protection

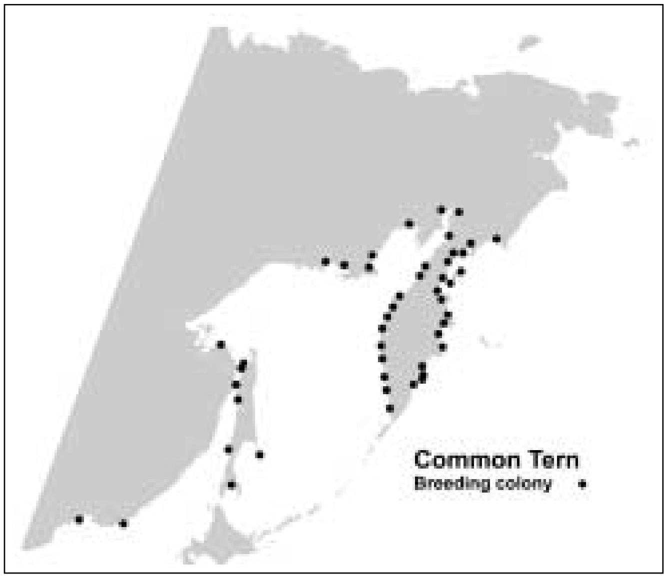
Breeding success depends mostly on weather conditions. Poor weather conditions intensify the impact of human disturbance and the activity of predators. The main threat is grazing by domestic reindeer.

COMMON TERN *Sterna hirundo*

Distribution and abundance

In the northern Far East, the Common Tern is distributed south of the Arctic Circle, only along the Kolyma River, and does not reach 67.5°N (Buturlin and Dement'ev 1934–1941). It nests widely around the southern Bering Sea, including the coastal area of the Koryak Highlands (Kishchinski 1980). Elsewhere in the Russian Far East, it nests along the sea coast as well as along inland rivers and lakes. Depending on food availability, it nests either in separate pairs or in colonies, often with gulls and other terns. In the Kamchatka Region, colonies of 500 pairs are known, but in the Magadan area, they do not exceed 100 nests. In the

[1] Johnson and Herter (1989) report 20 000–40 000 Ross' Gulls on passage.



Kamchatka area, preliminary estimates put the population at about 80 000 pairs, including colonial and solitary nesting birds (Lobkov and Golovina 1978). Along the northwestern Sea of Okhotsk, not more than 1000–1500 pairs nest (Kondratyev 1991). In the southern mainland, the Common Tern is a widespread breeding species, often sharing sites with the Aleutian Tern *S. aleutica* (Nechaev 1991; Poyarkov and Budris 1991). On Sakhalin Island, it nests mainly on the bays of the northeast coast, and the most numerous colony, in Nabilskiy Bay, holds 2500 pairs, according to counts in 1981, 1984, 1985, and 1986. There are colonies on the west coast of the Sea of Okhotsk, in Schastya Bay, with 4500–5000 pairs, according to counts in 1986 and 1987 (Babenko 1996), and at Mukhtel Lake in Aleksandra Bay, with 60–70 pairs in 1986. In Peter the Great Bay, there are 5–7 breeding sites, totalling about 300 pairs (Shibaev 1987). That population has been stable over the last 10–12 years.

Nesting habitat

On the coastline, the Common Tern inhabits grassy wetlands, river deltas with islets, and maritime sandbars.

Breeding biology

In the Kamchatka Region, the Common Tern arrives at nesting sites in the second part of May, and the first clutches are found at the end of May or in the first half of June. The peak hatch occurs in July, with fledging at the end of July or in the first half of August (Lobkov and Golovina 1978). In the Magadan area, the average clutch size is 2.1 (n = 36), and reproductive phenology is the same as in Kamchatka (A.Ya. Kondratyev, unpubl. data). On Sakhalin, mass egg laying begins in the second half of June. The clutch size is two or three eggs, rarely four or five. Hatching occurs in the middle of July (Nechaev 1991).

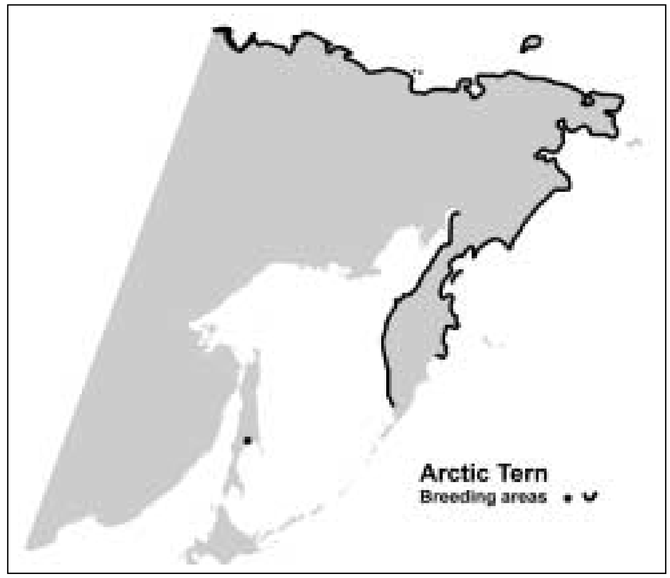
Threats and protection

In the Kamchatka Region, gulls, crows, and foxes are active predators, and there is also human egg collecting for food. Cattle grazing also causes damage in both Kamchatka and the Magadan area. In Schastya Bay, there are regular egg harvests (Babenko 1996).

ARCTIC TERN *Sterna paradisaea*

Distribution and abundance

The Arctic Tern is common but never numerous, nesting widely in the northern part of the Russian Far East, along the Arctic coast, on Wrangel Island, and on the Chukot Peninsula (Portenko 1973; Kondratyev 1978; Krechmar et al. 1991; Stishov et al. 1991). The southern boundary of the nesting range generally coincides with the northern limit of the Common Tern. Zones of sympatry are known on the Koryak Highlands, on the Kamchat Peninsula, and in Penzhinskaya Gulf. On Sakhalin Island, the only breeding site, at Nevskoe Lagoon, was found in 1980 and is one of the most southern nesting sites in the Pacific basin. Three pairs nested there on a small flat island, with Aleutian and Common terns (Voronov and Neverova 1987).



In the Arctic Far East, where it nests only in single pairs or small groups (2–3 pairs), a preliminary estimate puts the population at about 9000 birds (Kondratyev 1991). In Kamchatka, where colonies of several tens of pairs can be found, the population is likely not above 1000 pairs.

Nesting habitat

The Arctic Tern prefers sandy beaches or spits with scattered patches of grass. Rarely, it nests in colonies of gulls or on the grassy shores of lakes.

Breeding biology

The Arctic Tern has been comparatively well investigated in Arctic areas (e.g., Portenko 1973; Kondratyev 1978; Tomkovich and Sorokin 1983; Stishov et al. 1991). It reaches the breeding grounds at the end of May or the beginning of June. Egg laying starts in the first half of June, and fledging is usually complete by 1 August. Migrating flocks of terns can be observed along the Arctic coast from the beginning of September. In the Kamchatka Region, chick hatching was observed from the end of June to the beginning of July (Lobkov 1986). The clutch size on the western Chukotka coast was 2.0 (n = 71); three-egg clutches were found only twice (Krechmar et al. 1991).

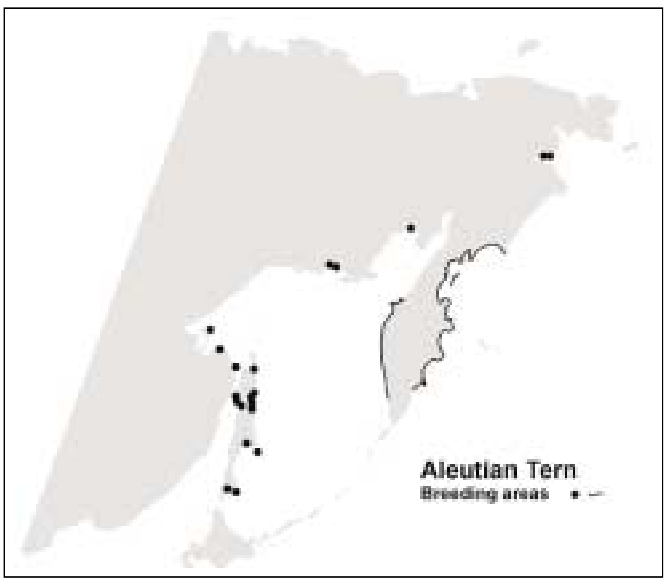
Threats and protection

In Chukotka, most damage to Arctic Terns comes from predation by dogs or grazing by domestic reindeer. In the Kamchatka Region, cattle grazing and egg collecting occur.

ALEUTIAN TERN *Sterna aleutica*

Distribution and abundance

In the Russian Far East, the Aleutian Tern is distributed from the Gulf of Anadyr in the north to Sakhalin Island in the south. It is a widespread breeder along the coast of the Koryak Highlands, eastern Kamchatka (Lobkov 1976; Ostapenko et al. 1977). In the northern Sea of Okhotsk, it nests on the western Kamchat Peninsula from Cape Lopatka north to the Tigil River. Along the northwestern coast of the Sea of Okhotsk, there are colonies in Shelikhov Gulf and in the Armanskaya lowland (Kondratyev 1996). The most recent observations show that this species nests in the northern Far East over a wider area than earlier believed, and new nesting areas may well be found in the near future. Colonies in the Kamchatka Region are usually fewer than 300 pairs, but the population is stable, near a total of 4000 pairs (Lobkov 1986). Information from other areas of the northern Far East is too scanty to allow a population estimate.



In the southern part of the region, the Aleutian Tern nests in only three areas: Sakhalin Island, the Shantar Islands, and the west coast of the Sea of Okhotsk in Schastya Bay and Aleksandra Bay (Mukhtel Lake). The total population of Sakhalin is 2300 pairs, based on counts from 1976 to 1987 (Nechaev 1991). The largest discrete colonies occur along the northeastern coast of Sakhalin; 500 pairs nested on Lyarvo Island in Dagi Bay in 1976, and 200 in 1984 and 1985; 600–700 pairs nested on Chayka Island in Nabilskiy Bay (Nechaev 1991). There are some smaller colonies in other parts of Sakhalin. The only colony reported from the Shantar Islands is a group of 300 birds, found in 1991, on Bol'shoy Shantar Island (Roslyakov and Roslyakov 1996). In 1987, colonies with a total population between 700 and 900 pairs were found in Schastya Bay on Tudum, Kevoy, Baydukov, Dyrgush, and Maliy Langr islands (Babenko 1996).

Nesting habitat

The Aleutian Tern nests on flat, grass-covered islands in shallow bays, lagoons, mouths of rivers, or marshes and on bare sand or dunes (Nechaev 1991; Babenko 1996; Kondratyev 1996). In Schastya Bay, colonies, as a rule, occupy the central part of the islands.

Breeding biology

On Sakhalin Island, most eggs are laid in the second half of June and hatch in mid-July (Nechaev 1991). In high-density areas, the minimum inter-nest distance is 1–2 m. Clutch size is one (32%) or two (68%) eggs (n = 153) (Babenko 1996), rarely three eggs (Nechaev 1991). The young terns fledge at 25 days, with the first flying at the end of July or in early August (Lobkov and Golovina 1978; Kaverkina 1986).

Threats and protection

The main threats in the Kamchatka Region include egg collecting and predation by red fox, Carrion Crow, or gulls. On Sakhalin, there is predation by Carrion and Large-billed crows, Northern Eagle-Owl, red fox, brown bear *Ursus arctos*, and wolverine (Nechaev 1991). However, the main threat overall is egging and disturbance, especially in those colonies near areas with settlements or petroleum development. All colonies on Lyarvo and Chayka islands were included in bird sanctuaries (Nechaev 1991).

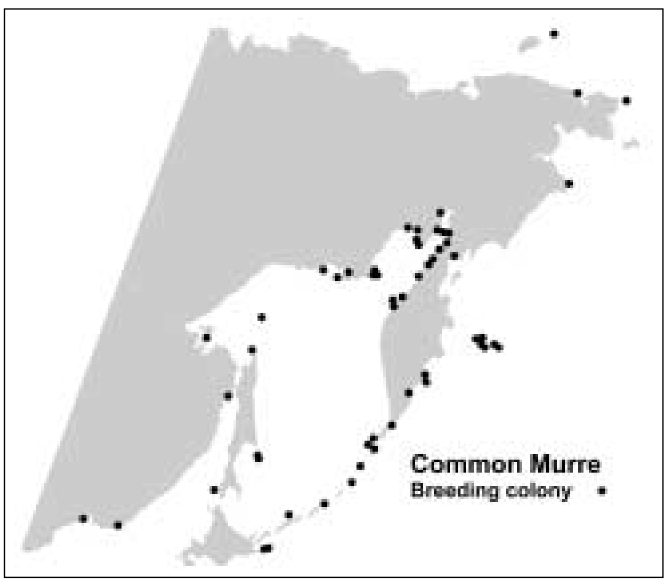
DOVEKIE *Alle alle*

The extent of nesting by the Dovekie in the Russian Far East is unknown, but it may nest on Big Diomede. It definitely nests on Little Diomede, 2.5 km east, and has been observed along the coast of Big Diomede. Unfortunately, the seabird colonies of Big Diomede have not received detailed attention. Observations from 3 to 14 July 1991 were not sufficient for thorough study of such a large and important site (Zubakin et al. 1992; Kondratyev et al. 1995). There are many summer aggregations of Dovekies in other parts of the Far East, from Gerald Island in the high Arctic (Stishov et al. 1991) to Talan Island in the northern Sea of Okhotsk (Kondratyev et al. 1992).

COMMON MURRE *Uria aalge*

Distribution and abundance

The Common Murre occurs throughout the Russian Far East, including the Arctic Ocean; however, it is most abundant in the North Pacific. In the Arctic basin, a few hundred nest on Wrangel and Gerald islands (Stishov et al.



1991), with a total population in the basin of about 20 000 birds (Kondratyev 1991). This number reflects a recent expansion of its range and an increase in numbers, so that new breeding sites extend westward 1000 km to Shalaurov Island in the East Siberian Sea (Kondratyev 1978, 1993a). At colonies shared with the Thick-billed Murre *U. lomvia*, Common Murres now form about 10% of the murres present (Kondratyev 1993a).

Similarly, the Common Murre appears to have become a larger component of mixed colonies in the northern Bering Sea. Together, the two murres made up about 66% of the birds breeding on Big Diomede in 1991, and about 10 000 were Common Murres. At this time, there are an estimated 1.2 million murres in the Bering Sea, but few reports distinguish between the two species, and no individual population estimate would be credible (Kondratyev 1993a).

In eastern Kamchatka, the Thick-billed Murre may be increasing. It has come to outnumber Common Murres in mixed colonies, but the number of Common Murres is stable near 125 000 (Vyatkin 1986, in press b) — 50 000 pairs on the west coast, and 55 400 on the Komandorskiye Islands (Artyukhin, in press b).

In the northern Sea of Okhotsk, the population of Common Murres is estimated to be 600 000 birds (Kondratyev 1991), and there are a number of large colonies in Gizhiginskaya and Tauyskaya bays.

In the southern Far East, the Common Murre is widespread and abundant in the Kuril Islands, with about 300 000 birds (Velizhanin 1978). It is a common breeder on the Shantars (Yakhontov 1977; Roslyakov and Roslyakov 1996). Small numbers nest on Sakhalin at Cape Terpeniya and Cape Elizaveta (Gizenko 1955); in 1981, however, this species was not observed at Cape Terpeniya (Nechaev 1986), and Cape Elizaveta was not surveyed. In 1949, 10 000–15 000 birds of both species occurred on Moneron Island (Gizenko 1955); in 1973 and 1976, however, there were only 140, and in 1991, 520 (Nechaev 1975; Shibaev and Litvinenko 1996). Similarly, the murre population on Tyuleniy Island has been greatly reduced since the 1940s, and the cause is clearly commercial egging and disturbance. The numbers have fallen from 628 000–650 000 birds in 1947–1948 (Gizenko 1955) to a low near 30 000 birds in 1960 (Kartashev 1963). The population increased to 100 000 birds in 1965 (Bychkov 1975) and has slowly increased from 100 000–150 000 birds in 1969–1976 (Nechaev and Timofeeva 1980) to 160 000–180 000 birds in 1989–1994 (Trukhin and Kuzin 1996).

In 1982, 600–700 pairs nested on the mainland coast of the Sea of Japan in Peter the Great Bay and probably in the north parts of Tatarsky Strait (Shibaev 1987).

Nesting habitat

This species nests in the Far East mostly on cliff shelves. The colonies on Tyuleniy Island, where murres nest on the flat top of the island, are atypical for the region.

Nesting biology

In the Kamchatka Region, Common Murres arrive at the colonies in the beginning of May and begin egg laying in the first half of June. Chicks fledge in the second half of August (Kharkevich and Vyatkin 1977). In the northern Sea of Okhotsk, in the Talan Island colonies, egg laying begins between 5 and 15 June, as a rule. In recent years, the breeding success has ranged from 0.43 to 0.74 fledglings per egg, and the population productivity has varied from 0.13 to 0.70 fledglings per nest site.

On Moneron and Tyuleniy islands, murres arrived in the first part of May 1948, and mass egg laying occurred in the middle of June. In 1947, chicks hatched in the first 10 days of July (Gizenko 1955).

Diet

On Tyuleniy Island, fish forms the basis of the chicks' diet (83.6% in 1980 and 87.3% in 1981, n = 36 872): capelin, young cod (Gadidae), spotted snake-blenny or daubed shanny, also known as langbarn *Leptoclinus maculatus*, and sand lance (Mikhtar'yantz 1986).

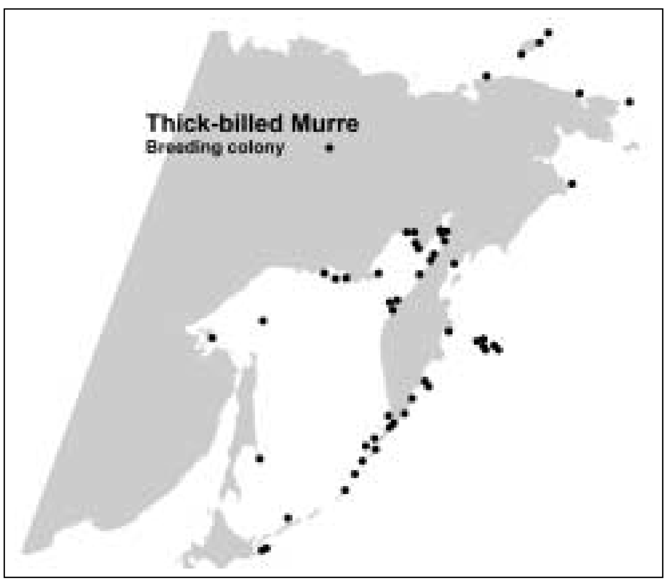
Threats and protection

Historically, the main threat in some localities has been uncontrolled egg collecting. On Tyuleniy Island, 150 000 eggs were collected in 1948, 87 000 in 1949, 60 000 in 1950 (Gizenko 1955), and 3000 in 1958 (Benkovsky 1968). The annual subsistence harvest of 5000–8000 eggs by local people lasted until the 1970s. Also on Tyuleniy Island, murres competed with fur seals *Callorhinus ursinus* for space and were displaced from rookeries on the grassy flat top of the island (Bychkov 1975). At present, Tyuleniy Island is protected by a 50-km buffer zone. Fishing, boat traffic, and overflights by aircraft are prohibited, and the murre colonies are physically protected from disturbance by a fence (Trukhin and Kuzin 1996).

THICK-BILLED MURRE *Uria lomvia*

Nesting and abundance

In Arctic seas, the Thick-billed Murre is more widespread and more abundant than the Common Murre; however, the western boundary of its distribution in the Arctic Far East is also at Shalaurov Island in the East Siberian Sea (Kondratyev 1986). The largest colonies of Thick-billed Murres are found on Wrangel, Gerald, and Kolyuchin islands (Kondratyev 1986; Kondratyev et al. 1987; Stishov et al. 1991). Kondratyev (1991) made a preliminary estimate for the total population in the Arctic portion of the Far East of 200 000, birds with interannual variation likely making the actual number of breeding birds fluctuate greatly (Stishov et al. 1991). More recent data suggest that the population lies between 200 000 and 300 000 birds (A.Ya. Kondratyev, unpubl. data). In mixed murre colonies in the Arctic, Thick-billed Murres are prevalent at 70–95%. On the Bering Sea coast of Chukotka, the proportion of Thick-billed Murres ranges from 34% on Big Diomede to just a few percent in southern Chukotka (Kondratyev et al. 1995).



The Thick-billed Murre is a widespread species in the Kamchatka Region, with a total of 370 000 nesting along the eastern coast of the peninsula, 160 000 along western Kamchatka (Vyatkin, in press b), and 164 000 on the Komandorskiye Islands (Artyukhin, in press b). In the northern Sea of Okhotsk, Thick-billed Murres make up 10–20% of mixed murre colonies, and the total number is estimated at 300 000 birds (Kondratyev 1991).

In the southern Far East, there are many colonies of Thick-billed Murres on the southern and middle Kuril Islands and also on the Lesser Kuril Archipelago; however, the total Kuril population is only about 35 000–50 000 birds (Velizhanin 1978). Sakhalin Island has colonies at Cape Terpeniya of approximately 1000 pairs (in 1981) (Nechaev 1991) and others at Cape Shmidta and Cape Elizaveta (Gizenko 1955). In the 1940s, Thick-billed Murres nested on Moneron Island (Gizenko 1955), but none was found in 1973, 1976, or 1991 (Nechaev 1975; Shibaev and Litvinenko 1996). On Tyuleniy Island, 300–800 birds nested from 1963 to 1965 (Bychkov 1975) and again in 1966. From 1974 to 1976, only about 100 birds nested there (Golovkin and Georgiev 1970; Nechaev and Timofeeva 1980), and only 8–16 pairs from 1989 to 1994 (Trukhin and Kuzin 1996). On the Shantar Islands, small nesting colonies of tens of pairs were found on Ptichy, Utichiy, Sukhotina, Prokof'eva, and other islands (Dulkeit and Shulpin 1937; Yakhontov 1977; Roslyakov and Roslyakov 1996).

Wintering

This species spends the winters in Kuril waters (Velizhanin 1972).

Nesting habitat

The Thick-billed Murre nests on much the same type of sea cliff as the Common Murre but appears to prefer narrower ledges.

Nesting biology

In the Arctic basin, Thick-billed Murres come to the nesting colonies in early or mid-May (Kondratyev 1978; Stishov et al. 1991), but egg laying begins much later, at the end of June. In the northern Sea of Okhotsk, egg laying began between 5 and 17 June in different years. Productivity there was 0.31–0.76 fledglings per egg laid in the 1990s. In 1996, the murres suffered a breeding failure; few attempted to breed, and, among those that did try, productivity fell to 0.08 fledglings per egg laid (A.Ya. Kondratyev, unpubl. data). At Cape Terpeniya in 1981, the peak of egg laying was 18–25 June (Nechaev 1991).

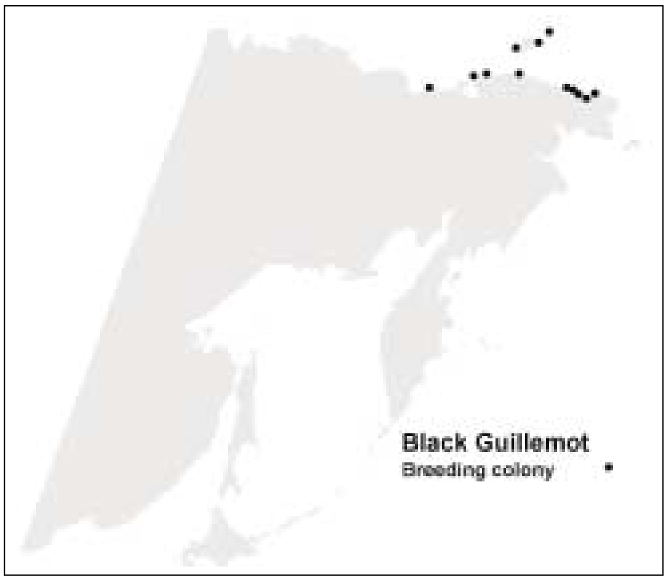
Threats and protection

In the Arctic, breeding success is influenced by the predatory activity of Glaucous Gulls; in some years, all the fledglings disappear en masse because ice covers the water near the colonies and the young birds cannot reach the open water (Kondratyev 1978).

BLACK GUILLEMOT *Cepphus grylle*

Distribution and abundance

In the Arctic portion of the Russian Far East, the Black Guillemot nests on all of the islands and along the mainland from Cape Shelagskiy in the west to Bering Strait (Portenko 1973; Tomkovich and Sorokin 1983; Kondratyev 1986; Stishov et al. 1991). It has not been found nesting in the Pacific basin. The total breeding population in the Arctic region has been preliminarily estimated at 3000 birds (Kondratyev 1991), but this number is tentative, and the total number of Black Guillemots could be much higher. On Wrangel Island, many more birds arrive on the nesting grounds in spring than will actually nest later in the year (Stishov et al. 1991). On nearby Gerald Island, in 1981, 3000–4000 were estimated on 11 May, but only about 100 birds were nesting on 7 July (Pridatko and Lutsyuk 1986). The total number of guillemots in the Wrangel Island area in spring is about 6000–10 000 birds (Pridatko 1986).



Nesting habitat

The Black Guillemot does not form big colonies; nesting groups usually do not exceed 10–15 pairs, and there are frequent solitary nests. The nests can be found in cliff crevices and under the rocks in the upper part of beaches.

Breeding biology

Breeding guillemots begin to occupy nest sites in the second 10 days of June, as soon as these are free of snow. Egg laying begins at the end of June (Kondratyev et al. 1987; Stishov et al. 1991). The incubation period is 26–30 days (Tatarinkova and Golovkin 1990), and chicks stay at the nests about one month. At fledging time, their average body mass is 94% that of the adults (range 80–110%) (Stishov et al. 1991; Kondratyev 1996).

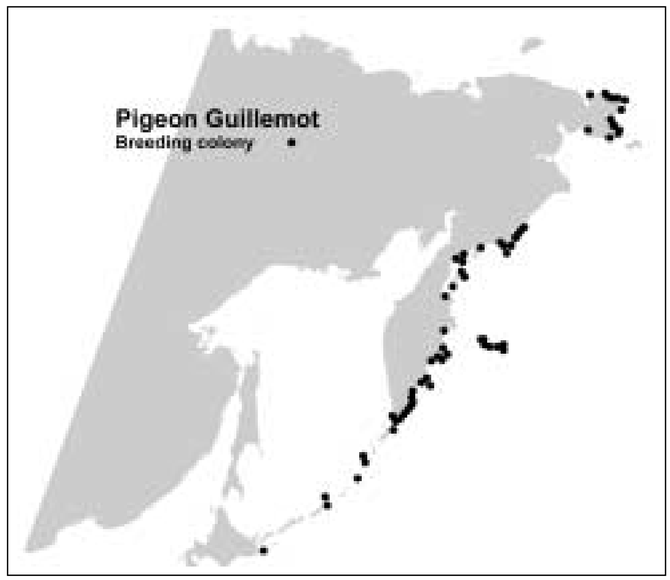
Threats and protection

The Black Guillemot has few enemies on the nesting grounds that can strongly influence its breeding success; food ability and weather conditions are probably the most important factors in productivity of this species.

PIGEON GUILLEMOT *Cepphus columba*

Distribution and abundance

The northern limit of the nesting range of the Pigeon Guillemot is in the Chukchi Sea basin, where it has a narrow sympatric zone with the Black Guillemot (Kondratyev 1993a; Kondratyev et al. 1995). The western nesting limit of their range is Kolyuchin Island, Cape Onman, and Cape Keleneut, where the Pigeon Guillemot breeds in single pairs at sites shared with the Black Guillemot (Kondratyev et al. 1995). Along the coast of the Chukot Peninsula and southward, it is widely dispersed through the Kuril Islands. Stepanyan (1975) recognized three subspecies in the Russian Far East, based on differences in body mass, wing coverts, and colour of the wing lining feathers: *C. c. columba*, nesting along the Chukot and Koryak highlands, along the coast of the Kamchat Peninsula, and on the northern Kuril Islands; *C. c. kaiurka* (similar colouring but less body mass than *C. c. columba*), nesting in the Komandorskiye Islands; and *C. c. snowi* (the same size as *C. c. columba*, but with brown wing feathers), nesting on the Kuril Islands.



The Pigeon Guillemot is a very common seabird on islands and along the mainland coast of the Bering Sea, although it never forms big communities. On Big Diomede, the population reaches 700–750 pairs (Zubakin et al. 1992; Kondratyev et al. 1995). On Karaginsky Island and along the

Kamchat Peninsula coast, there are about 1400 nesting pairs (Vyatkin, in press b), and on the Komandorskiye Islands, the population reaches 1600 pairs (Artyukhin, in press b).

In the southern Far East, this species nests only on the Kuril Islands, but in two subspecies: *C. c. columba* and *C. c. snowi*, which were described by Stejneger (1885) based on specimens from Raikoke Island. The former subspecies nests only on the northern Kurils, from Onekotan Island northward, and the latter inhabits all of the islands but is most common in the central part, from Onekotan Island in the north to Urup Island in the south. It appears to be non-migratory on the Kurils (Velizhanin 1977c). In 1963, not more than 10 000 Black and Pigeon guillemots nested on the Kurils; more than half of them were Pigeon Guillemots (Velizhanin 1977a).

Nesting habitat

In the northern Far East, the Pigeon Guillemot nests in the crevices of cliffs or spaces under the rocks at the foot of cliffs. In the southern part of the region, it nests on the rocky shores of islands, breeding near offshore rocks and among reefs in deep and quiet bays with rich patches of seaweed (Gizenko 1955). *Cepphus c. snowi* makes its nest between boulders and in the crevices of rocks usually 3–4 m up a slope or cliff face, and the nest itself is 20–50 cm from the entrance (Gizenko 1955; Velizhanin 1977a).

Breeding biology

In the Kamchatka Region, the Pigeon Guillemot arrives at nesting colonies in the second half of May, and chicks hatch in the second half of July (Kharkevich and Vyatkin 1977). Copulation in *C. c. snowi* was observed beginning around 11 June, and egg laying occurred in the second half of that month. On 29 June 1974, 11 eggs were freshly laid from 17 collected on Lovushki Island. There is usually one egg in the nest, rarely two. The small downy chicks were recorded in the middle of July; chicks in downy plumage with growing primaries were found on 15 August.

Diet

In the northern Far East and Kamchatka, the Pigeon Guillemot feeds on bottom and inshore fish, crustaceans, and squid. In the southern Far East, details of the diet are unknown.

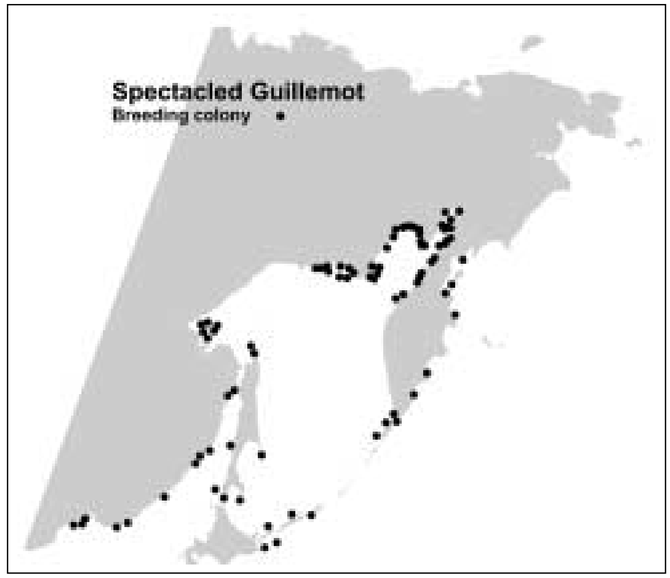
Threats and protection

According to observations in Kamchatka, oil spills, predation, and bird mortality in gill nets are the main threats to these birds.

SPECTACLED GUILLEMOT *Cepphus carbo*

Distribution and abundance

The Spectacled Guillemot is a common breeder in the northern Sea of Okhotsk and the southern part of the Far East. Its nesting range is comparatively narrow, lying between 40°N and 60°N, essentially farther south and west



on the continent than other members of the genus *Cepphus* in Asia. Very small numbers, about 15 pairs, nest on the eastern coast of Kamchatka (Vyatkin, in press b). On western Kamchatka, about 1000 pairs nest north of Cape Yuzhniy (Lobkov and Alekseev 1987; Shibaev 1990a). Along the coast of the northern Sea of Okhotsk, the Spectacled Guillemot is widely dispersed in suitable habitats but never forms large colonies, often nesting in single pairs. This behaviour is especially common in the northern part of its range, where the average nesting density reaches about 2–3 pairs/km^2. The number of birds in colonies is usually several tens and rarely several hundreds of pairs.

In the southern part of the Far East, the Spectacled Guillemot nests on the Shantar and Kuril islands, on Sakhalin Island, and along the coast of the Sea of Japan from Tatarsky Strait to Peter the Great Bay. It is most abundant on the Shantar Islands. The number of birds and the number of separate colonies in the archipelago vary strongly from year to year. For instance, in 1971, 1978, and 1982, 18 000–20 000 pairs nested on the Shantars, with major colonies of 7000 and 3000 pairs on Utichiy and Ptichy islands, respectively (Roslyakov 1986). However, in 1991 and 1992, the total breeding population on the southwestern coast of the Sea of Okhotsk was “not more” than 35 000 pairs, of which 17 500 pairs nested on Utichiy Island (Roslyakov 1994). On the Kuril Islands, the population of Spectacled and Pigeon guillemots combined does not exceed 10 000 individuals (Velizhanin 1977a,c). The Sakhalin population is probably fewer than 200 pairs (Nechaev 1986), because the coasts of Sakhalin are generally unsuitable for this species. There are many small colonies along the mainland coast of the Sea of Japan; 2500 pairs were counted along 440 km of coast of North Primorye (Elsukov 1984). Fewer than 6000 pairs nest in Peter the Great Bay, with most on Furugelm Island (Shibaev 1987, 1990a). That site held 4362 birds in 1979, 3300 in 1982, 3305 in 1984, 2040 in 1989, and 2500 in 1993. The main reason for this 43% decrease since 1979 is apparently climato-hydrologic changes in the North Pacific in this period (see Chapter 4).

Wintering

The Spectacled Guillemot spends winter along the eastern coast of Kamchatka and along the Kuril Archipelago (Velizhanin 1977a,c). It also winters along the mainland coast of the Sea of Japan (Elsukov 1984; Shibaev 1990a).

Nesting habitat

The Spectacled Guillemot nests on rocky coasts of islands and the mainland. It breeds in rock crevices and caves but prefers to build nests among boulders on talus slopes.

Breeding biology

In the northern Sea of Okhotsk, Spectacled Guillemots arrived at nesting colonies just after breakup of the ice, at the end of April and beginning of May (Kondratyev 1994b), but egg laying was delayed until after 10 June. In Peter the Great Bay, egg laying has been recorded in mid-May (Nazarov and Labzyuk 1972; Shibaev 1990a). Birds normally lay clutches of two eggs. Hatching lasted from 30 May to 1 July in 1976 and from 8 June to early July in 1983, but the peak of hatching that year was on 22–23 June (Shibaev 1990a). Hatching on the Shantar Islands was in late July (Yakhontov 1977). The peak of chick departures in South Primorye is mid-July (Shibaev 1990a); in the northern Sea of Okhotsk, chicks did not fledge until the second half of August (Kondratyev 1994b).

Diet

In the Kamchatka Region in the nesting season, the Spectacled Guillemot feeds on inshore fish, squid, and crustaceans. In the northern Sea of Okhotsk, the summer diet contained 70% sculpins (*Triglops* spp.), 17.5% other fish, and 12.5% various invertebrates. In the first days after hatching, the diet of chicks in Peter the Great Bay consisted of polychaete worms, small bullheads, ship-borers (Pholididae), half-beaks (*Hemiramphus sajori*), and, rarely, decapods (Nazarov and Labzyuk 1972). On Sakhalin Island, the diet of chicks contained Eurasian smelt, Pacific sardine, and Pacific herring (Gizenko 1955).

Threats and protection

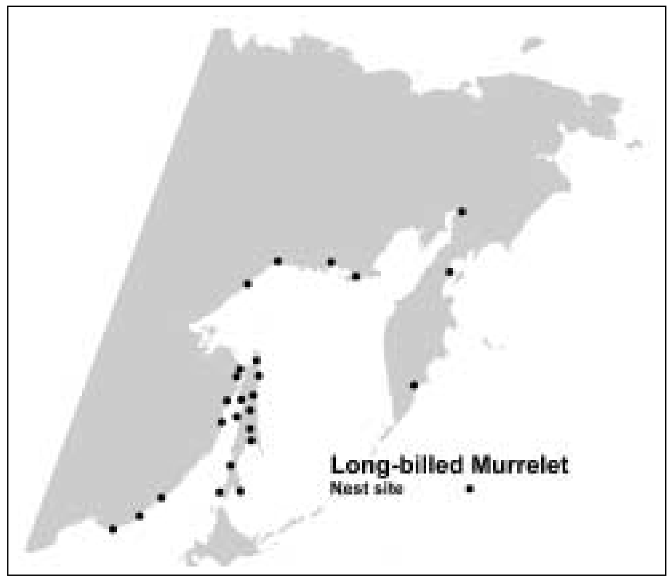
In the northern Sea of Okhotsk, the main predators on Spectacled Guillemots at nesting colonies are probably gulls and red foxes. There are also reports of predation by Peregrine Falcons and owls. In Primorye, the Peregrine Falcon and Northern Eagle-Owl are the main predators of this guillemot. In Peter the Great Bay, remains occurred in 5.9% of Peregrine Falcon pellets (Nazarov and Trukhin 1985). In Lazo Reserve, they occurred in 29.9% of 67 Northern Eagle-Owl pellets (Kolomijtsev and Poddubnaya 1985). The Large-billed Crow is adept at extracting eggs and chicks from shallow burrows. Black-tailed Gulls kleptoparasitize incoming birds (Litvinenko 1980). Other threats include red fox, Siberian weasel *Mustela sibirica*, yellow-throated marten *Martes flavigula*, and sable *Mustela zibellina* (Gizenko 1955; Labzyuk 1975).

Unfavourable climatic conditions frequently cause great losses: in 1983, after several typhoons, all fledglings perished in a sample of 30 nests on Furugelm Island (Shibaev 1990a). Negative human influence is mostly through the disturbance of birds at nesting sites and coastal oil spills.

LONG-BILLED MURRELET *Brachyramphus perdix*

Distribution and abundance

The Asian race of the Marbled Murrelet *B. m. perdix* has recently been raised to the status of discrete species as the Long-billed Murrelet *B. perdix*. It is one of the rarest and most poorly known seabird species in the Russian Far East.



The nesting areas are distributed approximately between 40°N and 60°N. The observation of nests is very rare, and the breeding area is described primarily on expectations from summer occurrence. In the Russian Far East, the Long-billed Murrelet is distributed southward from Karaginsky Gulf on eastern Kamchatka and Penzhinskaya Gulf in the northern Sea of Okhotsk to Sakhalin Island and the Bikin River in southern Primorye (Belopolski and Rogova 1947; Averin 1948). On the Komandorskiye Islands, it is very rare, and nesting is unconfirmed but likely (Taczanowski 1891; Hartert 1920; Yu.B. Artyukhin, unpubl. data). In the coastal waters of Kamchatka, the breeding season population is about 9000 birds, 7000 along eastern Kamchatka (Vyatkin, in press c). In some areas, Long-billed Murrelet density at sea reached 8.4 birds/km^2. In other Far East areas, the frequency of this species is usually lower; however, it can be moderately abundant locally. For example, in Nagaeva Gulf near Magadan, the Long-billed Murrelet's summer density reaches 6.5 birds/km^2 (A.Ya. Kondratyev, unpubl. data).

In the southern Far East, this murrelet nests on the Shantar Islands (Roslyakov 1986) and probably along the west coast of the Sea of Okhotsk (Babenko and Poyarkov 1987), on Sakhalin Island (Nechaev 1991), on the northwest coast of the Sea of Japan (Belopolski 1955; Elsukov 1984; Labzyuk 1987; Shibaev 1990b), and on the middle and southern Kurils (Velizhanin 1977a; Gluschenko 1988).

Throughout the south, it is scarce (Velizhanin 1977a; Shibaev 1990b; Nechaev 1991). It is most numerous on the west coast of the Sea of Okhotsk between the mouth of the Amur River and the Shantar Islands (Babenko and Poyarkov 1987) and reached 0.3–2.0 birds/km along the coast in July and August 1984–1985. The total number in this region is 300–400 pairs. In Amur Liman, 104 birds (0.2 birds/km) were recorded on 14–22 July 1982, along a census route of 493 km (Shibaev 1990b). More than 100 pairs appeared to be nesting on Bol'shoy Shantar Island in 1986 (Roslyakov 1986).

Nesting habitat

In the breeding period, the Long-billed Murrelet is closely associated with the distribution of taiga along the uplands of the Pacific coast (Kishchinski 1968). It forages in inshore waters, but it is often recorded on coastal lagoons and freshwater lakes (Lobkov 1986; Babenko and Poyarkov 1987; Nechaev 1991). Only two nests have been found in the northern Sea of Okhotsk (Kuzyakin 1959; Kondratyev and Nechaev 1989). Both were situated on the branches of a larch (*Larix* sp.). In the Kamchatka Region, the Long-billed Murrelet arrives in spring in April or May. One fledgling was observed on Azabache Lake at the end of July (Vyatkin 1981); in the northern Sea of Okhotsk, a young Long-billed Murrelet with remains of down in the plumage was observed on 9 September (Kondratyev et al. 1992).

In the southern Far East, the Long-billed Murrelet nests in coniferous forests (Labzyuk 1987; Shibaev 1990b; Nechaev 1991). Two nests were located in larches, about 2.5–5.0 m above the ground.

Breeding biology

Eggs and hatchling birds were found on 21 June in the South Primorye (Labzyuk 1987) and on 19 June on Sakhalin Island (Nechaev 1991). Adult birds carrying small fish for their nestlings were observed flying to the coast in the Amur estuary on 14 and 21 July 1982 (Shibaev 1990b).

Diet

Murrelets feed in fresh, brackish, and saline coastal waters. In the Amur estuary, they have been seen feeding at a depth of 1–10 m in turbid water of very low salinity (Shibaev 1990b).

Threats and protection

At present, there are no problems with the protection of Long-billed Murrelet, because the species nests mainly in poorly developed regions. However, problems may arise in the near future in connection with petroleum extraction along the Far East shelf, especially on Sakhalin Island, and the felling of mature forest in some coastal regions.

KITTLITZ'S MURRELET *Brachyramphus brevirostris*

Distribution and abundance

In the Russian Far East, Kittlitz's Murrelet is distributed on both sides of Bering Strait in the Arctic and along the Pacific coast, between 67°N and 55°N. Along the Arctic coast, it occurs east of 180° longitude, including the coastal

waters of Wrangel Island (Stishov et al. 1991). In the North Pacific, it congregates in nearshore waters during the nesting period and has been observed along the Chukotka coast to Kresta Bay (Stepanyan 1975), along the coast of the Koryak Highlands (Kishchinski 1980), and along eastern Kamchatka to Kamchatskiy Gulf in the south (Vyatkin, in press d). In the northwest Sea of Okhotsk, it occurs in Shelikhov Gulf to Koni Peninsula in the south. The actual nesting range is still almost unknown because of a shortage of information. Four nests have been found in the region to date: one on the Chukot Peninsula, near Provideniya Bay (Tomkovich and Sorokin 1983); one in northeastern Kamchatka (Smetanin 1992); and two in the northwestern Sea of Okhotsk, one in Shelikhov Gulf and one in Babushkina Bay (Kishchinski 1968; Andreev and Golubova 1995). There is circumstantial evidence that Kittlitz's Murrelets nest in Kolyuchinskaya Bay as well as along the Arctic coast of Chukotka near Cape Billings and Cape Shmidta (Kondratyev 1986).

The total number of Kittlitz's Murrelets in the Asian population is unknown. The total number in the Arctic basin is definitely fewer than 1000 birds. In nearshore waters of Chukotka, they are comparatively common around Wrangel Island (Stishov et al. 1991) and also in Longa Strait and Kolyuchinskaya Bay (Kondratyev 1986). In the northern Bering Sea, Kittlitz's Murrelet is quite rare, although there are small concentrations (Dorogoy 1995). It is more common along northeastern Kamchatka, where their density was estimated at 0.8 birds/km^2 within 3 km of shore (Vyatkin, in press d). About 5000 birds have appeared at the Kamchatka River delta in the south during the nesting period. The number nesting in the northwestern Sea of Okhotsk is evidently small.

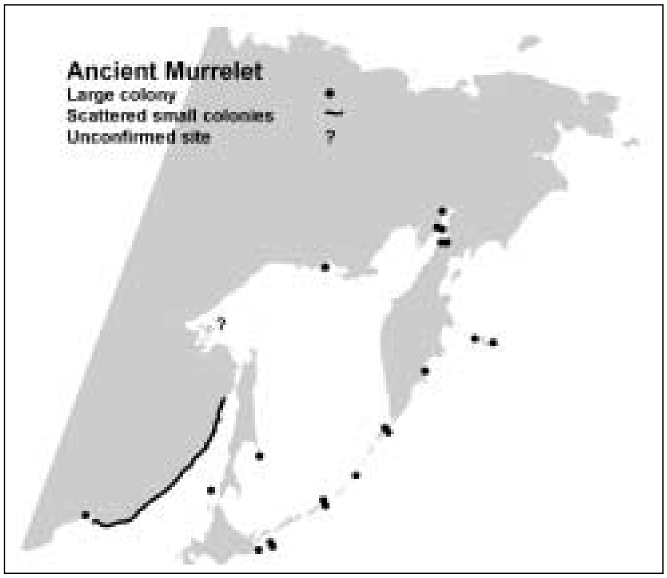
Nesting habitat

The nests that have been found in the region were situated in the alpine zone of the mountains at an elevation of 230–1070 m above sea level and occurred on the ground in stony areas.

ANCIENT MURRELET *Synthliboramphus antiquus*

Distribution and abundance

There are a number of discrete Ancient Murrelet nesting areas in the Russian Far East. The colony on Starichov Island in Avachinskaya Bay, in eastern Kamchatka, has 6500 pairs (Vyatkin 1983, 1986). On the Komandorskiye Islands, there are several hundred pairs (Artyukhin, in press b). In the northern Sea of Okhotsk, there are reports of nesting on several small islands in the Penzhinskaya Gulf: Krayniy, Vtoroy, Dobrzhanskogo, Rovniy, etc. (Yakhontov 1973, 1974). The largest Ancient Murrelet colony in the Asian part of the North Pacific, on Talan Island in Tauyskaya Bay, holds 12 000–13 000 pairs (Kondratyev 1993b).



In the southern Far East, about 3000 birds inhabit the Kuril Islands (Velizhanin 1972, 1978). On Sakhalin Island, the nesting has been confirmed on only two islands: Tyuleniy Island (Nechaev and Timofeeva 1980) and Moneron Island (Shibaev 1990b). The Ancient Murrelet occurs on the Shantar Islands in the breeding period, but no breeding sites have been found (Dulkeit and Shulpin 1937; Yakhontov 1977; Roslyakov and Roslyakov 1996). Scattered small colonies are known on the continental coast of the Sea of Japan from De-Kastri Bay to the southern boundary of Russia (Schrenk 1860; Labzyuk 1975; Elsukov 1984). In Peter the Great Bay, it inhabits four or five islands, and the largest colony, on Verhovsky Island, had about 500 pairs in 1976 (Shibaev 1987). About 100 pairs have been reported on Karamzin Island (Labzyuk et al. 1971).

Wintering

The Ancient Murrelet spends winter on the coastal waters of the Komandorskiye Islands, along the Kurils (Velizhanin 1972), in coastal waters of Japan, and along the southeastern coast of Sakhalin Island (Voronov 1972). It is not regular in South Primorye (Kozlova 1957; Shibaev 1990c).

Nesting habitat

The Ancient Murrelet nests on small islands covered with grass. It makes its nests usually in burrows excavated in soil along steep, grassy slopes, but sometimes also in rock crevices and between boulders. It will form mixed colonies with other seabird species. In the northern Sea of Okhotsk, it very often nests with the Tufted Puffin *Fratercula cirrhata*; the excavating activity of those large, powerful birds is helpful to the Ancient Murrelet in making nests (A.Ya. Kondratyev, unpubl. data). In Primorye, it forms mixed colonies with Black Guillemot, Rhinoceros Auklet, Streaked Shearwater, and Black-tailed Gull (Shibaev 1990c).

Breeding biology

In the northern Sea of Okhotsk, egg laying begins between 9 and 14 June, reaching a peak of activity after 20 June. In recent years, clutch size on Talan Island has ranged between 1.78 (n = 165) in 1988 and 1.97 (n = 135) in 1996. Incubation success has ranged from 64% (n = 52) in 1997 to 91% (n = 172) in 1989. In South Primorye, egg laying is in mid-April, but on the southern Kurils it occurs in early June. Clutch size in Primorye is two eggs (n = 32). Hatching was observed from 20 May to late June in South Primorye in 1976, and mass hatching was observed from 28 to 31 May (n = 32) (Shibaev 1990c). Chicks leave the nest at about 2–3 days of age with their parents. After leaving the colony, chicks are fed by parents for 1.5–2 months (Litvinenko and Shibaev 1987).

Diet

In Kamchatka, Ancient Murrelets consume crustaceans and squid. In the northern Sea of Okhotsk, small fishes and invertebrates were found in food samples in varying proportions, but fish prey were prevalent. The experimental raising of captive Ancient Murrelet chicks on Talan Island showed that in the first two weeks of age, they ate very actively and consumed the equivalent of 80–100% of their body mass daily (Kondratyev and Kondratyeva 1995). Family groups (parents and two chicks) observed from 29 June to 23 July 1980 at Furugelm Island (Peter the Great Bay) remained 50–200 m apart. Birds spent the day near the island and moved off to sea in the twilight. Adults fed chicks with young Pacific herring, Pacific saury, short-finned sand lance *Hypoptychus dybowskii*, and small crustaceans (Litvinenko and Shibaev 1987).

Threats and protection

In the northern Sea of Okhotsk, predation activity by red fox and Slaty-backed Gulls causes the most damage to

Ancient Murrelets at the nesting colonies. In Peter the Great Bay, Ancient Murrelets are taken by Peregrine Falcon and Northern Eagle-Owl (Kolomijtsev and Poddubnaya 1985; Nazarov and Trukhin 1985). On Moneron Island, the number is restricted by Norway rats (Shibaev 1990c).

Most nesting sites of this species in the Russian Far East occur in protected areas. In Peter the Great Bay, the Ancient Murrelet colonies were included in the Far East Marine Reserve and two Natural Monuments, established on Verhovsky and Karamzin islands.

JAPANESE MURRELET *Synthliboramphus wumizusume*

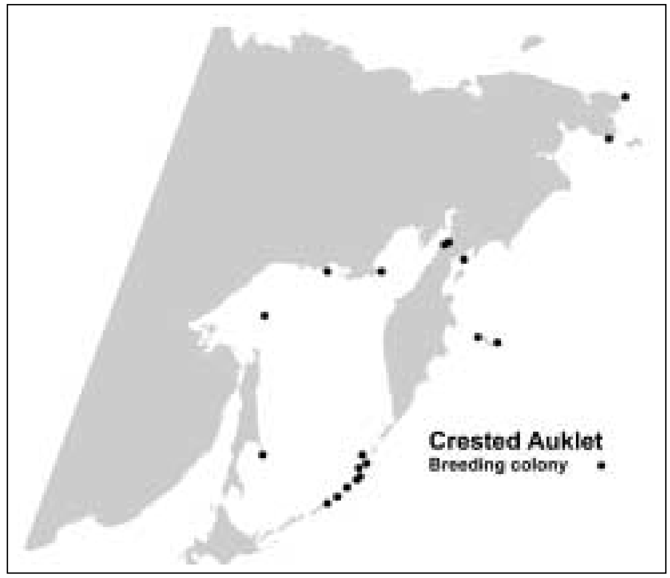
The discovery of a female Japanese Murrelet in juvenile plumage with remnants of down in Peter the Great Bay on 8 July 1984 suggests that this species might breed in South Primorye (most likely on islands in Peter the Great

Bay). The Japanese Murrelet has been found on five other occasions in this bay (Shibaev 1990d): adult females were found on each of 31 August 1959, 6 September 1971, and 28 June 1984; an adult bird of undetermined sex was seen on 28 June 1973 (Nazarov and Shibaev 1987); and an adult bird was observed from 7 to 27 September 1985 (N.M. Litvinenko, unpubl. data).

CRESTED AUKLET *Aethia cristatella*

Distribution and abundance

The Crested Auklet is one of the most characteristic seabirds in the North Pacific. The northern limit of its nesting range is the Diomede Islands in Bering Strait, but there are occasional observations of nonbreeding birds in the Arctic basin as far west as Wrangel Island and Cape Shmidta (Portenko 1973). Along the Kuril Archipelago, it occurs as far south as 47°N. The Crested Auklet forms breeding colonies, sometimes over one million individuals, but never nests in separate pairs. Large colonies of Crested Auklet with over 100 000 birds are known in the Bering Sea basin: on Big Diomede and Cape Yagnochimlo in the southern Chukot



Peninsula (Konyukhov 1990; Zubakin et al. 1992). In the northern Sea of Okhotsk, the Crested Auklet nests in Penzhinskaya Gulf (Yakhontov 1974). Large communities inhabit the Yamskiye Islands and also Talan Island (Velizhanin 1977c; Kondratyev et al. 1992, 1993; Kondratyev 1993b). The number of Crested Auklets on Talan Island was estimated at 1.15 million birds in 1997 (A.Ya. Kondratyev, unpubl. data). Crested Auklets also nest on Iona Island (Nechaev and Timofeeva 1973; Kharitonov 1975).

In the southern Far East, the Crested Auklet breeds in the Kuril Archipelago from Paramushir Island in the north to Urup in the south, with the biggest communities on Chirinkotan, Raikoke, Matua, Rashua, Usisher, Simushir, and Chyorniye Brataya (Velizhanin 1972). They nest, in small numbers, on most islands of the Shantar Archipelago (Yakhontov 1977). There are about 1000 pairs on Cape Terpeniya of Sakhalin Island (Nechaev 1986). On Tyuleniy Island, the Crested Auklet was recorded as a migrant from 1946 to 1976; by 1988, however, it was a common nesting bird. About 600 pairs nested in 1989, 1000–1250 pairs in 1990, more than 1000 pairs in 1991 and 1992, and about 1500 pairs in 1993 and 1994 (Trukhin and Kuzin 1996).

Wintering

In winter, the Crested Auklet is abundant near the Sakhalin coasts (Voronov 1972) and in the northern part of the Sea of Japan (Shuntov 1965).

Nesting habitat

The Crested Auklet nests in cliff crevices and stone talus, without plant cover. Peculiarly, all three colonies on Tyuleniy Island are in the basements or cellars of buildings, in one case an occupied house (Trukhin and Kuzin 1996).

Breeding biology

The schedule of reproduction is variable, depending on when the nesting habitats become free from snow and ice.

On Big Diomede, in 1991, egg laying began approximately in the second half of June. In the Kamchatka Region, birds arrive at colonies in the second half of May and begin laying eggs in June (Kharkevich and Vyatkin 1977). On Talan Island, egg laying was delayed in different years from 19 May to 2 June. Egg laying on Sakhalin in 1981 was recorded from 15 to 28 June (Nechaev 1991). On Talan Island, the nesting success of Crested Auklets in recent years has ranged from a low of 0.20 fledglings per egg in 1990 (n = 214) to a high of 0.63 in 1988 (n = 385) and 1993 (n = 170) (A.Ya. Kondratyev, unpubl. data).

Threats and protection

Many different predators, from voles to falcons, consume Crested Auklet eggs, chicks, and adult birds at the colonies without having a population impact, as a rule. Productivity failure and mass chick mortality occur because of food shortages, and many wintering birds perished near Sakhalin in hard frosts and snowstorms (Gizenko 1955).

WHISKERED AUKLET *Aethia pygmaea*

Distribution and abundance

This seabird is rare in the Russian Far East, and its distribution is poorly known. In the Kamchatka Region, it nests singly and in small groups, among other species, on the Komandorskiye Islands (Ioganzen 1934; Kartashev 1961;

Marakov 1963; Artyukhin 1991), and the total number on the Komandorskiye Islands is several thousand pairs (Artyukhin, in press b). Whiskered Auklets probably nest regularly in the northern Sea of Okhotsk, but the information is incomplete, and further inquiries are needed (Kondratyev 1990). It is known to nest in Penzhinskaya Gulf (Yakhontov 1973, 1975b), and A.G. Velizhanin (1975) recorded this species in 1974 on the Yamskiye Islands, where it has not been seen since (Kondratyev et al. 1993). Nesting by Whiskered Auklet would seem much more likely on the Yamskiye Islands than in Penzhinskaya Gulf, because the Whiskered Auklet is often associated with the type of eddies and upwelling zones that occur in that area (Kondratyev 1990). In 1971, it was found nesting on Iona Island (Nechaev and Timofeeva 1973), and about 1000 were counted there in 1974 (Kharitonov 1975). The Whiskered Auklet is widely spread on the Kuril Islands in the south. The largest extant colonies are on Chirinkotan, Matua, and Usishir islands. Generally, it is much less numerous than Crested Auklet (Velizhanin 1972). It may also nest on Moneron Island in small numbers (Nechaev 1975).

Wintering

The Whiskered Auklet spends winters in the central and southern parts of the Kuril Islands (Gizenko 1955) and in small numbers near the southern part of Sakhalin Island (Shuntov 1965).

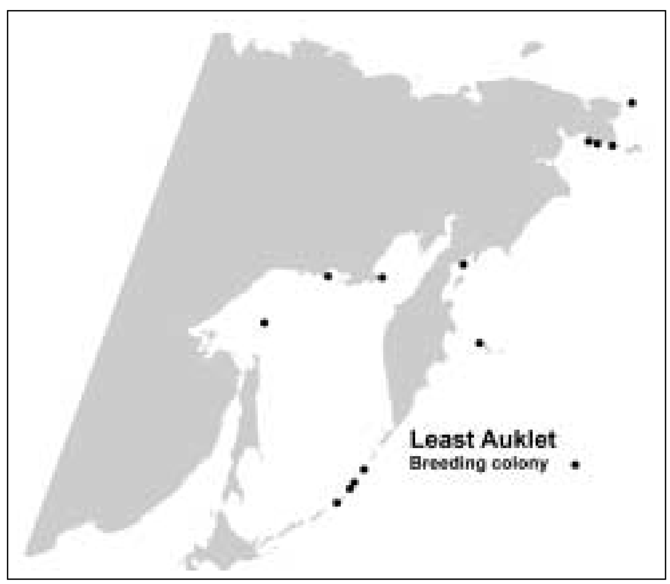
Breeding biology

Nesting habits and the breeding status of Whiskered Auklet populations in the Russian Far East are almost unknown. The Whiskered Auklet nests mainly in vertical cliff crevices (5–15 cm wide); 11 eggs were found between 31 May and 3 June on Chyorniye Brataya Islands in the Kurils (Velizhanin 1977a).

LEAST AUKLET *Aethia pusilla*

Distribution and abundance

The nesting range of the Least Auklet in the Russian Far East is very similar to that of the Crested Auklet. In the northern part of the Bering Sea, Least Auklet colonies occur in the Bering Strait area and on the southeastern coast of the



Chukot Peninsula (Portenko 1973; Konyukhov 1990). The largest colony, with over one million birds, is on Big Diomede (Zubakin et al. 1992). In the Kamchatka Region, a small number (15–150 pairs in different years) inhabit

Verkhoturova Island (Vyatkin 1981). The first small colony was found on Toporkov Island in the Komandorskiye Islands in 1969 (Mikhtar'yantz 1972). It is currently estimated to hold 30–40 pairs (Artyukhin 1991; Vyatkin and Artyukhin 1994). In the Kamchatka Region, the Least Auklet usually nests in small groups of tens of pairs, with other species. In the northern Sea of Okhotsk, it is a very numerous breeder; possibly the largest Least Auklet colony in the world, approximately six million birds in 1988, is on the Yamskiye Islands (Kondratyev et al. 1993). When A.G. Velizhanin visited the Yamskiye Islands on 3–4 July 1974, he landed only briefly on Matykil and Atykan islands and estimated only 60 000 birds on Matykil. There is a small colony of 600–700 birds nesting on Iona Island (Kharitonov 1975). In the southern Far East, the Least Auklet breeds only on the middle Kurils: Simushir, Usishir, Matua, and Lovushki. About 1000 birds were recorded in July 1963 (Velizhanin 1972). There are no reports of Least Auklets breeding in the southern Far East.

Wintering

The Least Auklet spends winters near the coasts of Sakhalin and Primorye (Shuntov 1965; Nazarov and Shibaev 1984).

Nesting habitat

In the northern part of the region, the Least Auklet usually nests in the same habitats as the Crested Auklet.

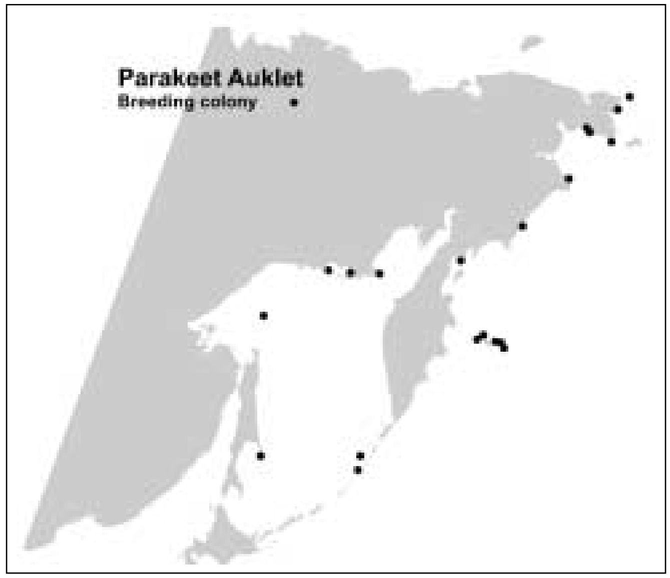
Breeding biology

In Kamchatka, the Least Auklet arrives on the nesting habitats in the beginning of June, and egg laying has been recorded in the second half of June (Kharkevich and Vyatkin 1977). On Big Diomede, intense egg laying was observed from 3 to 10 July 1991 (Kondratyev et al. 1995). On Matykil Island, in the northern Sea of Okhotsk, egg laying began on approximately 10–12 June in 1988 (Kondratyev et al. 1993).

PARAKEET AUKLET *Cyclorrhynchus psittacula*

Distribution and abundance

The Parakeet Auklet is a widespread breeder in the northern areas of the Russian Far East but is much less common in the south. The northern limit of its distribution is in the Bering Strait at Big Diomede, and it does not breed in the Arctic basin. Some nonbreeding birds can be found in the Chukchi Sea, westward to Cape Shmidta and the Amguena River (Kondratyev et al. 1995). About 45 000–60 000 birds were estimated on Big Diomede in 1991 (Zubakin et al. 1992). The total number of Parakeet Auklets in the northern part of the Bering Sea is about 25 000 birds (Kondratyev 1991, 1993a). It is comparatively common in the Kamchatka Region, and nesting colonies occur on Vasiliya and Verkhoturova islands on the eastern coast of the peninsula (Vyatkin 1986). The nesting population on Verkhoturova Island was 2500 pairs in 1975 and 5000 pairs in 1994 (Vyatkin, in press b). It inhabits all four islands in the Komandorskiye group, but the population is only about 1870



pairs (Artyukhin, in press b). In the northern Sea of Okhotsk, south of the Taygonos Peninsula and Gizhiginskaya Bay, there are several dozen small colonies, containing 20–30 pairs. The largest known colonies are the roughly 15 000 pairs on Talan Island and the nearly 70 000 pairs on the Yamskiye Islands.

Small numbers (25–30 pairs) were breeding at Cape Terpeniya on Sakhalin Island in 1981 (Nechaev 1986). From 1988 to 1994, about 30 pairs were recorded annually on Tyuleniy Island (Trukhin and Kuzin 1996). About 1000 birds nest on the Kuril Islands (Velizhanin 1972), where colonies have been confirmed only on Raikoke and Chirinkotan islands, but it probably nests on Lovushki Island (Belkin and Velizhanin 1965).

Wintering

The Parakeet Auklet is surprisingly uncommon in winter. Small flocks of 6–7 Parakeet Auklets were seen in Aniva Bay, Sakhalin Island, in December 1950 and January 1951 (Gizenko 1955). In Japan, it occurs more frequently in winter off Niigata-ken, Honshu, than off Hokkaido (Brazil 1991).

Nesting habitat

Parakeet Auklets nest in several different types of site, including grassy slopes with a mosaic of rocks and talus and crevices in cliffs. Most often, it nests in burrows excavated in soil or uses the vacant burrows of Tufted Puffins or Ancient Murrelets.

Breeding biology

In the Kamchatka area, Parakeet Auklets arrive at the breeding colonies in the beginning of June, and egg laying occurs from 10 to 20 June (Kharkevich and Vyatkin 1977). In the northern Sea of Okhotsk, the date for the first egg ranges from 7 to 15 June. The chicks fledge at the end of August or in the first days of September. In the Sakhalin area, eggs were laid at Cape Terpeniya in the second half of

June (Nechaev 1986). In the northern Sea of Okhotsk, productivity is generally more constant from year to year than that of Crested Auklets. On Talan Island, Parakeet Auklets achieved fledging rates ranging from 0.44 (n = 64) in 1993 to 0.76 (n = 74) in 1989 per nest with eggs.

RHINOCEROS AUKLET *Cerorhinca monocerata*

Distribution and abundance

Although the nesting range of Rhinoceros Auklet in Russia has often been shown to include Kamchatka and the Komandorskiye Islands (e.g., Dement'ev and Gladkov 1951–1954), recent observations have confirmed breeding

only in the South Region, in the southern Kurils, South Primorye, Tyuleniy Island, and Moneron Island (Shibaev 1990d). The greatest nesting concentration, more than 10 000 birds, is on the southern Kurils (Velizhanin 1972, 1978). Nechaev (1975) found 2000–2500 birds nesting on Moneron Island in 1973; about 3000 nested there in 1976, and about 4000 nested in 1991 (Shibaev and Litvinenko 1996). It is still unclear whether they nest on the Shantar Islands (Shulpin 1936; Dulkeit and Shulpin 1937), because they have not been recorded there recently (Yakhontov 1977; Roslyakov 1986). For the last 10 years, single nonbreeding visitors have been observed, annually, in the northern Sea of Okhotsk near Talan Island (Kondratyev et al. 1992).

Population trends

On Moneron Island, numbers of this auklet declined from 14 069 to 1500 birds in the period between 1938 and 1949, and the population has remained at that low level (Takahashi 1939; Gizenko 1955; Shibaev and Litvinenko 1996).

Nesting habitat

The Rhinoceros Auklet breeds in mixed colonies on islands situated near the mainland coast or in archipelagos. Colonies may hold from several pairs to a few thousand birds. It nests in burrows excavated in slopes with a thick soil layer (10–40 cm), covered with grasses such as *Elymus* sp., *Calamagrostis* sp., or *Artemisia* sp. Burrow length ranges from 30 to 230 cm, but usually from 100 to 150 cm (Shibaev 1990e).

Breeding biology

Birds come to nesting colonies in South Primorye in mid-April and start laying eggs in late April or early May. Approximately the same laying period occurs throughout the southern Far East, on the Kurils and on Moneron Island (Gizenko 1955; Shibaev 1990d). In Peter the Great Bay, the period of hatching in 1976 ranged from late May to late June. On Moneron Island, most fledglings departed at the end of July in 1976 (Shibaev 1990e).

Diet

Food of nestlings on Tyuleniy Island from 1958 to 1965 included capelin, Pacific sand lance, Eurasian smelt, eelpouts (*Zoarces* sp. and *Lycodes* sp.), gunnel (*Pholis* sp.), young coastal Atlantic cod *Gadus morhua*, and pink salmon *Oncorhynchus gorbuscha* (Bychkov 1975); on Moneron: Pacific herring, Pacific sardine, sand lance, smelt, and young salmon (*Oncorhynchus* sp.) (Gizenko 1955). In Peter the Great Bay, chicks have been fed exclusively on Japanese anchovy *Engraulis japonicus* for at least the last 20 years (Shibaev 1990e).

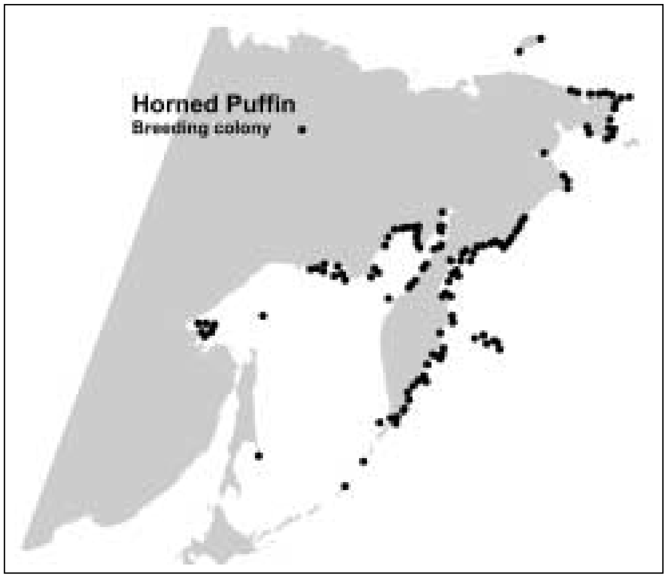
Threats and protection

Crows and gulls are the main predators of Rhinoceros Auklet in the breeding season. Large-billed Crow can remove fledglings from burrows in Peter the Great Bay, and Black-tailed Gulls kleptoparasitize the adult auklets (Litvinenko 1980). Many fledglings are taken by Slaty-backed Gulls on Moneron Island, where nesting birds are also threatened by Norway rats and fishermen who destroy burrows to take eggs (Shibaev 1990e). At this time, almost all of the known colonies of Rhinoceros Auklet in Russia are under protection, in zapovedniki, zakazniki (sanctuaries), or Natural Monuments.

HORNED PUFFIN *Fratercula corniculata*

Distribution and abundance

In the Russian Far East, the Horned Puffin nests on the Pacific coast north of 45°N latitude but is not nearly so widely distributed as suggested by widely published summaries such as *Birds of the USSR, Alcids* (Shibaev 1990e). We have used only confirmed nesting records in mapping the range of this species. It penetrates the Arctic basin as far as Wrangel Island and may nest there in single pairs. It may also inhabit Gerald Island (Stishov et al. 1991). Along the Arctic coast of the Chukot Peninsula, it nests on Kolyuchin Island in the west, where some 600 pairs were observed in 1985 (Kondratyev et al. 1987). Farther west, only nonbreeding birds were found. The total number of breeders in the Arctic basin is probably not above 2000 birds



(Kondratyev 1991). On the Komandorskiye Islands, about 3000 pairs nest (Aryukhin, in press b), and similar numbers were counted along the Kamchatka coast (Vyatkin 1986, in press b). Along the Bering coast, in the Kamchatka area, the Horned Puffin is widely dispersed but quite common, often nesting in single pairs or small groups. The situation is the same in the northern Sea of Okhotsk, but occasionally it forms very large colonies, such as the 100 000 birds nesting on Talan Island. On Verkhoturova Island, the number has increased in the last few decades. Only 250 pairs were counted in 1971 (Vyatkin and Marakov 1972), 400 pairs in 1975 (Vyatkin 1986), and 1500 pairs in 1994 (Vyatkin, in press b).

In the southern part of the Russian Far East, there are few Horned Puffin colonies, but it nests on small islands of the Shantar Archipelago. There were not more than 2000 pairs in 1978 and 1982 (Roslyakov 1986, 1991). For many years, the only confirmed nest site on Sakhalin was observed from 1947 to 1949 at Cape Terpeniya, and two or three pairs nested there in 1981 (Nechaev 1986). It may also have nested at Cape Kuznetsova at that time, but Sakhalin may generally lack suitable nesting habitat. One nesting pair was found on Tyuleniy Island, and several pairs have been found on Moneron Island (Gizenko 1955). Subsequent observations on Tyuleniy Island (from 1969 to 1977 and in 1991) and on Moneron Island (in 1973 and 1991) have not detected nesting Horned Puffins (Nechaev 1975; Nechaev and Timofeeva 1980; Shibaev and Litvinenko 1996; Trukhin and Kuzin 1996).

On the Kurils, the Horned Puffin nests only in the northern part of the chain, north of Chyorniye Brataya Island. The total population on the Kurils is 3000–4000 individuals (Velizhanin 1972).

Breeding biology

In the northern Sea of Okhotsk, the Horned Puffin begins egg laying between 3 and 14 June. The young puffins fledge in early September. In recent years, Horned Puffins achieved fledging rates per egg ranging from 0.33 (n = 115) in 1988 to 0.71 (n = 213) in 1980 on Talan Island.

In the southern part of the Far East, our knowledge of nesting biology is very sparse. The birds arrive on Moneron Island in the beginning of May, and copulation has been observed from the end of May to the beginning of June. The chicks appear in July–August (Gizenko 1955).

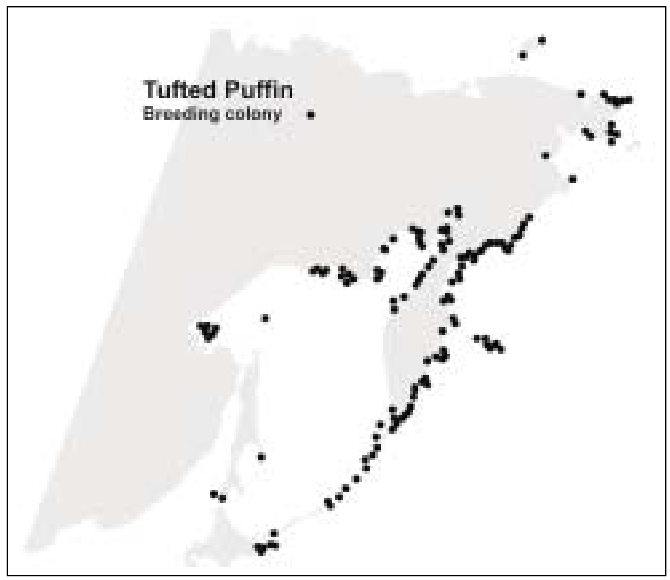
Diet

In the northern part of the nesting range, food for nestlings on the colonies consists of small fish (capelin, sand lance, young herring, and pollock) and, occasionally, small quantities of squid, polychaetes, and crustaceans.

TUFTED PUFFIN *Fratercula cirrhata*

Distribution and abundance

The nesting range is similar to that of the Horned Puffin, but the Tufted Puffin is rarer in the Arctic basin and only accidentally found on Wrangel Island (Stishov et al. 1991). The western border of the distribution in coastal



waters is near Cape Onman and Cape Keleneut as well as Kolyuchin Island (Kondratyev 1978, 1986). The total Arctic population is not more than 1000 birds (Kondratyev 1991). It becomes much more abundant along the Bering Sea coast, where it can find habitats with soil deep enough for the nesting burrows. In the northern part of the Bering Sea, including Chukotka and the Koryak Highlands, the number of Tufted Puffins was estimated at 50 000 birds (Kondratyev 1991). In the Kamchatka Region, the population has increased, and new colonies have appeared in recent years. There are 93 000 pairs along the peninsula coast and another 127 000 pairs on the Komandorskiye Islands (Vyatkin 1986, in press b; Artyukhin, in press b). In the 1970s and 1980s, 300 pairs were counted on Bogoslova Island, 600 on Verkhoturova, 4500 on Starichov, and 2500 on Utashud. In 1994–1995, the numbers at the same colonies were 1500, 3000, 16 000, and 10 000 pairs, respectively (Vyatkin, in press b).

In the northern Sea of Okhotsk, the largest Tufted Puffin colony, 140 000 birds, is situated on Talan Island (Kondratyev 1993a), and the total population is estimated as 500 000 birds (Kondratyev 1993b).

The Tufted Puffin is most numerous in the southern Far East. The biggest colonies are situated on the Kuril Islands and total 150 000–200 000 birds (Velizhanin 1972). On the Shantars, 3000 pairs were counted in 1978, 5000 in 1982, 4000 in 1986, and 3000–3500 in 1992 (Roslyakov and Roslyakov 1996). There were some small colonies on Sakhalin in 1947–1949 (Gizenko 1955), but only two nesting sites, with two or three pairs each, were found on that island in 1974, 1980, and 1981 (Nechaev 1991). About 20 pairs nested on Moneron Island in 1973 (Nechaev 1975), but not more than 10 in 1991 (Shibaev and Litvinenko 1996). Three or four pairs have nested on Tyuleniy Island for many years (Nechaev and Timofeeva 1980; Trukhin and Kuzin 1996). In the first part of the 20th century, the Tufted Puffin nested on the mainland coast of the Sea of Japan and in Peter the Great Bay (Shulpin 1936; Labzyuk 1975), but no nesting has been recorded there since 1960 (Shibaev 1987).

Wintering

The Tufted Puffin winters in Kuril waters, in small numbers (Velizhanin 1972).

Nesting habitat

The Tufted Puffin nests on rocky islands and capes. It prefers slopes with a steepness of 30° to 60°, covered with grass. In the Arctic, it nests in crevices and holes under rocks. Nests are situated up to 150 m above sea level (Gizenko 1955; Velizhanin 1972).

Breeding biology

The first clutches were found on Kamchatka in June (Kharkevich and Vyatkin 1977); in the northern Sea of Okhotsk from 5 to 10 June (A.Ya. Kondratyev, unpubl. data); and on Urup and Toporkov islands in late May (Gizenko 1955). Hatching started in early July 1947 on the Kurils (Gizenko 1955). On Talan Island, Tufted Puffins have achieved fledging rates per egg ranging from 0.40 (n = 32) in 1997 to 0.91 (n = 62) in 1987 (A.Ya. Kondratyev, unpubl. data).

Threats and protection

The main limit on the reproductive success in Kamchatka and the northern Sea of Okhotsk is food shortage. On the Kuril and Moneron islands, Peregrine Falcons take adult Tufted Puffins, and red foxes eat eggs, fledglings, and adult birds (Gizenko 1955).

The breeding colonies

INTRODUCTION

Given the large time frame and huge scale of the area under consideration, techniques for both description and quantification of seabird colonies have varied according to the environmental condition and with the opportunities and experience of the observers. However, the basic problems faced by observers and the solutions have been similar on most colonies. Extensive observation, to gain a general idea of the location and scale of the colonies, was achieved using light aircraft and helicopters. In the Arctic part of the Far East, aviation was little used, because most birds nested in the coastal lowlands. In many areas, particularly in the north, where there are few ornithological records, it has proved useful to inquire among the local people to make preliminary assessments of the distribution, abundance, and species of seabird colonies (A.Ya. Kondratyev, unpubl. data). Mapping, species accounts, and description of colonies were carried out on the ground. In some places, such as reserves and other protected areas, regularly counted plots have provided effective long-term monitoring; at most sites, however, population estimates have depended on detailed assessment of small plots that necessarily sampled only a small portion of a colony. The methods for counting highly visible seabirds that inhabit the coastal lowlands (gulls, terns) or cliffs (murres, kittiwakes, and cormorants) are standardized and well tested (e.g., Kaftanovski 1951; Belopolski 1952; Nettleship 1976).

The biggest problems are in estimating the numbers of alcids nesting in talus slopes (e.g., Crested and Least auklets). Counts of birds sitting on the surface or participating in aerial displays generally underestimate the breeding population and have great variance (Kondratyev 1992; Zubakin et al. 1992; Kondratyev et al. 1993). Correction coefficients may be used, but their value varies with slope condition, colony type, rock size, depth of shore zone, etc. Such coefficients must be calculated in each colony for each year, and less intensive observations are useful only for preliminary estimates. Horned Puffins, which usually nest under rocks and within large-stone talus slopes, cause the greatest methodological problems, even for intensive, stationary observations. The most precise estimates of the Horned Puffin population on Talan Island were achieved by counting courting pairs on plots in the preincubation period. During the nestling period, such counts became much more variable, especially as the fledging period approached (A.Ya. Kondratyev, unpubl. data).

Most of the information about the seabird colonies of the Far East has been entered in a computer database as part of an international project — *The Beringian Seabird Colony Catalog*, a cooperative project with Kenton D. Wohl and Vivian M. Mendenhall of the U.S. Fish and Wildlife Service in Alaska (Kondratyev et al. 1994). The objective is to develop a comprehensive atlas of seabird colonies for the Russian Far East and the Alaskan shores of the North Pacific. Basic information for about 453 colonies and colony complexes around the Russian Far East is now stored in this database. American ornithologists, especially Vivian Mendenhall and Scott A. Hatch, have also taken an active part in the observations of seabirds in the northern Sea of Okhotsk and on the Kamchat Peninsula.

THE NORTH REGION

The Arctic coast

The Arctic coast of the Far East is washed by the East Siberian and Chukchi seas for almost 3000 km. Rocky areas comprise about a quarter of that length, but only 2% is potentially suitable for cliff nesting.

The Arctic coast has a characteristic suite of climate and environmental conditions that affect seabird reproductive activity. The icy seas of the higher latitudes generate severe weather over much of the territory, but there is a gradual moderation in conditions as one travels from west to east towards the Pacific Ocean. That ocean affects the area with powerful influxes of warm water and circulating air masses. Evidence of its effect can be seen in the reduced sea ice and increased biological productivity in nearshore waters. These are nearly twice as large in the Chukchi Sea as in the East Siberian Sea (Kishchinski 1970) and influence the number and distribution of seabirds across the Arctic coast.

The maritime cliffs and slopes of the Arctic mainland and islands of the Far East are inhabited by 10 seabird species: Pelagic Cormorant, Glaucous and Herring gulls, Black-legged Kittiwake, Thick-billed and Common murres, Black and Pigeon guillemots, and Horned and Tufted puffins (Table 1). In addition, in the marine areas of the Arctic Ocean, there are occasional observations of some seabird species that do not nest there: Northern Fulmar, Short-tailed Shearwater, Red-legged Kittiwake, Dovekie, and Crested and Parakeet auklets.

The nature of the seabird colonies and their geographical distribution along the Arctic coast correspond to environmental conditions (Kondratyev 1986; Pridatko 1986; Pridatko and Lutsyuk 1986; Stishov et al. 1991). Seabird colonies occur infrequently and are, typically, small. In the western half of the Arctic coast (not including Wrangel and Gerald islands), fewer than 50 000 seabirds of only four species occupy four colonies, but there are numerous small colonies of gulls along the coastal lowlands. In the eastern half of the Arctic coast, about 150 000 seabirds of 10 species occupy 18 colonies.

In the maritime lowlands of the Arctic coast, Herring and Glaucous gulls and Arctic Tern are widespread, and in western areas of the Arctic coast, Ross' and Sabine's gulls are widespread. Most of these birds nest in small groups or even in isolated pairs; the colonies rarely exceed 30–35 nesting pairs.

Table 1
Distribution and abundance of seabirds breeding in the northern Russian Far East[a]

	No. of seabirds (000s)		
Species	Arctic Ocean	Northern Bering Sea	Northern Sea of Okhotsk
Northern Fulmar	0	150	1000–1300
Pelagic Cormorant	4	50	>20
Black-headed Gull	0	0	>12
Herring Gull	12	2	0
Slaty-backed Gull	0	0	80
Glaucous Gull	3	2.5–3	0
Mew Gull	0	0	1000s
Sabine's Gull[b]	2	0	0
Black-legged Kittiwake	250–300	900–1100	300–500
Ross' Gull[b]	1	0	0
Common Tern	0	0	2–3
Arctic Tern	9	1	0
Aleutian Tern	0	very rare	nests[c]
Dovekie	0	possibly	0
Common Murre	20	1200[d]	900–1100
Thick-billed Murre	200–300	[d]	300
Black Guillemot	4	0	0
Pigeon Guillemot	1	20	0
Spectacled Guillemot	0	0	25–30
Ancient Murrelet	0	0	25–30
Crested Auklet	0	1000	1100–1500
Whiskered Auklet	0	0	1–2
Least Auklet	0	>1000	>5500
Parakeet Auklet	0	100–125	250–300
Horned Puffin	2	35–40	250–300
Tufted Puffin	1	50	500

[a] Main sources: Portenko 1939, 1972, 1973; Yakhontov 1975a,b; Kondratyev 1978, 1986, 1991, 1993a,b, 1994a,b, and unpubl. data; Kishchinski 1980; Tomkovich and Morosov 1982; Tomkovich and Sorokin 1983; Pridatko 1986; Smirnov and Velizhanin 1986; Bogoslovskaya and Konyukhov 1987; Bogoslovskaya et al. 1988; Krechmar et al. 1991; Leito and Mand 1991; Stishov et al. 1991; Zubazin et al. 1992; Kondratyev et al. 1993, 1995.
[b] Maximum likely value.
[c] Numbers unknown.
[d] Includes both members of the genus.

Wrangel and Gerald islands

Wrangel Island is on latitude 71°N, on the boundary of the East Siberian and Chukchi seas, separated from the mainland coast by the 140-km-wide Longa Strait. The island is about 145 km long, almost equally divided by the 180th meridian, and 80 km wide. The shores are mainly low, but on the western (the area of Cape Blossom) and eastern (the area of Cape Uering) coasts, there are rocky precipices with heights up to 200 m. Gerald Island is the peak of an underwater mountain that towers out of the sea to 365 m about 65 km east of Wrangel Island. The surface of the island is about 15 km^2, and almost the entire coastline is rocky cliff.

The seabird colonies that inhabit the coastal rocks of these islands are the biggest in the Arctic sector of the Far East. Black-legged Kittiwake and Thick-billed Murre are the dominant species, but Pelagic Cormorant, Glaucous Gull, and Black Guillemot are also numerous. Nesting activity varies greatly from year to year, reaching 400 000 individuals in the most favourable years (Stishov et al. 1991).

Unfortunately, the present state of the Arctic seabird colonies is poorly known. Most information was collected from 1970 to 1980, when the Arctic field stations actively undertook expeditions and published many reports (e.g., Kondratyev 1978, 1986; Tomkovich and Sorokin 1983; Kondratyev et al. 1987; Krechmar et al. 1991; Stishov et al. 1991). Since the end of the 1980s, such observations have almost disappeared because of problems with funding scientific investigations. At present, the state of the Arctic seabird colonies is monitored to some degree by staff of the Wrangel Island Zapovednik and occasional fragmentary observations (Dorogoy 1995). Under these circumstances, the major sources of information have become the native peoples who exploit the birds and staff of the fishery and hunting inspection agencies (A.Ya. Kondratyev, unpubl. data). According to such information, the recent status of the Arctic seabird colonies has been rather good. We know of only one incident at a seabird colony caused by people: the colonies on Cape Shmidta were destroyed because of the development of a village. The breeding range of murres is expanding to the northwest, and they have appeared at Shalaurov Island. In addition, Common Murres have increased their proportion in the murre colonies of the Chukchi Sea.

The largest seabird communities of the Arctic Far East, which exceed 100 000 inhabitants, are situated on Wrangel and Kolyuchin islands in the Chukchi Sea, but, typically for Arctic areas, there is great interannual variability depending on environmental conditions (Kondratyev 1975, 1978; Kondratyev et al. 1987). In some years, the sea ice is late in breaking up, or snow cover delays access to the colony. Especially among the guillemots and murres, more birds arrive at the colony in spring than will actually attempt to nest.

The northern Bering Sea coast

The Bering Sea coast of the Chukot Peninsula is chiefly rocky and indented by many long, narrow fjords. The southern part of the Chukot coast is also rocky and has many islands that are the tops of submerged mountains. The topography of the coast is complex; in general, there is a complex mosaic of rocky slopes and small lowlands that offer a rich choice of places for nesting seabirds. Farther south, the rocky shores of the Chukot Peninsula give way to the vast, flat landscapes of the Gulf of Anadyr. The Gulf of Anadyr is the largest in the Bering Sea, with a coastline of about 1300 km. On its southern side, the swampy maritime plains of the Gulf of Anadyr are bounded by the rocks of the Koryak Highlands. Even farther south, the coast of the Bering Sea alternates between rocky capes and small swampy lowlands, separated from the sea by pebble and sandy spits and shallow lagoons.

The seabird colonies along the northern part of the Bering Sea differ from colonies of the Arctic coast in species composition and often in scale. Fourteen seabird species nest there: Northern Fulmar, Pelagic Cormorant, Glaucous and Herring gulls, Black-legged Kittiwake, Common and Thick-billed murres, Pigeon Guillemot, Horned and Tufted puffins, and Parakeet, Crested, and Least auklets. Also, Dovekie probably nests on Big Diomede Island, although that has never been confirmed. Other species wander in from adjacent areas: Glaucous-winged Gull, Red-legged Kittiwake, and Black Guillemot (Table 1) (Portenko 1939, 1972, 1973; Lebedev and Filin 1959; Tomkovich and Morozov 1982; Tomkovich and Sorokin 1983; Bogoslovskaya and Konyukhov 1987; Bogoslovskaya et al. 1988; Dorogoy 1995; Konyukhov et al. 1998).

There is a considerable difference between the colonies of the southern and eastern coasts of Chukot Peninsula. The proportion of Tufted Puffin to Horned Puffin increases as one moves north. Auklets do not nest farther north along the mainland coast, and the colonies on Big Diomede Island are unique, representing the northern limit for auklets in the Far East. The colonies of the southern coast tend to be larger but less numerous, with fulmars and auklets occurring mostly on the southern part of the peninsula. In total, there are about 80 seabird colonies on the rocky slopes of the Bering Sea coast of the Chukot Peninsula, with planktivorous seabirds and fulmars being the most numerous residents (Table 1).

On the coast of the Anadyr estuary and then southward to the Apuka Lagoon on the boundary between the Koryak Highlands and Kamchatka, seabird colonies are situated on almost every suitable rocky area of the mainland and nearshore islands. Colonies have been confirmed on Alyumka Islet in the delta of the Anadyr River, Geka Gulf; along the coasts of Ugolnaya Bay; on Cape Krasniy, Cape Barikova, Cape Navarin; etc. In total, there are about 20 large colony complexes along the northern Bering Sea southward from the Anadyr River estuary (A.Ya. Kondratyev, unpubl. data). Colonies on the capes and headlands reach tens of thousands of birds, but the majority hold fewer than 10 000 individuals. Murres and Black-legged Kittiwake are the most numerous inhabitants, but Pelagic Cormorants and both puffins are also widespread. Glaucous and Herring gulls are displaced on the Koryak Highlands coast by the Slaty-backed Gull.

Two areas in particular have large numbers and high densities of seabirds: the Bering Strait area, including Big Diomede Island and the adjacent coast of the Chukot Peninsula, and the Cape Navarin area on the northern coast of the Koryak Highlands. The large and numerous seabird colonies of the northern Bering Sea are likely the product of increased marine biological productivity, which supports small alcids, such as Crested, Parakeet, and Least auklets. Productivity in the Arctic Ocean is much suppressed by the longer period of seasonal darkness and greater ice cover. Horned and Tufted puffins are perhaps numerous in the Bering Strait because they can find islands with deeper and more extensive soil layers for burrows. The total number of inhabitants of seabird colonies along the coast of the Bering Sea needs more detailed examination, but it is approximately 3.5 million individuals.

The northern Sea of Okhotsk

The coastline of the northwest Sea of Okhotsk stretches more than 2500 km. The mainland and offshore islands are mainly rocky. Many colonial seabirds take advantage of high productivity in the numerous estuaries and extensive coastal shallows. Unfortunately, our knowledge of the distribution and number of seabird colonies is weak apart from large, well-established colonies. In addition, there are many single pairs and scattered nesting groups of gulls, Horned Puffins, Pelagic Cormorants, and Spectacled Guillemots on the rocks of the mainland coast and offshore islands. These would contribute significantly to the tally of seabirds for the area, but they remain uncounted because they are too widespread to be enumerated in any systematic survey.

At least 14 species of seabird nest on the coastal cliffs and stony talus slopes of the northern Sea of Okhotsk. The species composition of these colonies is significantly different from that of colonies of the Bering Sea. Glaucous Gull, Herring Gull, and Pigeon Guillemot are absent, but there are colonies of Whiskered Auklet, Spectacled Guillemot, and Ancient Murrelet (Table 1) (Yakhontov 1974, 1975b; Kondratyev et al. 1991; Leito and Mand 1991).

The most northern area with large and diverse seabird communities (and the least studied, unfortunately) is situated in Penzhinskaya Bay at the boundary between the Kamchat and Magadan districts. These colonies, on the numerous nearshore islands, hold 250 000–300 000 birds, including colonies of Ancient Murrelets and small auklets (Yakhontov 1973, 1974, 1975a,b). There is also a concentration of colonies on the capes and islands of Gizhiginskaya Bay, which hold 450 000–500 000 birds. These are most often large colonies of murres, but Black-legged Kittiwake, Pelagic Cormorant, and Slaty-backed Gull are very common also. The most important colonies are on Telan, Tainochin, and Halpili islands. There are also several dozen smaller but still considerable colonies of Horned and Tufted puffins and Spectacled Guillemot. Slaty-backed Gulls nest everywhere in the bird colonies of the northern Sea of Okhotsk.

Moving to the southwest along the coastline we find modest colonies of gulls, cormorants, and guillemots, with small numbers of puffins on practically all of the rocky capes of the coast. The cormorants, Slaty-backed Gulls, and Horned Puffins are dispersed relatively evenly, with locally high densities. Density estimates of 10 pairs/km of rocky coastal cliff may be an underestimate. The largest seabird colonies in the northern Sea of Okhotsk are near the Yamskiy upwelling, in the Yamskiye Islands archipelago. This area is included in the Magadanskiy Zapovednik. It consists of five modest islands and rocks inhabited by at least 12 seabird species. Their total number may reach several million birds (Velizhanin 1975; Kondratyev et al. 1993).

Southward, there are a number of large colonies of kittiwakes and murres on the rocky mainland of the Koni Peninsula, Tauyskaya Bay, and also on the Zavyalova and Talan islands. Talan Island is a small nearshore island (about 2.5 km^2) that supports as many as 1.5 million seabirds of 12 species. The nesting colonies of Crested Auklet and Ancient Murrelet on Talan are the largest in the Asian part of the North Pacific. More modest, diverse colonies occur on Umara Island, where 10 000–12 000 seabirds of six species nest (Velizhanin 1978; Kondratyev et al. 1991, 1992; Leito and Mand 1991; Golubova and Pleshchenko 1992; Kondratyev 1992, 1993b; Kondratyeva 1993, 1994). Most of the individual nesting areas do not reach 1000 birds. Many such small sites of not fewer than 250 birds occur on almost all of the rocky capes and islands along the coastline of the Sea of Okhotsk from Tauyskaya Bay to the boundary with the southern Far East. These colonies usually include Slaty-backed Gulls, cormorants, puffins, Spectacled Guillemots, and, more rarely, murres and kittiwakes. The larger sites are also inhabited by auklets and, very rarely, storm-petrels. Nansikan and Iona islands are the two most important such colonies.

The distribution of coastal colonies near the boundary with the southern Far East is still almost unknown. No professional ornithologist has visited those colonies, and our knowledge is limited to very fragmentary reports from hunters and fishermen. There are also many gull and tern colonies on the coastal wetlands where our knowledge is equally fragmentary. We can say only that the largest colonies consist of Black-headed, Mew, and, very rarely, Slaty-backed gulls, as well as terns. Most are situated on river deltas with salmon spawning areas. Some 200 km north of Sakhalin Island is Iona Island. This isolated rock is farther offshore than any other seabird colony in the Russian Far East, and its remote location makes visits difficult (Kharitonov 1975; Velizhanin 1977b). The total number of seabirds inhabiting the colonies on the northern Sea of Okhotsk can only be roughly estimated, but may be near 10 million individuals.

THE KAMCHATKA REGION

The Kamchatka Region includes the Kamchat Peninsula with adjacent areas of that part of the Koryak Highlands south of Cape Navarin and also large islands such as Karaginsky and the Komandorskiyes (see Appendix 1). These limits coincide with the administrative boundaries of the Kamchat District and extend a little north of the Koryak National Autonomous Area. The region stretches 1700 km from north to south, from latitudes 65°N to 51°N.

Eastern Kamchatka coast

Two-thirds of the sea coast of eastern Kamchatka is covered with mountain slopes and rocks. In the north, the coast of the Koryak Highlands is marked by high rocky precipices alternating with narrow fjords and numerous small bays (Kishchinski 1980). Flat areas are small and largely confined to river valleys. In such places, sand and gravel spits with many crowberry *Empetrum nigrum* and cereal meadows are typical. In the central and southern parts of the peninsula, the environmental conditions are considerably milder, and nearshore waters are characterized by high biological productivity. The coastline is a distinctive mix of mountainous landscapes. There are some big gulfs and bays (e.g., Kronotskiy, Kamchatskiy, Ozernoy, Karaginsky, Korfa), and large rocky capes jut into the sea (Shipunskiy, Kronotskiy, Kamchatskiy, Ozernoy), with coastal precipices of 200 m and more. The coastline is a series of broad but steep-walled bays. Talus slopes and piles of rocky blocks occur near the bottom of many precipices. The mainland capes are adjacent to numerous nearshore islands, isolated rocks, and reefs. This combination of elements in the landscape provides nesting opportunities for several species of seabird.

The results of many years of seabird colony observations in eastern Kamchatka (Belopolski and Rogova 1947; Averin 1948; Lobkov 1976, 1980, 1981; Kharkevich and Vyatkin 1977; Lobkov and Golovina 1978; Vyatkin 1981; Lobkov and Alekseev 1987) were summarized in the mid-1980s and are the basis for our current understanding of the species composition and number of colonies (Gerasimov 1970, 1979, 1986; Lobkov 1986; Vyatkin 1986). However, those reviews contained a large number of blank spots and unclarified reports. To resolve outstanding issues, P.S. Vyatkin undertook a survey of the area in 1994 and 1995. His route took him some 3500 km through the region in an inflatable boat with a 25-horsepower outboard motor. He was able to conduct many counts from the boat and landed on important islands, such as Signalniy, Verkhoturova, Ptichy, and Utashud. He used the standard survey techniques (Belopolski 1952; Uspenski 1956; Kartashev 1963), adding or modifying when necessary. The observers attempted to count all the nests of fulmars, cormorants, and gulls. Alcids were counted on nesting sites, on the water, and in the air. The objective of these expeditions was not only to add new information and improve on historic records of seabird abundance and distribution, but also to detect trends in the populations, where possible (Vyatkin, in press a,b,c).

This series of counts raised the total for the east coast of Kamchatka to 1314 colonies, with 1.5 million seabirds of 15 species. About 40% of the birds lived in small colonies (from 10 to 100 individuals), 30% in mid-sized colonies (from 100 to 1000 individuals), and 30% in large colonies (up to 10 000 individuals). Very large colonies (of more than 10 000 individuals) accounted for only 1% of the total population. Black-legged Kittiwakes were the most abundant species, at 404 000 individuals. The second and the third most abundant were murres, with 625 000 individuals, about 60% allocated to Thick-billed Murre and 40% to Common Murre. Slaty-backed Gull, Northern Fulmar, Tufted Puffin, Crested Auklet, and Pelagic Cormorant could be considered numerous species also, but Red-faced Cormorant, Ancient Murrelet, Parakeet Auklet, and Horned Puffin were rare. Two seabird species were very rare, Spectacled Guillemot and Least Auklet. Most colonies consisted of two or more species, depending mainly on the presence of suitable nesting habitats. Small and mid-sized colonies usually included Slaty-backed Gull and cormorants and, in most cases, Tufted Puffin, but rarely Pigeon Guillemot and Horned Puffin. These species also occurred in the large colonies; in those, however, kittiwakes and murres or, more rarely, Tufted Puffin and, very rarely, Northern Fulmar were the most abundant species. In multispecies colonies, Slaty-backed Gull nests were scattered on the upper areas and along the periphery of areas occupied by other species. The largest colony of Slaty-backed Gull was situated on Signalniy Island (40 000 individuals).

The geographical distribution of colonies on the eastern Kamchatka is extremely uneven, largely because of the heterogeneity of suitable habitats and local environmental conditions. The location of colonies seems to be influenced by three main factors: abundance of food, the presence of suitable nesting habitat, and pressure from predators (Modestov 1967). With a favourable combination of these factors, large multispecies seabird colonies may function for centuries. The dynamics of small and mid-sized colonies is rather different, as they form under a variety of conditions and survive for a shorter period. Changes in number and species composition may take place over short periods of time under the influence of mass mortality of some species brought on by epizootics, the influence of predators, or competitive increases in other bird populations.

In the last 25 years, there have been obvious changes in the number and distribution of cormorant colonies. In the 1970s, there were dozens of cormorant colonies with an average of 200 or more members in southeast Kamchatka. Both Red-faced and Pelagic cormorants nested at the majority of those sites, but often the number of Red-faced Cormorants was lower than that of Pelagic Cormorant. On Utashud Island in September 1972, there was a mass mortality of chicks at the colony of Pelagic Cormorants. Near the bottom of the cliffs, where the colony of about 300 nesting pairs was situated, 240 dead bodies and about a dozen moribund chicks were found. During one hour of observation, two more chicks fell from the precipice and quickly died. Their dead bodies were covered in ticks (*Ixodes* sp.). In 1983, the Pelagic Cormorant was completely replaced by Red-faced Cormorant at most sites. This latter species had increased by 3000 or 4000 to 11 000 individuals. In 1994 and 1995, many colonies of both species disappeared. The cause was perhaps an arbovirus infection carried by ticks, which attacked the Pelagic Cormorants in the 1970s and the Red-faced Cormorants at the end of the 1980s. In 1995, 11 new fulmar colonies were found on the coast where there had been cormorant colonies in 1983. Perhaps there was a connection between the decline in cormorant nesting and these new fulmar colonies.

In the 1970s on Verkhoturova Island, arctic fox and ermine *Mustela erminea* preyed on the colonies of seabirds (Vyatkin and Marakov 1972; Kharkevich and Vyatkin 1977); since the end of the 1980s, however, the arctic fox has not been reported on the island. During our observations in 1994, it was certainly absent. Significantly, we found dozens of new colonies of Slaty-backed Gull and Tufted Puffin. The number of Slaty-backed Gulls had increased 30 times and the number of Tufted Puffins five times over 1975 records (Vyatkin 1986). Apparently, these birds were able to take advantage of the absence of predation by the arctic fox, while ermine continue to have a strong negative influence on nesting by the small alcids, such as Parakeet, Crested, and Least auklets.

Numerous seabird colonies are known along the northern part of the eastern coast, north of the Olyutorskiy Peninsula, and also along the southern quarter of Kamchatka, on the Shipunskiy Peninsula. However, the highest concentration of seabirds and maximum species diversity are found along the shores and nearshore islands of Karaginsky Gulf.

Generally, the status of the seabird colonies on the eastern coast of Kamchatka is good, with most protected in zapovedniki or zakazniki. Nonetheless, different species may be in different phases of long-term population cycles. The populations of Northern Fulmar, Slaty-backed Gull, both murres, and Horned and Tufted puffins are increasing, traditional colonies are expanding, and new colonies are being established. The numbers of Black-legged Kittiwakes and Pigeon Guillemots appear relatively stable. Only the populations of cormorants seem deeply depressed, with many small colonies disappearing and numbers declining at all colonies, without exception. The number of Least Auklets on Verkhoturova Island has been reduced to a critical level, and the status of populations of other auklets is unknown.

The coastal lowlands and beaches of eastern Kamchatka are inhabited by colonies of gulls and terns dispersed in almost all suitable habitats. Numbers appear stable, but there have been no special studies of these sites.

The western Kamchatka coast

The west coast of Kamchatka is occupied mostly by low-lying plains and scattered wetlands. The coastal landscapes are monotonous in comparison with the eastern part of the peninsula, and there are few indentations. Some exposed rocky areas occur along the extreme south of the western coast. There, not far from Cape Lopatka, the coastline alternates between low areas covered with grass, marine terraces, and sandy bluffs. Coastal rocks are limited to the headlands of Lopatka, Kambalniy, and Sivuchiy capes. Northward, the low landscapes stretch hundreds of kilometres to Cape Hayrusova and to a rocky area from Cape Yuzhniy to Cape Utholokskiy. Farther north, the rocks are replaced by vast coastal lowlands along the shore of Penzhinskaya Bay.

In spite of severe climatic conditions, the Sea of Okhotsk washing the western coast of Kamchatka has high bioproductivity. There are rich shoals for flounder, swarms of herring, and one of the largest king crab (*Paralithodes* sp.) resources in the world. Unfortunately, there has been no recent review of the seabird colonies on the west coast, and estimates (Table 2) are largely based on 10-year-old observations (Lobkov 1986; Vyatkin 1986; Lobkov and Alekseev 1987).

The prevailing maritime landscape of western Kamchatka offers few opportunities for the colonial seabirds that inhabit the rocky precipices or deep rocky talus slopes; as a result, the seabirds are scarce and sparsely spread. Two exceptions are the Red-faced Cormorant, which is confined to the southern part of the Kamchat Peninsula, and the Spectacled Guillemot, which commonly nests northward from Cape Yuzhniy. Colonies of gulls and terns are widespread on the western coast but are found mainly in river deltas. The current status of most seabird colonies in western Kamchatka is unknown.

The Komandorskiye Islands

The Komandorskiye Islands lie 200 km east of the Kamchat Peninsula (see Appendix 1) and are a continuation of the Aleutian Islands. Their total surface area is 1848 km^2. They are of volcanic origin and are generally rocky. Bering Island is 85 km long and about 40 km wide. Medniy Island is 56 km long and but only 7 km wide. Toporkov is a small flat island lying 6 km northwest of Bering Island, and a further 6 km to sea there is a small rock, Ari Kamen. The Komandorskiye Islands have 17 species of seabirds, and some occur in very large numbers.

Many of the seabirds that nest on the Komandorskiye Islands are very rare or entirely absent from other parts of the Russian Far East. These include the Glaucous-winged Gull, Red-legged Kittiwake, and the local subspecies of the Pigeon Guillemot.

At the present time, the abundance and distribution of the seabird communities nesting on this remote archipelago are surprisingly well known. Much of this is due to the efforts of Yu.B. Artyukhin and recently P.S. Vyatkin, who have compiled and summarized the investigations of many of the early workers, such as Hartert (1920), Ioganzen (1934), who published in English as Johansen (1934), Kartashev (1961), Mikhtar'yantz (1972), and Firsova (1978a, 1983), and placed them in the context of their own studies (Artyukhin 1991, in press a; Vyatkin and Zelenskaya 1993; Vyatkin and Artyukhin 1994; Zelenskaya 1994). In addition to the ornitho-faunal studies, there have been more complex analyses of the archipelago's ecosystems (e.g., Marakov 1963, 1966, 1972, 1975, 1977).

During much of their history, the seabirds of the Komandorskiye Islands were an essential part of the subsistence harvest by indigenous peoples and, more recently, by Russians and other Europeans. This hunt lost much of its significance in the mid-1960s (Artyukhin 1991), but, at present, Aleut people still collect eggs and catch Tufted Puffins, Glaucous-winged Gulls, and murres on Ari Kamen Rock and Toporkov Island. The scale of this poaching is not large and does not have much impact on seabird populations. Natural events have the biggest effect on the seabird populations of Bering and Medniy islands; the direct influence of people is insignificant. The most important factor limiting productivity of some seabird species appears to be predation by arctic fox, but the effect of American mink *Mustela vison* and Norway rat, which were brought by humans and are widespread on the islands, is still insufficiently known and could be critical (Artyukhin 1991).

Table 2
Distribution and abundance of seabirds breeding in the Kamchatka Region of the Russian Far East[a]

	No. of seabirds (000s)		
Species	Eastern Kamchatka	Western Kamchatka	Komandorskiye Islands
Northern Fulmar	114	0	386
Leach's Storm-Petrel[b]	0	0	>2
Fork-tailed Storm-Petrel[b]	0	0	>2
Pelagic Cormorant	24	4	6.2
Red-faced Cormorant[c]	— 4 —		1.7–2.3
Black-headed Gull	200	0	0
Herring Gull	rare	rare	0
Slaty-backed Gull[c]	— 200 —		0
Glaucous-winged Gull	0	0	10.4
Mew Gull[c]	— 100 —		0
Black-legged Kittiwake	404	160	80
Red-legged Kittiwake	0	0	32.3
Common Tern[c]	— 160 —		0
Arctic Tern[c,d]	— 2 —		2
Aleutian Tern[c]	— 8 —		0
Common Murre	250	100	110.8
Thick-billed Murre	374	160	164
Pigeon Guillemot	2.8	0	3.2
Spectacled Guillemot	0.03	2	0
Ancient Murrelet	13	0	<2
Crested Auklet	12	nests[e]	0.24
Whiskered Auklet	0	nests[e]	>2[b]
Least Auklet	0.06	–	0.06–0.08
Parakeet Auklet[c]	— 11–12 —		3.7
Horned Puffin[c]	— 6 —		6
Tufted Puffin[c]	— 93 —		127

[a] Main sources: Averin 1948; Vyatkin and Marakov 1972; Kharkevich and Vyatkin 1977; Gerasimov 1986; Lobkov 1986; Vyatkin 1986, in press a,b, and unpubl. data; Artyukhin 1991, in press b, and unpubl. data.
[b] Value given as "several thousand pairs."
[c] Value given is for both the eastern and western Kamchatka Region.
[d] Value given is maximum.
[e] Nests but numbers unknown.

THE SOUTH REGION

The southern Far East is home to a diverse and abundant seabird assemblage. Thirty species breed in the region (Table 3), which extends from the Shantar Islands in the western Sea of Okhotsk to Peter the Great Bay and along the whole archipelago of the Kuril Islands, including the Lesser Kuril Islands (see Appendix 1). Peter the Great Bay marks the limits of the range for several species. Streaked Shearwater and Swinhoe's Storm-Petrel do not breed farther north, whereas Common Murre and Pelagic Cormorant do not breed farther south.

Asia's coast, from the Russian boundary with Korea to the southwest Sea of Okhotsk, has large seabird colonies only in the extreme south in Peter the Great Bay on the western shore of the Sea of Japan and at the extreme west among the Shantar Islands in the southern Sea of Okhotsk. The coasts of Sakhalin are generally unsuitable for seabird breeding. Some colonies occupy the rare rocky capes or two islands: Moneron and Tyuleniy. In comparison, the Kuril Islands extend almost 1200 km and offer abundant

Table 3
Distribution and abundance of seabirds breeding in the southern Russian Far East[a]

Species	Shantar Islands	Sakhalin, Moneron, and Tyuleniy islands	Kuril Islands	Islands of Peter the Great Bay	Coast from Shantar Islands to Tumangan River	Total
	No. of seabirds (000s)					
Northern Fulmar	0	some	>150	0	0	>1500
Streaked Shearwater	0	0	0	0.3	0	0.3
Swinhoe's Storm-Petrel	0	0	0	15–16	0	15–16
Leach's Storm-Petrel	0	some[b]	350	0	0	350
Fork-tailed Storm-Petrel	0	possibly	200	0	0	200
Great Cormorant	0	0	0	0.8	0	0.8
Japanese Cormorant	–	0.6	7	>3	4–5	15–16
Pelagic Cormorant	few	<0.1	50–60	0.3	1.7	50–60
Red-faced Cormorant	0	0	20–30	0	0	20–30
Black-headed Gull	7–8	0.02	0	0	>0.2	7–8
Slaty-backed Gull	0.5	>1	<90	some[b]	2	90
Black-tailed Gull	0	8	0.8	>100	0.8	>100
Black-legged Kittiwake	few	7.2	<90	0	0	90
Common Tern	0	14	0	0.6	>10	25
Arctic Tern	–	rare[c]	0	0	0	rare[c]
Aleutian Tern	>0.3	4.6	0	0	1.4–1.8	6–7
Thick-billed Murre	0.1	2–2.4	35–50	0	0	35–50
Common Murre	0.1	160–180	300	1.4	some[b]	460–480
Pigeon Guillemot	0	0	>5	0	0	>5
Spectacled Guillemot	12–15	1–1.2	<5	12	8–9	38–40
Long-billed Murrelet	>0.2	few	few	0	0.6–0.8	1000
Ancient Murrelet	few	<0.2	3	1.2	few	4.3–4.5
Japanese Murrelet	0	0	0	some	0	some
Parakeet Auklet	0	0.1–0.12	<1	0	0	1
Crested Auklet[d]	0	5	>100[d]	0	0	>100[d]
Whiskered Auklet[d]	some	possibly	[d]	0	0	[d]
Least Auklet	0	0	<1	0	0	<1
Rhinoceros Auklet	0	>4	>10	0.4	some[b]	15
Horned Puffin	3	some	3–4	0	0	7–8
Tufted Puffin	6–7	some[b]	150–200	–	some[b]	150–200

[a] Main sources: Lybzyuk 1975; Nechaev 1975, 1986, 1991; Voronov 1975; Elsukov 1984; Roslyakov 1986, 1994; Babenko and Poyarkov 1987; Shibaev 1987, 1990a,b,c; Litvinenko and Shibaev 1991, and unpubl. data; Anissimova 1996; Babenko 1996; Roslyakov and Roslyakov 1996; Shibaev and Litvinenko 1996; Trukhin and Kuzin 1996.
[b] A few dozen birds.
[c] Six to eight individuals.
[d] Crested and Whiskered auklets are both included in the single value for the Kuril Islands.

opportunities for seabird breeding sites. Counts have been carried out from the decks of ships at sea and by brief landings on the islands by boats, helicopters, and small aircraft, but many colonies are still not well known. The Shantar Islands were surveyed in 1991 and 1992 (Roslyakov and Roslyakov 1996). The most detailed surveys have been in Peter the Great Bay, where most islands have been visited periodically over the last 25 years.

Climatic cycles and fluctuations of pelagic fish stocks have been observed in this region over several centuries, and observations over the last 200 years suggest a 50- to 60-year periodicity (Klyashtorin and Sidorenkov 1996). In the late 1970s and the 1980s, there was an increase in the number of some seabirds breeding in the Sea of Japan, particularly Black-tailed Gull, Slaty-backed Gull, and Japanese Cormorant. These species apparently benefited from climatic changes in the north part of the Pacific. General temperature increases from the mid-1970s to the late 1980s brought population increases in Pacific sardine and walleye pollock *Theragra chalcogramma* (Shuntov 1986; Klyashtorin and Sidorenkov 1996), which are the main food of those birds. In the early 1990s, the seas cooled and the number of sardines decreased. In recent years, there has been mass mortality of Black-tailed Gull chicks in Peter the Great Bay, and fledging success has fallen below 5%. These observations suggest a direct link between seabird abundunce or productivity and long-term environmental cycles in the Sea of Japan.

Peter the Great Bay

Peter the Great Bay is situated in the southern Russian Far East (Appendix 1), where the warm Tsushima Current intrudes on colder waters from the north. It has a winding coastline with many gulfs and bays, capes, and islands and diverse types of shores and soil offering many nesting opportunities to seabirds. There are 20 significant seabird colonies. The Far East Marine Reserve established in Peter the Great Bay in 1978 includes 63 000 ha of water and 1300 ha of land on Furugelm, Falshivy, Vera, Bol'shoy Pelis, Stenin, Matveyev, De-Livron, and Gildebrandt islands. Most of the seabird colonies of Peter the Great Bay are included in its territory.

Seabird study in Peter the Great Bay has been based on a series of periodic observations and precise counts using several methods. As a rule, only some islands and part of the shoreline could be included in each attempt, and it was several years before the whole area was surveyed. The completeness of the counts varied depending on the species and method used. For example, direct counts of nests in small colonies of Black-tailed Gulls or Common Terns were made from water with the observers in a rowboat, motorboat, or ship and occasionally from the air with observers in a small helicopter. The best accuracy was obtained by direct count of nests from the ground or from a small rowboat, which could follow the shoreline closely with occasional stops (Firsov 1928; Nechaev and Yudakov 1968; Labzyuk et al. 1971; Labzyuk 1975; Nazarov and Trukhin 1985; Shibaev 1987) (Table 3).

Counts of all three species of cormorants were based on a complete tally of nests, conducted primarily from a rowboat (occasionally from other kinds of transport) or from convenient shoreline rocks. When a helicopter was used, the population count was necessarily only approximate. This is the case for helicopter surveys of all species. Only in the smallest, most compact colonies was the helicopter count more accurate. Counts conducted aboard ships also lacked the required degree of accuracy.

Estimates of Black-tailed Gulls in large colonies were based on direct counts of breeding birds from a rowboat, with subsequent correction of the results. At this time (breeding period), usually one but occasionally two birds were seen at each nest. To obtain the final result (the number of reproductive pairs), it was necessary to exclude these extra mates and any nonreproductive birds and calculate the number remaining unseen as a result of high grass or folds in the terrain. This adjustment factor was based on counts within a sample of completely counted plots. The proportion of birds overlooked (22%) turned out to be virtually equal to the proportion of extra mates (25%). Thus, the total number of birds counted could be used as the number of reproductive pairs.

Numbers of Common Terns were determined by counting all the nests in the colonies or by counting from various forms of transport. Usually, this latter case required an approximate evaluation of the number of birds flying above the colony.

Estimates of Spectacled Guillemot abundance were based on counts conducted between 06:00 and 09:00, at which time the largest number of birds gather in the sea opposite the colony. All birds sitting on the water were counted from a rowboat moving along the shoreline. Guillemots sitting on rocks in the open or in their burrows were also frightened and counted as they flew out. By our calculations, approximately 10% of the birds remained under cover and were not counted. It has not yet been possible to calculate how many of the birds counted were immature or nonbreeding subadults. The portion of birds overlooked among the rocks or, more especially, in the burrows must increase substantially when counts are conducted farther from the shore in passing motorboats or ships.

Long-billed Murrelets were also counted on the water. We felt that the number in the morning reflected the approximate number of breeding birds, whereas evening counts reflected the whole local population gathering for the night. Most Long-billed Murrelet movement occurs in the hours of darkness, when they cannot be counted effectively.

In seabird surveys, it is especially difficult to determine the number of burrowing birds, which are active in the nesting colony only at night. The small number of Rhinoceros Auklets could be obtained by direct observations on the colony, and the number of Swinhoe's Storm-Petrels, which excavate burrows in soft soil, could be extrapolated from sample 5 × 5 m plots. However, calculating nest densities of the Ancient Murrelet on samples of plots is impractical because the birds nest both in burrows dug into the ground and in crevices or openings in rocky rubble. In addition, their local distribution is extremely irregular. For this reason, we preferred to base our estimates on the numbers gathering at assembly areas adjacent to the colony in the morning and evening. The best time for counting is the second half of May and the beginning of June (incubation period). Calm weather is an important factor.

Northwest coast of the Sea of Japan from Cape Povorotniy to Cape Lazarevo

This part of the sea coast is the east slope of the Sikhote-Alin mountain ridge. The steep banks are rocky and sheer, but the shoreline is generally smooth, with mountain rivers entering the sea in the few small inlets. There are few sea cliffs or offshore islets. The forest (taiga) is contiguous with the sea edge, and there is a full array of terrestrial predators inhabiting the Ussuri taiga, limiting nesting seabirds to those cliffs inaccessible to mammals. The density of the human population in this area is low, with a few small (as a rule) settlements scattered along the full length of the shoreline.

There are 53 nesting colonies here, situated on the coastal cliffs and lowlands (Shulpin 1936; Elsukov 1984).

Shantar Islands

The Shantar Archipelago consists of 15 large and small islands. The area of the biggest of them — Bol'shoy Shantar — is 1790 km^2. The shores are lined with numerous reefs, cliffs, and islets, and the winter ice does not melt until June or even July. There are many small mountain rivers and streams. Tides are large, ranging from 5 to 8 m.

Big islands are covered with forest, consisting of Siberian spruce *Picea obovata*, Dahurian larch *Larix gmelini*, birch (*Betula* spp.), and mountain pine *Pinus pumila*. There are many mammalian predators, including brown bear, wolf, red fox, raccoon dog *Nyctereutes procyonoides*, wolverine, Eurasian river otter *Lutra lutra*, ermine, common weasel *Mustela nivalis*, and sable. The seabird colonies are situated in a few sites on sheer coastal cliffs and small islands, such as Ptichy, Utichiy, Yuzhniy, Sredniy, and Severniy, which are inaccessible to most terrestrial predators.

The census of colonies of the Shantars is still at a very early stage, and total numbers are unknown (Table 3), but colonies of 11 seabird species have been found, including the largest colony of the Spectacled Guillemot in the Russian Far East (Dulkeit and Shulpin 1937; Yakhontov 1977; Roslyakov 1986, 1991, 1994; Roslyakov and Roslyakov 1996).

Sakhalin Island

Sakhalin is a very large island (78 000 km^2) whose shores are, for the most part, gentle and of little use for seabird breeding colonies. Only 21 small seabird colonies have been described (Gizenko 1955; Mikhtar'yantz 1986; Nechaev 1986, 1991) (Table 3).

Moneron Island

Moneron Island lies 50 km from the southwest coast of Sakhalin Island. It is the remainder of an extinct volcano covering 21 km^2 and rising 440 m above the sea. Its precipitous coasts are volcanic igneous rocks. Vegetation consists mostly of shrubs and grasses, such as *Sasa kurilnsis*, *Filependula camtschatica*, *Petasites* sp., *Urtica platyphylla*, and *Angelica ursina*. In the area of the seabirds, the dominant plants are grasses such as *Artemisia* sp., *Senecio* sp., and *Elymus* sp. There are small patches of forest, where the most common trees are *Betula ermanii*, *Alnus maximovichii*, and *Phelodendron sachalinense.* Several species of mammal have been introduced on the island, including Norway rat, a vole (C*lethrionomys rufocanus*), shrews (*Sorex* spp.), red fox, and sable.

Norway rat may live in seabird colonies, eating eggs and chicks of Rhinoceros Auklets and Black-tailed Gulls. The rats probably reduce the numbers of Ancient Murrelets and Leach's Storm-Petrel, which are found only in small numbers. Red fox is very rare, and there is no detailed information on its influence on seabirds. Sable was introduced to Moneron in 1958–1959 and quickly destroyed all accessible colonies. Subsequently, their numbers declined.

Local people on Moneron and the crews of fishing boats systematically robbed colonies, using seabirds as a source of protein. This impact was especially severe in the 1950s and 1960s but is now much reduced.

More than 10 000 seabirds of at least 10 species nest here (Benkovsky 1968; Nechaev 1975; Shibaev and Litvinenko 1994) (Table 3).

Tyuleniy Island

Tyuleniy Island is in the southwest Sea of Okhotsk at a distance 15 km from the south tip of the Terpeniya Peninsula (Sakhalin Island). It is only 6.5 ha, rising 18 m from the sea to a plateau occupied by a colony of Common Murres. The island is covered (here and there) with grassy vegetation, such as *Elymus* sp., *Senecio* sp., *Chenopodium* sp., or *Mertensia* sp. Vegetation is absent from the Common Murre colony.

There are colonies of fur seals and Steller's sea lion *Eumetopias jubata*, as well as seals. The island is visited by many people from spring to autumn, and the local fishery has been carried on for more than a century.

Tyuleniy Island has been visited periodically by seabird biologists, and the colonies of the five species that nest there have become fairly well known (Golovkin and Georgiev 1970; Voronov 1972; Bychkov 1975; Nechaev and Timofeeva 1980; Gluschenko 1988; Trukhin and Kuzin 1996). It is of greatest importance for the Common Murre. However, long-term, uncontrolled exploitation of the seabirds for eggs and meat has greatly decreased their numbers. Gizenko (1955) reported 628 000–650 000 birds in 1947–1948, Kartashev (1963) about 300 000 in 1960, and Nechaev and Timofeeva (1980) only 100 000–150 000 in 1969–1976 (Table 3).

Kuril Islands

The chain of the Kuril Islands stretches nearly 1200 km from the southwest to the northeast (see Appendix 1). There are more than 30 islands in this archipelago and a great number of small islets and sea cliffs. The Kurils are an unbroken chain of mostly active volcanoes.

The first census of seabirds of the Kuril Islands was accomplished by A.G. Velizhanin more than 35 years ago in 1963 (29 May – 22 August), although there are reports of earlier observations (e.g., Bergman 1935). Velizhanin observed all islands of the archipelago from a ship or boat, landing where possible. He later carried out censuses in 1966 on Shikotan, Shumshu, and Paramushir islands and in 1968 on Iturup, Shikotan, and Kunashir islands (Velizhanin 1972, 1977a, 1978). There have been few more recent visits, and the study of the numbers and distribution of seabirds on this archipelago is at an initial stage (Belkin and Velizhanin 1965; Nechaev 1969; Voronov 1975; Ostapenko et al. 1977; Iliyashenko et al. 1988; Anissimova 1996).

More than 60 seabird colonies occur on the Kuril Islands; unfortunately, their number and structure are still largely unknown (Table 3).

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Chapter 4. Seabird distribution in the marine domain

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Summary

The seas of the Russian Far East provide seasonal habitat for millions of migrant seabirds, many from northern Asia, but also wanderers from the southern hemisphere. Birds on breeding colonies offer all sorts of opportunities to study food preferences and energetic requirements, but birds at sea are much less accessible, and our information is largely confined to the summer and early autumn, when ships are available for the study of plankton production and fishing activity. Early storms and lingering ice prevent most scientific activity in winter and spring; as a result, we have only fragmentary knowledge of bird movements and interannual variation in abundance. More importantly, we have a weak understanding of the specific mechanisms linking seabird concentrations to oceanographic and hydrobiological phenomena.

In spite of these difficulties, it is clear that the bird distributions in the Russian Far East respond in a general way to variations in food availability created by the complex topography, geography, and oceanography of the area. To some extent, the summer distribution of many species can be predicted by the effects of upwelling and other oceanographic factors on food availability. Some species, such as sea ducks, which are most abundant during migration, concentrate in the waters over the continental shelf, where bottom-dwelling prey is within reach of their diving capabilities, but the preferred habitat of planktivorous and piscivorous species that range over deeper water changes from year to year. In autumn, ice drives many species off the continental shelves, and most oceanic species completely abandon the Sea of Okhotsk, but some birds have learned to overwinter in the area. They have adapted to life in polynyas (open areas that are created each year by oceanographic phenomena) or along the ice edge, where there are local concentrations of nutrients. In spring, the pattern and timing of breakup of the pack ice have a strong effect on migration and the breeding schedule of birds on their way north.

Résumé

Les mers de l’Extrême-Orient russe accueillent chaque saison des millions d’oiseaux de mer migrateurs provenant en majeure partie d’Asie du nord, mais également de l’hémisphère sud. Si les occasions ne manquent pas pour étudier les préférences alimentaires et les besoins énergétiques des oiseaux des colonies de nidification, les oiseaux qui se trouvent en mer sont par contre beaucoup moins facilement accessibles et les données dont nous disposons ont pour l’essentiel été recueillies durant l’été et le début de l’automne, lorsqu’il est possible d’utiliser des navires pour étudier la production planctonique et l’activité halieutique. En hiver et au printemps, les tempêtes et les glaces font obstacle à la plupart des activités scientifiques et nous n’avons donc qu’une connaissance fragmentaire des déplacements des oiseaux et des variations interannuelles de leur abondance. Surtout, nous connaissons mal les mécanismes particuliers qui rattachent les concentrations d’oiseaux de mer aux phénomènes océanographiques et hydrobiologiques.

En dépit de ces difficultés, il est clair que la répartition des oiseaux dans l’Extrême-Orient russe dépend de façon générale des variations dans la disponibilité des ressources alimentaires, variations qui sont attribuables à la complexité du relief, de la géographie et de l’océanographie de la région. Dans une certaine mesure, la répartition estivale de nombre d’espèces peut être prévue en fonction des conséquences des phénomènes de remontée d’eau et d’autres facteurs océanographiques sur la disponibilité des ressources alimentaires. Certaines espèces, comme les canards de mer, qui sont plus abondantes durant les migrations, se concentrent dans les eaux du plateau continental, où les poissons de fond dont elles se nourrissent séjournent dans des eaux suffisamment peu profondes pour qu’elles puissent les atteindre. Toutefois, l’habitat préféré des espèces planctivores et piscivores qui parcourent les régions où les eaux sont plus profondes change d’année en année. En automne, la glace repousse bien des espèces loin des plateaux continentaux et la plupart des espèces océaniques abandonnent complètement la mer d’Okhotsk. Certains oiseaux ont cependant appris à y passer l’hiver. Ils se sont adaptés à la vie dans les polynies (des zones d’eau libre créées chaque année par des phénomènes océanographiques) ou le long du front des glaces, où ils trouvent de fortes concentrations d’éléments nutritifs. Au printemps, la manière dont la banquise se disloque et le moment où cette dislocation survient ont un effet marqué sur les schémas migratoires et de reproduction des oiseaux qui remontent vers le nord.

Общее изложение

Миллионы пролетных птиц избирают своим сезонным обиталищем моря российского Дальнего Востока. Многие из них прилетают из северных районов Азии, однако есть и такие, кто попадает туда из южного полушария. Птицы колоний, гнездящихся для выведения потомства, предоставляют разнообразные возможности для исследования привычек питания и энергетических потребностей, однако птицы в море менее доступны для наблюдений и имеющиеся сведения касаются в основном лета и начала осени, когда есть суда, на которых можно изучать производство планктона и рыболовецкую активность. Зимой и весной проведению научных исследований препятствуют ранние шторма и длительное присутствие льдов. Следовательно, наши знания о перелетах птиц и вариациях их числа в течение года носят лишь фрагментарный характер. Более того, мы недостаточно хорошо понимаем особые механизмы воздействия явлений океанографического и гидробиологического характера на численность морских птиц.

Несмотря на эти трудности, можно сделать вывод о том, что распределение популяций морских птиц на российском Дальнем Востоке в общей сложности соответствует вариациям в наличии корма, диктуемым сложной топографией, географией и океанографией региона. В определенной степени можно предсказать летнее распределение многих видов птиц в результате воздействия апвеллинга и других океанографических факторов на доступность корма. Некоторые виды птиц, например, нырковые утки, которые встречаются в большом количестве в период перелета, концентрируются в водах зоны континентального шельфа, где они могут доставать придонные виды добычи. Однако, предпочтительные места обитания планктоноядных и рыбоядных видов птиц, которые могут находиться над водами с большими глубинами, варьируют с каждым годом. Осенью лед заставляет птиц многих видов покидать континентальный шельф и многие океанские виды совершенно покидают Охотское море, однако многие виды приспособились и зимуют, оставаясь в этом регионе. Они адаптировались к жизни в полыньях (открытые зоны, появляющиеся ежегодно в результате явлений океанографического характера) или на ледовой кромке, где имеются локальные концентрации питательных элементов. Весной характеристики и сроки таяния льдов в значительной степени воздействуют на перелеты птиц и сроки выведения потомства птицами, направляющимися на север.

Oceanographic features

The character of the seas of the Russian Far East is the product of a suite of features: geographic configuration, connections to the great oceanic gyres, coastal topography and bottom contour, and the peculiarities of hydrological and hydrobiological circulation. All of these affect the seasonal activity, abundance, distribution, and species composition of seabirds. Feeding conditions and nesting opportunities modify the effect of the physical environment and lead to considerable diversity among the waters of the Far East. This is hardly surprising, considering that the Bering Sea borders on the Arctic Ocean, whereas the southern Kurils and Peter the Great Bay touch the subtropical zone. Even between adjacent regions, complex bottom relief or the convergence of currents can mix water masses, making fundamental differences in the conditions that affect birds.

Sea of Okhotsk

Seabird distribution

The geography of Russia's North Pacific coast places the Sea of Okhotsk at the junction of large avifaunal regions. Some northern seabirds migrate into it for the boreal winter, whereas others from the southern hemisphere arrive for the Russian summer, the austral winter. Although seasonal migrants make up the bulk of the numbers at most times of the year, the breeding populations are not insignificant. More than half of the seabirds breeding in the Russian Subarctic Pacific concentrate on sites within the Sea of Okhotsk or along the Kuril Islands, where they have been studied extensively by such workers as Gizenko (1955), Velizhanin (1972, 1978), Trukhin and Kosygin (1986), and Shuntov (1972, 1986). During the last decade, estimates of abundance for some of these species have changed significantly (Nechaev 1991; Kondratyev 1991, 1993, 1996; Kondratyev et al. 1992; Shuntov 1995a,b, 1997, in press a; Roslyakov and Roslyakov 1996; Trukhin and Kuzin 1996).

The Sea of Okhotsk is inhabited by 15.8 million seabirds of 32 species (Table 1). The alcids, at 11.5 million individuals (73% of the total), and the procellariids, at 3.2 million individuals (20% of the total), are the most numerous, leaving only 7% for other groups. Alcids tend to be the greatest component of populations in the inner parts of the basin, whereas procellariids concentrate along the Kuril Islands — i.e., on the boundary between the coastal seas and the open ocean. Three alcid species are represented by more than one million individuals — Least Auklet *Aethia pusilla* (5.5 million),[1] Crested Auklet *A. cristatella* (2.5 million), and Common Murre *Uria aalge* (1.3 million) — and one procellariid species, Northern Fulmar *Fulmaris glacialis* (2.0 million). Four other species have over half a million members: Fork-tailed Storm-Petrel *Oceanodroma furcata*, Black-legged Kittiwake *Rissa tridactyla*, Thick-billed Murre *Uria lomvia*, and Tufted Puffin *Fratercula cirrhata*. These estimates will likely change with more detailed observations and broader coverage in the future. This is especially true on the Kuril Islands, where the most recent counts were carried out by A.G. Velizhanin in the 1960s, and in the Ayan-Okhotsk Area, where no systematic observations have ever been made.

Interannual variation in the summer and autumn distributions of marine birds contributes to much local variation in species composition and abundance (Table 2) (Shuntov 1986, 1995a,b, 1997, in press a). On the northern shelf of the sea (Fishery Biostatistical Areas [FBAs] 1– 4; see Figs. 7 and

[1] See also Chapter 3 of this volume and Kondratyev et al. (1993).

Table 1
Species composition and abundance of seabirds nesting in the Sea of Okhotsk

Group	No. of seabirds (000s) Kuril Islands	Northeast	Northwest	Southwest	Total
Procellariids	2 600	500	70	some	3 170
Cormorants	87	16	20	0.2	123
Phalaropes	0	10	0	some	10
Jaegers	some	20	0	0	20
Gulls	181	638	85	7	911
Terns	possibly	57	10	25	92
Alcids	1 659	9 024	595	227	11 505
Total	4 527	10 265	780	259	15 831

Table 2
Percent composition of seabird groups in the Sea of Okhotsk in summer (June through August 1988) and autumn (October and November 1984) (Shuntov 1995a)

Fishery Biostatistical Areas[a]	Summer: Density (birds/km^2)	Summer: Non-diving birds (%)	Summer: Diving birds (%)	Summer: Shear-waters (%)	Autumn: Density (birds/km^2)	Autumn: Non-diving birds (%)	Autumn: Diving birds (%)	Autumn: Shear-waters (%)
1	5.5	30	67	3	9	13	83	4
2	13.2	31	66	3	16	8	63	29
3	3.7	46	53	2	6	44	8	48
4	2.5	37	63	0	2	54	18	29
5	2.7	40	60	0	3	32	28	41
6	1.6	85	14	2	6	16	13	72
7	2.1	53	23	24	15	13	38	50
8	10.7	26	5	69	23	13	8	78
9	1.4	60	9	31	2	57	32	11
10	2.3	60	16	24	2	28	66	6
11	27.7	1	2	97	4	26	45	29
12	2.2	65	13	22	4	79	17	4
13	14.1	18	7	75	13	73	24	3

[a] See Chapter 2, Figure 7.

8 in Chapter 2)[2] in summer, alcids are the largest group, and variation in their numbers seems to affect numbers of fulmars, kittiwakes, and Slaty-backed Gulls *Larus schistisagus*. In the abyssal parts of the sea (FBAs 9, 12, and 13), fulmars, shearwaters, and storm-petrels form the base of the seabird community in summer, although shearwaters prefer the margins of the deep areas. Waters around the TINRO and Derjugzina abysses at the northern edge of the deep waters (FBAs 5 and 6) have a transitional species composition, whereas waters around Sakhalin (FBAs 10 and 11) and Kamchatka (FBAs 7 and 8), outside the neritic zone, are dominated by shearwaters and fulmars in summer, but alcids and gulls are not rare. Under unusual oceanographic and hydrological conditions, the seabird distribution can vary considerably, even during the breeding season (Table 3).

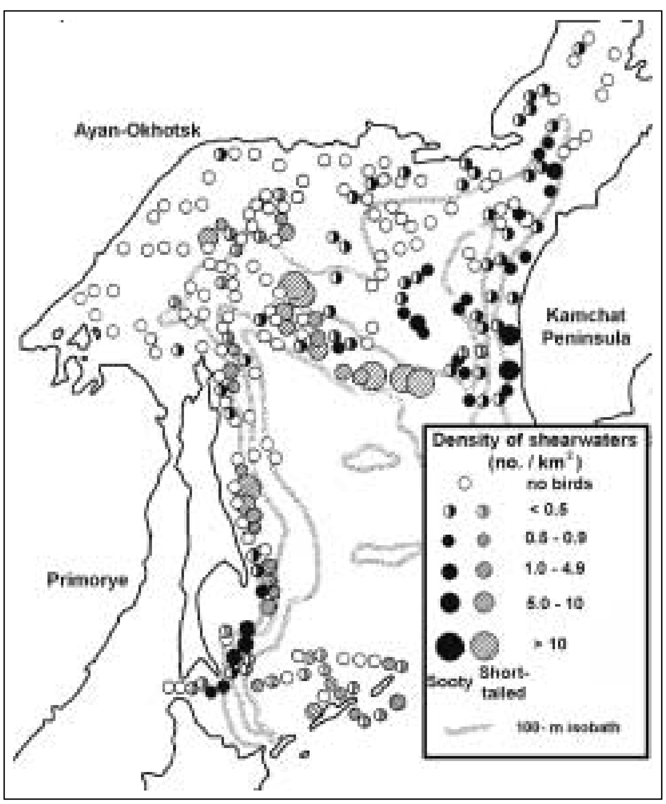
Abundant migrants from the southern hemisphere, mostly Sooty and Short-tailed shearwaters (*Puffinus griseus* and *P. tenuirostris*), also have a characteristic seasonal distribution, but one that differs from that of the breeding birds. They arrive in the southern part of the sea in May, to begin their winter processes of moulting and building up fat deposits (Shuntov 1972, 1995a). In summer, especially in early summer, Sooty and Short-tailed shearwaters are numerous only along the chain of the Kuril Islands and in the southern Sea of Okhotsk. It is not until late summer or early autumn that they become numerous in the north (Fig. 1). Even then, the Flesh-footed Shearwater *Puffinus carneipes* remains in the southern parts of the sea. For other species, mid-August sees a dramatic increase in the number of shearwaters between the Iona-Kashevarova area and southern Kamchatka, over the continental slope. In recent years, there has been a stronger influx in the northwest, possibly as a result of a weakening of the Western Kamchat Current and a subsequent strengthening of the Sredinnoje Current. By the end of summer, the number of shearwaters in the southern Sea of Okhotsk has declined significantly. Some have moved

[2] The Fishery Biostatistical Areas are those established by the Pacific Research Institute of Fisheries and Oceanography for fisheries research in the Sea of Okhotsk.

Table 3
Abundance and distribution of seabirds off Sakhalin and in the Iona–Kashevarova region of the Sea of Okhotsk, July–August 1997

	Sakhalin waters north of Cape Terpeniya		Sakhalin waters south of Cape Terpeniya		Iona–Kashevarova area	
Species or group	9–15 July	21–24 August	8 July	25–28 August	13 July – 2 August	16–21 August
Sooty and Short-tailed shearwaters	13.7	321.1	80.7	8.6	4.5	772.7
Northern Fulmar (dark phase)	90.1	12.2	61.0	150.4	94.7	251.7
Northern Fulmar (light phase)	5.5	0	1.6	1.3	72.0	26.4
Fork-tailed Storm-Petrel	62.5	0	61.0	0	109.8	26.4
Other procellariids	0	0	0	0.9	0	0
Black-legged Kittiwake	4.9	1.9	0	0	17.1	87.0
Slaty-backed Gull	1.6	0.4	0	0.9	9.3	6.4
Herring Gull	0	1.9	0	0	1.6	3.5
Other gulls	1.9	0	0	2.2	4.3	4.6
Terns	0	7.6	0	0	0	4.3
Jaegers	1.0	1.5	0	1.3	0	0.7
Phalaropes	7.1	0	0	262.9	9.1	0
Murres	17.9	7.6	2.1	3.0	72.4	151.8
Tufted Puffin	21.8	2.3	0	0	12.0	24.3
Horned Puffin	2.0	0	0	0	0.8	0
Crested Auklet	0	0	0	0	0	149.2
Parakeet Auklet	0	0	0	0	2.7	9.3
Rhinoceros Auklet	0	0	0.8	5.2	0	0
Total	230.0	356.5	207.2	436.7	410.3	1517.3
Birds/km^2	2.0	3.1	3.7	7.8	2.6	9.9
No. of observations	24	20	9	9	52	29

Figure 1
Distribution and abundance of Sooty Shearwater and Short-tailed Shearwater in the Sea of Okhotsk through July and August 1997



into northern waters, but many adult birds return to the southern hemisphere.

Migrations

Spring migration takes many of the seabirds that wintered in the Sea of Okhotsk to nesting areas in the north, whereas others arrive from farther south, including the southern hemisphere. These migrants increase the diversity of birds on the Sea of Okhotsk by about a third and make estimates of the ratio of nesting to nonnesting birds problematic. In some species, there is continuous substitution of individuals during an extended migration period, and we have not been able to distinguish residents from migrants. A preliminary estimate would place 4.0–4.5 million nonresident seabirds in the Sea of Okhotsk during migration and in winter, including three million shearwaters (Sooty, Short-tailed, and Flesh-footed), among which there is a great turnover in that group, and the total number of birds, breeding and nonbreeding, could be nearer 20 million. Including migrants and residents, the seabird composition of the Sea of Okhotsk is about 59% alcids, 31% procellariids, and 10% others. This latter category includes 2–3 million birds, such as grebes, loons, and ducks, that are not true seabirds but use coastal waters on migration and, to some extent, in winter. Sea ducks are the largest component of these.

Spring is marked by a general movement away from most of the open waters, but large movements may carry coastal species across open areas. Many birds concentrate for migration along the coasts and across the straits to coastal breeding areas in April and May. Subadult birds are among the last migrants and often do not move until June. Waterfowl and shorebirds migrate from the Sea of Okhotsk through Shelikhov Gulf into Penzhinskaya Gulf and then follow the valleys of the Penzina and Anadyr rivers into the Bering Sea and the Arctic Ocean. This same route is likely suitable for jaegers and phalaropes as well as Glaucous *Larus hyperboreus*, Herring *L. argentatus*, Ivory *Pagophila eburnea*, and Ross' *Rhodostethia rosea* gulls.

In autumn, distributions and movements are much more variable. Jaegers leave for the high seas before most other birds. The Slaty-backed Gull disperses unevenly from coastal colonies (Fig. 2), but numbers remain low in the central areas of the sea. It uses two basic migration routes to wintering areas — through Laperuza Strait, southward into the Sea of Japan, and from the northern Kuril area into the Pacific Ocean. The Black-legged Kittiwake, the most pelagic of the gulls, may stay in the shelf waters almost year-round but mostly disperses to the open Pacific, the Sea of Japan, or the East China Sea for the winter (Shuntov 1972). Most Tufted Puffins migrate to the abyssal areas at the end of their breeding season and then move gradually into the Pacific Ocean. Murres wait until ice begins to restrict the amount of open water before they move gradually to the Pacific Ocean or the Sea of Japan, following two main routes around the abyssal area.

In spite of distributional changes between summer and autumn, the proportion of surface-feeding birds is close to 30% in both seasons (Table 2) (Shuntov 1986, 1995a). Shearwaters, which comprise about 45% of all birds in summer, decline to about 35% in autumn, and the proportion of resident diving birds increases from 25% in summer to 34% in autumn.

Biotic and abiotic factors influencing distribution

About 92% of seabird nesting occurs in the eastern part of the Sea of Okhotsk or among the middle and northern Kuril Islands. Not more than 6% of birds use the western part of the basin. Much of this distribution is the product of three environmental events:

a) The effects of climate and marine conditions are mitigated by the moderating influence of nearby oceanic waters.

b) Biological productivity for the nekton and nektobenthos is enhanced by intrusions and upwellings of nutrient-rich oceanic waters, especially near the Kuril Islands and in the northeastern part of the sea (Shuntov 1985; Shuntov and Dulepova 1996).

c) There are more nesting opportunities in appropriate habitats in the eastern part of the sea, again especially on the Kuril Islands, but also on islands in Shelikhov and Tauyskaya gulfs.

The presence of suitable nesting places, especially small islands, plays a great role in the distribution of breeding colonies, and their clumped distribution quantitatively affects the distribution of birds at sea, but the relationship is not always straightforward. Observed abundances and coastal distributions (Figs. 3–5) do not always conform to the distribution of the most populous colonies. For instance, the largest breeding colonies are near the middle of the Kuril Islands chain (Velizhanin 1978), but, on average, the density

Figure 2
Distribution and abundance of Slaty-backed Gull in the Sea of Okhotsk in the summer of 1988 and autumn of 1984

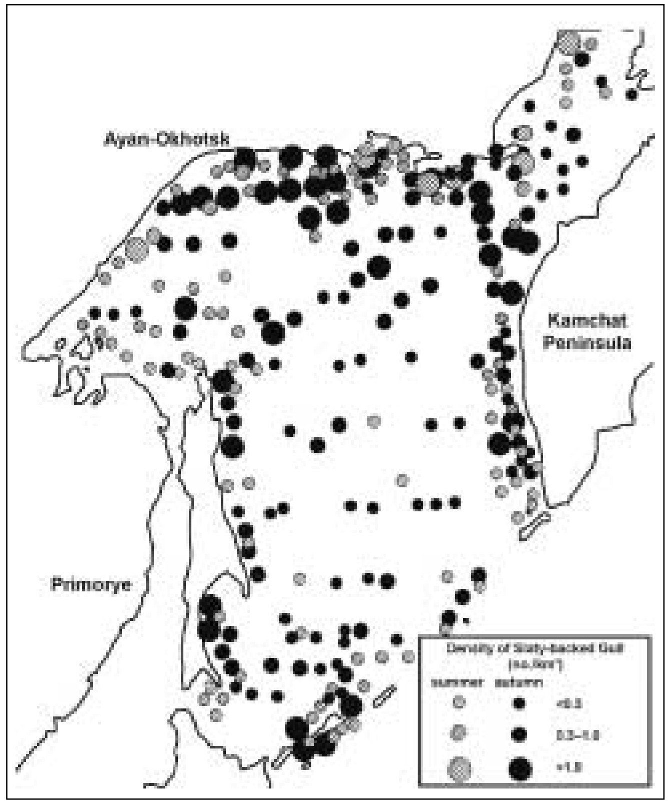


Figure 3
Distribution and abundance of all procellariids in the Sea of Okhotsk from June through August 1988

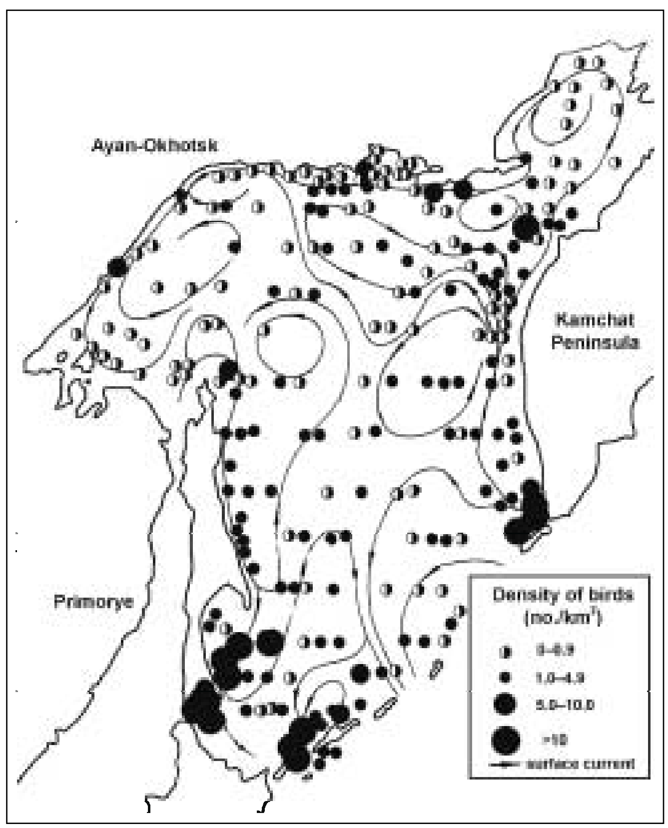


Figure 4
Distribution and abundance of seabirds, other than procellariids, in the Sea of Okhotsk from June through August 1988

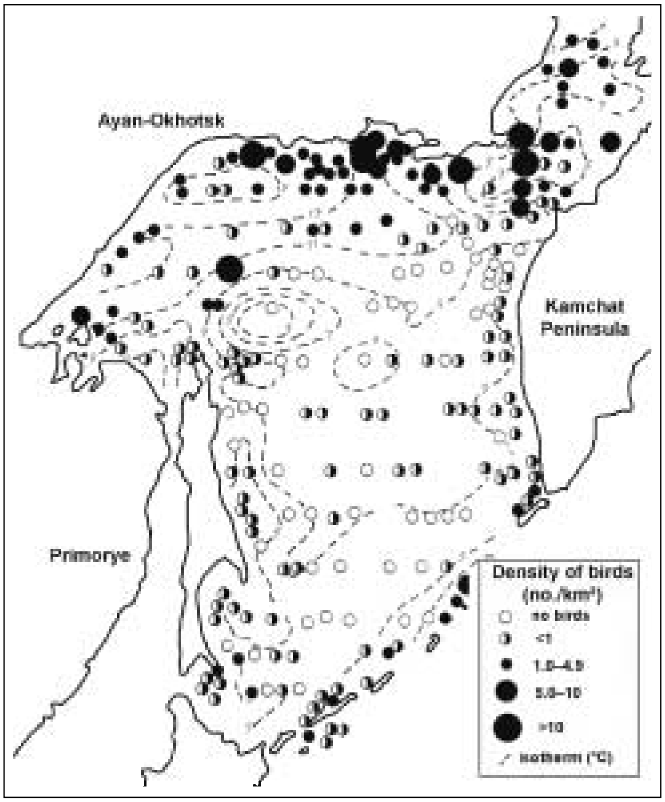
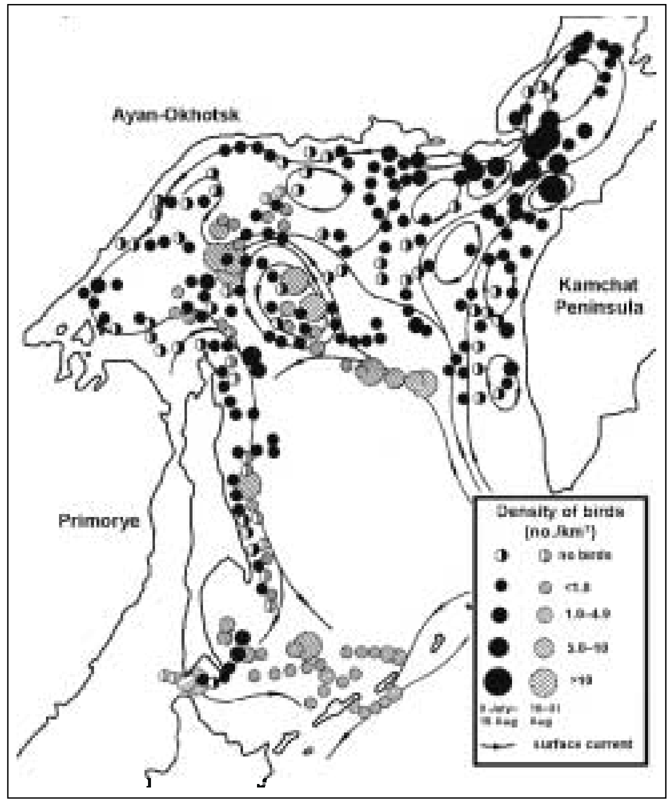


Figure 5
Distribution and abundance of seabirds in the Sea of Okhotsk from July through August 1997



of birds in the nearby sea is not very high. In contrast, densities at sea in summer and autumn are high, even very high along the southern coast of Sakhalin, off Hokkaido, among the southern Kuril Islands, and off western Kamchatka, but there are no large seabird colonies. This bird distribution reflects the impact of oceanographic and hydrobiological features on feeding opportunities.

Ice

In winter, the continental mass of Asia becomes very cold, and conditions in the Sea of Okhotsk become extremely severe under its influence. In the coldest months, the basin is almost completely closed by pack ice; except for shearwaters, which remain abundant over open water, the Sea of Okhotsk becomes unimportant for long-distance migrants compared with the Bering Sea or the Sea of Japan. Many birds are forced to emigrate to other regions, although there is a small-scale compensatory immigration of birds from the Arctic Ocean and the Bering Sea, where ice formation begins earlier, in November. However, ice in the Sea of Okhotsk soon becomes the dominant factor in bird distribution, simply by covering habitat. Ice formation occurs simultaneously in the west (Shantar Islands) and in the northeast (Shelikhov Gulf), quickly closing the western part of the sea but leaving considerable areas of open water along southwestern Kamchatka, where there is significant intrusion by oceanic water. For the same reason, waters around the Kuril Islands usually remain open all winter.

Currents and other hydrodynamic events create polynyas (predictable, extensive, and long-lived leads of open water) in the pack ice, even far inside the ice edge. These are particularly frequent in the mouth of Shelikhov Gulf, over the TINRO Abyss, over the Kashevarova Shoal, and in the area of the Central Abyss near Iona Island. The seabirds spend most of their time in these areas, even at the height of winter. In the first half of the winter, auklets, especially Crested Auklets, are the most numerous birds in all polynyas, but especially those in the north (Shuntov 1972). Trukhin and Kosygin (1986) observed wintering murres and Oldsquaw *Clangula hyemalis* with other sea ducks near Iona Island and in Shelikhov Gulf. These and other diving birds also occur on polynyas and open areas elsewhere, including coastal waters south and east of Sakhalin, depending on the distribution of continuous ice (Gizenko 1955; Shuntov 1972; Voronov 1972a,b). The biggest winter concentrations of diving birds occur among the Kuril Islands, where extensive pack ice is temporary and does not form every year. Wintering birds, especially cormorants, prefer the north and southern ends of the Kuril chain, where the shelf is broad and complex.

Surface-feeding seabirds such as Glaucous, Slaty-backed, and other large gulls, or, less frequently, the Northern Fulmar, also congregate in the waters near the Kuril Islands, but elsewhere their distribution is strongly linked to the presence of polynyas and ice edges. The gulls occasionally wander over the ice hundreds of miles from the edge (Trukhin and Kosygin 1986), but the fulmars remain in open water, at the ice edge or along large polynyas. The winter fulmar population is different from the summer population. The summer and autumn population consists mostly of dark-phase birds, which are replaced by light-phase birds in the winter, except over the southern abyss (Trukhin and Kosygin 1986). Near Iona Island, the winter population is

Table 4
Changes in observed abundance of seabirds in the southern Sea of Okhotsk (Chapter 2, Fig. 7, FBAs 11, 12, and 13)

	No. of seabirds (000s)			
Species or group	1988	1991	1993	1995
Sooty and Short-tailed shearwaters	2613.4	1226.3	797.3	1984.7
Other procellariids	462.6	800.8	1037.5	713.9
Alcids	127.2	70.9	131.4	119.9
Gulls	58.0	78.9	66.1	43.7
Other birds	9.2	38.1	27.1	79.7
Total	3270.6	2215.0	2059.4	2849.4
Total without shearwaters	657.0	988.7	1262.1	954.7

95% light phase; among the northern Kuril Islands, it is 75% light phase. Recently, Ross' Gull and Ivory Gull have begun to winter regularly in the Sea of Okhotsk.

Food and oceanic productivity

The prevalence of diving birds, particularly alcids and cormorants, among the breeding species and shearwaters among the migrants is correlated with the high concentrations of food in the form of macroplankton in the benthos, nekton, and nektobenthos of the Sea of Okhotsk. The proportion of the diving birds in the inner parts of the continental shelf is especially high, whereas surface feeders are more common over outer waters, especially over the abyssal areas.

Such a pattern implies a north–south gradient in bioproductivity, but there is no great contrast in bioproductivity between northern and southern parts of the Sea of Okhotsk. Throughout the sea, there is a great biomass of plankton, fish, and squid in the abyssal areas, and three powerful upwellings — Yamskiye, Iona-Kashevarova, and Kuril — enhance bioproductivity in the temperate water areas and are perhaps the most important oceanographic features of the Sea of Okhotsk (Shuntov and Dulepova 1996). This suggests that biotic resources are not a generally limiting factor in the Sea of Okhotsk. There may be some local exceptions, such as small areas near breeding colonies, where many birds are concentrated. On occasions when feeding conditions change significantly, seabirds may be substantially redistributed both within the season and interannually. Similarly, significant changes in the numbers of seabirds may be a response to the redistribution of waters between the Sea of Okhotsk and the adjacent oceanic regions (Table 4) (Shuntov, in press a).

Boats of the fishing fleet influence the distribution of gulls and fulmars in the Sea of Okhotsk. There is always a lot of waste and discarded by-catch, which increases the food base for thousands of large gulls and fulmars. The period of greatest fishing activity extends from autumn through winter and into spring, and large flotillas operate near the southwestern Kamchatka coast, south of Tauyskaya Gulf, over the slopes of TINRO Abyss, and, in some years, in the Iona-Kashevarova region. Many birds track the fishing activity when it is also displaced by winter ice.

Bathymetry and water masses

Most of the information on abundance and distribution of seabirds has been collected in the summer and autumn, when conditions are most likely to be suitable for both marine and terrestrial observations (Shuntov 1972, 1986, 1995a,b, 1997, in press a). The relationship between most species and the neritic, nerito-oceanic, and oceanic water masses has become fairly well understood in the Sea of Okhotsk, and most seabirds there are neritic, nerito-oceanic, or interzonal[3] types. Oceanic species are usually poorly represented, because that sea intrudes far into the continental land mass with only a weak exchange of water with the North Pacific.

Generally, there are high summer–autumn seabird densities in the south and low densities in the north, but much of this gradient is the product of the influx of shearwaters from the south. As summer progresses, the gradient is maintained by the gradual southward dispersal of seabirds that have finished breeding in the north. In autumn, the differences between the seabird communities become less distinct, but densities are stable or increase in the eastern Sea of Okhotsk through the summer and autumn, in spite of migrations to the south and a dispersal by postbreeding birds to the outer edges of the basin. Shearwaters move farther north as the season progresses, while postbreeding alcids and gulls arrive over abyssal regions.

The local distribution of neritic or coastal birds is complex and may best be explained in terms of trophic connections. The neritic group includes Spectacled Guillemot *Cepphus carbo*, Pigeon Guillemot *C. columba*, Ancient Murrelet *Synthliboramphus antiquus*, Rhinoceros Auklet *Cerorhinca monocerata*, Long-billed Murrelet *Brachyramphus perdix*, Kittlitz's Murrelet *B. brevirostris*, cormorants, and some other species, such as the "semimarine" birds: ducks, loons, grebes, and some gulls. Most frequently,

[3] Short-tailed Albatross *Diomedea albatrus* must be included among the interzonal species. Although it is widely dispersed across the North Pacific, it also uses nearshore marine areas, even over the continental shelf. On 15 August 1995, a second-year bird was observed near the southeastern coast of Sakhalin (47 17'N, 144 32'E). Another immature bird was seen on 7 August 1997 in Shelikhov Gulf (58 47'N, 156 11'E), and the next day a bird (possibly the same individual) was seen a little farther south (58 27'N, 156 11'E). Finally, on 14 August 1997, an adult was observed in the western Kamchat area (54 43'N, 153 17'E). These observations show that the Short-tailed Albatross can be found on migration in the northwest Pacific and in the Far East seas, as well as in the northeast Pacific.

these appear in coastal waters after the breeding season. Observations in the neritic zone have been too sparse to permit any comment on the abundance of seabirds; most information is collected farther offshore. In summer, neritic birds are generally confined to a narrow coastal strip, but small numbers of cormorants, gulls, and terns, among others, begin to wander over the open sea in autumn as they move to wintering areas. Migrating waterfowl, which tend to move in straight lines, cross the oceanic area en route from Tauyskaya Bay to the coast of Sakhalin.

Most of the typical seabirds (Black-legged Kittiwake, Northern Fulmar, Thick-billed and Common murres, Crested Auklet, Sooty and Short-tailed shearwaters, Tufted Puffin, Slaty-backed Gull, among others) concentrate over the inner shelf, especially near their colonies, in summer. Where the shelf is very broad, as in the northern part of the sea, the distribution of these birds is broader. Near the Kuril Islands, where the shelf tends to be very narrow, only the truly oceanic group, such as fulmars and Fork-tailed Storm-Petrels, wander far offshore. Leach's Storm-Petrel *Oceanodroma leucorhoa* also breeds on the Kuril chain and forages over oceanic waters east of the Kuril Islands. Nomads such as the Laysan Albatross *Diomedea immutabilis* and Black-footed Albatross *D. nigripes* tend to remain near the strongest oceanic influences, over the Kuril abyssal area or near the southwestern coast of Kamchatka. The latter area is influenced by the Western Kamchat Current, created by oceanic waters passing through the northern Kuril straits. This distribution reflects the albatross's role as an important predator on the great mass of squid that concentrate there.

The Northern Fulmar is distributed comparatively evenly over both the shelf and abyssal areas except in some of the inner shelf areas, such as Terpeniya and Aniva gulfs and some parts of Shelikhov Gulf. However, the distribution of the different colour phases has its own structure. The dark phase prefers the southern half of the abyssal plain, whereas the light phase is more abundant in the northern half, where waters are more shallow. These birds move south with the northern currents, providing clues about the boundary between northern and southern waters. The two phases are equally frequent near Tauyskaya Bay and off western Kamchatka from 54°N to 55°N (Shuntov, in press b). In 1995, an unusually strong thrust of water from the south brought considerable numbers of dark fulmars as far north as the mouth of Shelikhov Gulf, and the line of equal frequency moved to 55°30'N and between the longitudes 151°E and 153°E (Shuntov 1997). This event was connected to an unusual configuration of the cold Yamskiye Current, which turned south–southwest passing the Koni Peninsula (Fig. 6). The opposite situation occurred in 1997. In that year, the Western Kamchat Current slowed, but the Sredinnoje Current appeared in the Iona-Kashevarova area. In that year, dark-phase fulmars became less numerous along much of western Kamchatka for the only time during three years of observation (Figs. 7 and 8).

The Sea of Japan

The basin of the Sea of Japan lies on the boundary between two climatic and biogeographical zones. Warm-water systems along the coast of Japan and cold-water systems along the mainland coast are separated by the Subarctic Front between latitudes 39°N and 40°N (Yarichin 1982; Yurasov and Yarichin 1991). The cold North Korean Current pushes the western boundary southward, whereas the warm Tsushima Current moves the eastern boundary north. Generally, this front separates the boreal and subtropical seabirds, with the nesting areas of the boreal seabirds lying north of Sangarsky Strait, between Hokkaido and Honshu, Japan, or north of Peter the Great Bay and the Korean Gulf in the western part of the sea (Shuntov 1972). Two typically subtropical species, Audubon's Shearwater *Puffinus lherminieri* and Swinhoe's Storm-Petrel *Oceanodroma monorhis*, and the south temperate Japanese Murrelet *Synthliboramphus wumisuzume* have their northernmost colonies in Peter the Great Bay. The fact that these species have not spread along the western coast of Hokkaido through a zone of warm currents is extraordinary and unaccountable.

The two basic systems of currents in the Sea of Japan also have distinct seabird communities in the winter. Those species that breed broadly over the north boreal region winter on the shelf north of 40°N, and south boreal species prefer warmer water farther south (Shuntov 1972). From 1959 to 1965, the seabirds north of 40°N consisted of 45% alcids, 21% ducks, and 18% gulls. Crested Auklets, Least Auklets, and murres were the most numerous alcids. Almost all of the alcids seen over abyssal areas occurred in cold water, north of the Subarctic Front. Oldsquaw, White-winged Scoter *Melanitta fusca*, and Harlequin Duck *Histrionicus histrionicus* were the most numerous sea ducks. Slaty-backed Gull was the most abundant larid. South of the front, in warmer waters, about 80% of the seabirds were gulls, with kittiwakes contributing 40% and Black-tailed Gulls *Larus crassirostris* 20%. Common Black-headed Gull *L. ridibundus* was the most abundant larid close to shore. Most of the alcids were either Rhinoceros Auklets or Ancient Murrelets. The northern boundary for "warm-water" species is farther north in the east, where the sea is warmed by the Tsushima Current and many kittiwakes and Black-tailed Gulls are able to use Sangarsky Strait, even in the middle of winter.

Of 20 seabird species nesting around the shores of the Sea of Japan, about 70% are boreal or south boreal and 30% are subtropical or interzonal (three species in each). The low diversity among the breeding seabirds of this area may be attributable to the scarceness of suitable nesting sites or some other factor. It does not appear to be the result of oceanographic or hydrobiological factors, because this same area is used successfully by some 30 species of migrant and wintering seabirds, including alcids, gulls, jaegers, and phalaropes from the north and shearwaters from the south. The area is also used by a variety of wintering ducks, loons, and grebes.

There are almost two million seabirds resident in the Sea of Japan (Table 5). The majority of them, some 900 000 birds, nest in Japan (Hasegawa 1984; Fujimaki 1986). Only about 175 000 individuals inhabit Russian territory, and 83% of these nest in Peter the Great Bay (Shibaev 1987; Litvinenko and Shibaev 1991). Most oceanic species that reach the latitude of the Sea of Japan avoid it. This is a sea of the continental margin, not dissimilar in character to the Mediterranean. The Japanese Archipelago effectively isolates it from the North Pacific, in spite of the fact that waters joining the Sea of Japan through the Korean Strait are a continuation of the Kuroshio oceanic current. Further exchange is restricted by narrow straits. Albatross occasionally occur

Figure 6
Distribution of dark-phase Northern Fulmar in the northeastern Sea of Okhotsk, 20 June to 14 July 1995

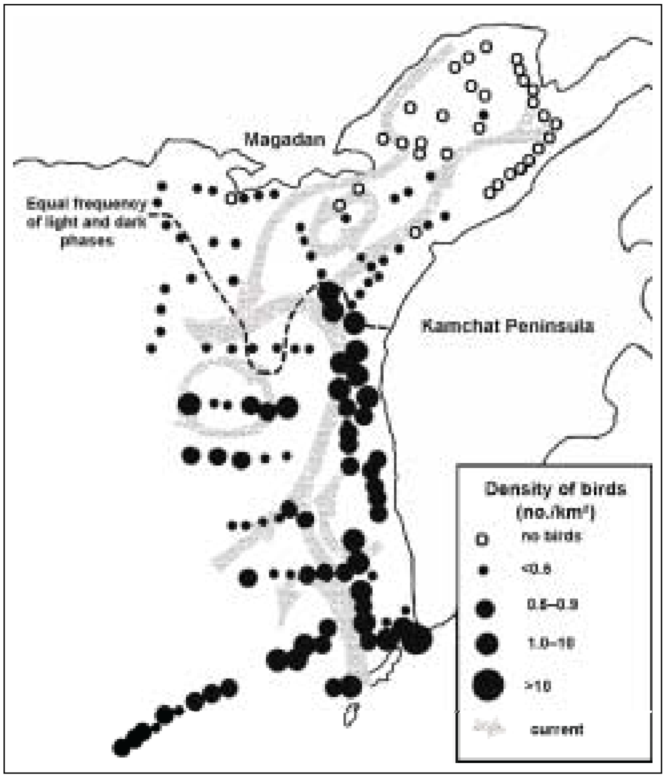


Figure 7
Distribution of light-phase Northern Fulmar in the northeastern Sea of Okhotsk through July and August 1997. The line of equal frequency of light and dark phases is also given for 1988.

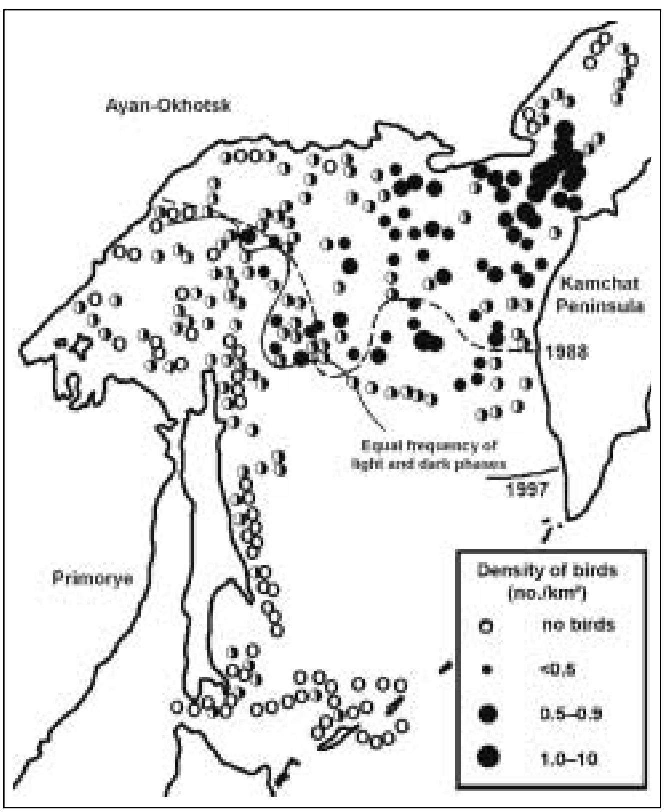


Figure 8
Distribution of dark-phase Northern Fulmar in the northeastern Sea of Okhotsk through July and August 1997. The line of equal frequency of light and dark phases is also given for 1988.

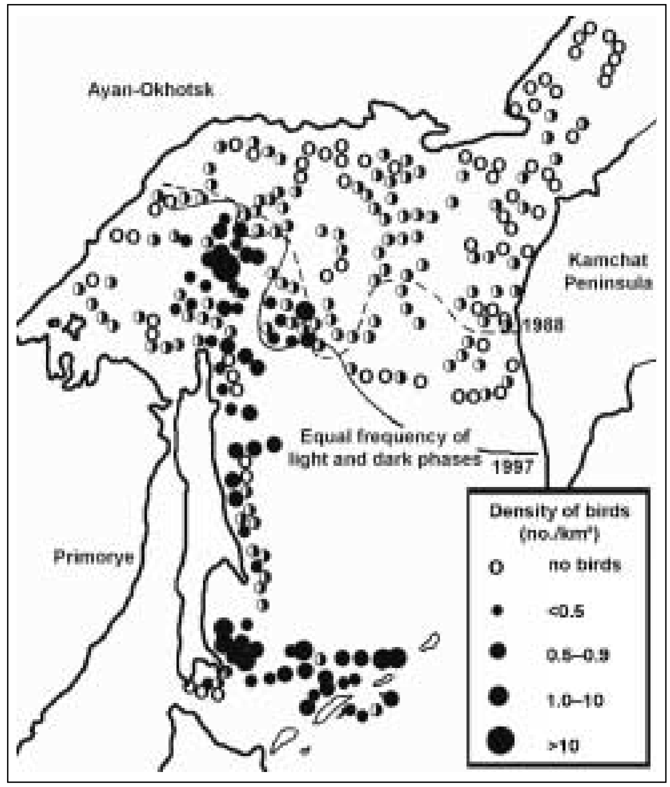


Table 5
Distribution and abundance of seabirds in the Sea of Japan

	No. of seabirds (000s)		
	Resident in the Sea of Japan		
Groups	Russian Zone	Japanese Zone	Migrants
Procellariids	159	350	255
Cormorants	11	15	21
Phalaropes	0	0	205
Jaegers	0	0	41
Gulls	115	153	500
Terns	some	some	88
Alcids	34	387	700
Totals	175	905	1810

here, but oceanic species of petrels and storm-petrels never visit. The bulk of the shearwaters from the southern hemisphere avoid the Sea of Japan, with the exception of the Flesh-footed Shearwater.

Gulls, especially Black-tailed Gull, comprise about 66% (115 000) of the seabirds on the Russian coast, and alcids contribute 19%, with Spectacled Guillemot (23 000 birds) being the most abundant species. Procellariids contribute about 9% of the remainder, mainly in the form of 15 000 Swinhoe's Storm-Petrel. Cormorants, mostly Japanese Cormorant, contribute 6%. Terns are very rare. The reported population of breeding Swinhoe's Storm-Petrel contrasts sharply with its almost complete absence in the northern part

Table 6
Average species composition of seabirds in the Sea of Japan during the 1980s and 1990s

	Species composition (%)				
	Peter the Great Bay – Laperuza Strait (June–July)		Laperuza Strait – Tsushima (August–September)		Offshore areas between Peter the Great Bay and Kita–Jamato Shoal (August–September)
Species	South of 43°N	North of 43°N	South of 41°N	North of 41°N	
Sooty and Short-tailed shearwaters	0.5	8.0	2.9	0	0
Flesh-footed Shearwater	3.4	4.1	11.0	0.1	0.8
Audubon's Shearwater	0.7	0	4.3	77.8	36.7
Northern Fulmar	3.9	48.4	5.6	0	0
Short-tailed Albatross	0	0	0	0.1	0
Fork-tailed Storm-Petrel	0.5	6.6	12.7	0	0
Swinhoe's Storm-Petrel	0	0	0	0.2	0
Black-tailed Gull	74.4	6.1	8.1	7.5	15.4
Slaty-backed Gull	0.5	4.0	1.5	0.2	0.8
Black-legged Kittiwake	0	0	1.2	0	0
Common Black-headed Gull	0	0	1.7	0	6.5
Glaucous Gull	0	0	0	0	0.4
Herring Gull	0.2	0.1	0.2	0.2	0.4
Terns	0.7	0.1	9.9	2.6	25.2
Jaegers	0	0	1.9	0.1	2.4
Rhinoceros Auklet	0	21.0	0	0	0
Common Murre	1.7	1.3	1.5	0	0
Ancient Murrelet	2.0	0.3	1.2	0.2	0.8
Spectacled Guillemot	1.5	0	0	0	0
Cormorants	0.2	0	0.2	0	4.5
Phalaropes	9.8	0	36.1	11.0	0.4
Ducks	0	0	0	0	5.7
Birds/km^2	0.8	1.0	0.3	0.5	0.4

of the Sea of Japan, including the waters adjacent to Peter the Great Bay (Shuntov 1972, in press b). Rhinoceros Auklet (350 000 individuals), Audubon's Shearwater (300 000–350 000 individuals), and Black-tailed Gull (150 000 individuals) are the predominant species.

The wintering and migrant groups are a completely different suite of species from the breeding population and tend to be dominated by birds that breed farther north: Common Murre, Thick-billed Murre, Least Auklet, Crested Auklet, Black-legged Kittiwake, Common Black-headed Gull, Northern Fulmar, Pelagic Cormorant *Phalacrocorax pelagicus*, Red-necked Phalarope *Phalaropus lobatus*, Parasitic Jaeger *Stercorarius parasiticus*, and Common Tern *Sterna hirundo*. Flesh-footed, Sooty, and Short-tailed shearwaters arrive from the south.

As early as August, the summer avifauna of the Sea of Japan (Table 5) begins to include a few hundred thousand migrants from other regions, including procellariids, Common Black-headed Gulls, jaegers, phalaropes, and terns. Counts of various regions in the 1960s give an average summer density of about 1.5 birds/km^2 (Shuntov 1972). The average density on the shelf is 2.0 birds/km^2 and over the abyssal areas, 0.3 birds/km^2. Similar values have been recorded in the 1980s and 1990s (Table 6). The autumn numbers and densities are approximately double those of summer. The breeding species and migrants, such as the alcids, cormorants, and some gulls, remain within the Sea of Japan, while most phalaropes, Common Black-headed Gulls, terns, and jaegers merely pass through on their way to distant areas. Some species also move to the adjacent East China Sea. As winter approaches, there is almost a complete changeover in the species composition of seabirds. The subtropical birds and most of the south boreal species leave the sea in autumn, whereas birds nesting in the northern boreal regions become prevalent in the winter. Bird densities drop with the nearly complete departure of the procellariids, terns, and jaegers but are partially offset by more seabirds from the north. However, it is the arrival of wintering ducks that may raise winter numbers higher than those from the summer.

Ice

The greater part of the Sea of Japan stays free of ice in the winter and remains suitable habitat for wintering seabirds. Only the northern part of Tatarsky Strait is covered regularly, and the inner parts of the gulfs in the northwestern part of the sea usually stay open. Floating ice blocks drift along the coast of Primorye and the northern part of the Korean Peninsula.

Bathymetry and currents

The shelf and abyssal regions differ in terms of their microstructure. On the shelf, currents have a turbulent character, rotational systems reach a diameter of 20 km, and current patterns are strongly affected by bottom relief and the configuration of the coastline. In contrast, abyssal areas have rotating systems 150–200 km in diameter (Yarichin 1980). The local circulation patterns over the shelf concentrate prey, attracting large numbers of seabirds, whereas irregular coastlines, islands, and straits attract birds by protecting them from winter storms. All of these factors combine to create very large concentrations of wintering seabirds in parts of the Korean, Sangarsky, and Laperuza straits, and also in Peter the Great Bay and the Korean Gulf.

Geographic factors maintain the contrast in seabird species composition across the Sea of Japan, even in summer, and the contrast between the density of birds over the shelf zone and in the abyssal areas is retained. In the 1960s, the density on the shelf, beyond the coastal zone, was about 2.0 birds/km^2; in the abyssal areas, on the other hand, it was only 0.3 birds/km^2 (Shuntov 1972). In the 1980s and 1990s, densities were much the same: 1.1 birds/km^2 around Peter the Great Bay and Tsushima Strait; 2.0 birds/km^2 near Laperuza Strait; and 0.3 birds/km^2 in the open waters of the northern and southern parts of the sea.

The detailed oceanographic observations during the sardine irruption in the 1980s could explain some aspects of seabird distribution (Dudarev et al. 1982; Dyomina and Dudarev 1984; Dyomina 1989). Seasonal and local fronts and eddies (5–9 km in diameter) played an important role in the formation of sardine aggregations. In summer, such systems develop from meanders in the fronts along the shelf and the continental slope, depending on the configuration of the bottom. They do not usually last more than a month, and they often last only a week. They are rarely perceptible on the surface and can best be detected at depths of 20–30 m. Occasionally, even a seasonal front is represented by local zones of increased temperature gradients across 15–30 km of sea. Along the southwestern coast of Sakhalin, the formation of secondary fronts is influenced by the invasion of cold water from the Sea of Okhotsk. Small-scale influences on foraging areas may offer some suitable explanation of seabird marine distribution, but only generalizations are possible without concrete data and surveys of birds during oceanographic studies. Regardless of the cause, the absence of at least a small increase in seabird density near the Subarctic Front in the Sea of Japan is unexpected.

Food

Overall, nesting populations and densities at sea are lower by an order of magnitude in the Sea of Japan than in the Sea of Okhotsk, the Bering Sea, or the Pacific waters adjacent to Kamchatka, the Kuril Islands, and Japan. Shortage of suitable nesting habitats, strongly aggravated by human disturbance and introduced predators, may be the most apparent cause. However, lower productivity by the Sea of Japan's ecosystems may also play a significant role. The Sea of Japan is marked by lower biomasses of zooplankton and fish (Shuntov et al. 1993), but lower availability of prey for seabirds is not obvious, and there is evidence of ample resources in some portions of the area. A great mass of sardines and other nektonic organisms migrates northward over the abyssal plain in the spring. In the second half of the summer, the sardine remains abundant in some parts of the abyssal area, but its main concentrations tend to be over the shelf and the continental slope (Dudarev et al. 1982). The absence of stable seabird concentrations, even for the areas of abyssal water, rich with fish and plankton, remains unexplained, whereas high densities immediately offshore may be explained by both greater food resources and more favourable foraging conditions.

In summer, the all-important breeding season for seabirds, migrant fish, in combination with the local nekton, should form a dependable resource base for fish-eating species. There are large migrations by juvenile and adult pelagic fishes such as sardine, anchovy, saury, mackerel, and others, and pelagic species of squid from the southern part of the Sea of Japan and from the East China Sea move northward. The presence of some large colonies in the Sea of Japan demonstrates that seabirds exploit these resources. The colony of Rhinoceros Auklets on Teurijima, Hokkaido, is a particularly spectacular example. The current population is estimated to be near 350 000 birds and was calculated as 600 000–800 000 in 1970 (Fujimaki 1986; Watanuki et al. 1988). Rhinoceros Auklets usually catch fish not more than 100 km from the breeding colony. This huge mass of birds subsists within a restricted marine area, indistinguishable in its productivity from the surrounding shelf seas.

Certainly the food resources of the Sea of Japan increased during the peak of sardine abundance in the 1970s and 1980s, when the landings of sardines exceeded those of all other pelagic fisheries together. Surprisingly, there did not appear to be any corresponding sudden redistribution of seabirds, even among those shearwaters from the southern hemisphere that arrived in the summer periods. Perhaps both the birds from the North Pacific and those from the south had choices of even more productive waters in the Sea of Okhotsk, in the Bering Sea, or even along the margin of the northwestern part of the Pacific Ocean. For example, the sardine occurred in greater quantities in the Pacific waters off Japan and off the southern part of the Kuril range than in the Sea of Japan.

Typically, peak production of zooplankton in the northwestern part of the Sea of Japan is in June, when it plays a great role in the feeding of sardines in the first stage of their migrations to the north. In the spring, the main masses of sardine move into the zone of the Subarctic Front between the warm East Korean Current and the cold South Primorskoye and North Korean currents and migrate across the central and western parts of the sea (Dudarev et al. 1982). Great masses of Pacific sardine *Sardinops sagax* (some million tonnes) move into the northern part of the sea following the 10° isotherm (and in some years even 8°) (Dudarev et al. 1982; Dyomina 1985). The distribution of sardines clearly reflects the greater productivity of the western sea. During irruptions of sardines, the hydrobiological situation in the Sea of Japan changes considerably.

Currently, the Pacific sardine dominates the diet of the larger seabirds, such as the Black-tailed Gull and Japanese Cormorant, in Peter the Great Bay. In the past, the Pacific saury *Cololabis saira* was the main food of the Black-tailed Gull, and bottom fish were the main food of the cormorant (Litvinenko 1980; Shibaev 1987). The numbers of these two species and some others nesting in Peter the Great Bay have increased from a few hundred to some 150 000 individuals (Shibaev 1987). Similar increases have occurred on Moneron Island (Shibaev and Litvinenko 1996) around Hokkaido (Fujimaki 1986; Watanuki et al. 1988). On the southwestern coast of Sakhalin, contrasting decreases in seabird populations during this same period may be attributable to human activity (Nechaev 1991); however, the numbers of Rhinoceros Auklets, murres, and Spectacled Guillemots decreased on Japanese colonies over the same period.[4]

Since 1980, the area of the high planktonic biomass along the continental shelf, from the southern coast of Sakhalin to the Korean Gulf and including a wide region between the Korean Gulf and Peter the Great Bay and the band along the Subarctic Front, has been a distinctive feature of the long-term distribution of plankton biomass of the Sea of Japan (Markina and Chernyavsky 1985). Lapshina et al. (1990) also recorded high biomasses of plankton in the same area, but strong gyres in the currents contributed to a patchier distribution.

In winter, food is more available in the Sea of Japan than elsewhere in the Russian Far East. Many of the rich northern areas become covered by ice. As their choices in the north are reduced, seabirds move south, their abundance demonstrating the considerable ecological capacity of the basin. However, the majority of wintering and migrating birds are distributed along the edges of the sea, in a comparatively small, elongated zone. Counts by Vishkvartzev and Lebedev (1986) in the shallows of Posiet Gulf demonstrate the phenomenon. During the waterfowl migration period, which is typically dominated by White-winged Scoter *Melanitta fusca*, the density of birds in the shallow coastal waters reached 260–1000 birds/km^2. Overall, birds consumed 2.7–6.0% of the available biomass during the year; in preferred feeding areas, big migrant flocks of ducks may consume up to 2% of the available biomass in just 24 hours.

The abundance of prey and feeding conditions are most favourable over the narrow shelf. Benthic organisms and fish of the shelf ecosystems contribute as much as plankton to the prey base for most birds. In winter, spawning by pollock and other fish produces an abundance of demersal eggs, fish larvae, and fry. North of the Subarctic Front, gulls, especially the Slaty-backed Gull, murres, and auklets occur over the abyssal areas that make up most of the sea basin. Seabird density over the abyss is 20–40 times lower than over the shelf, ranging from 0.2 to 4.0 or at most 8 birds/km^2 (Shuntov 1972). This scarcity is undoubtedly connected to the low quality of the prey base and poor conditions for foraging. There are effectively no squid or fish in the epipelagic zone over the abyssal plain in winter, and the average biomass of plankton is low (Kun 1975; Volkov and Chuchukalov 1985).

Summer

The shelf zone is narrow in the Sea of Japan, and this characteristic influences the marine distribution of the majority of the birds nesting there. Alcids and cormorants, for instance, tend to remain over the shelf, whereas shearwaters are the most abundant group on most offshore waters, where they offer little competition for the coastal-nesting birds. The Flesh-footed Shearwater is more abundant in the spring–summer period in the southern and northwestern parts of the sea, although it reaches the extreme northern points of the sea. Audubon's Shearwater becomes common north of the Subarctic Front with the warming of waters and a reduction of the temperature contrasts across the front. It is one of the less abundant species in the open waters of the Primorye in the second half of the summer but is the dominant species on most of the southern half of the sea. Outside the narrow coastal zone, it is an important member of a seabird complex that includes Flesh-footed Shearwater and Black-tailed Gull.

In the northwestern part of the sea, Ancient Murrelets, jaegers, and, more rarely, murres occur with the shearwaters and Black-tailed Gull in the open waters. Flesh-footed, Sooty, and Short-tailed shearwaters as well as Fork-tailed Storm-Petrel are common. The fulmar is also most abundant in the northern part of the sea. Light-phase fulmars are very rare.[5] Over the shelf, most of the birds are local breeders, such as Spectacled Guillemot and cormorants. The Rhinoceros Auklet is prevalent in the northeastern part of the sea, with some 4000 individuals on Moneron Island (Shibaev and Litvinenko 1996) and about 350 000 individuals on Teurijima off the northwest coast of Hokkaido (Fujimaki 1986; Watanuki et al. 1988). The influence of these colonies is even reflected in the species composition in the southern Sea of Okhotsk, on the shelf between Sakhalin and Hokkaido, where the Rhinoceros Auklet is particularly common. South Polar Skua *Catharacta maccormicki* and some tropical birds, such as frigatebirds, gannets, and tropical terns, mix with nonmigratory and nonbreeding members of northern species. In particular, loons, sea ducks, and gulls occur regularly in the coastal waters of Primorye through the summer (Labzyuk 1975; Elsukov 1984).

The slow northward movement of seabirds during the summer is correlated with a gradual decline of productivity that progresses from south to north, with the season. It is especially evident in the Sea of Japan, with its great range from 35°N to 50°N.

Autumn

The southward movement begins only at the end of September or in October. A visible increasing of the northern migrants in the Sea of Japan begins in October (Shuntov 1972); however, phalaropes, jaegers, and terns appear there even in mid-August. The main southward movement of terns, Common Black-headed Gull, and ducks along coasts occurs in September, which, depending on climatic conditions, is still a summer month in the Sea of Japan. Small numbers of larger gulls and kittiwakes also begin to arrive from the Sea of Okhotsk in September.

The total number of birds doubles over summer levels, so that the overall abundance and distribution are similar to those of the spring. Migration routes in autumn are also similar to spring routes. Some migrants enter the Sea of Japan from the Sea of Okhotsk through the narrow Nevelskogo Strait into Tatarsky Strait, but the majority of

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4 In *The birds of Japan*, Mark Brazil (1991) comments on the collapse of the Common Murre colonies on Hokkaido and predicts that Common Murres could be extinct as a breeding species there by the turn of the century. Rhinoceros Auklets, however, nest on several islands, and their population may be expanding [eds. note].

5 Single light-phase fulmars were observed near Laperuza Strait (Shuntov 1997c). One bird was seen on 5 July 1997 close to Cape Povoroshniy (42°40'N, 133°00'E).

seabirds, including alcids, enter through Laperuza Strait. At the end of that strait, gulls and jaegers fan out across the outer waters and over the abyss. Murres, auklets, and other alcids, however, move either along the coast of Japan or across the continental slope into the waters of the Primorskoye Current. This latter route is often the favourite. Fulmars and Fork-tailed Storm-Petrels return to the Sea of Okhotsk through Laperuza Strait in autumn.

The migration movement of young Black-tailed Gulls has been monitored closely through bird bands (Litvinenko 1980). In the western and eastern parts of the sea, these gulls migrate mainly northward, reaching the Sea of Okhotsk and the top part of Tatarsky Strait in August and September. Young Black-tailed Gulls that initially dispersed to the north may use the opposite coast, east or west, during their southward migration (Litvinenko 1980). Gulls from Peter the Great Bay have rarely been recovered in Japan in autumn or winter.

Three banded Japanese Cormorants, from the Sihote-Alinskiy Reserve, were recovered on the southwestern coast of Honshu (Kishchinski 1978). They could reach the southwestern coast of Honshu only by following the coastline.

Winter

The distribution of birds is not constant during the winter, with some seabirds moving southward through December and others beginning to return in early March. Those species that winter farther south move from the East China Sea through the Korean Strait. Black-tailed and Common Black-headed gulls, which prefer warm waters, disappear from the Vladivostok area in December and do not reappear until March (Lebedev 1986). In contrast, the Slaty-backed Gull is abundant along the Primorye coast in the depths of winter. The Mew Gull *Larus canus* has more intermediate preferences. Its numbers peak at both the beginning and the end of winter, declining in the coldest parts of January and February. The Black-legged Kittiwake disappears from open waters of the northwestern part of the sea in December. At Vladivostok, the arrivals and departures vary from year to year, depending on climatic conditions (Lebedev 1986). There is also considerable interannual variation in the number of other seabird species wintering in Peter the Great Bay, but there is not enough information to develop a correlation (Abramov et al. 1973).

Spring

The spring redistribution of seabirds coincides with large-scale climatic and hydrobiological changes in the sea. The northward seabird movement begins in early March in the southern part of the sea and in mid-March in the northern part, depending on winter conditions, nesting phenology, and the distance to nesting areas. As a result, migration usually ends before the onset of the most favourable feeding conditions in the Sea of Japan. In spring, the biomass of zooplankton doubles in the upper layer of the regions (Volkov and Chuchukalov 1985), and many pelagic subtropical fish and their young and squid migrate into the Sea of Japan to take advantage of this resource. They arrive after the departure of the boreal-breeding seabirds. Surprisingly, the main seabird migration routes occur along the Japanese Islands, despite the western part of the sea having higher bioproductivity (Markina and Chernyavsky 1985).

Spring migration by birds is complex. The major routes for seabird migration are along coastal and shelf areas, and large movements of alcids, ducks, and loons can be seen from the northern coast of the Korean peninsula to the southern Primorye, bypassing Peter the Great Bay (Shuntov 1972; Kosygin and Kuzin 1984). Kittiwakes, jaegers, and phalaropes all move northward on the eastern side of the sea. Kittiwakes are the most numerous bird in March but quickly become quite rare, but the Black-tailed Gull remains abundant even into April. Lone individuals of all of the large gulls, kittiwakes, and jaegers can be found over abyssal areas into May. Alcids depart from the northern part of the abyssal areas as the main flocks of procellariids arrive. The bird density in the abyssal area doubles in spring because of the influx of migrants, but it is still smaller, by a factor of 15, than that over the shelf or the continental slopes (Shuntov 1972).

The distribution of seabirds during migration is closely linked to the seasonality of marine biological processes. This does not mean, however, that the distribution can be predictably linked to the areas of highest productivity. Audubon's Shearwaters gradually spread northward in accord with its preference for warm water and the biotopic bonds with the branches of the Kuroshio–East Korean Current. They are especially attracted to the Tsushima Current, even though it is less productive than nearby cold waters. This distribution is correlated with the areas of highest biomass for concentrations of saury and pelagic squid, which remain in the southern part of the sea in April and May (Shuntov 1972). The birds and their prey both follow the 13°C and 18°C isotherms. In the 1960s, Audubon's Shearwater was not seen farther north than Peter the Great Bay; during the last sardine irruption, however, it became common almost to 45°N. In 1993 and 1995, the most northern individuals occurred at 43°41'N and 40°29'N (Shuntov 1972, in press b).

Flesh-footed Shearwaters closely track the migrating sardines (Shuntov 1972), whereas most Sooty and Short-tailed shearwaters remain at the entrances to the Sea of Japan at Laperuza and Sangarsky straits (Shuntov, in press b). Although these birds seem capable of adapting to a variety of conditions, some unknown biological restriction keeps them in the eastern sea. Transects between Peter the Great Bay and Laperuza and Tsushima straits in the 1980s and 1990s, across the Sea of Japan, suggest that there was less variation in distribution over the summer months than during the 1960s (Table 6) (Shuntov 1972).

The Bering Sea

The seabirds of the Bering Sea are the most studied group in the Russian Far East and have been observed not only on the breeding colonies (e.g., Konyukhov et al. 1998) but also at sea (Hunt et al. 1981; Gould et al. 1982; Schneider and Shuntov 1993; Shuntov 1993). Unfortunately, much of the work has been confined to the American side of the basin, and the western area is more poorly known. Recently, however, there has been a review of the distribution, nesting behaviour, and number of colonies. According to observations from the 1960s to the early 1980s, 4.1 million seabirds nest in the western area (Velizhanin 1978;

Table 7
Seabirds nesting in the Russian Far East along the coast of the Bering Sea[a]

	No. of seabirds (000s)			
Species group	North of Cape Olyutorskiy	South of Cape Olyutorskiy	Komandorskiye Islands	Total
Procellariiformes	80	110	674	864
Cormorants	56.3	33.5	9.2	99
Phalaropes	10	10	5	25
Jaegers	22	4	some	26
Gulls	1151.5	676	98	1925.5
Terns	3	23	0	26
Alcids	3821	491.6	473.5	4786.1
Total	5143.8	1348.1	1259.7	7751.6

[a] Sources: Vyatkin (1986); Artyukhin (1991, in press); Kondratyev (1991, 1993); Shuntov (in press b).

Table 8
Percent composition of the groups of seabirds in the western Bering Sea in September and October 1986

Fishery Biostatistical Areas[a]	Density (birds/km^2)	% composition		
		Diving birds	Nondiving birds	Shearwaters
1	26.4	14	17	68
2	7.5	57	20	24
3	11.2	4	22	74
4	3.3	24	33	43
5	17.2	10	35	55
6	6.9	11	54	34
7	12.6	5	60	35
8	4.6	5	77	19
9	6.1	34	43	24
10	12.1	77	14	10
11	8.2	31	54	15
12	4.3	6	77	17

[a] See Chapter 2, Figure 8.

Smirnov and Velizhanin 1986; Vyatkin 1986). Additional observations, especially in the northwest, show that the total is not less than 7.7 million (Table 7), with more than half in the northwest (Schneider and Shuntov 1993; Shuntov and Dulepova 1995). Alcids make up about 61.7%, gulls 24.8%, and procellariids 11.1%. Six species have more than 500 000 birds each: Black-legged Kittiwake, Least Auklet, Thick-billed Murre, Northern Fulmar, Crested Auklet, and Common Murre. As a group, they comprise about 90% (7.0 million individuals) of the seabirds nesting in the western part of the basin.[6]

In the western Bering Sea, not less than half of the birds on the Komandorskiye Islands and the rest of the Aleutian Archipelago forage in both the North Pacific and the Bering Sea (Table 8). The high bioproductivity of waters and good foraging conditions of the Bering Sea attract large numbers of seabirds anxious to build up their fat reserves. The Sooty and Short-tailed shearwaters from the southern hemisphere are the most numerous among them. The location of the Bering Sea, between the Arctic and North Pacific oceans, predetermines its role as a transit area for northern migrants and a wintering area for Arctic birds. It is hard to make a reliable estimate for the abundance of these birds, because many cross between eastern and western parts of the sea. Estimates are especially difficult for those species whose nesting areas include both areas. About three million seabirds breed in the western part of the sea, but the total number of birds depends on the size of the annual influx of nonbreeding species such as shearwaters (especially Short-tailed Shearwater), which comprise at least half of that total. Overall, 11 million seabirds may use the Russian part of the Bering Sea.

Large numbers of birds that nest on interior wetlands migrate through the Bering Sea. Some, such as jaegers, phalaropes, and gulls, are included in the above totals. Late in the season, however, they are joined by loons and many sea ducks. Most of the sea ducks, such as the Oldsquaw and eiders, stay for the winter in the Bering Sea on the polynyas and patches of ice-free water. A preliminary estimate of such semimarine birds may be as high as two or three million individuals.

Most (63%) of the breeding species in the western Bering Sea are divers, such as cormorants and alcids. The remainder includes gulls, jaegers, and phalaropes, which forage in the upper 0.5–1.0 m of the surface waters or in the littoral zone. This division between divers and surface-foraging birds also occurs among the nonbreeding species but increases to about 70% divers with the arrival of the postbreeding sea ducks and loons. Such a large proportion of divers offers indirect evidence of the high productivity among fish and other biota as well as the prevalence of suitable foraging conditions for the whole range of macroplankton and benthic, nektonic, and nektobenthic organisms. Surface-feeding birds must range over wide areas while searching for prey and, as a result, may appear in large numbers in areas with low concentrations of food (Table 8).

Of all the seas of the Russian Far East, the Bering Sea is the most open to the currents of the North Pacific. As a result, there are more oceanic birds, albatrosses, Mottled Petrel *Pterodroma inexpectata*, Leach's Storm-Petrel, and occasionally Red-legged Kittiwake *Rissa brevirostris* whose distribution is largely restricted to the abyssal areas and areas of the continental slope strongly influenced by the North Pacific Gyre and other large current systems. In comparison with other groups, the oceanic species are not numerous, particularly in that part of the western sea influenced by the Eastern Kamchat Current, where they are only 1% of the total. The total distribution of the Fork-tailed Storm-Petrel appears oceanic, but, in contrast to the typically oceanic Leach's Storm-Petrel, it is common in the shallows and declines in density over the outer shelf.

There are several species of neritic or coastal seabirds, such as cormorants, the *Brachyramphus* murrelets, Pigeon Guillemot, Mew Gull, and Common Black-headed Gull, which tend to stay within a few kilometres of the coast in the Bering Sea. However, they are not particularly abundant in the western area and make up only 1–2% of the total, if we exclude the "semimarine" species. Birds with a neritic-oceanic or interzonal distribution are prevalent in both

[6] See Chapter 3 of this volume.

diversity and abundance. The neritic-oceanic species, murres, auklets, and others, are more numerous on the shelf but are also common on the continental slope, near abyssal areas, and on the high seas, sometimes hundreds of kilometres from the coast. Some interzonal species, such as kittiwakes or Tufted and Horned *Fratercula corniculata* puffins, tend to be most abundant over the shelf waters in summer months but use oceanic areas during migration and in winter. Others are usually equally distributed on the shelf and in oceanic areas. The fulmar is the most prominent nesting species, and Sooty and Short-tailed shearwaters are the most prominent migrants.

Ice

The seabird ecology of the Bering Sea in the winter and spring periods is still unknown in the western basin. Ice fields cover almost the whole shelf at the peak of winter, forcing many species farther south and precluding the great concentrations typical for winter in the southeastern part of the basin near the Aleutian Islands. The extreme cold in the Russian part of the Bering Sea forces many species, perhaps more than 90% of the total numbers, to depart, although they may successfully winter at the same latitude off Alaska. Most of the seabirds breeding or summering in the western Bering Sea migrate to the waters of the Western Subarctic Gyre, generally to the eastern part of the basin, adjacent to oceanic waters.

All or almost all seabirds avoid areas of solid ice or are displaced from the freezing regions; in the patches of ice-free water, polynyas, and near the edge of the pack ice, however, favourable conditions form for obtaining food. Such a landscape may often be preferred by "ice-neritic" seabirds, such as Black Guillemot *Cepphus grylle*, Ivory Gull, and Ross' Gull. These gulls and perhaps some alcids follow the extension of winter ice fields onto the coast of Kamchatka and into the Sea of Okhotsk.

Polynyas form, even at the highest latitudes, by the action of currents and play a special role in the distribution of some species of birds by providing patches of open-water habitat, separated from other open water by great expanses of ice. The most important include the Sirenikovskaya polynya on the southeast coast of the Chukot Peninsula (Konyukhov 1990) and polynyas near Saint Lawrence Island (Fay and Cade 1959). Ten species of birds were observed on the Sirenokovskaya polynya in winter: Oldsquaw, Common Eider *Somateria mollissima*, King Eider *S. spectabilis*, Spectacled Eider *S. fischeri*, Glaucous Gull, Black Guillemot, Thick-billed Murre, Pelagic Cormorant, Kittlitz's Murrelet, and Ivory Gull, with the first two species occurring in large numbers (Konyukhov 1990). Ivory Gull as well as Ross' Gull do not avoid ice fields, but their main population spends winter near the edge of the pack ice as opposed to the polynyas.

Food

Zones of high plankton biomass tend to occur farther north in the Bering Sea during the second half of the summer and at the beginning of autumn. At that time, concentrations of macroplankton may be higher than concentrations in the southwestern part of the sea by an order of magnitude (Table 9). Consequently, there is a marked redistribution of procellariids, especially the abundant shearwaters and Fork-tailed Storm-Petrels, from the southern regions. In spite of these high concentrations of plankton in the north, its total resources are less than those of the abysses, where surface and interzonal plankton, mesopelagic fish, and squid comprise an almost unrestricted supply of food for the dispersed communities of albatross, fulmars, storm-petrels, and shearwaters. Crepuscular migration by most planktonic organisms enhances foraging opportunities for seabirds by bringing their prey to the surface.

Often high densities of birds are correlated with concentrations of macroplankton and nekton (Table 10), but there are discrepancies. These may result from the inaccessibility of much macroplankton or lower densities with small, high-density pockets insufficient to concentrate the birds. In general, seabird density is much higher over the shelf and the continental slope than over the abyssal areas. Shallow waters tend to have higher total bioproductivity, and numerous secondary fronts, high-gradient zones, and meso- or micro-circulatory systems enhance the passive accumulation of plankton, larvae, and fry in the nekton (Schneider 1982; Kinder et al. 1983; Schneider et al. 1987; Hunt et al. 1993; Shuntov 1993; Springer et al. 1993, 1996; Decker and Hunt 1996). In the 1960s, during large-scale observations of the Bering Sea by the Pacific Research Institute of Fisheries and Oceanography and the National Institute of Fisheries and Oceanography, the boundary between the shelf and the abysses was designated "the zone of life," in part because of the obviously high concentrations of seabirds (Shuntov 1972). In one recent report, it is called "the green band" in reference to the high level of primary bioproduction (Springer et al. 1996).

The important role of the continental slope in the biota of the Bering Sea is connected to unusually complex and intense water dynamics (Kotenev 1995; Sapozhnikov 1995). Generally, the contribution of dynamic processes over the continental slope is related to the transfer of materials and energy from different depths to enrich the euphotic layer with mineral nutrients. Meandering currents and gyres, typical for areas with complex bottom relief along the continental slope (canyons, dynamic topography, and changes in depth), play a major role in creating rich foraging areas for birds and for other animals. They are particularly important in promoting the local accumulation of macroplankton and early-stage nekton. An analogous situation occurs near islands and in straits where complex hydrodynamic processes are strengthened by the tidal phenomena.

Horizontal patchiness and vertical layering of zooplankton and small nekton are also typical of shelf areas, but the character of that distribution and the factors that influence it vary with the width of the shelf. For example, over the wide shallows of the eastern Bering Sea, the coastal, middle, and external secondary fronts, distributed over the 50-, 100-, and 170-m isobaths, greatly influence the distribution of birds. Diving species such as murres and shearwaters dominate the inner part of the shelf, whereas surface-feeding species such as fulmars, kittiwakes, and storm-petrels prevail over waters of the external shelf (Schneider and Hunt 1982; Schneider et al. 1986). A similar situation is observed in the Gulf of Anadyr (Shuntov 1993); there, however, the distribution and configuration of secondary fronts are influenced by the warm Navarinskiy Current, disrupting the cold spot in the middle of the shelf. An analogous influence of this current can be seen in Bering Strait, where gradient zones are formed

Table 9
Seabird density in relation to plankton and nekton densities in the western Bering Sea, September–October 1986

	Fisheries Biostatistical Area (Chap. 2, Fig. 8)											
Group	1	2	3	4	5	6	7	8	9	10	11	12
Birds/km^2	26.4	7.5	11.2	3.3	17.2	6.9	12.6	4.6	6.1	12.1	8.2	4.3
Macroplankton (mg/m^3)	207.3	283.1	1228	14.8	12.0	50.3	134.1	619.0	456.0	240.0	890.0	397.0
Macroplankton without *Sagitta* spp. (mg/m^3)	191.4	218.3	800	10.7	7.9	27.9	48.7	262	135	118	639	166
Nekton from 0 to 200 m (t/km^2)	1.93	0.91	18	0.37	27	11.5	35	3.72	2.5	9.18	29.7	9.4
Squid from 0 to 200 m (t/km^2)	0	0	0	0	0.4	some	0.7	0.2	0.1	0	0.4	0.3

Table 10
Seabird density in relation to plankton and nekton densities in the southwestern Bering Sea, June 1991

	Fisheries Biostatistical Area (Chap. 2, Fig. 8)				
Group	8	9	10	11	12
Birds/km^2	1.5	1.8	2.1	2.7	1.5
Macroplankton (mg/m^3)	670	521	311	403	443
Macroplankton without *Sagitta* spp. (mg/m^3)	222	211	182	273	170
Nekton (t/km^2)	0.9	0.05	1.6	0.3	1.3
Squid (t/km^2)	0.1	some	0	some	0.3

as a result of its meeting with cold northern waters. These gradient zones attract many foraging alcids, especially auklets. In other regions of the Bering Sea, the shelf is narrower, and its waters are influenced by currents running parallel to the coast. As a result, the mid-shelf front moves to the external edge of the shallows and is often joined with the external surface front by vertical movement (Verkhunov 1995).

Summer

In summer, most resident birds, including immature individuals, are concentrated near the nesting grounds. Where the shelf is narrow, as in the Sea of Okhotsk, the density of seabirds within 15 or 20 km of a colony, and sometimes even within 30 or 50 km, appears to depress the densities of plankton and nekton. Where the shelf is broad, on the other hand, as in the northern Bering Sea, the birds are more dispersed, and there seems to be little impact on plankton density (Tables 9 and 10).

Autumn

The period of autumn migration is prolonged, and movements are complex. At the end of summer (in August), birds may be moving in opposite directions at the same time. Phalaropes, jaegers, terns, and adult shearwaters begin their migration to the south, while immature shearwaters and other birds, including Fork-tailed Storm-Petrels (Shuntov 1972) and some species of gulls, continue their wandering to the northern part of the sea. For many birds, the migration route southward follows the western edge of the Bering Sea, but some migrate from the Chukotka area to the southeastern part of the sea and the Aleutian Islands. Tufted and Horned puffins and the more oceanic species migrate southward on a wide front along the abyss without following particular currents.

Generally, the major seabird migration in the Bering Sea begins in the second part of September and continues through early November. Even in the first half of the winter, however, a gradual southward movement can still be seen, spurred on by expanding ice fields. Nonetheless, other species of seabird continue to accumulate in December, at least in the waters of the Western Subarctic Gyre, where many birds from the Bering Sea and the Sea of Okhotsk spend the winter.

Winter

The light phase of the Northern Fulmar, Slaty-backed Gull, Herring Gull, Glaucous-winged Gull *Larus glaucescens*, Glaucous Gull, Ivory Gull, Ross' Gull, and also some alcids, including, at least, both species of murres, Black Guillemots, and Kittlitz's Murrelet, spend the winter in the western Bering Sea. Some auklets, especially Least Auklet, are also likely to spend the winter there but have not been recorded. A mass of incidental observations suggests that kittiwakes, Fork-tailed and Leach's storm-petrels, Tufted and Horned puffins, jaegers, terns, phalaropes, and other species of birds depart from the western part of the sea for winter (Shuntov 1972, 1993; Kosygin 1985; Lobkov 1986; Trukhin and Kosygin 1987). Because of the shortage of winter observations, there are no data about patchy distributions of the seabirds in the western Bering Sea. However, gulls and fulmars gather near vessels fishing for walleye pollock *Theragra chalcogramma* mainly in the Navarinskiy area and also on the continental slope of the Olyutorskiy and Karaginsky gulfs.

Spring

Spring migration begins in late March and peaks in April or May, when ice still covers much of the Bering Sea. In the northeast, the continental shelf is very broad and allows broad ice fields to extend far into the sea basin, so that those birds following the ice edge must travel in a great arc southward to reach the northwest part of the basin. Similarly, the broad shelf and slope of Karaginsky Gulf allow ice to dominate the seascape through May and into June, forcing migrant birds to cross broad areas of ice and depend on scattered ice-free patches and polynyas for stopover points. Many species take advantage of the deep gap between the Komandorskiye Islands and the westernmost Aleutian Islands, where a strong outflow of Arctic water breaks up the ice earlier in the season.

Table 11
Number of seabirds nesting in the Russian Far East along the coast of the Pacific Ocean[a]

	No. of seabirds (000s)			
Species group	Komandorskiye Islands	Eastern Kamchatka	Kuril Islands	Total
Procellariiformes	674	unknown	2600	3274
Cormorants	9.2	16.7	87.0	112.8
Gulls	98.0	61.3	<181	340.3
Terns	0	some	0	0
Alcids	473.5	61.5	1659.0	2194.0
Total	1254.7	139.4	4527.0	5921.0

[a] Sources: Velizhanin (1972, 1978); Vyatkin (1986); Artyukhin (1991); Litvinenko and Shibaev (1991); Shuntov (in press a).

Pacific waters of Kamchatka and the Kuril Islands

The North Pacific waters off the Kamchat Peninsula and the Kuril Islands are dominated by the Western Subarctic Gyre. The boundaries of this gyre are formed in the west by the East Kamchat and Oyashio currents, which pass along Kamchatka and the Kuril Islands. The southwest boundary, which is more flexible, is constrained by oceanographic structures where the subarctic waters of the Oyashio Current meet subtropical waters of the Kuroshio system. The southeastern, eastern, and northeastern boundaries of the Western Subarctic Gyre are created by western wind drift and the Subarctic and Alaskan currents (Favorite et al. 1976; Ohtani 1991). There is considerable interannual variation in the strength and position of these latter currents, and, as a result, the western contours of the Western Subarctic Gyre are less stable and poorly known.

From the point of view of oceanic landscapes, two characteristics are especially important. The western part of the gyre is strongly affected by much-modified outflow waters originating in the Bering Sea and the Sea of Okhotsk. Farther west, the influence of those outflow currents is reduced. The southern and southeastern parts of the gyre are greatly influenced by waters of the frontal zone and also by the eastern branch of the Kuroshio Current.

The main nesting habitats for birds in this area are in the Kuril Islands; since the 1960s, however, there have been no detailed observations there, and the estimate of six million seabirds (Table 11) seems too low. It implies that the seabird population nesting in the northwestern part of the Pacific Ocean is only 12% or 20% of the total for the North Pacific (21–31 million individuals).

Summer

In summer, most of the species associated with the Western Subarctic Gyre (Table 11) forage in the Bering Sea and the Sea of Okhotsk, not in oceanic waters. About 60% (3.6 million seabirds) of the species collect food from the surface waters (e.g., procellariids and gulls), and about 40% forage by diving (e.g., alcids and cormorants). The cormorants, guillemots, murrelets, Mew and Common Black-headed gulls, and Rhinoceros Auklet usually do not wander into the open oceanic waters. Most are best described as nerito-oceanic or interzonal. Only two species, Leach's Storm-Petrel and Red-legged Kittiwake, can be termed as truly oceanic species. During the spring and autumn migrations, some northern species also appear, including large numbers of ducks, loons, and sandpipers. Generally, these migrate and winter within a narrow coastal band. Most local storm-petrels roam southward and eastward. All jaegers and phalaropes move out completely. Tufted and Horned puffins, Parakeet Auklet *Aethia psittacula*, and Black-legged Kittiwake are widespread in the open subarctic waters and in the area of the Subarctic Front. Light-phase fulmars are numerous in winter in the Western Subarctic Gyre.

Most studies have occurred in summer. Beside early data (Shuntov 1972), I have made surveys from June to August in 1991, 1993, and 1995 in the western part of the Western Subarctic Gyre. In the 1960s, the average density was 11 birds/km^2 for the summer period along the outlying district of the northwestern part of the Pacific Ocean, along the Kuril Islands, Kamchatka, and the Komandorskiye Islands; and 1.6 birds/km^2 on the open ocean. The decline in density on the open waters, in comparison with spring, reflects the movement of many shearwaters to the Bering Sea and the northeastern part of the ocean (Shuntov 1972). According to the observations of 1991, 1993, and 1995, the average density of seabird concentrations in the Kamchatka–Komandorskiye area was 5.3/km^2 on the shelf (excluding coastal waters) and 4.9–6.5/km^2 in the open sea not farther than 540 km from shore in 1991; in 1993, however, those values were 11.9 and 1.9–2.2/km^2, respectively (Shuntov 1992, 1995b, in press a). In the near Kuril waters, in 1991, the density was 10.7–11.2/km^2 across the first tens of kilometres from shore and 5.2–5.6/km^2 in the open sea up to 360 km offshore; in 1993, the densities were 4.6–30.8 and 3.4–5.4/km^2, respectively. The density was 1.6/km^2 540 km farther west. In 1995, near the islands, the birds' density was 5.1–11.1/km^2; in the open sea 360 km out, it was 2.1–2.6/km^2. Seabird density declines as one moves west, but not sharply. Generally, densities and numbers of birds are higher around the northern Kurils than off the Kamchatka–Komandorskiye region. In part, this is related to the higher numbers nesting on the Kurils, but also to higher bioproductivity and better conditions created by many small gyres and currents.

In the eastern part of the Western Subarctic Gyre, in summer, Short-tailed Shearwater is the most abundant species, followed in order by Sooty Shearwater, Leach's Storm-Petrel, Fork-tailed Storm-Petrel, Audubon's Shearwater, Northern Fulmar, Laysan Albatross, Buller's Shearwater *Puffinus bulleri*, and Tufted Puffin (Sanger and Ainley 1988). In the western part of the gyre, in Russian waters, the Sooty Shearwater is most abundant, followed by Short-tailed Shearwater, Northern Fulmar, Fork-tailed and Leach's storm-petrels, Tufted Puffin, Laysan Albatross, murres, and Black-legged Kittiwake. Because of redistribution of birds between the ocean and the shallower seas, between the western and eastern parts of the gyre, and between the northern and southern parts of the Subarctic Pacific, the species abundance is somewhat variable (Table 12). The interannual dynamics of oceanographic conditions and primarily the changes in circulation of waters are the basis of considerable interannual variability. The basic types of summer seabird distribution in the western part of the Western Subarctic Gyre are illustrated in Figures 9, 10, and 11.

Autumn

During the migration period, the nesting species from the Russian Far East become more scattered across oceanic waters, and about the same 30 or so species can be seen across much of the northwestern Pacific Ocean. They are joined by about 19 species from the south, but only six of those (three albatrosses, Mottled Petrel, Sooty and Short-tailed shearwaters) occur in the Kurils or the Kamchatka–Komandorskiye region. Sooty and Short-tailed shearwaters contribute some six million individuals to the area, so the number of southern migrants is roughly equal to the number of migrants arriving from breeding sites in Asia. Relatively small numbers of the other southern species rarely occur north of the middle Kurils. In general, the southern migrants are heat-loving species or species escaping the outflow currents on the western edge of the Western Subarctic Gyre. In the warmer central and northeastern parts of the North Pacific, they occur somewhat farther north.

In autumn, the density of seabirds declines in the northwestern part of the Pacific Ocean. There is a large-scale departure of the southern procellariids and a dispersion of the storm-petrels, Tufted Puffins, and kittiwakes along vast regions of open ocean. Later, many winter species, such as auklets and murres, arrive from the Sea of Okhotsk and the Bering Sea.

Winter

A few southern migrants that winter in the northwest subarctic Pacific stay entirely within the Asian part of the Western Subarctic Gyre. Laysan Albatross occurs only there, with any regularity, in winter. The densest concentrations of wintering seabirds are in the northern Kurils or along the southeastern coast of Kamchatka (Fig. 11). There, numbers increase until midwinter, when some are displaced by ice fields from the Bering Sea or the Sea of Okhotsk. The small auklets (*Aethia* spp.), murres, and the Slaty-backed Gull are most numerous, but there is a strong influx of Glaucous-winged Gull from American waters. Most of the diving ducks and cormorants also spend the winter in the coastal waters of the Kuril Islands and Kamchatka, and increased concentrations extend to the waters off Hokkaido and Honshu (Shuntov 1972).

In the 1960s, the average density of seabirds was about 10–12 birds/km^2 in offshore areas of the northwest North Pacific (Shuntov 1972). It was only 4% as dense in the open ocean, beyond 180–270 km from shore; in those open waters, however, the total number of seabirds is large, in spite of the low density, because of the huge expanse of the sea. In November–December 1986, I found some different levels of density, with 4–9 birds/km^2 on both the outer shelf zone and the continental slope and 0.8–2.2 birds/km^2 beyond 540 km, on the open ocean. At that time of year, there were

Table 12
Variation in the abundance of seabirds along the Pacific coast of the Kuril Islands, 1991–1995 (Shuntov, in press a)

	No. of seabirds (000s)		
Species or group	1991	1993	1995
Migrant Procellariiformes	1697.5	2012.4	1133.9
Resident Procellariiformes	2126.5	1489.4	1624.8
Sooty and Short-tailed shearwaters	1551.7	1820.7	893.8
Albatross	131.4	186.3	236.1
Alcids	140.5	68.9	66.1
Gulls	32.8	25.3	28.3
Other birds	51.5	15.2	89.7
Total	4048.8	3611.2	2953.1
Total other than shearwaters	2497.1	1790.5	2059.3

Figure 9
Distribution and abundance of Laysan Albatross in relation to the major currents along the Kuril Islands from June through August 1991

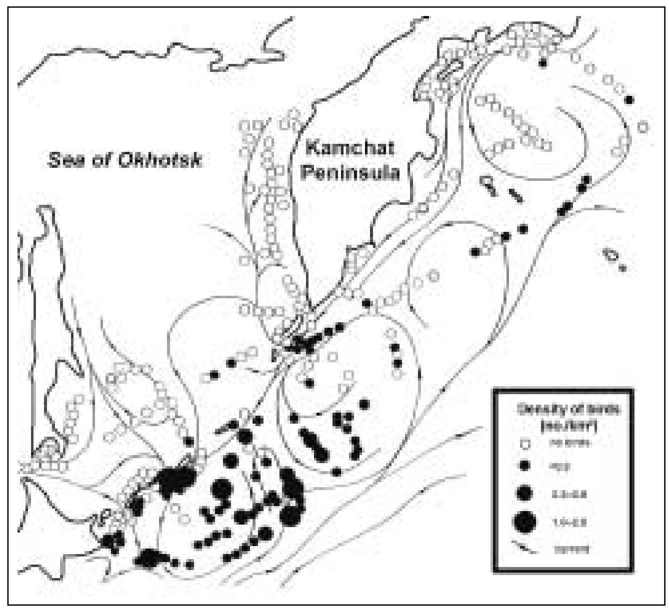


Figure 10
Distribution and abundance of Leach's Storm-Petrel in relation to the major currents along the Kuril Islands from June through August 1991

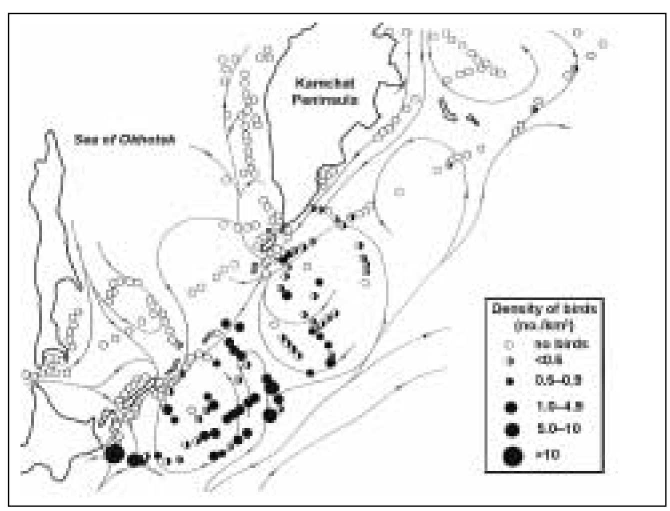
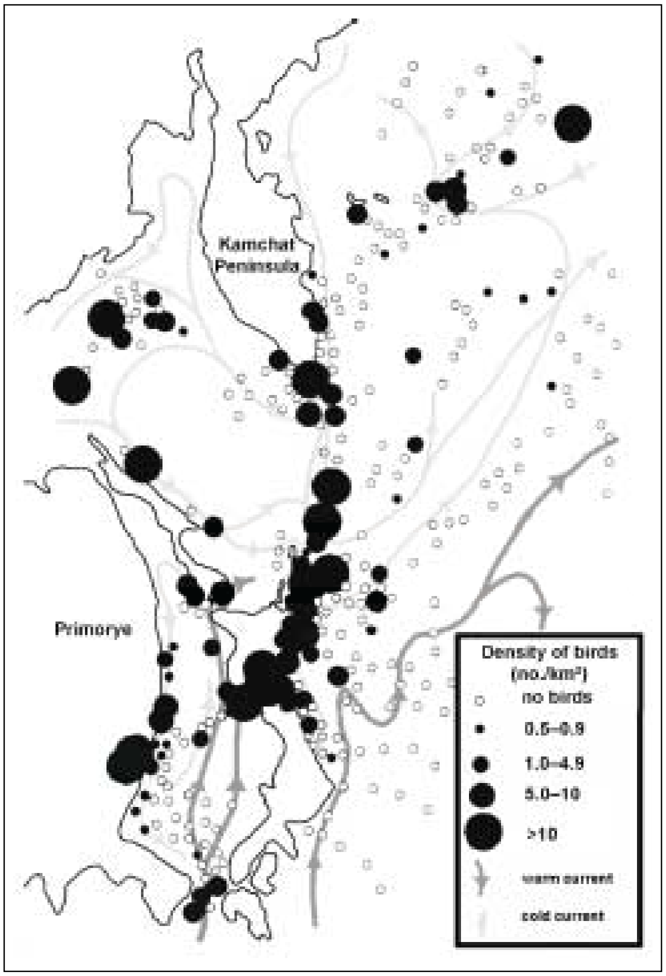


Figure 11
Distribution and abundance of small alcids, other than Crested Auklet, in relation to the major currents along the Kuril Islands and in the Sea of Okhotsk in the winters of the 1960s (Shuntov 1997c)



still considerable numbers of birds (including auklets and murres) in the Sea of Okhotsk and the Bering Sea. In general, however, winter distributions and densities for the area are poorly known.

Spring

Spring data are also very fragmentary. Many of the birds that wintered in that area or off Japan migrate along the western edge of the Western Subarctic Gyre — i.e., along the Kuril Islands and Kamchatka. Many species simply move generally northward, but there is a distinct migration route along the Aleutian Islands to the Komandorskiye Islands. The departure of birds to nesting areas in the Sea of Okhotsk or the Bering Sea, in the second half of spring, is compensated by the arrival of birds from southern latitudes. Seabird density in the open waters may even increase in spring to about 3 birds/km^2, on average. In the regions adjacent to Kamchatka and the Kuril Islands, the density remains close to winter levels of about 15 birds/km^2 (Shuntov 1972); however, the total number of birds continuously passing through the Western Subarctic Gyre during the 60- to 75-day spring period is much higher than in the winter period.

Conclusion

This brief overview demonstrates the often fragmentary nature of our knowledge about the marine period in seabird lives in the Far East. There are particularly large gaps in the winter and spring, and interpretations are difficult in the face of considerable interannual variability. Our understanding of the specific mechanisms linking seabird concentrations to oceanographic and hydrobiological phenomena is poor and suffers from a lack of opportunities for careful observation. In particular, there is little information on the diets and feeding strategies of birds in the marine period of their life. All these questions are a priority in future investigations.

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Chapter 5. Incidental mortality of seabirds in the drift net salmon fishery by Japanese vessels in the Russian Exclusive Economic Zone, 1993–1997

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Summary

The Russian fishery for salmon is largely land based, but there is a large Japanese drift net fishery operating in the Russian Economic Zone. When Russian observers began accompanying those vessels in 1992, the quota was 10 000 t of salmon, and there were 20 mid-sized (130–150 t displacement) ships in the fleet. Each year, the fishery uses an average of 101 000 km of monofilament net set in 4-km units; over five years, from 1993 to 1997, the observers had counted more than 160 000 drowned seabirds, representing 25 species. The calculated loss over the five fishing seasons is more than 827 000 birds, with the biggest losses in 1993 and 1997 and the smallest in 1994 and 1996. Members of the Alcidae, mostly Thick-billed Murres *Uria lomvia*, and the Procellariidae, mostly Sooty *Puffinus griseus* or Short-tailed *P. tenuirostris* Shearwaters, made up 99.4% of the victims. Shearwaters were most frequently caught in southern waters (67 200/year), particularly around the Kuril Islands. Most of the murres were caught in the north (39 100/year).

It is difficult to estimate the impact of the drift net fishery on seabird populations in the northwestern Pacific, because we know neither the origin of the net casualties nor the current status of breeding colonies in the region. The huge numbers of shearwaters, Tufted Puffins *Fratercula cirrhata*, Northern Fulmars *Fulmarus glacialis*, and Crested Auklets *Aethia cristatella* suggest that the current scale of drift net mortality is unlikely to influence the population status of those species. On the other hand, the drift net fishery for salmon may be the single most important threat for Thick-billed Murres in the western Bering Sea, especially in combination with other negative factors, such as environmental changes and human impact. Without doubt, this kind of fishery is dangerous for such rare species of seabird as the Short-tailed Albatross *Diomedea albatrus*.

Résumé

Les Russes pêchent le saumon principalement à partir de la terre, mais une importante flotte japonaise de pêche au filet dérivant exploite la zone économique russe. Lorsque des observateurs russes ont commencé à embarquer à bord de ces navires en 1992, le quota attribué était de 10 000 tonnes de saumon et les vingt bateaux employés étaient de taille intermédiaire (de 130 à 150 tonnes de déplacement). Chaque année, cette pêche utilise une moyenne de 101 000 km de filets monofilament par unités de 4 km. Au fil de cinq années, de 1993 à 1997, les observateurs ont compté plus de 160 000 oiseaux de mer noyés appartenant à vingt-cinq espèces différentes. Le calcul de la mortalité établi pour les cinq saisons de pêche s'élève à plus de 827 000 oiseaux, les principales pertes ayant eu lieu en 1993 et 1997 et les plus faibles en 1994 et 1996. Les oiseaux de la famille des alcidés, essentiellement des Guillemots de Brünnich *Uria lomvia*, et de la famille des procellariidés, surtout des Puffins fuligineux *Puffinus griseus* ou des Puffins à bec grêle *Puffinus tenuirostris*, constituaient 99,4 p. 100 des victimes. Les puffins ont été principalement capturés dans les eaux méridionales (67 200 par an), particulièrement autour des îles Kouriles, alors que les guillemots l'étaient dans le nord (39 100 par an).

Il est difficile d'évaluer l'incidence de la pêche au filet dérivant sur les populations d'oiseaux de mer du nord-ouest du Pacifique parce que nous ne connaissons ni l'origine des oiseaux pris dans les filets, ni l'état actuel des colonies de nidification de la région. Le grand nombre de puffins comme le Macareux huppé *Fratercula cirrhata*, de Fulmars boreaux *Fulmarus glacialis* et de Stariques cristatelles *Aethia cristatella* donne à penser que le niveau actuel de mortalité dû aux filets dérivants n'exerce probablement pas d'influence sur la situation dans laquelle se trouvent les populations de ces espèces. D'un autre côté, la pêche au saumon au filet dérivant constitue peut-être ce qui menace le plus les Guillemots de Brünnich dans l'ouest de la mer de Béring, d'autant que cette pêche est combinée avec d'autres facteurs négatifs comme des modifications de l'environnement et les effets des activités humaines. Il est certain que ce genre de pêche est dangereux pour des espèces d'oiseaux de mer rares comme l'Albatros à queue courte *Diomedea albatrus*.

Общее изложение

Российская индустрия ловли лососины располагается в основном на суше, однако в российской исключительной экономической зоне японские рыболовы применяют для этой цели плавучие сети. Когда российские наблюдатели начали сопровождать японские рыболовецкие суда в 1992 году, квота на лов составляла 10000 тонн лосося и им занимались 20 среднетоннажных судов (водоизмещение 130-150 т). Ежегодно для рыбной ловли используется в среднем

101000 км сетей из мононити по 4 км каждая. В течение пяти лет с 1993 по 1997 год наблюдатели насчитывали в среднем более 160000 утонувших морских птиц 25 видов. По подсчетам потери за пять рыболовецких сезонов составили более 827000 птиц с наибольшим числом потерь в 1993 и 1997 годах и наименьшим - в 1994 и 1996 годах. Птицы семейства чистиковых, в основном толстоклювые кайры, и семейства буревестников, в основном серые буревестники или тонкоклювые буревестники, составили 99,4% жертв. Буревестники чаще всего погибали в южных водах (67200 в год), особенно вокруг Курильских островов. Большинство кайр погибали на севере (39100 в год).

Влияние промысла плавучими сетями на популяции морских птиц в Северном Тихом океане оценить трудно, так как нам неизвестны причины гибели в сетях и современное состояние гнездовых колоний в этом районе. Огромное количество буревестников (*Fratercula cirrhata*), северных глупышей (*Fulmarus glacialis*) и конюг (*Aethia cristatella*) может указывать на то, что современный уровень гибели в плавучих сетях особого влияния на размеры популяций этих видов не оказывает. С другой стороны, ловля лососины плавучими сетями может быть единственной самой значительной угрозой для толстоклювых кайр в западной части Берингова моря, особенно в комбинации с другими такими отрицательными факторами, как изменения экологической обстановки и деятельность людей. Нет никакого сомнения в том, что этот тип рыбной ловли представляет опасность для таких редких видов морских птиц, как белоспинный альбатрос (*Diomedea albatrus*).

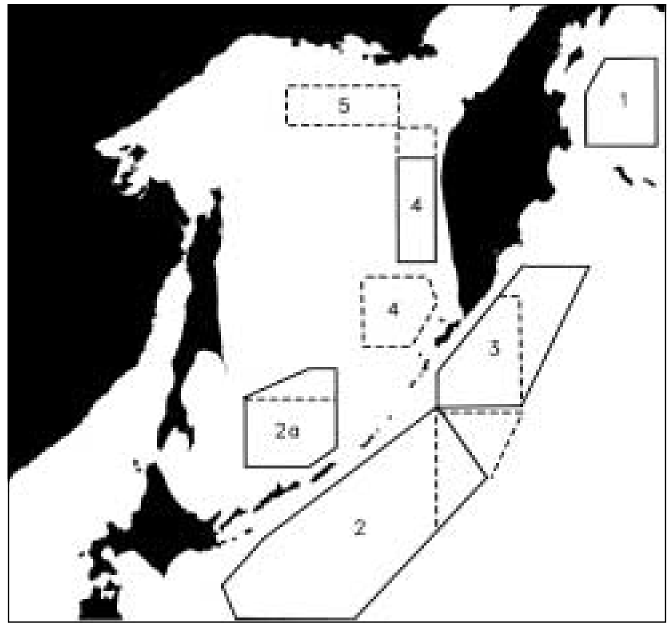
Introduction

No other fishery entails the direct killing of seabirds on the scale of drift nets. Incidental mortality of birds in the nets during the salmon fishery by Japanese drifters in the northwestern part of the Pacific Ocean in 1970–1980 has been examined in great detail by Japanese and American observers (Jones and DeGange 1988; DeGange et al. 1993). Since the beginning of the 1990s, the focus of the Japanese fishery has swung into the Russian Exclusive Economic Zone, but we have been unable to find any published information about subsequent bird mortality. Here, we present information collected by Russian observers on Japanese vessels from 1993 to 1997.

The history of the drift net salmon fishery in the Russian Economic Zone

The start of the Japanese drift net fishery for salmon in the northwestern part of the Pacific Ocean dates back to the middle 1930s, although it has undergone cycles of growth and decline. After the USSR implemented a 200-nautical-mile zone of marine economic interest in 1977, the Japanese drift net salmon fishery in the waters of the Russian Far East stopped temporarily. A Japanese mothership fishery for salmon continued to operate under international treaties in the U.S. Economic Zone and adjacent international waters of the Pacific Ocean and the central part of the Bering Sea (Jones and DeGange 1988). After the United States closed its Economic Zone to drift nets in 1989, fishery operations with motherships were sharply reduced

Figure 1
Fishery zones for the Japanese drift net salmon fishery in the Russian Economic Zone. Dotted line — trade zones of 1993–1996; solid line — trade zones of 1997 (see text).



and stopped completely in 1991 (DeGange et al. 1993). These circumstances accelerated a trend at the end of the 1980s in which Japanese drifters gradually began to move into the Russian Economic Zone, increasing the fishery effort in Russian waters from year to year.

The development of this fishery in the Russian Economic Zone is best illustrated by incidental statistics from the seas off the Kamchat Peninsula. In 1989, 32 Japanese vessels received the first quota of 2000 t of salmon in the Karaginsky area of the Bering Sea. In 1990, six Japanese vessels set and retrieved 30 420 nets near the western coast of Kamchatka in the Sea of Okhotsk from 15 to 26 July. In 1991, Japanese drifters operated in the Bering Sea between 56°N and 58°N, east of 165°E longitude, to the boundary of the Russian Economic Zone. During the period from 21 June to 23 July, 24 fishery and two research vessels worked in this region. In 1992, the Japanese quota for salmon in the Russian Economic Zone increased, exceeding 10 000 t in the regions adjacent to the Kamchat Peninsula (Fishery Zones 1, 3, and 4) (Fig. 1). That fishery used more than 20 vessels. In 1992, Russian observers began to accompany all Japanese vessels, and Kamchatribvod observers began to take an active part in the control of the fishery in 1993.

Russia, and formerly the USSR, never developed its own drift net fishery for salmon in the Pacific Ocean. Attempts at such a fishery were made from the mid-1960s up to the end of the 1970s, with 1–12 vessels taking part. However, the catch per season did not exceed 160 t. Interest in the development of a Russian drift net fishery resumed, on a research basis, in the early 1990s, and salmon were studied in the Pacific Research Institute of Fisheries and Oceanography program. In the first half of the 1990s, 1–3 vessels took part, catching 1000 t of salmon per season. In the last few years, activity by the Russian fleet has increased considerably, reaching a peak in 1996, when the scientific catch involved 24 vessels. Russian scientific research vessels worked mainly off the eastern coast of Kamchatka and the Pacific side of the northern Kurils.

The regulation of Japanese drift net fishery operations in Russian waters

The Japanese salmon fishery in Russian waters is permitted only in designated zones (Fig. 1) in which there are specific annual limits on catch and dates of operation. The fishery uses mid-tonnage drifters (130–150 t displacement) tied to a land base and calling at Japanese ports twice for the discharge of catch. The majority of vessels are busy with the commercial quota, but approximately 10% of the quota is taken up by scientific programs. Besides the middle-tonnage vessels, a small quantity of salmon is caught by a small-tonnage drift net fleet in the southern zones (Fishery Zones 2 and 2a). This fleet increased from 10 vessels in 1994 to 30 vessels in 1997.

The standard net consists of 50 8-m sections (tans) strung together as a 4-km monofilament net. According to the "Rules for anadromous fish resource-use in the Russian Far East," the total length of all nets set by one vessel in one set must not exceed 32 km (eight nets), and the distance between nets in all directions ought to be at least 4 km. Each net is marked with radar and radio beacons at the ends. The number of nets depends upon the type of fishery: all eight nets (32 km) are used if the catches are small, and fewer nets if the fish are at high densities or if the sea is particularly rough. Usually the nets are set in the evening twilight and retrieved at sunrise. According to the rules, nets should have a mesh of 110 mm when stretched diagonally, but commercial vessels usually use nets with a mesh of 124–130 mm, and research fisheries use nets with a mesh of 110 mm. On each of the mid-tonnage Japanese vessels, during all of the fishery, there is a Russian observer who records the catch of fish by species and also the number of incidental catches of marine mammals and seabirds.

The fishery is held from the middle of May to the end of July. In successful years, the majority of vessels end their work in mid-July. Drifters using the commercial quotas distribute their activity in a way to optimize the catch of the most valuable species of salmon during the season. From the beginning of the fishery season to mid-June, activity is concentrated in Zone 1, where the catch is largely sockeye salmon *Oncorhynchus nerka*. Later, in the second half of the fishery, the majority of vessels move into the northern Kurils and into the northern Sea of Okhotsk.

The distribution of vessels in each zone depends upon the fishery situation. In the Bering Sea, the majority of vessels are distributed along the southern and eastern boundaries of Zone 1; the northwestern corner is used the least. In Zone 3, the vessels operate mainly in the southwestern part, westward from 160°E. In Zone 2, practically all operations occur in the northern part, and the area south of Shimushir Island (Fig. 1) is almost unused. In Zone 2a, the vessels concentrate along the eastern boundaries, and in Zones 4 and 5, near the southern boundaries.

In the period from 1993 to 1997, boundaries of fishery zones, limits within the quotas, fishing effort, and vessel distribution among zones varied considerably. The total length of nets set ranged from 54 000 to 148 000 km annually, averaging 101 000 km. The particular characteristics of each fishery season influence the distribution of the fish efforts and the subsequent mortality of seabirds in the nets.

In 1993, the northern boundary of Zone 2a was along 48°N. Zone 2 was increased in the northeast and extended to the southeastern corner of Zone 3, and Zone 4 lay farther south than the present boundaries between 50°N and 52°N. Zones 3 and 4 were used only for a scientific catch of small volume. The total volume of the quota was not larger than in other years, but it was mainly distributed between Zones 1 and 2. However, the total fishing effort was the largest in the period of observation by a factor of 1.5. More than half of the nets were set in Zone 1.

In 1994, the size of Zone 2 was reduced; its eastern boundary was along 155°E. Zone 4 took up its present boundaries (north of 52°N). The commercial fishery was held in all zones, but the quota was the smallest of all years, and the fishing effort was half the average level.

In 1995, Zone 2a was increased to the north, to its present boundaries. Zone 5 was moved one degree southward. Zone 3 was opened only for research vessels. The quota was the largest of all years, but the fishing effort was close to the average level.

In 1996, Zone 5 was closed. Zone 2 was increased to the east, to its present boundaries, for the second time. Zone 3 was opened only for the research catch. Both the quota and the fishing effort were less than average.

In 1997, the commercial fishery was held in all regions within the boundaries shown in Figure 1. The total quota was not much bigger than the average level, but in Zones 2 and 3 it was the biggest of all years, and fishing effort was larger by 33%, the largest during the period of observation.

Materials and methods

Kamchatribvod observers recorded the frequency of seabird netting from 1993 to 1997 on the mid-tonnage vessels. We have used the results of 3251 net sets with total length of 93 704 km, 18.6% of the length of all nets set in these years by the Japanese drift net fleet in the Russian Economic Zone. In 1993, observations of 42 157 km of drift nets were used to calculate the seabird by-catch; in 1994, 19 706 km, in 1995, 21 144 km, in 1996, 4684 km, and in 1997, 6012 km. In all, 160 610 drowned birds were recorded. Some observers, especially in the first years, were able to record only the total number of birds killed in each set, without distinguishing species. Species composition of killed birds is based on 843 sets with a total length of 21 606 km (23.1% of the total length of nets observed). Within this sample, 32 929 birds were recorded (20.5% of the total number of birds recorded). Because the observers recorded only the number of birds brought on deck, we used 85 sets (2008 km) in 1996 and 1997 to calculate the number of birds that dropped from the nets to the water during net retrieval. We also collected and examined samples of some species to determine age distribution and reproductive status (based on the condition of the gonads and the presence or absence of brood patches).

We used the number of dead birds/km of net as a measure of the catch rate of seabirds for each of the 3251 settings. We extrapolated those data, according to the year, fishing zone, and fishing effort (the length of set nets in the

Table 1
Species composition of the seabird by-catch in the Japanese drift net salmon fishery in the Russian Economic Zone

Species	Species composition (%) of by-catch by fishery zone 1 (n = 11 977)	3 (n = 3920)	2 (n = 13 368)	2a (n = 1459)	4 (n = 1699)	5 (n = 506)	All zones (n = 32 929)
Red-throated Loon *Gavia stellata*	0	0	0	0.07	0	0	<0.01
Arctic Loon *Gavia arctica*	0.03	0	0	0	0	0	0.01
Yellow-billed Loon *Gavia adamsii*	0.02	0	0	0.07	0	0.4	0.02
Laysan Albatross *Diomedea immutabilis*	0.02	0.03	0.16	0.07	0	0	0.08
Northern Fulmar *Fulmarus glacialis*	3.58	4.54	7.92	22.14	10.77	25.89	6.99
Sooty Shearwater *Puffinus griseus*	0	0	0.14	0	0	0	0.06
Short-tailed Shearwater *Puffinus tenuirostris*	1.01	2.02	28.57	12.54	15.3	0.79	13.56
Puffinus spp.	2.81	59.57	37.93	35.3	20.48	3.36	26.18
Leach's Storm-Petrel *Oceanodroma leucorhoa*	0	0.05	0.01	0	0.06	0	0.02
Fork-tailed Storm-Petrel *Oceanodroma furcata*	0.05	0.33	0.52	0.89	0.24	0	0.32
Pelagic Cormorant *Phalacrocorax pelagicus*	0.01	0	0	0	0	0	<0.01
Pomarine Jaeger *Stercorarius pomarinus*	0.03	0	0	0	0	0	0.01
Slaty-backed Gull *Larus schistisagus*	0.03	0	0	0	0	0	0.01
Glaucous Gull *Larus hyperboreus*	0.01	0	0	0	0	0	<0.01
Black-legged Kittiwake *Rissa tridactyla*	0.13	0	0	0	0	0	0.05
Common Murre *Uria aalge*	1.69	0.13	0.07	0.89	0.24	0	0.71
Thick-billed Murre *Uria lomvia*	55.19	4.57	0.34	8.43	4.59	6.13	21.46
Uria spp.	8.18	2.35	0.01	1.3	0.65	5.53	3.44
Pigeon Guillemot *Cepphus columba*	0.01	0	0	0.07	0	0	0.01
Ancient Murrelet *Synthliboramphus antiquus*	1.16	0.23	0.19	0.34	1.12	0.2	0.6
Cassin's Auklet *Ptychoramphus aleuticus*	0.09	0	0	0	0	0	0.03
Crested Auklet *Aethia cristatella*	9.93	1.66	10.64	2.06	3.94	0	8.42
Least Auklet *Aethia pusilla*	1.46	0.08	0.01	0	0	0	0.55
Parakeet Auklet *Cyclorrhinchus psittacula*	0.38	0.23	0.1	0.07	0.29	0	0.22
Rhinoceros Auklet *Cerorhinca monocerata*	0	0	0.07	0.41	0	0	0.05
Horned Puffin *Fratercula corniculata*	0.52	1.22	0.85	2.26	5.06	4.15	1.1
Tufted Puffin *Fratercula cirrhata*	13.56	22.93	12.46	13.09	37.26	53.56	16.05
Unidentified birds	0.1	0.08	0	0	0	0	0.05

zone), to arrive at values for the average total mortality of seabirds. Values for individual species were calculated for each year and zone, and the total seabird mortality estimate per year is the sum of average values for all zones with an active fishery. To compensate for missing data for Zone 3 in 1993 and 1996, we extrapolated values from nearby Zone 2. For Zones 4 and 5, the rates from 1994 were used instead of those from 1993. The analysis of the total catch rates for seabirds was based on the 3251 net sets. A subsample of 843 sets, in which individual birds were identified, was used to determine the species composition. Data from observers on the commercial and research vessels were combined. In statistical analysis, we followed the protocols for the Mann-Whitney U-test for pair comparisons and Kruskal-Wallis analysis of variance (ANOVA) test for several selections.

The fishing effort of the Japanese fleet in 1993–1996 was defined for each fishery zone taken separately, on the basis of the number of nets set by vessels carrying observers of Kamchatribvod. The subsequent data were multiplied by a coefficient based on the ratio of total quota to the quota for the vessels with Kamchatribvod observers (the ratio of quota for these vessels varied every year from 26.3% to 36.8% of the total annual quota for all zones). For 1997, we used full indices of fishing effort of all Japanese vessels according to the data of the fishery registers.

Results

Species composition

From 1993 to 1997, 32 929 dead birds of 25 species were taken from drift nets. Overwhelmingly, the majority of birds belonged to the Alcidae (52.64%) or Procellariidae (46.79%). The remainder included Hydrobatidae (0.34%) and *Diomedea* spp. (0.08%) and single members of the Gaviidae, Phalacrocoracidae, Stercorariidae, and Laridae (Table 1).

Shearwaters (Short-tailed *Puffinus tenuirostris* and Sooty *P. griseus*) comprise about 40% of all the mortality. Many observers on the vessels recorded them only as *Puffinus* spp. On those ships with skilled observers from 1995 to 1997, 4485 were identified to species: 4466 (99.58%) Short-tailed Shearwaters and 19 (0.42%) Sooty Shearwaters. Murres (Thick-billed *Uria lomvia* and Common *U. aalge*) comprised 25% of birds; as in the case of shearwaters, these species were often lumped as one group. In the identified subsample (n = 7301) from 1993 to 1997, 7066 (96.78%) were Thick-billed Murres and 235 (3.22%) were Common Murres. Tufted Puffins *Fratercula cirrhata* (16.05%) and Northern Fulmars *Fulmarus glacialis* (6.99%) comprised most of the remaining casualties (Table 1). Generally, alcids dominated in the northern marine areas, and the proportion of Procellariiformes increased southward.

Table 2
Catch rates (mean birds/km of drift net SE) for all species of seabird combined in the Japanese drift net salmon fishery in different fishery zones of the Russian Economic Zone

Fishery Zone	Mean no. of birds/km of drift net ± SE 1993	1994	1995	1996	1997	1993–1997
1	1.851 ± 0.109 (33 554)[a]	1.734 ± 0.064 (9592)	1.594 ± 0.081 (7971)	1.715 ± 0.158 (1888)	0.876 ± 0.078 (1720)	1.722 ± 0.055
3	no information	2.696 ± 0.186 (2366)	3.054 ± 0.253 (2417)	no information	1.373 ± 0.236 (1120)	2.676 ± 0.140
2	3.049 ± 0.560 (7877)	3.751 ± 0.579 (2568)	2.436 ± 0.205 (3550)	1.328 ± 0.142 (1564)	1.908 ±0.355 (2036)	2.690 ± 0.221
2a	1.413 ± 0.309 (726)	0.565 ± 0.060 (2286)	0.356 ± 0.035 (3176)	0.629 ± 0.090 (736)	0.486 ± 0.080 (648)	0.572 ± 0.044
4	no information	1.018 ± 0.102 (956)	1.103 ± 0.104 (2653)	0.379 ± 0.051 (496)	0.557 ± 0.126 (488)	0.975 ± 0.067
5	no information	0.820 ± 0.061 (1939)	0.495 ± 0.030 (1378)	—[b]	—	0.676 ± 0.039
All zones	2.065 ± 0.137	1.950 ± 0.095	1.711 ± 0.072	1.246 ± 0.085	1.238 ± 0.127	1.810 ± 0.051

[a] The length (m) of examined nets is given in parentheses.
[b] — indicates absence of observers.

Age composition

Among 219 fulmars obtained in 1995–1997 in the northern Kurils (Zones 2, 2a, and 3), there were only 19 individuals (8.68%) with undeveloped gonads that could be classified as yearlings. Other fulmars had well-developed gonads in the active state and showed clear brood patches. According to the state of ovaries, 32 females (74.42%, n = 43) had laid eggs.

Among 716 Thick-billed Murres, adults were the most abundant (on average 70.53%) fishery in Zone 1 in 1995–1997. In 1995, 21.43% (n = 224) were immature birds; in 1996, 30.88% (n = 285) were immature; and in 1997, 36.23% (n = 207). In 1994, age determination was based on plumage rather than dissection, and only 13.45% (n = 275) appeared immature. All murres that were obtained during the period from 25 May to 10 June lacked brood patches, and females had no signs of egg production in the gonads.

In 1997, Tufted Puffins (n = 113) examined during the period from 13 June to 16 July in Zones 2 and 3 included 61.95% adults, 5.31% subadults, and 30.97% yearlings. Only one of 70 adult birds had signs of breeding. In the two previous seasons, when the first two age groups were lumped together (adult + subadult), the ratio of one-year-old birds comprised 30.10% (n = 309) in 1995 and 57.78% (n = 180) in 1996.

Among 10 Ancient Murrelets *Synthliboramphus antiquus* obtained in Zone 4 from 18 to 21 June 1997, there were one yearling and nine adults, eight of whom showed signs of breeding.

The catch rates of seabirds

The average number of dead seabirds of all species recorded during 3251 settings of drift nets in 1993–1997 was 1.81 birds/km (Table 2), with a range from 0 to 89.61 birds/km of set net. These catch rates varied according to fishery zone (Kruskal-Wallis test, $p < 0.001$). Generally, the birds were killed more often in the Pacific waters of the Kuril Islands and in the Bering Sea rather than in the fishery zones of the Sea of Okhotsk. There was no significant difference between Zone 2 and Zone 3 (Mann-Whitney U-test, p = 0.111). The catch rates were affected by geographic factors, because the species were not evenly distributed among zones (Fig. 2). For example, among the very abundant, widespread species, murres were drowned most frequently in the Bering Sea but were rarely killed in the other zones. Shearwaters were killed most frequently in the Pacific waters of the Kuril Islands and southern Kamchatka but rarely in the Bering Sea and Sea of Okhotsk; the differences between Zone 2 and Zone 3 were not significant (Mann-Whitney U-test, p = 0.588). The distribution of Tufted Puffin casualties was also uneven. They were killed in the northern part of the Sea of Okhotsk and more frequently in the marine areas adjacent to the southern part of Kamchatka than in the southern Sea of Okhotsk.

The catch rate for all seabird species combined varied from year to year (Kruskal-Wallis test, $p < 0.001$). Generally, the average rate of bird capture declined from 1993 to 1997 (Table 2). Paired comparisons of all possible combinations among fishery seasons using the Mann-Whitney U-test did not find significant differences between 1993 and 1994 (p = 0.860). The catch rates of some individual seabirds differed from the general tendencies. For instance, the least number of shearwaters was observed in 1996. Significant differences in the capture rate for shearwaters were found only between 1994 and 1996 (Mann-Whitney U-test, p = 0.023) and between 1996 and 1997 (Mann-Whitney U-test, p = 0.001). Murres were killed less frequently in 1997 than in the previous fishery seasons (Mann-Whitney U-test, p = 0.002, $p < 0.001$, p = 0.036, and p = 0.005 for 1993, 1994, 1995, and 1996, respectively). The reduction in nets set in the seasons after 1993 coincides with a significant decline in mortality over the previous season (Fig. 3) (Mann-Whitney U-test, p = 0.002).

In Zone 1, where the main kill of murres occurred, the capture rate for murres in 1993 was 0.698 birds/km, and in 1997, 0.515 birds/km (no significant difference, Mann-Whitney U-test, p = 0.243). In 1994, 1995, and 1996, rates were 1.476 birds/km, 1.106 birds/km, and 1.235 birds/km, respectively.

The estimation of total seabird mortality

During the period from 1993 to 1997, more than 827 000 birds died in the drift nets (Table 3). Annual totals

Figure 2
The rate of seabird by-catch in the Japanese drift net salmon fishery in the Russian Economic Zone, 1993–1997

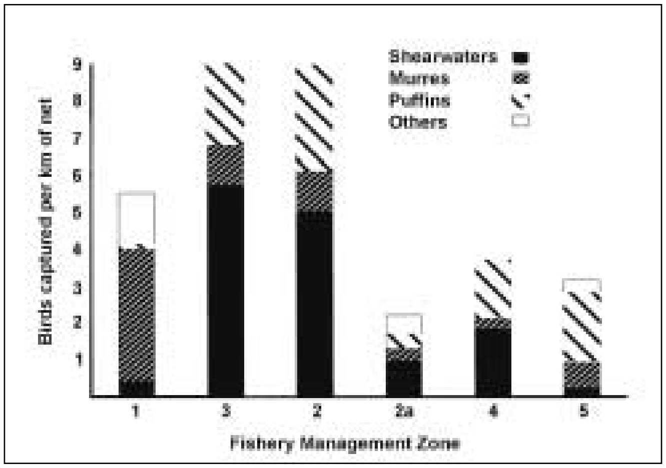
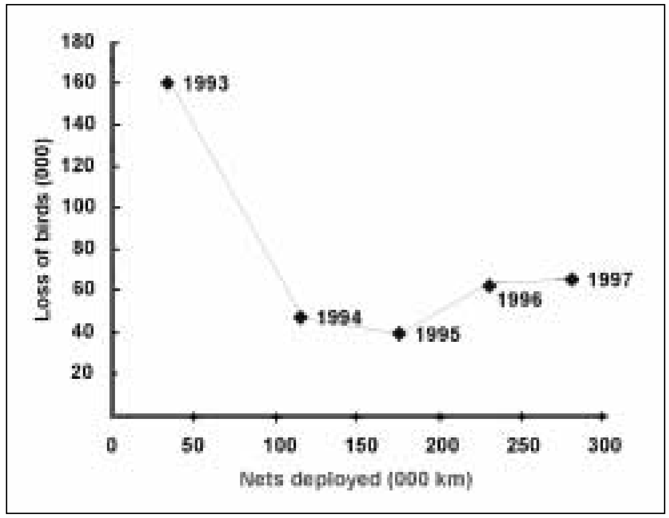


Figure 3
Changes in the annual mortality rate for seabirds in the Japanese drift net salmon fishery in the Russian Economic Zone, 1993–1997



varied considerably, but the average was 165 400 per season, with a maximum of twice this number in 1993. The smallest losses were observed in 1994 and 1996. The greatest mortality was recorded in Zones 1 and 2. Average annual mortality included more than 67 000 shearwaters (apparently less than 1% Sooty Shearwaters), more than 40 000 murres (about 96% Thick-billed Murres), about 24 000 puffins (93% Tufted Puffins), 18 200 Crested Auklets *Aethia cristatella*, and 11 000 Northern Fulmars (Table 4).

The loss of birds in the retrieval of nets

In 1996, between 12 and 1596 birds dropped from the nets during retrieval. These birds represent about 0.75% of the total by-catch. In 1997, from 17 to 1761 (0.97%) birds were missed in this way.

Discussion

General characteristics of seabird mortality in drift nets

The species composition of the birds caught in nets depends partially on the characteristics of the birds' use of marine regions, but mostly upon their feeding strategies. Piscivorous diving birds make up the greatest part of the observed by-catch (Table 1). These include shearwaters (plunge divers) and all alcids (pursuit divers) that obtain food beneath the surface. This group also suffered the greatest mortality in the North Pacific drift net fishery (DeGange et al. 1993). Of all the species at the surface of the water (gulls and procellariids other than shearwaters), only the Northern Fulmar was netted in considerable numbers. This results from their attempts to feed on fish in the nets.

The ratio of dead Common Murres to Thick-billed Murres (1:30) in the nets of Zone 1 is markedly different from the values recorded in the nesting colonies on the Kamchatka coast (1:2) (Vyatkin 1986) or on the Komandorskiye Islands (1:1.5) (Artyukhin, in press). This discrepancy may also be linked to differences in the feeding ecology of these two otherwise similar species. The diet of Thick-billed Murre is more diverse than that of Common Murre and includes less clustered kinds of prey. As a result, Thick-billed Murres use a wider range of marine regions while foraging (Springer et al. 1996). Ainley et al. (1981) demonstrated that the rate of a species' by-catch depends upon the density of birds on the sea. Basically, the mortality of birds in the different fishery zones (Table 2, Fig. 2) conforms to the general distribution of seabirds in the marine domains of the Far East (Shuntov 1992; see also Chapter 4). The highest concentrations of birds during the summer period and the highest mortality were observed in waters of the northern Kurils, including Zone 3 and the northern part of Zone 2. In the Sea of Okhotsk, the seabird density and by-catch in western Kamchatka (Zones 4 and 5) and in the deep-water marine regions (Zone 2a) are low (Shuntov 1995a; see Chapter 2).

The catch rate for some seabird species depends on seasonal peculiarities of their distribution. Variations in the indices of shearwater mortality among the fishery zones (Fig. 2) are connected, in part, to their seasonal migrations. The marine areas of the northern Kurils are one of the traditional moulting places for large concentrations of shearwaters. There, hydrodynamics create the conditions for stability of the prey base that is needed by this species in the moulting period (Shuntov 1992, 1997). The peak abundance of shearwaters in those areas coincides with high indices of relative and total mortality of birds in Zones 2 and 3. Comparatively infrequent capture of shearwaters in Zones 2a, 4, and, especially, 5, in the Sea of Okhotsk, reflects the shearwaters' tendency to remain in the southern outlying areas in the first half of summer, avoiding the deep-water areas (including Zone 2a). They do not penetrate the northern part of the basin in considerable numbers until the end of summer or autumn (Shuntov 1995a, 1997). In the western Bering Sea, the major migrations of shearwaters fall after the peak of fishing activity in Zone 1 (Shuntov 1992).

The prevalence of Short-tailed Shearwater over Sooty Shearwater in our samples is the product of differences in their pelagic distribution as they wander across the seas. The mass migration of Short-tailed Shearwater stretches to the Chukchi Sea, whereas the Sooty Shearwater accumulates in large numbers only at the latitudes of Japan and the southern part of the Kurils (Shuntov 1982). It is not accidental that

Table 3
Annual seabird mortality estimates for the Japanese drift net salmon fishery in the Russian Economic Zone, 1993–1997

	Estimated annual mortality of seabirds ± SE				
Fishery Zone	1993	1994	1995	1996	1997
1	160 657 ± 9442	41 648 ± 1544	45 694 ± 2330	41 800 ± 3858	27 434 ± 2442
3	5421 ± 996	12 510 ± 863	7381 ± 612	7563 ± 809	19 468 ± 3344
2	143 200 ± 26 298	33 399 ± 5151	68 018 ± 5719	34 271 ± 3665	108 938 ± 20 284
2a	8170 ± 1789	4191 ± 444	9479 ± 921	8047 ± 1152	8173 ± 1339
4	513 ± 51	2856 ± 287	7366 ± 697	2622 ± 353	5604 ± 1264
5	5022 ± 371	5022 ± 371	2716 ± 163	0	0
All zones	322 983 ± 38 947	99 626 ± 8660	140 654 ± 10 442	94 303 ± 9837	169 617 ± 28 673

Table 4
Mortality estimates by seabird species in the Japanese drift net salmon fishery of the Russian Economic Zone, 1993–1997

	Estimated no. of birds					
Species	1993	1994	1995	1996	1997	1993–1997
Gavia stellata	0	0	0	0	25	25
Gavia arctica	0	0	36	16	0	52
Gavia adamsii	0	24	47	0	18	89
Diomedea immutabilis	0	172	26	296	239	733
Fulmarus glacialis	15 771	7 930	12 419	9 089	9 601	54 810
Puffinus griseus	0	0	13	48	451	512
Puffinus tenuirostris	0	0	33 076	13 954	31 365	78 395
Puffinus spp.	142 111	26 576	27 532	14 011	48 450	258 680
Oceanodroma leucorhoa	0	0	11	48	13	72
Oceanodroma furcata	134	44	331	743	1 009	2 261
Phalacrocorax pelagicus	0	0	12	0	0	12
Stercorarius pomarinus	0	0	12	0	55	67
Larus schistisagus	0	0	24	0	18	42
Larus hyperboreus	0	0	0	16	0	16
Rissa tridactyla	468	97	24	0	37	626
Uria aalge	4 080	777	525	1 352	351	7 085
Uria lomvia	81 367	30 830	31 378	16 425	19 257	179 257
Uria spp.	345	959	4 359	11 028	18	16 709
Cepphus columba	0	0	0	40	0	40
Synthliboramphus antiquus	2 475	471	755	472	1 063	5 236
Ptychoramphus aleuticus	201	0	24	49	55	329
Aethia cristatella	34 914	15 122	8 192	3 723	29 006	90 957
Aethia pusilla	8 026	194	217	113	503	9 053
Cyclorrhinchus psittacula	736	121	149	264	573	1 843
Cerorhinca monocerata	0	0	13	192	159	364
Fratercula corniculata	1 436	1 036	1 141	777	3 498	7 888
Fratercula cirrhata	30 921	15 053	20 314	21 630	23 812	111 730
Unidentified birds	0	219	24	16	39	298

Short-tailed Shearwater was the prevalent species killed in the drift net fishery of both the U.S. (DeGange et al. 1985) and Russian economic zones, whereas Sooty Shearwater was prevalent in the southern international waters (Johnson et al. 1993; Ogi et al. 1993).

Similarly, the mortality of breeding birds is influenced by their movements. For instance, Ancient Murrelets are among the first to disperse with their precocious young. In Zone 4, the prevalence of reproductive adult birds among Ancient Murrelet casualties and repeated observations of their broods on the sea must be the result of their post-breeding movements from other areas, because there are no known nesting sites for this species on the southwestern coast of Kamchatka (Vyatkin 1986). Most likely these birds appear in Zone 4 when they drift northward with the West Kamchat Current, leaving the waters around the colonies on the northern Kurils (Shibaev 1990). The fishery for salmon starts in the second half of May while most seabirds are still migrating northward (Shuntov 1972; Gerasimov 1992) and ends with the start of the postnesting dispersal for most species.

The scale of seabird mortality in the different fishery zones is connected to the presence of colonies on nearby coasts. In the western Bering Sea, high indices of mortality are based on birds from the many breeding colonies rather than the migrant shearwaters (as can be seen in Zones 2 and

3). The absence of big seabird colonies on the southwestern coast of Kamchatka (Vyatkin 1986) is reflected in low densities of birds on the adjacent waters (Shuntov 1997) and, consequently, low by-catch rates of birds in Zone 4 (Table 2).

Although much of the abundance and marine distribution of seabirds can be accounted for by oceanographic and hydrobiological fluctuations (Shuntov 1995b), the inter-annual variations in seabird mortality from by-catch in nets may also depend upon climatic-oceanographic peculiarities of the fishery season. During the period of observation, the greatest anomalies in the water circulation occurred in 1993, typified by cold water. In that fishery season, there was a significant delay in the phenology of some biological processes and concurrent changes in seabird distribution (Shuntov 1995b). On the Komandorskiyes and Talan Island in the northwestern Sea of Okhotsk, 1993 was a poor year for reproduction by Black-legged and Red-legged kittiwakes (*Rissa tridactyla* and *R. brevirostris*) and murres (Kondratyeva 1994; Zelenskaya 1994; Artyukhin, in press). In that year, there was an abnormally high mortality of birds (mostly shearwaters) in Zone 2a (Table 2) and low capture of murres in Zone 1. The shearwaters had collected in unusually large concentrations in the southern Kurils and South Sakhalin marine areas (Shuntov 1995b). A low catch rate for murres in the Bering Sea during the cold anomaly of 1993 was repeated in 1997, during similar conditions. The lowest ratio of young to adult Thick-billed Murres in the by-catch was recorded in Fishery Zone 1 in 1994 and was likely connected to low murre productivity in the previous season.

In general, it is difficult to explain the steady reduction in seabird mortality during the period of observation and especially during the last two years of observation. It is dependent on a lower by-catch of shearwaters and, to a lesser extent, of murres in 1997. Unfortunately, we lack information about the distribution and abundance of seabirds among the fishery zones for recent seasons. It is not possible to predict the rate of loss to fish nets in any given area, because the factors affecting bird distribution at sea are poorly known (Shuntov 1995b); the same applies to the rate at which seabirds are caught in nets.

It is important to add that major changes in oceanographic conditions influence the migration routes followed by anadromous salmon (Shuntov 1994), and those routes influence the fishery and fishing effort, in turn. It is the level of fishery activity that controls the annual total mortality of birds to a great extent (Fig. 3).

The quality of the estimate and the scale of bird mortality in drift nets in Russian waters

The quality of the estimate of total bird mortality in the drift nets is influenced not only by methods of statistical treatment but also by a number of “technical” factors connected with the specific nature of the fishery.

To some extent, the catch rate of seabirds depends on the size of the mesh. Nets with a mesh of 93–138 mm, typical of the commercial fishery, have the highest catch rate for birds (Ainley et al. 1981; DeGange and Day 1991). In the past, catch rates measured on research vessels using finer and larger meshes were adjusted upward to avoid underestimates; however, the research vessels in Russian waters use nets of at least 110-mm mesh, and the data can be used without further correction.

Underestimates also occur because birds fall from the nets during retrieval and are not counted by fishery observers. During the commercial fishery for salmon by Japanese vessels in the U.S. Economic Zone, 0.5–2.2% of the birds were missed in this manner (DeGange et al. 1985). On the research vessels, the rate increased to 5–13% (Ainley et al. 1981), perhaps because different mesh sizes were used on the research vessels. On average, 0.87% of birds dropped from the nets during retrieval in Russian waters in 1996–1997. However, almost half (41.18%) were eventually recovered because of a special device designed to collect fish that also dropped from the nets.

There may be a small underestimate in bird mortality arising because of the loss of drift nets. Because such nets may float for a long time, they can pose a significant threat to large numbers of seabirds (DeGange and Newby 1980). We recorded the catch rates of birds per length of unretrieved net without accounting for the rare cases in which segments were lost.

We did not adjust the estimates of total mortality for losses of drowned birds while the nets were still set, assuming that these were partly compensated by renetting of such birds. In some zones, nearby vessels set nets within the minimum permitted distance (4 km), parallel to each other. Our observations show that, in such dense arrays of nets, seabirds (and also seals) taken from the nets of one vessel drifted on the surface of water when thrown overboard and were sometimes netted by the other vessel, where they could have been counted as by-catch a second time.

Estimates of mortality in the Russian Far East must consider the fishing operations of both the Japanese fleet and the Russian fleet with their associated research vessels. However, in 1995, the additional catch by Russian vessels comprised less than 1000 t. From 1995 to 1997, the Russian share of the quota increased to 30% of the total for Japanese fishermen. The fishery operation by Russian vessels is concentrated on the east coast of Kamchatka between 52°N and 55°N. In summer, the seabird density of this marine area is half that of Pacific waters in the northern Kurils (Shuntov 1995b), and the by-catch rate for seabirds may be considerably lower there. On the basis of very fragmentary data, we estimate that, in the Russian drift net fishery, the average annual mortality of seabirds probably did not exceed 20 000–25 000 birds from 1995 to 1997.

Taking into consideration all of the contributing factors, the total seabird mortality from 1993 to 1997 in the drift net fishery for salmon by Japanese and Russian vessels in the Russian Economic Zone was slightly more than 900 000 birds. Since 1989, not fewer than one million seabirds have died from drift net fishing in the Russian Economic Zone.

The impact of the drift net fishery on seabird populations

Estimating the amount of damage that drift net fisheries inflict on seabird populations is difficult, for a variety of reasons. In the majority of cases, it is difficult to determine the origin of the dead birds, because many species (especially procellariids) cross huge marine areas while foraging and may move hundreds of kilometres per day. Only the mortality in the large-scale high-seas drift net fishery in the North Pacific has been significant enough to reduce numbers of several seabird species over a period of 10 years (Jones and DeGange 1988; DeGange et al. 1993). Most other reports involve coastal fisheries near the breeding colonies, where the origin of dead birds is fairly evident. For example, Common Murre numbers declined on the coast of California (Takekawa et al. 1990). Reductions may also be evident where mortality affects a seabird species that has a rather limited nesting area and comparatively small total population, such as the impact on albatross of the drift net fisheries in international waters of the North Pacific (Gould and Hobbs 1993). Similarly, Japanese Murrelet *Synthliboramphus wumisuzume* populations have also declined (Piatt and Gould 1994). Unfortunately, there is little information on the demographic parameters of Russian colonies near the zones of the drift net fishery, and only generalized, preliminary conclusions can be made for those areas and species involved in the larger mortality.

In Russian waters, the Short-tailed Shearwater suffers the highest rate of mortality from drift nets each year. On average, more than 67 000 individuals die each season. Another 98 000 died each year between 1981 and 1984 in the Japanese mothership salmon fishery in the U.S. Economic Zone (DeGange et al. 1985). That activity moved into international waters in 1988 and disappeared in 1991 (DeGange et al. 1993). In addition, tens of thousands died annually in international waters of the North Pacific as a result of either the Japanese land-based salmon fishery, whose intensity also declined by the end of 1980 (DeGange and Day 1991), or the drift net fishery for fish and squid by Japanese, Taiwanese, and Korean vessels (Johnson et al. 1993). H. Ogi and his colleagues calculated that, in 1990, the total reduction in the Short-tailed Shearwater population by losses to all kinds of fishery was 0.02% (Ogi et al. 1993). Considering that salmon drift nets only recently came into use in Russian waters, their negative influence on a population of some 23 million Short-tailed Shearwaters is likely to be small (Everett and Pitman 1993) and not distinguishable from other more destructive factors, such as mass harvest of chicks in the breeding colonies. That harvest greatly exceeds the mortality of shearwaters in drift nets (Skira et al. 1985 in Everett and Pitman 1993; Skira 1987 in Everett and Pitman 1993).

The drift net fishery may have a greater influence on the populations of Thick-billed Murre that inhabit the western Bering Sea. Murres, with their relatively long lives, delayed maturity, and high level of annual survival (Tuck 1960; Hudson 1985), are sensitive to negative environmental changes and impacts of human activity, which cause minor increases in adult mortality (Ford et al. 1982; Hudson 1985).

The total mortality of Thick-billed Murres in the nets of Fishery Zone 1 alone amounted to 36 500 birds/year on average, ranging from 80 000 in 1993 to 16 000 in 1996. We cannot determine the breeding status of dead murres because of the fishery schedule. In Zone 1, the majority of vessels conduct their operations from the opening of the fishing season to the end of the first third of June. Murres do not lay eggs until mid-June in the western Bering Sea (Kharkevich and Vyatkin 1977; Kartashev 1979; Artyukhin 1991; Kharitonov 1992), and none of the casualties from 1995 to 1997 showed evidence of breeding. Because murres spend the prelaying period in foraging areas (Gaston and Nettleship 1981; Birkhead and Del Nevo 1987 in Kharitonov 1992), we recorded all dead adult murres as nesting on nearby coasts. However, we understand that some of them could be nonbreeders or could nest outside the boundaries of the fishery zone. The total population of Thick-billed Murres on the western coast of the Bering Sea was calculated from a tally of all individuals present on the colonies, without estimating the proportion of breeding birds. The observed count was multiplied by 2.0, while the appropriate coefficient for estimating the number of breeding murres usually does not exceed 1.6 (Birkhead and Nettleship 1980; Gaston and Nettleship 1981; Hatch and Hatch 1989). According to the most recent data (Chapter 3), the coasts of eastern Kamchatka and the Koryak Highlands from Cape Stolbovoy to Dezhneva Bay (including Verkhoturova and Karaginsky islands) are inhabited by about 510 500 individuals of both species of murres; 66.3% (338 500) are Thick-billed Murres (Vyatkin 1986). The Komandorskiye Islands have 164 000 Thick-billed Murres (Artukhin, in press), bringing the total around the coasts of Fishery Zone 1 to 502 500 individuals.

From the proportion of adult birds (70.53%) among the casualties, we can calculate that of some 36 500 Thick-billed Murres that die annually in nets in Fishery Zone 1, about 26 000 are breeding birds. This value comprises more than 5% of the total mortality of Thick-billed Murres in the zone. It is almost equal to estimates of 7–9% for the normal level of murre mortality (Birkhead and Hudson 1977; Harris and Wanless 1988). At such a rate, the current drift net fishery may be a real threat to the success of breeding colonies of Thick-billed Murres in the Far East, especially when combined with other unfavourable factors (including environmental conditions). For example, in 1993, the highest level of Thick-billed Murre mortality (56 500 adults) coincided with unfavourable conditions for reproduction. Similarly, almost half of the Tufted Puffin (45.16%) casualties from 1993 to 1997 were netted in Pacific waters, east of the Kuril Islands (Zones 2 and 3). Most were nonbreeding birds and subadults whose natal colonies were among the Kurils. Only some 200 000 Tufted Puffins inhabit that area (Velizhanin 1978).

The influence of the drift net fishery on fulmars is also most visible in the northern Kurils (Zones 2, 2a, and 3), and 74.53% of their annual mortality was observed there. In spite of the fact that a large percentage were breeding adults, the scale of annual fulmar mortality in the nets is small compared with the total Kuril population of 1.5 million (Velizhanin 1978), which is the biggest in the North Pacific (Hatch 1993).

Rather high mortality rates for Crested Auklets (Table 4) are distributed fairly equally between Zones 1 and 2, but this does not appear to be a threat to such an abundant species, especially since the number in the northwestern Bering Sea is increasing (Piatt et al. 1990; Konyukhov 1991). The drift net fishery is dangerous for such rare species as Short-tailed Albatross *Diomedea albatrus*, because recent migrations of this species have extended into Fishery Zones 2 and 3 (Shuntov 1982). In 1996–1997 in Zone 2, we observed one immature and two juvenile Short-tailed Albatrosses attracted to ships by the lifting of nets and attempts by the crew to offer one of them netted fish (Artyukhin 1997a,b). It was determined that the birds were from the colony of 75 birds (in 1990) on the Senkaku Islands, Japan (Hasegawa 1991).

Conclusion

The active drift net fishery for salmon by Japanese vessels in the Russian Economic Zone began in 1992. The annual fishing effort varied considerably but was on average 101 000 km of nets per season. The average kill of seabirds was about 170 000 individuals annually. Short-tailed Shearwaters, Thick-billed Murres, Tufted Puffins, Crested Auklets, and Northern Fulmars were the most numerous losses during the period 1993–1997. The estimate of total seabird mortality from the beginning of the drift net fishery in Russian waters at the end of 1980 is more than one million individuals. The scale of incidental mortality varied according to the fishery zones and from year to year. The reasons for these variations are partly dependent on the frequency with which birds are encountered at sea, which is a function of their feeding habits, location of breeding colonies, routes of seasonal migrations, environmental peculiarities of each fishery zone, and many other factors.

It is difficult to estimate the impact of the drift net fishery on seabird populations in the northwestern Pacific because of a lack of knowledge about the place of origin of the net casualties and the current status of breeding colonies in the region. After comparing the values of the total number of Short-tailed Shearwaters, Tufted Puffins, Northern Fulmars, and Crested Auklets with the rate of their mortality in the drift nets, we conclude that the by-catch is unlikely to influence the state of populations of those species. At the same time, the drift net fishery for salmon may be the most important threat for Thick-billed Murres in the western Bering Sea, especially in combination with other negative factors, such as environmental changes associated with human activities. Without doubt, this kind of fishery is dangerous for such rare species of seabird as the Short-tailed Albatross.

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Chapter 6. Conservation and protection of seabirds and their habitat

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Summary

In the Russian Far East, there is a long history of subsistence use of seabirds and their eggs by aboriginal peoples. This increased sharply with colonization from Europe in the 18th century; throughout the 20th century, particularly during World War II, seabird colonies were systematically exploited for food rich in proteins and fats. However, people have put other pressures on many seabird populations. The dependence on seabirds for survival did not prevent the use of many sites as a convenient food supply for fur-bearing mammals. Arctic *Alopex lagopus* and red *Vulpes vulpes* fox, American *Mustela vison* and European *M. lutreola* mink, sable *Martes zibellina*, and ermine *Mustela erminea* were the most frequently introduced. In addition, the Norway rat *Rattus norvegicus* became established at some sites, and others are visited by natural populations of bears and wolverine *Gulo gulo*. Scavenged waste from settlements also stabilized populations of gulls and foxes by providing food during the winter and allowing more of these predators to survive until the seabirds returned in the spring.

Terns and gulls nesting on the mainland face additional threats from feral dogs, especially near permanent settlements. Until recently, sled dogs were set loose to fend for themselves in the summer, but snow machines have reduced the number of sled dogs at most northern communities. Many residents of the north keep reindeer *Rangifer tarandus*, and these herds disturb colonies, trample nests, and even eat the young birds. Farther south, a similar problem was created by grazing cattle near tern colonies, but this is now quite rare, and some colonies have reappeared. The river estuaries are important fishing areas; that activity also disturbs some tern colonies, especially near large camps, and some land-based fisheries occur near murrelet colonies, where the birds are particularly vulnerable to nets set at night.

The major industrial impact on seabirds is through fishery interactions (see Chapter 5). Oil spills and pollution are generally confined to large centres such as Vladivostok and Petropavlovsk-Kamchatsky.

Three major initiatives have helped conserve seabirds: identification of threatened species, protected areas, and international agreements. The "Red List" for Russia includes Streaked Shearwater *Calonectris leucomelas*, Swinhoe's Storm-Petrel *Oceanodroma monorhis*, Glaucous-winged Gull *Larus glaucescens*, Red-legged Kittiwake *Rissa brevirostris*, Ross' Gull *Rhodostethia rosea*, Aleutian Tern *Sterna aleutica*, Long-billed Murrelet *Brachyramphus marmoratus*, and Kittlitz's Murrelet *B. brevirostris*. A chain of protected areas (zapovedniki, zakazniki, and natural monuments) protects many colonies throughout the region. International agreements have been made with Japan, the United States, the People's Republic of Korea, and the Republic of Korea. These create an opportunity to establish international refuges at points where each of these countries meets Russia.

Résumé

Dans l'Extrême-Orient russe, les peuples autochtones tirent depuis longtemps une partie de leur subsistance des oiseaux de mer et de leurs oeufs. Cette utilisation a été fortement accrue par la colonisation européenne du 18^{e} siècle. Durant tout le 20^{e} siècle, et surtout pendant la Seconde Guerre mondiale, les colonies d'oiseaux de mer ont été systématiquement exploitées puisqu'elles fournissent des aliments riches en protéines et en gras. L'humanité exerce cependant d'autres types de pressions sur bien des populations d'oiseaux de mer. Le fait que la survie des humains dépende des oiseaux de mer n'a pas empêché que nombre de sites soient employés comme sources commodes de nourriture pour les mammifères à fourrure. Les plus fréquemment introduits ont été le renard arctique *Alopex lagopus* et le renard roux *Vulpes vulpes*, le vison d'Amérique *Mustela vison* et d'Europe *M. lutreola*, la martre *Martes zibellina* et la belette *Mustela erminea*. Le rat surmulot *Rattus norvegicus* s'est également implanté à certains endroits et d'autres sites ont été fréquentés par des populations naturelles d'ours et de carcajous *Gulo gulo*. Les déchets qu'elles peuvent trouver près des établissements ont également stabilisé les populations de goélands, de mouettes et de renards en assurant leur subsistance durant l'hiver et en permettant à ces prédateurs de survivre en plus grand nombre jusqu'à ce que les oiseaux de mer reviennent au printemps.

Les sternes, les goélands et les mouettes qui nichent sur le littoral continental sont également menacés par les chiens sauvages, surtout à proximité des établissements permanents. Voilà peu, les chiens de traîneaux étaient encore mis en liberté et livrés à eux-mêmes durant l'été, mais les motoneiges ont réduit le nombre de ceux qui sont utilisés dans la plupart des collectivités septentrionales. Bien des habitants du nord élèvent des rennes *Rangifer tarandus* et ces troupeaux perturbent les colonies, piétinent les nids et mangent même les jeunes oiseaux. Plus au sud, un problème

similaire a été créé par le bétail qui vient paître à proximité des colonies de sternes. Ces troupeaux se sont toutefois beaucoup raréfiés et certaines colonies ont réapparu. Les estuaires constituent des aires importantes pour la pêche et cette activité perturbe également certaines colonies de sternes, surtout à proximité des grands camps de pêche, et certaines pêches des terres ont lieu à proximité de colonies de stariques, à des endroits où les oiseaux risquent particulièrement de se prendre dans les filets posés la nuit.

Les oiseaux de mer subissent surtout les effets de l'industrialisation par l'intermédiaire de leurs interactions avec les pêches (voir chapitre 5). La pollution et les déversements pétroliers sont en général confinés à des grands centres urbains comme Vladivostok et Petropavlovsk-Kamtchatsky.

Trois grandes initiatives ont contribué à la conservation des oiseaux de mer : le fait que les espèces menacées aient été répertoriées, l'instauration d'aires protégées et la mise en oeuvre d'accords internationaux. Pour la Russie, la « liste rouge » englobe le Puffin leucomèle *Calonectris leucomelas*, l'Océanite de Swinhoe *Oceanodroma monorhis*, le Goéland à ailes grises *Larus glaucescens*, la Mouette des brumes *Rissa brevirostris*, la Mouette rosée *Rhodostethia rosea*, la Sterne des Aléoutiennes *Sterna aleutica*, le Guillemot marbré *Brachyramphus marmoratus*, et le Guillemot de Kittlitz *B. brevirostris*. Une chaîne d'aires protégées (zapovedniki, zakazniki, et monuments naturels) protège un grand nombre des colonies de la région. Des accords internationaux ont par ailleurs été conclus avec le Japon, les États-Unis, la République populaire de Corée et la République de Corée, ce qui permet de créer des refuges internationaux à des endroits où ces pays jouxtent la Russie.

Общее изложение

Коренные народы Дальнего Востока России с незапамятных времен используют морские птицы и их яйца для пропитания. Это явление стремительно ускорилось после колонизации, пришедшей из Европы в 18-м веке. В течение всего 20-го века, особенно во время второй мировой войны, колонии морских птиц систематически эксплуатировались в виде продуктов питания из-за высокого содержания белков и жиров. Однако, люди оказывали и другие виды воздействия на многие популяции морских птиц. Зависимость от морских птиц для обеспечения выживания не помешало использовать многие места обитания в качестве удобного источника кормов для разведения меховых млекопитающих. Чаще всего здесь разводили арктический песец (*Alopex lagopus*) и рыжую лисицу (*Vulpes vulpes*), американскую (*Mustela vison*) и европейскую норки (*M. lutreola*), соболя (*Martes zibellina*) и горностая (*Mustela erminea*). Кроме того, в некоторых местах развелась серая крыса (*Rattus norvegicus*), а другие места регулярно посещают местные хищники - медведи и россомахи (*Gulo gulo*). Свалки мусора вокруг людских поселений способствовали стабилизации популяций чаек и лис, обеспечивая им пропитание зимой и выживание этих хищников до возращения морских птиц весной.

Крячки и чайки, гнездящиеся на материке, подвергаются дополнительной угрозе со стороны диких собак, особенно вблизи постоянных поселков. До последнего времени упряжных собак выпускали на лето, чтобы они сами заботились о себе, однако появление снегоходов привело к сокращению числа упряжных собак в большинстве северных поселений. Многие жители севера содержат северных оленей (*Rangifer tarandus*) и их стада беспокоят колонии птиц, вытаптывают их гнезда и даже поедают птенцов. Южнее подобная проблема возникла из-за скота, пасущегося вблизи колоний крачек, хотя в настоящее время это встречается редко и некоторые колонии появились вновь. Эстуарии рек являются важными местами рыбной ловли. Этот вид деятельности также нарушает некоторые колонии крачек, особенно вблизи крупных поселков рыбаков. Некоторые рыболовецкие поселки на суше оказываются вблизи колоний, где птицы особенно подвергаются опасности со стороны выставленных на ночь сушиться сетей.

Самое большое влияние от промышленной деятельности людей вызвано рыболовецким промыслом (см. Глава 5). Проливы нефти и другие виды загрязнения обычно ограничены близостью к таким крупным центрам, как Владивосток и Петрпавловск-Камчатский.

Три крупных мероприятия способствовали сохранению морских птиц: определение видов, находящихся под угрозой, создание защищенных зон и заключение международных соглашений. В «Красную книгу» России занесены пегий буревестник (*Calonectris leucomelas*), малая качурка (*Oceanodroma monorhis*), серокрылая чайка (*Larus glaucescens*), красногорая говорушка (*Rissa brevirostris*), розовая чайка (*Rhodostethia rosea*), алеутская крачка (*Sterna aleutica*), длинноклювый пыжик (*Brachyramphus marmoratus*) и короткоклювый пыжик (*B. brevirostris*). Система защищенных зон (заповедников, заказников и природных памятников) обеспечивают защиту многих колоний. Были заключены международные соглашения с Японией, США, Народно-демократической Республикой Кореи и Южной Кореей. Эти соглашения позволяют создать международные защитные зоны там, где эти страны непосредственно примыкают к территории России.

The North Region

The northern part of the Russian Far East is sparsely populated, and most of its sea coasts are practically untouched by industrial activities. There is no active exploration for oil or gas deposits, and the maritime mining of bituminous coal is rather small in scale. Also, there is much less impact on maritime or island ecosystems from introduced predators than in Kamchatka or the Kuril Islands. As a result, the natural habitat of seabirds has generally kept its original condition, and the majority of rocky nesting colonies seem safe. However, in some localities, the degree of negative human influence is rather large and can be a real threat for populations, especially of rare species with limited range or adaptability. The nature of interference by human activity varies from place to place but may include egg collecting and grazing by domestic reindeer. Along the northern Sea of Okhotsk, wood cutting and chemical pollution from industry and agriculture may have locally significant impacts.

The Arctic basin

In the Arctic sector of the Far East, the biggest seabird colonies, on Wrangel and Gerald islands, are included in a zapovednik and are protected by legislation (Stishov et al. 1991). Colonies on rocky precipices are the best off, protected by their inaccessibility. Inhabitants and workers at meteorological stations periodically collect fresh eggs from murres and kittiwakes; however, this disturbance is irregular and very minor. Industrial impact is almost absent, and we know of only one case: colonies of gulls and cormorants were destroyed during the construction of a village at Cape Shmidta.

The seabirds that inhabit the rare, small, nearshore islands such as Chetrekhstolbovoy, Shalaurov, Kolyuchin, and Ididlya islands or the rocky capes and maritime lowlands are, however, subjected to significant human influence. The greatest impact is in the maritime portion of the low tundra, where some gulls and terns prefer to nest (see Chapter 3). The colonies of these birds suffer greatly from the grazing by domestic reindeer *Rangifer tarandus*, which are driven from place to place in the summer. The herds trample the nests and occasionally eat the eggs and small chicks that they come across. The reindeer herders sometimes collect gull eggs from colonies along their route. Domestic reindeer are a real threat to Ross' *Rhodostethia rosea* and Sabine's *Xema sabini* gulls. These rare species inhabit the swampy maritime lowlands along the shores of lakes, which are on the routes used by herds of domestic reindeer. Not only do the reindeer damage the site by grazing, but the birds become so nervous and disturbed at the nests that they are unable to defend their nests from the predatory activity of larger gulls and jaegers (Kondratyev and Kondratyeva 1984, 1987).

Many of the terns nesting in the Arctic basin have a very narrow breeding period and choose the pebble spits and beaches along the coast. At such sites, their nests are often destroyed by temporary transportation routes for tractors and trucks. In the past, much of the damage has been done by dogs near villages and temporary encampments. Sled dogs, which were usually unleashed and fed irregularly in summer, found what food they could on the tundra and often destroyed eggs and fledglings. Fortunately, the increasing abundance of small snowmobiles in the last 10 years has led to a sharp decline in dog populations, and they have become less of a threat in most areas.

In the Arctic portion of the Russian Far East, the greatest human impact has clearly been through changes to the natural ecological balance. Human activities have enhanced habitat and stabilized populations of the most important natural predators, such as arctic fox *Alopex lagopus* and Glaucous *Larus hyperboreus* and Herring *L. argentatus* gulls, by providing a regular food supply. The number of these predators has become more independent of natural events, and predation on the colonies of seabirds has increased. These changes are the primary source of problems for Ross' and Sabine's gulls, which are rare and have a narrow range of adaptability.

The northern Bering Sea

Human influence on the seabirds of the north coast of the Bering Sea is also generally not extensive (Kondratyev 1994). The situation differs from the Arctic basin not by the degree but by the nature of the impact. For instance, there is little reindeer herding on the coastal habitats. On the colonies of the mainland and nearshore islands (mainly in Senyavina Strait), there are not only murres, kittiwakes, cormorants, and guillemots, typical for the Arctic basin, but also planktivorous alcids, such as Crested *Aethia cristatella*, Least *A. pusilla*, and Parakeet *Cyclorrhynchus psittacula* auklets and colonies of fulmar. The local people actively harvest eggs and seabirds for food, but the scale of such activity is rather small and cannot influence the status of populations. Along the coast of the Anadyr River estuary and to the south, on the northern coast of the Koryak Highlands, the colonies of seabirds on the rocky capes are almost untouched by human interference, and birds inhabiting the maritime region are exploited only periodically, but to a small degree.

The northern Sea of Okhotsk

In general, the harvest of eggs and birds on the seabird colonies of the northern Sea of Okhotsk is much more significant than in other parts of the Russian Far East and has a long tradition among the aboriginal inhabitants. Archeologists exploring old village sites often find proof of the importance of seabirds (especially murres, puffins, and auklets) in the diets of ancient people. On Talan Island, the middens contain numerous bird bones that date back about 3000 years (Lebedintsev 1992). Seabirds continued to be an important food for people, especially aboriginals, well into historic times. Primarily, this involved the eggs of murres, kittiwakes, and Slaty-backed Gulls *Larus schistisagus* for immediate consumption, whereas the meat of cormorants, murres, puffins, and auklets was dried and stored for future use. Official state agencies exploited the large colonies of seabirds as a tactical resource during the hard times of World War II. At that time, seasonally organized brigades collected eggs, meat, skins, and feathers on the largest seabird colonies of Tauyskaya Bay (most actively on Talan Island). Today, there is no official exploitation in seabird colonies; however, illegal egg collecting is a common activity by inhabitants of nearby villages and especially by crews of visiting vessels. Such uncontrolled harvests do a lot of harm in the more frequently visited colonies in the northern Sea of Okhotsk, especially on the nearshore islands of Penzhinskaya Bay, Tainochin and Halpili islands in Gizhiginskaya Bay, and Umara Island in Tauyskaya Bay. On Umara Island, there were no chicks of the Slaty-backed Gull in 1995 or 1996 as a result of immoderate collecting of eggs. Regrettably, declining resources for environmental and game inspections in recent years have allowed an increase in these illegal raids.

Mew *Larus canus* and Common Black-headed *L. ridibundus* gulls and Common Tern *Sterna hirundo*, inhabiting the maritime lowlands of the northern Sea of Okhotsk, are not so much affected by humans; however, their colonies suffer somewhat from cattle grazing and unleashed dogs. Land-based fishing activity poses a real threat to rarer species such as the Aleutian Tern *Sterna aleutica*, whose colonies are beside bays and channels of the river deltas where the salmon fishermen congregate.

The salmon fisheries on the coast, both commercial and private, also have an impact on some seabirds, especially the Ancient Murrelet *Synthliboramphus antiquus*. Because both the chicks and the adult Ancient Murrelets are on the sea at the end of July and the beginning of August, they are vulnerable to nets set at night. Pink salmon *Oncorhynchus gorbuscha*, in particular, are caught near seabird colonies, and sometimes there are many nets. In the southern part of Tauyskaya Bay, in 1996 and 1997, the coastal salmon fishery caught hundreds of Ancient Murrelets from the Talan Island colonies, where 2% or 3% of the young that reached the water were lost to nets.

One indirect result of the human influence is increased predatory pressure from Slaty-backed Gulls, whose population has increased everywhere in the northern Far East in recent years, but especially in the northern part of the Sea of Okhotsk. Human activities are clearly the main cause. Indiscriminate disposal of garbage, fur farm waste, and fish offal allows these gulls to overcome the autumn and winter periods of poor foraging. The impact is particularly evident on seabird colonies of Tauyskaya Bay. The increased number of gulls has inevitably led to an increase of their predatory activity on the seabird colonies in the breeding season.

The Kamchatka Region

Human exploitation of the seabird resources

Colonial marine birds have long been used in the everyday life and economic activity of people. Formerly in Kamchatka and the Komandorskiye Islands, when provisions failed to arrive from central Russia, the harvest of wild birds was important for the survival of the inhabitants. Uncontrolled harvest of seabirds and their eggs has been an important factor in the declining status of some species. In the middle of the 18th century, the Steller's or Spectacled Cormorant *Phalacrocorax perspicillatus*, endemic to the Komandorskiye Islands, completely disappeared, apparently from immoderate human exploitation. Similarly, there have been periodic reports that hunting depressed numbers of Red-faced *Phalacrocorax urile* and Pelagic *P. pelagicus* cormorants, Tufted Puffin *Fratercula cirrhata*, and Glaucous-winged Gull *Larus glaucescens* (Stejneger 1896; Bianki 1909; Marakov 1966, 1975). Many accessible colonies of murres were especially ravaged. The legislative basis of seabird protection and use was set out in the first half of the 20th century, and the collection of birds and eggs became regulated. However, the methods of exploiting the seabird resource did not change, and there was poor control, allowing serious violations and numerous acts of poaching to occur. On the Komandorskiye Islands from 1930 to 1950, fur farmers took the opportunity to shoot birds year-round (Artyukhin 1991). Great harm was done, especially to cormorants and Glaucous-winged Gull. Many colonies disappeared. Tufted Puffins declined because of indiscriminate egg collecting, and adults were obtained as food for arctic fox (Artyukhin 1991). During World War II (1941–1945), the intensity of seabird harvest increased considerably. On Kamchatka, organized teams collected more than 5000 seabirds annually (Vyatkin 1981), and tens of thousands of seabirds were brought to Kamchatka from the Komandorskiye Islands annually (Marakov 1966). In Kamchatka at the beginning of the 1950s, there was a regular harvest of eggs on the colonies, and the organizations that managed the systematic exploitation of this resource handled more than 100 000 seabird eggs annually (Vyatkin 1981). On the Komandorskiye Islands in the 1950s, about 6000 seabirds and 24 000 eggs were collected annually (Marakov 1966). Professional hunters also took large supplies for their own needs and those of their families and neighbours. These activities combined to lay waste to a whole series of colonies between 1920 and 1950. The greatest harm was done to the nesting colonies in the Pahachinskiy Lagoon, in Lavrova Inlet, and on islands such as Stolbovoy, Karaginsky, Verkhoturova, and Skala Rock (Vyatkin 1981).

In the last 35 years, the seabird harvest has gradually lost its value in the life of inhabitants and has almost disappeared, except for occasional cases of poaching. Fishermen, sailors, hunters, reindeer herders, and workmen at lighthouses and meteorological stations still collect eggs illegally. Those colonies of terns and Mew and Common Black-headed gulls in the river deltas where the fishery is active also suffer. Crews of fishing boats and crabbers near bird colonies on the seacoast obtain eggs whenever the opportunity arises. Some hunters take eggs as bait for sable *Martes zibellina* and fox.

The disturbance factor

Disturbance on the nesting colonies interrupts the natural rhythms of the colonies, leading to the loss of eggs and chicks and in some cases to the destruction of the whole colonies. In the Kamchatka Region, seabird colonies in the lower reaches of large rivers and on lagoons and lakes near populated areas or fishery operations are often regularly visited by people. The problem of disturbance is very widespread, and unthinking visits to colonies often lead to the direct destruction of birds or their nests. Recently, for example, Tufted Puffin burrows were destroyed on Toporkov Island. Many seabird nesting sites in hard-to-reach and sparsely populated places along the seacoast are disturbed by people who spend the summer outside the populated areas (geologists, reindeer herders, fishermen, etc.). In the rivers of Kamchatka, there is increased activity by large numbers of motorboats, close to the islands and spits used by colonies of gulls and terns. Much caterpillar and wheeled motor transport travels on unpaved roads built on the sea spits and beaches where the terns nest. Helicopters and small fixed-wing aircraft are widely active in Kamchatka and often fly at low elevation along rivers and seashores. Helicopters occasionally land in large seabird colonies, leading to mass mortality of eggs and chicks (Gerasimov 1970; P.S. Vyatkin, unpubl. data). Unfortunately, we have no precise estimate of the scale of damage done by disturbance, but there is consensus among seabird biologists that it affects the health of colonies.

Economic transformation of territories

From 1930 to 1950 in Kamchatka, much attention was given to the raising of livestock, usually reindeer, and increasing the area of pastures and other agricultural lands. The grazing sites coincided with the localities used by colonies of Black-headed, Mew, and Slaty-backed gulls. Nests were trampled down, and the reindeer ate the eggs and small chicks. Affected seabird colonies declined but have reappeared with the cessation of grazing in some areas. In the 1990s, the total number of domestic reindeer and meat cattle was reduced by a factor of 4–8 compared with the 1980s. The reappearance of tern and gull colonies was observed in the 1960s, after the closing of many fish factories on the coasts of Kamchatka.

Seawater pollution by petrochemicals

The pollution of marine areas negatively influences the status of populations of seabirds, and one of the most insidious is pollution by oil and oil products. The ecological state of the Kamchatka coasts appears satisfactory, so far. The areas of pollution with oil products are chiefly close to heavily populated areas, such as Petropavlovsk-Kamchatskiy, Ust-Kamchatsk, and Oktyabrsky.

Avachinskaya Bay is especially heavily polluted from the industrial activity in Petropavlovsk-Kamchatskiy. The average concentration of oil products in the water of the inlet exceeds admissible health standards by 6–12 times. The total quantity of oil products in the inlet varies in different years from 1360 to 2450 t, with the average value about 1800 t. Mass mortality of seabirds because of catastrophic oil pollution in Kamchatka has not been observed during the last 40 years, but coastline surveys of Kamchatka regularly reveal small numbers of oiled seabird carcasses along the tideline. Vessel traffic provides a source of chronic oil pollution of these waters. Hundreds of small spills of black oil and diesel fuel are recorded each year from various vessels, but a significant amount enters the marine environment from shore-based facilities with river and rain drainage. In the next two or three years, there will be extensive exploitation of oil and gas deposits along the west coast of Kamchatka and exploratory drilling on the East Kamchatka shelf and in Karaginsky Gulf. These are important potential sources of pollution for maritime waters.

In 1973, 1981, and 1983 on the coasts of Kamchatka, there was mass mortality of some species of seabirds (Lobkov 1986). In the summer of 1981 on the eastern coast of the peninsula, 10 000–15 000 seabirds died, and near Cape Lopatka in 1983, another 2000–3000 died (Lobkov 1986). The causes of such mass mortality of seabirds are not clear.

Predation by native and exotic animals

Predators destroy a considerable number of eggs and chicks of seabirds, but rarely take adult birds. Nonetheless, the activity of predators is an important factor in the population dynamics of some seabird species. In addition, predators actively influence the species composition and distribution of colonies, partially by limiting the use of suitable nesting habitats. On the Kamchatka coasts, there are areas where many seabird species could nest if the habitats were not accessible to terrestrial predators. Periodically, colonies of seabirds appear at these sites, only to be quickly destroyed by predators. This may be one reason that many gulls and terns change sites almost annually. Some species of seabirds, such as storm-petrels, Ancient Murrelet, and auklets, cannot occupy coastal areas because of predators.

The activity of predators, combined with the influence of other negative factors (weather, food shortage, diseases, etc.), can be the real threat to the existence of populations of rare and scarce seabird species. The recent structure of seabird colonies on the mainland is primarily the result of historical relations between predators and seabirds. The balance between predators and prey on these colonies has occasionally been disrupted by different kinds of human impact. Especially important value is given to the introduction of alien predators and the recent expansion of native animals to nearshore islands. Mink, rats, fox, and sable are the most important seabird predators in the Kamchatka Region.

American mink *Mustela vison* was brought to Kamchatka for the first time in 1960; in the 1980s, the animals were released in almost all the big rivers of the peninsula. The southern parts of the Kamchat Peninsula and Bering Island (Komandorskiyes) were settled by mink that escaped from fur farms. At present, the American mink lives along the whole coast of the peninsula and on Bering Island, inhabiting the valleys of rivers where colonies of terns and Common Black-headed and Mew gulls are situated. Undoubtedly, these colonies suffer predation by these mammals. In the big colony of Common Black-headed Gull on Hlamovitskoye Lake, in the delta of the Avacha River, chicks and adult gulls are frequently killed by mink (Lobkov 1981; P.S. Vyatkin, unpubl. data). On Bering Island, seabirds are the most important component of mink diet in summer and autumn. Artyukhin (1991) suggested that predation by mink was one of the main reasons for a sharp reduction in the number of ducks and Red-throated Loons *Gavia stellata* on Bering Island in the mid-1970s. Mink have clearly done a lot of damage to the avifauna of the Kamchatka Region and especially on Bering Island, but the real degree of future risk needs to be assessed.

The Norway rat *Rattus norvegicus* may have been brought to Kamchatka at the end of the 18th century. This species is widely distributed in the region, including Bering Island. In the winter, most are observed in populated areas, but the rat is widespread along the whole coast, where it can feed on beached flotsam year-round. The Norway rat often inhabits places near tern and gull colonies, but we have no clear evidence of predation in seabird colonies in Kamchatka. However, in the places with Norway rats, terns are scarce, and the productivity of their colonies is low.

The white race of the arctic fox inhabited the northeastern and western (to 55°N) coasts of Kamchatka in the mid-17th century. The last place of permanent occupation by this mammal was Verkhoturova Island. We observed it there in September 1979, but in 1994 it was absent. In previous winters, white foxes from Verkhoturova Island crossed the ice to the mainland and to Karaginsky Island. In 1928, eight pairs of foxes were brought to Karaginsky Island from the Komandorskiye Islands. However, the attempted introduction failed.

The blue race of the arctic fox inhabits Medniy and Bering islands. The main places of its habitation are along the seacoasts, where this predator controls all access by nesting seabirds. Near the end of the 1920s, an attempt to introduce blue foxes on Toporkov Island failed. Some of the released animals destroyed many Tufted Puffins at a large colony. On the Komandorskiye Islands, arctic foxes visit the colonies of seabirds every day, destroying many eggs and chicks. The scale of this activity can be judged by changes in the colonies on Verkhoturova Island during a period of absence of this predator (1980–1994). Between 1975 and 1994, the number of Slaty-backed Gulls increased by a factor of 30, the number of Tufted Puffins increased by a factor of five, and the number of Horned Puffins *Fratercula corniculata* increased by a factor of 2.7. New colonies of these birds also appeared.

Red fox *Vulpes vulpes* is a numerous and widespread species on Kamchatka, occupying river valleys and the seacoast where terns and gulls have colonies. Predatory activity by red foxes has occurred at seabird colonies on Karaginsky, Bogoslova, Manchdzhyr, and other islands and can influence the dynamics of tern and gull colonies considerably. The history of Karaginsky Island is particularly illustrative of earlier attitudes towards alien species. A fur farm was established there in 1928 for silver-black fox and the native red fox. In autumn of 1930, 50 pairs of silver-black foxes from Prince Edward Island (Canada) were brought to Karaginsky Island. In November 1931, 69 of these "Canadian" foxes were transported to Petropavlovsk-Kamchatskiy, and 14 pairs were left in the fur farm on Karaginsky Island. This fur farm was closed soon after, and the "Canadian" foxes were released on the island.

Sable is a common native predatory mammal on the rocky seacoasts of Kamchatka, and the results of sable predation on seabird colonies have been observed in many places along the western and eastern coasts of the peninsula. There was the case of two sables crossing the ice from Cape Khayryuzova to Ptichy Island, where they fed all summer on the Tufted Puffin colony (N.P. Mironov, unpubl. data). The sable has successfully acclimatized to Karaginsky Island, where it is trapped in the hunting season.

Ermine *Mustela erminea* is also a numerous, widespread species that can cross on ice from the mainland to nearshore islands. On Verkhoturova Island in 1971, we found no ermine (Vyatkin and Marakov 1972); in 1975, however, it was common (Kharkevitch and Vyatkin 1977). Ermine often prey on seabird colonies, destroying eggs and chicks and inflicting heavy damage on small alcids. In narrow shelters under the rocks, accessible only to ermines, we often found the remains of eggs, chicks, or adult auklets with signs of bites on the back of the head (Kharkevitch and Vyatkin 1977; Vyatkin 1981). It seems very likely that predation by ermine is responsible for the sparse distribution of auklets and the absence of storm-petrels on the Kamchat Peninsula.

Brown bear *Ursus arctos* is a common and widespread species in Kamchatka. It can be seen along the seacoast from spring to late autumn and is especially numerous in May and June. During 5–6 hours of flying in a light Antonov AN-2 along the coastline, we usually observed 50–250 bears. During trips between seabird colonies from June to August, we saw 2–6 or more bears every day from the motor boat. The brown bear actively visits the colonies, destroying the eggs and chicks of seabirds. While hunting, the bear often visits many nearshore islands, swimming across straits with a width of 10 km. On many islands (Manchdzhyr, Stolbovoy, Krasheninnikova, Kambalniy, etc.) that are regularly visited by bears, the Slaty-backed Gull and Tufted Puffin can nest only in the areas that are inaccessible to bears. These birds do not even try to use the most convenient areas for nesting. On Stolbovoy Island, for instance, the flat grassy areas are absolutely free from seabird nests. Among bears, there is known specialization; the regular visitors to the islands are usually limited to particularly big individuals.

Wolverine *Gulo gulo*, wolf *Canis lupus*, lynx *Felis lynx*, and river otter *Lutra lutra* are comparatively rare species on the seacoasts of Kamchtka, and we have rarely seen signs of their visits to tern and gull colonies on river islands.

Along the seacoasts of Kamchatka, there are many species of birds of prey, and Rough-legged Hawk *Buteo lagopus*, Peregrine Falcon *Falco peregrinus*, and Merlin *F. columbarius* have all been observed hunting near colonies. However, the role of seabirds in their diet is not large (Kishchinski 1980; Lobkov 1986). The predatory activity of Common Raven *Corvus corax*, Carrion Crow *C. cornone*, Slaty-backed Gull, and Glaucous-winged Gull does much more damage to seabird populations. These predators destroy many eggs and chicks and sometimes even catch and kill adult alcids. On Verkhoturova Island, numerous ravens and Carrion Crows are resident during the whole period of reproduction, destroying eggs and chicks of Parakeet and Crested auklets, but no nests of these predators were found on the island.

In summary, some degree of predation on seabird colonies by all terrestrial mammals and some birds is typical of Kamchatka. Absolutely no consideration was given to the health of the seabird colonies during long periods of attempts to enrich the local fauna with introductions of alien animals. In some cases, there have been important negative effects on seabird populations. Thus, the introduction of American mink on Kamchatka and especially on Bering Island failed to bring economic benefit but seriously damaged the seabird colonies.

The South Region

Introduced mammalian predators

Russian and American fur farmers began the introduction of mammals to the islands of the North Pacific late in the 18th century (Iljina 1950; Bailey and Kaiser 1993). In the Russian Far East, however, the first mammals, other than red fox and Norway rat, which were marooned earlier, were not introduced until the early 20th century. Arctic fox, raccoon dog *Nuctereutes procyonoides*, American raccoon *Procyon lotor*, sable, the tundra vole *Microtus oeconomus*, and some others were introduced to coastal and oceanic islands south of 59°N, but the raccoons and raccoon dogs, at least, soon disappeared (Bromley 1981; Voronov 1982).

Arctic fox (15 pairs) was first introduced on the Usishir Group, in the Kuril Islands, in 1915, by Japanese fur farmers and then on Matua, Simushir, and Yuriy and Lis'i in the Lesser Kurils. In 1925–1928, 47 arctic fox were marooned on the Shantar Islands. In 1929, 50 were released on Furugelm Island in Peter the Great Bay (V.G. Voronov 1972; Pavlov et al. 1974; G.A. Voronov 1982).

Arctic fox persisted only on the Usishir Group; in 1938, there were 600 pairs (Kuznetsov 1949), but only 15 or 16 pairs remained in 1971. They strongly depressed the seabird population; in the early 1960s, 94.7% and 86.2% of the fox food items were seabirds on Yankicha Island and Riponkicha Island, respectively, in the Usishir Group (Voronov and Voronov 1963). In 1971, 95.3% and 86.2% contained seabirds (Voronov 1982). Annihilation of the seabird colonies on the Usishir Islands proceeded through a succession of species (Voronov 1982). Before 1959, they ate mainly fulmars, until they ceased to nest on the island; then, from 1959 to 1978, they subsisted on Crested and Least auklets. On Toporkov Island in the Komandorskiyes, arctic fox, from Bering Island, destroyed the Tufted Puffin colony in 1927–1928 and then died out (Marakov 1966). The well-known Russian writer-naturalist N. Prishvin (1956) described another example of the losses caused by arctic fox. They were introduced on Furugelm Island in 1929, and for two years they fed on many thousands of Black-tailed Gull *Larus crassirostris* and Japanese Cormorant *Phalacrocorax filamentosus.* By July 1931, only a few pairs of cormorants, nesting on inaccessible ledges, survived. As recently as 1982, G.A. Voronov (1982) proposed to introduce a new group of arctic foxes to the Kurils, in spite of the immense damage to seabirds and native fauna.

Red fox was introduced repeatedly on the Kurils in the 19th and 20th centuries, as late as the 1950s on Moneron Island, but the program failed (Voronov 1974).

Sable were first introduced on Karaginsky Island in 1901, with the release of 10 animals and 20 more in 1928 (Pavlov et al. 1973). In 1927–1931, 90 sable were released on Bol'shoy Shantar, Maliy, and Feklistova islands in the Shantars. In 1958–1959, three males and a female were released on Moneron Island. In the following years, all available colonies of seabirds were destroyed by these predators (Voronov 1982). American mink escaped from Japanese fur farms in the 1940s on Urup Island and preyed on seabirds there (Bromley 1981). European mink *Mustela lutreola*, an endangered species, has recently been introduced on Kunashir Island. The introduction of this mink has begun on Iturup Island and is planned on the Shantar Islands (Ternovsky and Ternovskaya 1988). Some ermine migrated naturally from Kamchatka to Verkhoturova Island and over a few years annihilated a colony of Least Auklet (Vyatkin 1975).

Norway rat was accidentally introduced to the Kurils, Komandorskiyes, and other islands in the 18th and 19th centuries (Voronov 1982). Rats occur on Urup, Iturup, Kunashir, Shikotan, etc. in the Kurils and on Moneron Island. On Moneron, rats eat eggs and chicks of Rhinoceros Auklet and Black-tailed Gull. The tundra vole was introduced to several Kuril Islands (Atlasova, Shiashkotan, Onekotan, Usishir, Matua, Ketoy, and Simushir) by Japanese zoologists in 1916 as a food for arctic and red foxes (Bromley 1981).

Pollution

At present, there are few records of oiled birds in this region. Nevertheless, pollution of marine habitats by oil is a serious potential threat to the seabirds, and oil extraction has recently started off the east coast of Sakhalin Island.

Conservation and management

The conservation and use of colonial seabirds are regulated by federal and local legislation. The federal laws set the general principles for security and use of the animal kingdom and also affirm the network of protected natural areas in zapovedniki, zakazniki, etc. All concrete measures regarding particular species are contained in hunting regulations, regional Red Books, and protected natural territories of regional value. In the Far East, as in the other regions of Russia, all species of seabirds that are in the Red Books for Russia of the International Union for Conservation of Nature and Natural Resources (now the World Conservation Union) are prohibited for use or disturbance. The present book lists Streaked Shearwater *Calonectris leucomelas*, Swinhoe's Storm-Petrel *Oceanodroma monorhis*, Glaucous-winged Gull, Red-legged Kittiwake *Rissa brevirostris*, Ross' Gull, Aleutian Tern, Long-billed Murrelet *Brachyramphus marmoratus*, and Kittlitz's Murrelet *B. brevirostris*. A number of the international conventions on the protection of migratory birds and their habitats also play a role in seabird conservation: USSR–Japan, ratified in 1973; USSR–USA, ratified in 1976; USSR–People's Republic of Korea, ratified in 1987; and Russia–Republic of Korea, ratified in 1994.

The North Region

In the northern Far East, seabirds are not the object of amateur hunting, but they are not included in the list of nongame species. This gives an opportunity for uncontrolled hunting. The obtaining of eggs in the colonies is forbidden, however. Indigenous hunters may take loons, cormorants, jaegers, gulls, terns, and alcids, except species in the Red Book, during the whole year and in unlimited quantities. Sabine's Gull, Whiskered Auklet *Aethia pygmaea*, Ancient Murrelet, and the Komandorskiye subspecies of Pigeon Guillemot *Cepphus columba kaiurka* will be in the first edition of the Red Data Book for the northern Far East of Russia.

The Kamchatka Region

The conservation and management of colonial seabirds are regulated by *The Rules of Hunting on the Territory of the Kamchatka District and Koryak Autonomous Okroog*. Taking birds may occur in professional hunting for the provision of stores, whereas amateur and sport hunting meet only the personal needs of the hunters. Indigenous people, for whom hunting is a traditional part of life, may take all species of animals and birds for food year-round. Many of these people live as professional hunters, fishermen, reindeer herders, etc. The bag limit is not fixed, but birds taken as food may not be sold or bartered. Hunting for birds that are in the Red Data Book of Russia is prohibited, and five seabird species nesting on the Kamchat Peninsula or the Komandorskiyes are included: Glaucous-winged Gull, Red-legged Kittiwake, Aleutian Tern, Long-billed Murrelet, and Kittlitz's Murrelet.

In the Kamchatka Region, Northern Fulmar *Fulmarus glacialis*, Common Black-headed and Mew gulls, Thick-billed *Uria lomvia* and Common *Uria aalge* murres, Pigeon Guillemot, Crested and Parakeet auklets, and Tufted Puffin may be hunted. In the Koryak Autonomous Okroog, only four species are hunted: Common and Thick-billed murres and Tufted and Horned puffins. The taking of birds for scientific, cultural, economic, or other purposes is limited by the special permits issued by local agencies responsible for management of hunting. The summer and autumn hunting season for birds, including seabirds, begins on the third Saturday of August and continues to 1 November. There is no spring hunt of seabirds. The administrators of game facilities can set days that are closed for hunting and also time limits on the activities of individual hunters. Because of the lower standard of living on the Komandorskiye Islands, residents were allowed to collect seabird eggs in 1998, even in the reserve. Illegal taking of birds may subject a person to a fine of 60% of the current minimum daily wage, regardless of the species, sex, or age of the bird. The fine for poaching on the territory of government zapovedniki and zakazniki is twice as large. Collecting of eggs and destroying of nests of game birds are prohibited; however, the punishment for these actions is not foreseen in the rules that are in use at the present time. Before 1993, for each egg taken from the nest, the hunter could be fined 50% of the fine for a bird of the same species. There are no rules governing visitation of seabird colonies for the purposes of hunting, tourism, protection, surveying, etc. There are no special rules for the conservation of seabird colonies beyond those set for individual species. The conservation of seabirds is part of the mandate of the Department of Hunting of the Kamchatka and Koryak Autonomous Okroog local governments, with assistance from other agencies in inspection. Unfortunately, none of the organizations responsible for the inspection of hunting has transport suitable for travelling at sea. As a result, a vast territory that is occupied by seabirds is really not protected or regulated at this time.

The South Region

Similar laws and regulations also hold for the southern part of the Russian Far East. A number of seabird species included in the Red Data Book of Russia nest in or pass through the area: Short-tailed Albatross *Diomedea albatrus*, Streaked Shearwater, Swinhoe's Storm-Petrel, Glaucous-winged Gull, Aleutian Tern, and Long-billed, Kittlitz's, and Japanese *Synthliboramphus wumisuzume* murrelets.

Protected areas for seabirds

The most important form of protection for seabirds in the Russian Far East is, without a doubt, the creation of reserves covering nesting areas and surrounding waters. Hundreds of individual sites are protected in this way. The three most common and traditional types of protected area are zapovedniki (nature reserves), zakazniki (sanctuaries), and natural monuments. Each has a different official level and specialization, but each has a significant role in protecting seabirds. A zapovednik is a territory in which all human activity is prohibited except specific scientific activities and monitoring. It is a permanent establishment. A zakaznik is an area in which there is a specific goal such as protection for a particular species or group of organisms. Usually it is established for five or 10 years. A natural monument may be a small area of local importance such as a lake or natural structure. No human activity is permitted. Also, a number of very important proposals for a system of protected areas, including some international initiatives, are now in their early stages of establishment (Fig. 1).

The North Region

In the northern Far East, Wrangel Island Zapovednik in the Arctic and Magadanskiy Zapovednik in the Sea of Okhotsk have been established. Wrangel Island Zapovednik was created in 1976 with the aim of preserving fauna in the Eastern Arctic. It contains Wrangel Island (about 7670 km^2) and Gerald Island (8 km^2), 65 km northeast, and there is a protected buffer zone of 8 km around each island. The site preserves colonies of seabirds that are the biggest in the Arctic sector of the Far East, and there is a permanent station to provide long-term monitoring of the status of the colonies and the population dynamics of the seabirds. These observations have produced many articles by a variety of authors (see Chapter 3) and also a very informative book (Stishov et al. 1991).

The Magadanskiy Zapovednik (883.8 km^2) was created in 1982 and includes four separate subunits, two of which are important to seabirds: the Yamskiy Subunit, which includes the Yamskiye Islands, and the coast of the Koni-Pyagina Peninsula (between Cape Yapon and Cape Cherny). There are not huge colonies, but Spectacled Guillemot *Cepphus carbo*, Slaty-backed Gull, Pelagic Cormorant, and Horned Puffin are rather numerous on the coasts of the Koni-Pyagina Peninsula. However, the most unique feature, without doubt, is the Yamskiye Islands, a little archipelago of five small islands and rocks with no fewer than five million seabirds. The breeding populations of Northern Fulmar, Least Auklet, and Parakeet Auklet are among the largest in the Russian Far East and in the whole North Pacific.

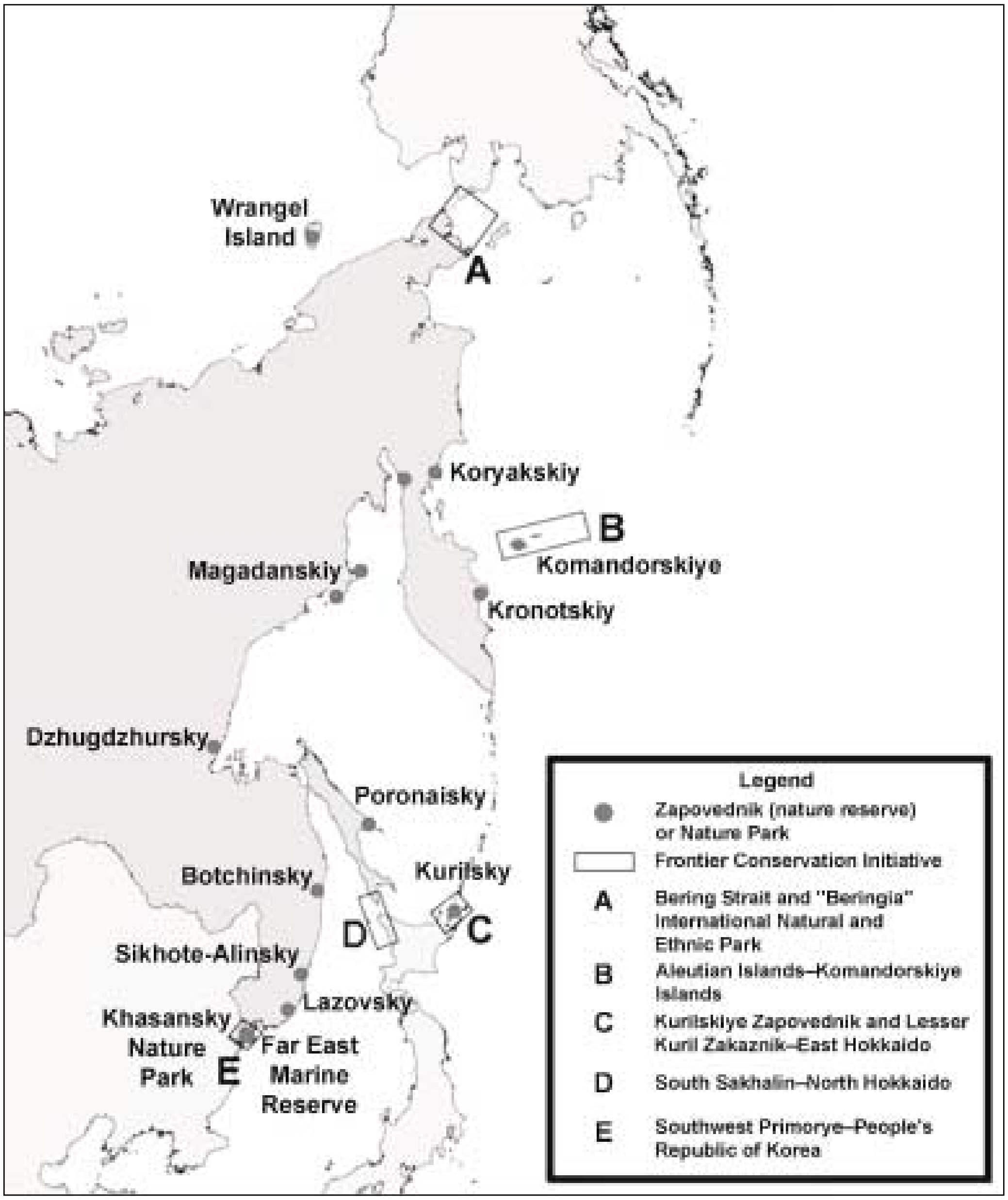
There are also many zakazniki and natural monuments in the northern Far East. Tumanskiy and Avtotkul zakazniki in the Anadyr River estuary are the only zakazniki in a coastal area. They were established to preserve waterfowl but are valuable to Sabine's Gull and Aleutian Tern. The Talan Island Natural Monument plays a great role in the preservation and study of seabirds of the northern Sea of Okhotsk by supporting one of the largest aggregations of breeding seabirds in the Russian Far East, with a total number between 1.1 and 1.5 million individuals. Ornithologists have worked on Talan Island constantly since 1987, observing different species and conducting long-term ecological studies to monitor populations and the influence of their communities on the ecosystem of the island (Kondratyev 1991).

The Kamchatka Region

Most of the large seabird colonies in Kamchatka are protected in zapovedniki, zakazniki, or natural monuments. The oldest reserve in the Russian Far East, Kronotskiy Zapovednik, was created in 1934 and covers 1142 km^2. There are no very large colonies of seabirds nesting on its coastal cliffs and precipices, but it has important colonies of Red-faced Cormorant. On its maritime lowlands, there are colonies of Aleutian Tern and Common Black-headed and Mew gulls, among others. Many of the seabird data for the area are somewhat out of date, but there are new initiatives for research and large-scale monitoring of seabird populations (Lobkov 1986).

In 1993, the Komandorskiye Zapovednik was established, protecting 3648.7 km^2, of which 3463.3 km^2 are adjacent waters of the Bering Sea. It includes the whole Komandorskiye Archipelago, Bering, Medniy, Ari Kamen, Toporkov, and more than 60 other islands and islets. It is important, first because of its geographical position, and second because of the species composition of its colonies. Being the continuation of the Aleutian Islands, the Komandorskiyes are a stepping stone between Asia and America in which we can explore exchange rates and intergradation between the two faunas.

Figure 1
Zapovedniki (nature reserves) in the Russian Far East that protect some seabird colonies



Koryakskiy Zapovednik (327.2 km^2) was established in 1995. It includes a vast wetland of international significance (Parapolski dol) in the west and uplands in the southern part of the Koryak Highlands. For seabirds, the most important part is in the east, where it protects the maritime lowlands of the Govena Peninsula with many colonies of seabirds. An offshore marine protected area covers 327.2 km^2.

The Kamchatka system of protected areas includes more than 20 zakazniki and nature parks, many mainly for the preservation of seabird communities on the Karaginsky, Verkhoturova, Starichov, and other islands. Seventeen zoological natural monuments also protect the largest seabird colonies on the coasts of the Kamchat Peninsula.

Seabird preservation and habitat protection in the zapovedniki, nature parks, and zakazniki are mandated by federal laws and local regulations. However, enforcement is at a low level due to a lack of resources for staff of zapovedniki and zakazniki, inspectors, and marine transport.

The objectives of the Kamchatka system of protected natural areas include:

a) The preservation of the seabird species and communities as part of the typical environment for the region's ecosystems.
b) The preservation of endemic, rare, and endangered seabird species and their habitats.
c) The encouragement of reproductive success and enhancing the economic value of species of seabirds.

To meet these goals, the zapovedniki, zakazniki, and natural monuments support scientific research for the comprehensive study of seabirds, develop ecologically oriented tourism in accordance with the aesthetic, scientific, and educational value of seabird colonies, and ensure the birds' security.

The South Region

There are a number of protected areas along the coastal zone of the southern part of the Far East, which vary in their status depending on the makeup of the responsible authority (e.g., federal or local). For many years, the main efforts at protection in the southern Far East zapovedniki were directed towards terrestrial communities. Of the coastal reserves, the Far East Marine Reserve (Dalnevostochny Morskoy Zapovednik) includes 64.3 km^2 of Peter the Great Bay to protect marine creatures and communities (Chugunov 1981; Litvinenko and Shibaev 1991). It is divided among three marine protected areas and 12 islands: a) along the coast between Cape Lva and Telyaskovskogo Bay and around Stenin and the other Rimsky-Korsakov Islands; b) a zakaznik between Cape Ostreno and Utes Golubiny Hill, including Falshivy and Vera islands, the area around Furugelm Island, and Sivuchya, Kolevala, and Pemzovaya bays; and c) educational nature parks on Popov and Likander islands. Twelve species of colonial seabirds nest in mixed colonies. The largest colonies are formed by Black-tailed Gull, Japanese Cormorant, and Spectacled Guillemot. The seabirds nest almost exclusively on small islands. The reserve is extremely important for the protection of the region's seabirds, particularly because it is situated in a zone of increasing human activity. In addition, it is an area where several species reach the limits of their breeding distribution (e.g., the southern limit of the Japanese Cormorant, Slaty-backed Gull, and Common Murre; and the northern limit of the Streaked Shearwater, Swinhoe's Storm-Petrel, and possibly Japanese Murrelet) (Shibaev 1987; Litvinenko and Shibaev 1991).

Dzhugdzhursky Zapovednik, established in 1990, in the Ayano-Mayskiy Region of Khabarovsk Territory, protects 806.3 km^2 of land and 53.7 km^2 of sea (Shlotgauer and Voronov 1997) and offers protection to seabird colonies on mainland coastal cliffs. Poronaisky Zapovednik (56.7 km^2), established in 1991 on the east coast of central Sakhalin Island, has 198 bird species, including breeding Aleutian Terns (Pirogov and Iskanderov 1997). This reserve protects the large colony at Cape Terpeniya. The Kurilsky Zapovednik, established in 1984 on Kunashir and adjacent islands of the Lesser Kurils, has a total area of 65.3 km^2, with many species of seabirds nesting along the coast (Martinov 1984; Anissimova 1996). Botchinsky Zapovednik was established in 1994 in the Botchi River Basin and has an area of 267.4 km^2. Part of the coastline is included in the zapovednik (Voronov 1997). Sikhote-Alinsky and Lazovsky zapovedniki, 116.5 km^2 and 347.1 km^2, respectively, were established in 1935. Japanese Cormorants and Spectacled Guillemots nest on mainland coastal cliffs and small islands. There is a proposal to link these reserves to adjoining marine areas, which would undoubtedly improve conditions for seabirds (Davydova and Koshevoi 1989).

Khasansky Nature Park was established in 1997 in the mouth of the Tumangan River. It has an outlet to the sea and is a feeding ground for many seabirds, mainly Black-tailed Gull and Great *Phalacrocorax carbo* and Japanese cormorants nesting on islands of the Far East Marine Reserve (Litvinenko and Shibaev 1996).

Tumninsky and Vasilkovsky zakazniki are on the mainland coast of the Sea of Japan, where they offer incidental protection to some seabirds. Severny Zakaznik on the Shmidta Peninsula, Sakhalin Island, has seabird colonies. There are also zakazniki on Vrangel Island in Piltun Bay, Lyarvo Island in Dagi Bay, and Chayka Island in Nabilskiye Bay, which hold the largest colonies of Aleutian and Common terns on Sakhalin (Nechaev 1991). The Lesser Kuril Zakaznik was established in 1983 and includes 45.0 km^2. It is vital for the protection of a complex of colonial seabirds with more than 11 species (Martinov 1984) and is supervised by the Kurilsky Zapovednik.

In Peter the Great Bay, Karamzin Island (107 m elevation, 600 m long) was declared a natural monument in 1984 as the only breeding site in Russia of Streaked Shearwater (not more than 150 pairs in 1969 and 1992). It also has colonies of other species (Litvinenko and Shibaev 1991). On the Verhovsky Islands, two groups of granite cliffs that reach 27.3 m in height and are 250 m long were made a natural monument in 1984 and are a breeding site of Swinhoe's Storm-Petrel (8370 pairs in 1988) and some other seabirds. Verhovsky and Karamzin islands are the only breeding site of Swinhoe's Petrel in Russia (Litvinenko and Shibaev 1991). In the Shantar Islands, there are two natural monuments where seabirds breed — Utichiy and Ptichy islands (Roslyakov et al. 1989).

Conservation opportunities and initiatives

The immediate priority is the establishment of international protected areas (parks and reserves) on the frontiers of the Pacific Rim nations. Such territories, which would protect seabirds as well as marine mammals and terrestrial flora and fauna, would remain under national administration but be managed by a management board or representatives. Biologists from these reserves could cooperate in monitoring resources and conducting research. Recent problems have made the need for international protected areas in the North Pacific clear for most scientists, and the concept offers a popular and attractive political contact between countries (Harrison et al. 1992; Matyushkin and Shibaev 1992; Ichida 1994; Shibaev and Litvinenko 1994; Zhirmunsky 1994; Fenn 1995; Shibaev 1995). The prospective areas, particularly for seabirds, are well known (Fig. 1), but progress on international protected area management has been slow in developing, with points of international coordination remaining unclear.

Russia–USA:

A) *"Beringia" International Natural and Ethnic Park.* Includes Bering Strait marine areas with adjacent portions of the Chukot Peninsula and Alaska. For many reasons, this project is the best-developed proposal for international cooperation in protected areas to date. Not only is it important for the protection of marine birds and mammals, but it is an important tool in restoring the traditional way of life and culture for indigenous people. The Diomede Islands are one of the best areas for monitoring global environmental conditions. Russia has already taken the first steps to manage the marine wildlife populations and protect the coastal ecosystems within the framework of this project.

B) *Komandorskiye Islands – Near Islands*. No practical efforts have been taken so far to coordinate seabird protection on the Komandorskiye Zapovednik (Russia) with seabird colony management on the Near Islands (Attu and Agattu islands) in the United States.

Russia–Japan:

C) *South Kuril Islands – Eastern Hokkaido*. On the Russian side, the Kurilskiy Zapovednik and Lesser Kurils Zakaznik protect the seabird colonies as part of the local ecosystems. In Japan there is Shiretoko Peninsula National Park (Watanuki et al. 1988) and two natural monuments on the Yururi and Moyururi islands (Fujimaki 1986), which also protect seabird colonies. International cooperation in the management of these areas is absent at this time.

D) *South Sakhalin (Moneron Island) – North Hokkaido (Rebun and Rishiri islands)*. Currently, there is a plan to establish a national park on Moneron Island (Shibaev and Litvinenko 1996). On the Japanese side, the Rishiri and Rebun islands are already declared as a national park, and there is a natural monument on nearby Teurijima Island, famous for its huge Rhinoceros Auklet colony (Fujimaki 1986). International cooperation in the management of these areas is absent at this time.

Russia – People's Republic of Korea:

E) *Southwest Primorye – Northeast People's Republic of Korea*. On the Russian side, the Far East Marine Reserve has been protecting seabird communities for more than 20 years, and the Hasanskiy National Park was established in 1997 on the Tumangan River delta of the Russian–Korean boundary. On the Korean side, there is a preserve on Arsom (or Nando) Island in the Tumangan River estuary, with some seabird colonies. International cooperation in the management of these areas is absent at this time.

In general, in the Russian Far East, the system of secured natural areas includes 13 state natural areas, over 10 natural parks, and many zakazniki and natural monuments with different degrees of importance for preserving seabirds in the region. On some of them (mainly the zapovedniki), protection is combined with colony monitoring and scientific observation of seabirds. At the present time, an adequate level of protection can be offered to colonies on only a few protected territories (primarily zapovedniki) because of economic hardship and poor resources for environmental inspections in the region.

The ongoing dramatic socioeconomic changes in Russia may lead to a reorganization of the protected natural areas in the Far East. Local administrative districts are being restructured, leading to the introduction of new regulations and greater influence on conservation efforts by local bodies. National parks are one new structure that has become available to the region. The development of international cooperation in the creation of protected natural areas on land and sea has very good prospects. Russia plans to expand the area of its protected territories to 3% of the area of land by the year 2000 and is considering new island reserves in the Kurils, the Shantars, and some other areas of the Far East.

Conclusions

1. The state of environmental conditions in the region is still rather good in general; the levels of industrial transformation of the habitat and pollution are not large. At the same time, in the most recent years, the exploration and development of oil and gas deposits have been planned or are active, sharply increasing the potential threat to the well-being of birds.

2. The level of harvest of seabirds (birds and eggs) in most of the Far East is not high, but it may significantly influence the well-being of seabird populations in some colonies in the northern Sea of Okhotsk, Kamchatka, the Kuril Islands, and the southern Far East. Of greatest concern is the fact that in most cases this is an uncontrollable, illegal activity.

3. In some regions of Kamchatka, the Kuril Islands, and the southern Far East, the major damage to seabirds on the colonies comes from the predatory activity of alien animals, including feral fur-bearing mammals and the Norway rat.

4. The mortality of seabirds in the commercial fisheries of the region ought to be monitored in the future. Clearly, the most significant impact is connected to salmon netting by Japanese fishermen (see Chapter 5). The scale of net mortality of some species of birds (e.g., Thick-billed Murre) likely influences the well-being of their populations. The practice of catching salmon in gill nets anchored to shore near nesting colonies may be dangerous for rarer species, such as the Ancient Murrelet, in spite of the relatively small scale of this activity. The mortality of seabirds in the long-line fishery operations needs to be explored and analyzed in the future. At present, this fishery occurs all year in the Bering Sea and the Sea of Okhotsk and also in waters near the Kurils. Only 20 vessels or so are busy with this cod and halibut fishery, but the information about the mortality of seabirds in these operations is very fragmentary.

5. The system of zapovedniki and zakazniki in the Russian Far East is well developed and includes many of the most important seabird nesting concentrations. The actual level of environmental control and scientific activity directed towards preserving these territories is unsatisfactory in most cases at present, because of a shortage of funds. The level of protection could be much improved by international cooperation in protecting breeding and wintering areas for seabirds.

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Appendix 1: Maps

Note: Map codes in italics are referred to in the list of place names, Appendix 2.

Figure 1
Base map: major features of the Russian Far East and the wildlife regions used in the text (*BM*).

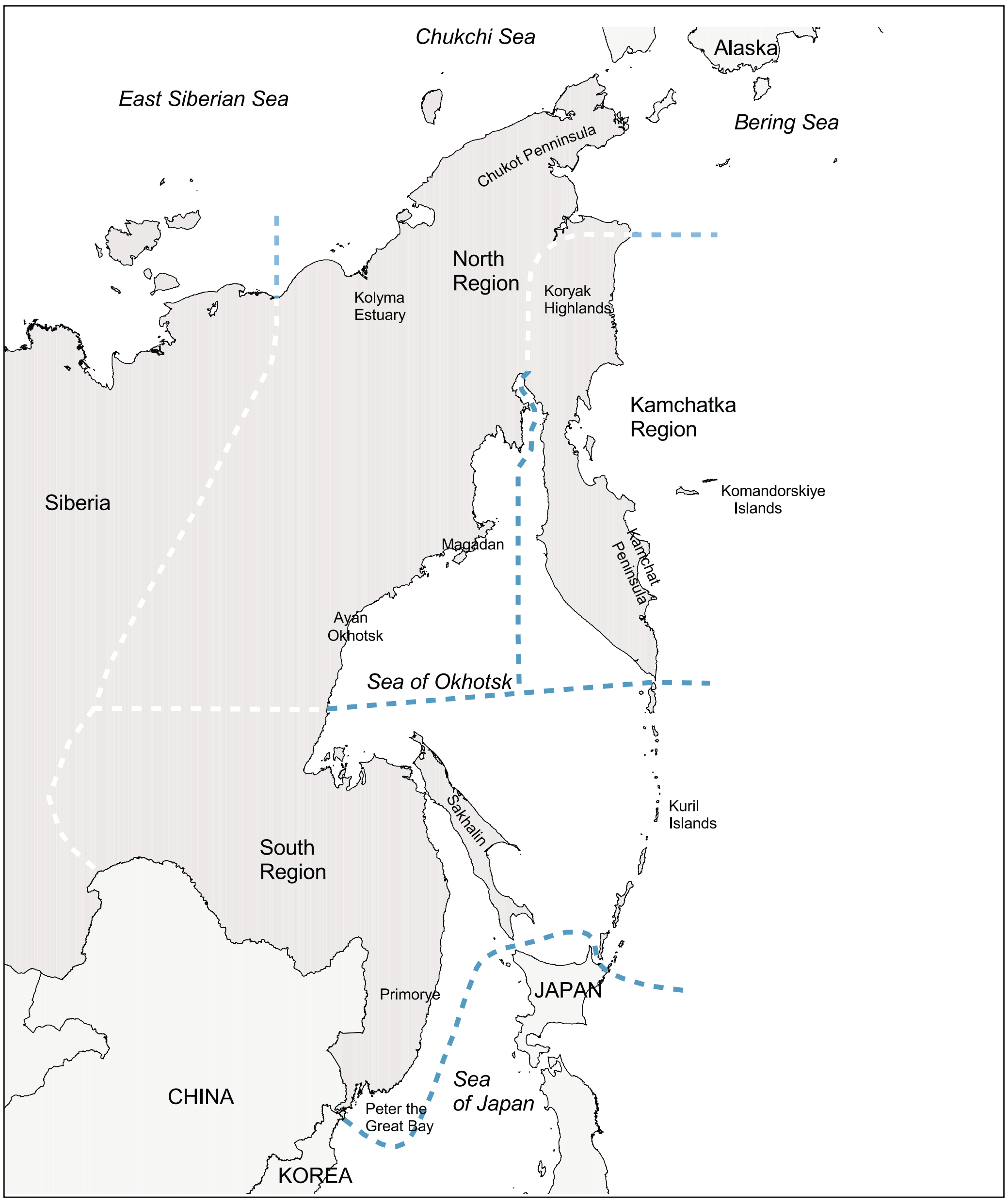


Figure 2
Southern Sea of Okhotsk (*SOK*)

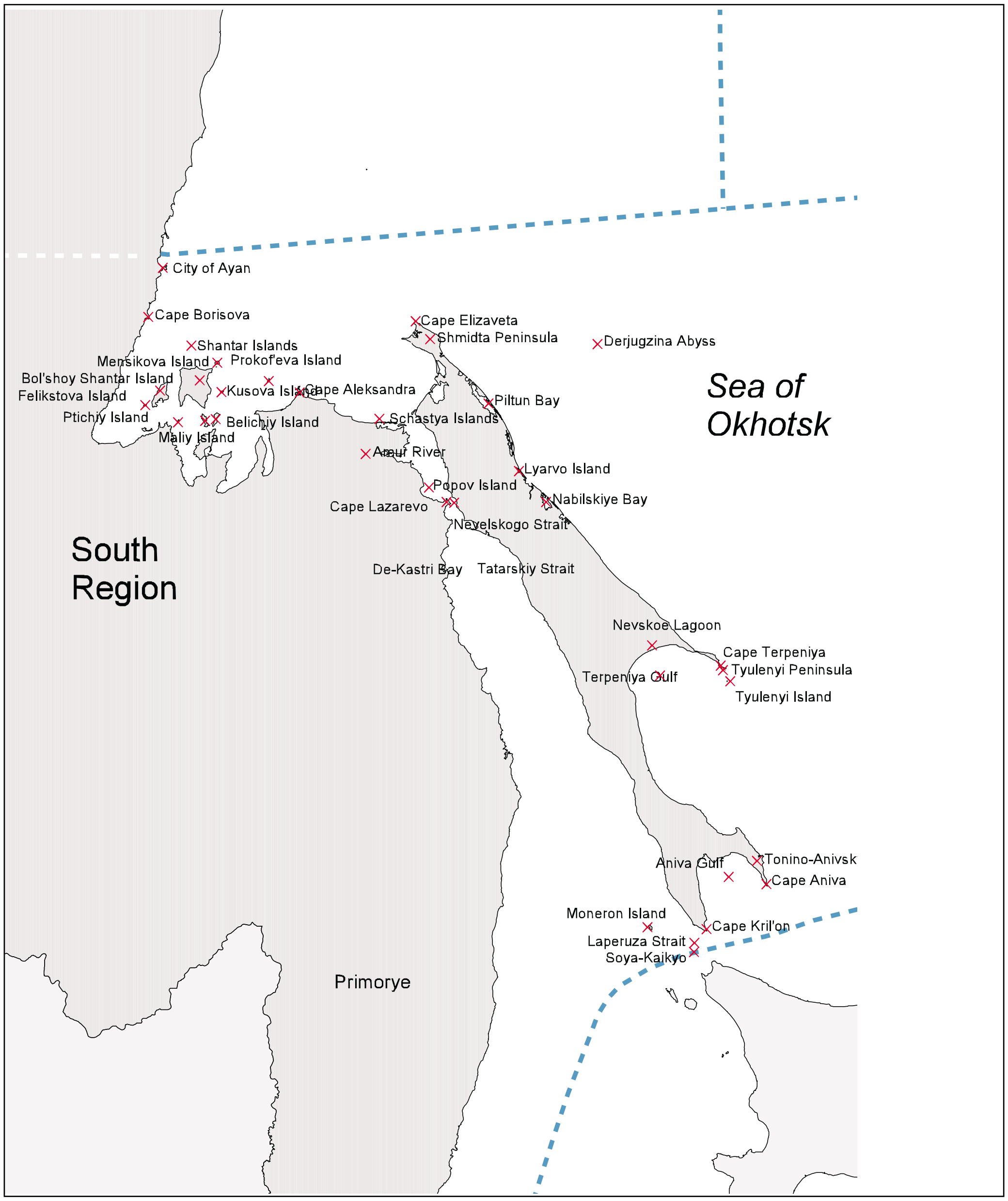


Figure 3
Peter the Great Bay (*PGB*)

Figure 4
Northern Sea of Okhotsk (*NOK*)

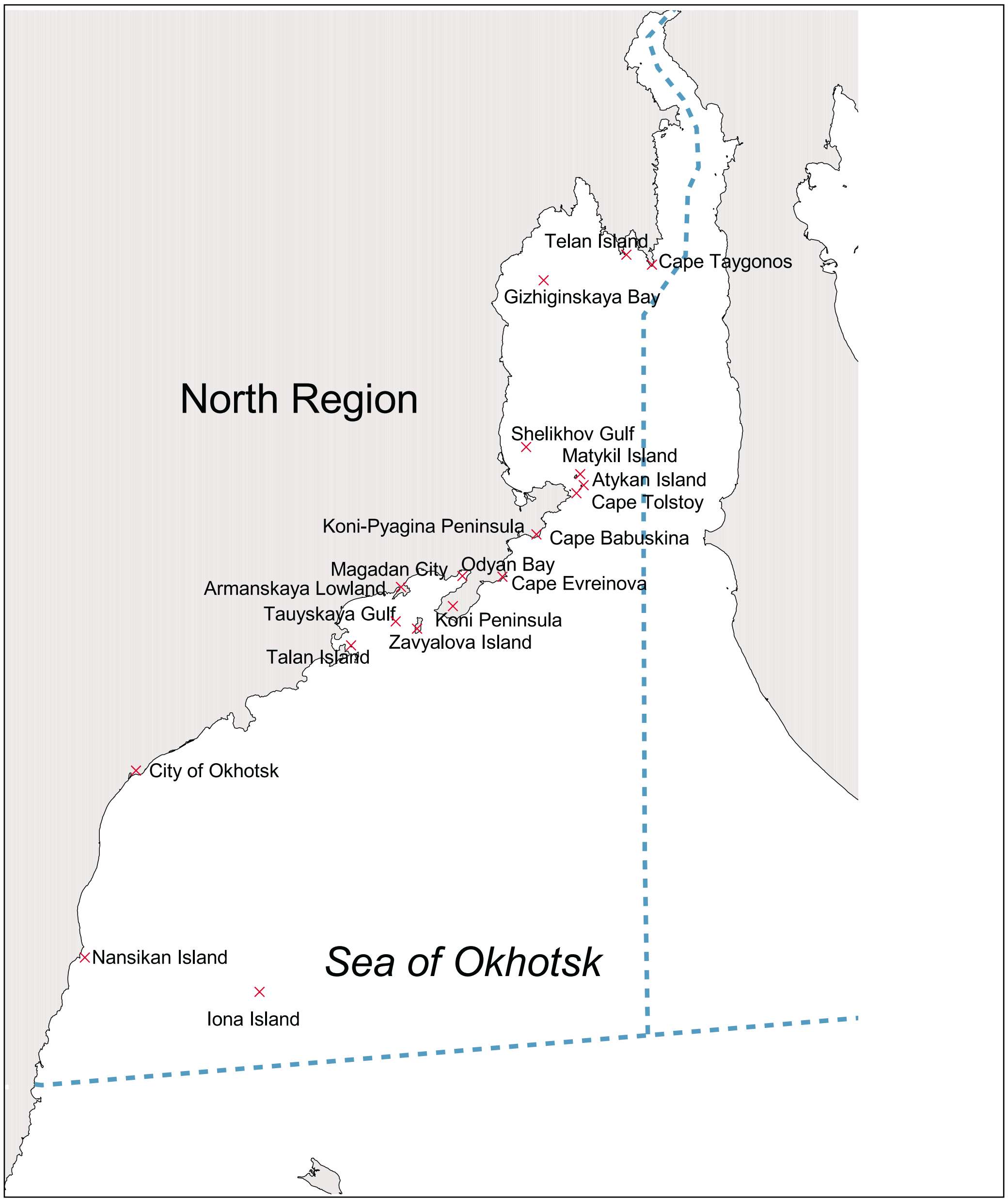


Figure 5
Northern Arctic and Bering Sea Coast (*NAC*)

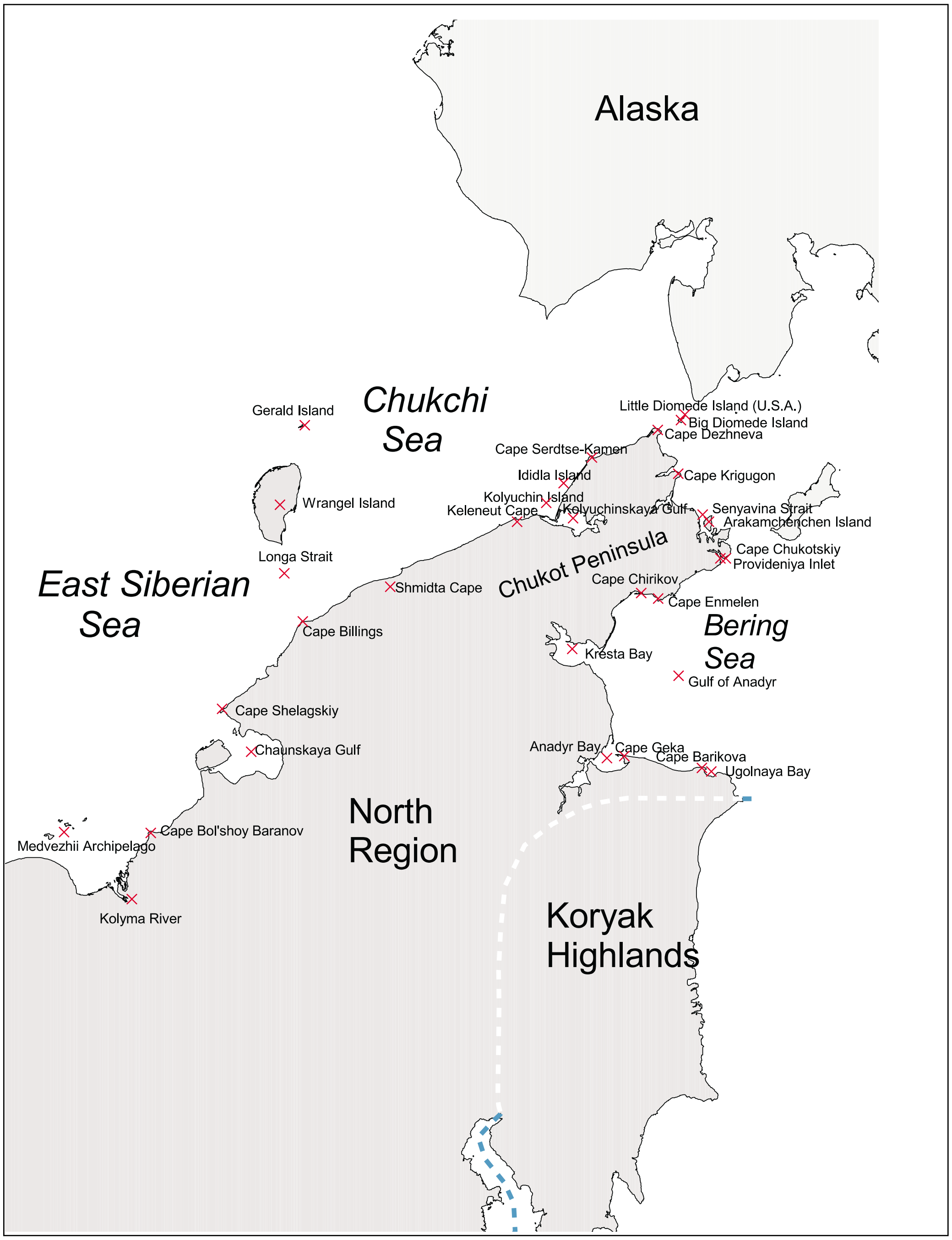


Figure 6
Kamchatka Region (*KAM*)

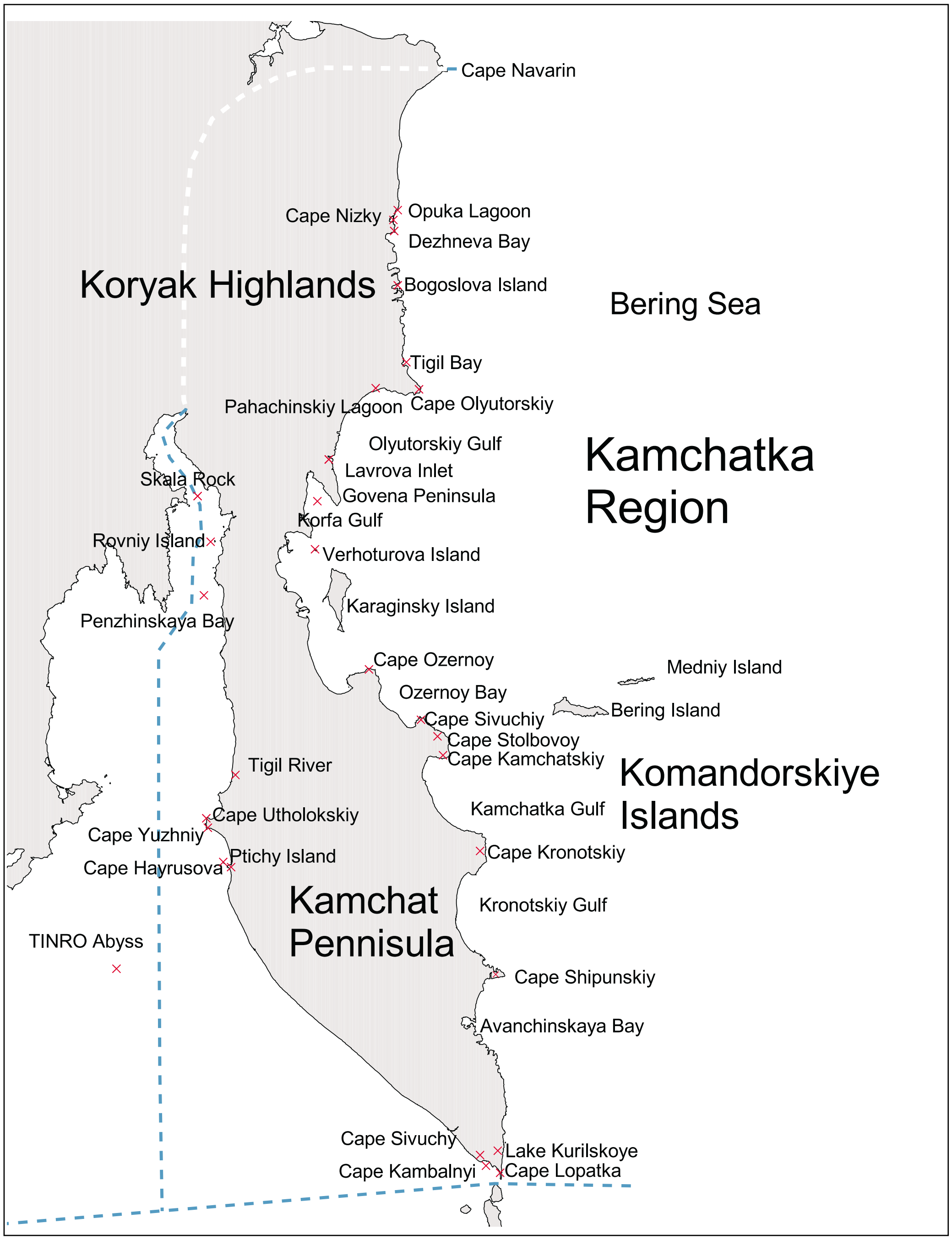
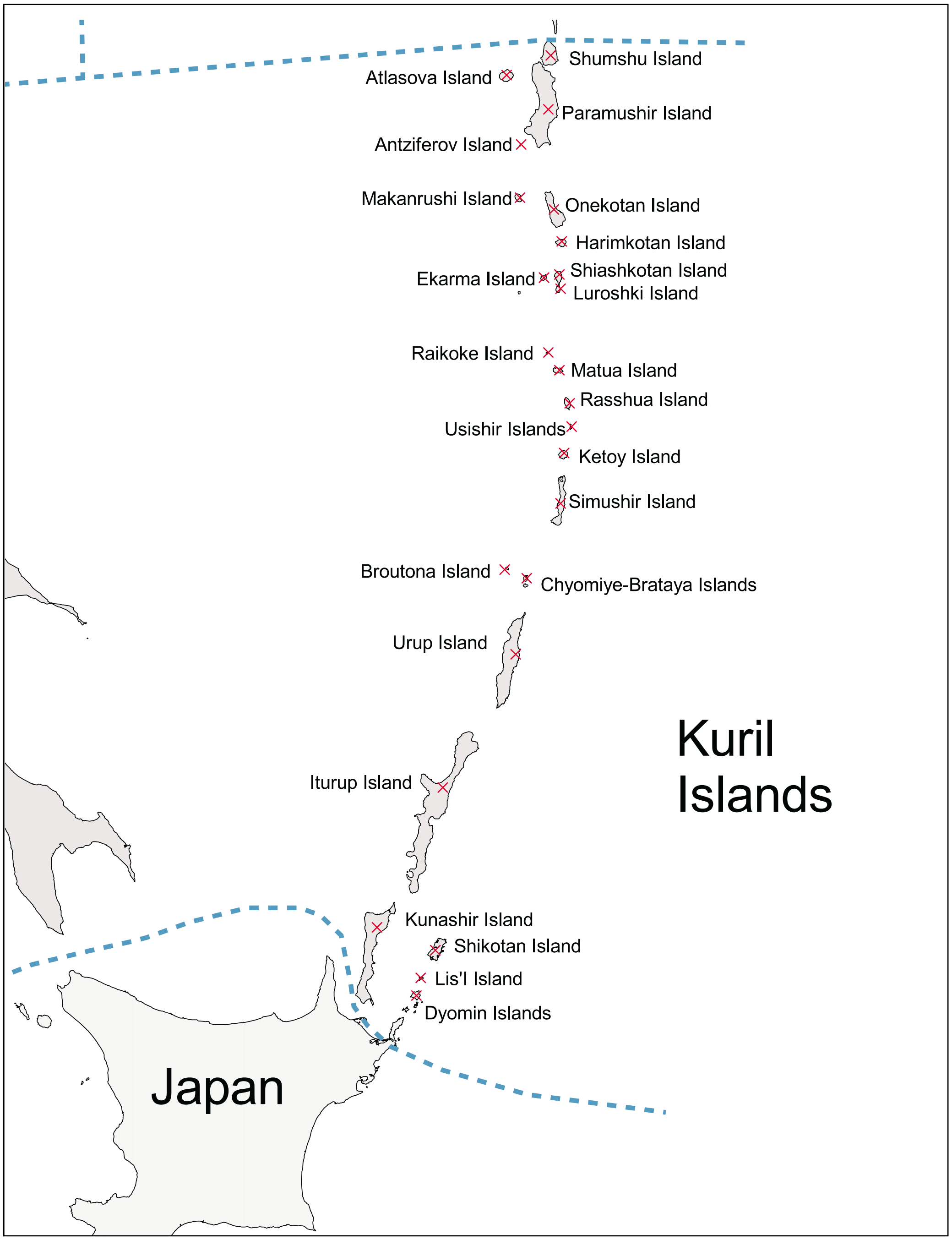


Figure 7
Kuril Islands (*KUR*)



APPENDIX 2: Place names in the Russian Far East

The following list includes most of the place names used in the text. Some for which there was no geographic reference or which could not be found on maps available in North America have been omitted. The style of the transcription varied among the authors and among the atlases that we consulted; as a result, some of the chosen spellings are entirely arbitrary. Those names in **boldface** appear on the maps in Appendix 1. Code letters in italics, usually at the end of an entry, refer to one of the maps in Appendix 1 (*BM* — Base Map, *SOK* — Southern Sea of Okhotsk, *PGB* — Peter the Great Bay, *NOK* — Northern Sea of Okhotsk, *NAC* — Northern Arctic and Bering Sea Coast, *KAM* — Kamchatka Region, and *KUR* — Kuril Islands).

Aleksandra Bay: in the southwestern Sea of Okhotsk, west from **Cape Aleksandra** (54°17'N, 139°47'E), 60 km to Cape Mukhtel. *SOK*

Alyumka Islet: in the delta of the Anadyr River at **Anadyr Bay**. *NAC*

Amguena River: enters the Chukchi Sea 200 km west of **Kolyuchinskaya Gulf**. *NAC*

Amur River: major waterway of the southern Far East, entering the sea near the north end of **Tatarsky Strait**. *SOK*

Anadyr Bay: western extension of the **Gulf of Anadyr**. *NAC*

Anadyr, Gulf of: the largest gulf in the Bering Sea, between Cape Navarin (62°16'N, 179°06'E) and **Cape Chukotskiy** (64°14'N, 173°07'W), 400 km to the ENE. *NAC*

Aniva, Cape and Gulf: southeastern Sakhalin Island (46°01'N, 143°25'E). *SOK*

Antziferov Island: islet off **Paramushir Island**. *KUR*

Anuchina Island: **Lesser Kuril Islands** (43°22'N, 146°01'E). *KUR*

Ari Kamen: small islet in the **Komandorskiye Islands**, 6 km off Toporkov Island. *KAM*

Armanskaya: a coastal lowland in **Tauyskaya Gulf**, northwestern Sea of Okhotsk. *NOK*

Atlasova Island: islet in the northern Kurils, off **Paramushir Island**. *KUR*

Atykan Island: in the Yamskiye Islands, off **Cape Tolstoy**. *NOK*

Avachinskaya Bay: water body beside the city of Petropavlosk-Kamchatskiy. *KAM*

Ayan Gulf: between Cape Tolkuchiy (56°23'N, 138°02'E) and Cape Vnesniy, 12 km to the ENE, northwestern Sea of Okhotsk.

Ayan-Okhotsk Area: the north coast of the Sea of Okhotsk between the cities of **Ayan** (*SOK*) and **Okhotsk** (*NOK*). *BM*

Azabache Lake: 20 km westward from the north end of **Kamchatka Bay**. *KAM*

Babushkina Bay: between **Cape Evreinova** (58°54'N, 152°54'E) and **Cape Babushkina**, 66 km to the ENE, northern Sea of Okhotsk. *NOK*

Barikova, Cape: in the southern **Gulf of Anadyr** (63°03'N, 170°26'E). *NAC*

Baydukov Island: one of the small islands in Schastya Bay, southern Sea of Okhotsk. *SOK*

Bering Cape: on the south shore of the **Chukot Peninsula** at 174°N. *NAC*

Bering Island: largest of the **Komandorskiye Islands**, 58 km by 40 km; known for the shipwreck of Vitus Bering and Georg Steller. *KAM*

Big Diomede Island: easternmost land mass in Russia (65°47'N, 169°04'W), in the Bering Strait. *NAC*

Bikin River: tributary of the Songhua Jiang along the international boundary in southern **Primorye**. *BM*

Billings, Cape: on the Arctic coast of Chukotka (69°55'N, 176°10'E); southwest of **Wrangel Island**. *NAC*

Bogoslova Island: small island on the Bering Sea coast of northeast Kamchatka (61°07'N, 172°28'E). *KAM*

Bol'shoy Baranov, Cape: on the Arctic coast, near the western boundary of Chukotka (69°05'N, 164°01'E). *NAC*

Bol'shoy Pelis Island: Far East Marine Reserve, **Peter the Great Bay** (42°39'N, 131°27'E). *PGB*

Bol'shoy Shantar Island: largest of the **Shantar Islands**, 1790 km^2, southwestern Sea of Okhotsk. *SOK*

Broutona (Broughton) Island: central island in the Kuril Archipelago, 50 km N of **Urup Island**. *KUR*

Butakov Island: small island in **Peter the Great Bay**. *PGB*

Chaunskaya Gulf: on the coast of the East Siberian Sea, west of **Cape Shelagskiy**, western Chukotka. *NAC*

Chayka Island: small island in **Nabilskiy Bay**, northeastern Sakhalin. *SOK*

Chetrekhstolbovoy Island: in the **Medvezhii Archipelago**, north of the **Kolyma River** estuary, in the East Siberian Sea (70°37'N, 162°20'E). *NAC*

Chirikov, Cape: two sites, southern **Chukotka** (65°16'N, 175°54'W) and northern Sea of Okhotsk (not shown). Also Chirikov Strait at the north exit of the **Gulf of Anadyr**. *NAC*

Chirinkotan Island: in the northern Kurils, 50 km southwest of **Onekotan Island**. *KUR*

Chukot Peninsula: the eastern extension of Chukotka beyond 180°E on the Arctic coast and marked by Kresta Bay in the south. *BM*

Chukotka: the northeastern portion of the Russian Far East, extending from the lowlands of the Kolyma River on the Arctic coast eastward through the Gulf of Anadyr in the Bering Sea. *NAC*

Chyorniye (Chernye) Brataya Island: just north of **Urup Island** in the Kurils. *KUR*

Commander Islands: see Komandorskiye Islands. *KAM*

Dagi Bay and River: eastern Sakhalin; see **Lyarvo Island**. *SOK*

De-Kastri Bay: on the Primorye coast of the Sea of Japan, in **Tatarsky Strait**. *SOK*

De-Livron Island: Far East Marine Reserve, **Peter the Great Bay**. *PGB*

Derjugzina Abyss: Sea of Okhotsk; deepest point (1780 m) near 53°00'N, 145°50'E. *SOK*

Dezhneva Bay: between Cape Yamlan (61°33'N, 173°30'E) and **Cape Nizkiy**, 13 km NE, northeastern Kamchatka. *KAM*

Dezhneva, Cape: most eastern point of the Asian mainland, Chukotka (66°05'N, 169°20'W); extends into the Bering Sea opposite Cape Prince of Wales, Alaska. *NAC*

Dobrzhanskogo Island: in **Penzhinskaya Gulf**, northeast Sea of Okhotsk. *NOK*

Doritzeni Lake: southern **Primorye**, 12 km from the coast. *SOK*

Dyomin Islands: small islets and pinnacles in the southern Kurils (43°25'N, 146°10'E). *KUR*

Dyrgush Island: **Schastya Islands**, southwest Sea of Okhotsk. *SOK*

East Korean Current: western branch of the Kuroshio Current carrying subtropical waters into the Sea of Japan.

Elizaveta, Cape: northern tip of Sakhalin (54°26'N, 142°42'E). *SOK*

Enmelen, Cape: southern Chukot Peninsula (65°02'N, 175°50'W). *NAC*

Falshivy Island: Far East Marine Reserve, **Peter the Great Bay**. *PGB*

Feklistova Island: Shantar Islands, southwest Sea of Okhotsk. *SOK*

Furugelm Island: Far East Marine Reserve, Peter the Great Bay. *PGB*

Geka Bay: southern coast of the **Koryak Highlands**. *KAM*

Gerald Island: 73 km northeast of **Wrangel Island**, Chukchi Sea (81°22'N, 175°32'W). *NAC*

Gildebrandt Island: Far East Marine Reserve, **Peter the Great Bay**. *PGB*

Gizhiginskaya Bay: between Cape Aregichinsky (60°31'N, 155°26'E) and **Cape Taygonos**, 260 km E; part of northwest **Shelikhov Gulf**, northeast Sea of Okhotsk. *NOK*

Govena Peninsula: in the eastern part of the Koryakskiye Zapovednik, Bering Sea (59°50'N, 166°15'E). *KAM*
Halpili Island: **Gizhiginskaya Bay**, northern Sea of Okhotsk. *NOK*
Halyustkina, Cape: eastern **Chukot Peninsula** (65°18'N, 172°11'W). *NAC*
Hayrusova, Cape: behind **Ptichiy Island**, south of **Cape Yuzhniy**, western Kamchatka (57°06'N, 156°45'E). *KAM*
Hokkaido: northernmost large island of Japan.
Ididlya Island: north coast of **Chukot Peninsula** (67°04'N, 172°45'W). *NAC*
Iona Island: small, isolated volcanic island in the central Sea of Okhotsk (56°24'N, 143°23'E), 220 km north of Sakhalin. *NOK*
Iturup Island: large island north of **Kunashir Island**, southern Kurils. *KUR*
Kambalniy, Cape: and island, 20 km northwest of **Cape Lopatka**. *KAM*
Kamchatka: large peninsula separating the Sea of Okhotsk from the Bering Sea; for the purposes of this study, it extends south from the Olyutorskiy Peninsula. *BM, KAM*
Kamchatka Gulf: due west of the Komandorskiye Group, south of **Cape Kamchatskiy**, eastern Kamchatka. *KAM*
Karaginsky Gulf: between **Cape Ozernoy** and **Cape Olyutorskiy**, about 58°N to 60°N, eastern Kamchatka. *KAM*
Karaginsky Island: largest island in eastern Kamchatka, about 2000 km^2. *KAM*
Karamzin Island: **Peter the Great Bay**. *PGB*
Keleneut, Cape: Arctic coast of Chukotka (67°35'N, 175°15'W). *NAC*
Ketoy Island: in the middle Kurils (47°20'N, 152°28'E). *KUR*
Kevoy Island: **Schastya Islands**, southwest Sea of Okhotsk. *SOK*
Khayryuzova, Cape: see **Cape Hayrusova**. *KAM*
Kievka Bay: southern Primorye, east of **Peter the Great Bay** (42°N, 133°E). *PGB*
Kittiwarken Rock: eastern **Chaunskaya Gulf**, near **Cape Shelagskiy**. *NAC*
Kolyma River: important valley and lowlands marking the western edge of the Russian Far East, entering the East Siberian Sea at about 160°E. *NAC*
Kolyuchin Island: northern Chukotka (67°30'N, 174°40'W). *NAC*
Kolyuchinskaya Gulf: Chukchi Sea, western limit of the Chukot Peninsula. *NAC*
Komandorskiye Islands: western end of the Aleutian Archipelago, 200 km east of Kamchatka. *KAM*
Koni Peninsula: eastern limit of **Tauyskaya Gulf**, west of Magadan. *NOK*
Koni-Pyagina Peninsula: extends into the Sea of Okhotsk, east of Magadan. *NOK*
Korfa Gulf: south of **Olyutorskiye Gulf**, eastern Kamchatka. *KAM*
Koryak Highlands: territory between the Gulf of Anadyr and the Kamchatka Peninsula, more than 900 km of Bering Sea coast. *BM, KAM*
Krasheninnikova Island: 12 km off eastern Kamchatka (53°09'N, 159°23'E). *KAM*
Krayniy Island: Penzhinskaya Gulf, eastern Kamchatka. *KAM*
Kresta Bay: northern extension of the Gulf of Anadyr. *NAC*
Krigugon, Cape: eastern Chukot Peninsula (65°28'N, 171°03'W). *NAC*
Kril'on, Cape: southwestern tip of Sakhalin extending into Laperuza Channel. *SOK*
Kronotskiy Gulf and Peninsula: south of Kamchatka Gulf, southeastern Kamchatka. *KAM*
Kronotskoye Lake: northwest of **Kronotskiy Gulf**, eastern Kamchatka. *KAM*
Kunashir Island: southernmost of the Kurils, very large. *KUR*
Kuril Islands: a string of many small volcanic islands forming the eastern boundary of the Sea of Japan. *BM, KUR*
Kurilskoye Lake: inland from the southern tip of Kamchatka. *KAM*
Kuroshio Current: a flood of warm water moving northward, past southern Asia, branching just south of Japan. The eastern branch crosses the Pacific as the Japan Current. See Tsushima Current.
Kuznetsova: townsite near **Cape Kril'on** in southern Sakhalin (46°03'N, 141°55'E). *SOK*
Laperuza (La Perouse) Strait: separates Hokkaido and Sakhalin, about 55 km wide, also called Soyakaikyo. *SOK*
Lavrova Inlet: Olyutorskiy Gulf, northeast Kamchatka (60°49'N, 166°08'E). *KAM*
Lazarevo, Cape: forms narrows of **Nevelskogo Strait** between Sakhalin and the mainland. *SOK*
Lesser Kurils: a southwestern extension of the Kuril Islands about 100 km long, east of **Kunashir Island**. Largest of the six islands are **Shikotan** and Zeleniy. There are many rocks and islets. *KUR*
Lis'i Islands: small islets and pinnacles in the Lesser Kurils (43°34'N, 146°24'E). *KUR*
Little Diomede Island: western extremity of Alaska in the Bering Strait. *NAC*
Longa Strait: separates **Wrangel Island** from Chukotka, 140 km wide. *NAC*
Lopatka, Cape: southern tip of Kamchat Peninsula (50°52'N, 156°40'E). *KAM*
Lovushki Island: middle Kurils (48°33'N, 153°52'E); remains of an underwater volcano. *KUR*
Lyarvo Island: small, flat island in Dagi Bay, northeast Sakhalin (52°07'N, 143°07'E). *SOK*
Magadan: major port in the northern Sea of Okhotsk (59°35'N, 150°50'E). *NOK*
Maliy Island: in the **Shantar Islands**, southwest Sea of Okhotsk. *SOK*
Maliy Langr Island: **Schastya Islands**, southwest Sea of Okhotsk. *SOK*
Manchdzhyr Island: islet in Karaginsky Gulf. *KAM*.
Matua Island: central Kurils. *KUR*
Matveyev Island: Far East Marine Reserve, **Peter the Great Bay**. *PGB*
Matykil Island: off **Cape Tolstoy**, northern Sea of Okhotsk. *NOK*
Medniy Island: northwest of **Bering Island** in the **Komandorskiye Islands**; long and narrow, 56 7 km. *KAM*
Moneron Island: at the western end of **Laperuza Strait**, 50 km southwest of Sakhalin (46°17'N, 141°14'E). *SOK*
Mukhtel Lake: southeast of **Cape Aleksandra**. *SOK*
Nabilskiy Bay: northeastern Sakhalin (51°30'N, 143°14'E). *SOK*
Nansikan Island: 4 km off Cape Odyan (57°29'N, 139°47'E). *NOK*
Navarin, Cape: southern limit of the **Gulf of Anadyr** (*NOK*), marking the boundary of the North and South regions. *KAM*
Navarinskiy Current: passes through Bering Strait into the Chukchi Sea.
Nevelskogo Strait: narrowest separation of Sakhalin and the mainland. *SOK*
Nevskoe Lagoon: behind Terpeniya Bay, eastern Sakhalin. *SOK*
Nizmenniy Cape: Geka Gulf, southern coast of the **Koryak Highlands**. *KAM*
Okhotsk-Ayan Area: see Ayan-Okhotsk Area. *NOK*
Olyutorskiy Peninsula: large land mass with a much larger submarine ridge, extending southward into the Bering Sea (59°58'N, 170°13'E at the tip). *KAM*
Onekotan Island: south of **Paramushir Island**, northern Kurils. *KUR*
Onman Cape: Arctic coast of **Chukotka** (67°40'N, 175°15'W). *NAC*
Opuka Lagoon: midway between **Cape Navarin** and Cape Olyutorskiy in the Bering Sea (61°50'N, 174°10'E). *KAM*
Oyashio Current: a flood of cold water moving out of the Bering Sea, southward along the northeast coast of Asia between the Komandorskiye Islands and Kamchatka.
Ozernoy Gulf: extreme southeastern Kamchatka. *KAM*
Pahachinskiy Lagoon: in the estuary of the Pahacha River, Olyutorskiy Bay, Koryak Highlands. *KAM*

Paramushir Island: largest of the northern Kurils. *KUR*
Penzhinskaya Bay: shallow water body between Cape Taygonos (60°34'N, 160°09'E) and Cape Bozhedomova in northern ShelikHov Gulf, eastern Kamchatka. Highest tidal flux (13 m) in the North Pacific. *KAM*
Peter the Great Bay (Zaliv Petra Velikogo): northwestern Sea of Japan, containing many islands in its 5500 km^2: Amursky, Vostok, Ussuryskiy, America, etc. *PGB*
Piltun Bay: northeastern Sakhalin, between 53°43'N, 143°13'E and 53°22'N, 143°13'E). *SOK*
Popov Island: rocky islet, just south of the narrows in Tatarsky Strait (52°07'N, 141°30'E). *SOK*
Posiet Bay: immediately northeast of the international border with the People's Republic of Korea. *PGB*
Povoroshniy, Cape: east of **Peter the Great Bay**, northwest Sea of Japan (42°40'N, 133°00'E). *PGB*
Primorye or Primorskiye Krai: administrative district along the northwest coast of the Sea of Japan from Korea northward to the Amur River and Tatarsky Strait. *SOK, BM*
Prokof'eva Island: outermost of the Shantar Group, western Sea of Okhotsk. *SOK*
Provideniya Inlet: fjord on the south side of the **Chukot Peninsula** between Cape Stolyeta (64°20'N, 173°39'W) and Cape Lisaya Golova, 14 km ESE; northwestern Bering Sea. *NAC*
Ptichiy Island: one off eastern **Kamchatka** (*KAM*) (57°11'N, 156°35'E) and another in the **Shantar Islands** (*SOK*), western Sea of Okhotsk.
Raikoke Island: north of **Matua Island** among the middle Kurils (48°17'N, 153°15'E). *KUR*
Rashua Island: islet among the middle Kurils. *KUR*
Ratmanova: occasionally used as the name of **Big Diomede Island**, but the latter has precedence. *NAC*
Rovniy Island: Penzhinskaya Gulf, northeastern Sea of Okhotsk. *KAM*
Sakhalin: very large island off **Primorye**, separating the western arm of the Sea of Japan from the Sea of Okhotsk. *BM*
Sangarsky Strait: separates Hokkaido from Honshu in Japan.
Schastya Bay: shallow area with many small islands on the mainland coast of Sakhalin Bay (53°18'N, 141°25'E), southern Sea of Okhotsk.
Senyavina Strait: separates **Arakamchenchen Island** from the mainland**,** 85 km long, 35 km wide, northern Bering Strait (65°04'N, 172°06'W). *NAC*
Serdtse-Kamen, Cape: Arctic coast of the Chukot Peninsula (66°55'N, 171°40'W). *NAC*
Severniy Island: islet among the **Shantar Islands**, southwestern Sea of Okhotsk. *SOK*
Shalaurov Island: islet in the **East Siberian Sea** (69°58'N, 172°46'E). *NAC*
Shantar Islands: west of **Cape Aleksandra**, southwestern Sea of Okhotsk. *SOK*
Shelagskiy, Cape: northern tip of the Russian Far East, Arctic Chukotka (70°06'N, 170°25'E). *NAC*
Shelikan Island: nearshore islet, northern Sea of Okhotsk.
Shelikhov Gulf: between **Cape Tolstoy** (59°11'N, 155°11'E) and Cape Utholoksiy (57°51'N, 157°00'E) in the northeastern Sea of Okhotsk; including **Gizhiginskaya Gulf** and Penzhinskaya Bay. *NOK*
Shiashkotan Island: narrow, 25-km spit between two volcanoes in the middle Kurils (48°48'N, 154°06'E). *KUR*
Shikotan Island: east of **Kunashir Island**, Lesser Kurils. *KUR*
Shipunskiy, Cape: east of Petropavlosk-Kamchatskiy, southeast Kamchatka. *KAM*
Shirinski Island: islet among the middle **Kuril Islands**. *KUR*
Shmidta, Cape: Arctic coast of Chukotka (68°56'N, 179°30'E). *NAC*
Shmidta Peninsula: northwestern tip of Sakhalin. *SOK*
Shumshu Island: the most northeastern of the **Kuril Islands**. *KUR*
Signalniy Island: at the northern entrance of **Avachinskaya Bay** (53°00'N, 158°38'E). *KAM*
Simushir Island: large island north of Urup Island in the middle **Kuril Islands**. *KUR*
Sivuchiy, Cape: 35 km northwest of **Cape Lopatka**, western Kamchatka. *KAM*
Skala Rock: 10 km offshore in western Kamchatka (61°20'N, 163°45'E). *KAM*
Soyakaiko: see Laperuza Strait.
Sredniy Island: islet in the Shantar Group, southwestern Sea of Okhotsk. *SOK*
Starichov Island: islet in **Avachinskaya Bay**. *KAM*
Stenin Island: Far East Marine Reserve, Peter the Great Bay. *PGB*
Stolbovoy, Cape: eastern Kamchatka (56°41'N, 173°17'E), Stolbovoy Island lies 5 km NNW. *KAM*
Sukhotina Island: **Shantar Group**. *SOK*
Tainochin Island: **Gizhiginskaya Bay**. *NOK*
Talan Island: nearshore, northern Sea of Okhotsk (59°18'N, 149°05'E). *NOK*
Tatarsky Strait: separates Sakhalin and Primorye. *SOK*
Tauyskaya Bay: west of **Magadan**, between Cape Shestakova (59°14'N, 148°56'E) and Cape Alevina, 145 km ESE, in the northern Sea of Okhotsk. Contains several smaller bays: Motykleyskiy, Amahtonskiy, Odyan, and Nagaeva. *NOK*
Taygonos, Cape: extends into Shelikhov Gulf, northern Sea of Okhotsk. *NOK*
Telan Island: western **Gizhiginskaya Bay**. *NOK*
Terpeniya Gulf: between **Cape Terpeniya** (48°39'N, 144°45'E) and Cape Soyamonova, 13 km WNW, southeastern Sakhalin. *SOK*
Teurijima: island northwest of Hokkaido, Japan, with a very large colony of Rhinoceros Auklets.
Tigil Bay: north of the Olyutorskiy Peninsula, southern Koryak Highlands (60°20'N, 170°55'E). *KAM*
Tigil River: west-central Kamchatka. *KAM*
TINRO Abyss: northeastern Sea of Okhotsk; deepest point 991 m (56°40'N, 153°30'E). *KAM*
Tonino-Anivsky Peninsula: ends with Cape Aniva, southeast Sakhalin. *SOK*
Toporkov Island: 6 km northwest of Bering Island in the **Komandorskiye Islands**. *KAM*
Tsushima Current: an eastern branch of the Kuroshio Current carrying subtropical waters into the Sea of Japan.
Tsushima Strait: separates Korea and Japan.
Tudum Island: Schastya Bay, southwest Sea of Okhotsk. *SOK*
Tumangan (or Tumen) River: forms the frontier between Primorye and the People's Republic of Korea. *(Chapter 6, Figure 1)*
Tyuleniy Peninsula: extends south of Cape Terpeniya, eastern Sakhalin (48°29'N, 144°37'E) (see **Tyuleniy Island**). *SOK*
Tyuleniy Island: 15 km south of the Terpeniya Peninsula, eastern Sakhalin (48°07'N, 144°11'E). *SOK*
Ugolnaya Bay: 50 km north of Cape Navarin. *NAC*
Umara Island: islet in **Tauyskaya Bay**, northern Sea of Okhotsk. *NOK*
Urup Island: large island north of **Iturup Island** in the southern Kuril Islands. *KUR*
Usishir Group: 20 km northeast of **Ketoy Island**, includes Yankicha and Riponkicha, middle Kuril Islands. *KUR*
Ussuriland: southern portion of the Russian Far East from the boundaries of Korea and China, northward to the Amur River including **Primorye** and southern Khabarovskiye Krai. *BM*
Utashud Island: eastern Kamchatka.
Utholoskiy, Cape: western Kamchatka (57°51'N, 157°00'E). *KAM*
Utichiy Island: islet in the **Shantar Islands**, southwestern Sea of Okhotsk. *SOK*
Vasiliya Islands: islets near Tigil Bay in eastern Kamchatka.
Vera Island: Far East Marine Reserve, **Peter the Great Bay**. *PGB*
Verhovsky Islands: two islets in **Peter the Great Bay** (42°52'N, 131°48'E). *PGB*
Verkhoturova: island in eastern Kamchatka (59°37'N, 164°40'E). *KAM*
Vladivostok: major port in the southern Russian Far East. *PGB*

Vrangel Island: islet in **Piltun Bay**, eastern Sakhalin. *SOK*
Vtoroy Island: **Penzhinskaya Gulf** , northern Sea of Okhotsk. *NOK*
Western Alaska Current: passes through the eastern portion of Bering Strait into the Chukchi Sea.
Wrangel Island: between the East Siberian and Chukchi seas, about 145 km by 80 km. *NAC*
Yagnochimlo, Cape: southern **Chukot Peninsula**. *NAC*
Yamskiye Islands: five islands off **Cape Tolstoy**: **Atykan**, Baran, Kokonste, **Matykil**, and Hatemalyu; northern Sea of Okhotsk (59°N, 155°E). *NOK*
Yano-Indigirskaya Lowland: along the southern Siberian Sea in eastern Yakutia.
Yuriy Island: 2.5 km northeast of Anuchina Island, **Lesser Kuril Islands**. *KUR*
Yuzhniy, Cape: western Kamchatka (57°44'N, 156°45'E). *KAM*
Yuzhniy Island: islet in the **Shantar Group**, southwestern Sea of Okhotsk. *SOK*
Zavyalova Island: 30 km south of **Magadan**, northern Sea of Okhotsk. *NOK*

APPENDIX 3: English names and acronyms for agencies and organizations that appear in the text and bibliographies

DVNTS: Far East Science Centre
DVO: Far East Branch
IBPN: English acronym for IBPS; may appear in other literature
IBPS: Institute for Biological Problems of the North
ICBP: International Council for Bird Preservation
IUCN: International Union for the Conservation of Nature and Natural Resources; now known as World Conservation Union
Kamchatribvod: Kamchat Department of the Federal Fisheries Committee
MGU: Moscow State University
MOIP: Moscow Society of Naturalists
RAN: Russian Academy of Sciences
RAS: English acronym for RAN; may appear in other literature
SSSR AN: Union of Soviet Socialist Republics Academy of Sciences
TINRO: Pacific Research Institute of Fisheries and Oceanography
TINRO Centre: Headquarters of TINRO in Vladivostok
VNIRO: National Institute of Fisheries and Oceanography