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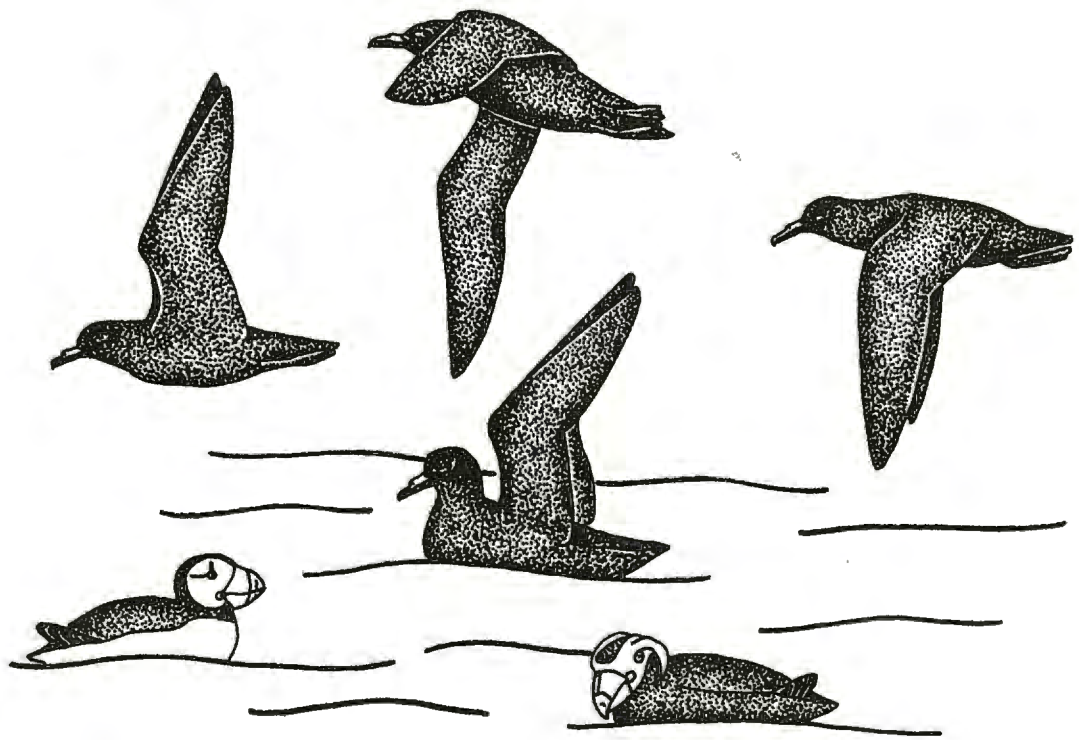
Biological Services Program FWS/OBS-82/48

# PELAGIC DISTRIBUTION AND ABUNDANCE OF SEABIRDS IN THE GULF OF ALASKA AND EASTERN BERING SEA



by

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## ERRATA

| Page No. | Column | Line | Error & Correction |
|---|---|---|---|
| 1 | Left | 40 | Insert "in Appendix B" between "listed" and "along" |
| 2 | Right | 38 | Change "Eleven" to "Nine" |
| 2 | Right | 39 | Change "1,000,000" to "100,000" |
| 7 | Left | 49 | Change "Diccoverer" to "Discoverer" |
| 7 | Right | 44-46 | Delete the sentence "Individual counts....... standard procedures." |
| 25 | Left | 16 | Change "33°N" to "53°N" |
| 26 | Right | 37 | Change "Maps III 99-106" to "Maps 137-144" |
| 28 | Left | 38 | Change "107-197" to "114-197" |
| 28 | Right | 41 | Change "Two species" to "Three species" |
| 31 | Left | 18 | Change "...Aleutian and western Islands" to "...and western Aleutian Islands..." |
| 32 | Left | 12-35 | Table 20: All dates have the first column missing. The dates should read, from top to bottom; 4 Oct, 6 Oct, 4 Oct, 8 Sep, 6 Oct, 17 Aug, 24 Aug, 3 Jul, 26 Aug, 1 Jul, 12 Sep, 6 Sep, 12 Jun, 25 Jul, 1 Aug, 26 Aug, 14 Jul, 9 Jun, 29 May, 25 Oct, 27 Jul, 3 Sep, 21 Sep, 10 Sep. |
| 32 | Right | 49 | Add ", but" to end of line: i.e., "individuals, but" |
| 34 | Right | 9 | Change "...behavior; jaegers are known to occurr..." to "...behavior since jaegers occurred..." |
| 36 | Right | 35 | Change "larger" to "smaller" |
| 38 | Right | 6 | Change "100" to "75" |

The biological Services Program was established within the U. S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issures that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

° To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

° To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.

° To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decision-making process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify ifformation gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal exraction and conversion; power plants; geothermal mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staff, who provide a link to problems at the operating level, and staff at certain Fish and Wildlife Service research facilities, who conduct inhouse research studies.

# Pelagic Distribution and Abundance of Seabirds in the Gulf of Alaska and Eastern Bering Sea

BY

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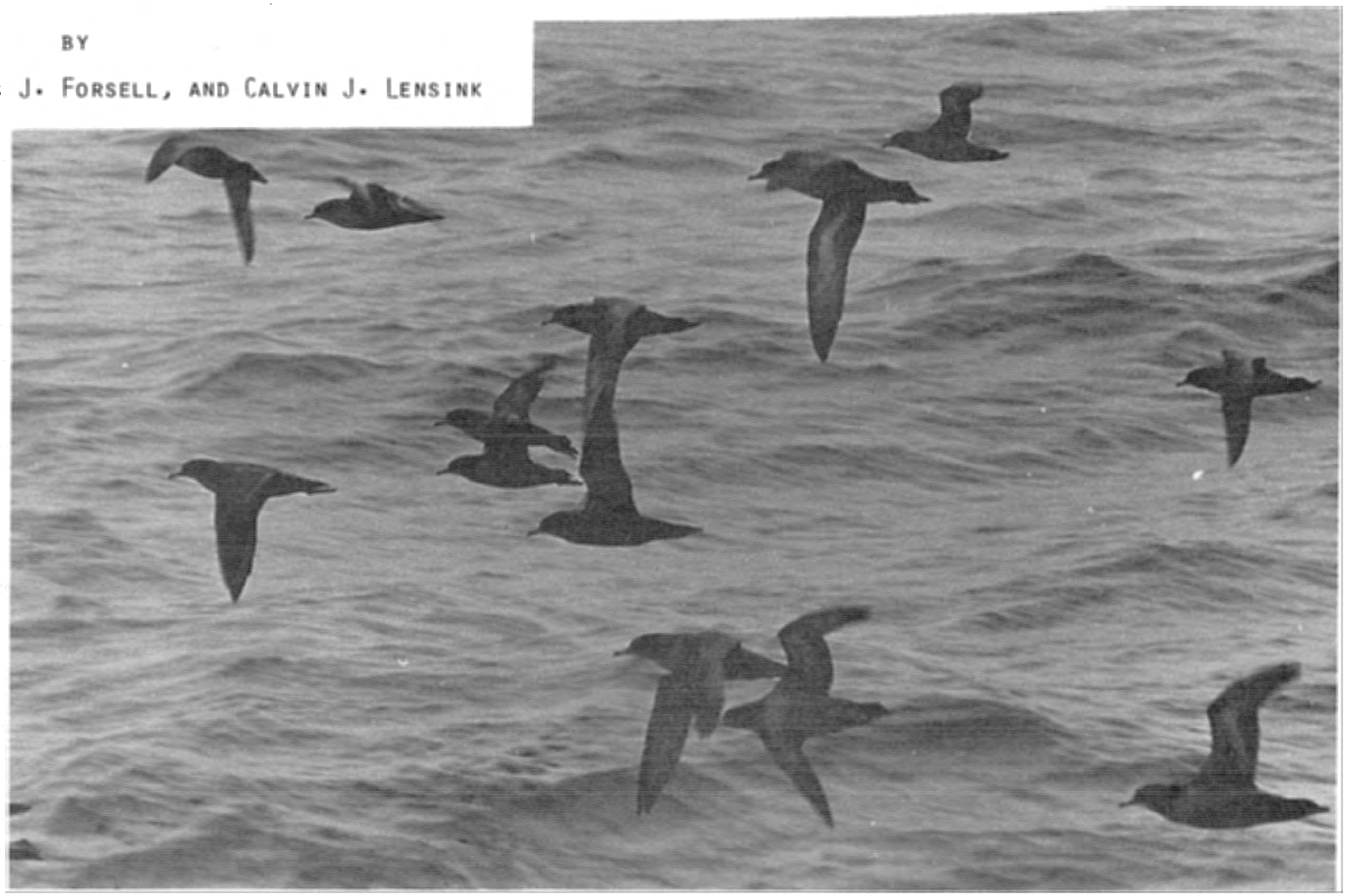

SHORT-TAILED SHEARWATERS. PHOTO BY ANTHONY R. DEGANGE

## PREFACE

This atlas is based on censuses conducted from ships and aircraft over waters of the Gulf of Alaska and eastern Bering Sea. On such censuses we were able to observe and record only a part of the population of each species that occupied the census area, the actual proportion observed varying with weather and sea state, and particularly with the size, color, and behavior of individual species. For some species our counts probably approximate the number present, but for others we may see only a fraction. On evaluation of the numerous factors that affect our counts, our impression of numbers is that we perhaps see most gulls, jaegers, and kittiwakes, nearly as many shearwaters (but are sometimes confused by their extreme abundance), a smaller proportion of large alcids, and fewer still of small alcids, storm-petrels, and phalaropes. For species such as albatrosses and fulmars which are much attracted to ships, our counts may at times indicate larger populations than actually occur.

Because of the differences in the accuracy with which we count individual species, comparing numbers between different species or treating data in the maps and tables of the atlas as estimates of the size of populations may lead to serious error. For this reason we use the term "index" rather than "estimate" when referring to our counts --the index must be multiplied by some unknown correction factor to obtain a true estimate. We anticipate that our data will be often misused as estimates of population size and that such use will nearly always result in minimum estimates of populations.

Although there is hazard from using our data for estimating sizes of populations, they are more reliable for other purposes. Because our procedures were consistent and because we carefully controlled conditions under which we conducted censuses, or analyzed data, differences in counts between seasons or geographic areas should accurately portray the movements, changes in distribution patterns, and relative abundances of individual species as well as regions that are most important to them.

Because our work was largely confined to ships of opportunity, usually research vessels operated by the National Oceanic and Atmospheric Administration, or to aircraft which soon became prohibitively expensive, our data is largely confined to spring, summer, and early fall; and to regions over the continental shelf of the Gulf of Alaskas and eastern Bering Sea. Thus, lack of observations in late fall and winter or in oceanic habitats, particularly south of the Aleutian Islands Islands and western Bering Sea, constitute an important gap in our information. Even in areas of the eastern Bering Sea and the Gulf of Alaska for which we have most data, the data remain inadequate for showing changes in distribution that may occur over a relatively short period of time, as during migration, or for comparing changes in distribution from one year to another that result from slight natural changes (temperature, currents, salinities, etc.) that occur in the marine environment. Nevertheless, the atlas should be of considerable value as a contribution to understanding of the use of marine environments by birds and for evaluating the potential effects of mans activities there.

## ACKNOWLEDGMENTS

This study was supported by the Bureau of Land Management through interagency agreement with the National Oceanic and Atmospheric Administration, under which a multi-year program responding to needs of petroleum development of the Alaskan continental shelf is managed by the Outer Continental Shelf Environmental Assessment Program (OCSEAP) Office.

We have benefited from the cooperation and support of nearly all of the research scientists and technicians currently studying marine ecosystems in Alaska. We especially thank the following people who contributed significantly to our program: James C. Bartonek, Robert L. Blanscett, David R. Cline, Michael Crane, Gary L. Fidler, Juan P. Guzman, Dennis W. Heinemann, Wayne Hoffman, Laurie E. Jarvela, Susan Miller, Harold Petersen, Jr., and Gerald A. Sanger. Craig S. Harrison developed and supervised the aerial surveys in this investigation and contributed greatly to all of our efforts before accepting a new position in late 1977. Anthony R. DeGange wrote much of the preliminary draft for Appendix B of this report. We are especially grateful to Robert H. Day, Malcolm E. "Pete" Isleib, and Brina Kessel for reviewing this manuscript. All three made significant contributions to the style and content of the final report. Charlotte I. Adamson designed and prepared the frontispiece. John M. Stout spent many hours as publication manager for this report and was competently assisted by Bertram A. Lewis.

Data obtained during our studies were collected by many persons: Jeffrey Allen, Edgar P. Bailey, Patricia A. Baird, James C. Bartonek, Judith Benson, John Blankenship, Kenneth T. Briggs, G. Vernon Byrd, David R. Cline, Robert H. Day, Anthony R. DeGange, Matthew H. Dick, George J. Divoky, Thomas J. Early, Todd Eberhardt, Douglas J. Forsell, David A. Frazer, Allan K. Fukuyama, Robert E. Gill, Jr., Patrick J. Gould, Juan P. Guzman, Larry Haddock, John D. Hall, Colleen M. Handel, David Hardy, Craig S. Harrison, Scott A. Hatch, Martha A. Hatch, Dennis W. Heinemann, Karen Henderson, Valarie F. Hironaka, Eric P. Hoberg, Wayne Hoffman, George L. Hunt, Jr., Malcolm E. "Pete" Isleib, Robert D. Jones, Jr., Nathanial Johnson, Matthew D. Kirchhoff, Lynne D. Krasnow, Craig Larson, Richard A. MacIntosh, Susan Bates Matthews, Keith A. Metzner, Allen R. Moe, Jay W. Nelson, David R. Nysewander, Margaret R. Peterson, Mark Phillips, Kevin D. Powers, Mark J. Rauzon, Jerry Reuhle, Gerald A. Sanger, Theodore Shad, Arthur L. Sowls, Michael A. Spindler, Rebecca S. Timson, Claudia L. Voss, Irving M. Warner, H. S. "Duff" Wehle, David Wiswar, and Kenton D. Wohl.

Throughout our work we have benefited from the Young Adult Conservation Corps (YACC) program. We thank Ronald Stanek and Rhon M. Lyons, both of whom were YACC coordinators during our studies. YACC enrollees who contributed to the preparation of this report include Charlotte I. Adamson and James D. Lockhart (draftspersons and illustrators), Jeffrey H. Kogan (computer aide), and the following biological aides: Janet Burke, Charles W. Elmore, Jan L. Greilich, Nancy Harrison, Katherine Muller, Kristin Richards, Donald J. Sheilds, and Martha V. Wiley.

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BLACK-FOOTED ALBATROSS. PHOTO BY ANTHONY R. DEGANGE

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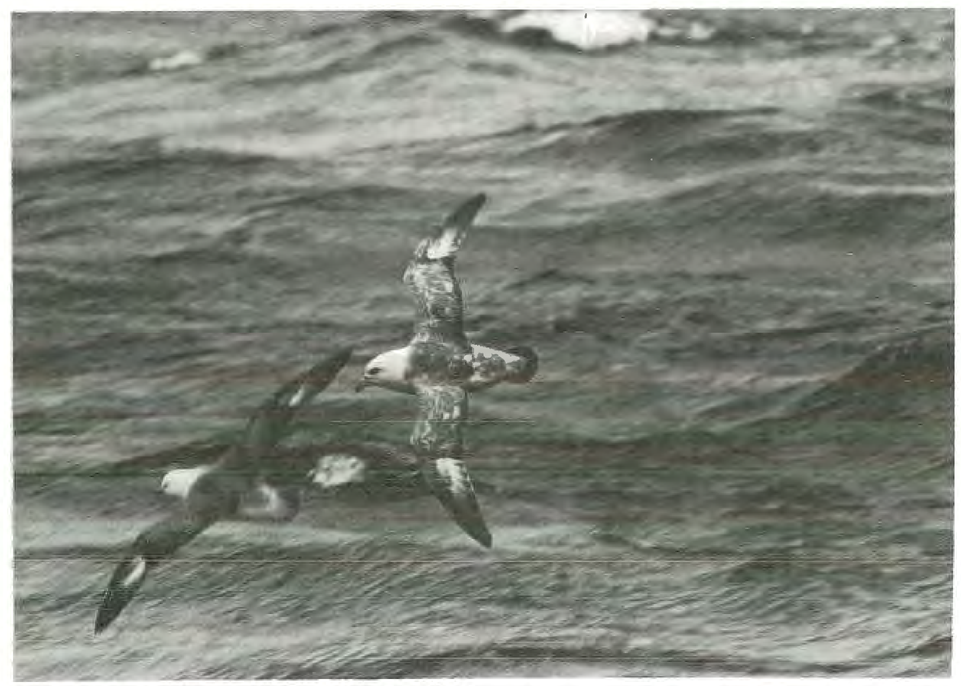
MAPS OF BIRD DISTRIBUTIONS IN THE BERING SEA



NORTHERN FULMARS. PHOTO BY ANTHONY R. DEGANGE

## INTRODUCTION

Populations of seabirds in Alaska are unique in size and diversity; breeding populations of storm-petrels, cormorants, gulls, terns and alcids number 37 species and an estimated 40 million individuals at more than 1,000 colonies. This array of breeding seabirds is augmented by a large number of shearwaters that breed in the southern hemisphere and spend the austral winter in the North Pacific and Bering Sea. The Alaskan population of marine birds is further unique in still being relatively intact, although some colonies have been devastated by the introduction of rats and foxes, and populations at other colonies may have been seriously affected by loss of birds in high seas gillnet fisheries.

This natural wealth and beauty, called Alaska's most neglected resource by Sowl and Bartonek (1974), is daily becoming more and more threatened by pollution of Alaska's marine habitats, and high levels of impact, at least on short term bases, appear inevitable with the continued development of the state's coastal regions. Understanding the varied and complex patterns of distribution and abundance of each of the hundred-odd species of birds that depend on coastal and marine environments of Alaska is prerequisite to identifying their critical habitats and periods of vulnerability, and to providing clues as to their often less than obvious relation with the marine environment. This kind of information is but a part of that required by natural resource management agencies to eliminate, minimize, or mitigate adverse impacts resulting from offshore development of petroleum resources.

The objective of this study is to describe the seasonal abundance and distribution of marine birds in the portions of the Gulf of Alaska and Bering Sea that have been identified by the U.S. Department of the Interior for leasing and development of their gas and oil potentials. This research considers only the offshore environment and does not include species generally confined to nearshore and littoral habitats, nor does it directly consider the distribution of pelagic species when they occupy shoreline habitats, e.g., during the breeding season.

For the purposes of this report, we recognize 86 species of Alaskan seabirds, of which about 20% are vagrants or rare visitors. The total includes loons (4), grebes (4), albatross, shearwaters and storm-petrels (14), cormorants (4), sea ducks (17), phalaropes (3), jaegers (4), gulls (17), terns (3), and alcids (16). Each species is listed along with a brief description of its currently recognized world and Alaskan distribution and abundance. Swans, geese, dabbling ducks (Anas and Aix), bay ducks (Aythya), and shorebirds have been excluded because their use of marine waters is generally restricted to nearshore and littoral habitats. Of the 86 species, 59 breed in Alaska, 19 breed only in nearby areas of Asia, Hawaii, and Canada, and 8 breed only in the Southern Hemisphere, including Australia, New Zealand, and Chile.

## CURRENT STATE OF KNOWLEDGE

Information relating to the distribution and abundance of marine birds in Alaskan waters is scattered in a wide and unwieldy variety of publications, unpublished reports, and private and institutional data bases. Important bibliographic sources relevant to this subject can be found in Gabrielson and Lincoln (1959), Kessel and Gibson (1978), Bartonek and Lensink (1978), and Handel et al. (1981).

The following summary of literature is not exhaustive, but does present an overall picture of the work that has been conducted on the distribution and abundance of seabirds in marine waters of the subarctic North Pacific, and the Bering, Chukchi, and Beaufort Seas. By and large, the published and unpublished data were acquired from platforms of opportunity. Few observers were able to repeat a survey along the same cruise track at a later date, and even fewer could designate the track to be taken. In general, the reports present fragmentary information on numbers and distribution from which generalizations for even some of the more abundant and widely occurring species could be misleading.

### PUBLISHED ACCOUNTS

In the North Pacific Ocean, about 100 years elapsed after initial observations reported by naturalists on James Cook's expeditions until Dall's (1873) observations in the eastern Aleutian Islands and surrounding marine waters. Since then, information on seabirds has been published sporadically but at an ever-increasing rate.

The most comprehensive discussions of marine birds in subarctic and arctic waters of the Pacific Ocean are those of Gabrielson and Lincoln (1959), Shuntov (1972), Sanger (1972a), Kessel and Gibson (1978), and Sowls et al. (1978). Gabrielson and Lincoln summarized all previously published and unpublished material on Alaskan birds, focusing primarily on their distributions. Shuntov summarized many years of observations on the numbers and distributions of seabirds in relation to the physical and biological structure of the Pacific Ocean. Sanger, using original data and that of Shuntov, estimated the numbers and biomass of birds in various oceanographic domains within the northern North Pacific Ocean and the Bering Sea. Sowls et al. combined all available information on the size and distribution of seabird colonies in Alaska.

Sowl and Bartonek (1974) gave an excellent summary of Alaska's seabird resource particularly, from the viewpoint of management and conflicts with other resources. Recently, Bartonek and Nettleship (1979) assembled a series of papers from the International Symposium on the Conservation of Marine Birds of Northern North America. This series of papers contained a wealth of information on Alaskan seabirds covering such diverse topics as the marine environment of birds, the status of marine bird populations, the biology and ecology of marine birds in the north, conflicts between the conservation of marine birds and uses of other resources, programs and authorities related to marine bird conservation, and conservation of marine birds in other lands.

Substantial information on marine birds was included in regional avifaunas by Bailey (1948), Kuroda (1955, 1960), Murie (1959), Bartonek and Gibson (1972), Isleib and Kessel (1973), Wahl (1978), Forsell and Gould (1981), and Hunt et al. (1981a, 1981b, 1981c). Most important to the present study are those by Kuroda, who related numbers of seabirds to oceanographic conditions in the vicinity of the Kurile and western Aleutian Islands; Bartonek and Gibson, who described summer bird distribution and density in Bristol Bay using data obtained from shipboard surveys; Wahl, who documented the distribution and abundance of seabirds between Japan and Bristol Bay, Alaska, as recorded from a shipboard survey in June and July; and Forsell and Gould, who used density indices from shipboard and aerial surveys to estimate the size of seabird populations wintering in the Kodiak Archipelago. Hunt et al. (1981a) discussed the feeding ecology of seabirds in the eastern Bering Sea; Hunt et al. (1981b) described the biology and distribution of seabirds breeding in the eastern Bering Sea; and Hunt et al. (1981c) documented the distribution and abundance of seabirds in pelagic habitats of the eastern Bering Sea.

Less rigorous treatments of marine birds in local and regional avifaunas have also been provided by Nelson (1883), McGregor (1902), Reichnow (1909), Clark (1910), Laing (1925), and Jaques (1930), all of whom described birds observed and collected in the Bering Sea. Arnold (1948) quantitatively described the relative abundance and distribution of seabirds seen while transiting between Kodiak, Unalaska, and Attu Islands during the summer. Irving et al. (1970) reported the wintering birds seen along the Bering Sea ice. Swartz (1967) and Watson and Divoky (1972) provided data on the distribution of birds during mid to late summer in the Chukchi Sea. Frame (1973) and Watson and Divoky (1975) described the birds in the ice of the western Beaufort Sea during late summer. In addition, unanalyzed data on birds observed in the Bering Sea are irregularly published with the oceanographic and fisheries records of the R/V Osharo Maru of Hokkaido University, Japan.

A number of publications have been devoted to species or species groups. Kuroda (1957) discussed the migration patterns of "Tubinares" in the Pacific Ocean and attempted to correlate these patterns with meteorological conditions. Shuntov (1963) discussed the distribution and abundance of Kittiwakes in the Bering Sea. Kenyon (1950), Shuntov (1968), Robbins and Rice (1974), and Sanger (1974a, 1974b) described the distribution of Black-footed and Laysan Albatrosses in the north Pacific. Sanger (1973) discussed the pelagic distribution of Glaucous-winged and Herring Gulls in the Gulf of Alaska. Nakamura and Tanaka (1977) described the distribution and abundance of Scaled Petrels in the North Pacific Ocean. Shuntov (1964) discussed the trans-equatorial migrations of Slender-billed Shearwaters. Bedard (1969) dealt with the feeding stategies of Least, Crested, and Parakeet Auklets near St. Lawrence Island. Maher (1974) presented a great deal of life history information on jeagers in Alaska.

Dement'ev and Gladkov (1951), Dement'ev et al. (1951, 1952), Palmer (1962), Shuntov (1972), and Bent (1919, 1921, 1922, 1923, 1925, 1926) generalized about the patterns of migration and delineated the breeding and wintering areas for many species of marine birds found in Alaskan waters. References that provide the broadest perspective of worldwide and Pacific Ocean distribution patterns include the following: A.O.U. (1957), Peterson (1961), Alexander (1963), Robbins et al. (1966), Palmer (1962, 1976), Bellrose (1976), and Tuck and Heinzel (1979). Information of the sizes of world and Alaskan populations are likewise scattered throughout the literature or, in most cases, simply not available. Sowls et al. (1978) gave estimates for numbers of colonial seabirds in Alaska, and Bellrose (1976) gave estimates of waterfowl populations in North America.

Intensive and extensive banding efforts provided information on migration routes, survival rates, and harvest problems (King and Lensink 1971, and Bellrose 1976). Radar was used by Flock (1972, 1973) to track birds across and through the Bering Strait and along the Arctic Coast. Accounts of bird migrations, some giving first and last dates of occurrence, were reported by Bailey (1948), Fay and Cade (1959), Gabrielson and Lincoln (1959), and Williamson et al. (1966). Discussions of the migration of birds in Alaskan marine habitats were presented in annual and final reports to the Outer Continental Shelf Environmental Assessment Program (OCSEAP) by Lensink and Bartonek (1976a), and Gill et al. (1979).

Few investigators were able or willing to estimate numbers of seabirds even for the specific areas of their research. The few that did so generally presented estimates in the form of densities for surveyed areas, relative abundances, or simply educated guesses. However, Shuntov (1972) estimated that at-sea populations in the Bering Sea numbered 4.2 million birds in winter and 23.8 million in summer. Isleib and Kessel (1973) listed about 80 species of seabirds for the northern coast of the Gulf of Alaska and Prince William Sound region; they indicated that 6 of these species probably attain populations of over 1 million each during the course of a year, although not all are present at any one time. Eleven other species probably number 1,000,000 or more. Sanger (1972a) provided estimates of at-sea bird populations for surface domains of the North Pacific Ocean. For the total area north of 40°N, excluding waters of the Transitional Domain, he gave estimates of a winter population of 6.4 million birds and a summer population of 49.4 million birds. Wahl (1978) indicated generally higher densities than either Shuntov or Sanger but did not provide estimates of population size. Sowls et al. (1978) gave a figure of 40.3 million birds for 28 species associated with seabird colonies in Alaska.

## UNPUBLISHED ACCOUNTS

Unpublished reports and unanalyzed data exist for birds in

Alaskan marine waters, but they are not readily available to all potential users. Considerable information on bird densities in Prince William Sound during four seasons of the year was obtained by U.S. Fish and Wildlife Service personnel from 1973 through 1975, but the death of Larry Haddock, principal investigator, has delayed the interpretation and analysis of those data. King and McKnight (1969) and Montgomery (1972) reported bird densities in Bristol Bay during a fall and spring, respectively. King et al. (1974) provided quantitative assessments of the birds in the eastern Bering Sea in fall and winter and in the Gulf of Alaska in summer. Trapp (1975) reported bird densities in summer throughout the Aleutian Island chain, and these investigations have been continued to the present by the staff of the Aleutian Islands National Wildlife Refuge. Divoky (1972) described the birds of late summer in the Chukchi Sea. Bartels (1971, 1973) described bird populations seen from shipboard and during aerial surveys in summer in the Beaufort Sea.

Files of the U.S. Fish and Wildlife Service in Anchorage, Alaska, contain extensive data and reports on marine birds in Alaskan waters. These data were, for the most part, collected under contracts from the OCSEAP Program and summarized in annual reports by Lensink and Bartonek (1975, 1976b), Lensink et al. (1976), Gould (1977a), Harrison (1977), and Gould et al. (1978). Studies of the distribution and abundance of marine birds in Alaskan waters were also conducted by other OCSEAP investigators and summarized in annual or final reports, include the following: Arneson (1976, 1977, 1978), Divoky (1976, 1977, 1978a, 1978b), Guzman (1976), Hunt (1976, 1977, 1978), Myres and Guzman (1977), Schamel (1976), Wiens (1976, 1977), and Wiens et al. (1978).

## STUDY AREA

We have conducted surveys of marine birds in the North Pacific from California, Hawaii, and Japan north into the Arctic Ocean, although most of our effort has been over the continental shelf of the Gulf of Alaska and southeastern Bering Sea. In this report, we consider only the data collected in the Gulf of Alaska and Bering Sea as illustrated in Figures 1 and 2. The marine environment in this region covers over 3.2 million $km^2$ of surface area (Tables 1-2), and borders about 57,500 km of tidal coastline. About 53% of the marine surface area is over depths greater than 2,000 m (Oceanic Habitat), 12% is over depths of 200-2,000 m (Shelfbreak Habitat), 31% is over depths of less than 200 m and outside the headlands of bays and fjords (Continental Shelf Habitat), and 4% is within inlets with well-defined headlands (Bay and Fjord Habitat).

## ENVIRONMENTAL FACTORS

The distribution and abundance of birds at sea is influenced by many interrelated factors that operate directly by influencing the bird's behavior or indirectly by affecting the bird's food supply. The positive relation between seabirds and the physical character of the ocean was clearly demonstrated by Murphy (1936), and has been supported by many subsequent authors, including Kuroda (1955), Bourne (1963), Bailey (1966), Ingham and Mahnken (1966), Ashmole and Ashmole (1967), Gould (1971), Brown et al. (1975a), Joiris (1978), and Pocklington (1979). The emphasis in most of these papers is on the relation of seabirds to available food. Kuroda, Gould, Brown et al., Joiris, and Pocklington also attempted to relate seabird distribution directly to surface water conditions. The effect of meteorological conditions on seabird distribution patterns was discussed by a number of authors, especially Kuroda (1957) and Manikowski (1971). The features of the Alaskan marine environment that most obviously affect the pelagic distribution and abundance of seabirds are ice cover, proximity to breeding colonies, extent of continental shelf, circulation patterns (including currents, fronts, etc.), and biological productivity.

### Ice Cover

Ice is a dominant feature of the Arctic Ocean and Bering Sea, but freeze-up and breakup are highly variable, depending on temperature and wind conditions. Breakup at Point Barrow may occur as early as mid-June or as late as late August, and freeze-up may occur from early September to late November. Generally, the sea ice reaches its southern limit in February and March, when it extends along the edge of the Bering Sea continental shelf into Bristol Bay; however, the time and location vary considerably from year to year. For example, Alexander and Cooney (1979) found the southern limit in 1975 to be 18-83 km south of the Pribilof Islands and to cover most of Bristol Bay, whereas in 1978 it was 333 km north of the Pribilofs and penetrated only the northernmost edge of Bristol Bay.

Ice cover has a direct negative affect on the distribution and abundance of seabirds by restricting the available water surface. Ice scour may also reduce the abundance of prey in nearshore areas. Poor productivity of water beneath ice is offset in spring by a bloom of micro-algae that occurs in the ice. As the ice melts, the algae attract zooplankton which in turn attract larger predators. This sequence results in high densities of seabirds and mammals along the ice front (McRoy and Goering 1974; Fay 1974; Cooney 1976; Divoky 1977, 1981).

### Breeding Colonies

Sowls et al. (1978), who summarized the distribution of seabird colonies in Alaska (Figure 3), showed that large numbers of breeding colonies are present along the southern coast of the Alaska Peninsula and throughout the Aleutian Islands; fewer, but usually large, colonies occur in southeastern Alaska, the Bering Sea, and the Chukchi Sea.

Most marine birds are highly mobile, and foraging expeditions often cover large areas--particularly for species that forage over

Table 1. Surface areas ($km^2$) of Alaskan waters by habitat.[a]

| Geographic Regions | Bays and Fjords | Shelf 0-200 m | Shelfbreak 200-2,000 m | Oceanic 2,000 + m | Total |
|---|---|---|---|---|---|
| ARCTIC OCEAN: North to 73°N, South to 66°N, East to Demarcation Point, West to US-USSR Convention Line | 16,306 | 253,682 | 25,865 | 72,896 | 368,749 |
| BERING SEA: North to 66°N, West to 171°W or the US-USSR Convention Line, South to the Aleutian Islands | 35,921 | 523,232 | 248,242 | 648,341 | 1,455,736 |
| GULF OF ALASKA: South to 52°N, West to 165°W, East to 132°W. | 64,008 | 217,906 | 100,493 | 1,024,587 | 1,406,994 |
| TOTAL: | 116,235 | 994,820 | 374,600 | 1,745,824 | 3,231,479 |

[a] Surface areas derived by planimeter from NOAA National Ocean Survey Charts

Table 2. Surface areas ($km^2$) of selected geographical regions by habitat.[a]

| Geographic Area | Bays and Fjords | Shelf 0-200 m | Shelfbreak 200-2,000 m | Oceanic 2,000 + m | Total |
|---|---|---|---|---|---|
| BEAUFORT SEA: North to 73°N, East to Demarcation Point, West to Point Barrow | 4,428 | 42,470 | 25,865 | 72,896 | 145,659 |
| CHUKCHI SEA: North to 73°N, East to Point Barrow, South to 66°N, West to US-USSR Convention Line | 11,878 | 211,212 | 0 | 0 | 223,090 |
| ALEUTIAN ISLANDS: West to 171°40'E, East to 164°43'W, North and South to 2,000 m. | 4,150 | 49,463 | 106,049 | 0 | 159,662 |
| COOK INLET: South to 59°N, West to 151°W. | 2,772 | 16,305 | 0 | 0 | 19,077 |
| BARREN ISLANDS: South to 59°40'N, North to 59°N, East to 150#W, West to Land | 0 | 7,339 | 0 | 0 | 7,339 |
| SHELIKOF STRAIT: North to 58°40'N, South to 57°N, West to 156°W, East to Land | 2,128 | 7,046 | 6,645 | 0 | 15,819 |
| KODIAK: North to 58°40'N, East to 150°W, West to 156°W excluding Shelikof Strait, South to 56°N x 150-151°W and 55°40'N x 151-152°W and 55°N x 152-156°W. | 3,638 | 43,291 | 17,653 | 29,456 | 94,038 |
| PRINCE WILLIAM SOUND: | 8,804 | 0 | 0 | 0 | 8,804 |
| NORTHEAST GULF OF ALASKA: South to 58°N, East to 138°W, West to 147°W, North to Land. | 2,591 | 31,591 | 14,327 | 53,689 | 102,198 |

a Surface areas derived by planimeter from NOAA National Ocean Survey Charts.

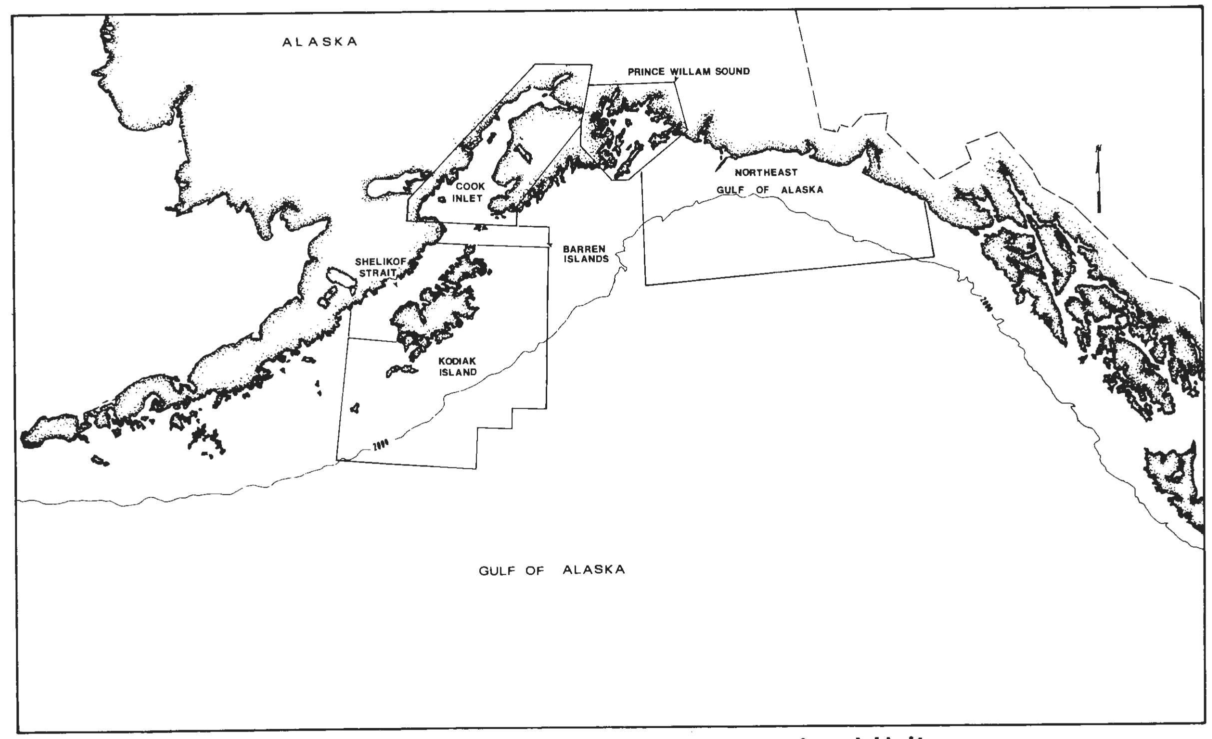



**Figure 1. Gulf of Alaska and Selected Regional Units.**

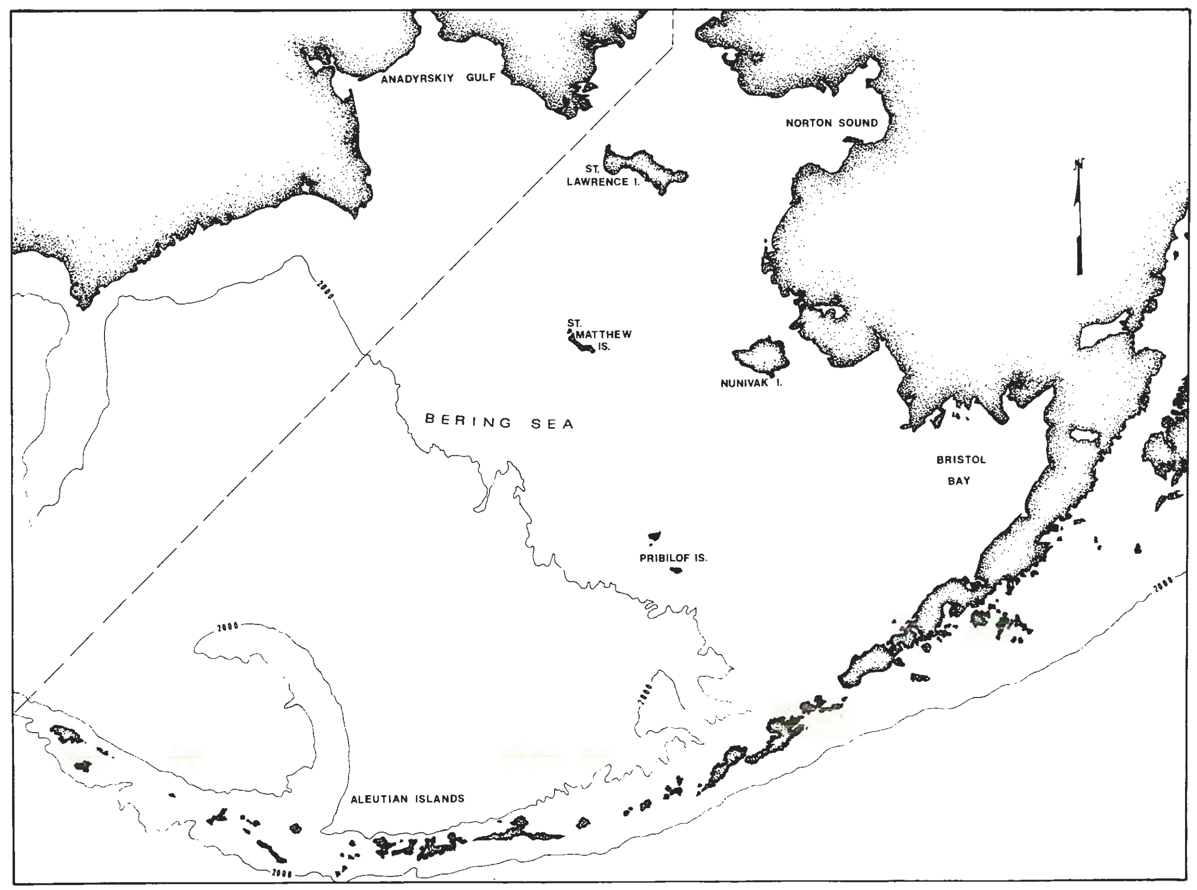



**Figure 2. Bering Sea.**

offshore waters. During summer, however, the location of nesting sites has a direct effect on the pelagic distribution of breeding birds. The need for the birds to return to nest sites at regular intervals places limits on the areas where birds can forage and to some extent on the choice of roosting areas for subadults. Conversely, the suitability of a site for breeding may be determined by its nearness to adequate foraging habitat.

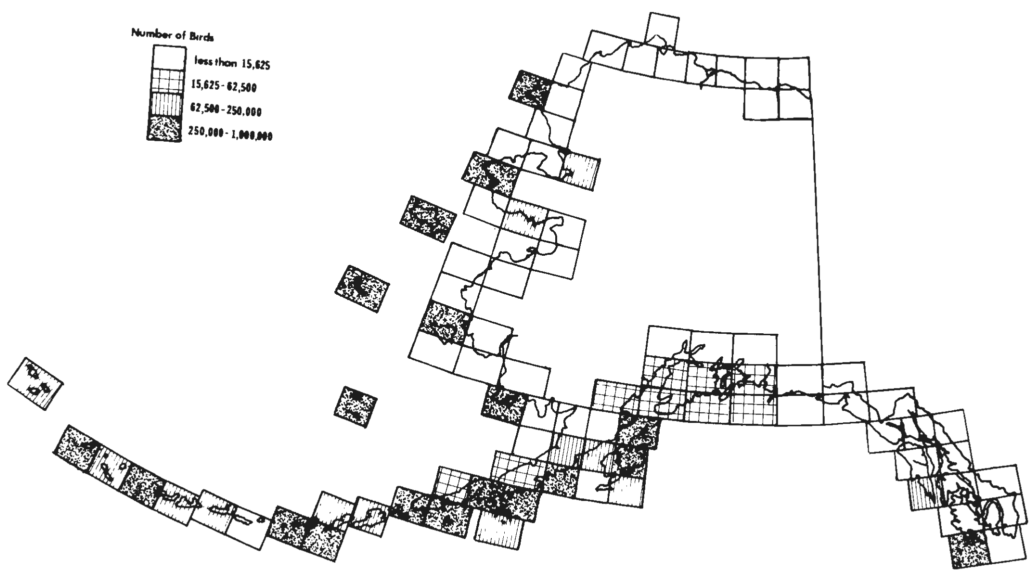



Figure 3. Distribution of seabird breeding colonies in Alaska.

## Continental Shelf

One of the most notable features of the Alaskan marine ecosystem is the continental shelf, which covers nearly 1 million $km^2$ of surface area; half of this area is in the Bering Sea, and one-quarter each in the Arctic Ocean and the Gulf of Alaska. The shelf varies in maximum width from about 50 km in the southeast, to 100 km in the eastern Gulf of Alaska and Beaufort Sea, to 180 km south of the Alaska Peninsula, and to upwards of 550 km in the Bering Sea. The Chukchi Sea has no depths greater than 200 m.

Many seabirds are dependent, to varying degrees, on Alaska's continental shelf; Sooty and Short-tailed Shearwaters are the most notable examples. Areas of entrained water, the slopes between troughs and banks, the shelfbreak-continental shelf boundary, and protected areas near islands and coastlines appear to be especially important. Forsell and Gould (1981) suggested that continental shelf habitat is improved if well-sheltered bays and fjords are nearby to allow seabirds to escape severe storms.

## Current Systems

The pattern of water flow through marine ecosystems is probably the major environmental factor affecting the distribution and abundance of seabirds in Alaska. The dominant feature of the circulation pattern in Alaskan waters is the Alaska Current System, which is formed by the northward deflection of the Subarctic Current System at about 50°N in the eastern North Pacific. This system converges at the head of the Gulf of Alaska, where it turns southwest to flow south of the Alaska Peninsula and Aleutian Islands. Part of this flow is deflected south to form the Alaskan Gyre. Exchanges with Bering Sea water occur primarily as tidal currents at various openings in the Aleutian Island chain, notably at Unimak, Amukta, Amchitka, Buldir, and Near Island Passes. Tidal surges through these shallow passes and straits produce rip tides that provide extremely important foraging areas for many species of seabirds. The Subarctic Boundary, at about 40°N - 42°N, represents a zoogeographic border between subtropical and subarctic avifaunas (Gould 1977b) and, as such, defines the southern limits of the Alaskan seabird community, even though many Alaskan species migrate farther south in the northern winter. Favorite et al. (1976a) provided an excellent description of the oceanography of the Subarctic Pacific Region.

The Bering Current System is complex and difficult to separate entirely from other current systems. It is generally cyclonic, the water flowing eastward along the north side of the Aleutian Islands, northward in the eastern portion, and southward in the western portion. Three gyres have been assumed to occupy the surface layer, one each over the eastern shelf, central basin, and western basin (Favorite et al. 1976a). A system of fronts has recently been described for the southeastern Bering Sea (Coachman and Charnell 1977, Kinder and Coachman 1978, Coachman and Charnell 1979, and Schumacher et al. 1979). Iverson et al. (1981) and Hunt et al. (1981c) presented data suggesting that these fronts play a significant role in the distribution and density of marine organisms over the continental shelf.

## Biological Productivity

Marine waters in Alaska are extremely productive, as evidenced not only by their large bird and mammal populations, but also by their support of a large, multi-national fishing industry, which harvests over 2 million metric tons of fish and shellfish each year (Ronholt et al. 1978, North Pacific Fishery Management Council 1979, State of Alaska commercial fisheries statistics, prepared annually). These large stocks of consumers are supported by a generally high primary productivity, which is in turn supported by such classical features as extensive inflow of river and lagoon systems into marine waters, large spring phytoplankton blooms in open waters, and upwelling over large areas of continental shelf and along vast stretches of structurally complicated coastlines. High productivity in the Bering Sea is further complicated by a unique pattern of blooms of ice algae along a seasonally advancing and retreating ice edge (McRoy and Goering 1975).

The diet of Alaskan seabirds includes a wide variety of vertebrates and invertebrates, but only a few forms have been identified as being particularly important (G.A. Sanger, USFWS, personal communication, Hunt et al. 1981a). In pelagic waters, the most important prey items of seabirds include Arctic cod (*Boreogadus saida*), walleye pollock (*Theragra chalcogramma*), euphasiids, calanoid copepods, capelin (*Mallotus villosus*), Pacific sand lance (*Ammodytes hexapterus*), Pacific sand fish (*Trichodon trichodon*), and gonatid squids. For waterfowl in coastal areas, mysids and shellfish such as *Protothaca*, *Mytilus*, and *Spisula* are extremely important food sources.

## SOURCES, METHODS, AND RATIONALE OF DATA COLLECTION

Most shipboard investigators of bird populations have relied on modifications of line-transect methodology and reported their results in terms of relative abundance, supplemented with anecdotal information (e.g., Wynne-Edwards 1935, King and Pyle 1957, Kuroda 1960, King 1970, Shuntov 1972, Gould 1974, Brown et al., 1975b). Bailey and Bourne (1972) discussed the problems involved in counting birds at sea and pleaded for standardization of techniques. In particular, they stressed the need to use observation methods that are adaptable to widely varying situations and are amenable to analyses that can be compared with those used in other studies. In this regard they suggested the use of 10- to 15-minute transects that can be analyzed separately or combined depending on local density and distribution patterns. Wiens et al. (1978) analyzed in some detail the problems of detectablity and determining densities of birds at sea, and suggested techniques that allow for greater control of specific bias-producing factors such as flying birds and determination of distances at which birds are observed. However, the effort needed to meaningfully reduce the entire suite of biases inherent in transect surveys of seabirds seriously reduces the cost-effectiveness of the surveys--especially if information other than density is also being sought.

We know of no published methodology for aerial surveys of birds at sea. Martinson and Kaczynski (1967) discussed aerial surveys of terrestrial waterfowl populations and provided ratios of air-to-ground observation that could be used as correction factors. They found that the species composition of waterfowl observed in aerial surveys was biased because some species were more conspicuous than others. Such biases are probably no less a problem in the marine environment. Although there is no vegetation to obscure sea-birds, there are numerous differences in size, color, and behavior that affect the visibility of individual species. For example, small species and those that dive at the sound of an airplane are systematically underestimated. Numerous papers have addressed the problems of censusing mammals by aerial methods, and many of the conclusions are valid for marine bird work. Caughley (1974) concluded that, in aerial censuses of terrestrial mammals, the observer misses a significant number of animals on the transect and accuracy deteriorates progressively with increasing width of the transect, cruising speed, and altitude. LeResche and Rausch (1974) found that accuracy in counts of moose (*Alces alces*) were significantly affected by observer experience, by the number of observers, and by terrain. They also found that experienced observers had internally consistent counts. Pennycuick and Western (1972) concluded, in an aerial sampling of populations of large-mammals that flight at low altitudes and confinement of observation to narrow strips gave the largest estimates of numbers. Leatherwood and Platter (1975), who censused marine mammal populations, concluded that a strip census is superior to a line transect or random block design as long as a method of estimating transect width is available. An excellent review of the available techniques and associated problems for censusing marine mammals was published by Eberhardt et al. (1979). Much of their discussion is also applicable to the censusing of seabirds.

Our methods were designed and conducted to accumulate the maximum possible amount of information on the distribution and abundance of marine birds, within realistic time, money, logistics, and enviromental constraints. Of primary importance was the establishment of a standardized system that was easy to use and that provided consistent results. The basis of our surveys is a short strip census (Kendeigh 1944) with a width of 300 m from ships and 50 m from aircraft. In particular, our efforts have been directed toward deriving indices of density from short, simple, and easily reproduced transects. These indices, although they are not "beak counts," are consistent within the data base and provide accurate baseline data needed to define and interpret fluctuations in the size and distribution of populations both within and between areas and time periods. The indices also allow, as reasonably as any other method, a prediction of population size that, depending on sample size, is adequate for most environmental assessment needs. Several special procedures were incorporated into our census techniques to provide flexibility in data analysis and to improve the accuracy of density estimates:

- the use of both ship and aircraft as platforms
- the use of five, standardized and coded, experimental designs
- the incorporation of all observations of birds outside the census area into the data base
- instantaneous counts of flying birds
- a forward scan to the projected end of the transect
- the use of a range finder to determine census boundaries

The use of a 300-m width for shipboard surveys and two 50-m widths for aerial surveys is a compromise between effective use of survey time in high density areas and adequate detection distance for different species. The complete detection, within 300 m, of small or inconspicuous birds such as storm-petrels, small alcids, or dark birds on the water is not possible, but our concentration on only the 300 m area and the lengthened forward scan reduce this bias. Also, several of the small species, such as phalaropes, frequently form large flocks which increases their detectability. In general, our indices of density for small and inconspicuous birds are substantially lower than actual numbers and are so treated in our discussions.

One of the most functional values of our techniques is the reduced necessity for determining distances. We need accurate measurements for only one distance, i.e., 300 m. Range finders are only moderately accurate under most pelagic conditions and cannot be used when the horizon is obscured. Using the range finder for each sighting results in the loss of valuable time needed to search for and record other individuals. Our techniques allow us to conduct transects in both open ocean and bay situations with little loss in uniformity. This ability is of the utmost importance in evaluation of habitat preferences and general distribution patterns.

Aerial surveys are most cost-effective in covering large geographic areas in a short period of time, and we have generally restricted their use to this purpose. The rapidity with which specific areas are covered, however, seriously reduces the observer's time to detect individual birds. This is one reason why widths of aerial transects were restricted to 50 m. The speed of passage and reduced observation zone also decrease the chances of detecting uncommon species and reduce the observer's ability to identify individual birds. Shipboard surveys, on the other hand, were most effective for assessing short-term and local fluctuations in populations and resulted in more observations of uncommon species, and the identification of a higher proportion of individual species. The use of both ship and fixed-wing aircraft in our surveys allowed us to interpret abundance and distribution patterns from two perspectives, and thus increased the reliability of our final assessments. However, except for the perspective obtained by comparing the two census methods and the probable difference in bias each introduces to our sample, we have no satisfactory estimate of the relation of our indices to the actual population of any species.

## SHIPBOARD CENSUS

Shipboard surveys were conducted from a wide variety of vessels ranging in length from about 5 to over 90 m. In 1975-1976, and occasionally 1977-1978, we used research vessels of the National Oceanic and Atmospheric Administration (NOAA), especially the Research Vessels Diccoverer, Surveyor, Miller Freeman, and the Moana Wave chartered by NOAA from the University of Hawaii. Inasmuch as these vessels were principally occupied in collecting oceanographic data, and sampling marine fisheries and marine mammals, the ornithologists were aboard on a secondary basis and had only limited opportunity to stipulate cruise tracks and survey periods. Our data were thus usually collected on an opportunistic basis, and we were seldom able to repeat cruise tracks or make extended observations in any one area. These vessels were over the continental shelf most of the time; consequently our early data contain little information from nearshore habitats. Oceanic areas (> 2,000 m) were visited only occasionally, usually when ships were in transit between ports.

In 1977 we used the YANKEE CLIPPER, an 18 m vessel with a Westport, semi-planing hull. From this ship we made extensive observations from May to August in bays and inner shelf habitats south of Kodiak Island. In 1978 we conducted surveys in bays and inner shelf areas of Kodiak Island with the 20 m Research Vessel COMMANDO as part of a cooperative, multi-disciplinary study of marine food webs. Throughout the study we used a number of other vessels, including U. S. Coast Guard ships, fishing vessels, luxury liners, and a variety of small boats.

### Transect Censuses

In theory, we would like to get an instantaneous count of birds within the transect zone. Actually, our strip censuses are based on a 10- or 15-minute (temporal) cruising time. The ship must be moving along a straight path at a constant speed (usually 8-11 knots). From 1975 through May 1976, the observer counted all birds seen forward of mid-ship and laterally on one side out to 300 m, and the duration of most transects was 15 minutes. In May 1976 the forward scan was extended to the projected end of the transect (maximum of 3,000 m at 10 knots) and most transects were reduced to 10 minutes. The extended forward scan increases the detection of birds which may leave the area or dive before the ship reaches them. Forward scans are especially important when one is counting ship-avoiding species. Birds observed beyond the transect boundary, and those following the ship, were recorded separately and were not used in calculating indexes of density.

Flying birds present a special problem. If the observer counted all the individuals flying through the transect zone, estimates of densities would be greatly exaggerated. In June 1976 we began using two techniques to reduce this sort of bias:

1. Periodic "instantaneous" counts were made of flying birds within a discrete portion of the transect area. The number of such counts depended on the lengths of transects and the distance birds could be seen and identified. Individual counts were added to the number of birds observed within the transect area by using standard procedures. For example: on a 10-minute transect at a speed of 10 knots the ship covered 3,087 m. We made three instant counts, one each at 3-minute intervals beginning at the start of the transect, using an area 1,000 by 300 m. These three counts were

then added together to produce the number of flying birds in the census area. We used two counts at 7 knots, four counts at 13 knots, and five counts at 16 knots. Care must be taken to avoid counting the same birds twice.

2. In situations in which extremely large numbers of birds streamed across the bow of the ship, which made instantaneous counts unfeasible, the number of birds crossing per minute within a specific distance (1,000 m for shearwaters, 500 m for storm petrels) were counted. Three to five counts were made during the course of one 10-minute transect. The average time it took for one bird to cross the 300-m zone was also measured. These two pieces of data were used to estimate the total number of flying birds present at any one time within the transect area. This technique was not used in our surveys until mid 1976.

The timing and number of transects on each day of a cruise depended on the ship's and observer's routine and on the weather. During this study we used three basic strategies: single transects taken at random or at specific time intervals; a series of 3-6 tandem transects taken at random or at specific time intervals; and continuous transects throughout the day. The last of these approaches was preferred but required that at least two observers spell each other to avoid fatigue or ennui. Most of our data from Kodiak Island in 1977, but few of the remaining data in the data base, were collected by continuous transects.

Distances were determined where possible by using the range finder developed by Dennis Heinemann (Heinemann 1981). In bays, estimates were made by observers who had used the range finder under good conditions and had verified their ability to judge distances.

### Census of Ship-Followers

Special surveys were occasionally taken to develop an index of the abundance of ship-followers. The observer began the survey by making several complete circuits of the ship, noting behavior patterns of individual birds; he or she then stood at the most effective vantage point, preferably one that gave a 360-degree view of the surrounding waters, or the best view of birds behind the ship. After 5 minutes, the maximum number of individuals per species observed at any one time around the ship was recorded.

### Station Censuses

Stations consisted of counts taken from a fixed point, usually from ships stopped for oceanographic sampling. The survey area was divided into four concentric zones with the platform at the center. The first three zones were each 200 m wide, and the fourth extended to the horizon. All birds were counted within each zone by making as rapid a circular sweep of the entire (360°) area as was consistent with accurate detection and counting of birds within the area. Only one sweep was made per survey. The length of time the platform had been stationary was usually recorded for each survey, since the numbers of birds usually continue to increase for a long period after the platform has stopped. Our data base, however, is inconsistent in this respect. Surveys were often repeated at regular intervals for as long as the ship remained in a fixed position. We have used these censuses to document distribution, but not to determine density.

### General Observations

A variety of non-standard incidental observations were recorded and maintained within this data base. Among these were aborted transects and those that diverged from established procedures.

### Collection of Specimens

We occasionally collected specimens as an aid to identification, but more frequently to obtain the stomach contents for studies of food habits. Such collections also provided information on sex ratios, age class structures, and breeding condition of birds occupying the sampling area.

## AERIAL CENSUSES

Aerial surveys were conducted from a Lockheed P2V ("Neptune") until August 1976 and then from a Grumman Turbo-goose modified to provide improved safety, range, and forward and lateral visibility for over-water surveys. Both aircraft were equipped with a GNS 500, Global VLF Navigation System (Karant 1976), which provided a continuous readout of latitude and longitude and was capable of locating tracklines within 200 m of accuracy.

### Transect censuses

Surveys followed lines of latitude and longitude whenever possible and were selected to maximize the ratio of hours of actual survey time to the total hours of flying time. All observations were recorded by transect segments encompassing 1 minute of latitude for north-south censuses or 5 minutes of longitude for east-west censuses and summarized by 10 minutes of latitude and longitude. Surveys were flown at a speed of 200-225 km/hr and at a height of 30-55 m. Counts were made of birds in strips 50 m wide on each side of the plane and the data were combined to produce one 100-m transect. Widths were determined by use of a clinometer, the aircraft altitude, and elementary trigonometric functions.

Three biologists were required for the surveys. One sat on each side of the plane and conducted observations. The third recorded these observations, monitored the GNS 500, and recorded positions at appropriate intervals. About every 30 minutes (temporal) the biologists changed assignments, to avoid aerial hypnosis and to allow one of the three to ease eyestrain by recording data and monitoring the GNS 500, a less demanding task.

## General Observations

Incidental or non-standard data of general interest were recorded and maintained within the data base. Aborted transects or those that diverged from established standards were also maintained under this category.

## METHODS AND RATIONALE FOR DATA ANALYSIS

The present report represents our first series of analyses that describe the broad pattern of distribution and abundance displayed by seabirds in the Gulf of Alaska and Bering Sea. A proper interpretation of this information is contingent on a firm understanding of the original data base (Appendix A) and on the software used to manipulate it. The analyses of digital data hinge on a number of key data fields depending on the type of product and level of precision required. The following discussions direct the user to the key elements necessary for analyzing our data and interpreting the results.

### Platform Type

We have used four basic types of platforms for our surveys: fixed-winged aircraft, small and large ships, and outboard motorboats. Data obtained from each platform type are best analyzed and interpreted separately because of the differences in observational bias inherent in each. For practical reasons, however, we have combined all small- and large-ship surveys, and have used outboard motorboat surveys only for qualitative analyses. Thus, for each season or habitat we derived two density indices, one for shipboard and one for aerial surveys.

### Survey Type

We used five major experimental designs: transects, ship-follower surveys, station surveys, coastline surveys, and general observations. Transects formed, by far the largest and most important part of our overall data base, and indexes of density were derived only from this type of survey. The remaining four experimental designs were used primarily to provide qualitative supplemental information on occurrence, and to some extent relative abundance, for areas (e.g., nearshore), situations (e.g., stationary platforms), and species (e.g., ship-followers and rare species), not easily assessed by transect methods.

For analyses involving qualitative information, all survey types may be pooled. For quantitative information, however, each must be analyzed separately. Care must be exercised in deriving density indices or estimates from station, coastline, and ship-follower surveys because such data often contain serious limitations. For example, the number of seabirds around stationary platforms is a function of how long the platform has been at rest, and coastline surveys are taken from platforms that are usually changing speed and direction during the survey. Counts of ship-followers cannot be used for estimates of density, but indices (e.g., maximum number of birds noted at any given time within a specified time period or area) can be determined for dedicated ship-followers such as albatrosses.

### Start Latitude and Longitude

All information associated with a transect or survey is related to the starting position. The location of an individual sighting is thus only as accurate as the distance between the start and end positions. Similarly, if the depth at the beginning of the transect is 100 m and at the end it is 400 m, the birds seen at the end of the transect will be associated only with a 100 m depth. As our transects generally covered between 3.0 and 4.5 km, biases created by associating all data with the starting position are few and for the most part of only minor significance.

### Observation Conditions

In addition to the standard information on weather, sea state, wind, etc., each observer recorded his or her impression, on a scale of 1 to 7, of the combined effect of all factors affecting the ability of that observer to see, identify, and count birds. Censuses were not conducted under inappropriate conditions, and all transects met at least minimal standards. In our analyses, however, we developed indices of density only from the transects that were coded as three (3) or higher, to increase consistency and reliability of pooled data.

### Outside Zone

The development of estimates of density is facilitated by observations on each transect that are as complete as possible within an area of known size. Thus, indices were calculated only on data obtained within transects of known widths, usually our standard widths of 300 m from ships and 50 m from planes. However, observations of birds beyond these boundaries were recorded and provided important supplementary information, particularly on the distribution and size of flocks and the occurrence of rare and uncommon species. Recording of birds beyond the transect boundary permits direct comparison of our data with those of other investigators (e.g., Gould 1974, Brown et al. 1975b) who did not limit the width of transects.

## DATA ANALYSIS

The basic working unit of our data is the TRANSECT, which represents a rectangular patch of water with specific geographical and temporal limits. All data retrieval is keyed to the starting point of a transect, i.e., one corner of that rectangle. The first step in our processing of data was to simplify and restructure the NODC format into a SPECIES TRANSECT RECORD by eliminating unnecessary data fields and retaining only the basic data, by species, for the survey area. At this point the computer also calculates the square kilometers of area covered by each transect and attaches it to the record. Other special editing programs may be used at this point. For example, depth and habitat classification were added to the record if they had not already been provided. Species Transect Records were then divided into selected geographic regions or subregions and stored as separate files. The products from these files include species listings, tables of abundance by season and habitat, and graphs or tables of Density Indices, as described below by 20' latitude and 30' longitude blocks.

Our primary analysis consisted of calculating the NUMBER OF BIRDS OBSERVED PER SQUARE KILOMETER OF OCEAN SURFACE ($B/km^2$). We have used two basically different methods of calculating this value from the same set of data and the calculated values are frequently different one from the other.

Density Indices or Transect Densities

Density indices are obtained by calculating the number of $birds/km^2$ for each transect, adding these together, and then dividing by the number of transects. The resulting index thus represents the mean of individual transect densities with each transect weighted equally, regardless of the area it covered. These density indices can provide year-to-year comparisons of populations and allow monitoring of local or regional patterns of distribution. Density indices have been calculated as described for "total birds" as well as for 16 major species or species groups of marine birds. These indices, along with tables of "highest single transect densities" which provide a range of values for each index, are presented in Appendices C and D for the Gulf of Alaska and Bering Sea, respectively. We have not attempted correction or adjustment for biases resulting from differences in observers or the detectability of species.

The variation in numbers of birds from one transect to the next, even within similar areas and dates, can be very high, reflecting the frequently clumped distributions and high mobility of marine birds. Sooty and Short-tailed Shearwaters and Northern Fulmars are prime examples. Indices for any given area may change from 0 to 1,000 $B/km^2$ in a matter of hours. For marine bird species, the pattern of occurrences of high and low densities typically does not conform to a statistically normal distribution. Indeed, the pattern is usually bimodal with a large number of 0 $B/km^2$ transects and a large number of moderate density transects located within a wide range of values. For the less common species, the curve may have only a single peak, but this is skewed to the far right by large numbers of 0 $B/km^2$ transects. Due to this highly skewed and variable distribution, strict comparison of means should be done with caution. Confidence intervals around mean densities were calculated (1.645 x standard error), but should be interpreted in terms of levels of biological significance which we define in the following manner:

| 1.645 x Standard Error Expressed as Percent of $\bar{X}$ | Our Interpretation of its Biological Significance for Density Indices |
|---|---|
| >100 % | Inadequate. $\bar{X}$ could change drastically with larger sample size or replicate sampling. |
| 75-99 % | Low. Barely adequate and subject to much change with increasing sample size or replicate sampling. |
| 50-74 % | Moderate. Adequate but somewhat risky for predictive purposes. |
| 25-49 % | High. We accept these data with only minor reservations. |
| 1-24 % | Very High. We feel this represents an accurate picture of the local density. |

Density indices have also been calculated by blocks of 20' of latitude x 30' of longitude. These are presented on seasonal maps for the Gulf of Alaska and Bering Sea. For these maps, densities are rounded to the nearest whole number and all densities of less than 0.5 $B/km^2$ are recorded as "+". We have also used a "+" to indicate that the species was observed off-transect or during general observations. A "+" thus means that the species occurred in relatively small numbers, but that our sampling was not adequate for calculating a reliable index to the size of its population.

Relative Density

We found that a complete and separate computer analysis of each taxon, especially for species which were uncommon or difficult to detect, was neither practical nor warranted. We did, however, calculate for each taxon its relative abundance and the percent which it constituted of the total birds observed; we then related this percentage to the appropriate density index of "total birds" (see Appendix Tables C 17 and D 17). The relative density of a taxon, i.e., its relative abundance times the density index of "total birds," is not equivalent to the density index of that taxon because it is derived from total birds rather than from means of transects. In our data, the difference between the values of relative density and the density index for any given taxon is usually on the order of 10 percent or less, but may occasionally be greater than 20 percent.

Population Index

Both density indices and relative densities have been used to provide an indication of the sizes of populations. This "population index" is obtained merely by multiplying either the density index or the relative density by the total area in square kilometers of any geographic region of concern. Its reliability as an index, like the reliability of density as an index, rests primarily on the number and distribution of our transects (samples) within the region. The "population index" is not a population estimate, as it is uncorrected for known biases such as our failure to observe all birds occurring in transect areas. For some highly visible species the population index may closely approximate the actual size of populations, but for others--for example the small alcids--the index may be much smaller than the population. Nevertheless, either the population index or the density index from which it is derived provides a means for developing relatively unbiased estimates of temporal or geographic differences in population sizes, and is useful as a basis for making subjective estimates of the numbers of birds within a region.

Frequency of Occurrence

As a subprogram in our calculation of density indices, we obtained Frequencies of Occurrence for Total Birds and the 16 major species and species groups (see Appendices C and D), by dividing the number of transects on which a taxon was observed by the total number of transects completed. The frequency of occurrence, although relatively insensitive to moderate changes in density, proves a useful measure of the dispersion of a taxon throughout a region. Because the chance for the occurrence of a bird on a transect is proportional to the area covered by the transect, our samples may be slightly biased by variation in the areas of our transects. But since this variation was largely random, any bias that occurs is probably irrelevant to our evaluation of distribution patterns.

NORTHERN FULMAR. PHOTO BY ANTHONY R. DEGANGE

## DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS IN THE GULF OF ALASKA

Sixty-five species of marine birds were seen during our surveys of the Gulf of Alaska, some 76 % of the total recorded in the literature for the state. Our surveys of the Gulf included about 5,500 shipboard and 1,900 aerial transects covering more than 6,900 and 2,700 km$^2$ of ocean, respectively (see Appendices C1-C4, and Maps 1-8). Nearly 44 % of our shipboard observations were conducted in May, June, and July, and about 47 % of our aerial surveys in March or April. Only 5 or 6 % of either ship or air surveys were conducted during the winter (Table 3).

Table 3. Percent of total surveys conducted during different months in the Gulf of Alaska, 1975-1978.

| Month | Type of Survey: Shipboard Transects | Shipboard Stations | Aerial Transects |
|---|---|---|---|
| January | 0.9 | 0.3 | 4.9 |
| February | 4.6 | 4.4 | 0.3 |
| March | 8.3 | 26.6 | 31.3 |
| April | 9.1 | 22.7 | 15.4 |
| May | 15.3 | 6.5 | 8.8 |
| June | 15.3 | 8.0 | 19.2 |
| July | 13.2 | 5.3 | 6.2 |
| August | 9.0 | 2.4 | 1.3 |
| September | 11.6 | 12.8 | 0.0 |
| October | 5.9 | 6.7 | 12.9 |
| November | 6.4 | 3.9 | 0.0 |
| December | 0.5 | 0.4 | 0.0 |

The following species accounts contain summaries and highlights of these observations and draw freely from other information sources, including Gabrielson and Lincoln (1959), Isleib and Kessel (1973), Kessel and Gibson (1978), Sowls et al. (1978) and Forsell and Gould (1981), as well as the personal observations of the authors. Density indices and frequencies of occurrence for seasons and habitats for total birds and the 16 most abundant species and species groups within the Gulf of Alaska, as well as in the sub-regions of Kodiak and the Northeast Gulf, are provided in Appendix C. Maps 9-197 show the seasonal distribution and abundance of 12 important marine bird species or species groups. The occurrence and relative densities of all avian taxa identified in our surveys are presented by season and habitat in Tables 4-7.

GAVIIDAE

Four species of loons--the Arctic, Common, Red-throated, and Yellow-billed Loon--occur in the Gulf of Alaska. All nest within

Table 4. Percentage of total seabirds seen in spring (March–May) during shipboard and aerial surveys of different habitats in the Gulf of Alaska. Total birds seen (No./Km$^2$) in each habitat and during each type of survey are shown in parentheses.

| Species | Type of Survey, and Habitat | | | | | | |
|---|---|---|---|---|---|---|---|
| | Shipboard | | | | Aerial | | |
| | Bay | Shelf | Shelfbreak | Oceanic | Bay & Shelf | Shelfbreak | Oceanic |
| | (29.0) | (158.2) | (57.2) | (43.8) | (37.7) | (15.4) | (10.5) |
| Common Loon | 0.2 | + | + | 0 | + | 0 | 0 |
| Yellow-billed Loon | + | + | 0 | 0 | 0 | 0 | 0 |
| Arctic Loon | 0.1 | + | + | + | + | 0 | 0 |
| Unidentified Loon | 0.6 | 0.1 | 0.1 | 0 | + | 0 | 0 |
| Red-necked Grebe | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Horned Grebe | + | 0 | 0 | 0 | + | 0 | 0 |
| Unidentified Grebe | 0 | 0 | 0 | 0 | + | 0 | 0 |
| Black-footed Albatross | 0 | + | + | 0.1 | 0 | 0 | + |
| Laysan Albatross | 0 | + | + | + | 0 | 0 | 0 |
| Unidentified Albatross | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Northern Fulmar | + | 1.3 | 57.1 | 3.1 | 8.6 | 10.9 | 9.5 |
| Flesh-footed Shearwater | 0 | + | 0 | 0 | + | + | 0 |
| New Zealand Shearwater | 0 | 0 | 0 | 0 | + | 0 | + |
| Sooty Shearwater | 14.4 | 35.3 | 15.1 | 32.2 | 0 | 0 | 0 |
| Short-tailed Shearwater | 0 | 6.3 | 1.9 | 0.8 | 0 | 0 | 0 |
| Unidentified Shearwater | 0.5 | 39.6 | 9.7 | 45.4 | 33.6 | 15.0 | 3.8 |
| Fork-tailed Storm-Petrel | 0.1 | 0.9 | 0.7 | 3.5 | 4.0 | 15.2 | 14.5 |
| Leach's Storm-Petrel | 0 | + | + | 1.3 | 0 | 0 | 0.1 |
| Unidentified Storm-Petrel | 0 | + | + | 1.3 | + | + | 0.1 |
| Scaled Petrel | 0 | 0 | 0 | + | 0 | 0 | + |
| Double-crested Cormorant | 0 | + | + | 0 | 0 | 0 | 0 |
| Pelagic Cormorant | 0.5 | 0.1 | + | 0 | 0 | 0 | 0 |
| Red-faced Cormorant | 0.1 | + | 0 | 0 | 0.1 | 0 | 0 |
| Unidentified Cormorant | 0.8 | 0.1 | + | 0 | 1.2 | 0 | 0 |
| Unidentified Swan | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Canada Goose | 0.1 | + | 0 | 0 | 0.1 | 0 | 0 |
| Brant | 1.9 | + | 0 | 0 | 0 | 0 | 0 |
| Greater Scaup | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Scaup | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Barrow's Goldeneye | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Goldeneye | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Oldsquaw | 3.9 | 0.1 | + | 0 | 0.9 | + | 0 |
| Harlequin Duck | 0.3 | 0 | 0 | 0 | 0.2 | 0 | 0 |
| Steller's Eider | + | 0 | 0 | 0 | 0.3 | 0 | 0 |
| Common Eider | + | + | 0 | 0 | 2.2 | 0.1 | 0 |
| King Eider | + | + | 0 | 0 | 0.7 | 0 | 0 |
| Unidentified Eider | 0 | + | 0 | 0 | 0.4 | 0 | 0 |
| White-winged Scoter | 4.1 | 0.4 | 0 | 0 | 1.8 | 0 | 0 |
| Surf Scoter | 0.1 | + | 0 | 0 | 0.1 | 0 | 0 |
| Black Scoter | 0.3 | + | 0 | 0 | 1.3 | 0 | 0 |
| Unidentified Scoter | 0.1 | 0.2 | 0 | 0 | 7.9 | 0 | 0 |
| Red-breasted Merganser | 0.1 | + | 0 | 0 | + | 0 | 0 |
| Unidentified Geese & Ducks | 0.2 | + | + | + | 0.9 | 0 | 0 |
| Red Phalarope | 0 | 0.2 | 0.1 | + | 0 | 0 | 0 |
| Northern Phalarope | 9.9 | 1.0 | 2.3 | 0 | 0.1 | 0 | 0 |
| Unidentified Phalarope | 0.1 | 0.2 | + | 0.2 | 0 | 0.2 | + |
| Pomarine Jaeger | + | + | 0.1 | 0.1 | + | 0 | 0 |
| Parasitic Jaeger | + | + | + | 0.1 | + | 0.1 | 0.1 |
| Long-tailed Jaeger | 0 | + | + | 0 | + | 0 | 0 |
| Skua | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Unidentified Jaeger | + | + | + | 0.1 | + | 0.1 | 0.1 |
| Glaucous Gull | + | + | + | 0.1 | + | 0 | 0 |
| Glaucous-winged Gull | 6.3 | 0.9 | 1.7 | 1.5 | 3.3 | 3.9 | 2.0 |
| Herring Gull | 1.0 | 0.1 | 0.8 | 0.2 | + | 0.1 | 0 |
| Thayer's Gull | 0 | 0 | + | 0 | 0 | 0 | 0 |
| Mew Gull | 1.4 | + | 0 | + | 0.1 | 0 | 0 |
| Bonaparte's Gull | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Black-legged Kittiwake | 7.9 | 1.7 | 3.3 | 6.0 | 4.7 | 26.0 | 20.4 |
| Unidentified Kittiwake | 0.2 | 0.2 | 0.2 | 0.3 | + | 0.3 | 1.1 |
| Sabine's Gull | 0 | + | 0 | 0 | + | 0 | 0 |
| Unidentified Gull | 0.4 | 0.1 | 0.4 | 0.6 | 0.2 | 1.1 | 3.4 |
| Arctic Tern | 1.4 | 0.3 | 0.2 | 0.4 | 0.3 | 0.5 | 0.1 |
| Aleutian Tern | 0.1 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Tern | 0.1 | + | + | 0 | 0 | 0 | 0 |
| Common Murre | 3.2 | 0.5 | 0.6 | + | + | + | + |
| Thick-billed Murre | 0.3 | 0.1 | + | 0.2 | + | + | + |
| Unidentified Murre | 7.3 | 4.7 | 2.9 | 0.5 | 20.2 | 14.2 | 5.0 |
| Pigeon Guillemot | 2.4 | 0.1 | + | 0 | + | 0 | 0 |
| Marbled Murrelet | 1.6 | 0.1 | 0.1 | 0 | 0 | 0 | 0 |
| Kittlitz's Murrelet | 0.1 | + | + | 0 | + | 0 | 0 |
| Unidentified Murrelet | 2.4 | 0.1 | 0.1 | 0 | 0.1 | 0 | 0 |
| Ancient Murrelet | 0.1 | 0.3 | + | 0 | 0.5 | 0.1 | 0 |
| Cassin's Auklet | + | 0.1 | + | + | 0.3 | 0.2 | 0.2 |
| Parakeet Auklet | 0 | + | + | 0 | 0.1 | 0.1 | 0 |
| Crested Auklet | 0 | + | 0 | 0 | 0.6 | 0.8 | 26.1 |
| Least Auklet | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Whiskered Auklet | 0 | 1.8 | 0.3 | 0 | 0 | 0 | 0 |
| Rhinoceros Auklet | 0 | + | + | + | + | + | 0.3 |
| Horned Puffin | 0.4 | 0.1 | 0.1 | 0 | 0.1 | 0.1 | + |
| Tufted Puffin | 19.3 | 2.1 | 0.7 | 1.5 | 1.9 | 3.6 | 2.3 |
| Unidentified Alcid | 4.8 | 0.8 | 0.6 | 0.2 | 1.6 | 6.6 | 9.1 |

Table 5. Percentage of total seabirds in summer (June–August) during shipboard and aerial surveys of different habitats in the Gulf of Alaska. Total birds seen (No./Km$^2$) in each habitat and during each type of survey are shown in parenthesis.

| Species | Type of Survey, and Habitat | | | | | | |
|---|---|---|---|---|---|---|---|
| | Shipboard | | | | Aerial | | |
| | Bay | Shelf | Shelfbreak | Oceanic | Bay & Shelf | Shelfbreak | Oceanic |
| | (56.7) | (134.1) | (55.8) | (14.7) | (64.8) | (10.2) | (2.5) |
| Common Loon | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Arctic Loon | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Red-throated Loon | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Loon | + | + | + | 0 | + | 0 | 0 |
| Black-footed Albatross | 0 | + | 0.2 | 1.2 | + | 0.9 | 0 |
| Laysan Albatross | 0 | + | 0 | + | 0 | 0 | 0 |
| Unidentified Albatross | 0 | 0 | + | 0 | 0 | 0 | 0 |
| Northern Fulmar | 0.3 | 1.9 | 8.8 | 11.4 | 2.4 | 9.5 | 21.4 |
| Flesh-footed Shearwater | 0 | 0 | + | 0 | + | 0.1 | 0 |
| New Zealand Shearwater | 0 | 0 | 0 | + | + | 0.2 | 0.9 |
| Sooty Shearwater | 2.9 | 17.4 | 35.9 | 21.6 | + | + | + |
| Short-tailed Shearwater | 5.0 | 23.2 | 4.6 | 0.3 | + | 0 | 0 |
| Unidentified Shearwater | 14.4 | 36.8 | 13.8 | 31.4 | 67.2 | 10.2 | 7.5 |
| Fork-tailed Storm-Petrel | 1.1 | 1.5 | 7.9 | 8.3 | 6.9 | 15.5 | 25.9 |
| Leach's Storm-Petrel | 0 | 0.1 | 0.6 | 6.9 | 0.1 | 1.3 | 5.1 |
| Unidentified Storm-Petrel | 0 | + | 0.5 | 3.1 | 0.1 | 0.2 | 0.3 |
| Scaled Petrel | 0 | 0 | 0.3 | 3.6 | + | 0.2 | 16.0 |
| Double-crested Cormorant | 0.1 | + | 0 | 0 | 0 | 0 | 0 |
| Pelagic Cormorant | 0.2 | + | 0 | 0 | + | 0 | 0 |
| Red-faced Cormorant | + | + | 0 | 0 | + | 0 | 0 |
| Unidentified Cormorant | 0.6 | 0.1 | + | + | 0.1 | 0 | 0 |
| Canada Goose | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Scaup | 0 | 0 | 0 | 0 | + | 0 | 0 |
| Oldsquaw | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Harlequin Duck | + | 0 | 0 | 0 | + | 0 | 0 |
| White-winged Scoter | 0.1 | 0.5 | 0 | 0 | + | 0 | 0 |
| Surf Scoter | + | + | 0 | 0 | + | 0 | 0 |
| Black Scoter | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 |
| Unidentified Scoter | 0.1 | + | 0 | 0 | + | 0 | 0 |
| Unidentified Geese & Ducks | + | 0 | 0 | 0 | + | 0 | 0 |
| Red Phalarope | 0.1 | 0.2 | 2.0 | 0.1 | + | 0.1 | 0 |
| Northern Phalarope | 2.2 | 0.4 | 0.1 | 0.1 | + | 1.8 | 0 |
| Unidentified Phalarope | 0.5 | 0.2 | 0.2 | 0.1 | 0 | 0.1 | 0 |
| Pomarine Jaeger | 0.2 | 0.2 | 0.1 | 0.3 | + | 0 | 0 |
| Parasitic Jaeger | 0.1 | + | + | 0.2 | + | 0.1 | 0 |
| Long-tailed Jaeger | + | + | 0.1 | 0.1 | 0 | 0 | 0 |
| Skua | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Jaeger | 0.1 | + | 0.1 | 0.6 | + | 0 | 0.6 |
| Glaucous Gull | + | + | + | 0 | + | 0.1 | 0 |
| Glaucous-winged Gull | 3.7 | 0.4 | 0.4 | 0.2 | 2.4 | 0.7 | 0.6 |
| Herring Gull | + | + | 0.1 | + | + | 0 | 0 |
| Mew Gull | + | + | 0 | + | + | 0 | 0 |
| Black-legged Kittiwake | 16.6 | 1.8 | 1.6 | 1.7 | 3.1 | 0.8 | 5.4 |
| Unidentified Kittiwake | 0.4 | 0.4 | 0.6 | 0.8 | 2.8 | 2.4 | 1.8 |
| Sabine's Gull | 0.1 | 0.1 | 0 | 0.1 | + | 0.1 | 0.9 |
| Unidentified Gull | 0.1 | + | 0.1 | + | 1.6 | 47.3 | 5.1 |
| Arctic Tern | 0.9 | 0.2 | 1.0 | 1.1 | 0.4 | 0.5 | 0 |
| Aleutian Tern | 0.2 | + | + | + | + | 0 | 0.3 |
| Unidentified Tern | 0.9 | + | 0 | 0 | 0.7 | 0 | 0 |
| Common Murre | 1.5 | 0.7 | 0.9 | + | 0 | 0 | 0 |
| Thick-billed Murre | + | + | + | 0 | 0 | 0 | 0 |
| Unidentified Murre | 2.2 | 3.1 | 4.1 | 0.1 | 2.8 | 5.2 | 0 |
| Pigeon Guillemot | 1.8 | 0.1 | 0 | 0 | 0.1 | 0 | 0 |
| Marbled Murrelet | 1.3 | 0.1 | 0.1 | 0 | 0 | 0 | 0 |
| Kittlitz's Murrelet | 0.1 | + | 0 | 0 | + | 0 | 0 |
| Unidentified Murrelet | 4.1 | 0.3 | 0 | 0 | 0.1 | 0 | 0 |
| Ancient Murrelet | 0.3 | 0.4 | 0.7 | 0.1 | + | 0 | 0 |
| Cassin's Auklet | 0.3 | 0.6 | 0.1 | + | 0 | 0 | 0 |
| Parakeet Auklet | + | 0.1 | 0.1 | + | + | 0 | 0 |
| Crested Auklet | 0 | + | + | 0 | + | 0 | 0 |
| Least Auklet | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Whiskered Auklet | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Rhinoceros Auklet | + | + | + | 0.4 | + | 0 | 0 |
| Horned Puffin | 0.9 | 0.6 | 2.0 | 0.1 | 0.2 | 0 | 0 |
| Tufted Puffin | 34.7 | 6.7 | 9.8 | 4.2 | 3.2 | 0.5 | 1.5 |
| Unidentified Alcid | 1.4 | 1.7 | 2.8 | 0.8 | 5.3 | 2.0 | 4.8 |

Table 6. Percentage of total seabirds seen in fall (September-November) during shipboard and aerial surveys of different habitats in the Gulf of Alaska. Total birds seen (No./$Km^2$) in each habitat and during each type of survey are shown in parantheses.

| Species | Type of Survey, or Habitat: Shipboard | | | | Aerial | | |
|---|---|---|---|---|---|---|---|
| | Bay | Shelf | Shelfbreak | Oceanic | Bay & Shelf | Shelfbreak | Oceanic |
| | (35.6) | (59.9) | (22.4) | (6.7) | (10.8) | (8.6) | (5.6) |
| Common Loon | + | 0 | + | 0 | 0.1 | 0 | 0 |
| Yellow-billed Loon | + | + | 0 | 0 | 0 | 0 | 0 |
| Arctic Loon | + | + | + | + | 0.2 | 0 | 0 |
| Red-throated Loon | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Loon | 0.1 | + | + | + | 0.1 | 0 | 0 |
| Horned Grebe | + | 0 | 0 | 0 | + | 0 | 0 |
| Black-footed Albatross | + | + | 1.3 | 1.4 | 0 | 0.7 | 1.6 |
| Laysan Albatross | 0 | + | 0.4 | 0.5 | 0 | 0.7 | 0.3 |
| Unidentified Albatross | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Northern Fulmar | 0.2 | 2.6 | 34.4 | 29.1 | 17.4 | 36.7 | 32.5 |
| Flesh-footed Shearwater | 0 | 0 | 0 | 0 | 0.1 | 0.2 | 0.9 |
| New Zealand Shearwater | 0 | + | + | + | 0 | 0 | 0.3 |
| Sooty Shearwater | 7.7 | 12.6 | 2.1 | 7.2 | + | + | + |
| Short-tailed Shearwater | 2.9 | 3.6 | 1.1 | 0.5 | + | 0 | 0 |
| Unidentified Shearwater | 19.0 | 57.0 | 15.3 | 11.5 | 7.2 | 6.9 | 4.4 |
| Fork-tailed Storm-Petrel | 1.0 | 0.8 | 17.0 | 6.9 | 3.2 | 7.0 | 30.0 |
| Leach's Storm-Petrel | 0 | 0.2 | 0.1 | 5.0 | 0 | 0 | 0.3 |
| Unidentified Storm-Petrel | 0.1 | + | 0.2 | 1.0 | 0 | 1.1 | 0.6 |
| Scaled Petrel | 0 | + | + | 0.6 | 0 | 0 | 0 |
| Double-crested Cormorant | 0.1 | 0.1 | 0 | 0 | 0 | 0 | 0 |
| Pelagic Cormorant | 0.3 | + | + | 0.1 | 0 | 0 | 0 |
| Red-faced Cormorant | 0.2 | + | + | 0 | 0.1 | 0 | 0 |
| Unidentified Cormorant | 0.4 | 0.2 | 0.2 | 0.5 | 1.3 | 0.2 | 0 |
| Canada Goose | 0 | + | 0 | 0 | 0.3 | 0 | 6.3 |
| Emperor Goose | 0 | 0 | 0 | 0 | 0.6 | 0 | 0 |
| Brant | 0 | 0 | 0 | 0 | 0 | 0 | 0.3 |
| White-fronted Goose | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Oldsquaw | 0.1 | + | 0.2 | 0 | 0.6 | 0 | 0 |
| Harlequin Duck | 0.1 | + | + | 0 | 0 | 0 | 0 |
| Greater Scaup | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Common Goldeneye | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Common Eider | 0 | 0 | 0 | 0 | 1.3 | 0 | 0 |
| Spectacled Eider | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Eider | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 |
| White-winged Scoter | 0.5 | 0.1 | 0 | + | 4.3 | 0 | 0 |
| Surf Scoter | 0.2 | + | 0 | 0 | 0.1 | 0 | 0 |
| Black Scoter | + | + | 0 | 0 | 0.9 | 0.2 | 0 |
| Unidentified Scoter | 0.2 | 0 | 0 | 0 | 14.6 | 0 | 0 |
| Common Merganser | 0 | 0 | + | 0 | 0 | 0 | 0 |
| Red-breasted Merganser | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Unidentified Geese & Ducks | 0.1 | + | 0.4 | + | 0.1 | 0 | 0 |
| Red Phalarope | 0 | 0.1 | 0 | 0.1 | 0 | 0 | 0 |
| Northern Phalarope | 0.8 | 0.3 | 0.2 | 0.6 | 0 | 0 | 0 |
| Unidentified Phalarope | 0.3 | 0.1 | 0.2 | 0.1 | 1.2 | 2.4 | 0 |
| Pomarine Jaeger | 0.2 | 0.1 | 0.3 | 1.3 | 0.1 | 0.4 | 0 |
| Parasitic Jaeger | 0.1 | + | 0.1 | 0.4 | 0 | 0 | 0.3 |
| Long-tailed Jaeger | 0 | + | + | 0 | 0 | 0 | 0 |
| Skua | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Jaeger | 0.2 | + | 0.1 | 0.6 | 0.2 | 0 | 0 |
| Glaucous Gull | 0 | + | 0 | 0.1 | 0.1 | 0 | 0 |
| Glaucous-winged Gull | 7.4 | 1.7 | 4.6 | 4.6 | 14.0 | 3.7 | 0.6 |
| Herring gull | 0.6 | 0.1 | 0.9 | 0.4 | 0 | 0 | 0 |
| Thayer's Gull | 0 | + | + | 0 | 0 | 0 | 0 |
| Mew Gull | 1.9 | + | 0.1 | 0 | 0 | 0 | 0 |
| Bonaparte's Gull | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Black-legged Kittiwake | 21.4 | 3.1 | 3.7 | 3.8 | 9.2 | 4.8 | 5.4 |
| Red-legged Kittiwake | 0 | 0 | + | + | 0 | 0 | 0 |
| Unidentified Kittiwake | 1.2 | 0.7 | 1.9 | 4.5 | 7.9 | 3.0 | 2.2 |
| Sabine's Gull | 0 | + | 0.1 | + | 0.1 | 0.4 | 0 |
| Unidentified Gull | 3.7 | 0.1 | 0.7 | 0.4 | 0.8 | 0 | 0.9 |
| Arctic Tern | 0.1 | + | 0.1 | 0.4 | 0 | 0 | 0 |
| Aleutian Tern | 0 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Tern | + | + | 0 | 0 | 0 | 0 | 0 |
| Common Murre | 13.1 | 2.4 | 0.4 | 0.3 | 0 | 0 | 0 |
| Thick-billed Murre | + | + | 0.1 | 0.1 | 0 | 0 | 0 |
| Unidentified Murre | 5.4 | 4.0 | 4.4 | 0.5 | 4.3 | 2.6 | 0.3 |
| Pigeon Guillemot | 0.5 | + | + | 0 | 0 | 0 | 0 |
| Marbled Murrelet | 0.4 | + | 0 | 0 | 0 | 0 | 0 |
| Kittlitz's Murrelet | + | + | + | 0 | 0 | 0 | 0 |
| Unidentified Murrelet | 1.1 | + | 0 | 0 | 0 | 0 | 0 |
| Ancient Murrelet | 0 | + | + | 0 | 0 | 0 | 0 |
| Cassin's Auklet | 1.5 | 0.5 | 1.3 | 0.6 | 0 | 0 | 0 |
| Parakeet Auklet | 0 | 0.6 | 1.7 | 0.7 | 0.1 | 0 | 0 |
| Crested Auklet | 0.4 | 2.3 | 0 | 0.2 | 1.0 | 0 | 0 |
| Least Auklet | 0 | 0 | 0 | 0 | 0.1 | 0 | 0.6 |
| Rhinoceros Auklet | 0 | 0.1 | 0 | 0.7 | 0 | 0 | 0 |
| Horned Puffin | 1.8 | 1.5 | 1.3 | 0.6 | 0.3 | 0.4 | 0 |
| Tufted Puffin | 2.8 | 3.0 | 4.1 | 12.6 | 1.8 | 14.3 | 2.8 |
| Unidentified Alcid | 1.1 | 1.4 | 1.2 | 1.7 | 5.4 | 13.7 | 8.5 |

Table 7. Percentage of total seabirds seen in winter (December-February) during shipboard and aerial surveys of different habitats in the Gulf of Alaska. Total birds seen (No./$Km^2$) in each habitat and during each type of survey are shown in parentheses.

| Species | Type of Survey, and Habitat: Shipboard | | | | Aerial | | |
|---|---|---|---|---|---|---|---|
| | Bay | Shelf | Shelfbreak | Oceanic | Bay & Shelf | Shelfbreak | Oceanic |
| | (18.2) | (13.7) | (22.0) | (3.2) | (27.8) | (4.5) | (2.0) |
| Common Loon | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Loon | 0.2 | 0.1 | 0 | 0 | + | 0 | 0 |
| Black-footed Albatross | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 |
| Laysan Albatross | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 |
| Northern Fulmar | 0 | 16.8 | 31.7 | 32.9 | 2.0 | 12.0 | 41.1 |
| Short-tailed Shearwater | 0 | 0.1 | 0.1 | 0 | + | 0 | + |
| Unidentified Shearwater | 0 | 0.4 | 0 | 0.1 | 1.3 | 01.1 | 05.5 |
| Fork-tailed Storm-Petrel | 0 | 0 | 0.3 | 13.8 | 0 | 0 | 0 |
| Unidentified Storm-Petrel | 0 | 0 | 0.1 | 1.5 | 0 | 0 | 0 |
| Pelagic Cormorant | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Cormorant | 1.8 | 0.1 | 0.1 | 0 | 12.7 | 0 | 0 |
| Emperor Goose | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Barrow's Goldeneye | + | 0 | 0 | 0 | 0 | 0 | 0 |
| Oldsquaw | 0 | 0 | 0 | 0.1 | 0.3 | 0 | 0 |
| Steller's Eider | 0 | 0 | 0 | 0 | 27.5 | 0 | 0 |
| Common Eider | 0 | 0 | 0 | 0 | 1.9 | 0 | 0 |
| King Eider | 0 | 0 | 0 | 0 | + | 0 | 0 |
| Unidentified Eider | 0. | 0 | 0 | 0 | 5.8 | 0 | 0 |
| White-winged Scoter | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 |
| Surf Scoter | 0 | 0 | 0 | 0 | 0.3 | 0 | 0 |
| Black Scoter | 0 | 0 | 0 | 0 | 5.7 | 0 | 0 |
| Unidentified Scoter | 0 | 0 | 0 | 0 | 9.6 | 0 | 0 |
| Common Merganser | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Red-breasted Merganser | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Merganser | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Geese & Ducks | 0.4 | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Phalarope | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Glaucous Gull | 0 | 0 | 0 | + | 0 | 0 | 0 |
| Glaucous-winged Gull | 5.9 | 15.8 | 15.0 | 7.1 | 13.4 | 12.0 | 0 |
| Slaty-backed Gull | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 |
| Herring Gull | 3.4 | 0.9 | 1.0 | 0.5 | + | 0 | 0 |
| Mew Gull | 15.5 | + | 0.3 | 0 | 0 | 0 | 0 |
| Black-legged Kittiwake | 0 | 7.5 | 10.0 | 26.7 | 2.6 | 53.3 | 16.1 |
| Red-legged Kittiwake | 0 | 0.3 | 0.1 | 0 | 0 | 0 | 0 |
| Unidentified Kittiwake | 0 | 6.6 | 0.8 | 0.1 | 0 | 0 | 0 |
| Unidentified Gull | 16.5 | 8.8 | 4.3 | 2.4 | 0.1 | 0 | 0 |
| Common Murre | 20.5 | 2.2 | 0.9 | 0.1 | 0 | 0 | 0 |
| Thick-billed Murre | 0.4 | 0.3 | 0.1 | 0 | 0 | 0 | 0 |
| Unidentified Murre | 22.8 | 30.1 | 31.6 | 1.6 | 9.8 | 15.2 | 0 |
| Marbled Murrelet | 3.0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ancient Murrelet | 0.3 | 0 | 0 | 0.1 | 0 | 0 | 0 |
| Cassin's Auklet | 0.5 | 0 | 0 | 0.1 | 0 | 0 | 0 |
| Crested Auklet | 0 | 0 | 0 | 0 | 3.0 | 0 | 0 |
| Rhinoceros Auklet | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 |
| Horned Puffin | 0 | 1.2 | 0.3 | 4.7 | 0 | 0 | 0 |
| Tufted Puffin | 0.2 | 2.6 | 2.0 | 6.9 | 0.1 | 5.4 | 37.5 |
| Unidentified Alcid | 7.0 | 4.6 | 1.0 | 0.9 | 3.3 | 1.0 | 0 |

the state, but the Yellow-billed Loon nests only in the Arctic and occurs in the Gulf of Alaska primarily in migration or during winter. The distribution of most loons is generally confined to nearshore habitats at all seasons. Because our surveys rarely included their habitat, our data reflected only a small part of the Alaskan population. Loons were recorded in the Gulf throughout the year; most sightings and highest densities are in bays and over the continental shelf from Yakutat to Cook Inlet (Maps 9-16). Population indices for loons ranged from 10,000 to 30,000 birds over offshore waters in the Gulf of Alaska in both summer and winter, and perhaps an additional 50,000 to 70,000 occurred there during the peak of migration (Appendix C5).

† COMMON LOONS constituted 56 % of all loons identified to species on our surveys. They were found in bay, shelf, or shelfbreak habitats throughout the Gulf in all four seasons of the year. Their relative abundance, as compared with that of other loons, was probably related to the dominant status of their breeding population within the region.

† YELLOW-BILLED LOONS were observed five times (only a single bird each time): three sightings near Kodiak Island in April, May, and October; one sighting in Cook Inlet in October; and one sighting just west of Icy Bay in May. Forsell and Gould (1981) reported sightings in November and February near Kodiak Island, the only area where extensive data for winter or nearshore habitat is available. The dates of these sightings indicated that this species occurs as both a migrant and a winter visitor in the Gulf of Alaska.

† ARCTIC LOONS composed 39 % of all loons identified to species in our surveys. They were found in bay, shelf, or shelfbreak habitats from southeast Alaska to Unimak Pass in all seasons except winter.

† RED-THROATED LOONS were observed on only two surveys: one bird was seen near northern Afognak Island in July and three birds in Lower Cook Inlet in September. Forsell and Gould (1981) found six birds near Kodiak in November but none in February. Our lack of observations during summer may have resulted from our inadequate sampling of nearshore habitat and a relatively low nesting population in adjacent mainland regions.

PODICIPEDIDAE

Grebes are even more restricted to inshore marine and inland fresh water habitats than are loons. They were thus only rarely observed in our surveys and our data base was inadequate for assessing their status in the Gulf of Alaska. Of the four species that occur in the Gulf, Western and Pied-billed Grebes are rare visitors and Red-necked and Horned Grebes are common residents.

† RED-NECKED GREBES were observed by us only in the areas of Kodiak Island, Lower Cook Inlet, and Resurrection Bay.

† HORNED GREBES were found in Lower Cook Inlet, at sea south of the Kenai Peninsula, in Prince William Sound, and near Kayak Island.

† WESTERN GREBES are rare winter visitors to the northeast and southeast Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† PIED-BILLED GREBES are rare visitors to the northeast and southeast Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

DIOMEDEIDAE

Three species of albatrosses have been found in the Gulf of Alaska. Black-footed and Laysan Albatrosses are regular nonbreeding visitors and Short-tailed Albatross are, at best, rare nonbreeding visitors. Albatrosses are generally restricted to shelfbreak and oceanic waters but were found mostly in shelfbreak habitat. A few birds stray or follow ships into the shallower waters of the continental shelf but rarely remain there long. Postbreeding Laysans tend to move into the Western Pacific, whereas Black-foots tended to move into the Eastern Pacific. Thus, although the world population of Laysans outnumbers Black-foots by about 5:1 (Rice and Kenyon 1962), the overall ratio in the Gulf of Alaska, as determined from our data, is one Laysan to 12 Black-foots.

Albatrosses are attracted to ships, which they often follow for extended periods, feeding on garbage thrown over the side. Miller (1940) found that marked Black-foots rarely followed a ship for more than 30 or 40 miles. Our experience was similar and indicated that there was a regular turnover of individuals following a ship. In the following analysis we report data in terms of Frequency of Occurrence (defined as the number of transects on which a species was sighted, divided by the number of total transects taken), and Relative Abundance (defined as the number of birds divided by the number of transects).

† BLACK-FOOTED ALBATROSSES were observed from March through November over the deeper waters of the Gulf, and small numbers were observed in the extreme southeast in February and December (Map 17). Monthly frequency and relative abundance were high from June through October, and peaked in September (Table 8, Figure 4). This pattern was consistent with their occupation of breeding grounds in the Leeward Hawaiian Islands from October through June. The largest concentration in the Gulf was observed on 6 September 1975 at 59°37'N x 142°50'W when Irving Warner recorded an accumulation of 103 birds around a ship that had been stopped on station for 2 hours. Noteworthy records in the literature include 100 birds in the Unimak Pass area in June (Arnold 1948), and moderate densities (15/hr) south of Cape Fairweather in July and September (Isleib and Kessel 1973).

† LAYSAN ALBATROSSES were recorded from March through November throughout the deeper waters of the Gulf. Small numbers were

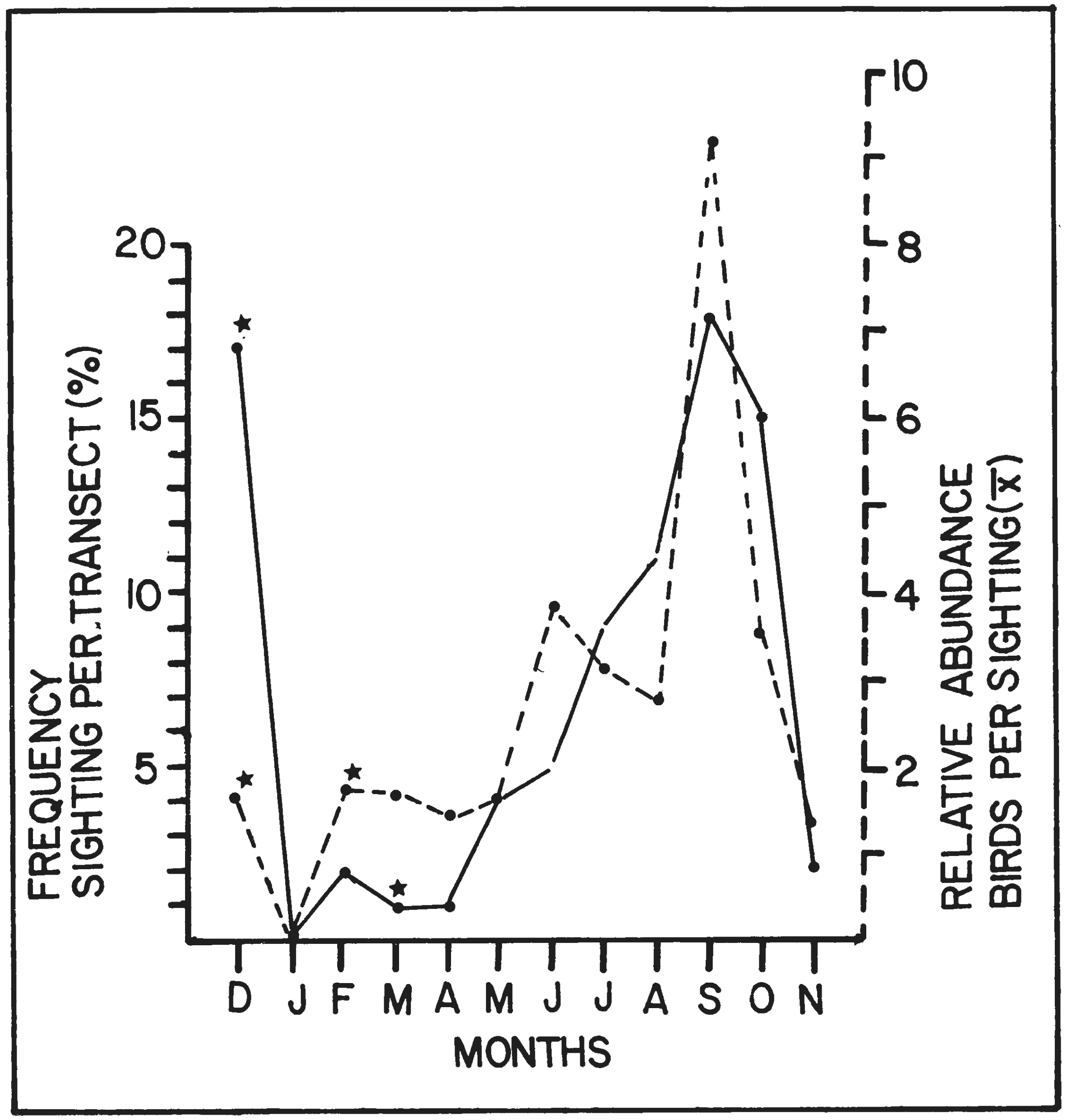



Figure 4. Relative abundance (broken lines) and frequency of occurrence (solid lines) of Black-footed Albatrosses in the Gulf of Alaska. Stars indicate low sample sizes, and that albatrosses occurred only in the extreme southeast at these times.

observed in the extreme southeast in February (Map 18). Monthly frequency and relative abundance were highest in September and October (Table 8). There is no obvious center of abundance in the Gulf of Alaska. Most sightings, however, were of birds near shelfbreak waters in the western half of the area. The largest concentration was seen on 2 October 1975 over a small seamount south of Kodiak Island at 56°17'N x 152°26'W when David Nysewander counted a total of 10 birds during a 15-minute shipboard transect.

† SHORT-TAILED ALBATROSSES formerly occurred throughout the Gulf of Alaska but their world population is now so small that they must be considered extrememly rare anywhere. We did not see this species.

FULMARINAE

The Northern Fulmar is the only member of this subfamily occurring in the North Pacific and is also the only species in the family Procellariidae breeding in Alaska. Under natural conditions this species tends to be solitary and uniformly distributed throughout preferred habitats. However, fulmars are strongly attracted to ships, about which they gather for extended periods feeding on garbage or offal thrown overboard. This behavior makes it extremely difficult to census their populations and to interpret observed distribution patterns.

† NORTHERN FULMARS are resident throughout the Gulf of Alaska (Maps 19-26). Densities at sea were highest in spring and fall during migration and at scattered locations from the Kenai Peninsula south to the 2,000-m isobath and west through the Kodiak Basin to Mitrofania Island. They were occasionally found in protected and shallow waters, especially near their breeding sites, but most foraged over deep water where their numbers tended to be highest in or near shelfbreak habitats (Appendix C6). Isleib and Kessel (1973) cited an exceptional record of ca. 10,000 fulmars in summer near Montague Island, and Arnold (1948) found 38,000 feeding in Unimak Pass on 9 June 1944. Aerial surveys are not inflated by ship-following behavior and thus may provide the most accurate interpretations of population size. The population index for fulmars, derived from aerial data, is 1.1 million birds at any given time over marine waters in the Gulf, and an additional 1.0-1.5 million passing through during migration periods. Isleib and Eberhardt (1975) estimated the size of the winter population in the northeast Gulf of Alaska at over 100,000.

PUFFININAE

Seven members of this subfamily occur in the Gulf of Alaska, all as nonbreeding visitors. Shearwaters and especially gadfly petrels are among the most pelagically oriented of all seabirds in Alaska and are numerically the dominant species group from May through October.

† FLESH-FOOTED SHEARWATERS are casual visitors to the Gulf. We saw only a single bird, which was over the shelfbreak south of Middleton Island on 6 May 1975. Kessel and Gibson (1978) listed two other records: one bird off Yakutat in July and one off the Kenai Peninsula in August.

Table 8. Seasonal frequency of occurrence (FO), relative abundance (RA) and largest sighting (MAX) of Black-footed and Laysan Albatrosses in the Gulf of Alaska.

| Species, Season, and Region | Shipboard | | | Aerial | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | FO | RA | MAX | FO | RA | MAX | FO | RA | MAX |
| BLACK-FOOTED ALBATROSS | | | | | | | | | |
| Winter | | | | | | | | | |
| Kodiak | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 |
| Northeast Gulf | 0 | 0.0 | 0 | - | - | - | 0 | 0.0 | 0 |
| Total Gulf | 3 | 0.1 | 4 | 0 | 0.0 | 0 | 2 | + | 4 |
| Spring | | | | | | | | | |
| Kodiak | 1 | + | 1 | + | + | 1 | 1 | + | 1 |
| Northeast Gulf | 4 | 0.1 | 5 | 0 | 0.0 | 0 | 4 | 0.1 | 5 |
| Total Gulf | 2 | + | 5 | + | + | 1 | 2 | + | 5 |
| Summer | | | | | | | | | |
| Kodiak | 2 | + | 4 | 1 | + | 3 | 2 | + | 4 |
| Northeast Gulf | 29 | 1.8 | 72 | 6 | 0.1 | 4 | 21 | 1.2 | 72 |
| Total Gulf | 8 | 0.3 | 72 | 2 | + | 4 | 7 | 0.2 | 72 |
| Fall | | | | | | | | | |
| Kodiak | 8 | 0.5 | 31 | - | - | - | 8 | 0.5 | 31 |
| Northeast Gulf | 21 | 2.2 | 103 | 1 | + | 1 | 16 | 1.6 | 103 |
| Total Gulf | 13 | 1.0 | 103 | 3 | + | 2 | 12 | 0.8 | 103 |
| LAYSAN ALBATROSS | | | | | | | | | |
| Winter | | | | | | | | | |
| Kodiak | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 |
| Northeast Gulf | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 |
| Total Gulf | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 |
| Spring | | | | | | | | | |
| Kodiak | 1 | + | 1 | 0 | 0.0 | 0 | + | + | 1 |
| Northeast Gulf | 0 | 0.0 | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 0 |
| Total Gulf | 1 | + | 2 | 0 | 0.0 | 0 | + | + | 2 |
| Summer | | | | | | | | | |
| Kodiak | + | + | 2 | 0 | 0.0 | 0 | + | + | 2 |
| Northeast Gulf | 1 | + | 1 | 0 | 0.0 | 0 | + | + | 1 |
| Total Gulf | + | - | 3 | 0 | 0.0 | 0 | + | + | 3 |
| Fall | | | | | | | | | |
| Kodiak | 5 | 0.1 | 10 | - | - | - | 5 | 0.1 | 10 |
| Northeast Gulf | 5 | 0.1 | 6 | 2 | + | 1 | 4 | 0.1 | 6 |
| Total Gulf | 5 | 0.1 | 10 | 2 | + | 1 | 4 | 0.1 | 10 |

† PINK-FOOTED SHEARWATERS are regular, but uncommon, nonbreeding visitors to the Gulf. We observed 13 birds in 12 sightings between 19 May 1977 and 17 October 1975. While in Alaskan waters, this species seems to prefer continental shelf and shelfbreak habitats. Kessel and Gibson (1978) reported seeing at least 20 during September over the Fairweather Grounds of the Northeast Gulf.

† NEW ZEALAND SHEARWATERS are regular, but uncommon, nonbreeding visitors to the Gulf of Alaska. We found 18 birds in 14 sightings from 20 April 1977 to 17 October 1975. This species appears to prefer oceanic and shelfbreak habitats within the Gulf, although we sighted several birds over the continental shelf. All of the nine birds seen by Wohl (1975) were along the inner edge of the shelfbreak in the Northeast Gulf between 16 and 29 September 1974.

† SOOTY and SHORT-TAILED SHEARWATERS are difficult to differentiate in the field except under good observing conditions and by experienced observers. For this reason we have chosen to treat them as a single group for most of our analyses. We do, however, have a reliable sample of shearwaters identified to species from the Gulf (Table 9). There, Sooty Shearwaters outnumbered Short-tailed Shearwaters by almost 9:1 in the Northeast, but from Kodiak westward Short-tails outnumbered Sooties by about 1.2:1. Sooties thus composed about 68 percent of the shearwaters in the Gulf of Alaska. Isleib and Kessel (1973) also considered Sooty Shearwaters to be

Table 9. Proportion of Sooty Shearwaters, expressed as percent of all shearwaters identified to species, in the Gulf of Alaska, 1975-1978.

| Habitat or Season | Northeast Gulf | Kodiak Area | Total Gulf |
|---|---|---|---|
| Habitat | | | |
| Bays and Fjords | 98 | 47 | 62 |
| Continental Shelf | 86 | 44 | 66 |
| Shelfbreak | 91 | 68 | 88 |
| Oceanic | 85 | 99 | 98 |
| Season | | | |
| Winter | 0 | 0 | 0 |
| Spring | 86 | 48 | 96 |
| Summer | 99 | 40 | 47 |
| Fall | 77 | 79 | 78 |
| Total | 87 | 45 | 68 |
| Number of Birds | 68,310 | 84,480 | 174,882 |

far more common than Short-tailed Shearwaters in the northeast Gulf of Alaska. They listed two records of exceptional concentrations: 2.6 million in one concentration between the Chugach and Barren Islands in July and 'square miles of sitting birds' in Hinchinbrook Entrance in June. We have 22 records of concentrations of 10,000 or more shearwaters (Table 10) but only one is larger than 100,000 birds. We found that both species tended to remain in monospecific flocks and that larger assemblages were the result of flocks coalescing over rich feeding areas. Even the larger flocks tended to be of mostly one species or the other, with ratios of one species to the other rarely smaller than 8:1.

Table 10. List of all shearwater groups of more than 10,000 birds recorded by us in the Gulf of Alaska, 1975-1978.

| Flock Size | Species | Behavior | Location | Date |
|---|---|---|---|---|
| 300,000 | Unidentified | Feeding | 53°55'N x 164 47'W | 18 Jun. 1976 |
| 80,000 | Unidentified | Feeding | 54°10'N x 162°33'W | 03 Sep. 1976 |
| 60,000 | Short-tails | Sitting | 57°12'N x 152°20'W | 31 May 1977 |
| >50,000 | Short-tails | Feeding | 57°10'N x 152°43'W | 25 May 1978 |
| 35,000 | Short-tails & a few Sooties | Feeding | 55°38'N x 155°30'W | 01 Sep. 1976 |
| 32,000 | 33% Short-tails | Milling | 64°41'N x 153°34'W | 29 Jun. 1978 |
| 31,000 | Unidentified | Milling & Sitting | 57°01'N x 152°43'W | 11 May 1976 |
| 30,000 | Unidentified | Unknown | 57°00'N x 152°10'W | 03 Sep. 1976 |
| 26,000 | Unidentified | Sitting | 55°38'N x 158°17'W | 10 Jun. 1976 |
| 25,000 | Unidentified | Unknown | 10 km east of Kodiak Island | 02 Sep. 1975 |
| 25,000 | Both Species | Feeding | 57°55'N x 150°51'W | 12 May 1976 |
| 25,000 | Short-tails | Milling | 56°44'N x 153°27'W | 30 May 1977 |
| 23,000 | 85% Short-tails & 15% Sooties | Milling | 58°21'N x 151°24'W | 08 Sep. 1977 |
| 15,000 | Sooties | Milling & Sitting | 59°19'N x 146°25'W | 06 May 1975 |
| 14,000 | Some Short-tails | Milling & Sitting | 57°45'N x 152°11'W | 19 Jul. 1976 |
| 13,000 | 80% Short-tails & 20% Sooties | Feeding | 57°22'N x 152°20'W | 25 Jul. 1977 |
| 12,500 | Unidentified | Feeding | 58°36'N x 149°15'W | 08 May 1976 |
| 10,000 | 95% Short-tails & 05% Sooties | Feeding | 57°23'N x 152°22'W | 29 Jul. 1977 |
| 10,000 | Unidentified | Milling | 59°12'N x 151°02'W | 24 May 1977 |
| 10,000 | Some Short-tails | Milling | 59°06'N x 151°09'W | 24 May 1977 |
| 10,000 | Sooties | Feeding | 58°06'N x 152°10'W | 12 Jun. 1978 |
| 10,000 | 36% Short-tails & 64% Sooties | Feeding | 57°35'N x 152°08'W | 26 Jun. 1978 |

For the most part, density indices of shearwaters have high standard errors, principally as a result of the frequent and often random occurrence of very large flocks (Appendix C7). Shearwaters were found in all months, but their numbers and frequencies were very low during the winter and highest in late spring to early summer. Our earliest and latest sightings of 100 or more birds were on 13 March and 11 November. These dates probably represent the first arrival and final departure of migrants. The birds observed in winter are probably part of a small nonbreeding cohort that remains in the North Pacific through at least one breeding season.

Highest densities and frequencies were found over the continental shelf, particularly in a comma-shaped area extending from the Barren Islands southwest over the continental shelf south of Kodiak Island to the Shumagin Islands (Maps 27-34). Population indices from aerial surveys in the Gulf of Alaska range from 250,000 in winter to 12,400,000 in summer. Maximum numbers as indicated by the data from shipboard censuses would be 35 million birds in summer.

† MANX SHEARWATERS have been recorded a few times in the Gulf of Alaska (Kessel and Gibson 1978) but they can, at best, only be considered a casual visitor there. We did not see this species.

† SCALED PETRELS are common, nonbreeding residents in the Gulf of Alaska from June through October; a few birds arrived as early as 4 May 1976 and remained through 25 October 1976 . These birds typically occupy oceanic and, to a lesser extent, shelfbreak habitats while in the Gulf. We found only a few birds over the continental shelf. Highest frequency (2-5%) and density (0.1 B/$km^2$) occur in summer. Our data indicate a population index of about 110,000 total birds for the Gulf of Alaska during summer. The center of abundance appears to be over the seamounts in the southcentral Gulf, where Patricia A. Baird found over 200 birds in small groups on 20 June 1976.

HYDROBATIDAE

Storm-Petrels are common in the Gulf of Alaska; two species breed at scattered colonies throughout the area (Maps 35-42). The small size of these birds and their habit of flying low over the water make them difficult to detect. Both shipboard and aerial surveys may consequently result in underestimates of density. Conversely, Fork-tailed Storm-Petrels frequently follow ships, which increases their detectability and may inflate density indices (Appendix C8). The formation of flocks during migration also increases detectability. Sowls et al. (1978) estimated that Fork-tails made up about 60 percent of the storm-petrels in Alaska. Their data, on the other hand, indicated that Leach's Storm-Petrels composed almost 60 percent of the population in the Gulf of Alaska. Our data indicate that Fork-tails are numerically dominant to Leach's in all habitats, although shipboard surveys indicated that they were relatively less dominant in oceanic habitats (Table 11).

Table 11. Ratio of Fork-tailed Storm-Petrels to Leach's Storm-Petrels in the Gulf of Alaska.*

| Type of Survey, and Season | Bay Habitat | Shelf Habitat | Shelf-break Habitat | Oceanic Habitat | Total Marine |
|---|---|---|---|---|---|
| SHIPBOARD* | | | | | |
| Winter | -- | -- | 100:0 | -- | 100:0 |
| Spring | 100:0 | 99:1 | 100:0 | 5:1 | 32:1 |
| Summer | 100:0 | 16:1 | 13:1 | 1:1 | 6:1 |
| Fall | 100:0 | 7:1 | 99:1 | 1:1 | 7:1 |
| Total | 100:0 | 16:1 | 24:1 | 2:1 | 9:1 |
| AERIAL* | | | | | |
| Winter | -- | -- | -- | -- | -- |
| Spring | -- | 100:0 | 100:0 | 99:1 | 99:1 |
| Summer | -- | 99:1 | 12:1 | 5:1 | 49:1 |
| Fall | -- | 100:0 | 100:0 | 99:1 | 99:1 |
| Total | -- | 99:1 | 49:1 | 32:1 | 99:1 |

*95% of all Storm-petrels observed on shipboard surveys were identified to species (N=9,626).
99% of all Storm-petrels observed on aerial surveys were identified to species (N=5,085).

† FORK-TAILED STORM-PETRELS were common throughout the Gulf of Alaska from late April through October and occurred most frequently over the deep waters of shelfbreak and oceanic habitats. Their occurrence in bay and inshore areas was mostly associated with stormy weather in summer and fall. They were uncommon and generally found only in waters beyond the shelfbreak from November through March. The areas where high densities were most consistent were in the deeper waters of the Stevenson and Amatuli Troughs and the Barren Deep southeast of East Amatuli Island, where there is a colony of more than 300,000 birds. This may be indicative of a strong interdependence between colony location and a suitable foraging area. Population indices from ship and aerial surveys ranged from 0.5 million in winter to 2.2 to 3.1 million in summer. Because of censusing biases, however, the above indices are probably well below the actual numbers present in the Gulf. Isleib and Eberhardt (1975) estimated a winter population of 5,000-10,000 for the Northeast Gulf of Alaska.

† LEACH'S STORM-PETRELS were found from 13 May 1976 to 26 October 1976 in the Gulf of Alaska. High relative abundances, 30-50 birds per transect, were found only over the Sanak Bank at depths of 60-130 m, just south of the large colonies in the Sandman Reef area. In localities far removed from large colonies, however, this species occurred mostly over oceanic and shelfbreak habitats, only an occasional bird wandering over the continental shelf. This species is obviously more highly pelagic than the Fork-tailed Storm-Petrel. Relative densities (adapted from Tables 4-7) indicate a population index of 1 million Leach's Storm-Petrels over marine waters in the Gulf of Alaska--an obvious underestimate of the actual population size. The original density index would be considerably higher if our surveys had been randomly distributed through the Gulf, e.g., if we had adequately sampled the western Gulf, where there are numerous colonies, or southeastern Alaska, where a single colony on Petrel Island has about 0.7 million birds.

PHALACROCORACIDAE

Four species of cormorants occupy rocky coastlines in the Gulf of Alaska. Their pelagic distribution is centered on these coastlines, both frequency and abundance being highest in bays and nearshore habitat and lowest over oceanic habitat. Cormorants are often difficult to differentiate in the field, and only 30 % of all cormorants seen during our surveys were identified to species. Population indices from shipboard and aerial surveys ranged from 30,000 to 100,000 cormorants over offshore waters in the Gulf of Alaska at any one time during the year (Appendix C9).

† DOUBLE-CRESTED CORMORANTS were common in the Gulf throughout the year; numbers were greatest along rocky shorelines and in bays, especially near rookeries and roosting sites. We have no records from waters deeper than 1,500 m. There is a pronounced migration of this species along the northern coast, rarely out of sight of land, but it is not known how many birds are involved nor from where they come.

† BRANDT'S CORMORANTS are rare and local summer visitors. They have been found breeding in very small numbers at the entrance to Prince William Sound, and there is at least one record for southeast Alaska. We did not see this species.

† PELAGIC CORMORANTS are year-round residents throughout the Gulf; numbers are greatest along rocky shorelines and in bays near colonies and roosts. We made several sightings of this species over waters 2,000-5,200 m deep; probably the birds were wandering immatures or nonbreeding adults. Part of the Alaskan population, especially birds in the Bering Sea, may be migratory, the migration path abutting the North Gulf Coast.

† RED-FACED CORMORANTS are residents of the Western Gulf of Alaska. We made only a few sightings from east of 150°W and only one east of 146°W: one bird on 1 November 1975 at 59°11'N x 142°02'W. This was also our only observation of a Redfaced Cormorant over waters deeper than 200 m.

ANATIDAE

Swans, geese, and ducks are poorly represented in our surveys for a variety of reasons. During summer many of them remain in fresh water habitats or stay within the nearshore zone. Most follow coastlines in migration and those that fly over the ocean do so at relatively high elevations and without stopping. In winter, many leave the state, and those that remain become concentrated, especially in bay and nearshore areas. We found this group to be common to abundant in bays and uncommon to common over the continental shelf during winter and migration periods (Appendix C10). Waterfowl are relatively uncommon in any marine habitat during the summer and are rare at any time over shelfbreak and oceanic habitats (Tables 4-7). Although several species of ducks, geese, and swans occur in large numbers in estuarine and nearshore habitats, our surveys have not provided a suitable sample of these habitats and do not contribute significant new information on most species. We have thus confined our discussion to sea ducks (tribe Mergini), although even these species are poorly sampled by our surveys.

† COMMON GOLDENEYES were observed only once; two birds over Portlock Bank east of Kodiak Island in September.

† BARROW'S GOLDENEYES are relatively common in nearshore habitats both as migrants and as winter visitors. We have numerous records for Southeast Alaska, Kodiak Island, and Lower Cook Inlet. Our surveys were not appropriate, however, for assessing the abundance of this or other important coastal species of waterfowl.

† BUFFLEHEADS were not found in our surveys. Forsell and Gould (1980) reported this species to be common in back bays of the Kodiak Archipelago in winter. Isleib and Kessel (1973) found them to be rare in summer and common in winter in the Northeast Gulf of Alaska.

† OLDSQUAWS are abundant as migrants and winter visitors throughout the Gulf of Alaska. Our earliest arrival and latest departure dates are 8 October 1975 and 6 June 1975 respectively. This duck was the fourth most abundant waterfowl species found in our surveys, and was the one most likely to be found over shelfbreak and oceanic habitats.

† HARLEQUIN DUCKS are common year-round residents along rocky shorelines throughout the Gulf of Alaska. Our only observations of birds away from nearshore habitats were of a single bird over the shelfbreak in October and two birds over the continental shelf in November.

† STELLER'S EIDERS were observed from January through April, except for one sighting of four birds on 5 July in Imuya Bay on the southeast Alaska Peninsula. Forsell and Gould (1981) found them in the Kodiak Archipelago as early as November. We found this species only west of 152°W, and then usually in small flocks. One group of 700 birds, however, was found in January about 6.5 miles west-southwest of the Barren Islands.

† COMMON EIDERS are year-long residents of the western Gulf of Alaska and we observed them both in bays and over the continental shelf. We made only two observations east of 152°W: 125 birds just east of the Chiswell Islands in May and two birds in Yakutat Bay in March. Most of our sightings were of small flocks. Larger groups of 100-300 birds were observed east of the Chiswell Islands in May, south of Kupreanof Point in March, in Katmai Bay in March, and in shallow water just west of Tugidak Island in March.

† KING EIDERS are uncommon winter visitors to the region and we found them only west of 151°W. We made scattered observations from January through April and one sighting of eight birds in Imuya Bay, Southeast Alaska Peninsula, on 5 July 1976. This species was generally found in small flocks. The two largest groups, both seen in March, consisted of 50 birds in Kachemak Bay and 63 in shallow water just north of Chirikof Island. Forsell and Gould (1981) found large numbers wintering in nearshore waters of the Kodiak Archipelago.

† SPECTACLED EIDERS were seen only once. This observation was of a single female by Mark Rauzon on 16 October 1975 at 54°00'N x 164°00'W.

† WHITE-WINGED SCOTERS were observed over bays, in nearshore habitat, and over inner continental shelf waters from Southeast Alaska to Unimak Pass; they were also the only scoters to occur in shelfbreak and oceanic habitats (Tables 4-7). They were the most abundant species of waterfowl found in our surveys, especially in the Western Gulf. Our data do not adequately reflect bay and nearshore habitats in the Northeast Gulf, particularly in winter, but Isleib and Kessel (1973) stated that Surf Scoters were more abundant than White-winged Scoters in that area. Forsell and Gould (1981) considered White-wings to be the most abundant species of waterfowl wintering in the Kodiak Archipelago. The largest concentration we found was a flock of 800 birds in June between Ugak Island and Narrow Cape, Kodiak Island. Robert Jones (personal communication) found about 10,000 birds wintering in outer Kachemak Bay during 1977-78. No seasonal differences in numbers are apparent from our data, but numbers almost certainly diminish during summer when breeding birds move into freshwater habitats.

† SURF SCOTERS were found in low densities throughout the year from Southeast Alaska to Unimak Pass. No exceptional concentrations were observed, but Isleib and Kessel (1973) reported that flocks of several hundred to a few thousand regularly occurred in nearshore habitats of the Northeast Gulf. We made only an occasional observation of Surf Scoters over the continental shelf and none in oceanic habitats.

† BLACK SCOTERS were found in moderate numbers throughout the year from Southeast Alaska to Unimak Pass, but were most abundant west of 150°W. As with Surf Scoters, we found none in shelfbreak or oceanic habitat and only a few over the outer portion of the continental shelf.

† RUDDY DUCKS are rare visitors to the Southeast Gulf of Alaska

(Kessel and Gibson 1978). We did not see this species.

† SMEWS are accidental anyplace in Alaska and there is only one record for the Gulf (Kessel and Gibson 1978). We did not see this species.

† HOODED MERGANSERS are rare visitors to marine habitats in the Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† COMMON MERGANSERS were found in Southeast Alaska in winter and at Kodiak Island and the central Alaska Peninsula in summer. One migrant was found on 18 October 1975 over the continental shelf.

† RED-BREASTED MERGANSERS are resident throughout the region and we found them in small numbers in nearshore habitats from the Central Alaska Peninsula eastward. One bird observed over the continental shelf on 17 May 1976 and another over oceanic water on 20 October 1975 were almost certainly migrants.

PHALAROPODIDAE

Of the nearly 7,000 phalaropes recorded in our surveys, 72 % were identified as northerns and 14 % as reds; 14 % were not identified to species. The small size of these birds makes them very difficult to detect from either ship or airplane, and population indices obtained by either method substantially underestimate actual numbers. Phalaropes were seen less frequently and in lower numbers in our aerial surveys then in our shipboard surveys (Appendix C11). Our best population index is thus taken from shipboard indices; it suggests a minimum of 910,000 phalaropes over offshore waters in the Gulf at the peak of migration. Numbers peak in late May and many migrants are still passing through the area in early June. Included in the unidentified group are our earliest and latest observations: 20 birds on 27 February 1976 and 1 bird on 3 November 1977. The birds in late February consisted of a single flock found at 56°43'N x 147°24'W over a depth of about 4,000 m. All of our February and March sightings of phalaropes were made over shelfbreak and oceanic habitats (Maps 43-50).

† RED PHALAROPES were common spring migrants in continental shelf, shelfbreak, and oceanic habitats of the Western Gulf of Alaska. We have no observations for Southeast Alaska and only a few for the Northeast Gulf. Our only observations of this species in bay habitat were of three small groups, all seen on 5 June 1977 in the southern part of Marmot Bay, Kodiak Island. Relative densities for this species reached a high of 1.1 $B/km^2$ over shelfbreak habitat in summer (see Tables 4-7). Extreme occurrence dates were 18 May 1976 and 25 October 1975. This early date agrees roughly with Isleib and Kessel's (1973) early date of 14 May and the late date extends Gabrielson and Lincoln's (1959) late date of 2 October. However, we recorded only four sightings from August through October. Their pattern of occurrence suggests that phalaropes have a trans-gulf migration route in the spring, the birds flying directly from northwest Washington and the central Pacific to the northcentral and northwest coasts of the Gulf of Alaska. The fall migration appears to follow a more westerly route.

† WILSON'S PHALAROPES have been found only a few times in the Gulf of Alaska and these records are all from the Southeast. We did not find this species in our surveys.

† NORTHERN PHALAROPES were found across the entire Gulf of Alaska, but there were only a few sightings over oceanic waters. Local concentrations were found in nearshore areas of Icy Strait in southeast Alaska and from Prince William Sound southwest through the Kodiak Basin. Relative densities were highest in spring, the largest being 2.9 $B/km^2$ from bay habitat (see Tables 4-7). Like Red Phalaropes, however, Northern Phalaropes were considerably less abundant in fall than in spring, indicating that different migration routes may be used or that the fall migration is prolonged and fewer birds on passage are present at any one time.

STERCORARIIDAE

Four species of jaegers have been reported from the Gulf of Alaska: South Polar Skuas are casual visitors, Parasitic Jaegers are both migrants and breeding visitors, and Pomarine and Long-tailed Jaegers are migrants and occasionally nonbreeding visitors. Gabrielson and Lincoln (1959) reported that jaegers occurred regularly throughout the Gulf of Alaska, except for their being uncommon spring visitors to the southeast. We found jaegers to be evenly distributed throughout all habitats from Yakutat westward, but did not see them in southeastern Alaska (Maps 51-58). Earliest and latest dates of occurrence were 20 April 1977 and 15 November 1976. Frequency and density indices from shipboard surveys were consistently higher than those from aerial surveys (Appendix C12). Shipboard data indicated that peak numbers occurred during summer when about 300,000 jaegers may have been present at any one time, whereas, data from aerial surveys indicated a population index of less than 30,000. The shipboard data are believed to reflect most accurately the actual size of the population. Jaegers were usually found as single birds and less frequently in groups of two to four. We made only three observations of large groups (Table 12); in all of these groups the jaegers were acting as kleptoparasites on kittiwakes or shearwaters within large assemblages of mixed species of seabirds.

† POMARINE JAEGERS were the most abundant members of this family in the Gulf of Alaska, constituting 64 percent of all jaegers identified to species. This numerical dominance held for all habitats except bays, where Parasitic Jaegers outnumbered Pomarines by about 2:1. Our earliest and latest observations were on 4 May 1976 and 15 November 1976 respectively. The largest single sighting was of 350 birds in a large flock of shearwaters near Narrow Cape, Kodiak Island. Four days earlier in almost the same location only 25 Pomarines were with what were probably the same shearwaters (Table 12).

Table 12. Large assemblages of jaegers observed in the Gulf of Alaska, 1975-1978.

| No of Jaegers Poma-rine | Long-tailed | Para-sitic | Date (Dy/Mo/Yr) | Latitude (N) | Longitude (W) | Total Birds (No.) |
|---|---|---|---|---|---|---|
| 25 | 1 | - | 25/07/77 | 57°22' | 152°20' | 14,000 |
| 350 | - | 15 | 29/07/77 | 57°23' | 152°22' | 10,000 |
| 103 | 1 | 75 | 15/08/77 | 56°57' | 153°14' | 2,000 |

† PARASITIC JAEGERS composed 27 percent of all jaegers identified to species in our surveys. They were the second most abundant species of jaegers in continental shelf, shelfbreak, and oceanic habitats and outnumbered all other jaegers in bays. Our earliest sighting was 21 April and our latest was 14 November. The only exceptional concentration of this species was of 75 birds in a flock of Black-legged Kittiwakes and Sooty Shearwaters seen south of Sitkalidak Island on 15 August (Table 12).

† LONG-TAILED JAEGERS were found in small numbers in all habitats from the Northeast Gulf westward. The largest group observed was of seven birds over the shelfbreak east of Kodiak Island on 11 August 1975. Our earliest and latest sightings were 7 May and 12 September.

† SOUTH POLAR SKUAS were recorded only four times: one observation of one bird and another of two birds in July 1976 near Kodiak Island; and sightings of one bird on 20 May 1977 over oceanic habitat southeast of Kodiak Island and one bird on 14 September 1977 over the continental shelf west of Yakutat in the Northeast Gulf.

LARINAE

Gulls and kittiwakes are the most conspicuous portion of the marine avifauna in the Gulf of Alaska, frequently accounting for 20 percent or more of the population of all seabirds other than shearwaters (Appendix C13). Fourteen species have been recorded from the Gulf of Alaska, but only three occur there regularly in large numbers: Glaucous-winged Gull, Mew Gull, and Black-legged Kittiwake. Of these three species, kittiwakes are the most pelagic in distribution and the Mew Gull is the least pelagic.

† GLAUCOUS GULLS were found scattered in small numbers through all marine habitats from Yakutat Bay west to Unimak Pass, although they do not nest within this region. Our only winter record was also our only record for the Southeast Gulf: one bird on 4 December 1975 at 52°56'N x 135°39'W over a water depth of 3,109 m. Otherwise our earliest and latest records were 3 March 1976 and 14 November 1975. This species is probably regular in the Gulf in winter, but our surveys were probably too few to detect them then. Isleib and Eberhardt (1975) believed that the late winter population of Glaucous Gulls in the Northeast Gulf of Alaska was about 300 birds. We obtained a population index of 1,000 to 3,000 Glaucous Gulls in the Gulf of Alaska during the summer, and perhaps larger numbers are there during spring and fall (see Tables 4-7).

† GLAUCOUS-WINGED GULLS were the most numerous large gulls in the Gulf of Alaska (Appendix C14). They were common throughout the year from Southeast Alaska to Unimak Pass, although it was uncommon to find more than 10 birds together in a single sighting, except at artificial food sources such as canneries. Large numbers of Glaucous-winged Gulls are also frequently attracted to ships, which they may follow for short periods. This behavior is most prevalent in winter, when we recorded sightings of up to 300 birds following a moving ship and up to 900 gathering about a stopped ship.

In summer, density indices were highest in bays and there were very few sightings over oceanic habitats (Maps 59-66). In winter, densities decreased in bays and increased over the continental shelf, shelfbreak, and deeper waters. Overall, the population in the Gulf of Alaska appeared to more than double, from a population index of 0.3-0.6 million birds in summer to one of 1.1-1.3 million birds in winter. The estimated size of the population in winter is consistent with the complete evacuation of nesting areas after the young fledge. The extent to which this increase was also due to a greater tendency for the birds to be attracted to ships in winter is not known, but could be significant. Isleib and Eberhardt (1975) estimated the winter population in the Northeast Gulf to be 200,000-250,000.

† SLATY-BACKED GULLS have not been previously recorded in the Gulf of Alaska east of the Aleutian Islands. During our surveys, Patricia A. Baird saw one bird over the shelfbreak at 58°04'N x 150°12'W on 30 January 1977.

† HERRING GULLS were surprisingly common in our surveys, considering that they breed primarily on inland fresh water habitats and only a few breeding colonies have been found on the coast in Cook Inlet and Glacier Bay, where they hybridize with Glaucous-winged gulls (Williamson and Peyton 1963, Patten and Weisbrod 1974). We saw this species in uniform numbers in all habitats from southeast Alaska west to the Kodiak Archipelago. The western limit of their regular pelagic range in the Gulf is indicated by two sightings: one bird at 55°19'N x 156°13'W in July and one bird at 55°05'N x 157°08'W in March. Considerably more field work, however, is needed to clearly define the pelagic range of this species in Alaska.

Shipboard surveys produced what appear to be exceptionally high density indices, i.e., 0.1-0.6 B/km$^2$ (Tables 4-7). Winter population indices in the Gulf may range from 3,000 to as high as 95,000 birds and those in summer from 5,000 to 20,000. Our best evaluation of the data is that the number of birds over marine waters in the Gulf of Alaska at any time of the year is roughly 8,000-11,000. Isleib and Eberhardt (1975) thought that the combined population of Herring and Thayer's Gulls in the Northeast Gulf was about 3,000 in winter.

† THAYER'S GULLS were observed on only three occasions, all within the Northeast Gulf of Alaska: one bird on 22 April 1976 and another on 19 September 1975 over the shelfbreak; and one or two birds on 22 September 1975 over the continental shelf. This species is not easily differentiated from the Herring Gull in the field and it is probably more abundant than these few sightings indicate.

† CALIFORNIA GULLS are rare visitors to southeast Alaska and have never been recorded farther north nor west. We did not see this species.

† RING-BILLED GULLS are rare visitors to the Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† MEW GULLS were common in bays and nearshore habitats from southeast Alaska to Kodiak Island and rare in deeper and more western waters. We did not find them between Kodiak Island and Unimak Pass. Although the number of breeding and wintering birds undoubtedly drops off sharply west of the Kodiak Archipelago, our failure to see them must be attributed partly to a lack of surveys in nearshore habitats. Forsell and Gould (1981) estimated that 10,000 Mew Gulls occurred over the marine waters of the Kodiak Archipelago in winter. Isleib and Kessel (1973) estimated thousands in winter, tens of thousands in summer, and possibly hundreds of thousands in migration in the Northern Gulf Coast-Prince William Sound region. Isleib and Eberhardt (1975) estimated about 10,000 birds in winter in the Northeast Gulf of Alaska.

† BLACK-HEADED GULLS are accidental visitors to the Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† FRANKLIN'S GULLS are accidental visitors to the Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† BONAPARTE'S GULLS breed inland in Alaska and apparently rarely occur far from shore even during migration. We recorded a few birds in nearshore and bay habitats from Icy Straits west to Kodiak Island.

† IVORY GULLS are accidental visitors to the Gulf of Alaska (Kessel and Gibson 1978). We did not see this species.

† BLACK-LEGGED KITTIWAKES composed over 50 percent of all Larinae encountered in our surveys except in Southeast Alaska, where they were always uncommon. As the young fledged in the fall, kittiwakes dispersed widely to sea, causing density indices to decrease in bay and shelf habitats and increase in shelfbreak and oceanic habitats. By mid to late November in the Gulf of Alaska, these birds had become rare in bays and nearshore areas and common over deeper waters (Maps 67-74). Reoccupation of colonies in the spring and a concomitant rise in density indices in bays occurs as early as 1 March in some areas and by mid March in all remaining areas.

Black-legged Kittiwakes are attracted by ships, which they may follow for short periods, especially in winter, or merely circle before proceeding on their original course. In either event, unqualified use of density indices derived from shipboard surveys may tend to inflate estimates of population size (Appendix C15). Aerial-shipboard population indices for kittiwakes over marine waters of the Gulf of Alaska are 1.3-1.6 million in summer and 0.9-1.6 million in winter, and upwards of 3-4 million may have occurred there for short periods during the spring migration. Isleib and Eberhardt (1975) estimated a wintering population of 302,000-325,000 in the Northeast Gulf.

Black-legged Kittiwakes are generally scattered as single birds over marine waters in the Gulf of Alaska. They do, however, form flocks over food sources and are the primary catalysts for the formation of multispecies feeding flocks (Hoffman et al. 1981). Flock sizes tend to be small, most being 50 birds or less, but groups of 100-200 are common in bays and near land. We have seven observations of flocks with 500 or more birds, the largest being of 2,800 birds (Table 13). Wiens et al. (1978) reported a flock of 10,000 kittiwakes associated with 40,000 Sooty Shearwaters and 100 Pomarine Jaegers on 6 July 1976 near Kodiak Island. In winter, large numbers of kittiwakes frequently accumulated in rafts around stationary ships, especially when food rewards were present in the form of garbage, offal, etc.

Table 13. Groups of > 500 kittiwakes observed in the Gulf of Alaska.

| Flock | Behavior | Location | Date | Depth | Habitat |
|---|---|---|---|---|---|
| 2,800 | Feeding | 58°09'N x 152°15'W | 29 Jun 1978 | 127 m | Bay |
| 2,000 | Feeding | 56°27'N x 153°10'W | 14 Nov 1976 | 35 m | Shelf |
| 1,400 | Feeding | 57°55'N x 152°44'W | 18 Aug 1977 | 90 m | Bay |
| 1,000 | Feeding | 56°57'N x 153°13'W | 15 Aug 1977 | 46 m | Shelf |
| 1,000 | Feeding | 58°21'N x 151°24'W | 8 Sep 1977 | 128 m | Shelf |
| 750 | Feeding | 57°11'N x 153°18'W | 30 Jun 1976 | 110 m | Bay |
| 500 | Sitting | 57°50'N x 152°17'W | 12 Jul 1978 | 14 m | Bay |

† RED-LEGGED KITTIWAKES were uncommon visitors to the western Gulf of Alaska. Our easternmost record was of a single bird at 57°57'N x 148°47'W on 26 January 1977. We found seven birds in January and February over the continental shelf (80-130 m depth) to the south and east of Kodiak Island, and four birds over shelfbreak and oceanic waters on 22 September 1975, 24 October 1976, and 26 January 1977. Kessel and Gibson (1978) listed Redlegged Kittiwakes sightings in the Gulf of Alaska in March, late May, and June.

† SABINE'S GULLS were found from Yakutat to Unimak Pass as migrants and nonbreeding summer visitors. Migrating flocks of 21, 45, and 60 birds were seen at 59°33'N x 140°10'W on 5 June 1975, and a feeding flock of 15 birds was located at 56°57'N x 153°13'W on 15 August

1977. Otherwise, we found 1-4 birds scattered between 31 May and 7 November, except for one remarkably early bird seen on 7 March 1975.

STERNINAE

When in Alaska, Arctic and Aleutian Terns are basically birds of bays, protected coasts, and inland fresh waters, although they occasionally forage over deep water and much of their migration occurs over the continental shelf and deeper ocean (Appendix C16). We found them in greatest numbers in the Northeast Gulf, with densities decreasing to the south and west. The high density and frequency of terns over shelfbreak and oceanic habitats in the Northeast Gulf probably resulted from the narrower continental shelf in that region, bringing these deep-water habitats within effective foraging range from colonies.

† ARCTIC TERNS were found from 22 April through 10 October and composed 95 percent of all terns identified to species in our surveys. They tended to be distributed as single birds or as small groups, which is in accord with the small size and scattered distribution of their colonies. The three largest flocks observed by us were all in the spring before egg-laying had begun: 50 birds feeding at 59°00'N x 144°02'W on 12 May 1976 over a depth of about 3,900 m; 37 birds flying SE at 58°39'N x 149°27'W on 8 May 1976 over a depth of 165 m; and 25 birds feeding at 58°29'N x 141°10'W on 27 April 1976 over a depth of about 1,900 m. Population indices of terns occurring over marine waters in the Gulf of Alaska, exclusive of oceanic habitat, ranged from 153,000 to 218,000 as derived from shipboard and aerial surveys, respectively.

† ALEUTIAN TERNS constituted only 5 percent of all terns identified to species in our surveys. This gives a population index of about 8,000-11,000 summer visitors in the Gulf of Alaska, mostly scattered between Yakutat Bay and the Kodiak Archipelago. Numbers were greatest in bay systems and nearby continental shelf areas of Kodiak Island. A few single birds were found over shelfbreak and oceanic habitats in June 1975 and July 1976. Rarely were five or more of these birds found together at any one time, but some were occasionally found associated with small flocks of Arctic Terns in especially good feeding areas. Our only definite record for migration was of two single birds at 54°30'N x 160°41'W on 2 September 1976.

ALCIDAE

Alcids composed at least 10 percent of the avifauna in the Gulf of Alaska, regardless of season or habitat, and at times made up 40-50 percent of all birds observed. Their numbers were divided unequally among 13 species; of which two--Common Murres and Tufted Puffins--together made up 70-90 percent of all alcids identified to species (Appendix C17). In summer, densities at sea tended to be highest in the vicinity of major rookeries such as those in the Semidi, Shumagin, and eastern Aleutian Islands. Our limited data from winter indicated that densities were highest in Southeast Alaska and that general distribution was more pelagic there then in summer (Maps 75-82).

† COMMON and THICK-BILLED MURRES were difficult to differentiate in the field except under ideal observing conditions and at close range; we therefore chose to treat them as a single group for most of our analyses (Maps 83-90). Although we combined species, the analyses relate most specifically to Common Murres, since that species made up 96-97 % of all the murres identified to species in our surveys. Only over shelfbreak and especially oceanic habitats did Thick-billed Murres ever compose more than 15 % of the combined population (Table 14). Our only records of Thick-billed Murres east of 148°W were of birds wintering (February and March 1976) in Southeast Alaska and of one bird observed on 20 February 1977 over the central Gulf at 57°25'N x 146°06'W. Recent studies in the Gulf of Alaska (Hatch et al. 1978; Baird et al. 1979) have found ratios of breeding Common Murres to Thick-billed Murres ranging from 100:0 in Southeast Alaska, Prince William Sound, and Cook Inlet, to 32:1 on Middleton Island, to 9:1 on the Barren, Ugaiushak, and Shumagin Islands, and to 4:1 on the Semidi Islands. Sowls et al. (1978) suggested that 15-20 % Thick-bills occur in the Gulf of Alaska, even though their raw data indicated 99 % Common Murres. The overall high proportion of Common Murres in our pelagic surveys is the result of combining surveys from the eastern and western portions of the Gulf. The high percentage of Thick-bills in spring and fall are probably a result of the addition of migrants from the Bering Sea, and the high percentages in deep water habitats suggest a difference in selection of habitats between the two species, Thick-bills possibly preferring deeper waters.

Table 14. Ratio of Common Murres:Thick-billed Murres in shipboard surveys of the Gulf of Alaska. (Total numbers of birds shown in parentheses).

| Type of Survey, and Season | Habitat: Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| SHIPBOARD | | | | |
| Winter | 59:1 (238)* | 8:1 (36) | 11:1 (12) | 1:0 (1) |
| Spring | 10:1 (242) | 7:1 (1049) | 16:1 (155) | 1:7 (25) |
| Summer | 90:1 (263) | 38:1 (1204) | 28:1 (116) | 3:0 (3) |
| Fall | 995:1 (996) | 104:1 (1362) | 5:1 (28) | 4:1 (9) |

Murres frequently form moderate to large flocks, especially when not occupied with foraging or nesting chores, and prebreeding birds often congregate in large rafts just offshore from colony sites in the spring. We regularly encountered flocks of 10-300 birds, especially in winter, and found one group of 1,000 birds on 22 April about 9 miles south-southeast of the large colony on Spitz Island. Forsell and Gould (1981) found Kodiak Island to be a major foraging and resting area for adult and young murres in fall and winter. They observed one exceptional concentration of 125,000-130,000 birds in the east entrance to Sitkalidak Strait in February, associated with exceptionally large numbers of capelin (Mallotus villosus).

Sowls et al. (1978) estimated a total Alaskan population of 10 million murres, 2 million of which breed in the Gulf of Alaska. Population indices derived from aerial-shipboard density indices (Appendix C18) were obviously minimal but indicated about a 60-67 percent increase in numbers, from 0.6-1.6 million birds in summer to 1.0-2.4 million in winter. Differences between air and shipboard surveys are probably a result of the low visibility of murres from aircraft--a factor possibly made more serious by the murres diving well in advance of an oncoming plane. Both survey types, however, indicated that highest densities were in the western half of the Gulf, in bay and inner continental shelf habitats, and in the winter and spring seasons. Isleib and Eberhardt (1975) estimated a wintering population of about 300,000 murres in the Northeast Gulf.

† PIGEON GUILLEMOTS are abundant residents in neritic habitats throughout the Gulf of Alaska. We have no records of this species in shelfbreak or oceanic habitats and only a few in waters 200-400 m deep over submarine canyons of the continental shelf. They are generally dispersed as single birds or small groups. The largest flock encountered in our surveys was in Chiniak Bay, where 46 birds were found in a feeding assemblage that also contained cormorants, gulls, and kittiwakes. Forsell and Gould (1981) estimated a winter population of 7,000 Pigeon Guillemots for Kodiak Island.

† MARBLED and KITTLITZ'S MURRELETS are difficult to differentiate in the field, and most of our data are anlayzed on the basis of total "Brachyramphus Murrelets." Of the 1,055 murrelets that were identified to species in our surveys, the ratio of Marbled to Kittlitz's was 16:1. Both species were resident from Unimak Pass to Glacier Bay, and Marbled Murrelets continued south from there to at least Prince of Wales Island. Winter sightings, however, were rare. Although murrelets are probably among the most numerous of Alaskan seabirds, they were not well-represented in our surveys because of their preference for inner bay and nearshore habitat (Appendix C19). Isleib and Kessel (1973) reported large numbers of both species in Prince William Sound. We found large numbers during small-boat surveys of many Kodiak and Alaska Peninsula Bays: 200-400 birds per hour in such areas as Alitak Bay, Kiliuda Bay, Port Wrangell Bay, Kuiukta Bay, and Katchemak Bay. Forsell and Gould (1981) estimated that 17,800 wintered in the bay systems of Kodiak Island. Isleib and Eberhardt (1975) believed that a minimum of 38,000 murrelets wintered in the Northeast Gulf, and that a significant portion of the North Gulf Coast-Prince William Sound population wintered in nearshore waters of Southeast Alaska and British Columbia.

† ANCIENT MURRELETS were common over the continental shelf from southeast Alaska to Unimak Pass. We have only five sightings of this species over oceanic habitat, and all cases were east of 145°W in areas where the continental shelf is relatively narrow. Numbers were lowest in the Northeast Gulf and increased westward, highest numbers being found between Unimak Pass and the Shumagin Islands. These birds were occasionally found singly but more often in groups of 2 to 25. The largest flocks noted in our surveys were 300 birds sitting on the water near Umga Island (north of Sanak Island) on 30 May 1976, and 320 just offshore from Big Koniuji Island on 25 May 1975. Most of our observations of this species were made between March and August; winter sightings were rare. Two early sightings were on 18 February 1976 in the Inland Passage area of Southeast Alaska and 27 February 1976 over oceanic habitat in Southeast Alaska. Gerald A. Sanger (pers. comm.) found 77 birds over the shelf just southeast of Kodiak Island on 22 February 1967. Our latest sightings were 21 October 1975 in oceanic waters of the Northeast Gulf and 10 November 1975 over shelfbreak habitat southeast of the Shumagin Islands. Forsell and Gould (1981) found this species around Kodiak Island in November and February and estimated a winter population of 200-500 birds for the Kodiak Archipelago.

† CASSIN'S AUKLETS were common in the Gulf of Alaska from April through November. Four early records were 16 February 1976 and 18 March 1976 in Southeast Alaska and 21 February 1977 and 19 March 1976 in oceanic habitat of the Northcentral and Northeast Gulf. Our latest observation was of nine birds on 14 November 1976 over the continental shelf just south of Kodiak Island. These auklets were found as single birds or in groups of 2 to 40. Scott Hatch found one exceptionally large assemblage--an estimated 20,000--of this species on 27 August 1978 at 56°15'N x 154°32'W over water depths of 90 m. He wrote at the time of the observation: "Thousands of Cassin's Auklets in this area, both on water and flying in groups as far as can see any direction. Concentration confined to area about 10 km across from east to west." Forsell and Gould (1981) found a single bird in Sitkalidak Strait of Kodiak Island on 30 November 1979.

† PARAKEET AUKLETS are summer visitors to the Gulf of Alaska, nesting at a few large colonies in the Western Gulf and many small colonies scattered from Unimak Pass east to Prince William Sound (Sowls et al. 1978). Our earliest and latest observations were on 5 March 1976 and 8 November 1977. We found a few birds in spring and summer as far east as 138°W, but most of our observations were from the major breeding areas in the Western Gulf. A surprisingly large number of Parakeet Auklets were scattered over the outer continental shelf and shelfbreak of the Central Gulf on 6-14 September 1977. In light of our lack of winter records for anywhere in the Gulf and the scarcity of records from Southeast Alaska and Canada, the September records suggest that birds follow the shelfbreak east and south to as yet unlocated subarctic or subtropical oceanic wintering areas. Perhaps they overwinter off Washington, Oregon, and California, as suggested by the occurrence of dead birds that are washed ashore in winter in those areas.

† CRESTED AUKLETS are resident in the Western Gulf of Alaska, where they are known to breed only in the Shumagin Islands. At sea, they

are highly gregarious, and flocks of 10-60 birds are common. The largest flock observed in our surveys was a group of 250 over oceanic water south of the Shumagin Islands on 21 April 1977. We have only a few summer observations of this species and most of these were made near major rookeries. Two notable exceptions were of 30 birds flying NW just off Chowiet Island, Semidi Islands, on 7 June 1976 and of one bird at 56°30'N x 155°00'W on 19 June 1977. The latter sighting is the easternmost summer record for this species. There is a pronounced eastward movement in winter to the Kodiak Archipelago, where Forsell and Gould (1981) found about 50,000 wintering in northern and eastern bays of Kodiak Island. Crested Auklets are occasionally found in winter as far east as Prince William Sound, and our easternmost record is of 25 birds over the shelfbreak at 59°00'N x 147°50'W on 29 March 1976. Our data also indicate a pelagic dispersal, both in the Kodiak area and south from Unimak Pass to at least 33°N.

† LEAST AUKLETS were observed between 30 April 1976 and 12 October 1977 in the extreme Western Gulf of Alaska. We have only two observations of this species east of 160°W: three birds at 56°51'N x 153°03'W on 14 August 1977, and two birds at 57°12'N x 152°46'W on 28 May 1977. Forsell and Gould (1981) recorded one bird in early November from Uyak Bay, Kodiak Island. The breeeding population in the Gulf of Alaska is restricted to a few pairs on the Semidi and Shumagin Islands--which explains our lack of records for this rather sedentary alcid.

† WHISKERED AUKLETS were found during spring and summer in the Krenitzin Island area of the eastern Aleutians. This species is apparently very sedentary and rarely occurs far from its breeding sites. The apparently high density in the spring (Table 4) was a result of our finding large numbers on a few transects in a localized area of the eastern Aleutian Islands.

† RHINOCEROS AUKLETS were found in small numbers from Southeast Alaska west to Kodiak Island. We saw only one bird west of 155°W, this being in Unimak Pass on 5 June 1976. All but one of our sightings occurred between 6 March 1975 and 3 November 1975. The exception was three birds seen just northeast of Chirikof Island on 8 January 1976. Rhinoceros Auklets tend to be solitary and the most recorded together at any one time was five. They have a tendency to flush or dive well in advance of an oncoming ship or plane, a behavior that may bias our observation of this species.

† HORNED PUFFINS were common breeding birds throughout the Gulf of Alaska, but their at-sea densities and frequencies of occurrence were highest in the west. Indeed, although this species is known to breed in Southeast Alaska, we did not find it east of 146°W in the summer, and our southeasternmost observation was of one bird on 19 February 1976 at 58°20'N x 138°15'W. Horned Puffins were mostly distributed as single birds or small groups. Flocks as large as 10-50 were uncommon away from colonies. The largest flock we found consisted of 150 birds at 56°00'N x 155°39'W on 8 September 1978. With the fledging of young in late fall, these birds dispersed into oceanic habitats to the south and only an occasional bird remained in bays or nearshore habitats during the winter. We saw 42 birds between 56°N x 145°W and 57°N x 149°W on 27-28 February 1976. Forsell and Gould (1981) reported six birds over the continental shelf south of Kodiak Island on 17-18 February 1980. Sanger (1972b) found several birds 400 miles from the nearest land in the Gulf in February-March 1967. Horned Puffins are very difficult to identify from the air, and aerial surveys produced maximum population indices of only 28,000 birds in summer for the Gulf of Alaska--less than 5% of the estimated breeding population for that area. Relative densities (Tables 4-7) from shipboard surveys give population indices for the Gulf of about 186,000 in winter and 317,000 in summer. Isleib and Eberhardt (1975) estimated that about 400 Horned Puffins wintered in the Northeast Gulf.

† TUFTED PUFFINS are second only to Fork-tailed Storm-Petrels in breeding abundance in the Gulf of Alaska and, along with Black-legged Kittiwakes, they were the most abundant and frequently observed seabirds over bay and continental shelf waters during summer. These puffins were found throughout the Gulf, but were most abundant from Kodiak Island westward (Maps 91-98). Density indices in summer were highest in bays, dropped sharply over the shelf and shelfbreak, and were lowest in oceanic habitat. Like Horned Puffins, most of these birds dispersed to sea in fall and remained there through winter (Appendix C20). Tufted Puffins were often found as single birds and in small groups, but large rafts frequently formed in favorable foraging areas near colonies. The largest assemblages recorded during our surveys were 5,000 in June 1976 and 10,000 in September 1976 in the tide rips of Unalga Pass, and 10,000 in May 1976 from the tide rip area between Rootok and Akun Islands in the Eastern Aleutians. Groups of 100-400 were commonly associated with other species in feeding flocks throughout the western Gulf.

Shipboard and aerial surveys provided widely differing density estimates for Tufted Puffins. Their only point of agreement was that densities in summer decreased progressively as one moved from bays outward through continental shelf and shelfbreak habitats to oceanic waters. The color and behavior of Tufted Puffins apparently reduces the probability of their being detected from aircraft. Flying birds were occasionally attracted to ships, which they often circled several times before continuing on their way. They did not, however, follow the ship as did albatross, fulmars, kittiwakes, or large gulls. This behavior may have increased estimates of frequencies of occurrence. Density indices were affected to a small degree, perhaps by as much as 0.1 B/km$^2$ in some areas, by ship attraction which in extensive areas of low density could produce significantly higher population indices.

Sowls et al. (1978) provided data indicating that about 2.3 million Tufted Puffins are associated with colonies in summer in the Gulf of Alaska. Our shipboard surveys indicated almost twice this number, whereas our aerial surveys indicated about one-third of it. Population indices derived from shipboard surveys showed a low of 0.34 million birds in winter, which rose to a high of 4.12 million in summer. Spring and fall population indices were intermediate at 1.82 and 1.44 million birds, respectively. Aerial surveys produced indices of 0.75 and 0.74 million birds in winter and summer, respectively, and unexplainably lower numbers of 0.45 million birds in spring and 0.40 million in fall. Isleib and Eberhardt (1975) estimated that about 20,000 Tufted Puffins wintered in the Northeast Gulf.

DISCUSSION AND SUMMARY

The Subarctic Current System, located between 40° and 50°N Latitude across the North Pacific, marks the boundary between subtropical and subarctic avifaunas (Gould 1977b). South of this area the avifauna is characterized by Wedge-tailed Shearwaters (*Puffinus pacificus*), Juan Fernandez Petrels (*Pterodroma externa*), Red-footed Boobies (*Sula sula*), Red-tailed Tropicbirds (*Phaethon rubricauda*), and Sooty Terns (*Sterna fuscata*). North of this boundary in summer are the omnipresent Short-tailed Shearwater, Fork-tailed Storm-Petrel, Common Murre, and Tufted Puffin. In subarctic waters, different habitats are characterized by a numerical dominance of different species associations. Scaled Petrels and Leach's Storm-Petrels are most abundant in oceanic waters, and Laysan Albatrosses, Black-footed Albatrosses, and Northern Fulmars reach their highest densities in shelfbreak waters. Waters over the continental shelf typically have the largest assortment of species and the highest numbers of seabirds. Common Murres, Sooty Shearwaters, and Short-tailed Shearwaters reach their greatest numbers in this area. Black-legged Kittiwakes, Tufted Puffins, and Arctic Terns dominate the avifaunas of bays, especially near rookeries, and Red-faced Cormorants, Pelagic Cormorants, and Pigeon Guillemots are characteristic of all nearshore areas. The most nearly ubiquitous species in the Gulf of Alaska are the Glaucous-winged Gull in winter and the Tufted Puffin in summer.

Seventy-three species of marine birds were identified in the Gulf of Alaska. Eight of these species that have populations exceeding 1 million birds in summer are listed here in approximate order of decreasing abundance: Sooty Shearwater, Short-tailed Shearwater, Fork-tailed Storm-Petrel, Common Murre, Black-legged Kittiwake, Tufted Puffin, Northern Fulmar, and Leach's Storm-Petrel. The Northern Phalarope, Marbled Murrelet, and Arctic Tern were probably underestimated in our surveys, and their numbers may also exceed one million. The number of species occurring within the Gulf was highest during spring and fall migration periods, when 63 of the 73 species were observed (Tables 4-6).

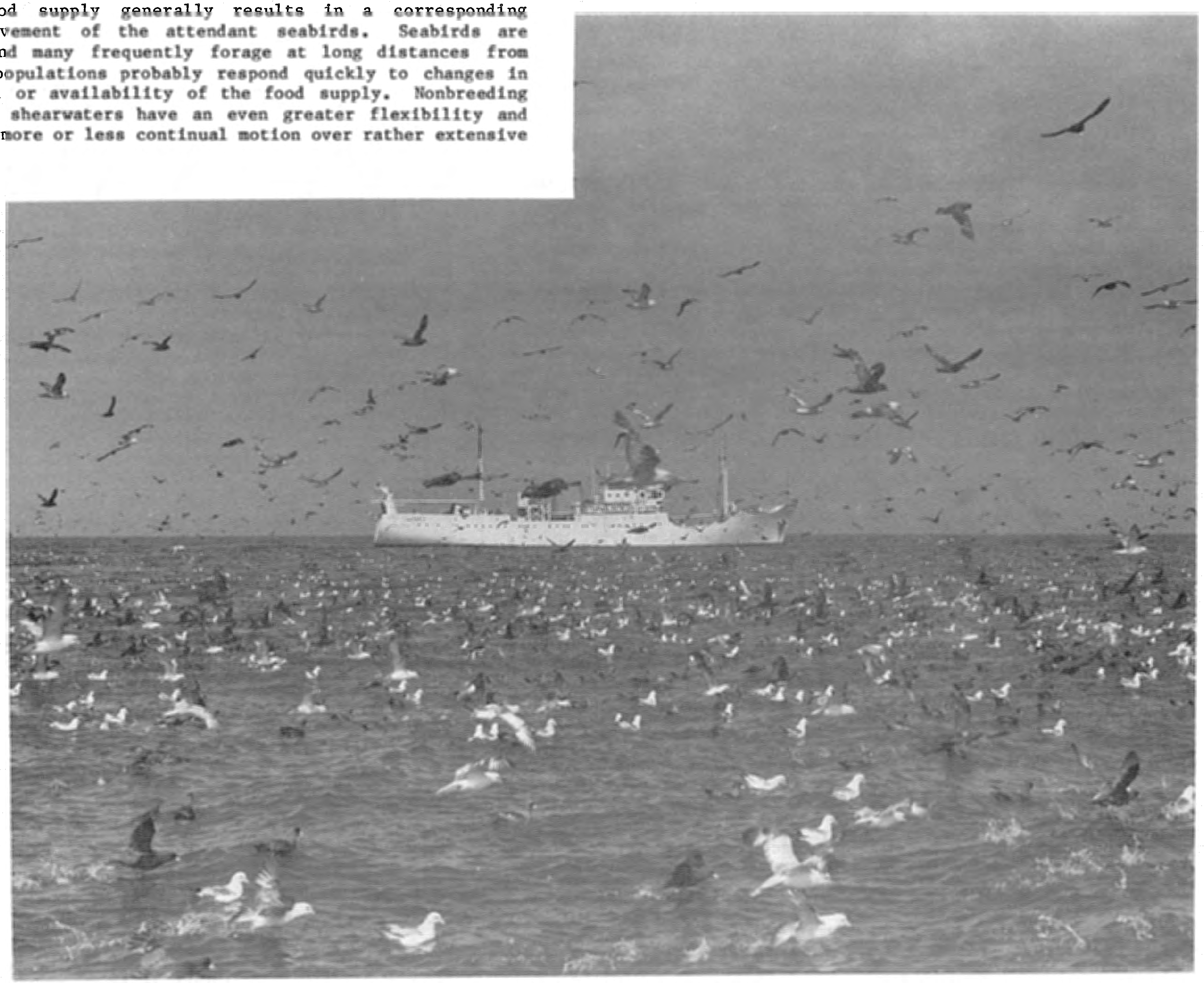
At least one bird was observed on 97 % of all shipboard transects and 92 % of all aerial transects (Appendix C21), indicating that there are few areas or times when seabirds cannot be found within marine habitats of Alaska. Lowest frequencies of occurrence were recorded over oceanic habitat in winter, and highest frequencies in bays in summer. Interpreting density indices for "total birds" (Appendix C21), we derived population indices of about 10 million seabirds in winter and 38 million in summer over marine waters of the Gulf of Alaska. This figure excludes birds that may be present in colonies. Shipboard surveys indicated that upwards of 87 million birds could occur over these waters during peak migration periods.

Distribution patterns observed during surveys indicated that most species of marine birds enter and leave the Gulf of Alaska along three rather broad offshore corridors and one narrow coastal corridor. The coastal route is used by species such as loons, cormorants, and waterfowl, which are closely associated with inshore habitats throughout the year. Most seabirds from the southeast Pacific and west coast of North America generally enter the Gulf by way of waters of the continental shelf off Washington and British Columbia. Species from the southwest and central Pacific move along a broad front with the Hawaiian Island region at its center, while some species from the Southwest Pacific and those from the Western Pacific move northeast past Japan by way of waters south of the Aleutian Islands. Months of greatest migratory activity in the Gulf of Alaska are May and October, although migrants may arrive as early as mid March and depart as late as mid November. Forsell and Gould (1981) found waterfowl still moving into the Kodiak Archipelago as late as early December.

Alaskan waters, especially the Gulf of Alaska, Bering Sea, and Chukchi Sea, are the northern terminus for many of the more common migrants, so that peak numbers in these regions are reached later in summer. Migration is generally more rapid and concentrated in spring than in fall, movement in the fall often being a slow southward withdrawal or simply a pelagic dispersal of individuals. Thus, densities in local areas of the gulf tend to be higher in spring than in fall.

Sea birds in the Gulf of Alaska reach their maximum numbers over the continental shelf south of Kodiak Island and the Alaskan Peninsula, locations corresponding to the largest and most diverse breeding colonies. This general area also supports the majority of seabirds in winter, although there is considerable fluctuation from year to year as a result of shifting climatic and oceanographic conditions (Maps III 99-106). In mild winters, many individuals tend to remain in the southern Bering Sea or in the far western Gulf. In severe winters, however, large numbers move east into the Kodiak Archipelago, where many deep bays and fjords offer protection from the elements. This pattern is especially evident in King Eiders and Crested Auklets, whose winter distributions reach their easternmost extension in the Kodiak area.

There is also a considerable shifting about of local seabird concentrations in response to the occurrence and movements of food species. Large assemblages of birds develop in areas of high food availability, such as the million or more Common Murres associated with the large numbers of capelin that occurred near Kodiak Island in the winter of 1979-80 (Forsell and Gould 1981). Springer et al. (1979) documented such changes by noting seasonal shifts in flight directions of murres leaving and returning to the Cape Thompson and Cape Lisburne colonies in the Chukchi Sea. Depletion or movement of the food supply generally results in a corresponding reduction or movement of the attendant seabirds. Seabirds are highly mobile and many frequently forage at long distances from colonies; such populations probably respond quickly to changes in the distribution or availability of the food supply. Nonbreeding species such as shearwaters have an even greater flexibility and appear to be in more or less continual motion over rather extensive areas.



NORTHERN FULMARS. PHOTO BY ANTHONY R. DEGANGE.

## DISTRIBUTION AND ABUNDANCE OF MARINE BIRDS IN THE BERING SEA

Sixty species of marine birds were encountered in surveys of the Bering Sea, this being 70 % of the total species recorded in the State. Our surveys of the Bering Sea included about 2,300 shipboard and 1,700 aerial transects covering more than 3,400 and 2,300 square kilometers of ocean, respectively (see Appendices D1-D2, and Maps 107-113). Nearly 54 % of shipboard surveys were conducted in May, June, and July and 61.5 % of aerial surveys in either August or October. We conducted no shipboard surveys and only a few aerial surveys in the Bering Sea from December through February (Table 15).

Table 15. Percent of total surveys conducterd during different months in the eastern Bering Sea, 1975-1978.

| | Percent of Total Transects or Stations | | |
|---|---|---|---|
| Month | Shipboard Transects | Shipboard Stations | Aerial Transects |
| January | 0.0 | 0.0 | 0.0 |
| February | 0.0 | 0.0 | 8.5 |
| March | 1.9 | 7.5 | 6.6 |
| April | 6.6 | 14.6 | 13.3 |
| May | 15.8 | 5.9 | 0.0 |
| June | 28.1 | 5.9 | 6.0 |
| July | 10.1 | 5.6 | 3.3 |
| August | 11.1 | 33.5 | 32.3 |
| September | 19.4 | 14.3 | 0.0 |
| October | 4.4 | 8.4 | 29.2 |
| November | 2.6 | 4.3 | 0.0 |
| December | 0.0 | 0.0 | 0.7 |

The following accounts contain summaries and highlights of these observations and draw freely from other information sources including Murie (1959), Gabrielson and Lincoln (1959), Kessel and Gibson (1978), Sowls et al. (1978), and Hunt et al. (1981c), as well as the personal experience of the authors. Density indices and frequencies of occurrence for seasons and habitats within the Bering Sea are provided in Appendix D. Maps 107-197 show the seasonal distribution and abundance of marine birds throughout the Bering Sea. The occurrence and relative densities of all avian taxa identified in our surveys of the Bering Sea are presented by season and habitat in Tables 16-19.

### GAVIIDAE

Four species of loons occur in the eastern Bering Sea as regular visitors and migrants. Our earliest and latest records were 25 April 1977 and 14 November 1975, although Gabrielson and Lincoln (1959) indicated that several, if not all, of the species may winter near the Aleutian Islands. Breeding and visiting birds were rarely seen farther than 50 km from land and seldom over water depths greater than 50 m. Migrants, on the other hand, frequently flew directly north from Unimak Pass over waters 50 to more than 100 m deep and were often up to 300 km from the nearest coast (Appendix D3 and Maps 114-120). Migrants rarely drifted westward, and we have only a few observations of loons west of 168°W, other than in the Aleutian Islands.

† COMMON LOONS constituted 24 % of all loons identified to species in our surveys. Our early and late records were 31 May 1978 and 17 October 1975.

† YELLOW-BILLED LOONS were found on only two occasions: 1 bird on 5 June 1978 near Atka Island in the Aleutians and 1 bird on 26 August 1976 near St. Lawrence Island.

† ARCTIC LOONS composed 59 % of all loons identified to species in our surveys. Our early and late sightings were 21 May 1976 and 17 October 1976. A single bird of this species observed near St. Paul on 25 September 1975 was the only loon sighted in the vicinity of the Pribilof Islands.

† RED-THROATED LOONS constituted 15 % of all loons identified to species in our surveys. Our early and late records were 7 July 1975 and 19 October 1976, respectively.

### PODICIPEDIDAE

Grebes are mostly restricted to inshore marine and inland fresh water habitats. Such areas were not well surveyed during our studies in the eastern Bering Sea and our data base is inadequate for assessing their status.

† RED-NECKED GREBES were the only grebes observed in our surveys. We found them on five occasions. The earliest and only spring or summer observation was near Shemya Island in the Western Aleutians on 23 May 1976. The remaining sightings were all near the Alaskan Peninsula in Bristol Bay, the latest occurring on 21 November 1975.

† HORNED GREBES are occasional breeding visitors and uncommon winter visitors to the eastern Bering Sea and Aleutian Islands (Kessel and Gibson 1978). We did not see this species in Bristol Bay.

### DIOMEDEIDAE

Two species of albatrosses occur as nonbreeding visitors in the southeastern Bering Sea from April through October. Our observations indicated that, with only an occasional exception, their distribution within the Bering Sea was restricted to the immediate

Table 16. Percentage of total seabirds seen in spring (March-May) during shipboard and aerial surveys of different habitats in the Bering Sea. Total birds seen (No./$Km^2$) in each habitat and during each type of survey are shown in parentheses.

| Species | Shipboard Shelf & Bay (67.3) | Shipboard Shelfbreak (54.2) | Shipboard Oceanic (13.5) | Aerial Shelf & Bay (45.5) | Aerial Shelfbreak (8.4) | Aerial Oceanic (8.8) |
|---|---|---|---|---|---|---|
| Common Loon | 0 | + | 0 | 0 | 0 | 0 |
| Arctic Loon | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Loon | + | 0 | 0 | + | 0 | 0 |
| Red-necked Grebe | + | 0 | 0 | 0 | 0 | 0 |
| Laysan Albatross | 0.1 | 0.8 | 2.7 | 0 | 0 | 0 |
| Northern Fulmar | 7.4 | 27.9 | 20.4 | 1.0 | 26.8 | 11.9 |
| Flesh-footed Shearwater | 0 | + | 0 | 0 | 0 | 0 |
| Sooty Shearwater | 0.5 | 0.3 | 0 | 0 | 0 | 0 |
| Short-tailed Shearwater | 0.7 | 1.1 | 0 | 0 | 0 | 0 |
| Unidentified Shearwater | 6.6 | 7.0 | 3.9 | 0 | 0.3 | 0 |
| Fork-tailed Storm-Petrel | 1.4 | 3.3 | 4.8 | 0.1 | 34.5 | 60.4 |
| Leach's Storm-Petrel | + | 0.1 | 0 | 0 | 0.3 | 0 |
| Unidentified Storm-Petrel | + | 0 | 0.2 | 0 | 0 | 0 |
| Double-crested Cormorant | + | 0 | 0 | 0 | 0 | 0 |
| Pelagic Cormorant | 0.2 | + | 0 | 0 | 0 | 0 |
| Red-faced Cormorant | 5.4 | 0.1 | 5.5 | 0.1 | 0 | 0 |
| Unidentified Cormorant | 3.7 | + | 0.2 | 0.4 | 0.5 | 0 |
| Brant | 0.3 | 0 | 0 | 0 | 0 | 0 |
| Emperor Goose | + | 0 | 0 | 0 | 0 | 0 |
| Greater Scaup | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Scaup | + | 0 | 0 | 0 | 0 | 0 |
| Common Goldeneye | + | 0 | 0 | 0 | 0 | 0 |
| Oldsquaw | 1.2 | 0 | 0 | 2.5 | 0 | 0 |
| Harlequin Duck | + | 0 | 0 | 0.4 | 0 | 0 |
| Steller's Eider | + | 0 | 0 | 1.2 | 0 | 0 |
| Common Eider | + | 0 | 0 | + | 0 | 0 |
| King Eider | 0.5 | 0 | 0 | 34.5 | 0 | 0 |
| Unidentified Eider | 0.1 | 0 | 0 | 1.2 | 0 | 0 |
| White-winged Scoter | 0.1 | 0 | 0 | 1.7 | 0 | 0 |
| Black Scoter | + | 1.7 | 0 | 1.5 | 0 | 0 |
| Unidentified Scoter | + | 0 | 0 | 1.8 | 0 | 0 |
| Unidentified Ducks & Geese | + | 0 | 0.5 | + | 0 | 0 |
| Red Phalarope | + | 0.1 | 0 | 0 | 0 | 0 |
| Northern Phalarope | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Phalarope | + | 0.1 | 0 | 0 | 0 | 0 |
| Pomarine Jaeger | + | 0 | 0 | + | 0 | 0 |
| Parasitic Jaeger | + | + | 0 | 0 | 0 | 0 |
| Long-tailed Jaeger | + | + | 0 | 0 | 0 | 0 |
| Unidentified Jaeger | + | 0 | 0 | 0 | 0 | 0 |
| Glaucous Gull | 0.2 | + | 0.2 | + | 0 | 0 |
| Glaucous-winged Gull | 1.7 | 4.8 | 4.8 | 1.3 | 7.0 | 3.0 |
| Slaty-backed Gull | + | 0 | 0 | 0 | 0 | 0 |
| Herring Gull | + | + | 0 | 0 | 0 | 0 |
| Thayer's Gull | + | + | 0 | 0 | 0 | 0 |
| Mew Gull | + | 0 | 0 | + | 0 | 0 |
| Black-headed Gull | + | + | 0 | 0 | 0 | 0 |
| Ivory Gull | 0 | 0 | 0 | + | 0 | 0 |
| Black-legged Kittiwake | 2.9 | 3.3 | 9.4 | 1.0 | 5.7 | 11.9 |
| Red-legged Kittiwake | 0.3 | + | 0.3 | + | 1.0 | 0 |
| Unidentified Kittiwake | 0.2 | 0.1 | 0.2 | + | 0 | 0 |
| Sabine's Gull | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Gull | 0.1 | + | 0.3 | + | 0 | 0 |
| Arctic Tern | + | 0 | 0 | 0 | 0 | 0 |
| Aleutian Tern | + | 0 | 0 | 0 | 0 | 0 |
| Common Murre | 1.4 | 0.2 | 0.3 | + | 0 | 0 |
| Thick-billed Murre | 2.0 | 0.8 | 0.2 | + | + | 0 |
| Unidentified Murre | 21.7 | 2.4 | 2.2 | 48.5 | 22.1 | 11.2 |
| Pigeon Guillemot | 0.2 | 0 | 0 | 0.2 | 0 | 0 |
| Kittlitz's Murrelet | + | 0 | 0 | 0 | 0 | 0 |
| Ancient Murrelet | 5.3 | 3.2 | 5.1 | 0 | 0 | 0 |
| Cassin's Auklet | 0.1 | 0 | 0 | 0 | 0 | 0 |
| Parakeet Auklet | 0.6 | 4.5 | 0 | 0.1 | 0 | 0 |
| Crested Auklet | 1.7 | 7.8 | 0.5 | 0.1 | 0 | 0 |
| Least Auklet | 9.9 | 19.7 | 11.8 | 1.1 | 0 | 0 |
| Whiskered Auklet | 9.7* | 0.1 | 0 | 0.1 | 0 | 0 |
| Unidentified Aethia | 4.5 | 5.2 | 0.3 | 0 | 0 | 0 |
| Horned Puffin | 0.1 | 0.1 | 0 | + | 0.3 | 0 |
| Tufted Puffin | 3.6 | 1.2 | 6.2 | + | 0.3 | 0 |
| Unidentified Alcid | 4.9 | 4.1 | 18.9 | 0.9 | 0 | 1.5 |

*Density for Whiskered Auklet is high as a result of encountering one large concentration.

Table 17. Percentage of total seabidrds seen in summer (June-August) during shipboard and aerial surveys of different habitats in the Gulf of Alaska.

| Species | Shipboard Shelf & Bay (211.6) | Shipboard Shelfbreak (67.7) | Shipboard Oceanic (13.9) | Aerial Shelf & Bay (54.8) | Aerial Shelfbreak (7.1) | Aerial Oceanic (9.7) |
|---|---|---|---|---|---|---|
| Common Loon | 0 | 0 | 0 | + | 0 | 0 |
| Yellow-billed Loon | + | 0 | 0 | + | 0 | 0 |
| Arctic Loon | + | 0 | 0 | + | 0 | 0 |
| Red-throated Loon | 0 | 0 | 0 | + | 0 | 0 |
| Unidentified Loon | + | 0 | 0 | + | 0 | 0 |
| Black-footed Albatross | 0 | + | + | 0 | 0 | 0 |
| Laysan Albatross | + | 0.6 | 0.6 | 0 | 0 | 0 |
| Northern Fulmar | 3.3 | 27.2 | 24.2 | 0.2 | 15.0 | 27.7 |
| Flesh-footed Shearwater | + | 0 | 0 | + | 0 | 0 |
| Sooty Shearwater | 0.6 | 2.5 | 0.5 | 4.3 | 0 | 0 |
| Short-tailed Shearwater | 7.2 | 2.2 | 1.4 | 0 | 0 | 0 |
| Unidentified Shearwater | 68.9 | 16.9 | 21.5 | 61.7 | 30.1 | 58.8 |
| Fork-tailed Storm-Petrel | 2.0 | 12.2 | 17.8 | 0.1 | 0.8 | 0 |
| Leach's Storm-Petrel | 0.2 | 0.2 | 1.2 | 0 | 0 | 5.4 |
| Unidentified Storm-Petrel | + | 0.1 | 0.3 | + | 0 | 0 |
| Scaled Petrel | + | + | + | 0 | 0 | 0 |
| Pelagic Cormorant | + | 0 | 0 | + | 0 | 0 |
| Red-faced Cormorant | 2.7 | 0.2 | 0.1 | 0 | 0 | 0 |
| Unidentified Cormorant | 0.4 | 0.3 | 0 | 2.3 | 11.3 | 0 |
| Tundra Swan | 0 | 0 | 0 | + | 0 | 0 |
| Brant | 0 | 0 | 0 | + | 0 | 0 |
| Emperor Geese | + | 0 | 0 | + | 0 | 0 |
| Oldsquaw | 0 | 0 | 0 | + | 0 | 0 |
| Harlequin Duck | + | 0 | 0 | 0 | 0 | 0 |
| Common Eider | 0 | 0 | 0 | + | 0 | 0 |
| King Eider | + | 0 | + | 0.6 | 0 | 0 |
| Unidentified Eider | + | 0 | 0 | 0.3 | 0 | 0 |
| White-winged Scoter | + | 0 | 0 | 0.6 | 0 | 0 |
| Surf Scoter | 0 | 0 | 0 | 0.3 | 0 | 0 |
| Black Scoter | 0 | 0 | 0 | 0.6 | 0 | 0 |
| Unidentified Scoter | + | 0 | 0 | 0.4 | 0 | 0 |
| Unidentified Geese & Ducks | + | 0 | 0 | 0.2 | 0 | 0 |
| Red Phalarope | 0.1 | + | 0.1 | 0 | 0 | 0 |
| Northern Phalarope | 0.3 | + | 0.3 | 0 | 0 | 0 |
| Unidentified Phalarope | 0.1 | 0.2 | 0.4 | 0.2 | 0 | 2.0 |
| Pomarine Jaeger | 0.1 | 0.3 | 1.2 | + | 0 | 0 |
| Parasitic Jaeger | + | 0.1 | 0.1 | + | 2.3 | 2.0 |
| Long-tailed Jaeger | + | 0.1 | + | + | 0 | 0 |
| Unidentified Jaeger | + | 0.2 | 0.1 | 0.1 | 1.5 | 0 |
| Glaucous Gull | + | 0 | 0 | 0 | 0 | 0 |
| Glaucous-winged Gull | 0.5 | 1.6 | 2.0 | 1.5 | 4.5 | 0 |
| Herring Gull | 0 | 0 | 0 | 0.1 | 0 | 0 |
| Mew Gull | 0 | 0 | 0 | + | 0 | 0 |
| Black-legged Kittiwake | 1.2 | 2.1 | 4.6 | 0.5 | 0 | 0 |
| Red-legged Kittiwake | + | 0.1 | 2.5 | 0 | 0 | 0 |
| Unidentified Kittiwake | 0.6 | 0.6 | 2.3 | 2.4 | 8.3 | 0.7 |
| Sabine's Gull | + | + | 0 | + | 0 | 0 |
| Unidentified Gull | 0.1 | + | 0 | 1.7 | 0 | 0 |
| Common Tern | + | 0 | 0 | 0 | 0 | 0 |
| Arctic Tern | + | 0.5 | 0.4 | 0.1 | 0 | 0 |
| Aleutian Tern | 0 | 0 | 0 | + | 0 | 0 |
| Unidentified Tern | + | 0 | 0 | + | 0 | 0 |
| Common Murre | 1.8 | 0.1 | 0.3 | + | 0 | 0 |
| Thick-billed Murre | 0.5 | 0.3 | 0.9 | + | 0 | 0 |
| Unidentified Murre | 5.7 | 1.2 | 1.6 | 7.3 | 0.8 | 2.7 |
| Pigeon Guillemot | + | + | 0 | 0.1 | 0 | 0 |
| Kittlitz's Murrelet | + | 0 | 0 | 0 | 0 | 0 |
| Ancient Murrelet | 0.4 | 1.1 | 0 | 0 | 0 | 0 |
| Cassin's Auklet | + | + | 0 | 0 | 0 | 0 |
| Parakeet Auklet | + | 0.1 | 0.1 | 2.2 | 0 | 0 |
| Crested Auklet | 0.4 | 0.9 | 6.0 | 6.6 | 0 | 0 |
| Least Auklet | 0.3 | 1.4 | 1.7 | 3.2 | 0 | 0 |
| Whiskered Auklet | 0.1 | 0.2 | 0 | 0 | 0 | 0 |
| Unidentified Aethia | 0.6 | 4.9 | 0.3 | 0 | 0 | 0 |
| Rhinoceros Auklet | 0 | 0 | + | 0 | 0 | 0 |
| Horned Puffin | 0.2 | 0.6 | 0.7 | + | 0.8 | 0 |
| Tufted Puffin | 1.3 | 3.5 | 6.0 | 0.4 | 23.3 | 0 |
| Unidentified Alcid | 0.4 | 15.2 | 1.0 | 1.4 | 1.5 | 0.7 |

Table 18. Percentage of total seabirds seen in fall (September-November) during shipboard and aerial surveys of different habitats in the eastern Bering Sea. Total birds seen (No./Km$^2$) in each habitat and during each type of survey are shown in parentheses.

| Species | Type of survey, and Habitat | | | | | |
|---|---|---|---|---|---|---|
| | Shipboard | | | Aerial | | |
| | Shelf & Bay | Shelfbreak | Oceanic | Shelf & Bay | Shelfbreak | Oceanic |
| | (81.4) | (241.0) | (14.8) | (50.3) | (88.4) | (24.1) |
| Common Loon | + | 0 | 0 | + | 0 | 0 |
| Arctic Loon | 0.1 | 0 | 0 | + | 0 | 0 |
| Red-throated Loon | + | 0 | 0 | + | 0 | 0 |
| Unidentified Loon | 0.1 | 0 | 0 | 0.2 | 0 | 0 |
| Red-necked Grebe | + | 0 | 0 | 0 | 0 | 0 |
| Black-footed Albatross | + | 0 | 1.0 | 0 | 0 | 0 |
| Laysan Albatross | 0 | 0 | 0.5 | 0 | 0 | 0 |
| Northern Fulmar | 5.7 | 14.7 | 47.4 | 46.6 | 69.3 | 68.5 |
| Flesh-footed Shearwater | + | 0 | 0 | 0 | 0 | 0 |
| Sooty Shearwater | 0.2 | + | 0.3 | 0.1 | 0.1 | 0 |
| Short-tailed Shearwater | 34.5 | 73.7 | 0.2 | 0 | 0 | 0 |
| Unidentified Shearwater | 33.9 | 2.6 | 13.9 | 20.5 | 0.5 | 0 |
| Fork-tailed Storm-Petrel | 2.2 | 4.0 | 14.9 | 0.3 | 1.7 | 23.9 |
| Leach's Storm-Petrel | 0 | + | 0.5 | 0 | 0 | 0 |
| Unidentified Storm-Petrel | 0 | + | 0 | 0 | 0 | 0 |
| Scaled Petrel | 0 | + | 2.1 | 0 | 0 | 0 |
| Pelagic Cormorant | + | 0 | 0 | + | 0 | 0 |
| Red-faced Cormorant | + | 0 | 0 | + | 0 | 0 |
| Unidentified Cormorant | 0.1 | 0 | 0 | 0.3 | 0 | 0 |
| Brant | + | 0 | 0 | 0 | 0 | 0 |
| Emperor Goose | + | 0 | 0 | + | 0 | 0 |
| Unidentified Geese | + | + | 0 | 0 | 0 | 0 |
| Oldsquaw | + | 0.1 | 0 | 0.2 | 0 | 0 |
| Harlequin Duck | + | + | 0 | 0.1 | 0 | 0 |
| Steller's Eider | + | 0 | 0 | 0 | 0 | 0 |
| Common Eider | + | 0 | 0 | + | 0 | 0 |
| King Eider | + | 0 | 0 | 0.1 | 0 | 0 |
| Spectacled Eider | 0 | 0.1 | 0 | 0 | 0 | 0 |
| Unidentified Eider | + | 0 | 0 | 0.6 | 0 | 0 |
| White-winged Scoter | 0.1 | 0 | 0 | 0.2 | 0 | 0 |
| Surf Scoter | 0 | 0 | 0 | + | 0 | 0 |
| Black Scoter | + | + | 0 | 3.2 | 0 | 0 |
| Unidentified Scoter | 0 | 0 | 0 | 2.6 | 0 | 0 |
| Unidentified Merganser | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Geese & Ducks | 0.4 | 0.1 | 0.1 | 0.3 | 0 | 0 |
| Red Phalarope | 0.3 | 0.1 | 0 | 0 | 0 | 0 |
| Northern Phalarope | 0.4 | 0.3 | 0.3 | 0 | 0 | 0 |
| Unidentified Phalarope | 0.2 | 0.4 | 0.4 | 4.4 | 4.2 | 0 |
| Pomarine Jaeger | 0.1 | + | 0 | + | 0 | 0 |
| Parasitic Jaeger | 0.1 | 0 | 0 | + | 0 | 0 |
| Long-tailed Jaeger | + | 0 | 0 | + | 0 | 0 |
| Unidentified Jaeger | 0.1 | + | 0.1 | + | + | 0 |
| Glaucous Gull | 0.1 | + | 0 | 1.1 | 0 | 0 |
| Glaucous-winged Gull | 0.7 | 0.8 | 0.1 | 3.4 | 5.6 | 0 |
| Slaty-backed Gull | + | 0 | 0 | 0 | 0 | 0 |
| Herring Gull | + | + | 0 | + | 0 | 0 |
| Thayer's Gull | + | 0 | 0 | 0 | 0 | 0 |
| Ivory Gull | + | 0 | 0 | 0 | 0 | 0 |
| Black-legged Kittiwake | 1.5 | 0.7 | 3.3 | 4.7 | 14.1 | 1.7 |
| Red-legged Kittiwake | + | 0 | 0 | + | 0.1 | 1.2 |
| Unidentified Kittiwake | 3.1 | 0.6 | 1.7 | 0 | 0 | 0 |
| Sabine's Gull | + | + | 0.1 | + | 0 | 0 |
| Unidentified Gull | 0.1 | + | 0.1 | 0.4 | 0 | 0 |
| Arctic Tern | 0.1 | + | 0 | 0 | 0 | 0 |
| Aleutian Tern | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Tern | + | 0 | 0 | 0 | 0 | 0 |
| Common Murre | 0.2 | + | 0 | 0 | 0 | 0 |
| Thick-billed Murre | 0.4 | + | 0.1 | + | 0 | 0 |
| Unidentified Murre | 5.0 | 0.5 | 0.4 | 7.2 | 3.3 | 0 |
| Pigeon Guillemot | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Guillemot | + | 0 | 0 | 0 | 0 | 0 |
| Marbled Murrelet | + | 0 | 0 | 0 | 0 | 0 |
| Unidentified Murrelet | + | 0 | 0 | 0 | 0 | 0 |
| Ancient Murrelet | 0.2 | + | 0 | 0 | 0 | 0 |
| Cassin's Auklet | + | 0 | 0 | 0 | 0 | 0 |
| Parakeet Auklet | 0.7 | + | 0 | 0.5 | + | 0 |
| Crested Auklet | 1.9 | 0.1 | 0.4 | 0.2 | 0.1 | 0.3 |
| Least Auklet | 0.6 | 0 | 0.1 | 0.9 | 0 | 0 |
| Whiskered Auklet | + | 0 | 0 | 0 | 0 | 0 |
| Horned Puffin | 0.2 | + | 0 | + | 0 | 0 |
| Tufted Puffin | 4.6 | 0.8 | 8.6 | 1.3 | 0.9 | 4.4 |
| Unidentified Alcid | 1.6 | 0.1 | 2.8 | 0.3 | 0.2 | 0 |

Table 19. Percentage of total seabirds seen in winter (December-February) during shipboard and aerail surveys of different habitats in the eastern Bering Sea. Total birds seen (No./Km$^2$) in each habitat and during each type of survey are shown in parentheses.

| Species | Type of Survey, and Habitat | | | | | |
|---|---|---|---|---|---|---|
| | Shipboard | | | Aerial | | |
| | Shelf & Bay | Shelfbreak | Oceanic | Shelf & Bay | Shelfbreak | Oceanic |
| | (-) | (-) | (-) | (27.7) | (9.1) | (6.2) |
| Northern Fulmar | - | - | - | 4.6 | 32.4 | 27.0 |
| Fork-tailed Storm Petrel | - | - | - | 0 | 28.7 | 20.2 |
| Unidentified Cormorant | - | - | - | 0.4 | 0 | 0 |
| Oldsquaw | - | - | - | 3.5 | 0 | 0 |
| Common Eider | - | - | - | 0.5 | 0 | 0 |
| King Eider | - | - | - | 22.9 | 0 | 0 |
| Unidentified Eider | - | - | - | 1.3 | 0 | 0 |
| White-winged Scoter | - | - | - | 0.1 | 0 | 0 |
| Surf Scoter | - | - | - | + | 0 | 0 |
| Unidentified Geese & Ducks | - | - | - | 1.9 | 0 | 0 |
| Glaucous-winged Gull | - | - | - | 0.7 | 14.8 | 2.2 |
| Black-legged Kittiwake | - | - | - | + | 0 | 4.5 |
| Red-legged Kittiwake | - | - | - | 0 | 0.9 | 11.2 |
| Unidentified Kittiwake | - | - | - | 0 | 0 | 3.4 |
| Unidentified Gull | - | - | - | 0 | 1.9 | 4.5 |
| Thick-billed Murre | - | - | - | 0.1 | 0 | 0 |
| Unidentified Murre | - | - | - | 56.1 | 0 | 0 |
| Kittlitz's Murrelet | - | - | - | 0.1 | 0 | 0 |
| Parakeet Auklet | - | - | - | 0.9 | 3.7 | 0 |
| Crested Auklet | - | - | - | 4.9 | 0 | 0 |
| Least Auklet | - | - | - | 0.2 | 15.7 | 24.7 |
| Horned Puffin | - | - | - | + | 0 | 0 |
| Unidentified Alcid | - | - | - | 1.3 | 0.9 | 2.2 |

vicinity of the Aleutian Islands or waters deeper than 200 m. An occasional bird may follow a ship into waters over the continental shelf but none apparently remain there for long.

† BLACK-FOOTED ALBATROSSES were uncommon and restricted to deep waters near the Aleutian Islands. The single exception during our surveys was a single bird found over the continental shelf just north of Unimak Pass. Our sightings were scattered between 2 July 1977 and 9 October 1975, the largest number seen at any one time being six, over deep water just north of Kanaga Island. Irving et al. (1970) reported a dark-backed albatross which they thought to be this species on 6 March 1968 about 30 miles north of Unalaska Island.

† LAYSAN ALBATROSSES outnumbered Black-foots in the southeastern Bering Sea by about 16:1. This is the reverse of the 1:12 ratio found in the Gulf of Alaska and emphasizes the geographic separation of the two species. Not only were Laysans more frequent and abundant in the Bering Sea than Black-foots, but they also occurred farther north, penetrating to 57°30'N with fair numbers found around the edge of Bower's Ridge north of the central Aleutian and western Islands. The largest number sighted on any one transect was 14 birds on 17 May 1975 over deep water northwest of Kiska Island.

† SHORT-TAILED ALBATROSSES formerly occurred around the Aleutian Islands and in oceanic habitat within the Bering Sea. Their world population is now so small that they must be considered extremely rare in any region (Hasagawa 1978). We did not see this species.

FULMARINAE

The Northern Fulmar is the only member of this subfamily occurring in the North Pacific and is also the only species in the family Procellariidae breeding in Alaska.

† NORTHERN FULMARS occur over all ice free waters in the Bering Sea throughout the year (Shuntov 1972). We found them to be very uncommon over waters less than 50 m deep and extremely abundant along the 200 m isobath between Unimak Pass and the Pribilof Islands (Maps 121-127). Fulmars were strongly attracted to ships, about which they gathered to forage on garbage or offal, and all of our sightings of concentrations of 1,000 or more fulmars were in the vicinity of either large rookeries or fishing vessels. The attraction of fulmars to ships and the frequent occurrence of large assemblages resulting from such behavior produced very high density indices on many of our surveys (Appendix D4). Population indices from our aerial surveys indicated an at-sea population of about 2.1 million fulmars in summer, and much higher numbers in fall. The fall indices may be biased by inclusion of several very large aggregations of fulmars that we encountered over the shelfbreak at that time.

PUFFININAE

Eight members of this subfamily have been observed in Alaskan waters but only three species of shearwaters and the scaled petrel were observed in our surveys. All of the eight species are non-breeding visitors to the North Pacific, migrating there from the far South Pacific at the beginning of the austral winter and returning there at the start of the boreal winter. These birds are the numerically dominant group of seabirds over pelagic waters of the Bering Sea from at least May through October; Short-tailed Shearwaters composed at least 90 percent of all shearwaters observed on transects.

† FLESH-FOOTED SHEARWATERS are rare visitors in summer to the southern Bering Sea (Kessel and Gibson 1978). We did not see this species in Bristol Bay.

† PINK-FOOTED SHEARWATERS were not recorded from the Bering Sea until our surveys in 1975. During that year, we made four sightings: one bird at 58°20'N x 158°00'W on 14 June, one bird at 57°21'N x 165°50'W on 14 September, one bird at 52°48'N x 173'44'E on 12 June, and one bird at 52°20'N x 176°33'E on 18 May.

† SOOTY and SHORT-TAILED SHEARWATERS are difficult to differentiate in the field and most of our data were collected and analyzed on the basis of "unidentified dark shearwaters." Shuntov (1972), who summarized much of what is known about the pelagic biology of these birds in the Pacific, found that they entered the Bering Sea through the Aleutian passes in May and June and departed in September and especially in October. Our data agree with Shuntov's observations. Early and late dates of occurrence in our surveys were 24 April and 22 November.

We found both species in the Bering Sea, but Sooty Shearwaters composed only 3 % of the 55,538 shearwaters identified to species. Densities of Short-tailed Shearwaters were high from the Aleutians north through the Bering Strait into the Chukchi Sea, whereas most Sooties were restricted to areas near the Aleutian Islands and in a roughly triangular area of the southeast region delineated by 53°40'N x 168°30'W, 56°40'N x 160°00'W, and 59°10'N x 168°30'W. The largest single group of Sooty Shearwaters in our surveys was 5,900 individuals associated with 600 Short-tailed Shearwaters at 56°18'N x 162°59'W on 28 September 1976. Short-tails, in contrast, often numbered in the hundreds of thousands of birds; Guzman (1976) reported an estimated 10 million shearwaters northeast of the Pribilof Islands (ca. 58°50'N x 157°40'W) on 17 August 1975. What may have been components of this aggregation were found by us south of Nunivak Island on 17 and 24 August 1975 (Table 20). Assemblages of over 10,000 shearwaters observed in our surveys are listed in Table 20. The locations of these large flocks and, concomitantly of areas of high density (> 900 B/km$^2$), lie in a generally V-shaped path beginning over the shelfbreak near the eastern Aleutian Islands and following the coast into eastern Bristol Bay then northward along the 50-m isobath to about 59°N x 168° W (Maps 128-134). Hunt et al. (1981c) suggested that this distribution is influenced by oceanographic conditions, especially frontal systems, in the eastern Bering Sea and the influence of these systems on organisms preyed upon by shearwaters. Several large flocks have also been recorded in the far north between St. Lawrence Island and the Chukchi Sea.

Table 20. List of all shearwater assemblages of more than 10,000 birds recorded by us in the Bering and Chukchi seas; listed by location from north to south.

| Location | | | | | |
|---|---|---|---|---|---|
| Latitude (N) | Longitude (W) | Flock size (thousands) | Species[a] | Behavior[b] | Date |
| 67°54' | 166°20' | 10 | UNSH | NR | 4 Oct. 76 |
| 67°00' | 165°25' | 10 | UNSH | NR | 6 Oct. 76 |
| 66°42' | 166°20' | 26 | UNSH | NR | 4 Oct. 76 |
| 65°50' | 169°34' | 205 | STSH | Flying | 8 Sep. 76 |
| 64°30' | 168°00' | 22 | UNSH | NR | 6 Oct. 76 |
| 58°56' | 167°52' | 136 | 90% STSH | NR | 7 Aug. 75 |
| 58°34' | 166°31' | > 100 | Mixed | Sitting | 4 Aug. 75 |
| 58°23' | 157°52' | 300 | UNSH | NR | 3 Jul. 76 |
| 58°18' | 165°50' | > 100 | Mixed | NR | 6 Aug. 75 |
| 58°14' | 164°32' | 25 | STSH | NR | 1 Jul. 76 |
| 58°09' | 166°52' | > 100 | STSH | Flying | 2 Sep. 75 |
| 58°04' | 160°40' | 32 | STSH | Flying | 6 Sep. 76 |
| 58°00' | 162°00' | 10 | UNSH | NR | 2 Jun. 75 |
| 57°40' | 158°00' | 12 | UNSH | NR | 5 Jul. 75 |
| 55°35' | 163°00' | 19 | UNSH | NR | 1 Aug. 75 |
| 54°58' | 165°56' | 10 | UNSH | NR | 6 Aug. 75 |
| 54°34' | 165°00' | 40 | UNSH | Flying | 4 Jul. 76 |
| 54°24' | 164°57' | 60 | Mixed | Sitting | 9 Jun. 76 |
| 54°22' | 164°56' | 30 | UNSH | NR | 9 May 76 |
| 54°20' | 165°22' | 12 | UNSH | NR | 5 Oct. 75 |
| 54°09' | 166°14' | 50 | STSH | Flying | 7 Jul. 75 |
| 54°03' | 166°30' | 60 | STSH | Feeding | 3 Sep. 76 |
| 54°00' | 166°28' | 77 | 98% STSH | Feeding | 1 Sep. 76 |
| 53°43' | 167°08' | > 1,000 | UNSH | Sitting | 0 Sep. 75 |

[a] UNSH = Unidentified Shearwater, STSH - Short-tailed Shearwater, Mixed = Both species present in fair numbers.

[b] NR = Behavior not recorded.

On the average, our shipboard surveys produced far higher density indices than did our aerial surveys, but large variances were associated with both (Appendix D5). Population indices derived from shipboard surveys, especially for summer over the continental shelf and fall over the shelfbreak, were probably greater than the actual population. Aerial surveys for summer in the eastern Bering Sea produced data indicating a population index of about 12 million shearwaters. Minimum estimates range as low as 9 million and maximum estimates to 50 million or more. An Alaskan population index for Short-tailed Shearwaters would be 97 % of 12 million shearwaters in the Bering Sea, plus 32 % of 12.4 million shearwaters in the Gulf of Alaska, plus an unknown number south of the Aleutian Islands for a total of > 16 million. This is close to the nearly 16.4 million estimated for Tasmania--basically the entire world population (Naarding 1980). Using the same numbers the Alaskan population of Sooty Shearwaters would be > 8.8 million. The number of shearwaters in the Bering Sea fluctuates, however, as birds move back and forth through the Aleutian passes and the Bering Strait.

† SCALED PETRELS are uncommon non-breeding visitors to oceanic habitat in the Bering Sea. Kenyon and Phillips (1965) observed 28 birds in 2 hours on 25 July 1961 at 55°20'N x 175°25'W. We saw 3 birds in the western Aleutian Islands in July and August 1975, and 23 in the oceanic area between 53-58°N and 170-173°W in September and October 1975.

HYDROBATIDAE

In the eastern Bering Sea, storm-petrels breed only among the Aleutian Islands, and their abundance at sea decreases to the north (Maps 135-141). There are few records in the literature for birds north of the Bering Strait but our northernmost sighting was of four Fork-tailed Storm-Petrels on 14 September 1975 at 65°37'N x 168°29'W. The small size of these birds and their habit of flying low over the water make them difficult to detect. Consequently, both shipboard and aerial surveys usually produce underestimates of density. Fork-tails, however, frequently follow ships--a habit that increases their detectability and may occasionally cause inflated density indices (Appendix D6). The formation of flocks during migration also increases the detectability of storm-petrels.

Sowls et al. (1978) estimated that about 9 million storm-petrels are associated with colonies in Alaska, and their raw data suggested that 48 percent occurred in the Aleutian Islands in a ratio of about 1 Fork-tail to 1.5 Leach's. Recent detailed surveys of the eastern Aleutian Islands by David Nysewander and Douglas Forsell (personal communication), indicated that Fork-tails were actually more abundant in that area than Leach's, with a ratio of about 1.8 Fork-tails to 1 Leach's. Leach's Storm-Petrels were much more restricted to deep water habitats than were Fork-tails and these habitats were only lightly covered in our surveys. Of the almost 9,000 storm-petrels identified to species in our surveys of the eastern Bering Sea, only 1.3 percent were Leach's. Even in oceanic areas the percentage of Leach's reached only 6 percent in summer. It appears that, for the storm-petrels breeding in the Aleutian Islands, Fork-tails forage mostly northward into the Bering Sea and Leach's southward into the North Pacific. Population indices for total storm-petrels derived from shipboard surveys indicated about 6 million in summer and 4.4 million in the fall for the eastern Bering Sea-Aleutian Islands area. Indices from aerial surveys were 0.4 million in summer and 3.5 million in the fall.

† FORK-TAILED STORM PETRELS were generally scattered as individuals

flocks of up to 200 or more were observed during migration and large numbers assembled to feed on offal around factory ships for offshore fisheries. Surveys in spring, summer, and fall indicated that Storm-petrels were abundant over shelfbreak and outer continental shelf waters near the 200- and 100 m-isobaths. Sightings were uncommon north of 58°N and shoreward of 100-m depths, and all but absent in shallow coastal waters. During our one winter survey, this species was found only over shelfbreak and oceanic waters. The attractiveness of offal as a food source may reinforce a naturally occurring concentration of Fork-tails over the rich fishing grounds of the shelfbreak between the eastern Aleutian and Pribilof Islands. Shuntov (1972) also found that Fork-tails reached their highest densities over shelf and depression areas and estimated that their numbers exceeded 4 million in the Bering Sea. Shuntov (1972) and Wahl (1978) both believed that the Fork-tailed Storm-Petrel was the numerically dominant species of sea bird over deep water areas of the Bering Sea. Our data generally support this conclusion (Tables 16-19), except that we occasionally found Northern Fulmars to be more abundant over oceanic waters than storm-petrels.

† LEACH'S STORM-PETRELS were relatively uncommon in the Bering Sea, especially over waters shallower than 1,000 m. Most of our sightings were from the deep water immediately north of the central and western Aleutian Islands, an area in which our survey effort was relatively limited. We have only three sightings of this species over the continental shelf of the eastern Bering Sea: three birds on 21 May 1976 at 56°18'N x 160°14'W, one bird in May 1975 at 56°43'N x 159°55'W, and three birds on 17 July 1975 at 57°13'N x 163°51'W. Most of the Leach's Storm-Petrels associated with the Aleutian Island colonies probably forage to the south over the deeper waters of the North Pacific Ocean.

PHALACROCORACIDAE

Three species of cormorants have been found in the Bering Sea, but their distributions are centered on rocky coastlines rarely covered by our surveys, and our data base is thus inadequate to assess their status. Sowls et al. (1978) estimated a population of about 171,000 cormorants in the eastern Bering Sea and the Aleutian Islands. Their raw data indicate that the population was composed of about 3 % Double-crested, 43 % Pelagic, and 54 % Red-faced Cormorants. During our summer surveys, cormorants were usually found within a few kilometers of their colonies and few were sighted over the open ocean (Appendix D7). In spring and more particularly in fall, small numbers of cormorants were found far out to sea. The three species were difficult to differentiate, however, and we combined all cormorant sightings for analyses.

† DOUBLE-CRESTED CORMORANTS were identified only twice (both times in April) in our surveys: six birds were seen in the eastern Aleutian Islands and four over the continental shelf at 56°00'N x 166°24'W.

† PELAGIC CORMORANTS were identified throughout the area from the western Aleutians east to Bristol Bay and north to St. Lawrence Island and Norton Sound.

† RED-FACED CORMORANTS were common throughout the Aleutians and from there north through Bristol Bay to Cape Newenham and the Pribilof Islands. They composed 98 % of all cormorants identified to species in our surveys, suggesting that they are more likely to be found in offshore waters than are Pelagic or Double-crested Cormorants.

ANATIDAE

Most of our pelagic observations of swans, geese, and ducks represent migrants taking short cuts across the open waters between Unimak Pass or the Alaskan Peninsula and Cape Newenham, Cape Avinof, Nunivak Island, etc. Larger numbers of waterfowl were found in our aerial surveys than in our shipboard surveys (Tables 16-19), probably because most aerial survey tracks began or ended over the coast and thus covered a relatively greater percentage of coastal and lagoon habitat. Although several species of ducks, geese, and swans occur in large numbers in estuarine and nearshore habitats (Appendix D8), our surveys did not provide a suitable sample of these habitats and do not contribute significant new information on most species. We thus confine our discussions to sea ducks (tribe Mergini), although even these species were poorly sampled by our surveys.

† COMMON GOLDENEYES were found only once: four birds were seen near Tanaga Island in the Aleutian Islands in May.

† BARROW'S GOLDENEYES are occasional visitors to the Aleutian Islands and southeastern Bering Sea (Kessel and Gibson 1978). We did not see this species in the Bering Sea.

† BUFFLEHEADS are casual visitors to the southeastern Bering Sea and occasional visitors to the Aleutians Islands (Kessel and Gibson 1978. We did not see this species in the Bering Sea.

† OLDSQUAWS were abundant in the eastern Aleutian Islands and common in bay and coastal areas from there east through Bristol Bay and north to Norton Sound and the Bering Strait. Most of our observations were from March through May and September through November. However, few birds were seen in February 1976 and one in June 1975.

† HARLEQUIN DUCKS were found in small numbers from the Aleutian Islands and Alaska Peninsula north to 63°N.

† STELLER'S EIDERS were common in bays and lagoons along the north coast of the Alaska Peninsula. We also have a few sightings from the Pribilof Islands and from coastal areas north to Nunivak Island.

† COMMON EIDERS were found in small numbers throughout the surveyed area.

† KING EIDERS were the most abundant duck found by us in the Bering

Sea. They were common from the Alaska Peninsula north to Norton Sound. Exceptionally large numbers were seen along the northern coast of Bristol Bay.

† SPECTACLED EIDERS were observed on only one occasion: 6 males and 20 females were observed by Matthew Kirchoff on 18 November 1975 north of Unimak Pass at 54°29'N x 165°57'W.

† WHITE-WINGED SCOTERS were common in bays and over coastal waters from the Alaska Peninsula north to St. Lawrence Island, but we have no records for Norton Sound.

† SURF SCOTERS were found in small numbers from the Alaska Peninsula north to Norton Sound. Densities were highest between northeastern Bristol Bay and Nunivak Island.

† BLACK SCOTERS were common nearshore from the Alaska Peninsula north to Hooper Bay.

† SMEWS are rare visitors to the Aleutian and Pribilof Islands (Kessel and Gibson 1978). We did not see this species.

† HOODED MERGANSERS are accidental visitors to the eastern Bering Sea-Aleutian Islands area (Kessel and Gibson 1978). We did not see this species.

† COMMON MERGANSERS are uncommon winter visitors to the Aleutian Islands and accidental elsewhere in the Bering Sea (Kessel and Gibson 1978). We did not see this species in the Bering Sea.

† RED-BREASTED MERGANSERS are common residents in coastal areas throughout the Bering Sea (Kessel and Gibson 1978). We did not see this species in the Bering Sea.

PHALAROPODIDAE

Phalaropes were common throughout the Bering Sea in both summer and fall. Summer observations were mostly in coastal waters, whereas fall sightings frequently occurred over the continental shelf or deeper waters between Unimak Pass and Nunivak Island (Maps 142-148). Our earliest and latest records were 25 May 1975 and 14 October 1975. Phalaropes are small and difficult to detect except when in large flocks; consequently, density indices based on shipboard and aerial surveys undoubtedly underestimate actual numbers (Appendix D9). Population indices obtained from our surveys indicated a minimum of 1 million birds in summer and up to 2 million during the peak of migration.

† RED PHALAROPES composed 35 % of all the phalaropes identified to species in our surveys. They were common in summer and fall from the eastern and western Aleutians north to about 62°N.

† NORTHERN PHALAROPES were common summer and fall visitors to all areas censused by us in the Bering Sea and constituted 65 % of all of the phalaropes identified to species.

STERCORARIIDAE

Of the four species of jaegers recorded from Alaska, three have been found in the Bering Sea. These were observed only in small numbers throughout all marine habitats during our surveys and we could detect no correlations between their distributions and any environmental feature. All three species are well known as kleptoparasites and their distributions in the Bering Sea may reflect this behavior; jaegers are known to occurr throughout the ranges of their host species (Maps 149-155). All three jaegers should be easily detected and our population indices may closely approximate actual populations (Appendix D10). Aerial and shipboard density indices indicate a population index of 195,000-341,000 jaegers in the eastern Bering Sea in summer.

† POMARINE JAEGERS constituted 67 % of all jaegers identified to species in our surveys. They were scattered throughout all habitats as singles or in groups of 1-4. The largest group sighted in our surveys was of 11 birds gathered around a stopped ship. Our earliest and latest dates of occurrence were 25 April 1977 near the ice edge, and 12 October 1977.

† PARASITIC JAEGERS composed 25 % of all jaegers identified to species in our surveys. Parasitics were scattered throughout all marine habitats as singles or in groups of 1-6, as were other jaegers. Our early and late dates of occurrence were 20 May 1976 and 16 October 1975.

† LONG-TAILED JAEGERS composed 9 % of all jaegers identified to species in our surveys of the Bering Sea. They were also scattered throughout the area in small groups or as single birds. Our earliest and latest dates of occurrence were 15 May 1977 and 10 October 1976.

LARINAE

Gulls and kittiwakes generally composed about 5 % of the avifauna of the continental shelf in the eastern Bering Sea, and were somewhat more abundant, relative to other species, over shelfbreak and oceanic waters (Appendix D11). Fifteen species have been recorded from the Bering Sea but only four appear to occur regularly in large numbers: Glaucous Gull, Glaucous-winged Gull, Black-legged Kittiwake, and Red-legged Kittiwake.

† GLAUCOUS GULLS were found throughout the area as year-round visitors or residents. Sightings were rare over oceanic waters but small numbers of birds were seen in all other habitats, especially over the shelfbreak between the eastern Aleutian and Pribilof Islands and in coastal areas from northern Bristol Bay north to Kotzebue Sound. Relative densities of Glaucous Gulls derived from aerial surveys were much different than those derived from shipboard surveys, partly because of different geographic coverage, but partly because of differences in biases affecting the two survey

methods. Population indices for the number of Glaucous Gulls occupied over waters of the eastern Bering Sea in summer and fall were 17,000 and 153,000, respectively.

† GLAUCOUS-WINGED GULLS were common over bay, continental shelf, and shelfbreak habitats from the western Aleutian Islands east to Bristol Bay and north to Nunivak Island. An occasional bird was found as far north as Kotzbue Sound. Densities were occasionally very high along the Alaska Peninsula, over the rich fishing grounds between the Aleutian and Pribilof Islands, and at least once in the Cape Newenham area (Maps 156-162). These birds were generally scattered as singles or in small groups, although several thousand sometimes accumulated around a ship or cannery that was providing food in the form of offal. Glaucous-wings are frequently attracted to ships, which they may follow for short periods. Population indices for the number of these birds occupied at any one time over waters of the eastern Bering Sea in summer, as determined from aerial and shipboard surveys, were 634,000 and 828,000, respectively (Appendix D12).

† SLATY-BACKED GULLS were observed during two cruises; as many as four individuals were seen near the Russian fishing fleet on 6-10 May 1976 between 56°33'N-58°27'N and 170°33'W-174°08'W, and a single bird was observed on 22 November 1975 at 55°20'N x 167°56'W.

† WESTERN GULLS are accidential in the Bering Sea (Kessel and Gibson 1978). We did not see this species.

† HERRING GULLS were uncommon in the eastern Bering Sea. Largest numbers were found in Bristol Bay, especially in the Cape Newenham area. We saw only one individual south of 56°N and only scattered individuals north into the Chukchi Sea. Many of these, especially those seen to the north, were apparently of the subspecies Larus argentatus vegae, which breeds in Siberia and in small numbers on St. Lawrence Island.

† THAYER'S GULLS were identified several times in May along the shelfbreak east of the Pribilof Islands. One bird was found near St. Lawrence Island on 6 September 1976.

† MEW GULLS were associated primarily with coastal and inland habitats poorly represented in our surveys. We saw only a few, scattered over shallow waters from Unimak Pass into Bristol and Kuskokwim Bays.

† BLACK-HEADED GULLS are rare visitors to the eastern Bering Sea. We have two sightings, both in the area of the Aleutian Islands in 1976: one bird near Kiska Island on 18 May, and one bird north of Unalaska Island on 25 May.

† FRANKLIN'S GULLS are accidental in the Bering Sea (Kessel and Gibson 1978). We did not see this species.

† BONAPARTE'S GULLS occur in small numbers in nearshore waters of the Aleutian Islands and eastern Bering Sea. We did not see this species in the Bering Sea.

† IVORY GULLS are uncommon visitors to the Bering Sea and usually occur in association with pack ice. We saw seven birds on three transects on 15 November 1975 between Nunivak and St. Lawrence Islands, three birds on two transects on 29 March 1976 near 56°N x 163°W, and two birds on 1 March 1976 near 57°10'N x 171°45'W.

† BLACK-LEGGED KITTIWAKES were the third most frequently observed birds in our surveys of the eastern Bering Sea, being exceeded in frequency only by murres and fulmars. In summer they were common in all areas. Most observations were of single birds, but flocks of up to 50 were also occasionally found. Our only observations of flocks larger than 50 were in situations where the birds accumulated around fishing vessels or stopped ships. After the fledging of young in the fall, these birds dispersed from colony sites and became more abundant over deep waters offshore. By winter we found no birds in the shallower waters of Bristol Bay nor over the continental shelf, although fair numbers were seen over shelfbreak and oceanic waters (Maps 163-169).

Shuntov (1972), who discussed the pelagic biology of Black-legged Kittiwakes in the Bering Sea, recorded them in all ice-free waters throughout the year and suggested an orientation toward land in summer. He also suggested that they disperse in September and October, not only over the shelf, but also over oceanic waters. Shortly thereafter, most of the population abandons the Bering Sea in favor of nomadic wandering in the Pacific, only to return in early April. Shuntov indicated that the total population numbered about 1.5 million birds in the entire Bering Sea. Sowls et al. (1978) provided data that suggested a breeding population of about 1.1 million in the eastern Bering Sea and Aleutian Islands area. Especially in winter, Black-legged Kittiwakes are attracted to ships, which they may follow for short periods, or merely circle before proceeding on their original course. This behavior may bias density indices derived from shipboard surveys and the actual population may be somewhat larger than indicated (Appendix D13). Aerial and shipboard population indices ranged between 1.2 and 2.6 million kittiwakes over marine waters of the eastern Bering Sea in summer and 3.1 and 4.5 million kittiwakes in fall.

† RED-LEGGED KITTIWAKES were commonly encountered near their breeding grounds and over deep water north of the Aleutian Islands to at least 58°N. In mid-April and mid-August, as many as 50-200 accumulated around stopped ships in the rich fishing grounds along the outer continental shelf and shelfbreak between the eastern Aleutian and Pribilof islands. Sightings of Red-legs over waters shallower than 100 m were rare: one bird on 2 July 1976 at 58°45'N x 168°30'W, one bird on 4 July 1976 at 58°17'N x 161°55'W, and one bird on 21 October 1975 at 57°02'N x 162°00'W. Our northernmost sightings were five single birds found on 1 September 1976 near 60°00'N x 168°30'W over water depths of 30-35 m.

† ROSS' GULLS are rare visitors anywhere within the Bering Sea and are almost unknown south of St. Lawrence Island (Kessel and Gibson 1978). We did not find this species in our surveys.

† SABINE'S GULLS were found scattered as singles or pairs throughout the area surveyed. No pattern of distribution was discernible, although most of the sightings were from August to October, indicating that most of the birds found over the pelagic areas of the eastern Bering Sea were probably postbreeding wanderers or migrants.

STERNINAE

Terns are common in bay and nearshore areas throughout the Bering Sea and were thus only occasionally found on our surveys of deeper water areas. Most of our sightings, and especially those over waters deeper than 100 m, were made during their migration in August and September. Our earliest and latest dates of occurrence for all terns were 27 May 1976 and 22 September 1975, indicating that these birds arrive later in the spring and leave earlier in the fall than most other species of seabirds. Terns seemed surpisingly inconspicuous at sea and were more frequently recorded in shipboard surveys than in aerial surveys (Appendix D14). Aerial and shipboard surveys produced population indices of 50,000 to 100,000 terns for summer and fall over the pelagic waters of the eastern Bering Sea.

† COMMON TERNS are rare visitors to the southern Bering Sea. We saw only one: Eric Hoberg sighted a single bird on 12 June 1975 about 10 km WNW of Shemya Island in the western Aleutians.

† ARCTIC TERNS composed 98 percent of all terns identified to species in our surveys. They were found as singles or in groups of as many as 30, scattered from the Aleutian Islands to the Bering Strait. Early and late dates of occurrence were 31 May 1976 and 22 September 1975.

† ALEUTIAN TERNS were found on only three occasions: three birds on 27 May 1975 at 52°48'N x 173°18'E, two birds on 25 August 1976 at 63°40'N x 165°00'W, and two birds on 20 September 1975 at 54°15'N x 160°00'W. Inasmuch as the known nesting population of this species in the Bering Sea is very small (Sowls et al. 1978), this scarcity of sightings is not surprising.

ALCIDAE

Alcids formed up to 60 percent of the avian population of the Bering Sea in winter and spring but only 10 % in summer and fall, when shearwaters became dominant (Appendix D15). Highest local densities were generally within 75 km of major colony sites such as the Diomede and Pribilof islands, although large numbers of alcids were occasionally found more than 100 km from land during migration in spring and fall (Maps 170-176). Murres were the numerically dominant members of this group, composing 43 % of the alcids observed during shipboard surveys and 63 % of the alcids found in aerial surveys. Their apparent dominance, however, is partly attributable to the difficulty in seeing the smaller alcids.

According to Sowls et al. (1978), the total number of alcids associated with breeding colonies in the eastern Bering Sea-Aleutian Island area exceeds 18 million. Our population indices for at-sea populations in summer were 7.3 and 17.2 million, as derived from aerial and shipboard surveys, respectively. Even the larger index based on shipboard surveys is probably much smaller than the actual population. For shipboard surveys, the 300-m counting distance was usually greater than that within which one can effectively detect many alcids, particularly those of the smaller species. Obscure coloration, small size, and behavior all contribute to our failure to observe many alcids in aerial surveys.

† COMMON and THICK-BILLED MURRES are abundant and widespread in pelagic waters of Alaska. Shuntov (1972), who summarized most of the available data on their biology in the Bering Sea, reported murres abundant throughout the year, being most common over the continental shelf. There is a widespread dispersal of postbreeding adults and young away from colonies but most of the population apparently remains over the shelf. In summer, Bartonek and Gibson (1972) found large numbers throughout Bristol Bay, mostly between the 50 m isobath and the shore. Wahl (1978) found murres most abundant over shelf waters near major colonies.

Since Common and Thick-billed Murres are difficult to tell apart in the field, particularly from aircraft, the data for these two species were combined in our analyses. We found murres to occur regularly in small numbers over oceanic waters, but they were most abundant over the continental shelf, especially near large colonies (Maps 177-183). In winter and spring their distribution was greatly influenced by the location of the ice pack. In late March and April, Rauzon (1976) found murres and gulls concentrated in and near polynyas, where capelin were most abundant. Our observations of local concentrations generally fell into three categories: (1) We sighted at least eight flocks of 500-2,300+ murres feeding at the edge of the ice pack between 162-170°W from 28 February to 29 March; (2) found assemblages and flocks of 500-1,500+ murres flying to and from colonies or sitting on water below the colonies from 26 April through 12 October; and (3) found one flock of 1,400+ murres associated with several hundred fulmars on 15 September 1975 at 58°02'N x 170°28'W. Most of the 1,400+ murres were sitting on the water and represented either a feeding flock or a group of birds that were staging in advance of the main migration.

Sowls et al. (1978) estimated that about 7.3 million murres, 55 percent of which were Thick-billed Murres, were associated with breeding colonies in the eastern Bering Sea-Aleutian Islands area. Tuck (1960) placed the North Pacific population at about 20 million and the world population at about 56 million. Shuntov (1972) estimated a pelagic population in the Bering Sea in summer of about 3.2 million Thick-billed Murres. Density indices obtained from our aerial and shipboard surveys provided an at-sea population index in the eastern Bering Sea in summer and fall of 2.7-6.9 million murres (Appendix D16). These numbers are considerably lower than would be expected on the basis of the work of Sowls et al. Our lower estimate probably results from our failure to see all birds on transects and the inadequacy of our surveys in sampling areas near colonies where large numbers of birds are usually found.

† DOVEKIES are rare residents in the northern Bering Sea south to St. Lawrence Island (Kessel and Gibson 1978). We did not see this species.

† BLACK GUILLEMOTS are uncommon in winter and rare in summer south to the Pribilof Islands (Kessel and Gibson 1978). We did not see this species.

† PIGEON GUILLEMOTS were common in coastal waters throughout the Aleutian Islands and eastern Bering Sea. They were decidedly uncommon in waters deeper than 50 m, except when such depths occurred near to land. We have less than a handful of sightings of this species over the continental shelf.

† MARBLED and KITTLITZ'S MURRELETS were very uncommon in our surveys of the eastern Bering Sea and Aleutian Islands (Appendix D17). Five Marbled, seven Kittlitz's, and three unidentified Brachyramphus murrelets were found in the area between Adak Island and eastern Bristol Bay and between Unimak Pass and Nunivak Island. These birds are most abundant in nearshore and bay habitats, and are thus not adequately represented in our more pelagic surveys.

† ANCIENT MURRELETS were abundant throughout the Aleutian Islands. Their pelagic distribution, other than near breeding colonies, was centered between the 40- to 85-m isobaths, from about 57°N x 160°W northwest to about 59°N x 169°W. Our northernmost records are of two birds near St. Lawrence Island on 6 September 1976, and one from the Chukchi Sea at 66°33'N x 169°38'W on 14 September 1976.

† CASSIN'S AUKLETS were found in small numbers in the western Aleutian Islands and over water depths of 60-80 m between the Pribilof Islands and Bristol Bay.

† PARAKEET AUKLETS were common throughout the Aleutian Islands, especially in May around Buldir Island, which supported a large colony. North and east of the Aleutians, Parakeet Auklets were scattered in small numbers over the continental shelf, becoming abundant again near St. Lawrence and Diomede Islands, where major colonies are located. Birds from the large colonies on the Pribilof Islands apparently do not forage far from that coast.

† CRESTED AUKLETS were found abundantly around their major breeding islands, but only a few were identified in other areas. Likewise, this species is highly gregarious and forms large flocks around its rookeries. It was rare, however, to find more than 15 birds in a group away from the breeding islands.

† LEAST AUKLETS were abundant near large rookeries in the central and western Aleutian, St. Lawrence, and Diomede Islands. In spring, huge concentrations were also found along the ice edge north and east of the Pribilof Islands. Otherwise, small numbers were found scattered over all available pelagic habitats throughout the year.

† WHISKERED AUKLETS were common in the Aleutian Islands from Unimak Pass west to Buldir Island. They have rarely been identified away from this area and we have no sightings from any habitat other than coastal waters of the Aleutian Islands.

† RHINOCEROS AUKLETS were identified only once in our surveys of the eastern Bering Sea: a single bird was found at 54°52'N x 170°20'W on 28 June 1978 over a water depth of 2,100 m.

† HORNED PUFFINS were found throughout the Aleutian Islands and eastern Bering Sea, our earliest and latest records occurring on 28 February 1976 and 17 November 1975. They were most abundant in coastal waters but were scattered as singles or small groups of as many as 30 over the continental shelf, and were only occasionally seen in oceanic habitats.

† TUFTED PUFFINS were common in the Bering Sea, their center of breeding abundance possibly represented by the large colonies in the eastern Aleutian Islands. In spring, summer, and fall they could be found throughout all available marine habitats from the eastern Aleutians to Bristol Bay and from Unimak Pass to the Chukchi Sea. Partial evaluation of data from a few selected cruises suggests that the distribution of Tufted Puffins may be limited by water temperatures lower than 4-6°C. Further work will be necessary, however, to test this hypothesis. None were found on our single winter survey; our early and late dates of occurrence were 18 April 1975 and 24 November 1975, (Maps 184-190). Tufted puffins tended to be distributed as single birds or small groups. Although these small groups often coalesced into large loose aggregations such as those previously described for areas with riptide areas in the eastern Aleutians (the Gulf of Alaska section of this report), tightly knit flocks larger than 100 birds were rare. Only three such groups were found away from colony sites; all were located along the same transect: flocks of 230, 300, and 370 sitting on the water on 12 September 1975 at 58°09'N x 166°52'W.

Sowls et al. (1978) estimated that about 1.7 million Tufted Puffins were associated with rookeries in the eastern Bering Sea-Aleutian Islands area, some of which ranged into the North Pacific south of the Aleutian Islands. Shipboard and aerial surveys produced markedly different density indices, apparently reflecting the difficulty of detecting this species from fast moving aircraft and the propensity for Tufted Puffins to alter their flight pattern to investigate ships (Appendix D18). Population indices from shipboard surveys in the summer indicated the presence of about 2.3 million Tufted Puffins over marine waters of the eastern Bering Sea, whereas indices from aerial surveys indicated a population of only 0.5 million.

## DISCUSSION AND SUMMARY

The avifauna of the Bering Sea has much the same basic composition as that of the Gulf of Alaska. Short-tailed Shearwaters, Forktailed Storm-Petrels, Common Murres, and Tufted Puffins are ubiquitous in summer in both areas. Shearwaters are the most abundant marine bird species in summer and murres are the most abundant species in winter. Also, the numerically dominant species and species groups for each marine habitat are the same in the two regions. There are, however numerous specific differences in avifaunal composition between the two areas. In the Aleutian Islands, Laysan Alabatrosses outnumber Black-footed Albatrosses, and only the Laysan regularly ranges north of these islands. Whiskered Auklets are endemic to the Aleutian Islands, where they are most abundant in nearshore and rip tide areas. Red-legged Kittiwakes are endemic to the Pribilof-Aleutian-Komandorsky Islands and are good indicators of shelfbreak and oceanic habitats. Thick-billed Murres, Parakeet Auklets, Least Auklets, and Crested Auklets are many times more numerous in the Bering Sea than in the Gulf of Alaska, whereas the reverse is true for Rhinoceros Auklets, Cassin's Auklets, and Ancient Murrelets.

Sixty-four species of marine birds were identified in the Bering Sea; 10 species with estimated populations exceeding one million are listed here in approximate order of decreasing abundance: Short-tailed Shearwater, Least Auklet, Thick-billed Murre, Forktailed Storm-Petrel, Common Murre, Tufted Puffin, Northern Fulmar, Black-legged Kittiwake, Crested Auklet, and Northern Phalarope. The Sooty Shearwater may also number more than a million birds and the Leach's Storm-Petrel probably exceeds 1 million in the immediate vicinity of the Aleutian Islands. The number of species occurring within the eastern Bering Sea was very low during the winter, when 15 species were recorded, but was uniformly high through the spring, summer, and fall when 51 or 52 species were found in each season. More species were located over the continental shelf than in any other habitat, and fewest species were found in oceanic habitat (Tables 16-19).

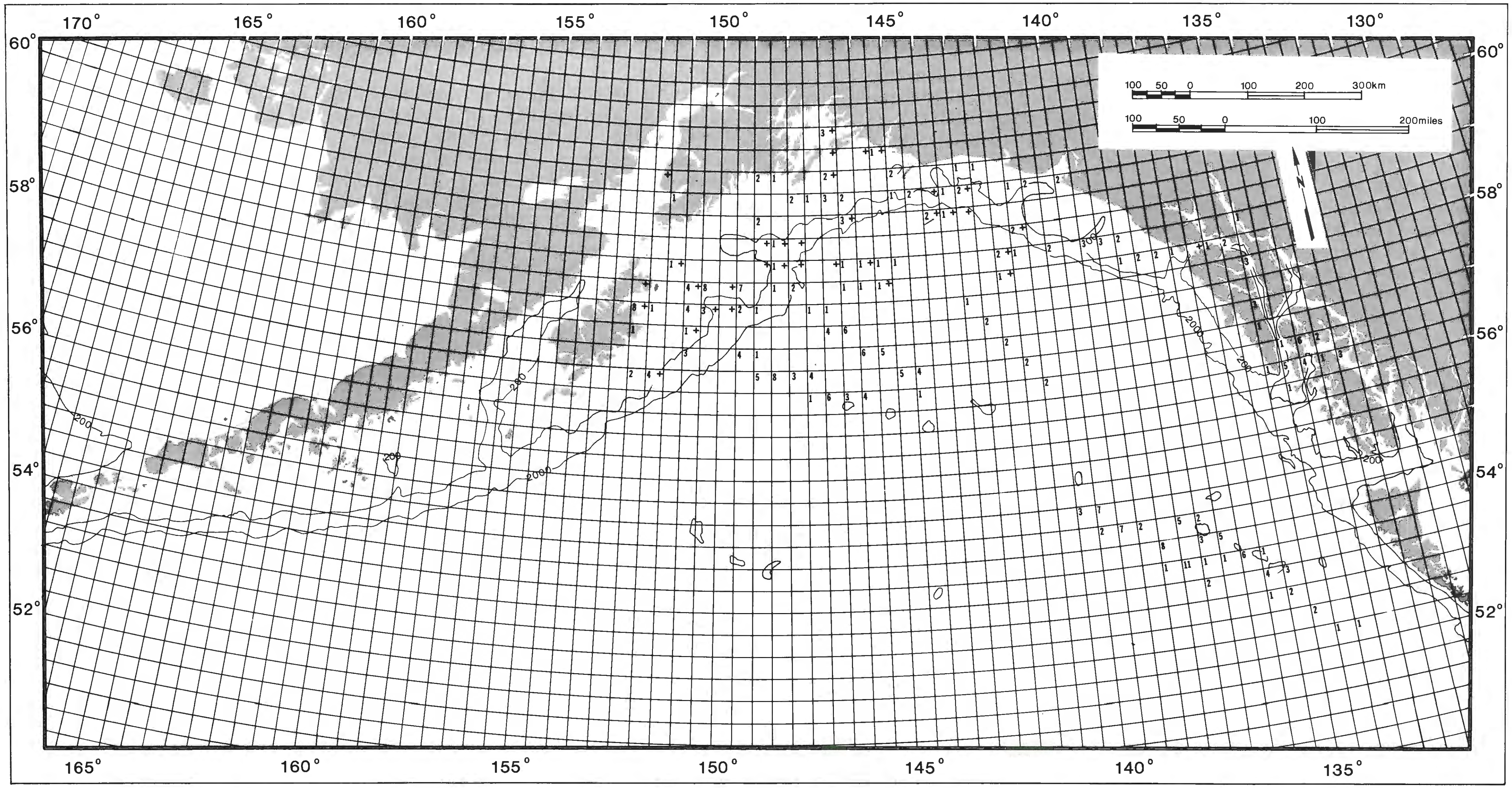
At least one bird was observed on 97 % of all shipboard transects and 83 % of all aerial transects (Appendix D19). These frequencies of occurrence were fairly consistent from season to season and habitat to habitat, except for relatively low values found over the continental shelf during aerial surveys. The values on aerial surveys were low because the area sampled by each east-west transect was very small and the proportion of some species that are detected from the air are relatively low (but unknown).

Using density indices for "total birds" (Appendix D19), excluding both shearwaters and fulmars (which together compose 66 % of the aerial and 79 % of the shipboard estimates) we estimated the number of "seabirds minus shearwaters and fulmars" for the eastern Bering Sea in summer to be 13 million on the basis of aerial surveys and 30 million on the basis of shipboard surveys. To these figures we conservatively add the aerial population indices of 12 million shearwaters and 2 million fulmars to establish an estimated total population of 27-44 million. Considering these millions, along with a population index of 38 million birds in the Gulf of Alaska, and many more occurring south of the Aleutian Islands and north of the Bering Strait, we believe that no fewer than 100 million seabirds occupy Alaskan marine waters in the boreal summer. Considering the probable biases in our surveys, the total may be higher than our indices.

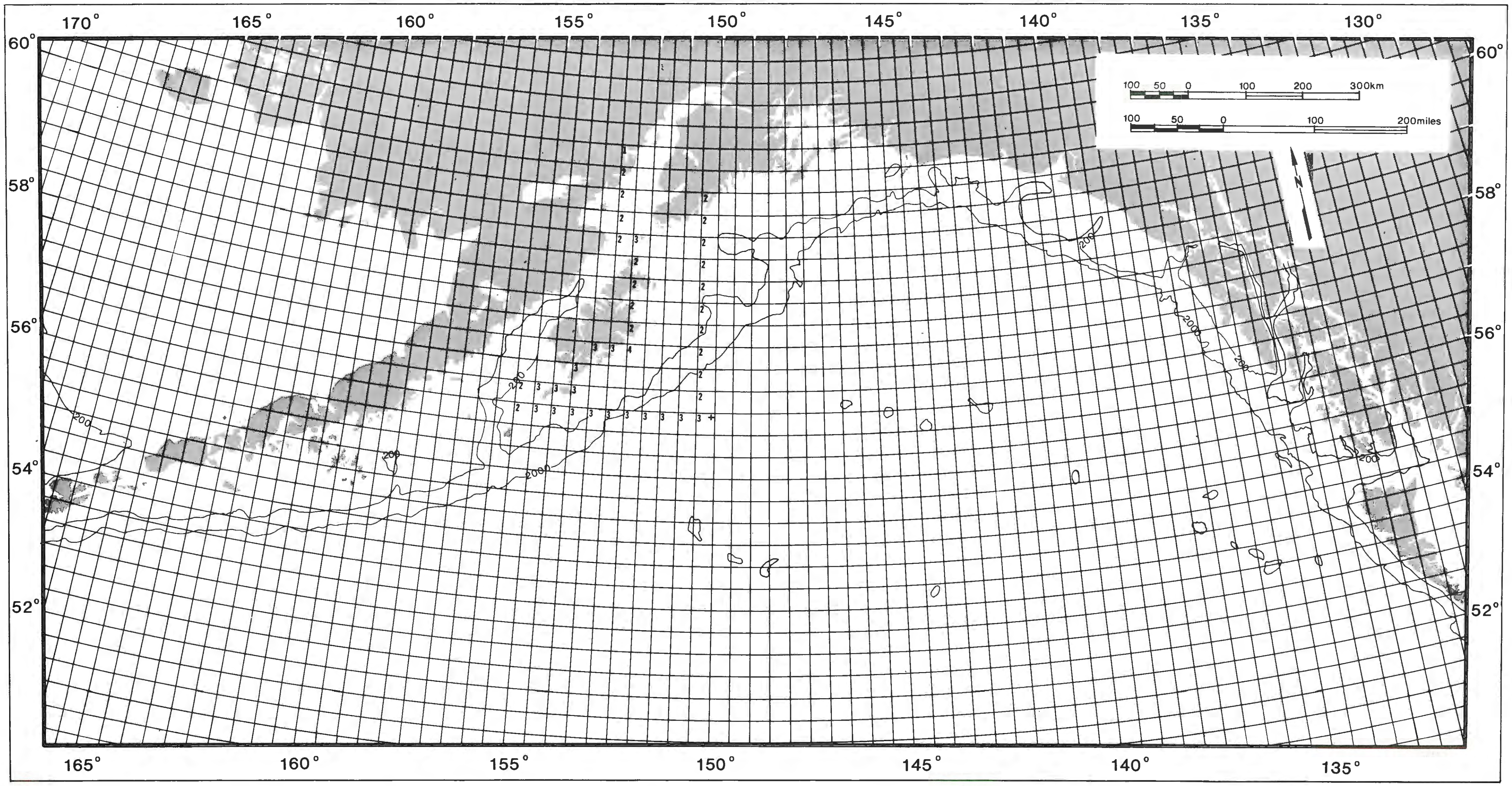
High densities of marine birds in the Bering Sea are closely tied to availability of food and location of nesting colonies (Maps 191-197). We found large numbers of seabirds near major breeding colonies, near active fishing fleets (especially between the eastern Aleutian and Pribilof Islands), and in waters where food organisms tend to be concentrated, such as at tide rips between islands and at the edge of the ice pack. Large concentrations of shearwaters occurred near and inside the 50-m isobath, an area which is probably very productive because the water column is completely mixed from top to bottom (Hunt et al. 1981c).

Flock (1972, 1973) and Shuntov (1972) suggested that migratory patterns within the Bering Sea are complicated by such factors as east-west movements, postbreeding wandering in late summer, chronological differences in migration between species, development and breakup of ice, and poorly defined migratory pathways. Our observations were restricted to the eastern Bering Sea and we collected few data from November through March. Our analyses and interpretations are in basic agreement with those expressed by Shuntov (1972). Our data suggest that for most species the major point of entry to and departure from the eastern Bering Sea is Unimak Pass. Lesser numbers of seabirds also enter and leave the area by way of the continental shelf along the Asiatic coast and through other Aleutian passes.

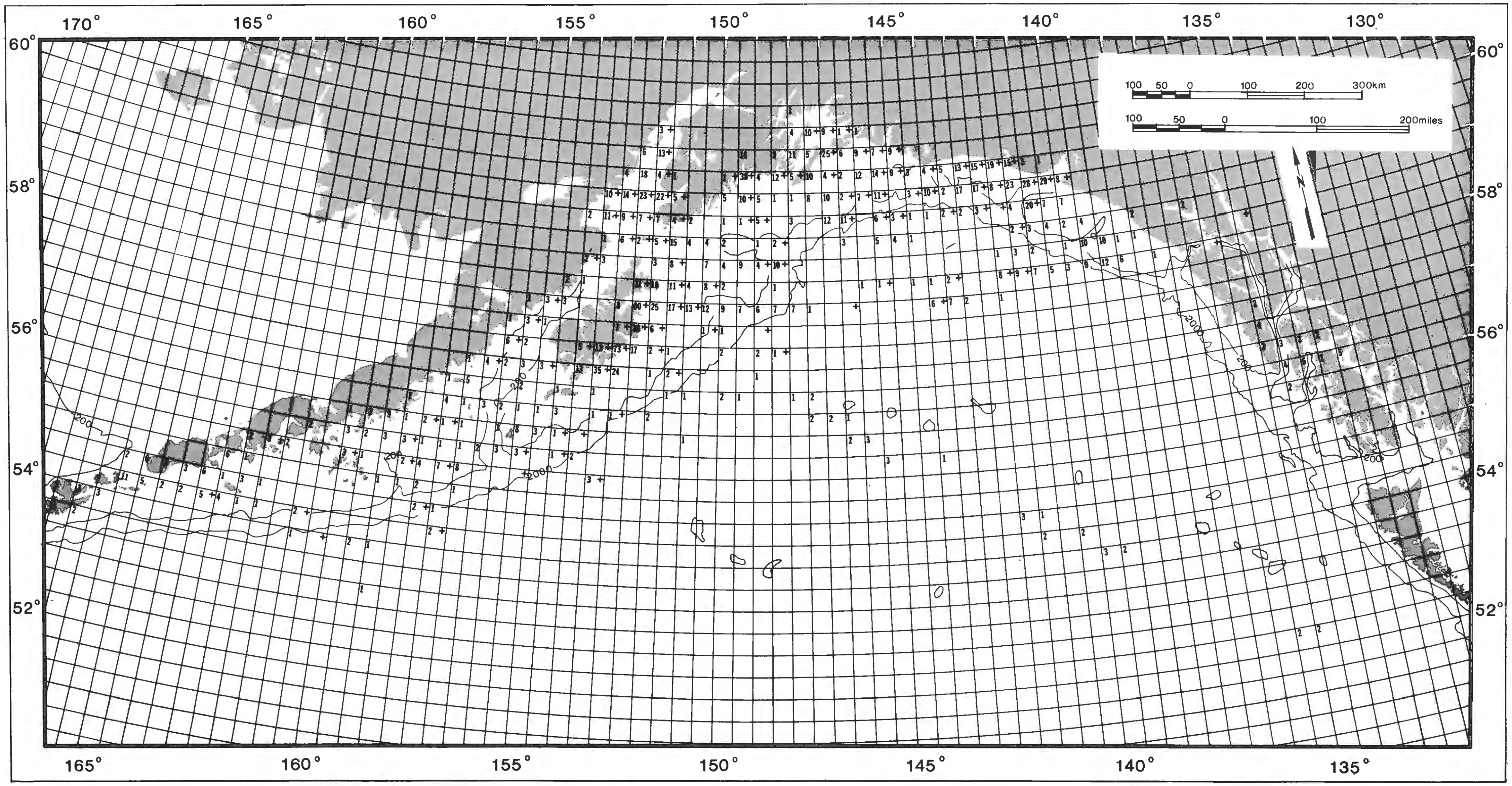
Migrants entering the Bering Sea by way of Unimak Pass split into three major corridors. Some turn east and move along the coast of the Alaskan Peninsula and others turn west and move into the eastern Aleutian Islands. The rest move north on a relatively broad path to the area of Saint Lawrence Island and then then concentrate through the Bering Strait. Spring migration occurs from late March through early June. Breeding birds generally arrive in peak numbers in mid-April and nonbreeding visitors arrive in early to mid-May. Fall migration occurs from August well into November. Postbreeding birds tend to disperse leisurely to the south; heaviest movements are in late September or early October. Nonbreeding visitors leave more abruptly, most moving south in late October.



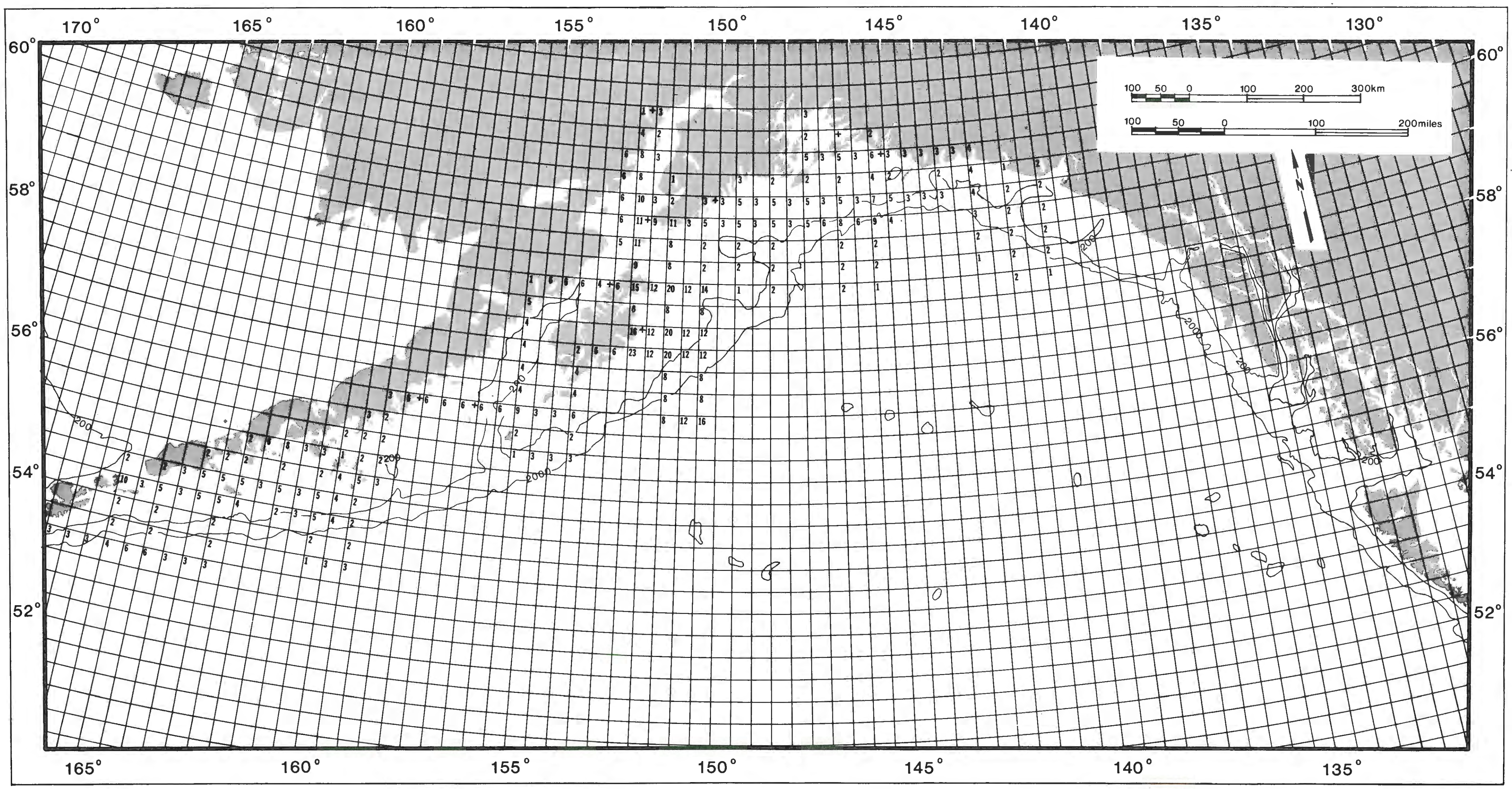

Map 1. Number of transects conducted in shipboard surveys of the Gulf of Alaska in winter.



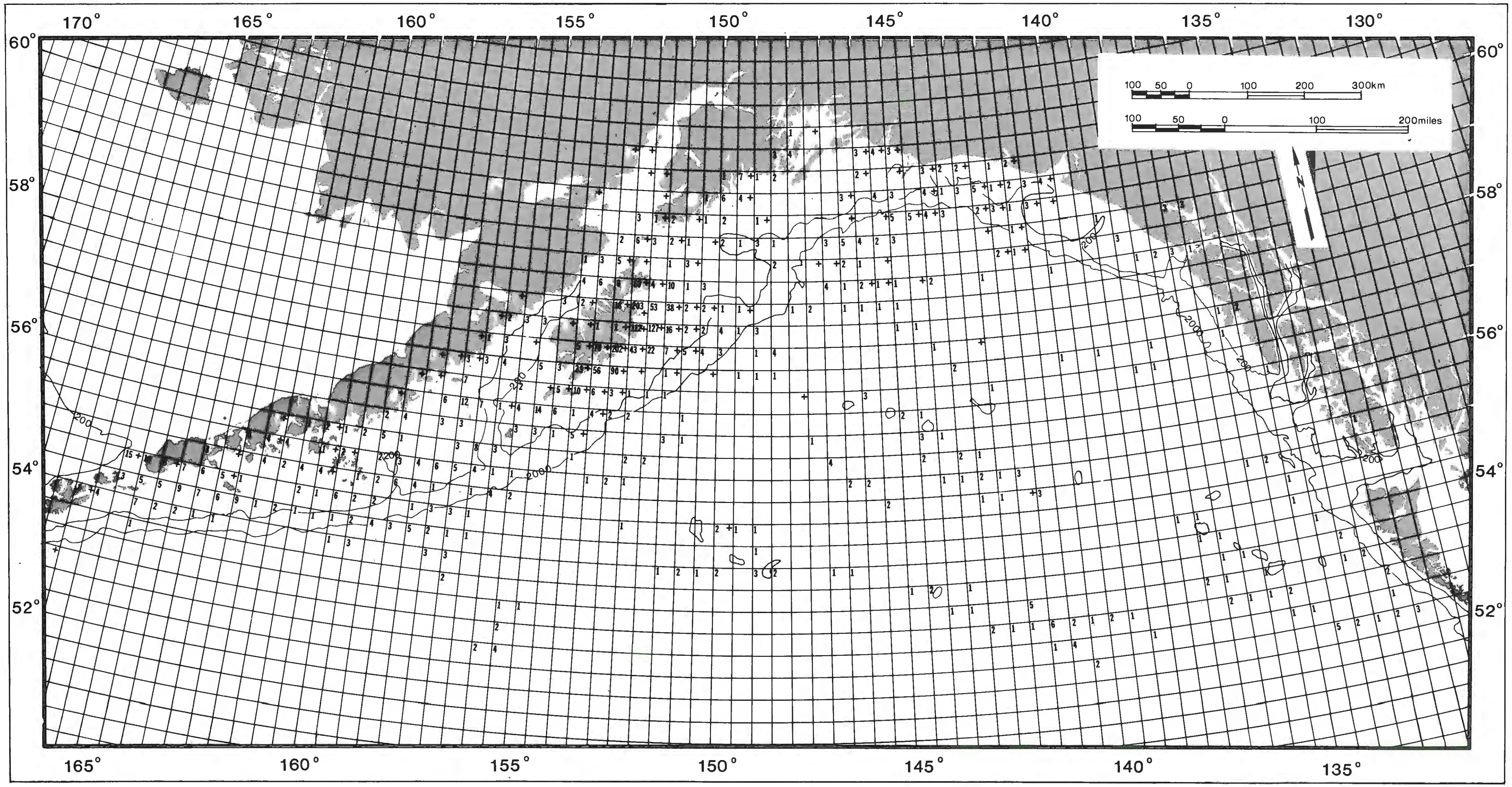

Map 2. Number of transects conducted in aerial surveys of the Gulf of Alaska in winter.



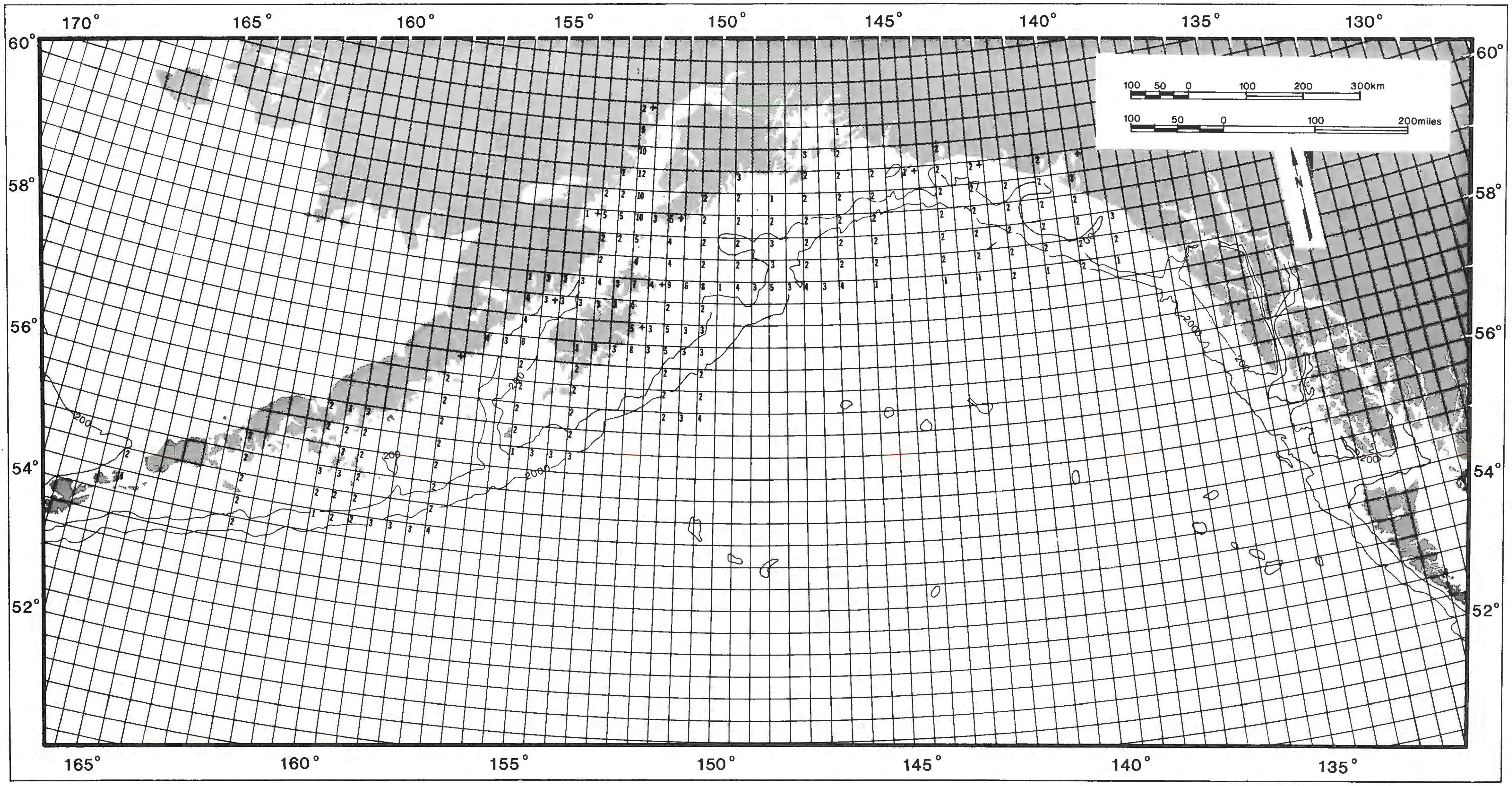

Map 3. Number of transects conducted in shipboard surveys of the Gulf of Alaska in spring.



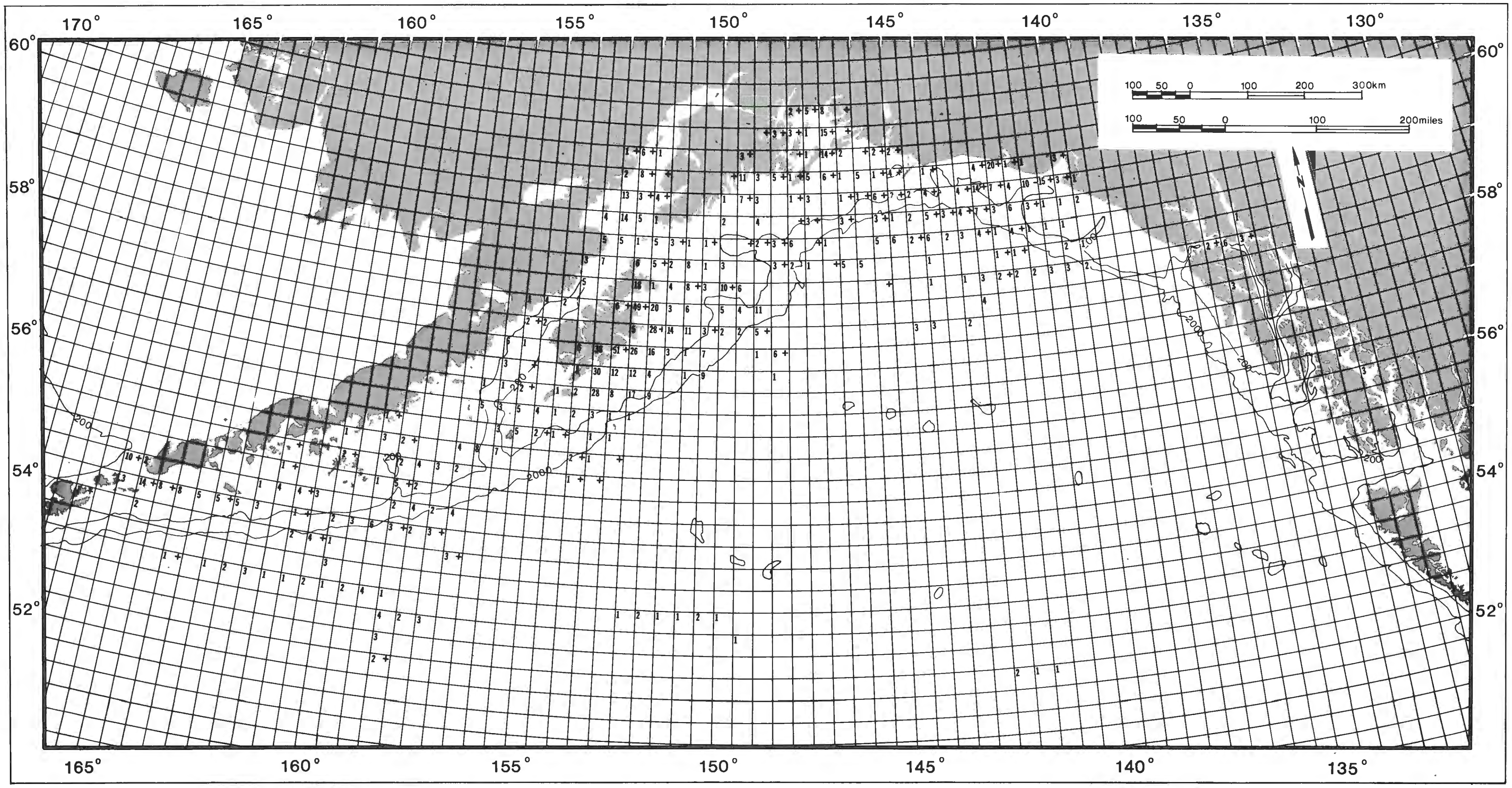

Map 4. Number of transects conducted in aerial surveys of the Gulf of Alaska in spring.



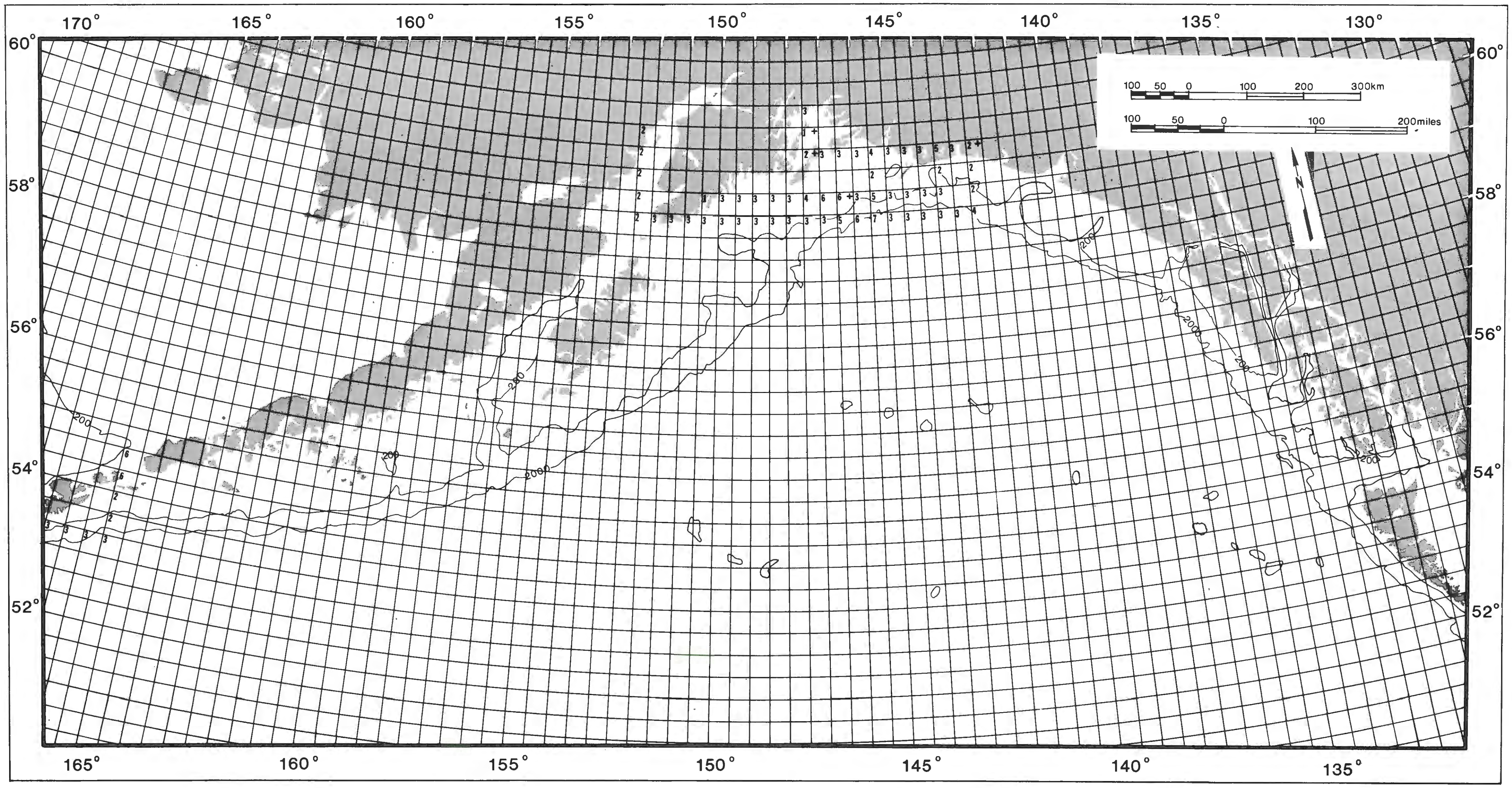

Map 5. Number of transects conducted in shipboard surveys of the Gulf of Alaska in summer.



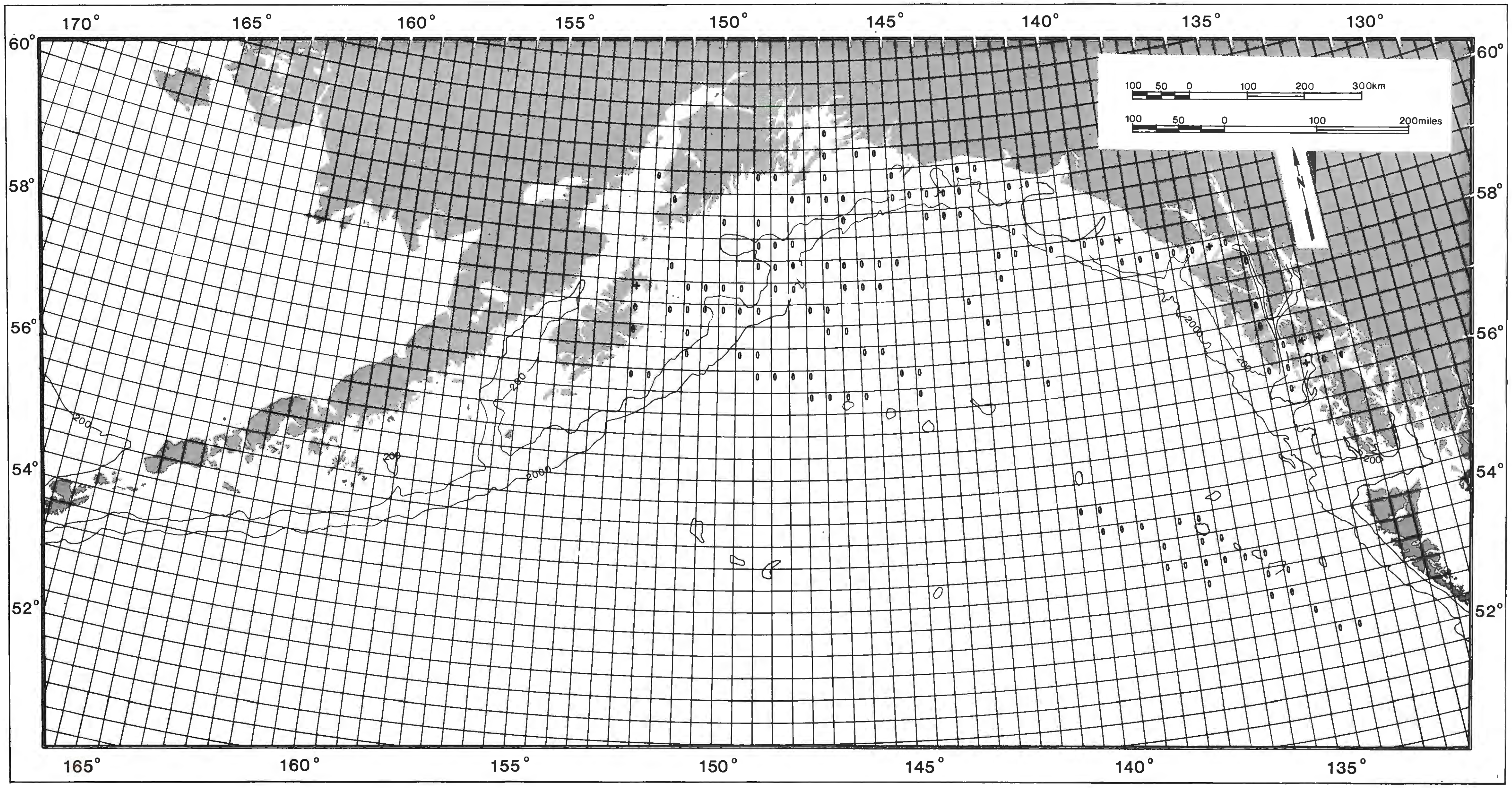

Map 6. Number of transects conducted in aerial surveys of the Gulf of Alaska in summer.



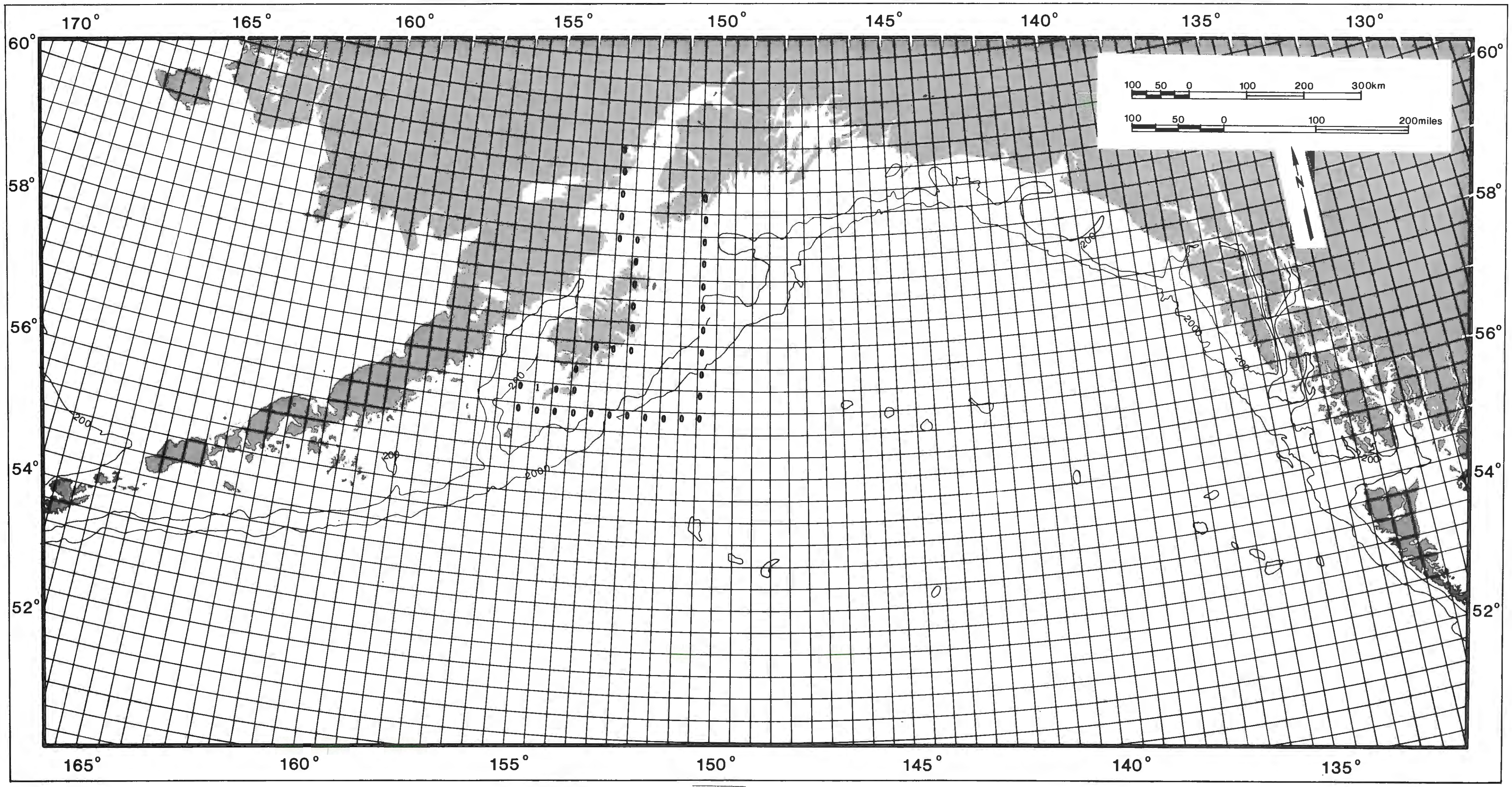

Map 7. Number of transects conducted in shipboard surveys of the Gulf of Alaska in fall.



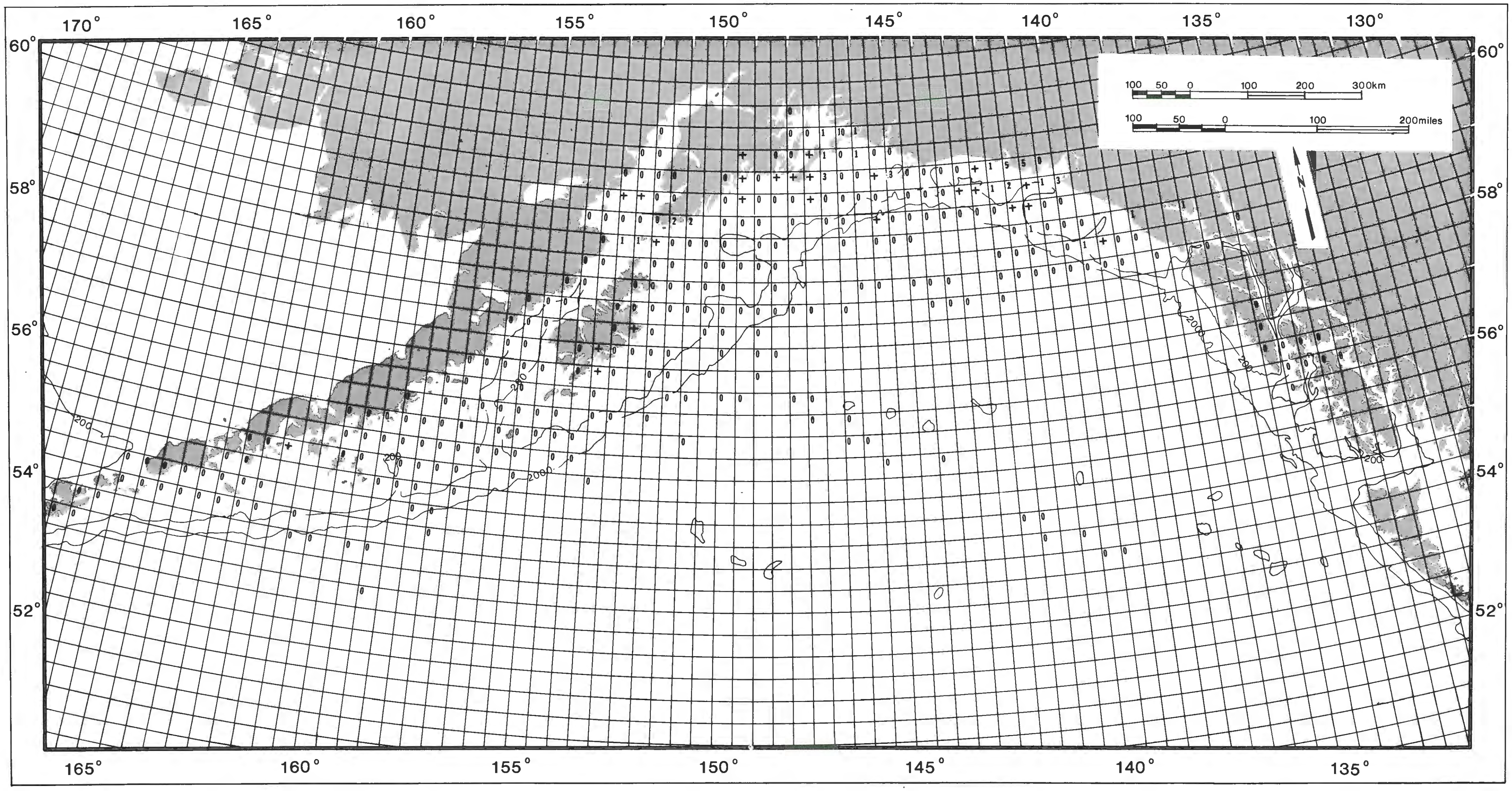

Map 8. Number of transects conducted in aerial surveys of the Gulf of Alaska in fall.



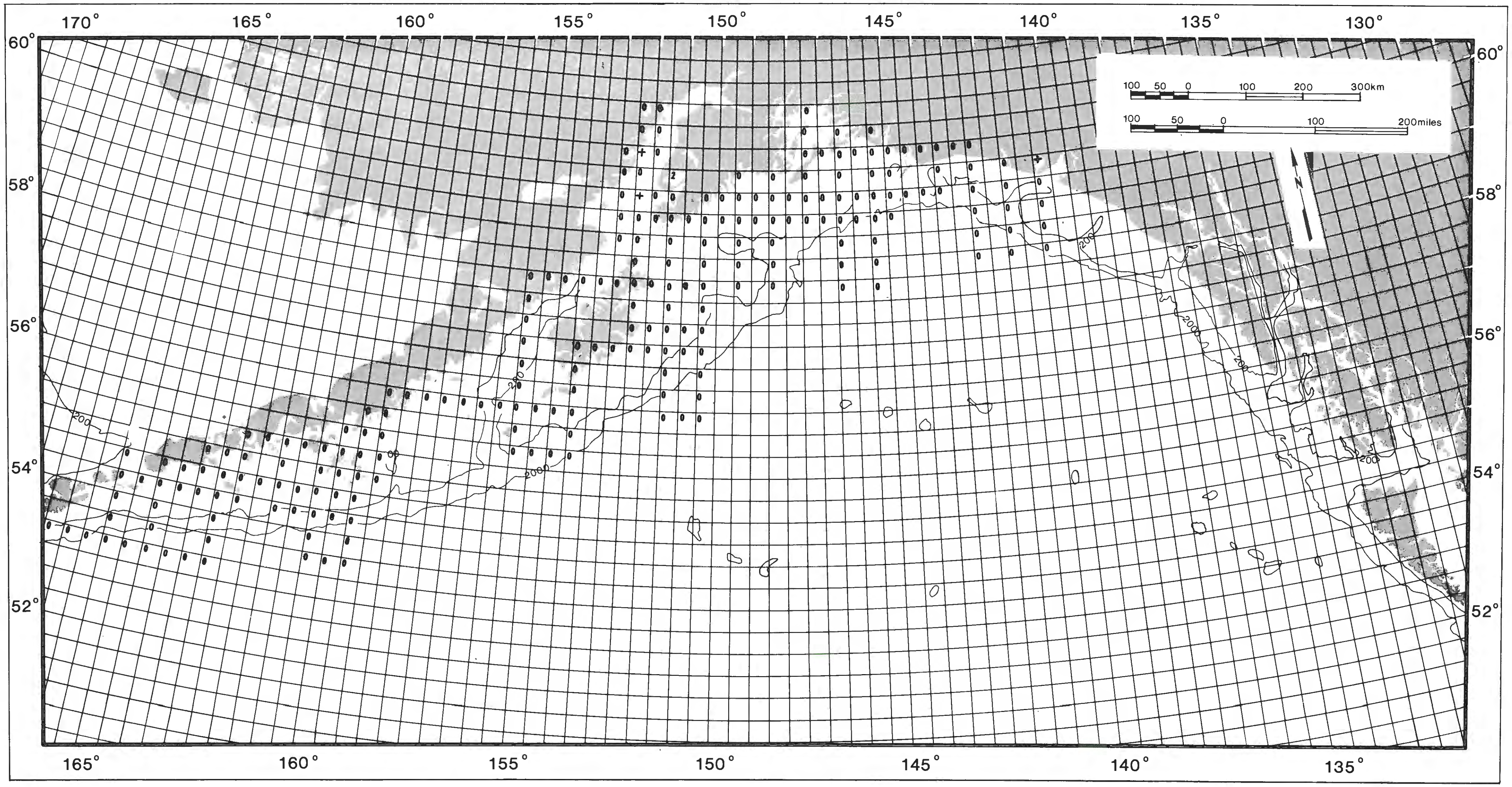

Map 9. Density indices of total loons obtained from shipboard surveys of the Gulf of Alaska in winter.



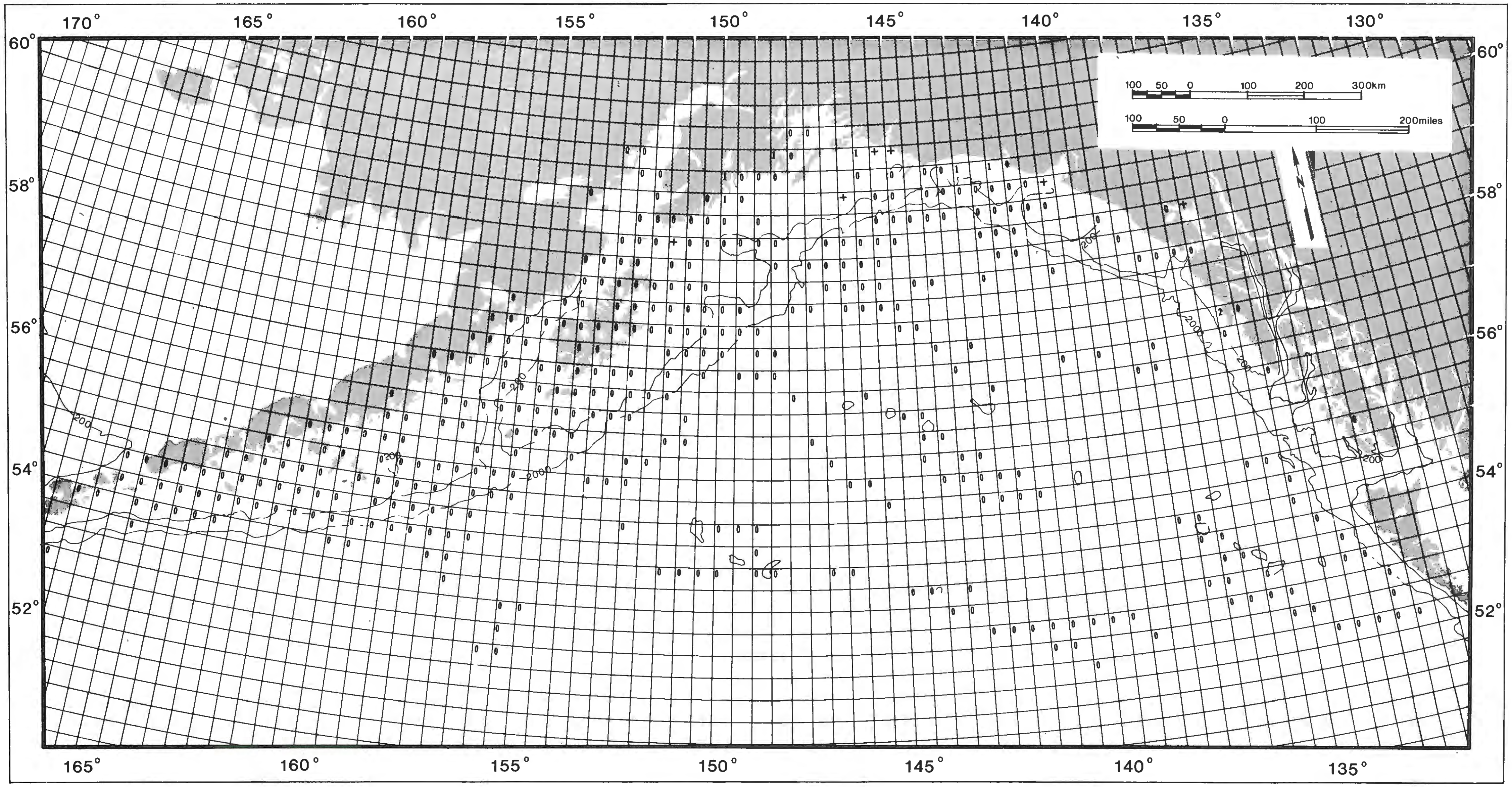

Map 10. Density indices of total loons obtained from aerial surveys of the Gulf of Alaska in winter.



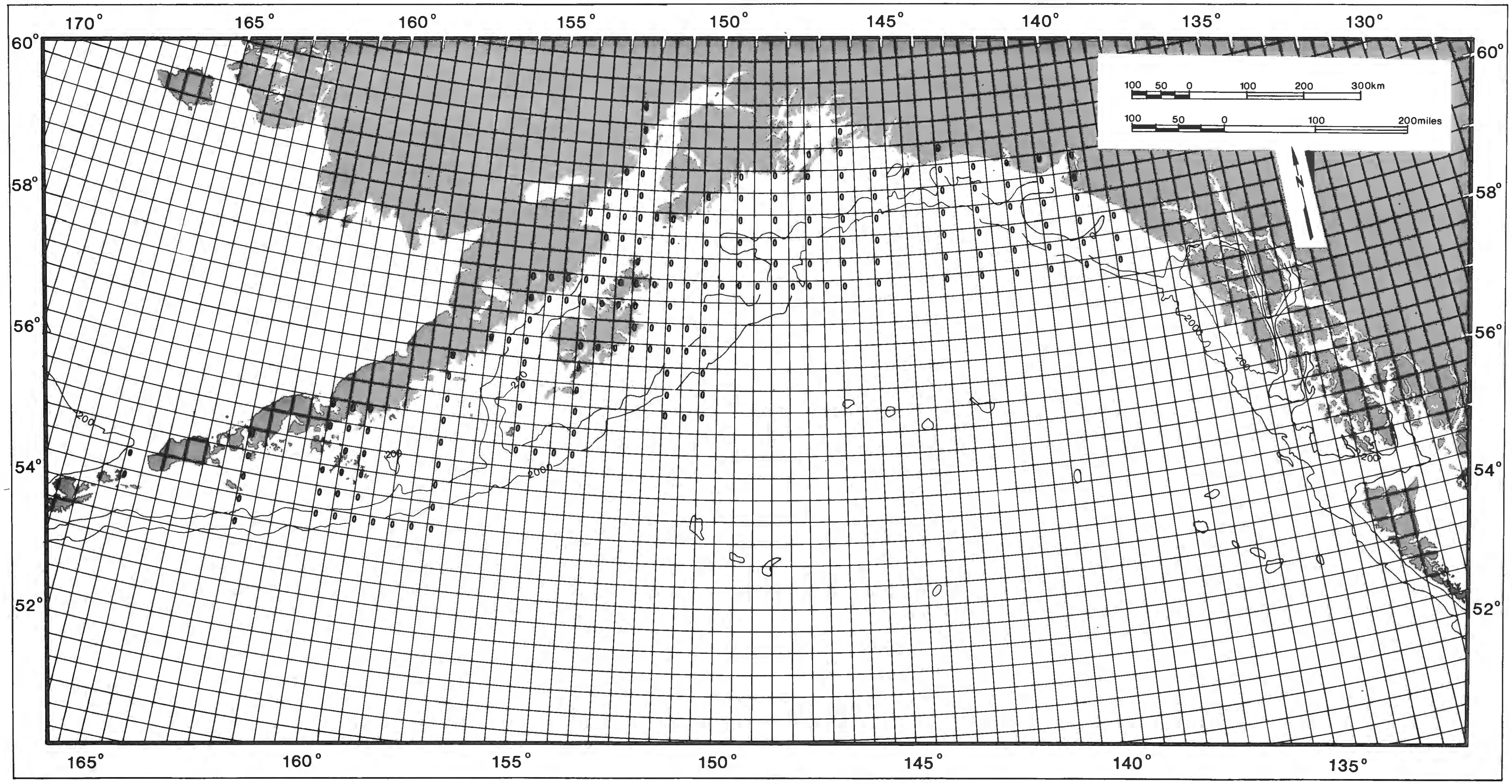

Map 11. Density indices of total loons obtained from shipboard surveys of the Gulf of Alaska in spring.



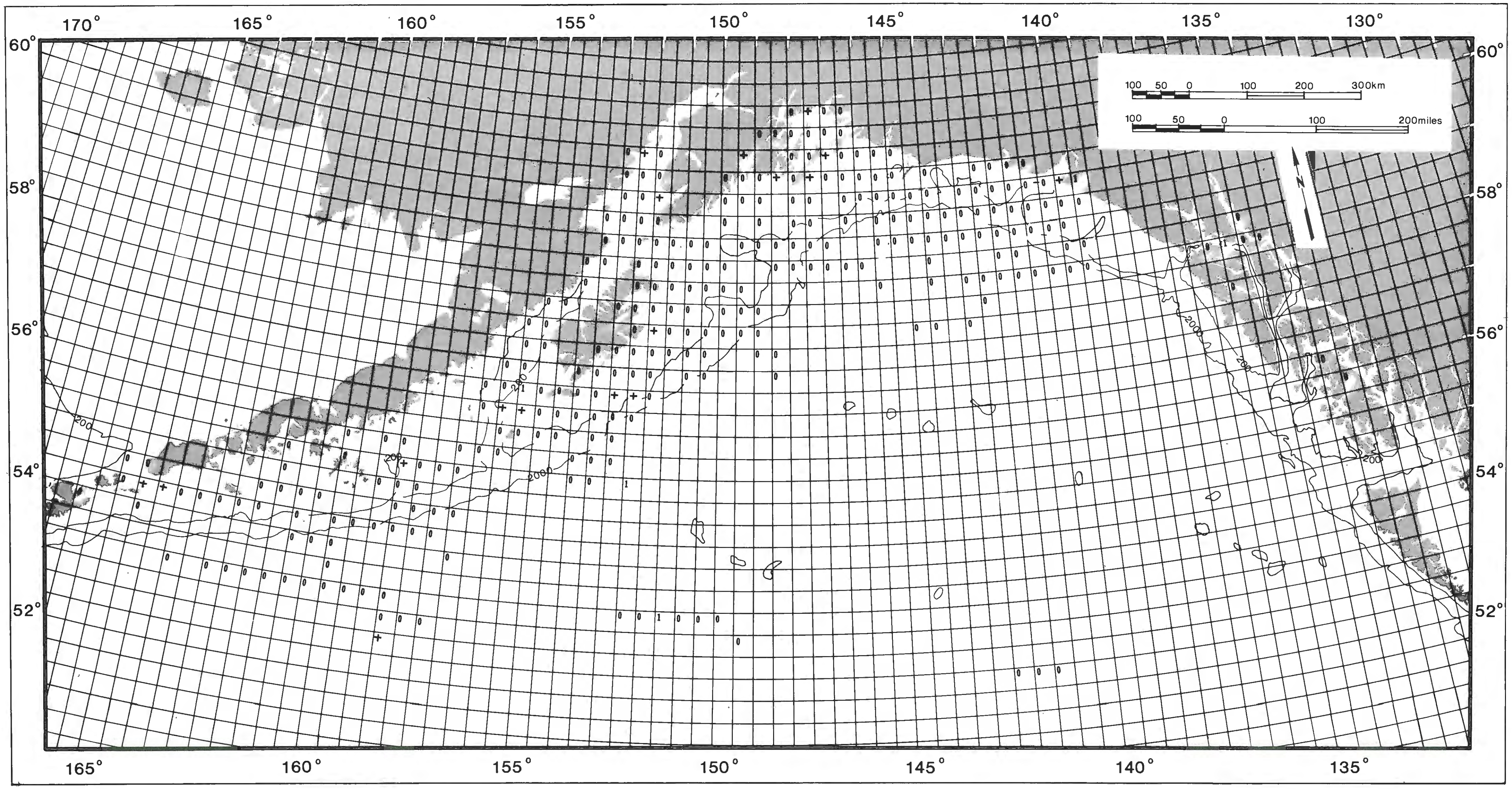

Map 12. Density indices of total loons obtained from aerial surveys of the Gulf of Alaska in spring.



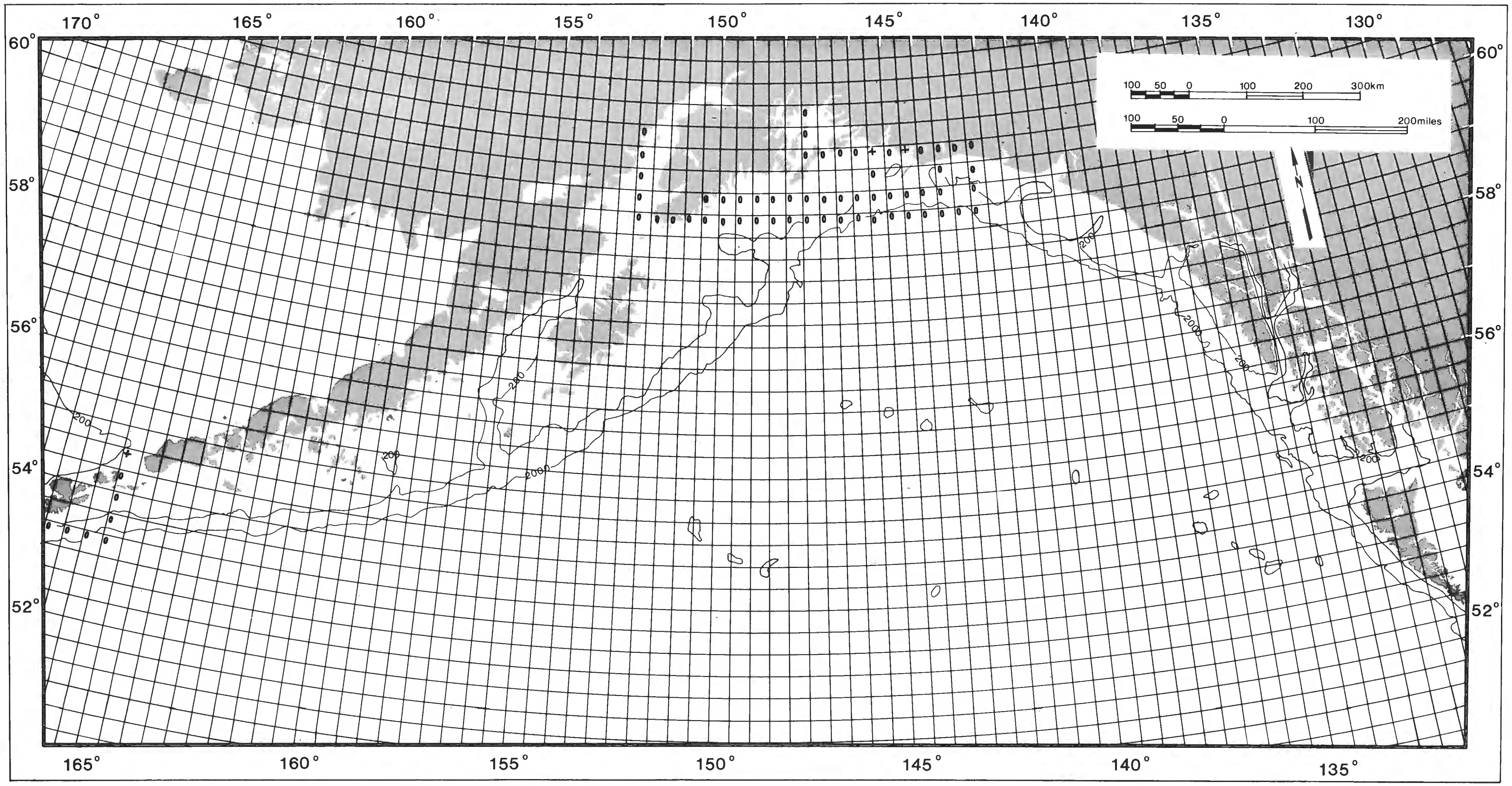

Map 13. Density indices of total loons obtained from shipboard surveys of the Gulf of Alaska in summer.



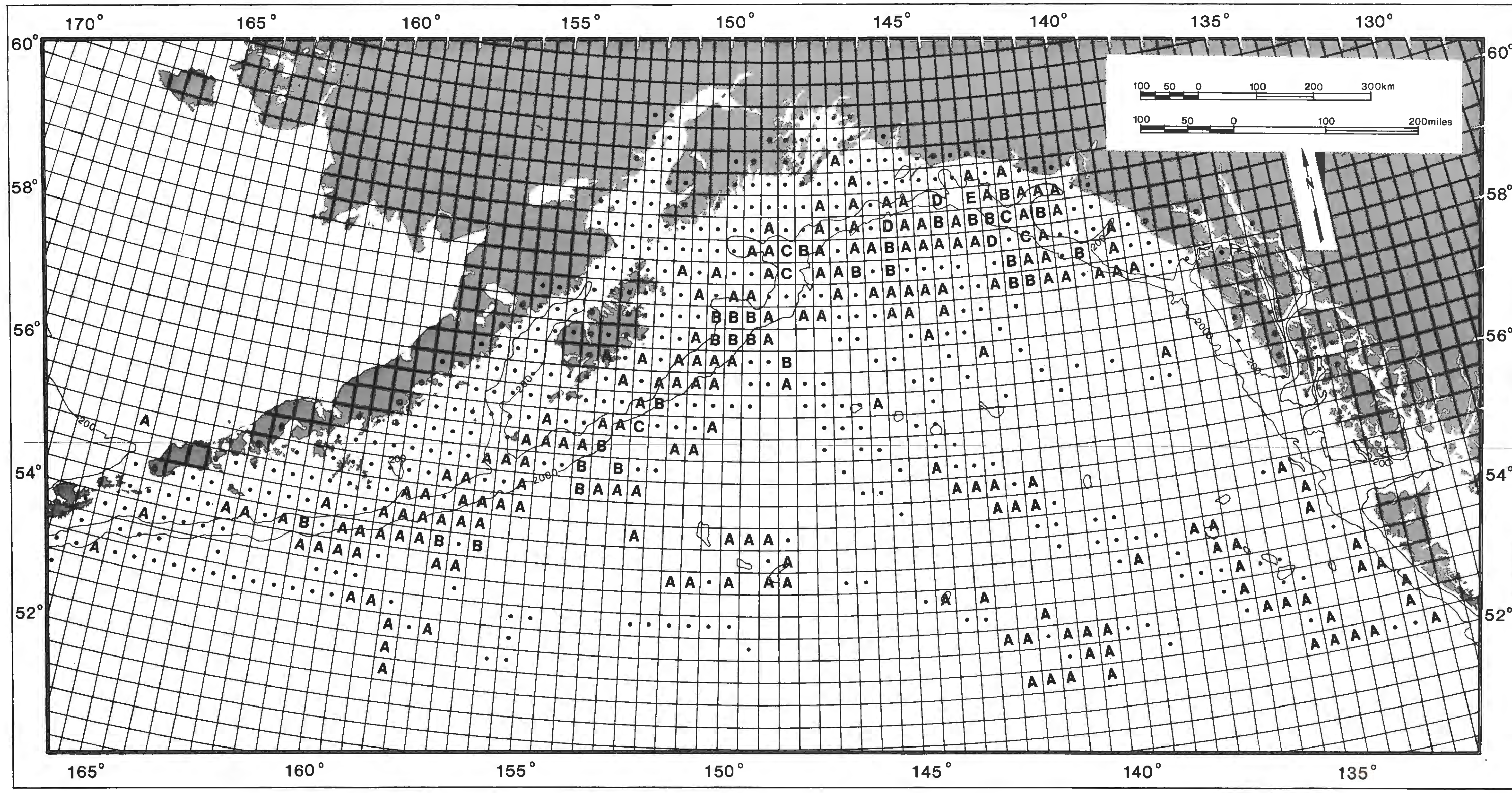

Map 14. Density indices of total loons obtained from aerial surveys of the Gulf of Alaska in summer.




Map 15. Density indices of total loons obtained from shipboard surveys of the Gulf of Alaska in fall.

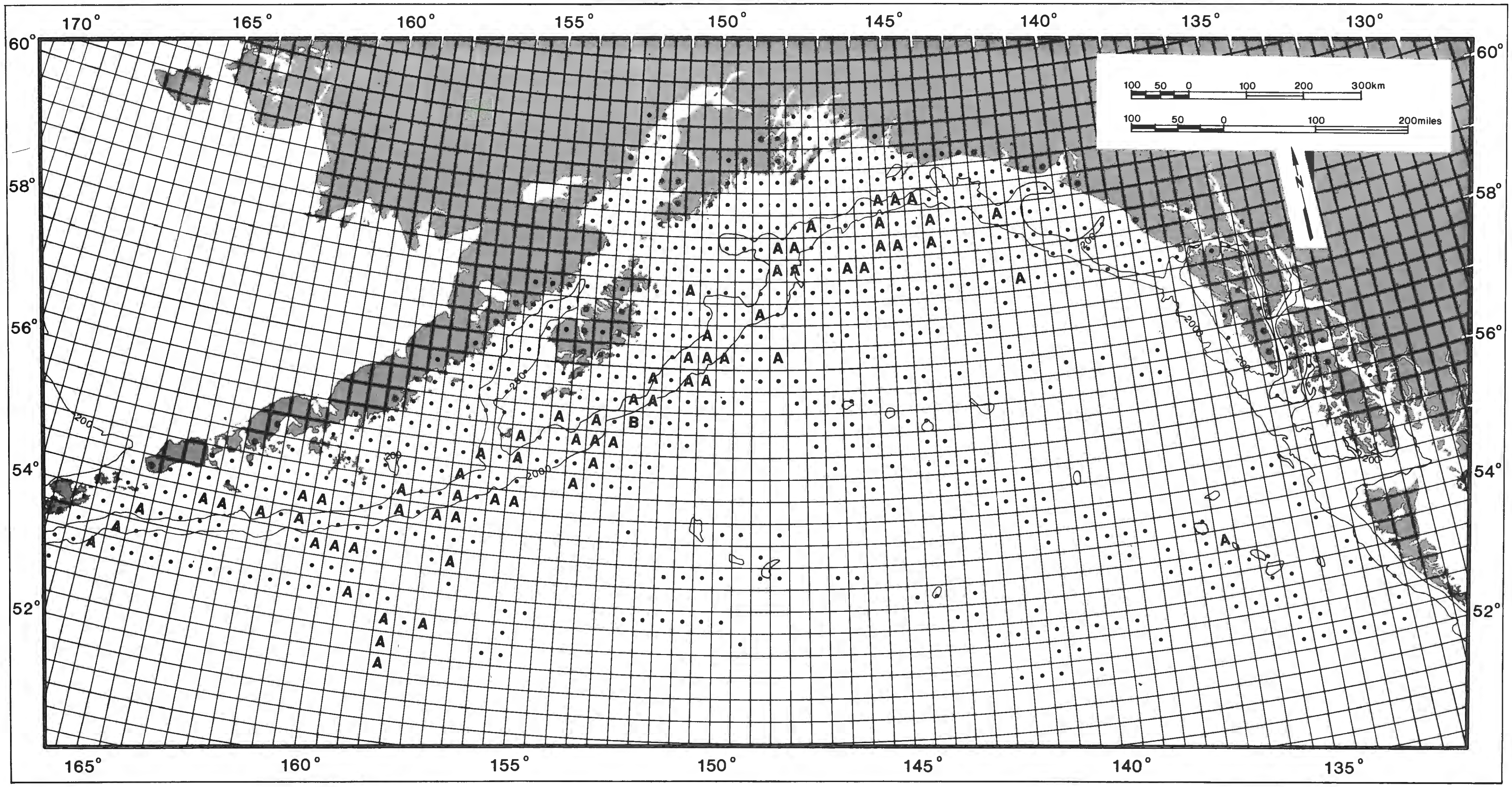



Map 16. Density indices of total loons obtained from aerial surveys of the Gulf of Alaska in fall.

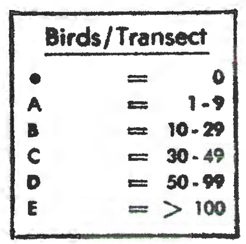


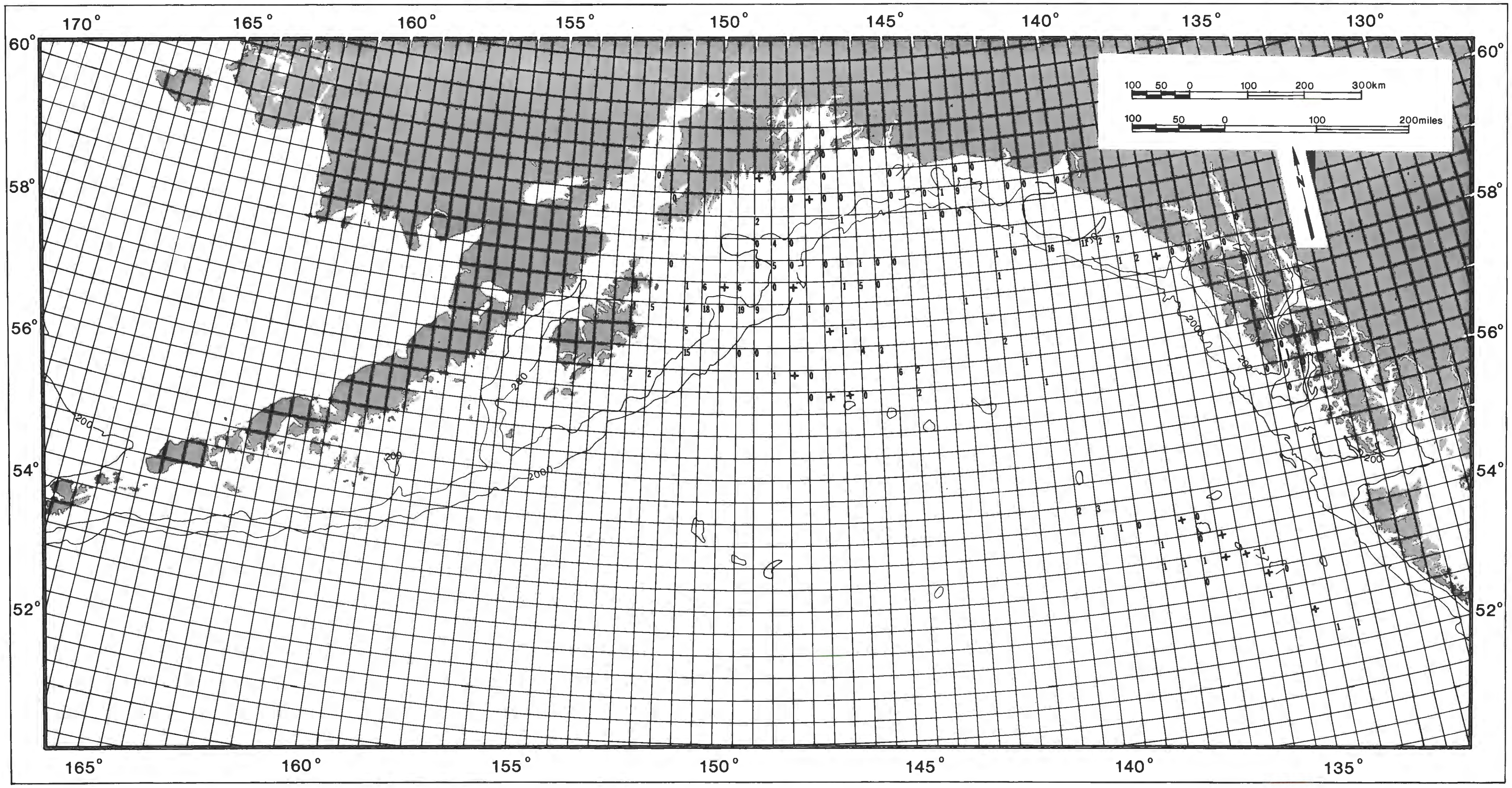

Map 17. Relative abundance of Black-footed Albatross in the Gulf of Alaska.

| Birds/Transect | | |
|---|---|---|
| • | = | 0 |
| A | = | 1-9 |
| B | = | 10-29 |
| C | = | 30-49 |
| D | = | 50-99 |
| E | = | > 100 |

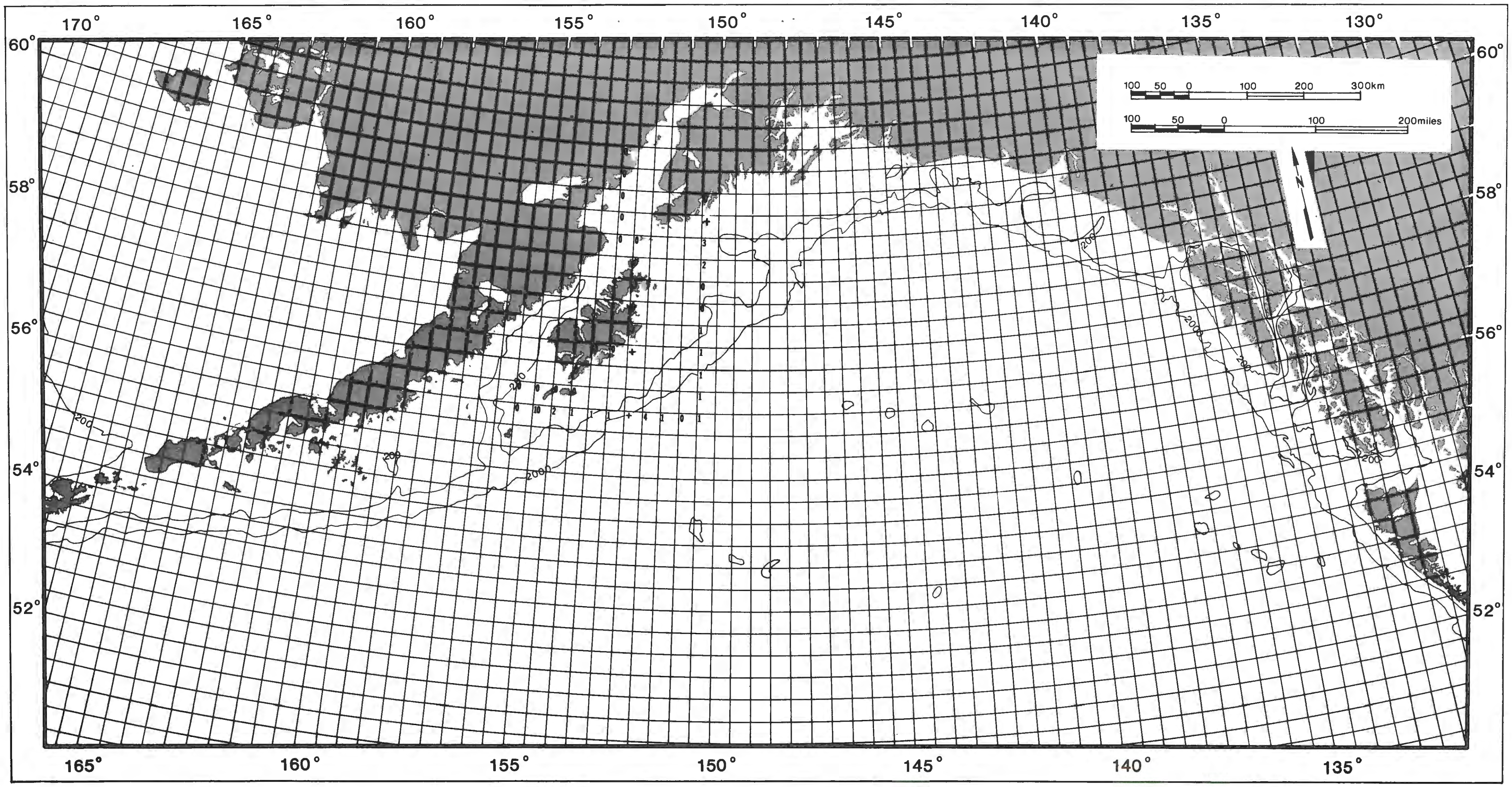



Map 18. Relative abundance of Laysan Albatross in the Gulf of Alaska.

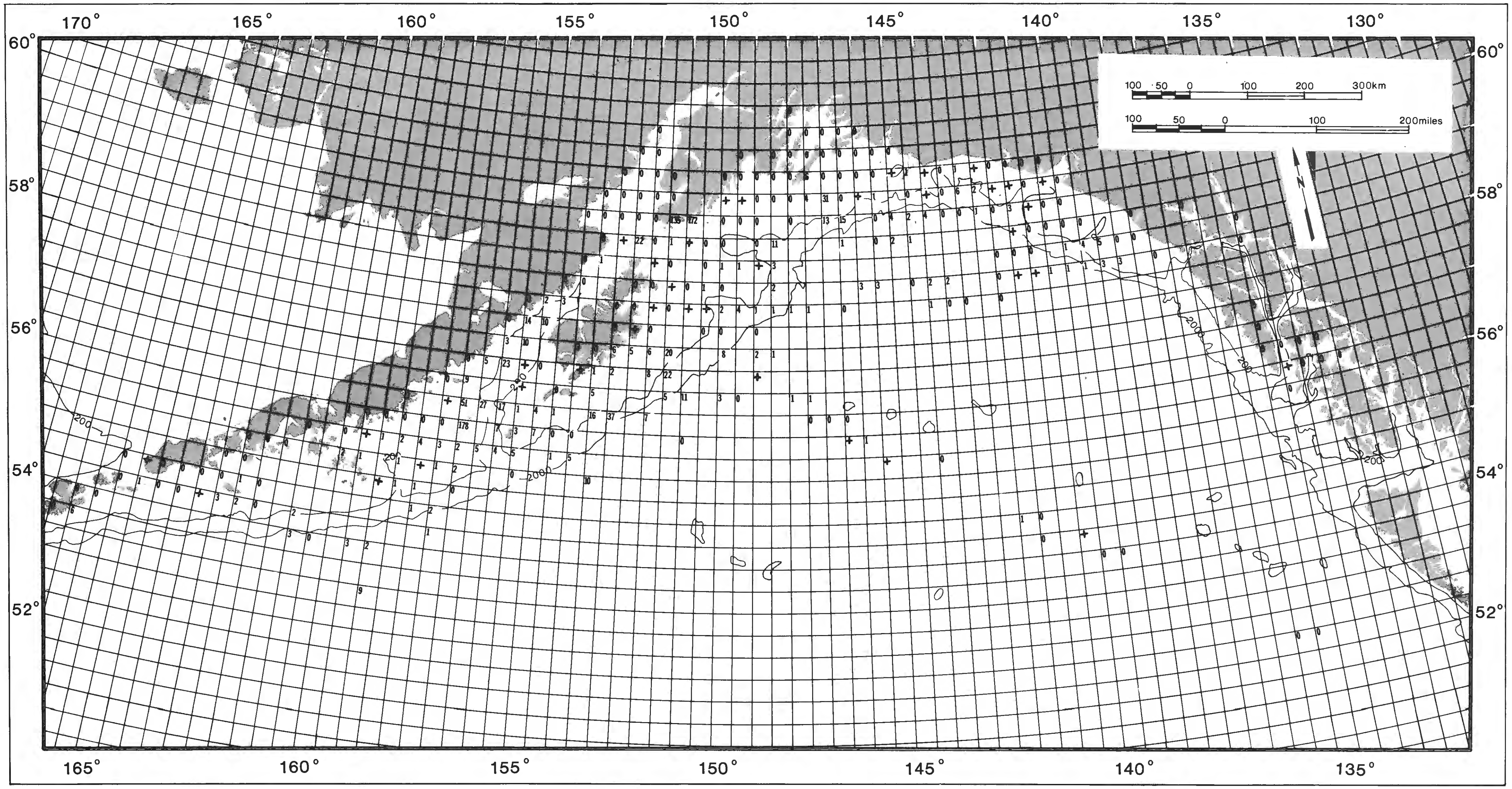




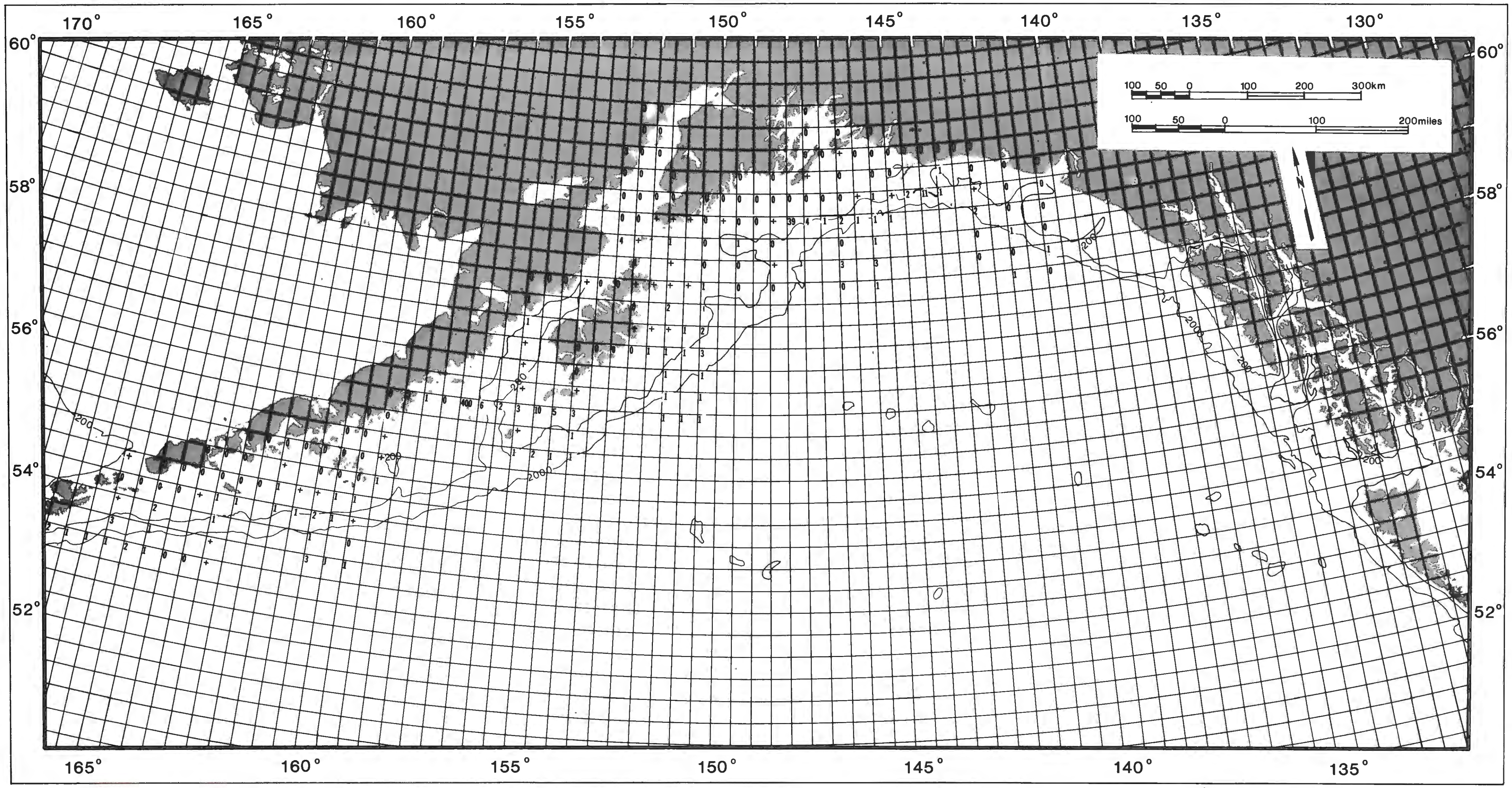

Map 19. Density indices of the Northern Fulmar obtained from shipboard surveys of the Gulf of Alaska in winter.



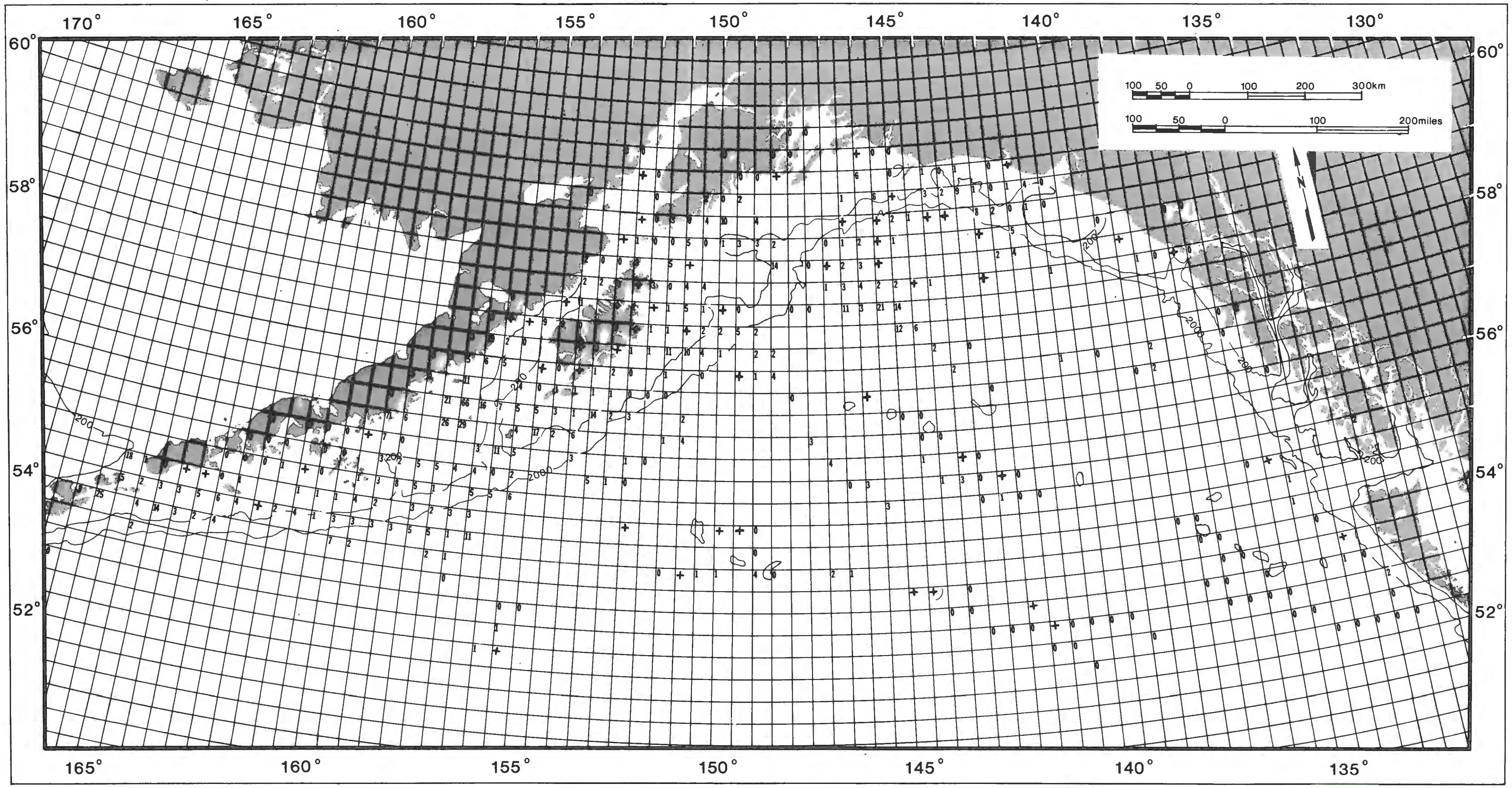

Map 20. Density indices of the Northern Fulmar obtained from aerial surveys of the Gulf of Alaska in winter.



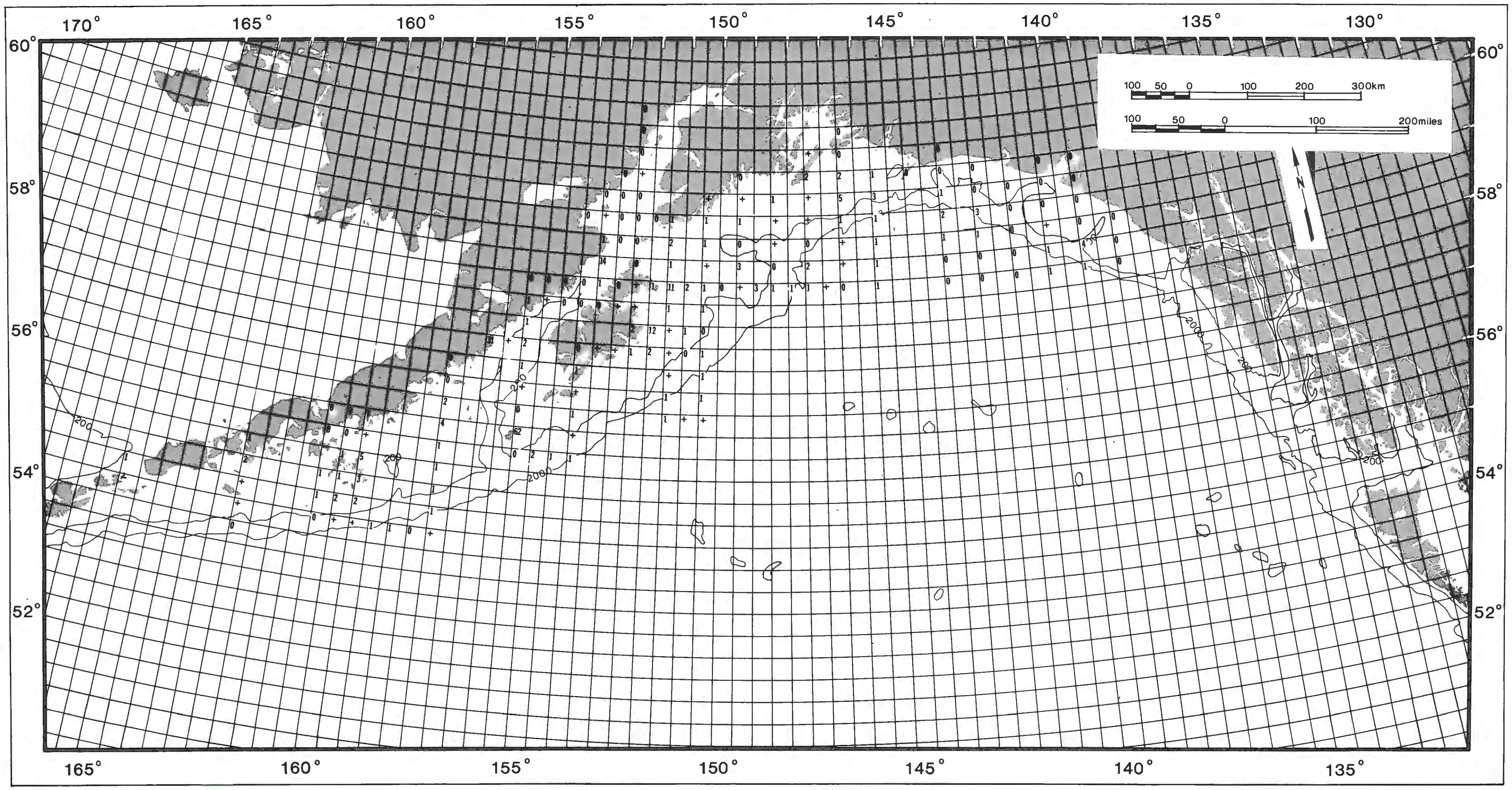

Map 21. Density indices of the Northern Fulmar obtained from shipboard surveys of the Gulf of Alaska in spring.



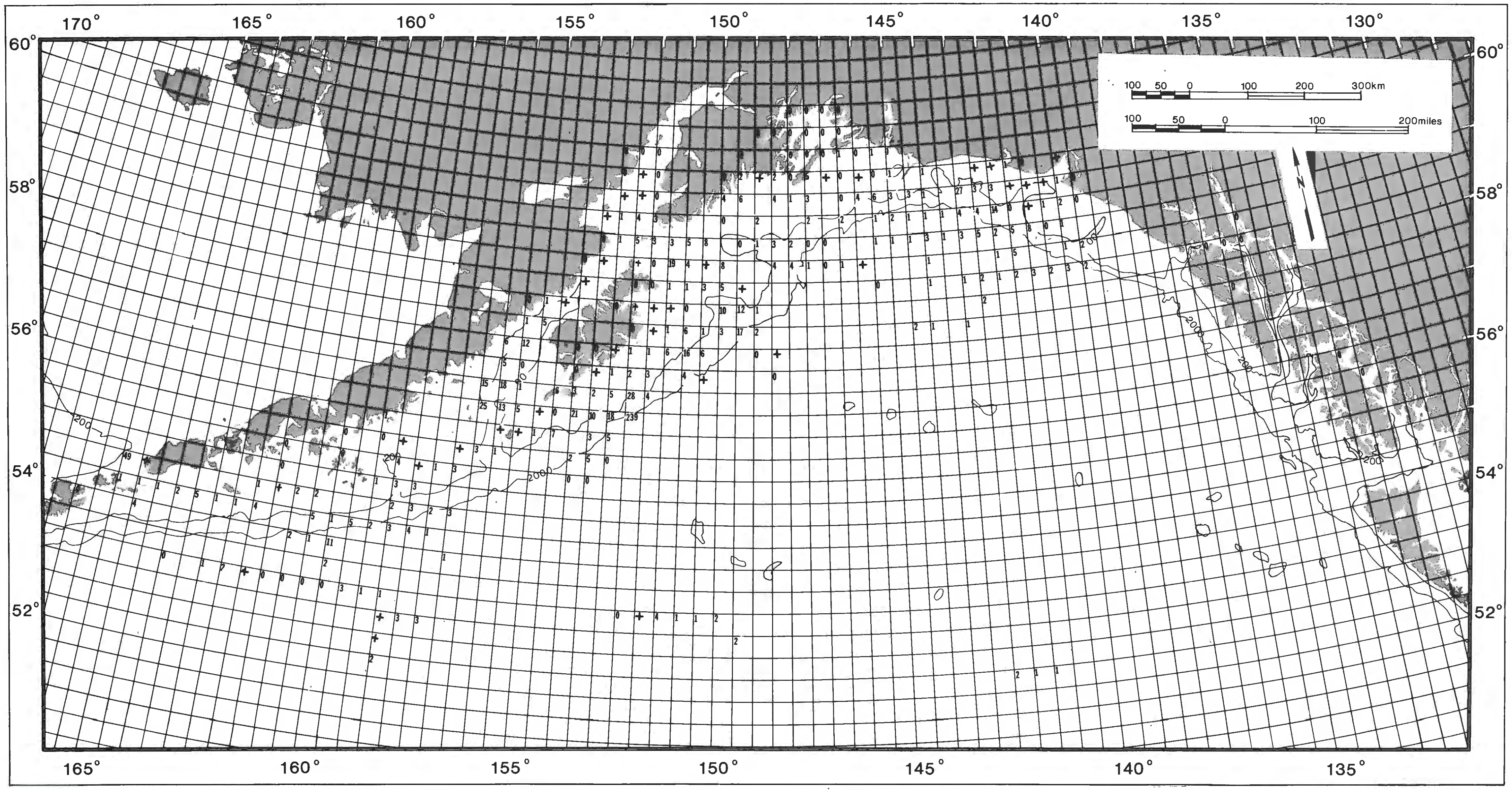

Map 22. Density indices of the Northern Fulmar obtained from aerial surveys of the Gulf of Alaska in spring.



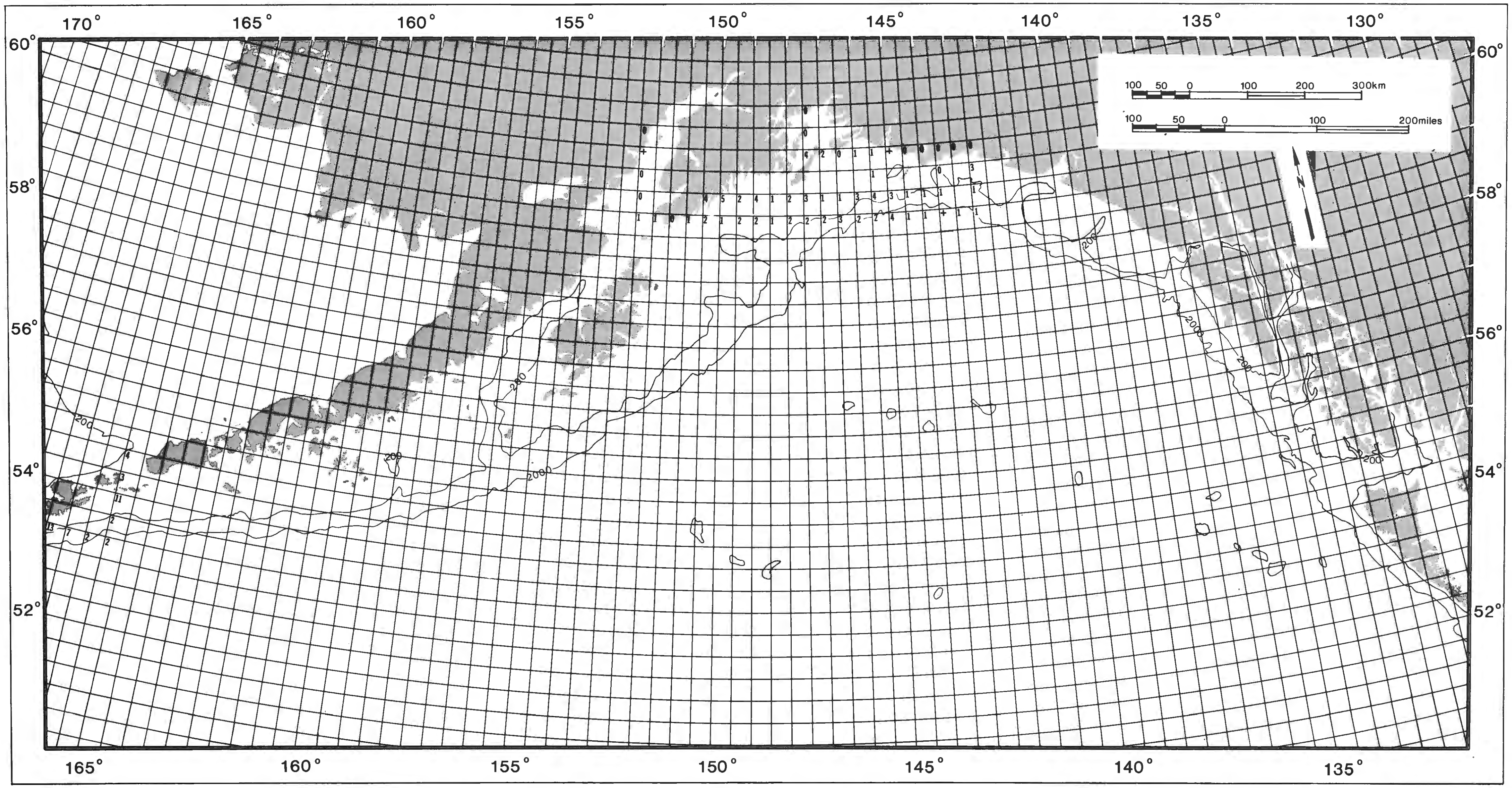

Map 23. Density indices of the Northern Fulmar obtained from shipboard surveys of the Gulf of Alaska in summer.



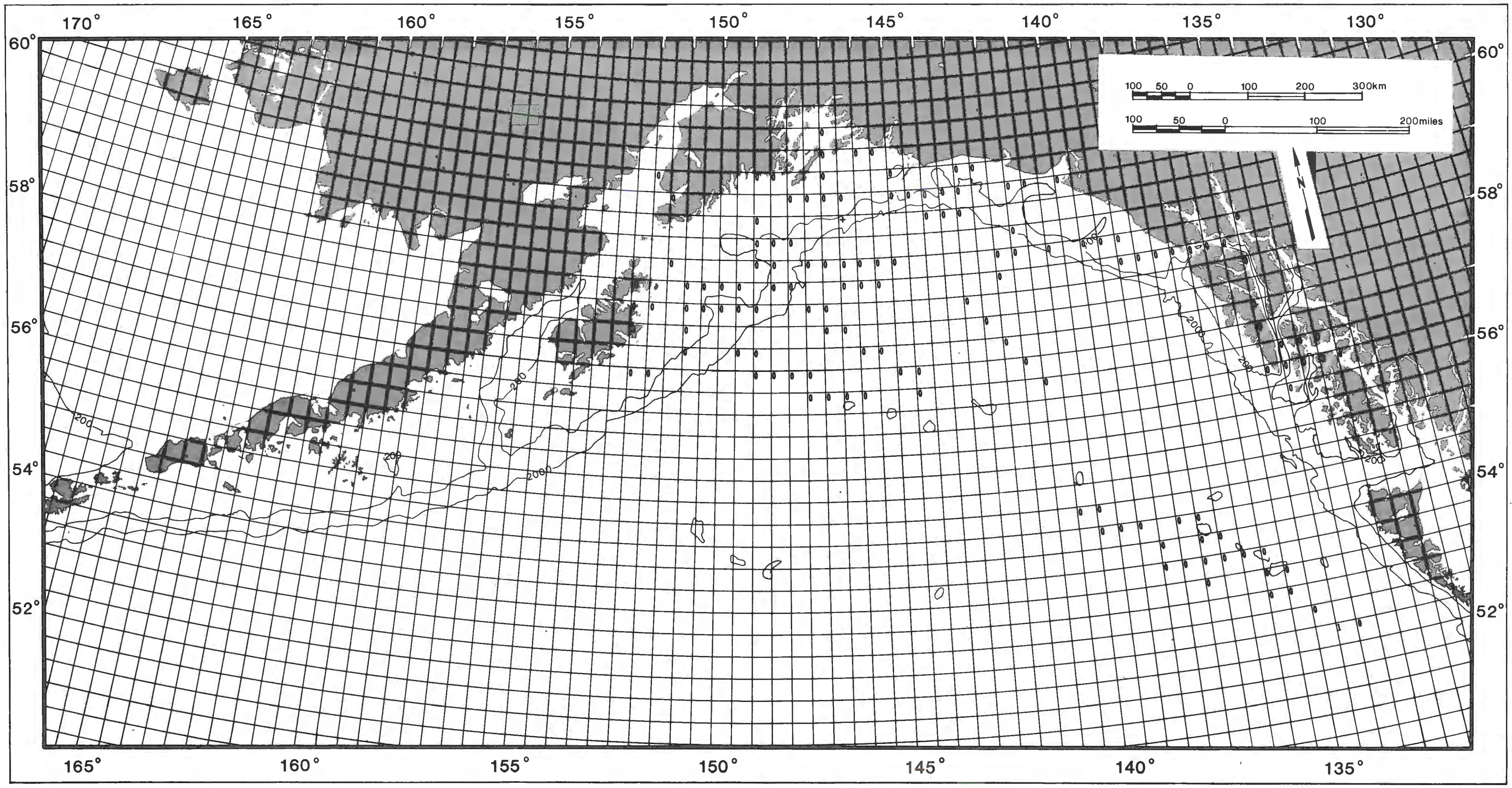

Map 24. Density indices of the Northern Fulmar obtained from aerial surveys of the Gulf of Alaska in summer.



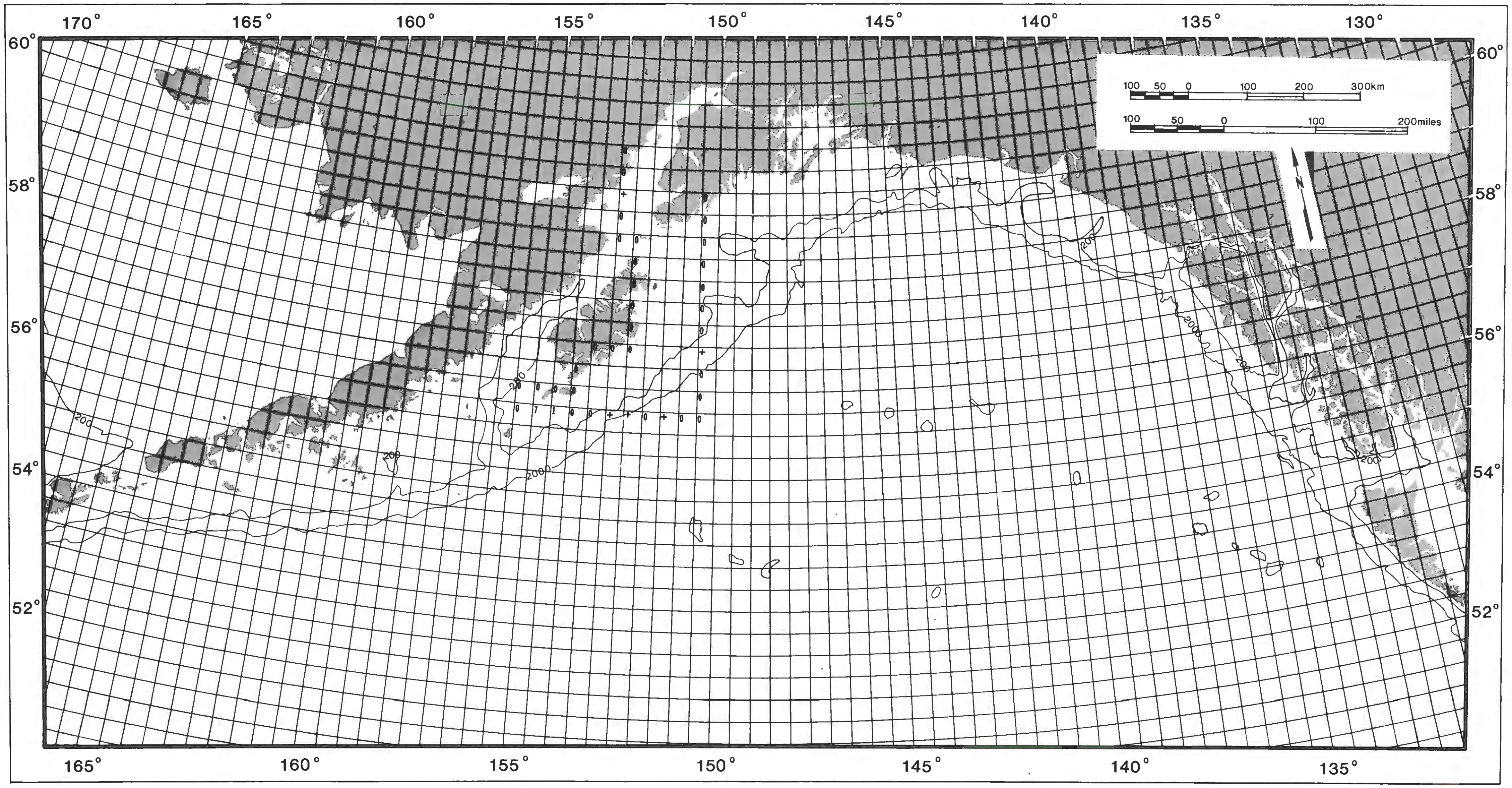

Map 25. Density indices of the Northern Fulmar obtained from shipboard surveys of the Gulf of Alaska in fall.



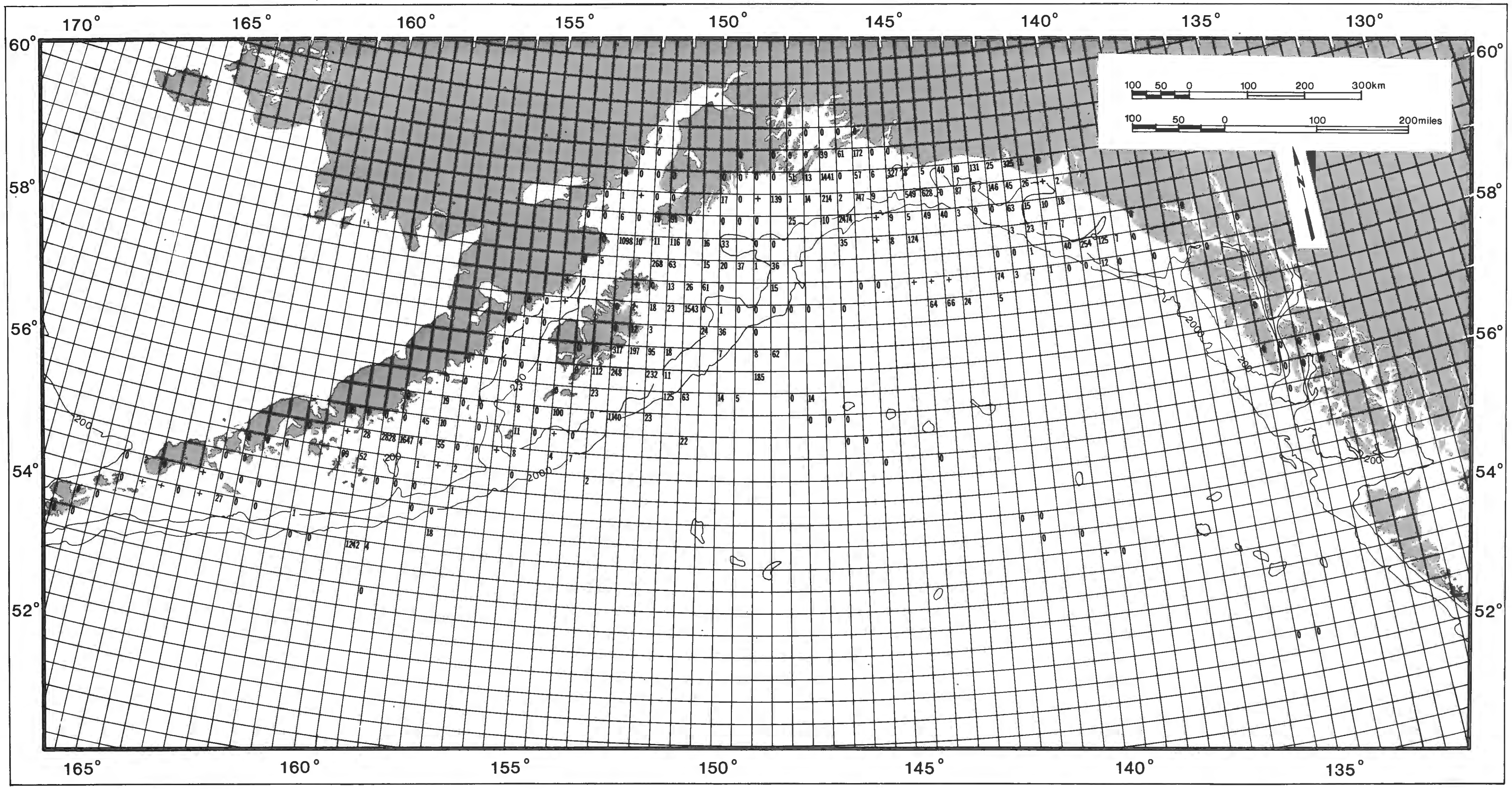

Map 26. Density indices of the Northern Fulmar obtained from aerial surveys of the Gulf of Alaska in fall.



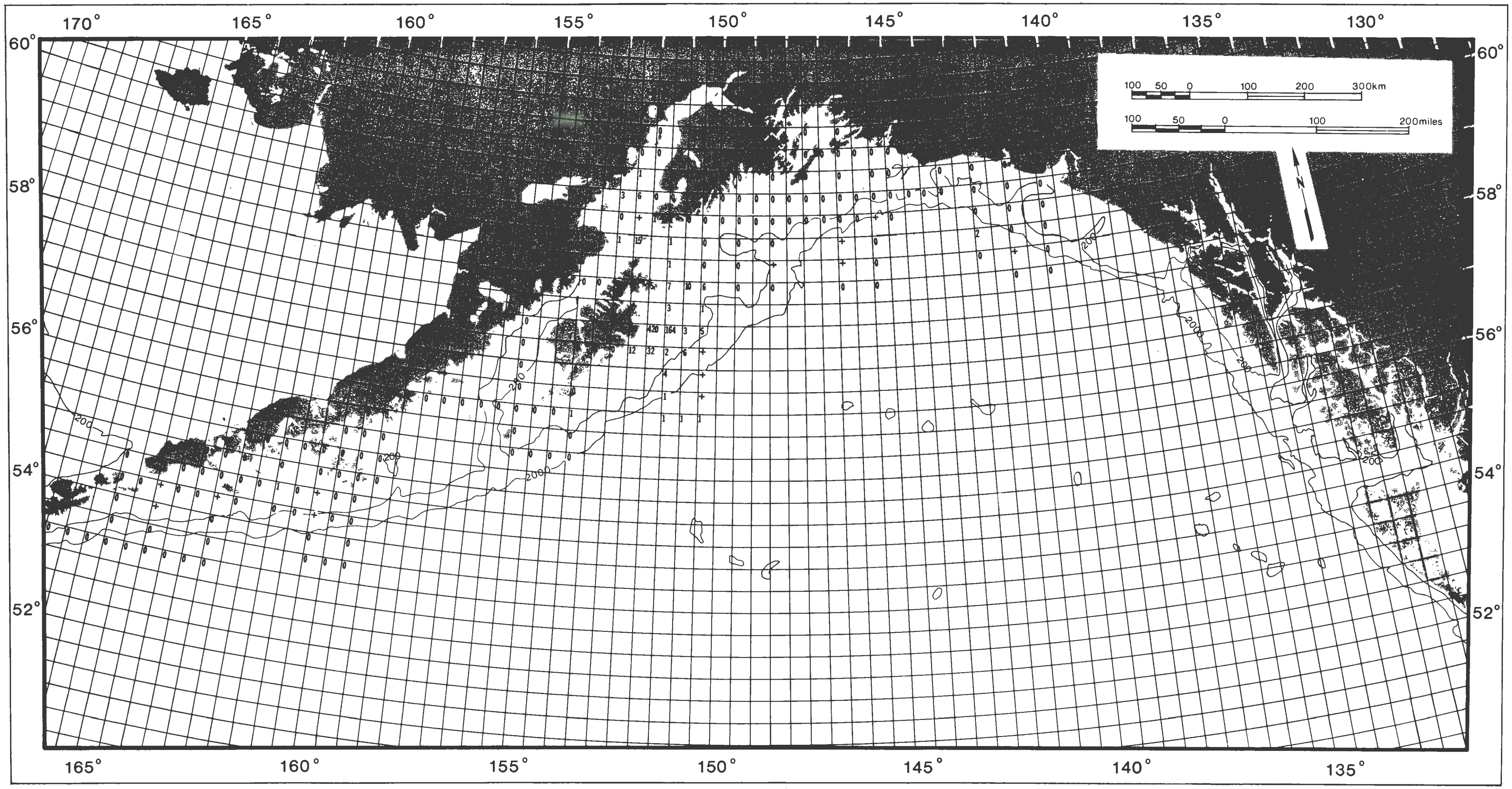

Map 27. Density indices of total shearwaters obtained from shipboard surveys of the Gulf of Alaska in winter.



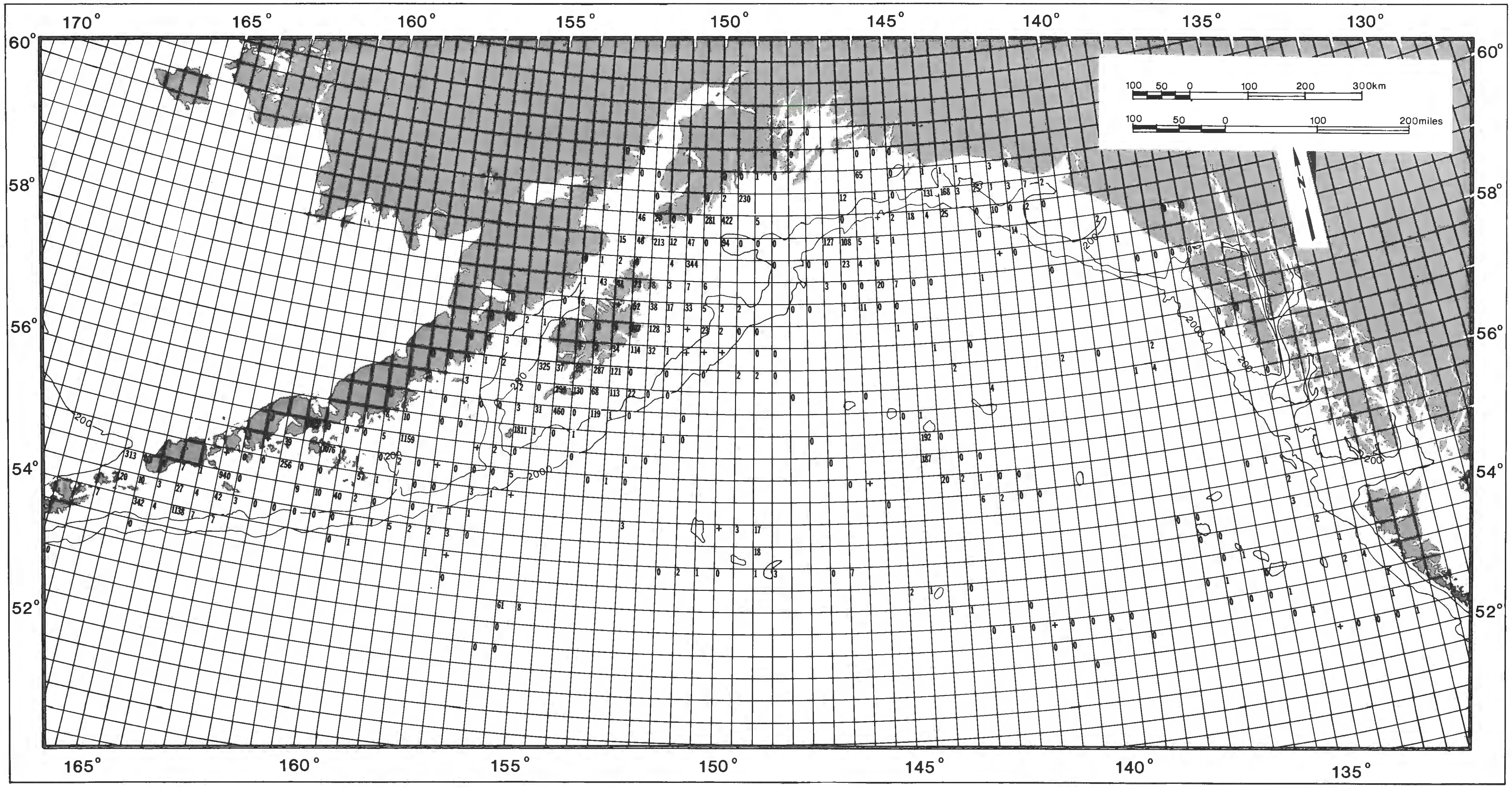

Map 28. Density indices of total shearwaters obtained from aerial surveys of the Gulf of Alaska in winter.



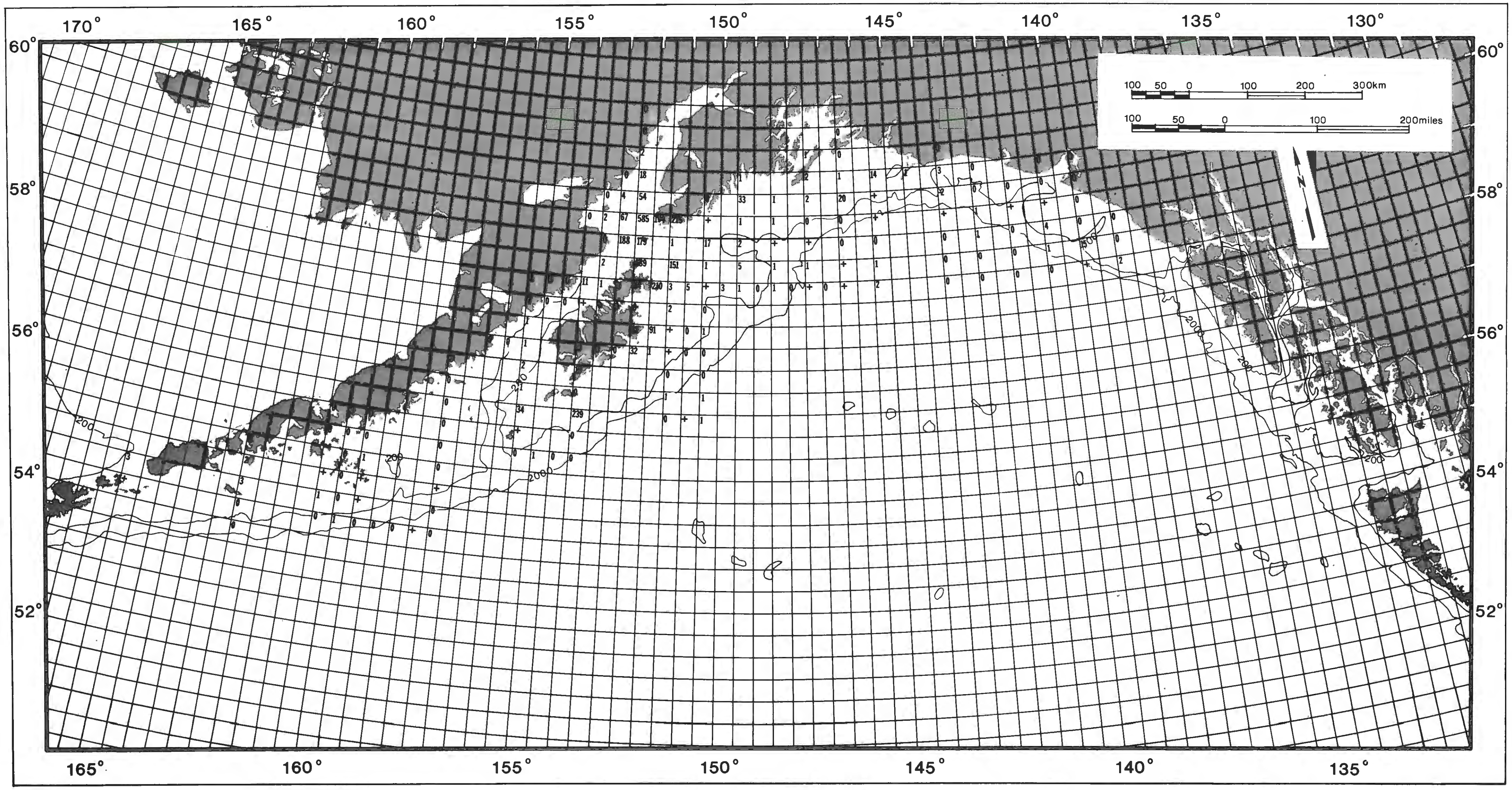

Map 29. Density indices of total shearwaters obtained from shipboard surveys of the Gulf of Alaska in spring.



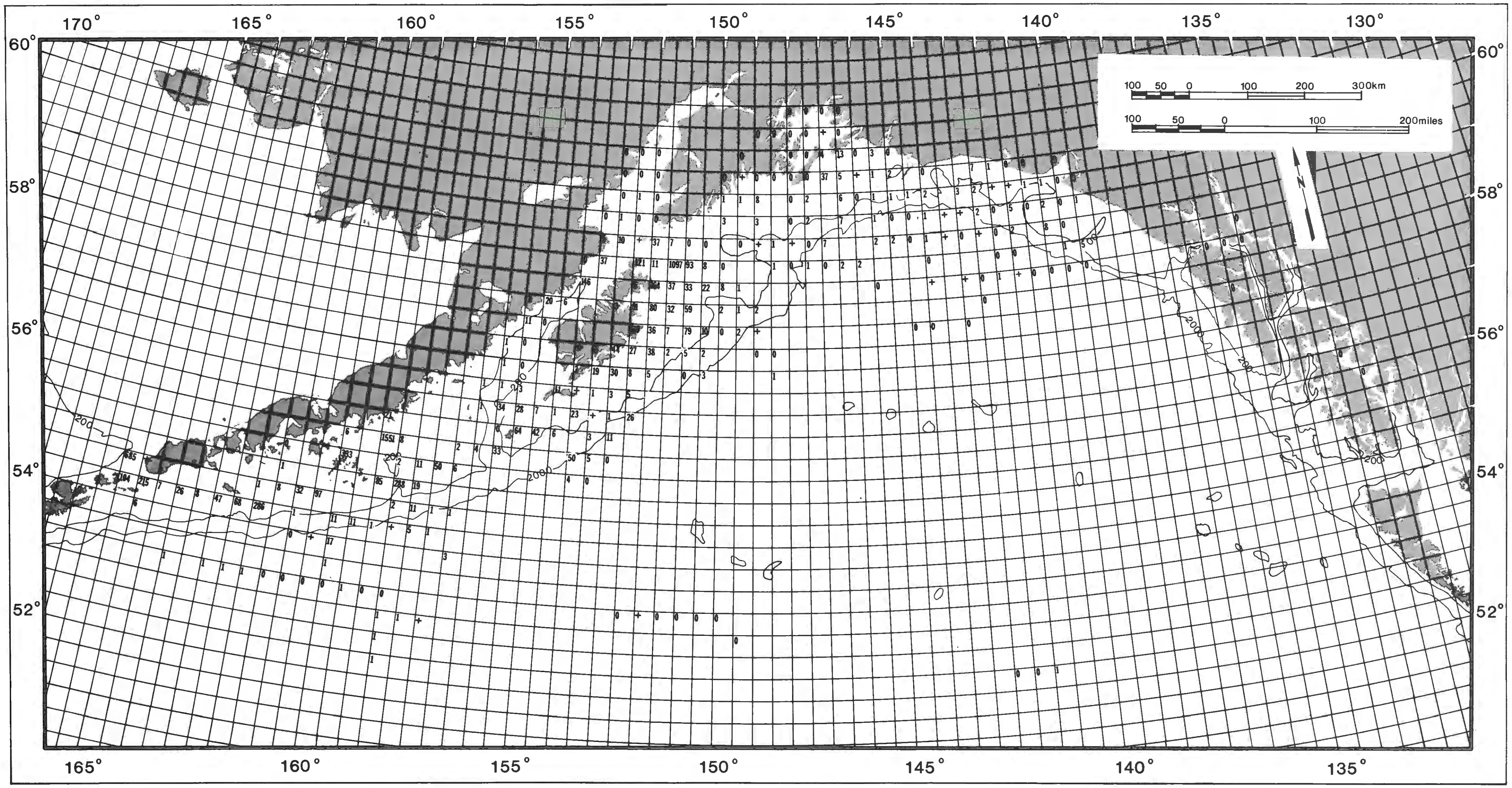

Map 30. Density indices of total shearwaters obtained from aerial surveys of the Gulf of Alaska in spring.



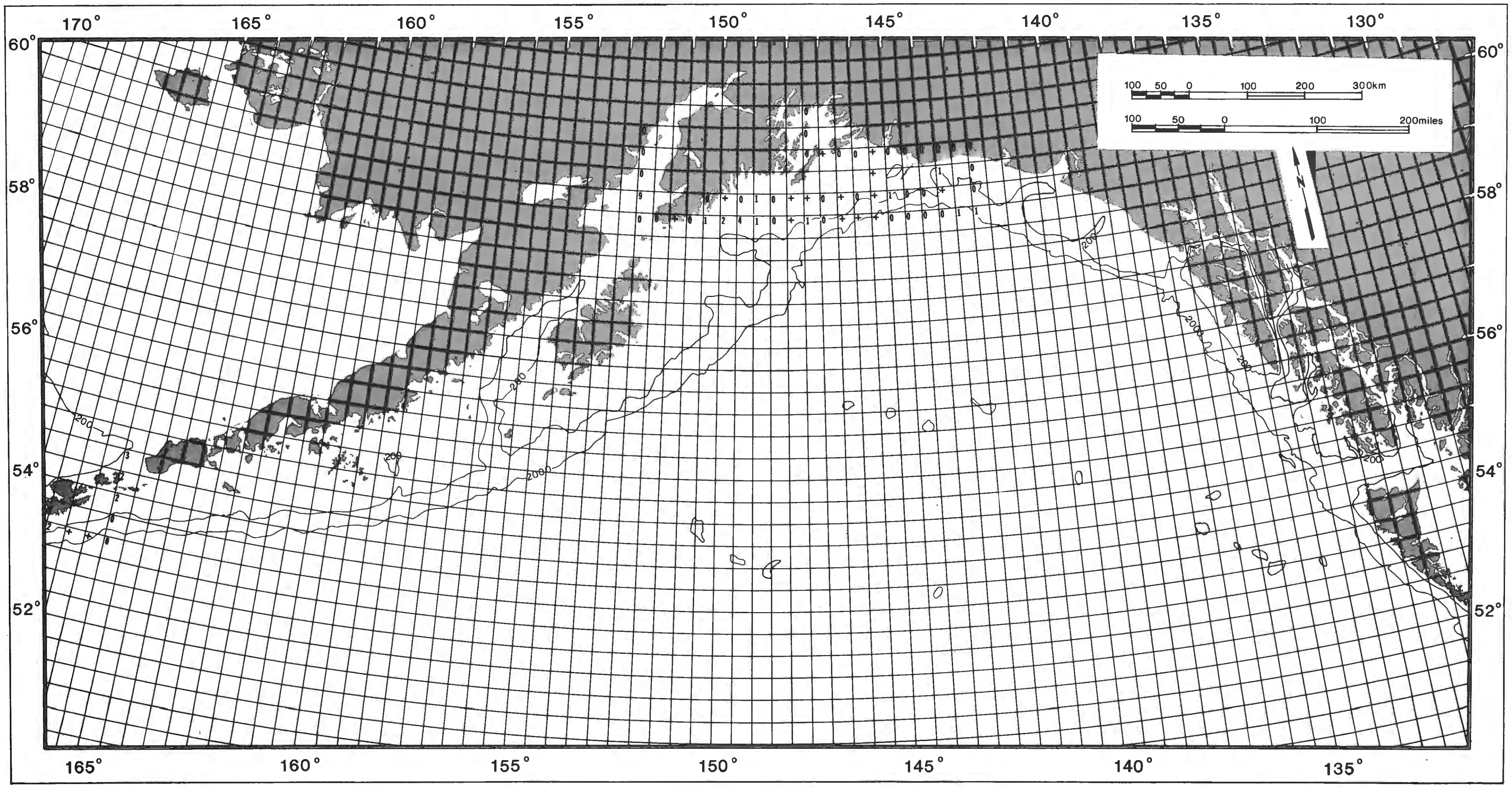

Map 31. Density indices of total shearwaters obtained from shipboard surveys of the Gulf of Alaska in summer.



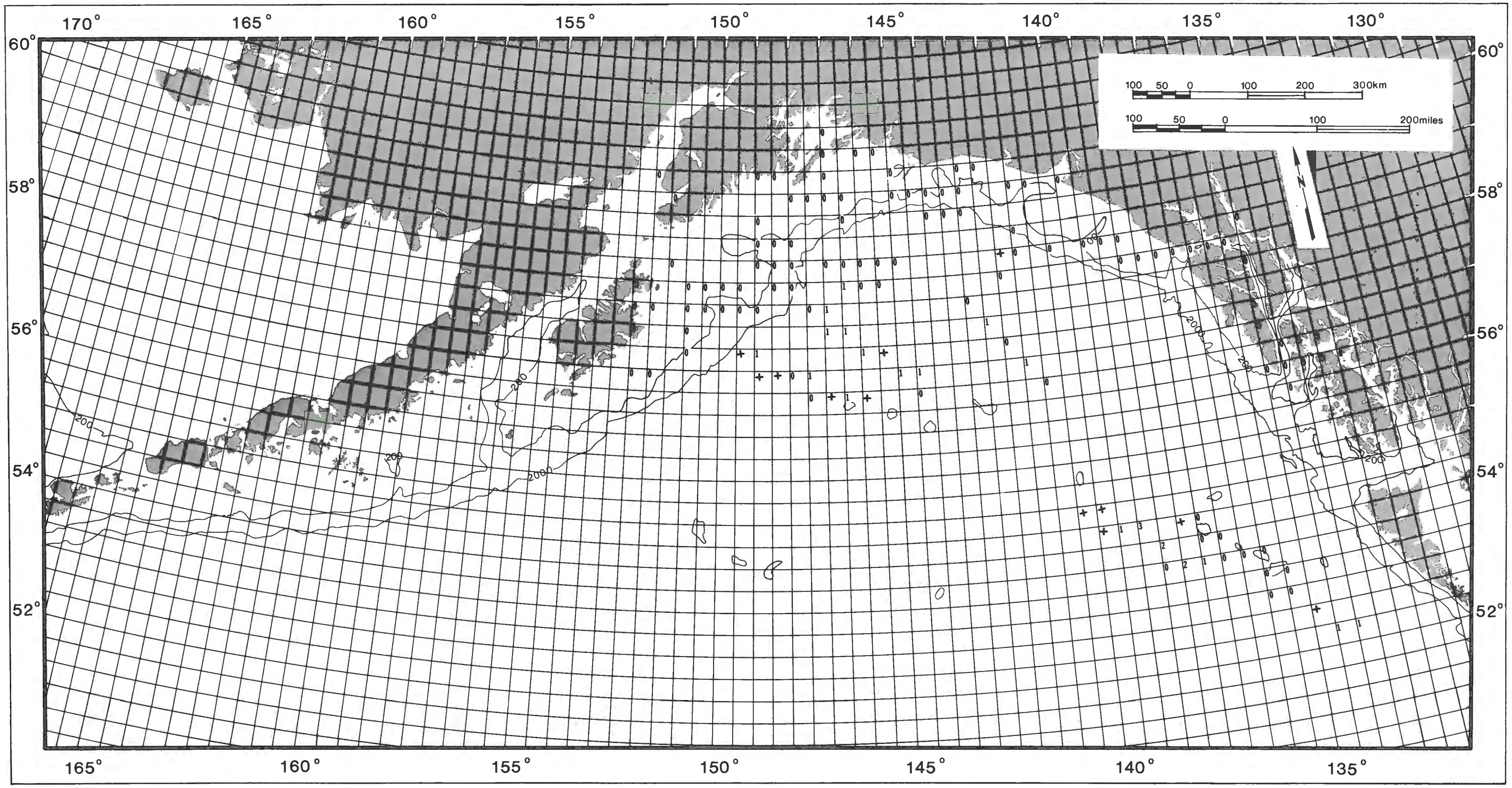

Map 32. Density indices of total shearwaters obtained from aerial surveys of the Gulf of Alaska in summer.



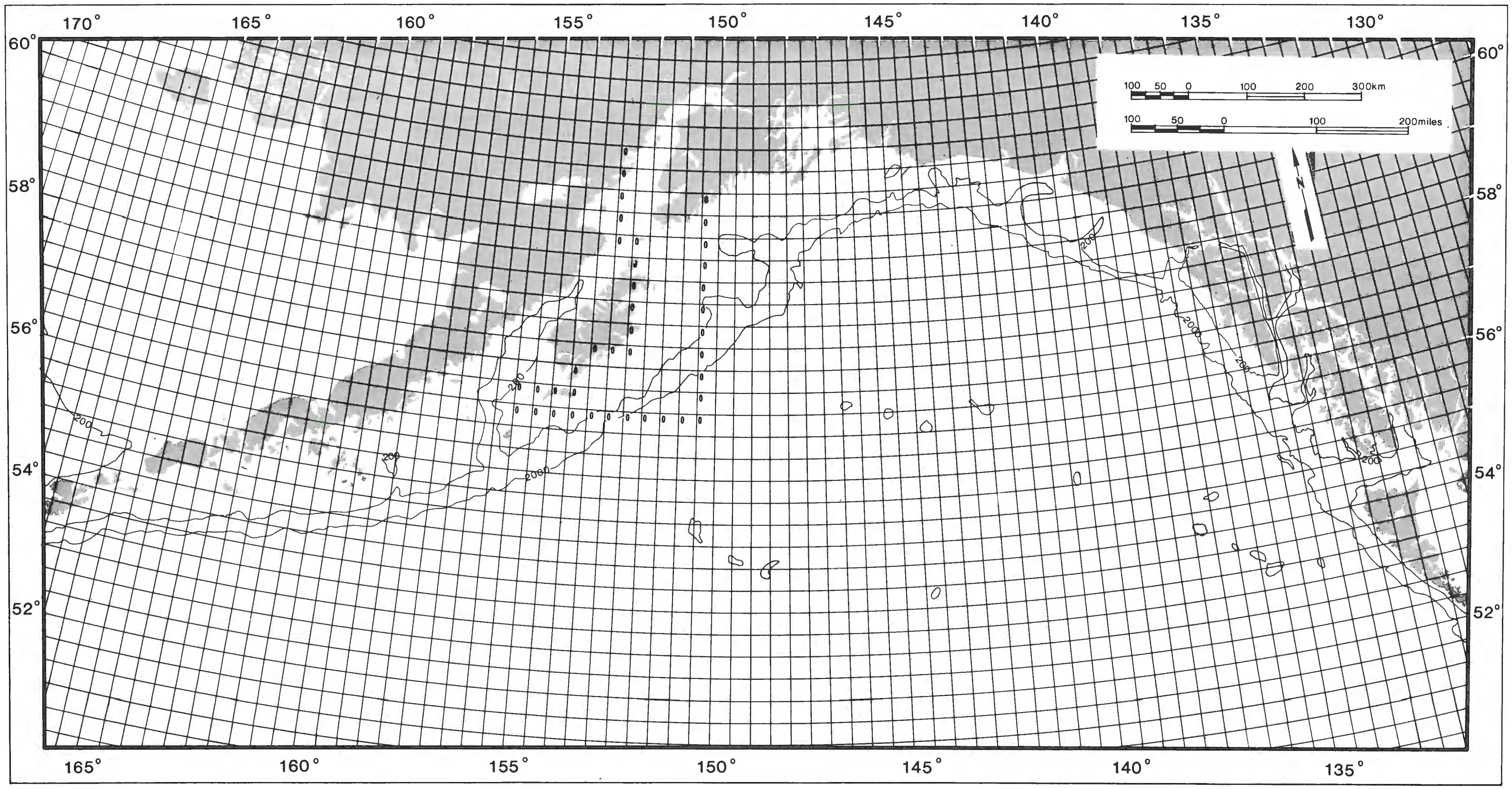

Map 33. Density indices of total shearwaters obtained from shipboard surveys of the Gulf of Alaska in fall.



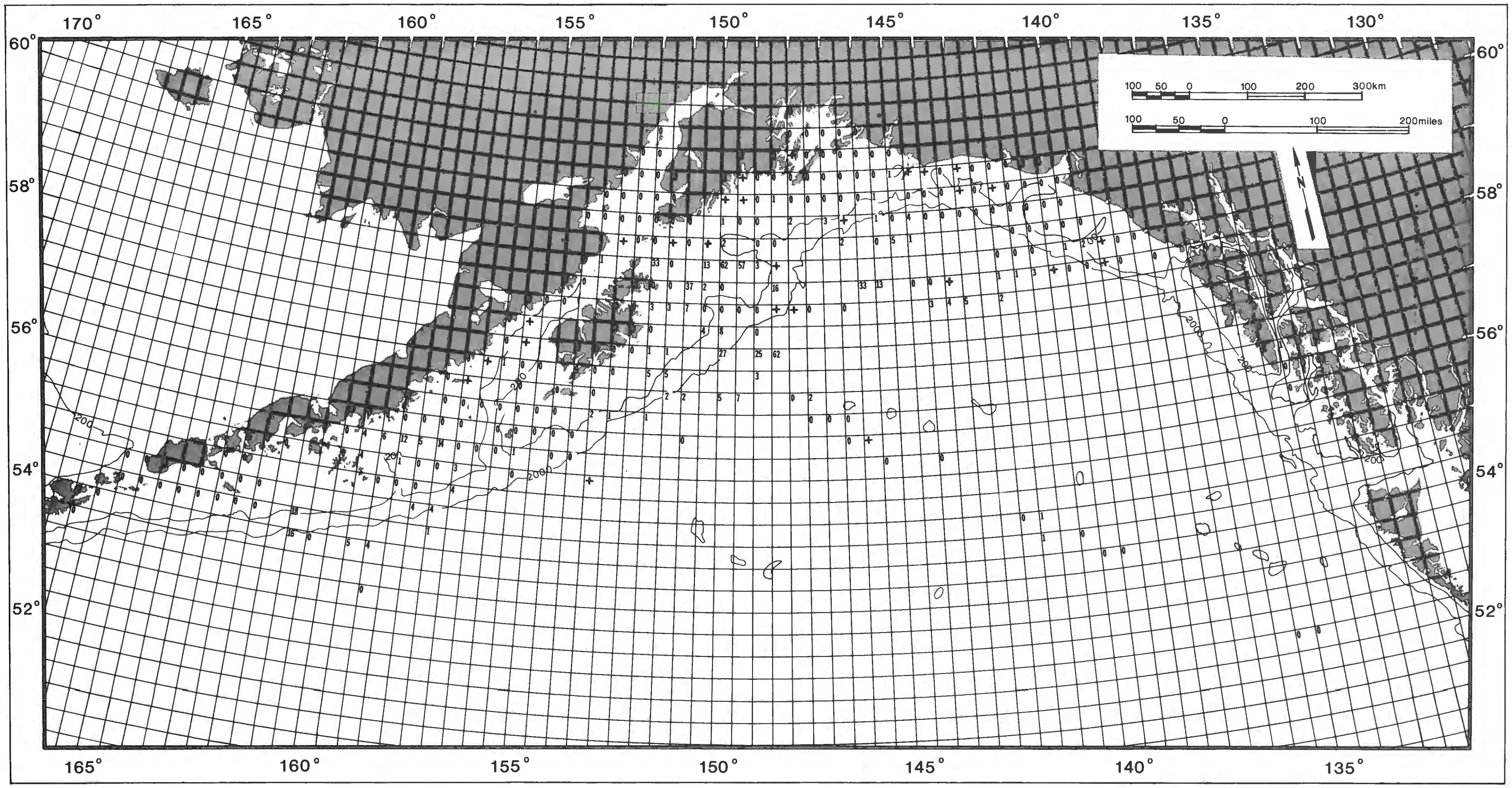

Map 34. Density indices of total shearwaters obtained from aerial surveys of the Gulf of Alaska in fall.



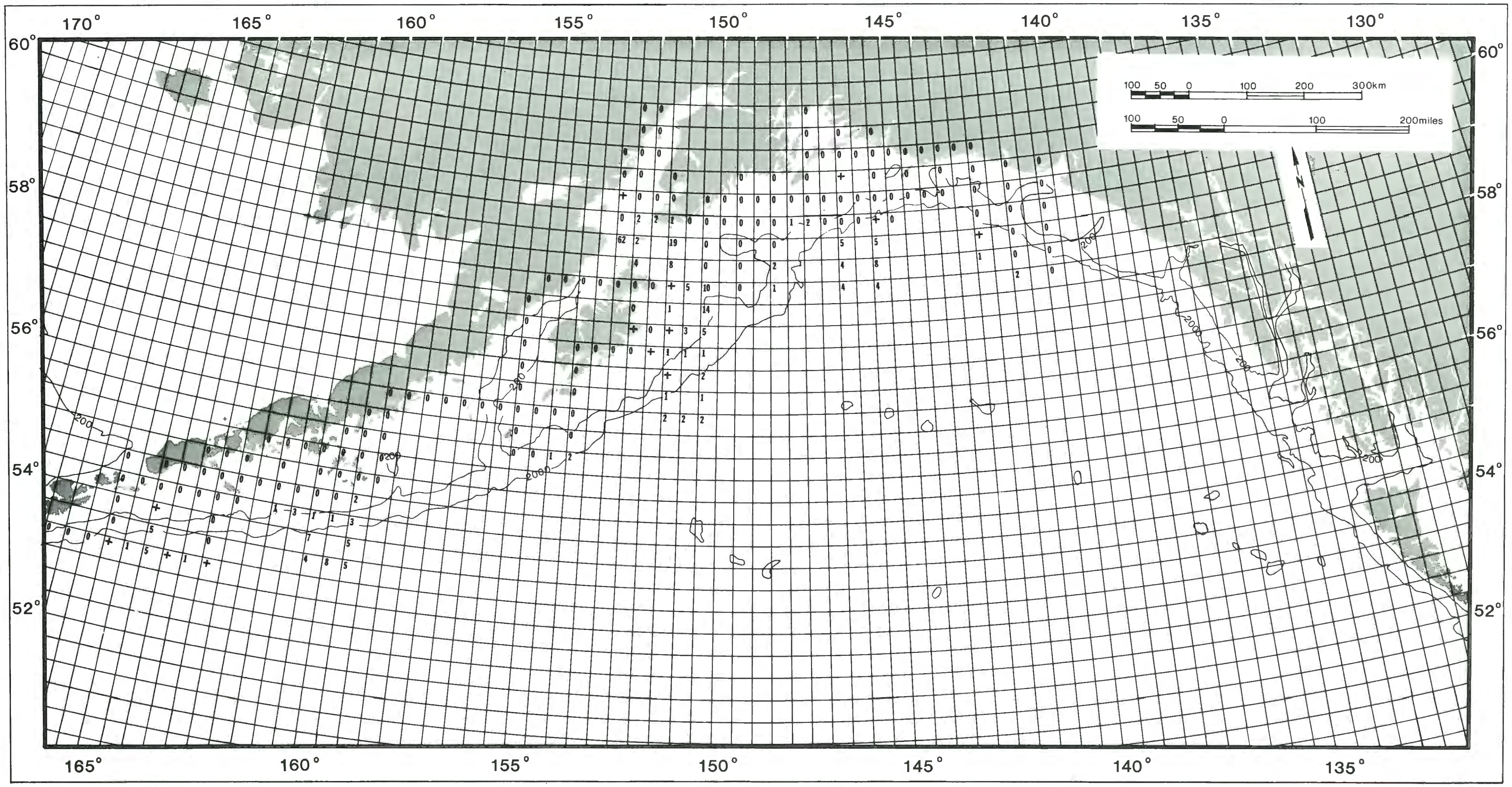

Map 35. Density indices of total storm-petrels obtained from shipboard surveys of the Gulf of Alaska in winter.



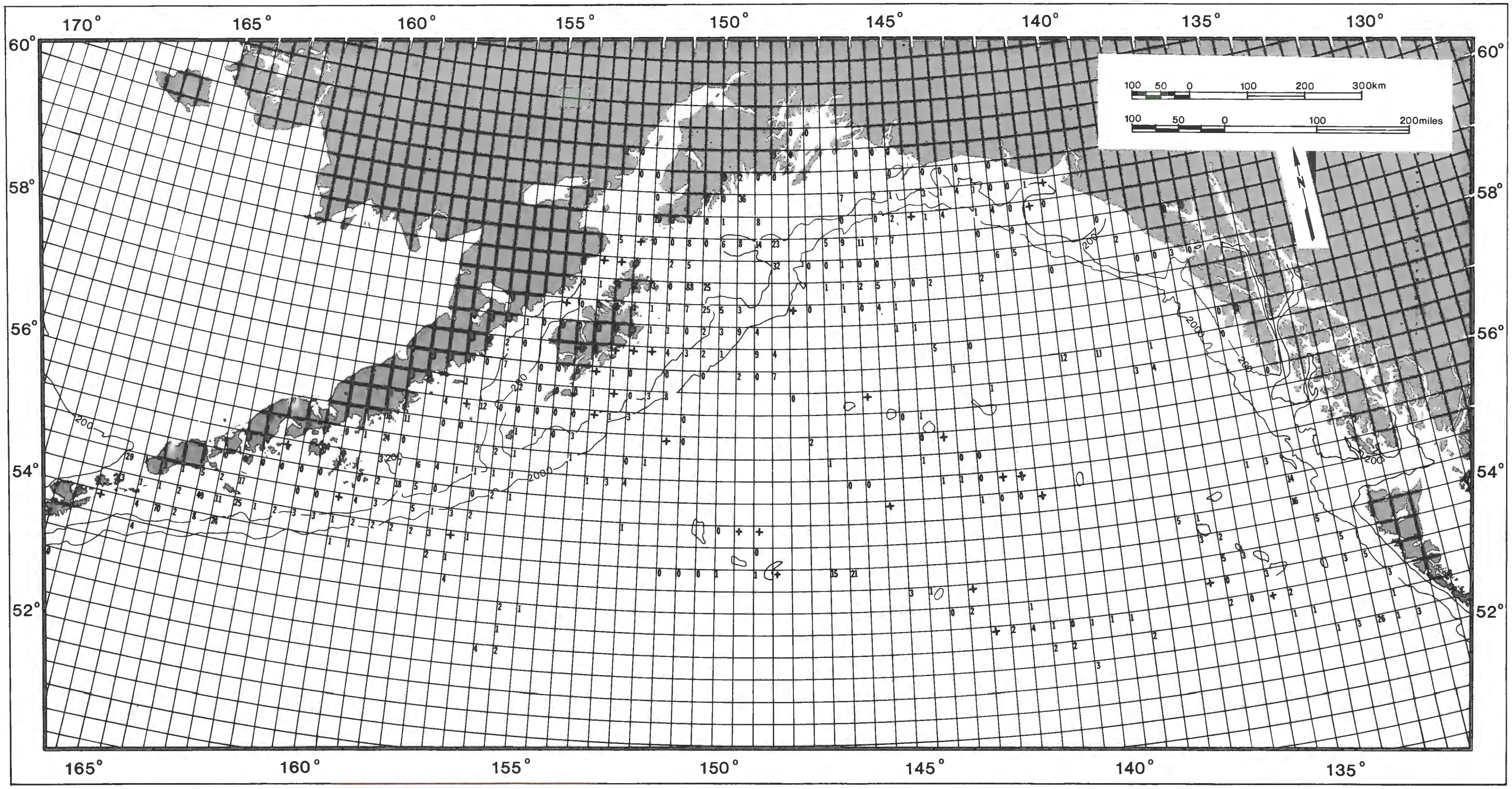

Map 36. Density indices of total storm-petrels obtained from aerial surveys of the Gulf of Alaska in winter.



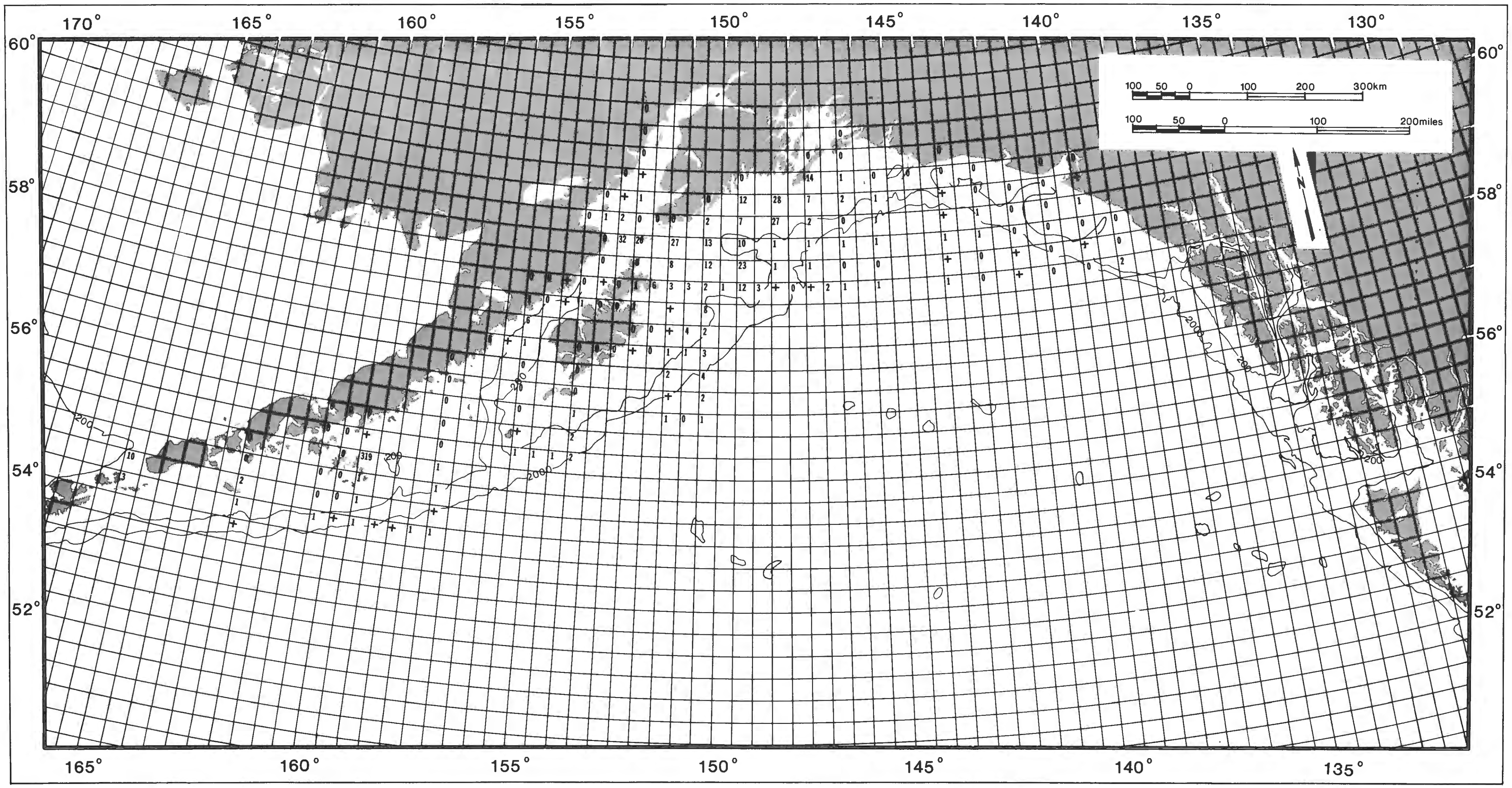

Map 37. Density indices of total storm-petrels obtained from shipboard surveys of the Gulf of Alaska in spring.



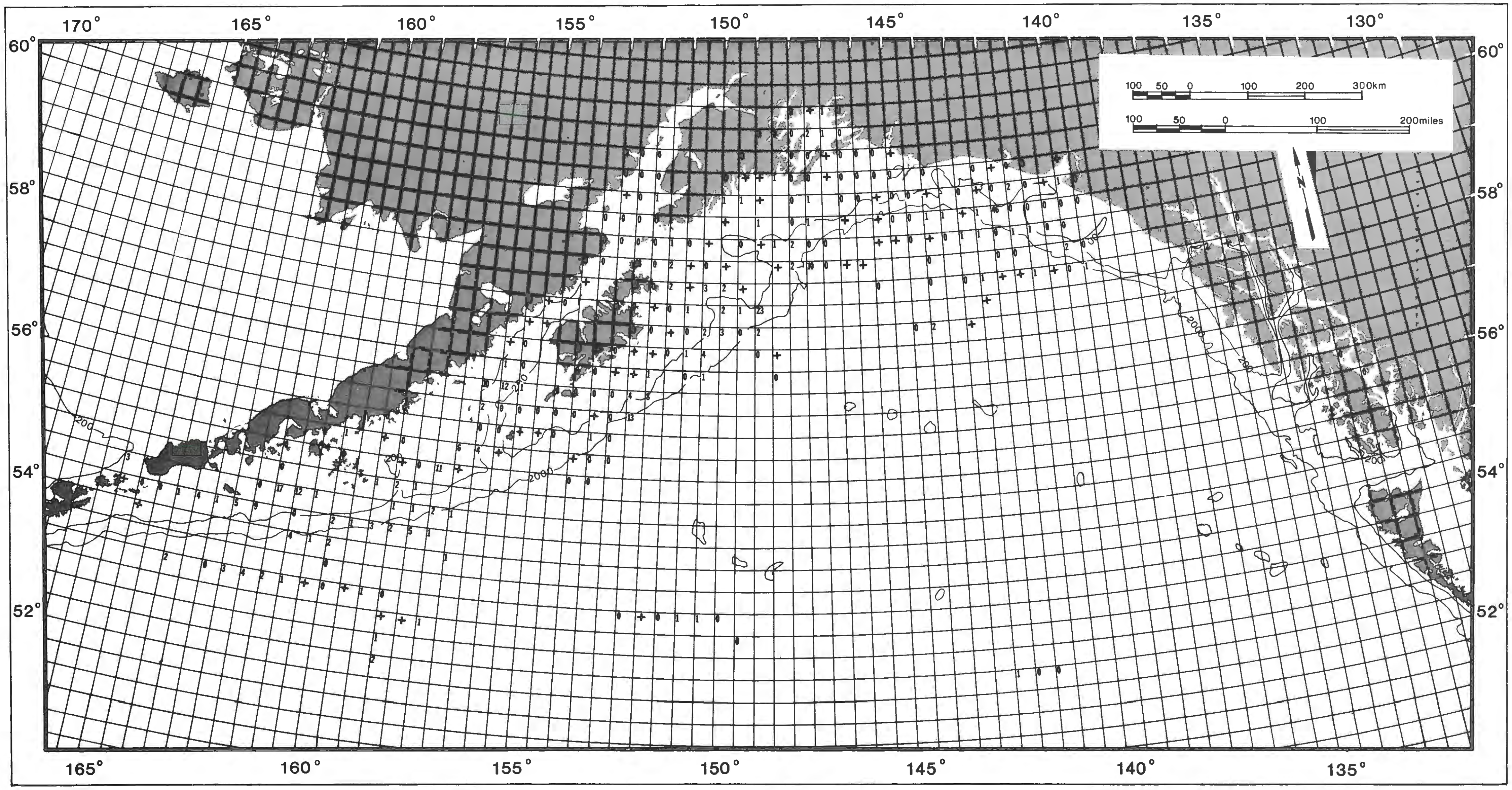

Map 38. Density indices of total storm-petrels obtained from aerial surveys of the Gulf of Alaska in spring.



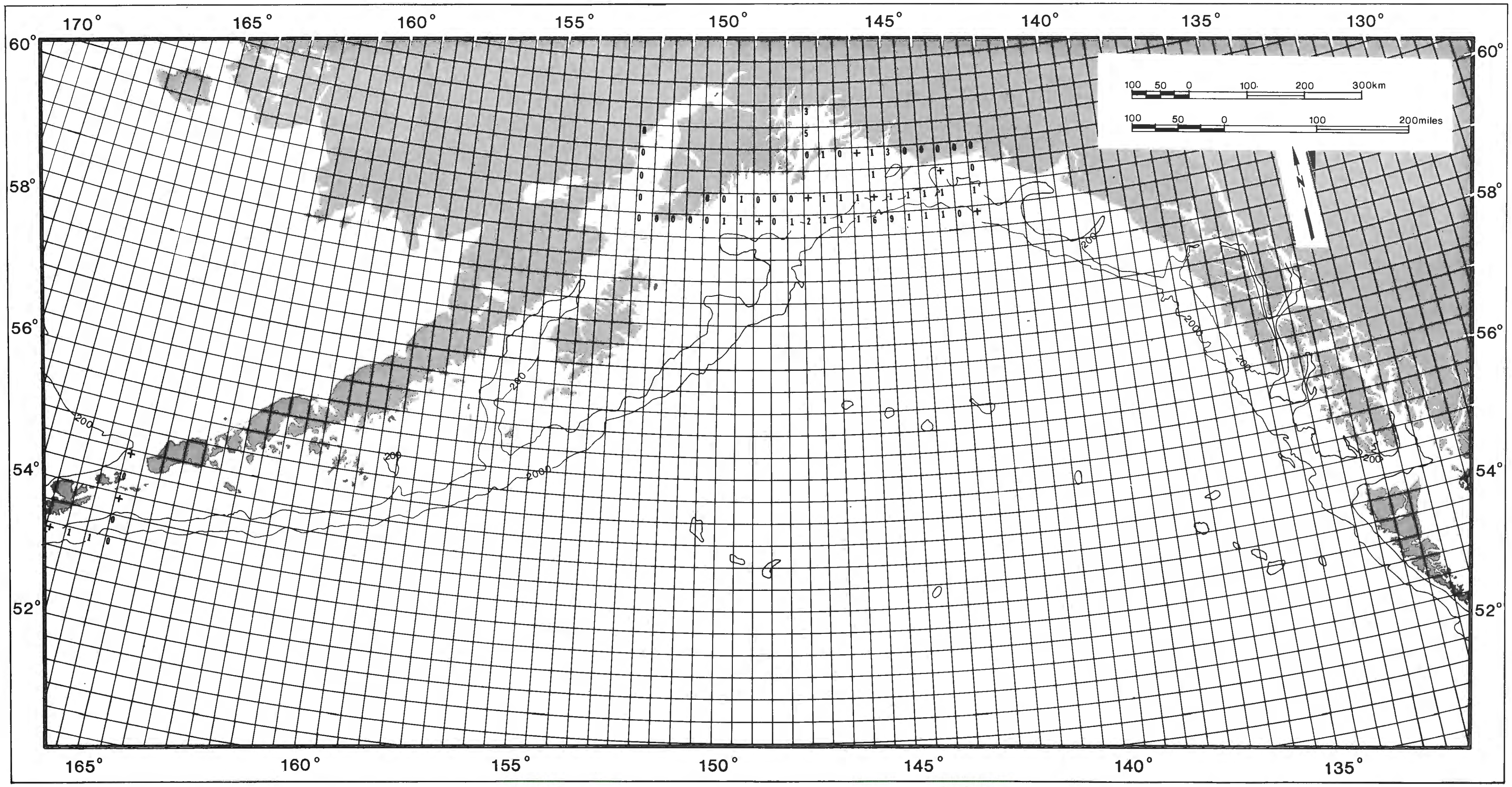

Map 39. Density indices of total storm-petrels obtained from shipboard surveys of the Gulf of Alaska in summer.



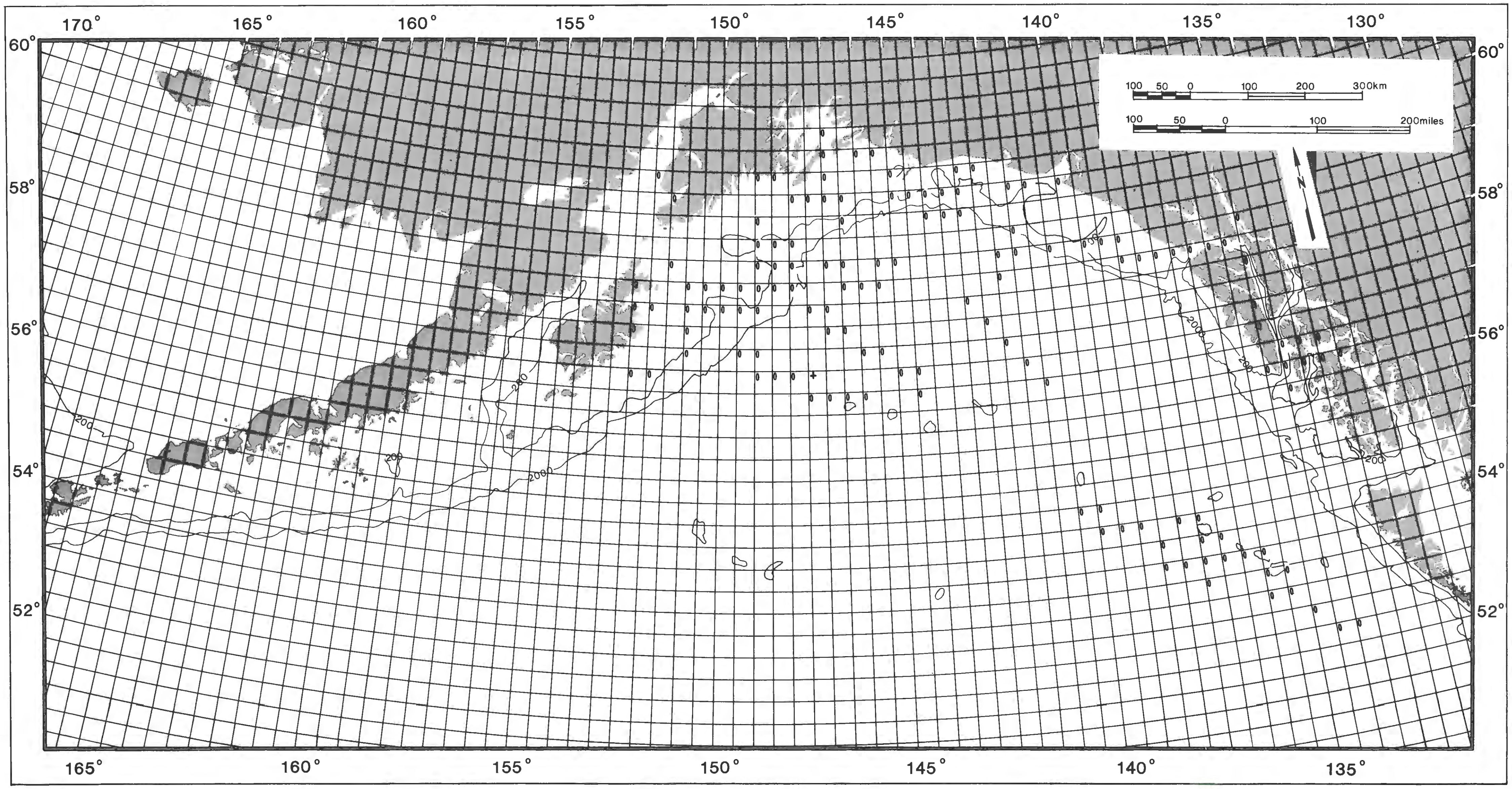

Map 40. Density indices of total storm-petrels obtained from aerial surveys of the Gulf of Alaska in summer.



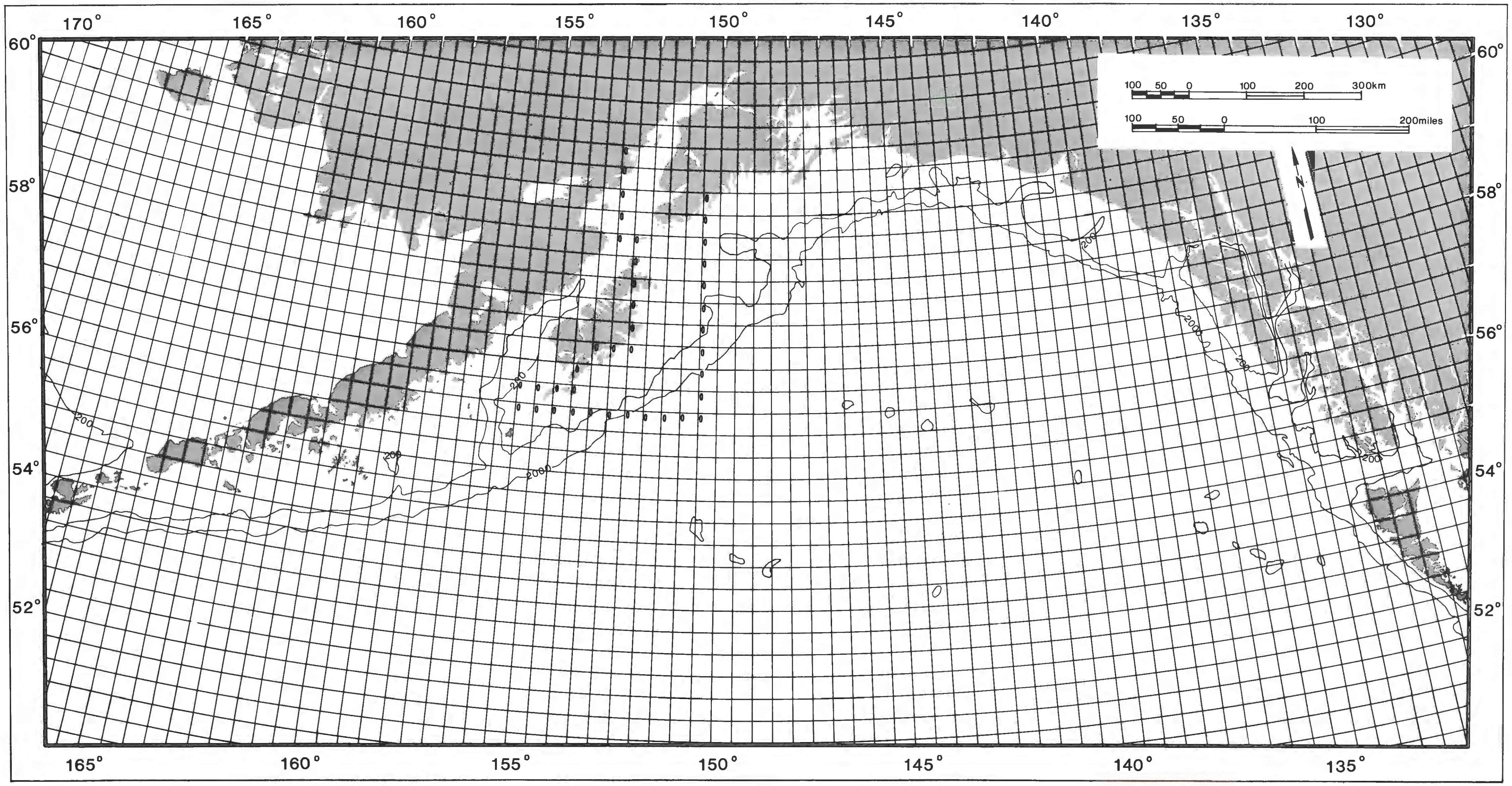

Map 41. Density indices of total storm-petrels obtained from shipboard surveys of the Gulf of Alaska in fall.



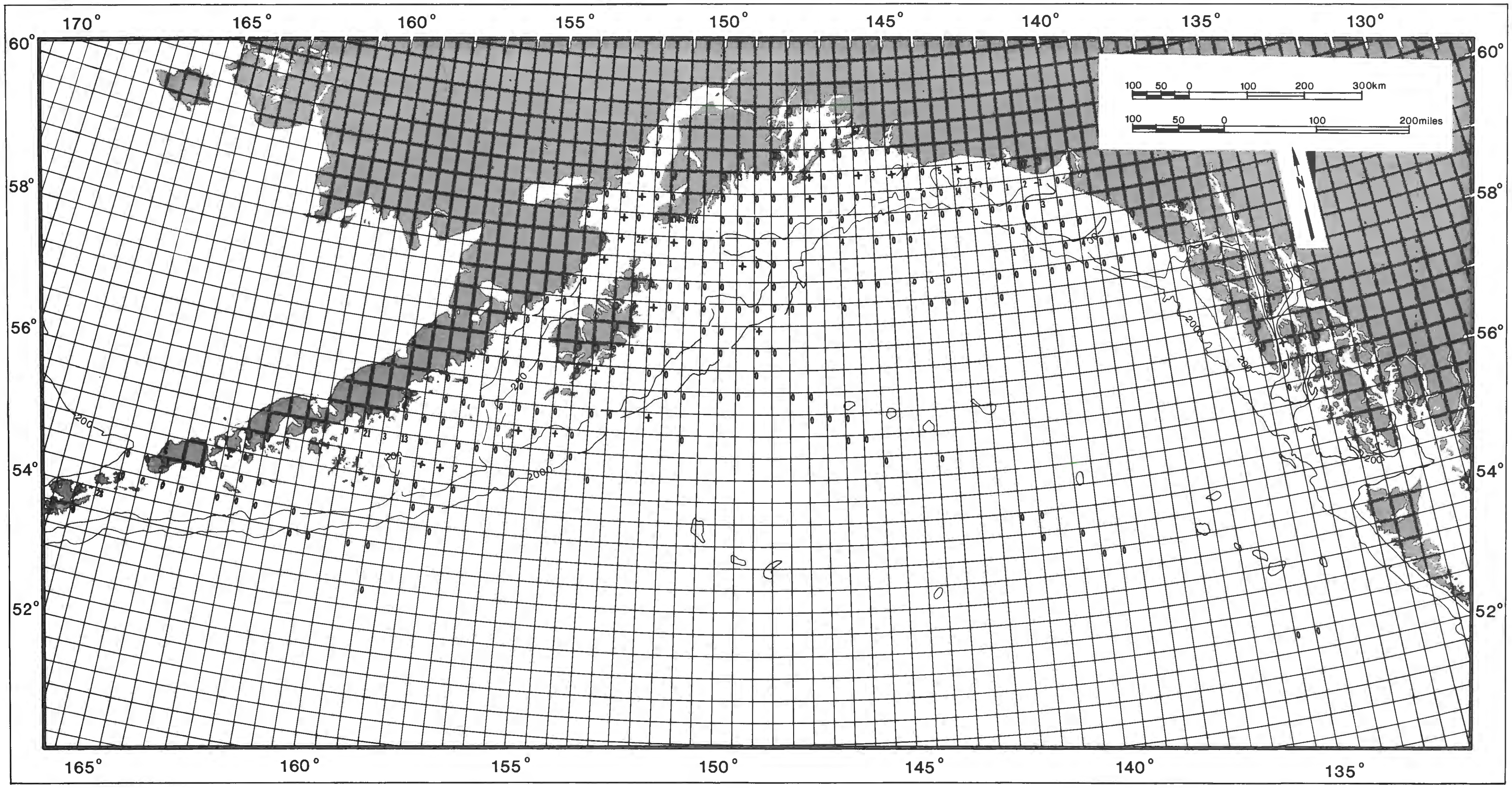

Map 42. Density indices of total storm-petrels obtained from aerial surveys of the Gulf of Alaska in fall.



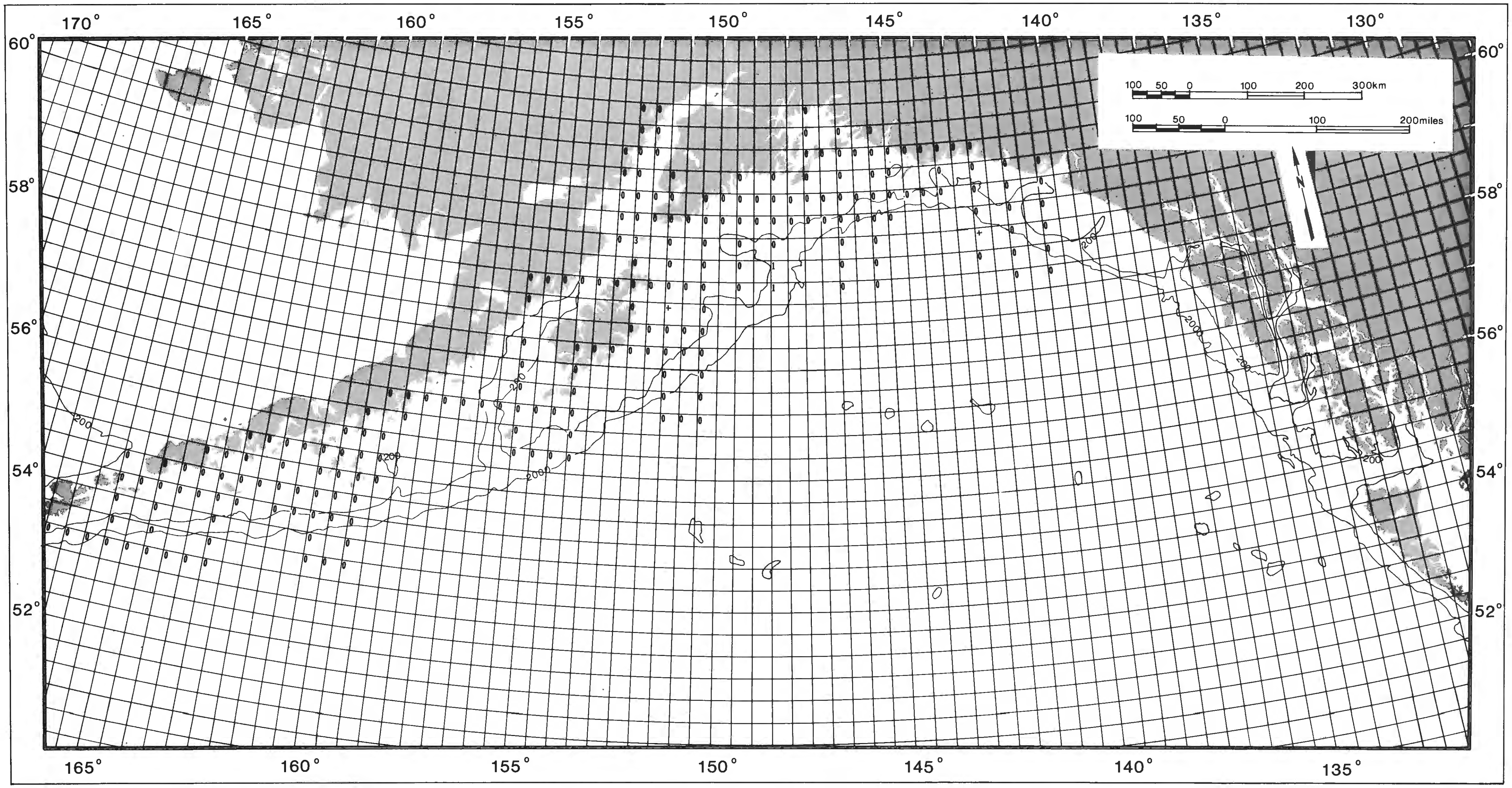

Map 43. Density indices of total phalaropes obtained from shipboard surveys of the Gulf of Alaska in winter.



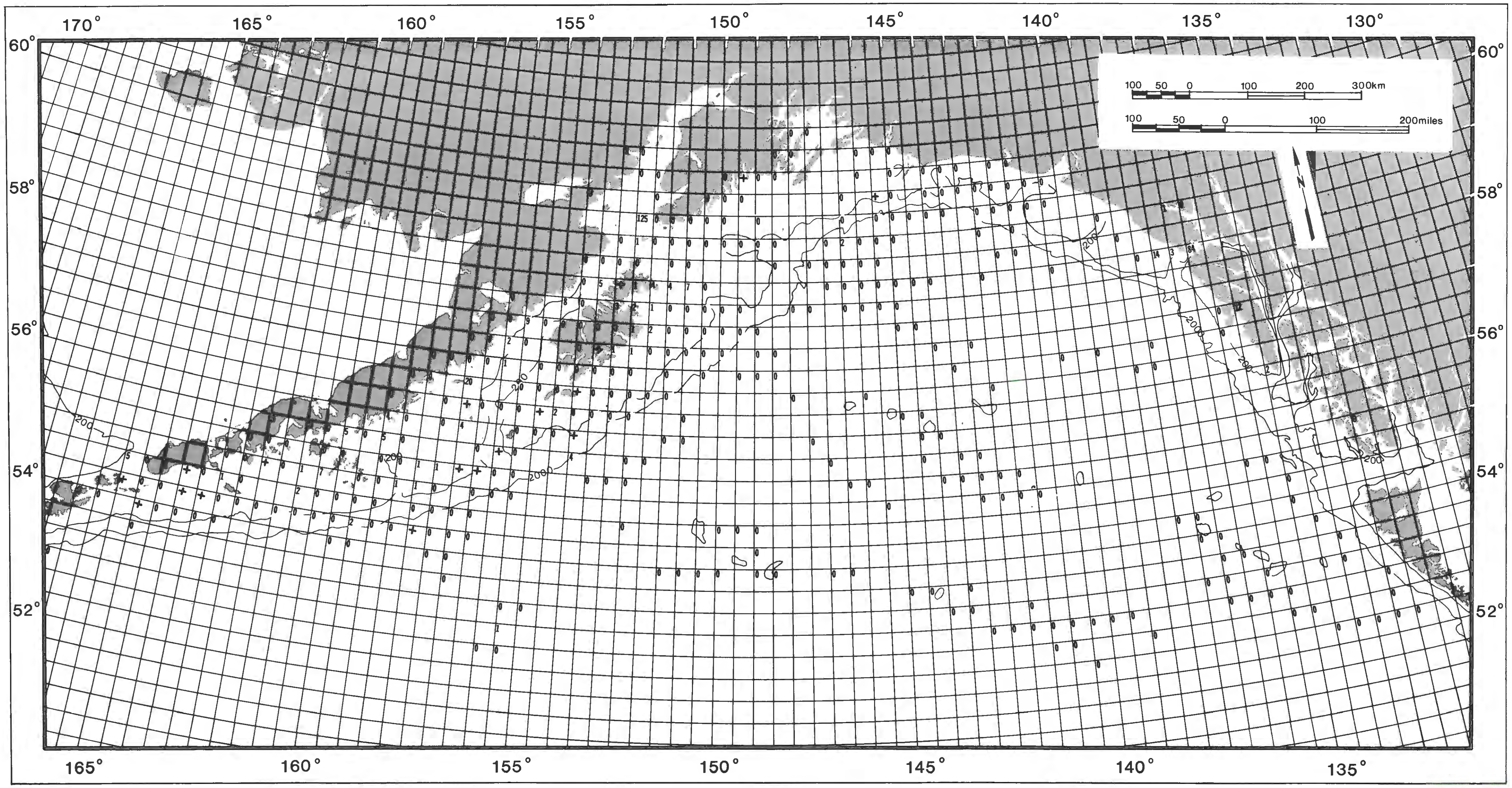

Map 44. Density indices of total phalaropes obtained from aerial surveys of the Gulf of Alaska in winter.



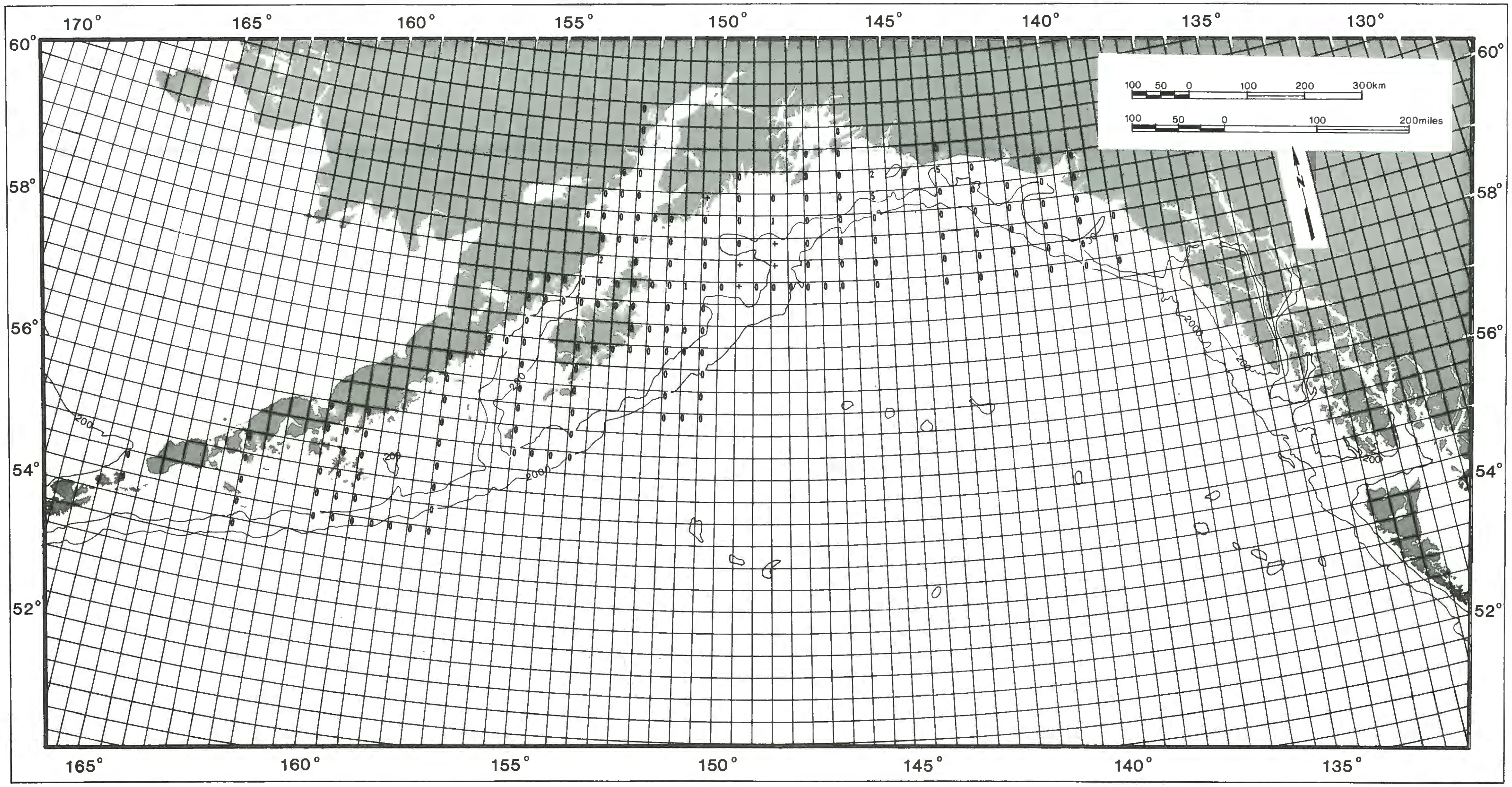

Map 45. Density indices of total phalaropes obtained from shipboard surveys of the Gulf of Alaska in spring.



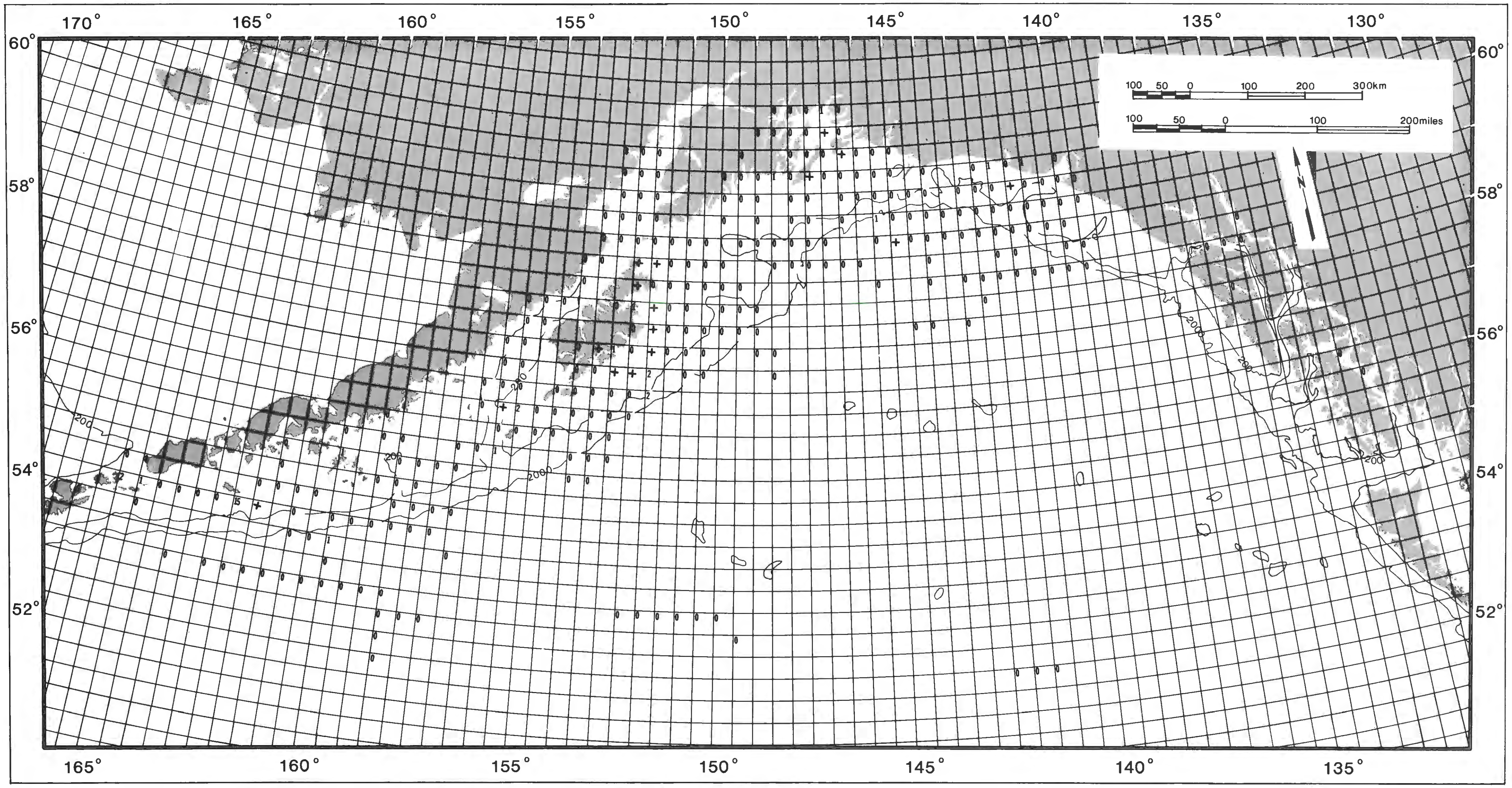

Map 46. Density indices of total phalaropes obtained from aerial surveys of the Gulf of Alaska in spring.



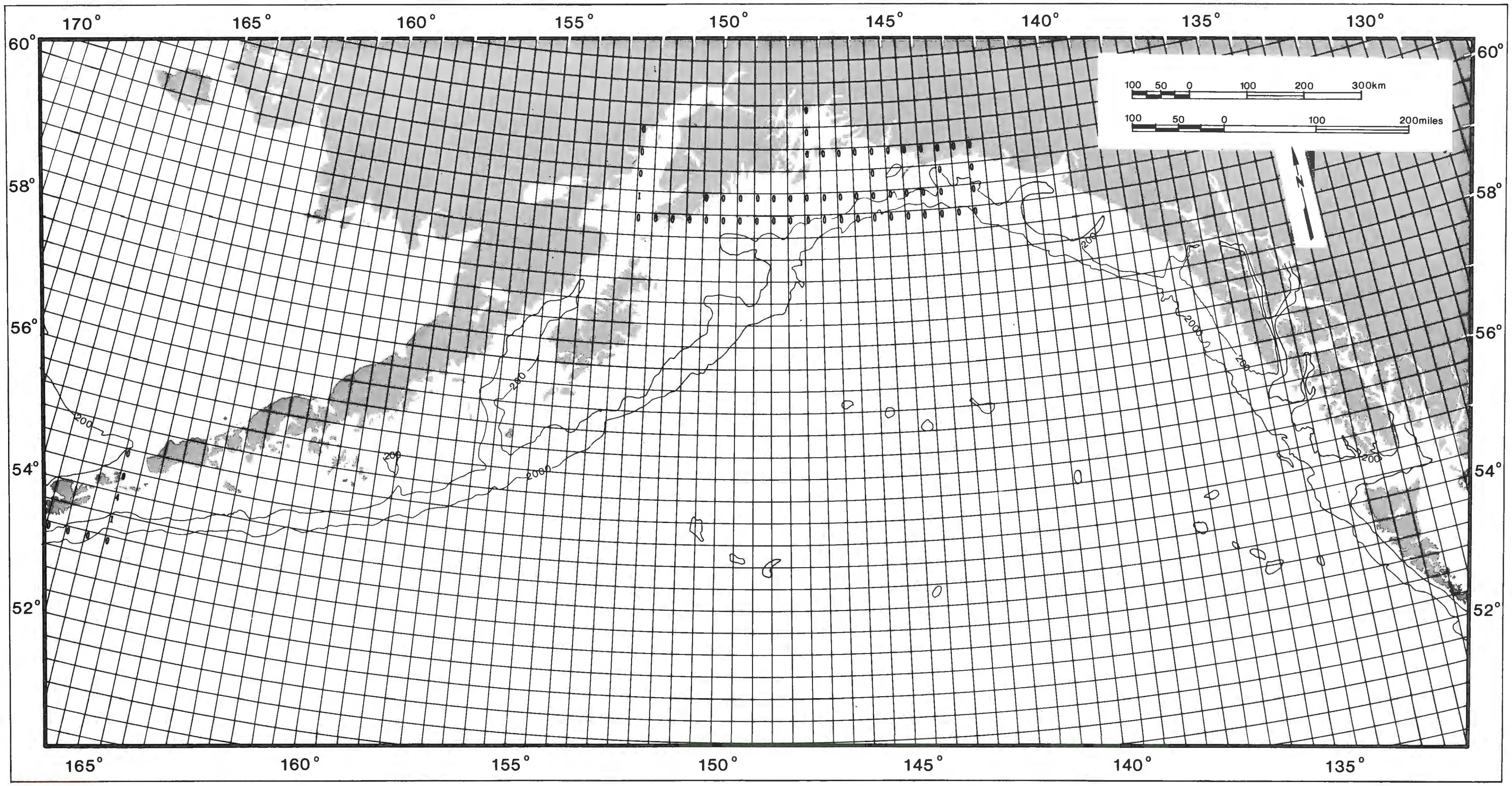

Map 47. Density indices of total phalaropes obtained from shipboard surveys of the Gulf of Alaska in summer.



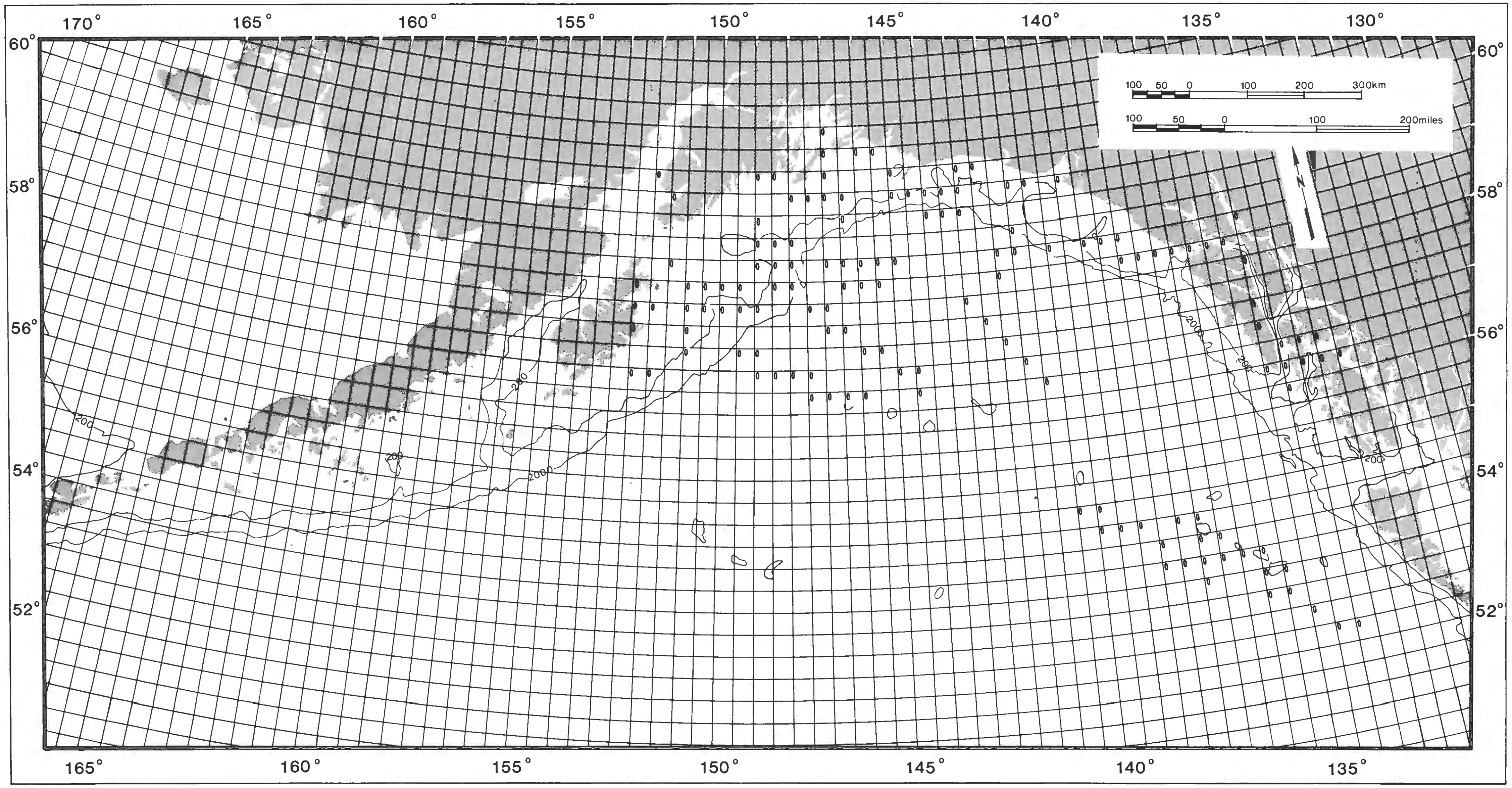

Map 48. Density indices of total phalaropes obtained from aerial surveys of the Gulf of Alaska in summer.



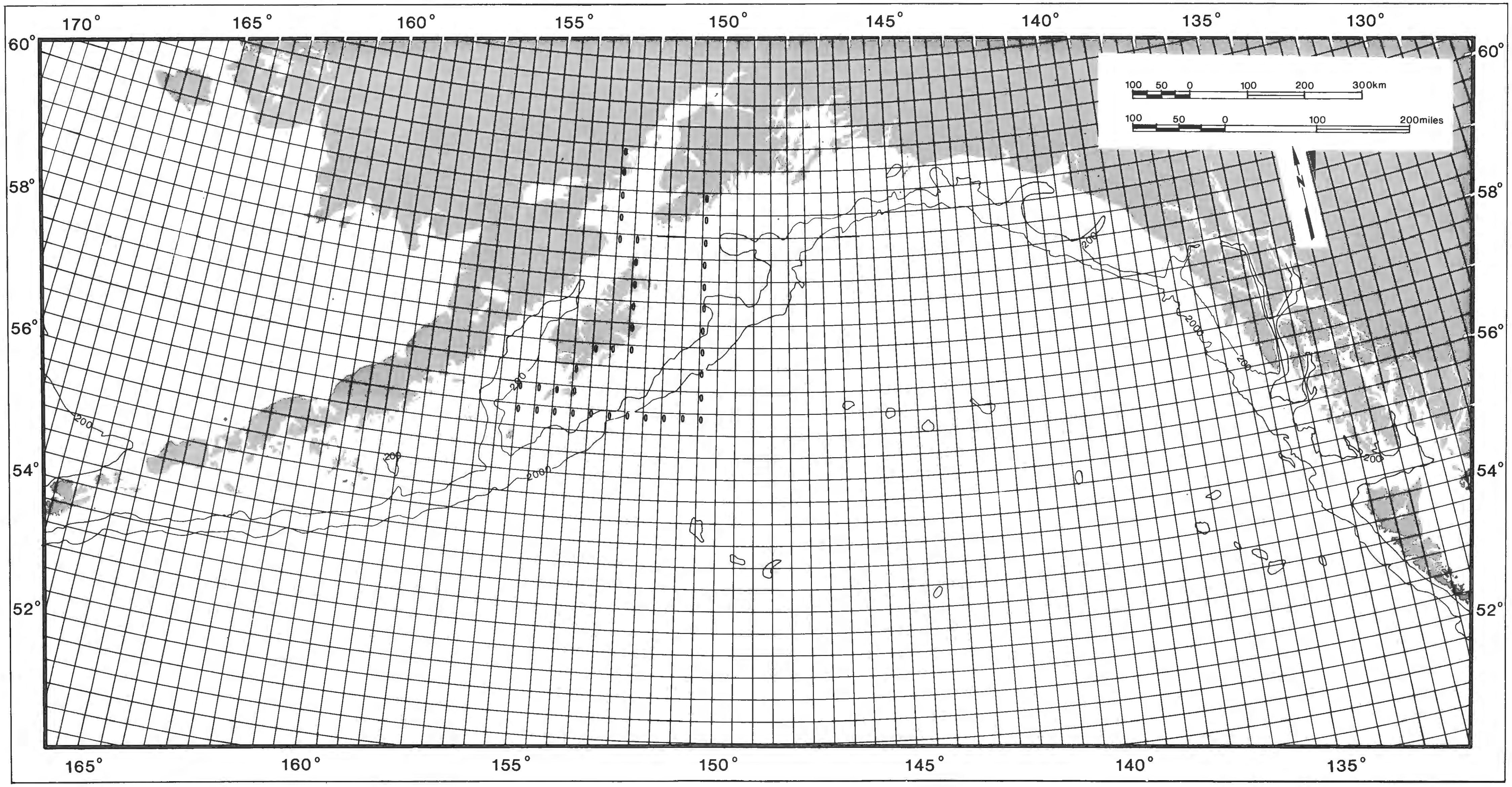

Map 49. Density indices of total phalaropes obtained from shipboard surveys of the Gulf of Alaska in fall.



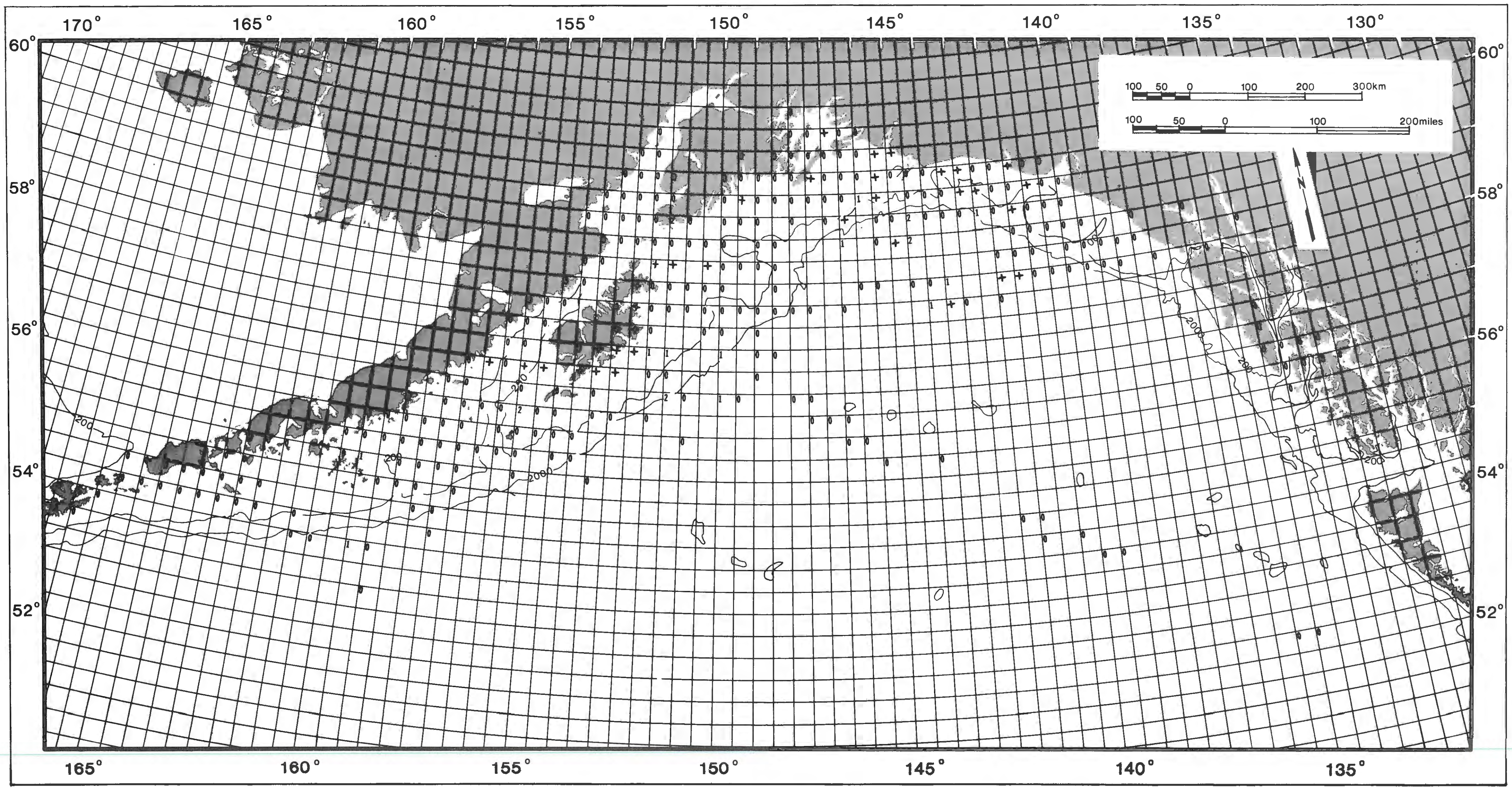

Map 50. Density indices of total phalaropes obtained from aerial surveys of the Gulf of Alaska in fall.



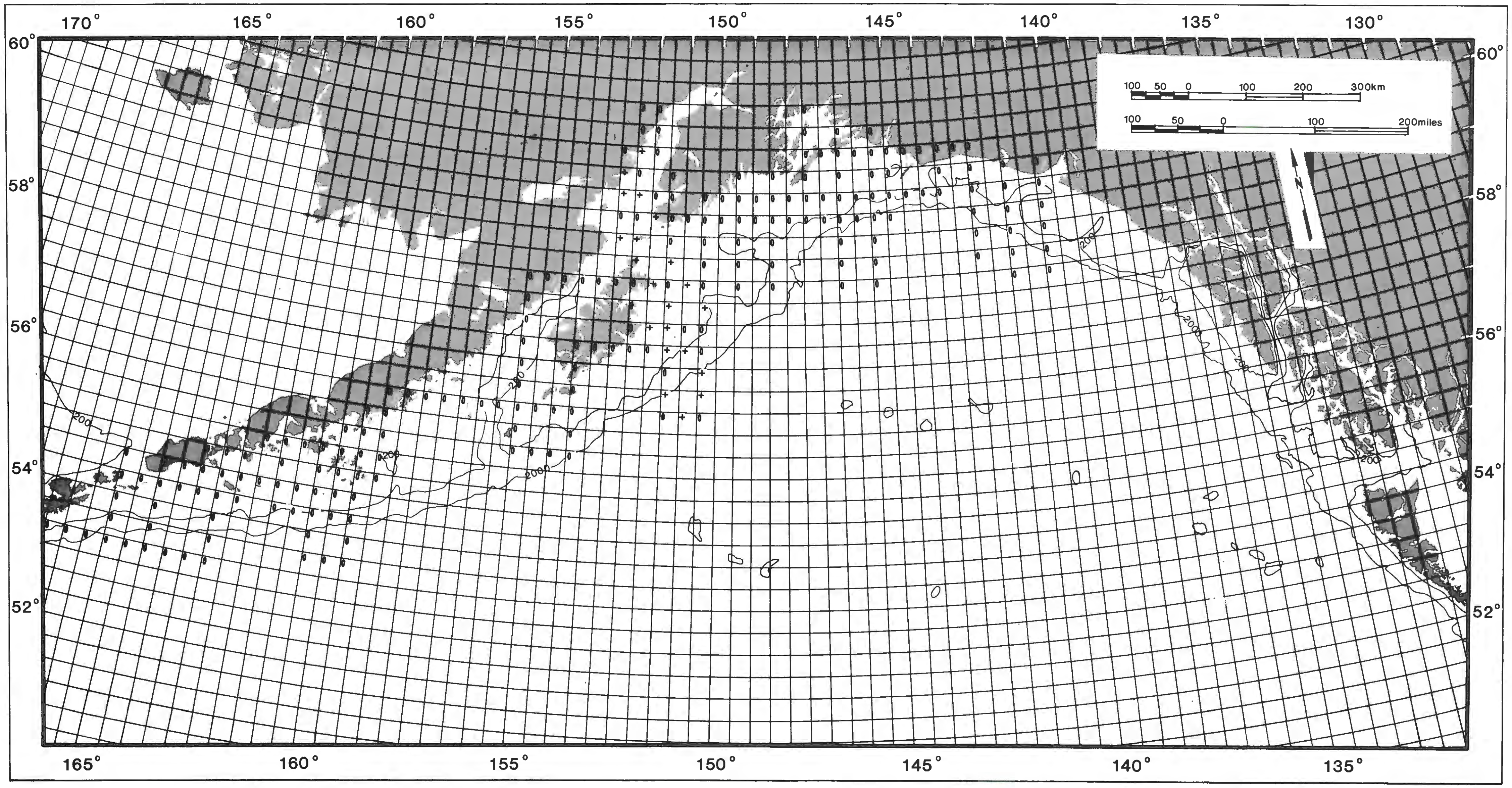

Map 51. Density indices of total jaegers obtained from shipboard surveys of the Gulf of Alaska in winter.



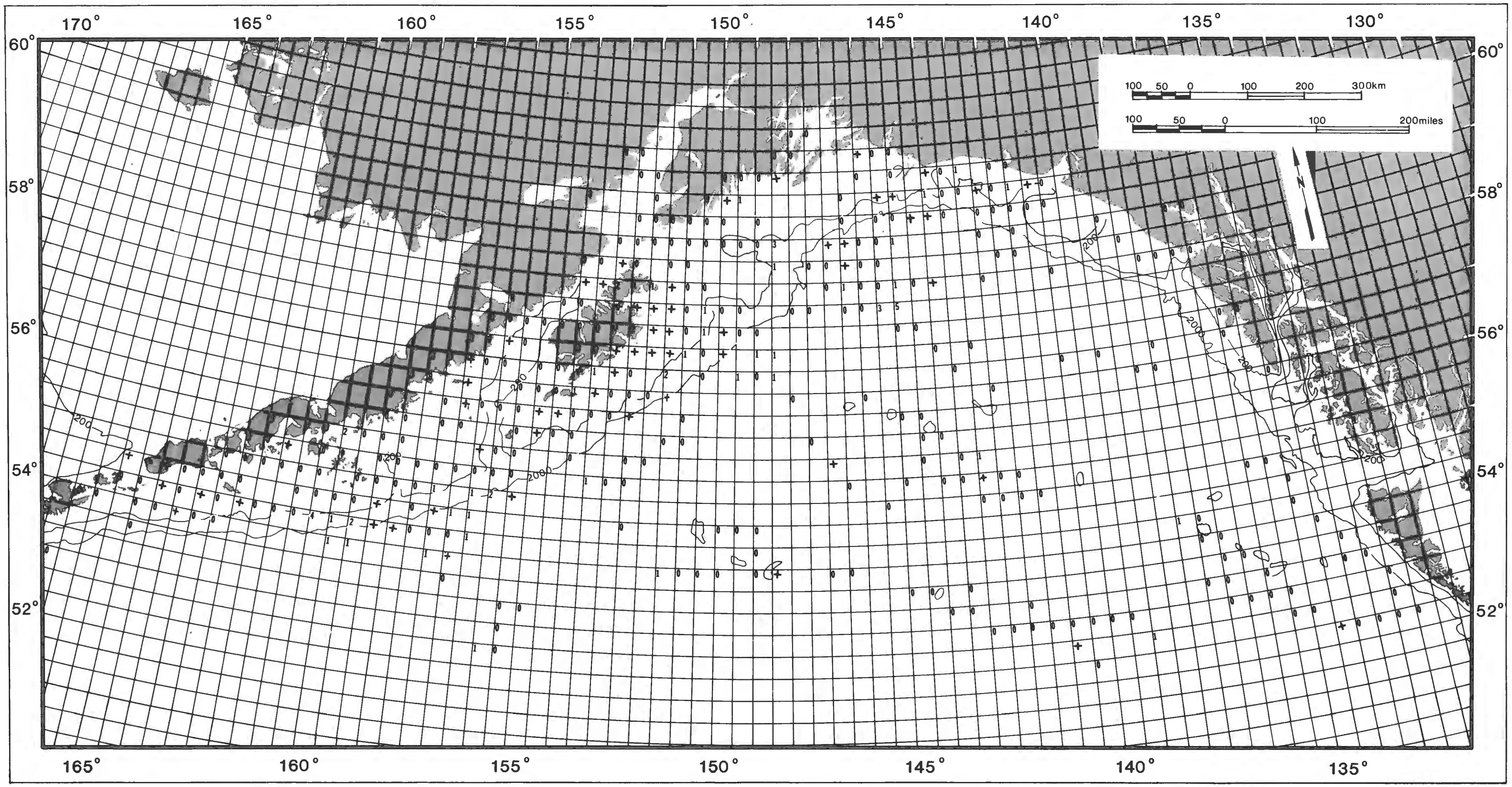

Map 52. Density indices of total jaegers obtained from aerial surveys of the Gulf of Alaska in winter.



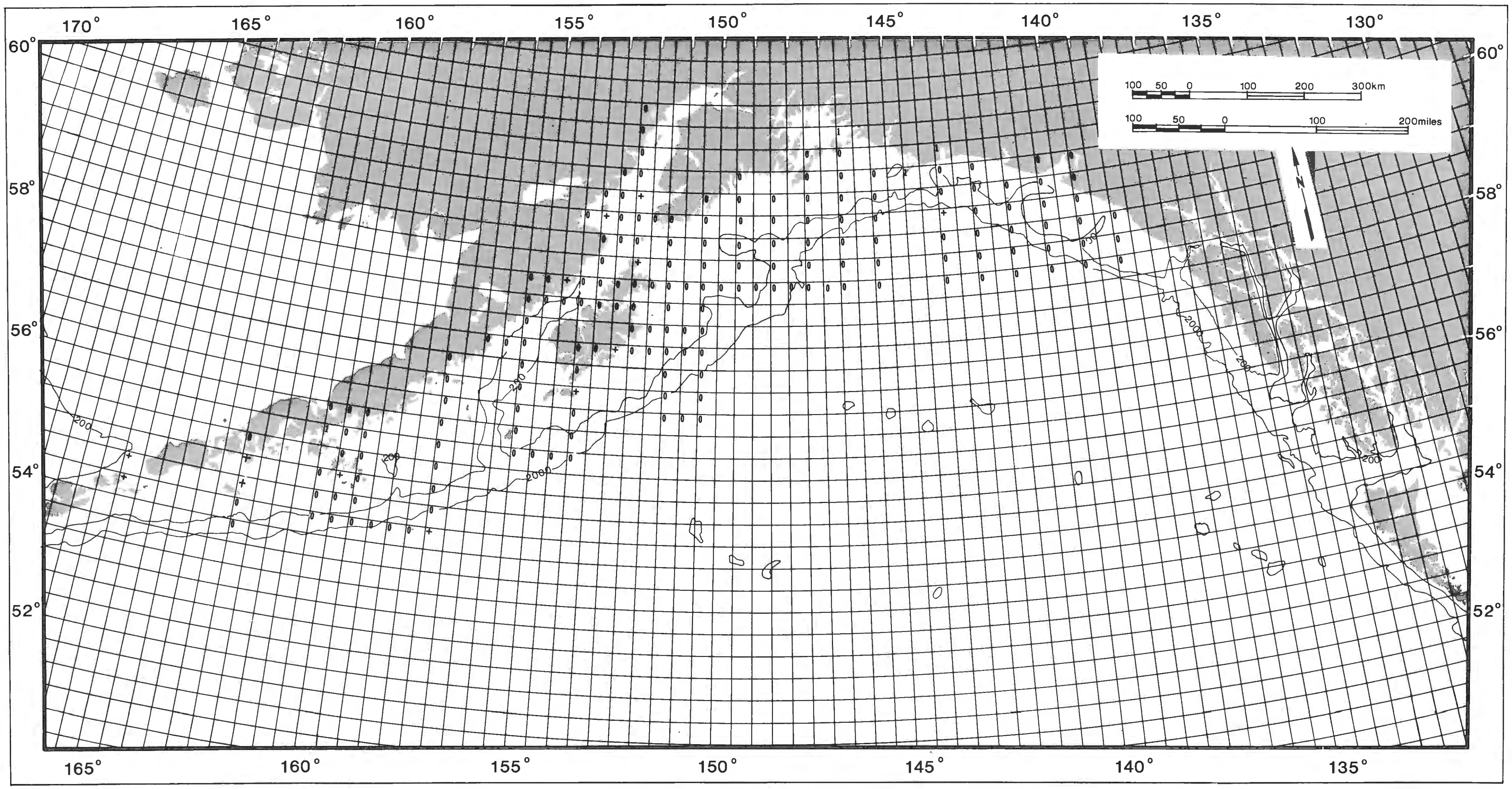

Map 53. Density indices of total jaegers obtained from shipboard surveys of the Gulf of Alaska in spring.



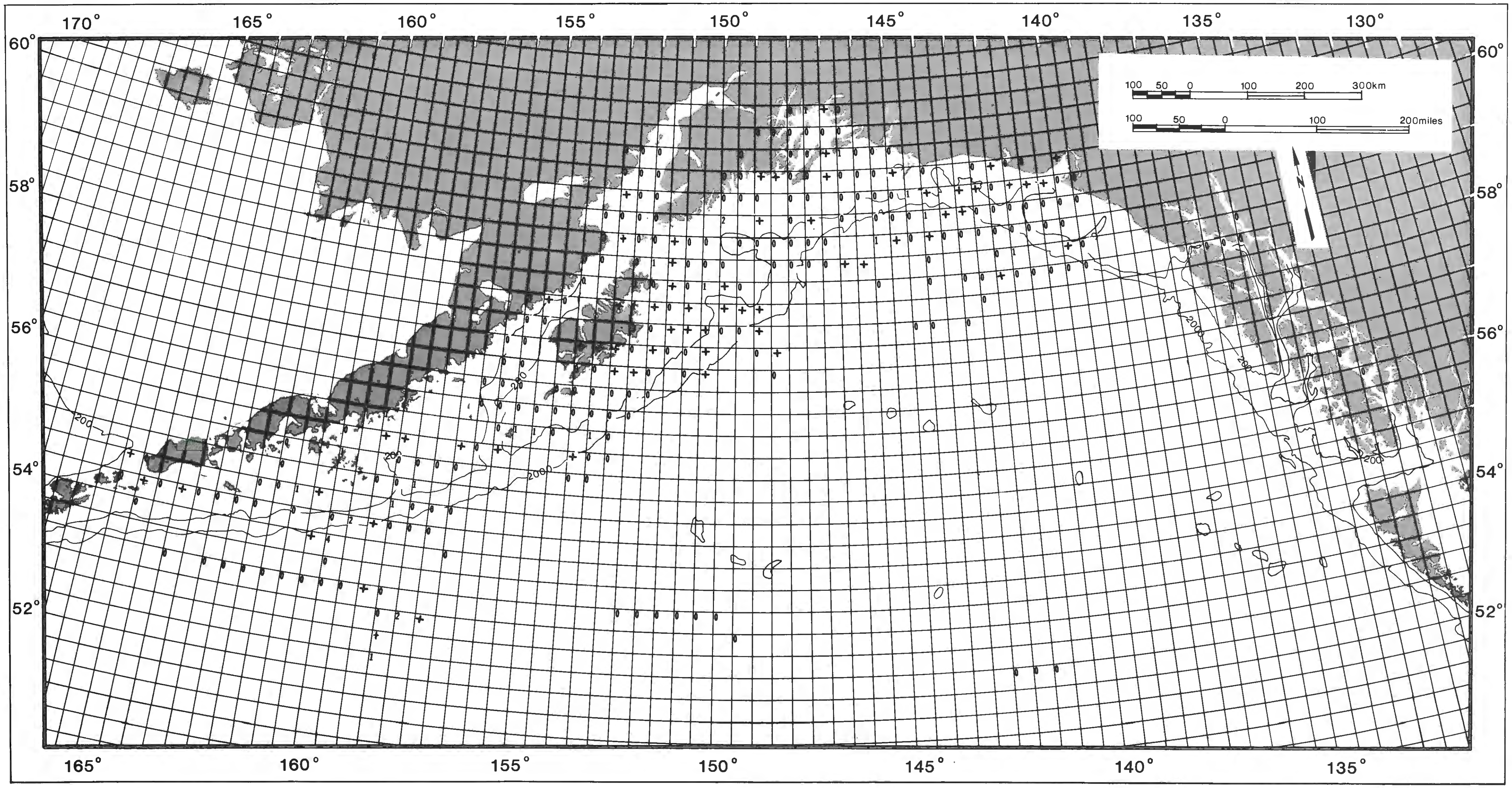

Map 54. Density indices of total jaegers obtained from aerial surveys of the Gulf of Alaska in spring.



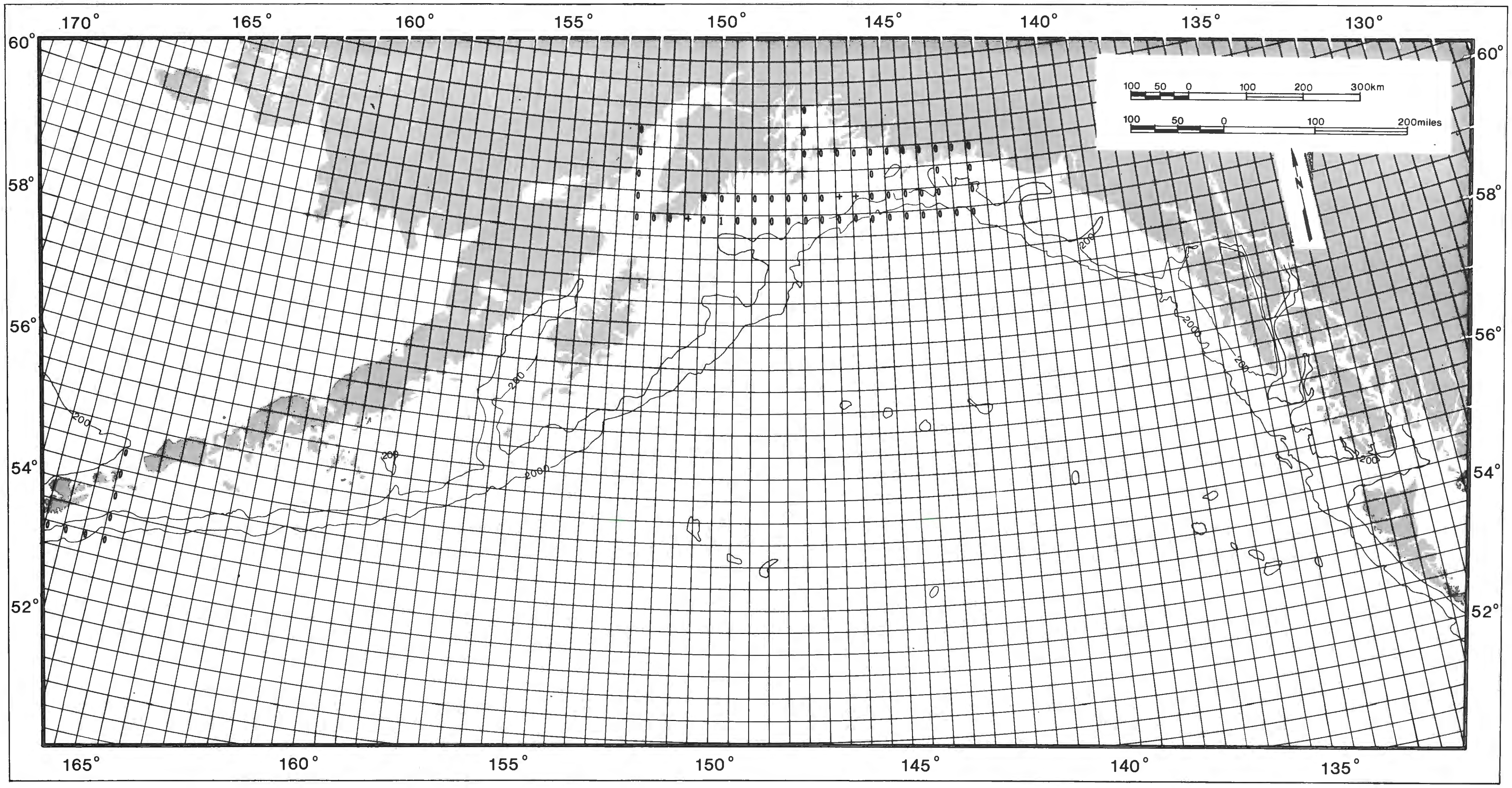

Map 55. Density indices of total jaegers obtained from shipboard surveys of the Gulf of Alaska in summer.



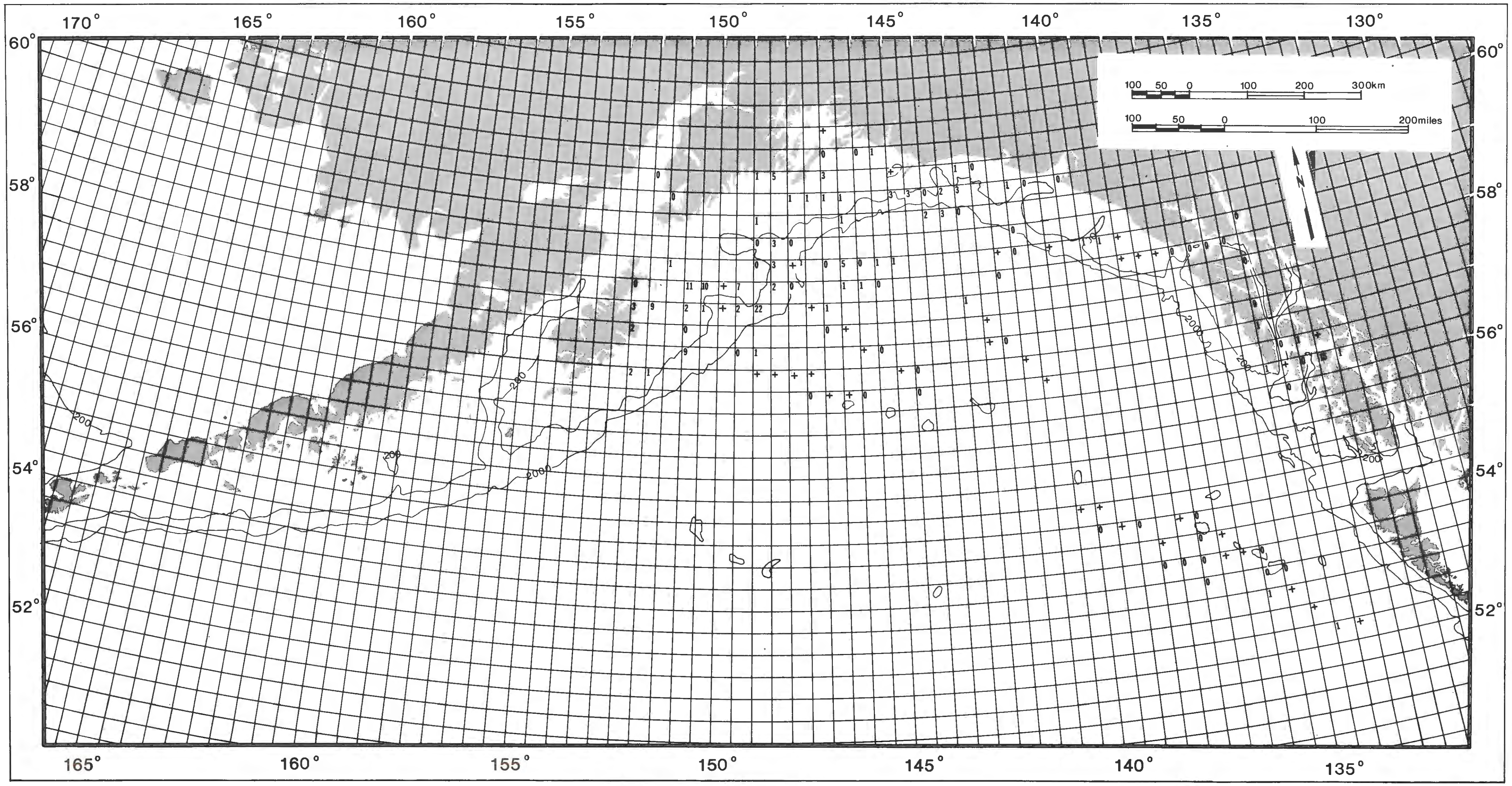

Map 56. Density indices of total jaegers obtained from aerial surveys of the Gulf of Alaska in summer.



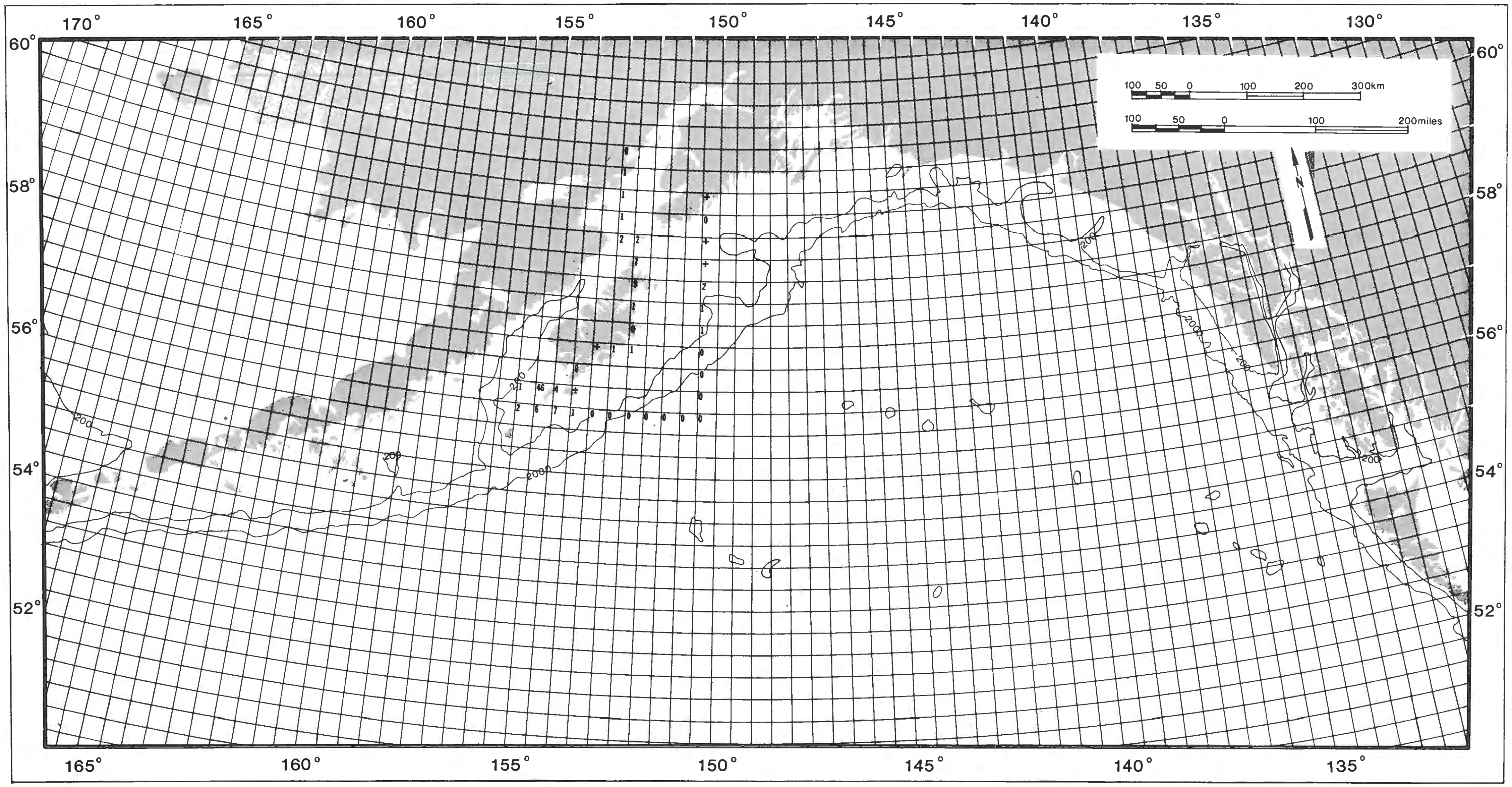

Map 57. Density indices of total jaegers obtained from shipboad surveys of the Gulf of Alaska in fall...



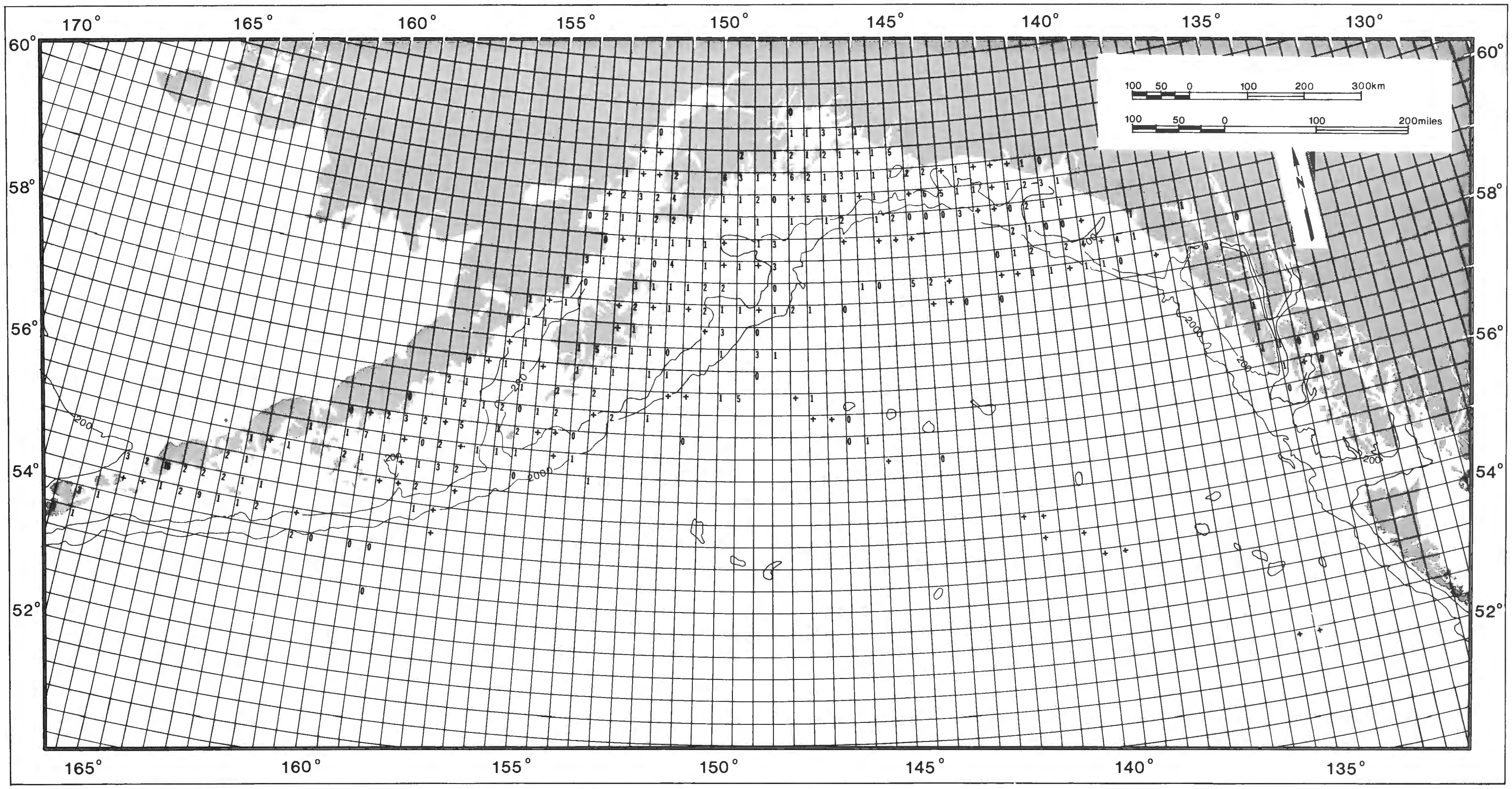

Map 58. Density indices of total jaegers obtained from aerial surveys of the Gulf of Alaska in fall...



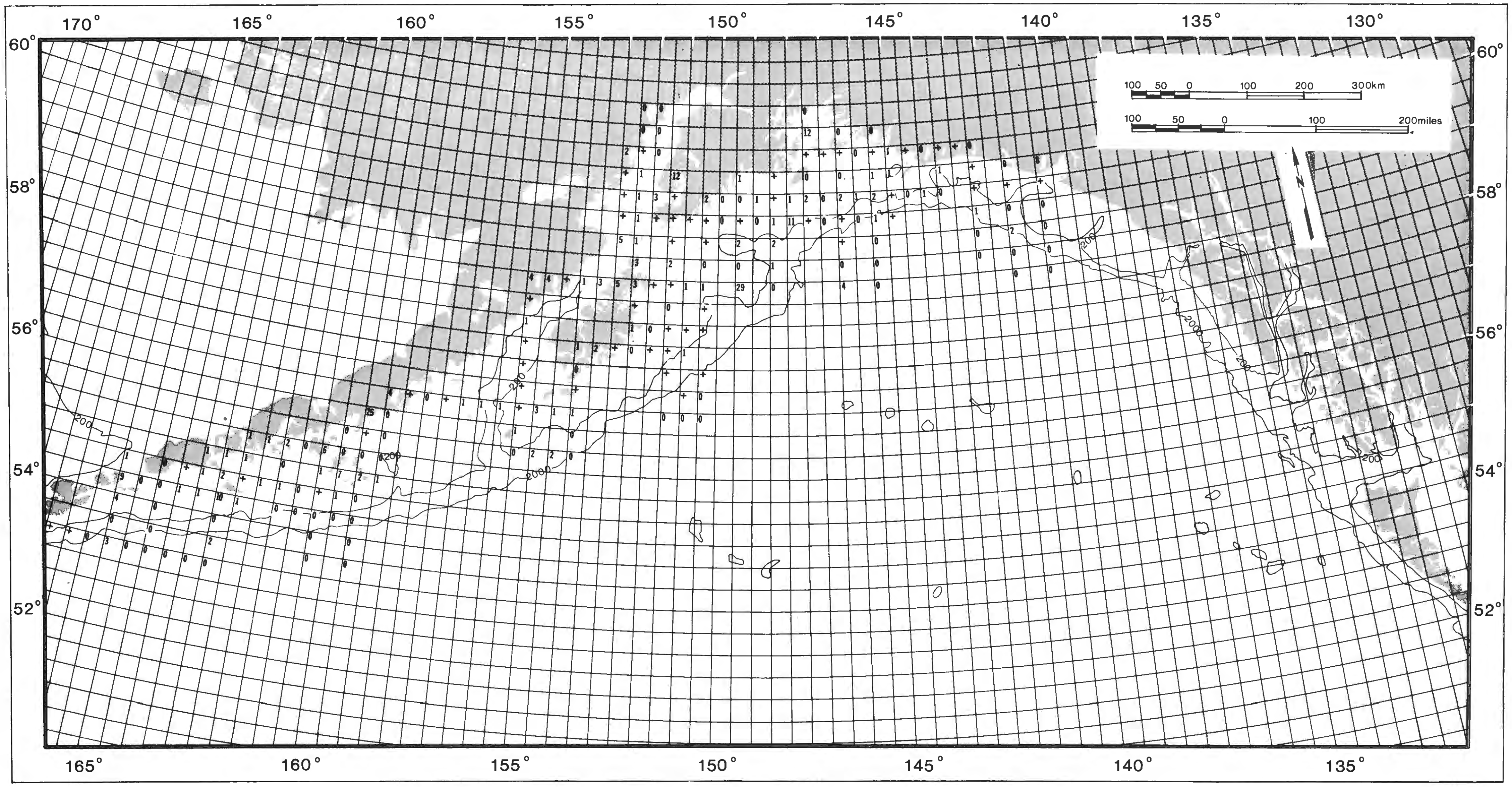

Map 59. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the Gulf of Alaska in winter.



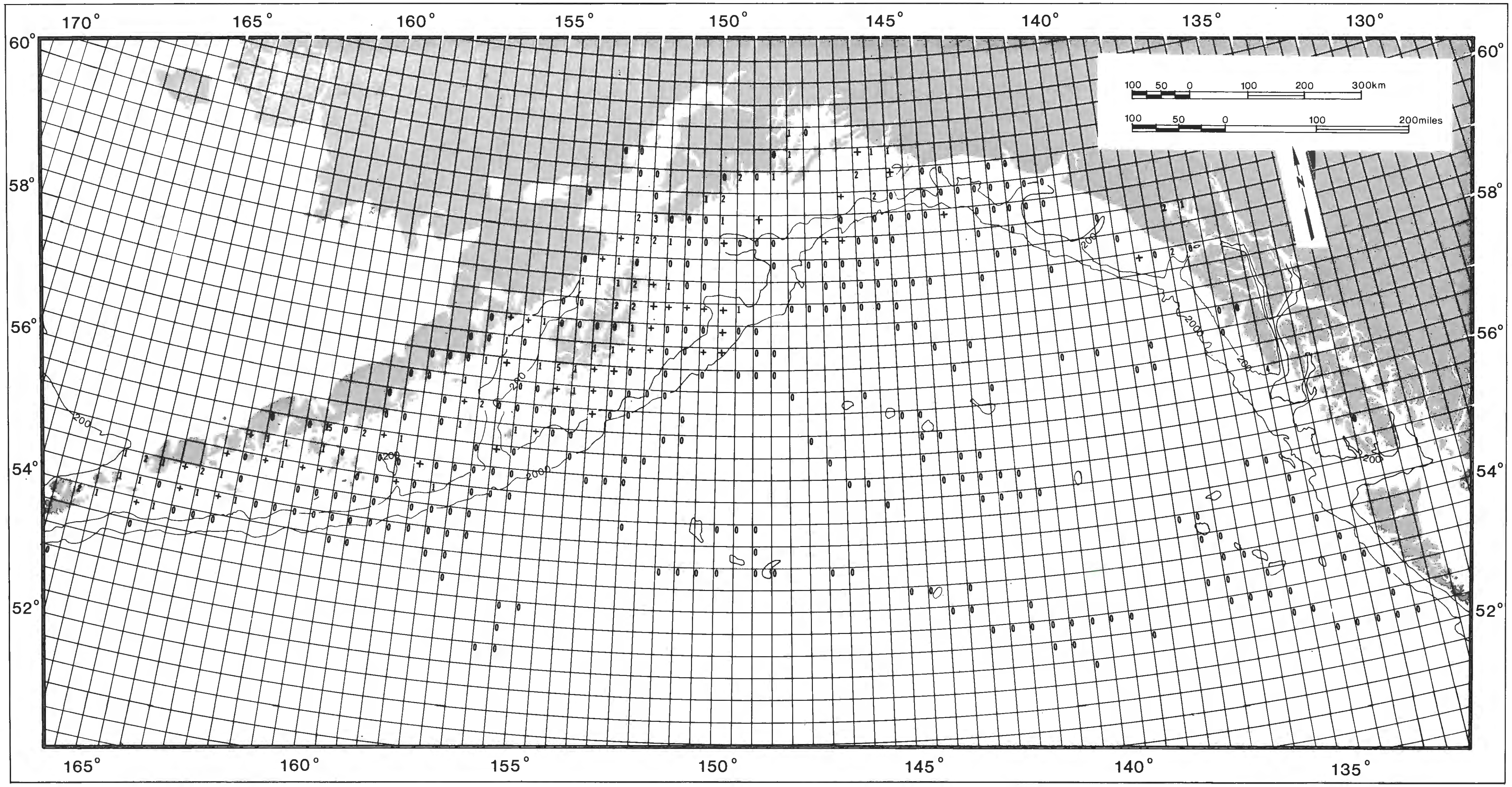

Map 60. Density indices of Glaucous-winged Gull obtained from aerial surveys of the Gulf of Alaska in winter.



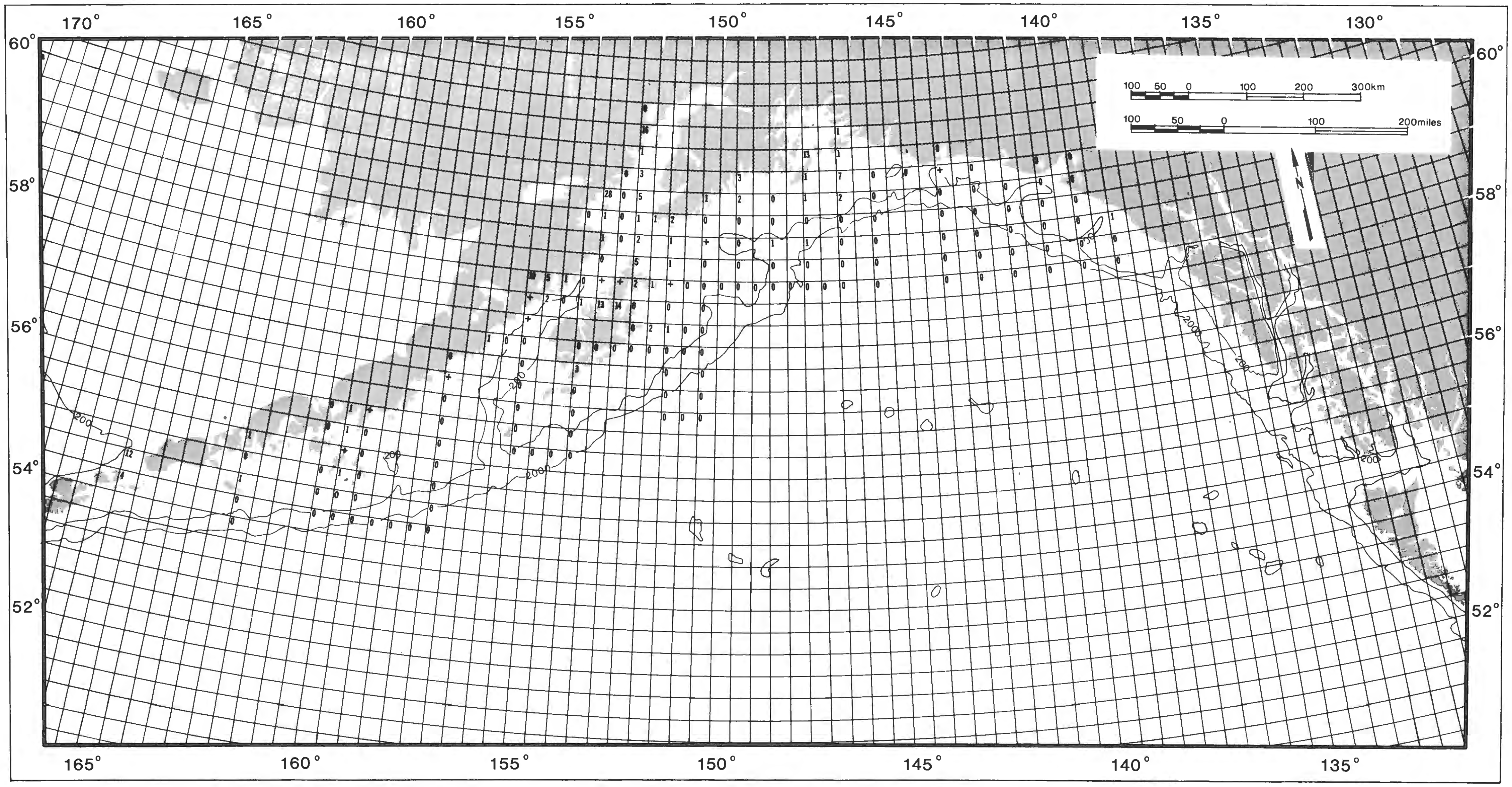

Map 61. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the Gulf of Alaska in spring.



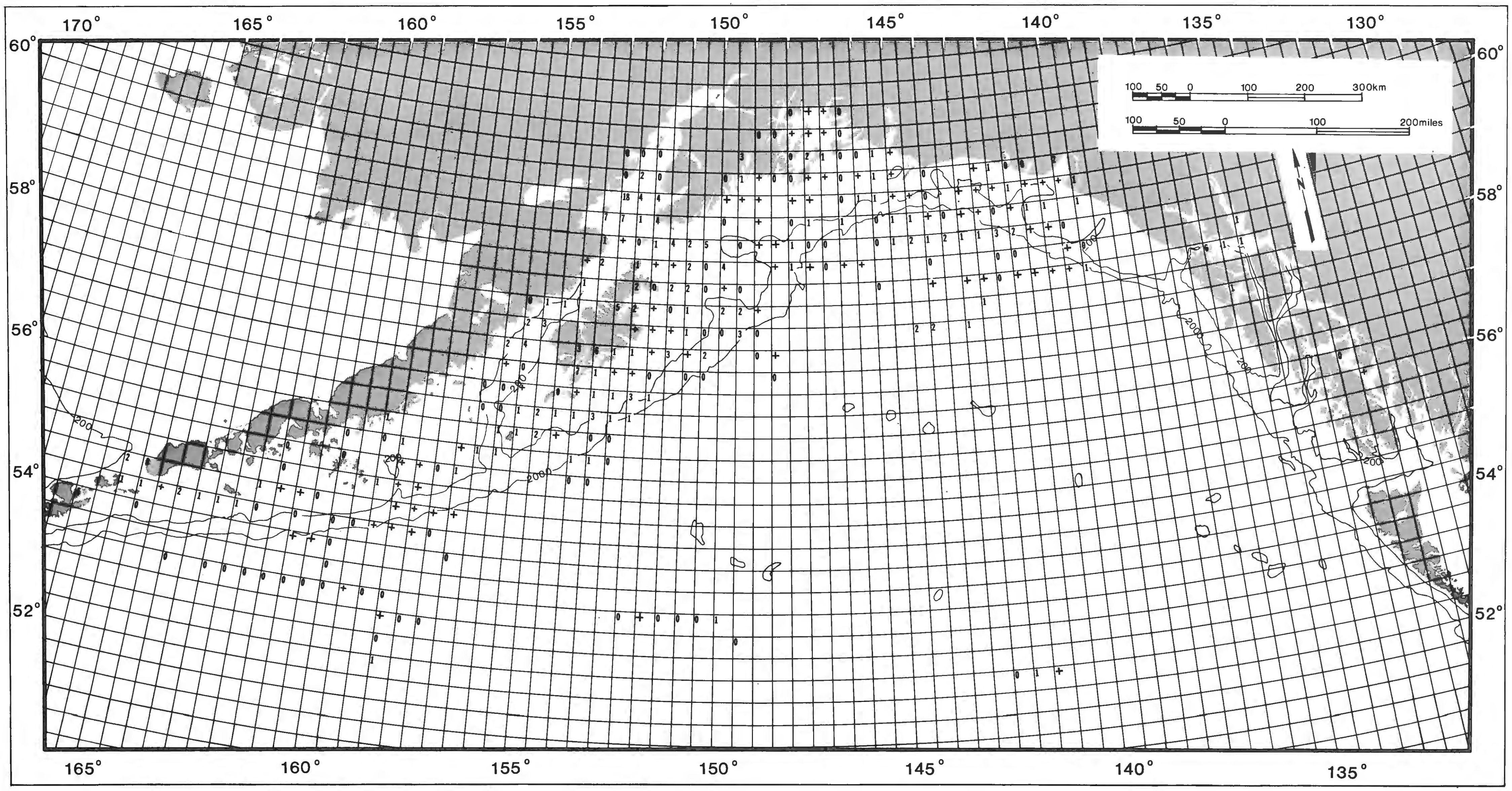

Map 62. Density indices of Glaucous-winged Gull obtained from aerial surveys of the Gulf of Alaska in spring.



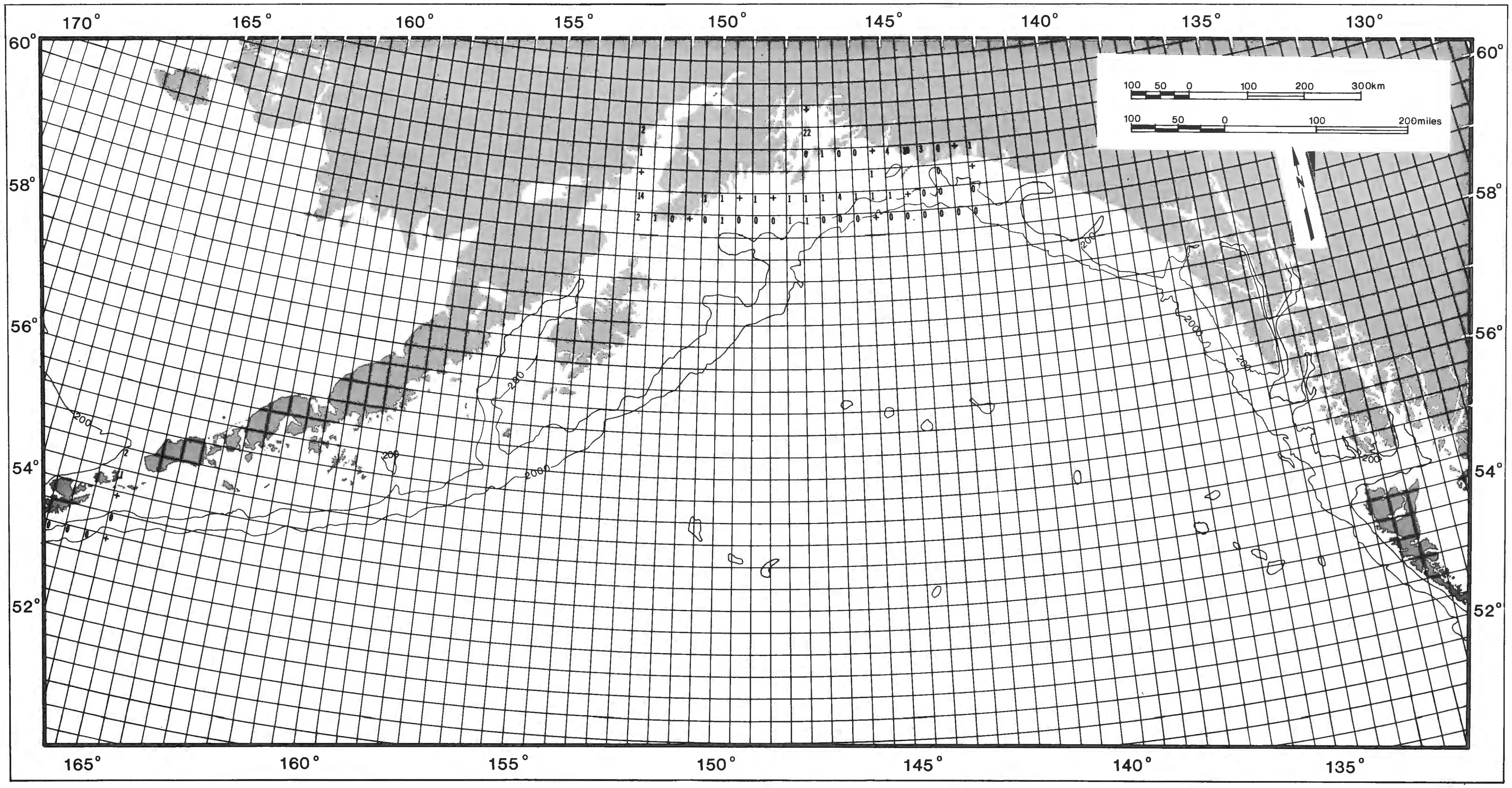

Map 63. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the Gulf of Alaska in summer.



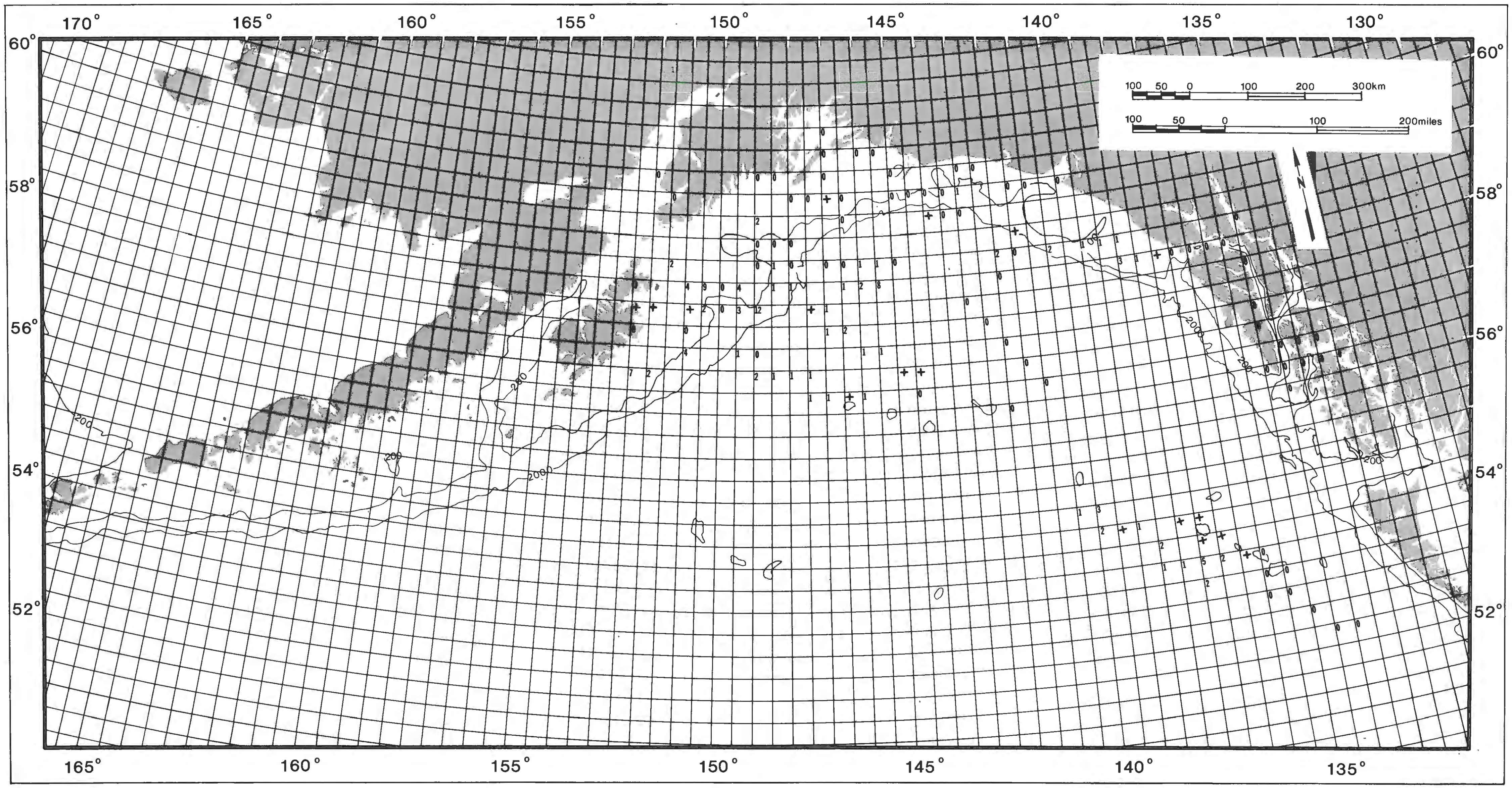

Map 64. Density indices of Glaucous-winged Gull obtained from aerial surveys of the Gulf of Alaska in summer.



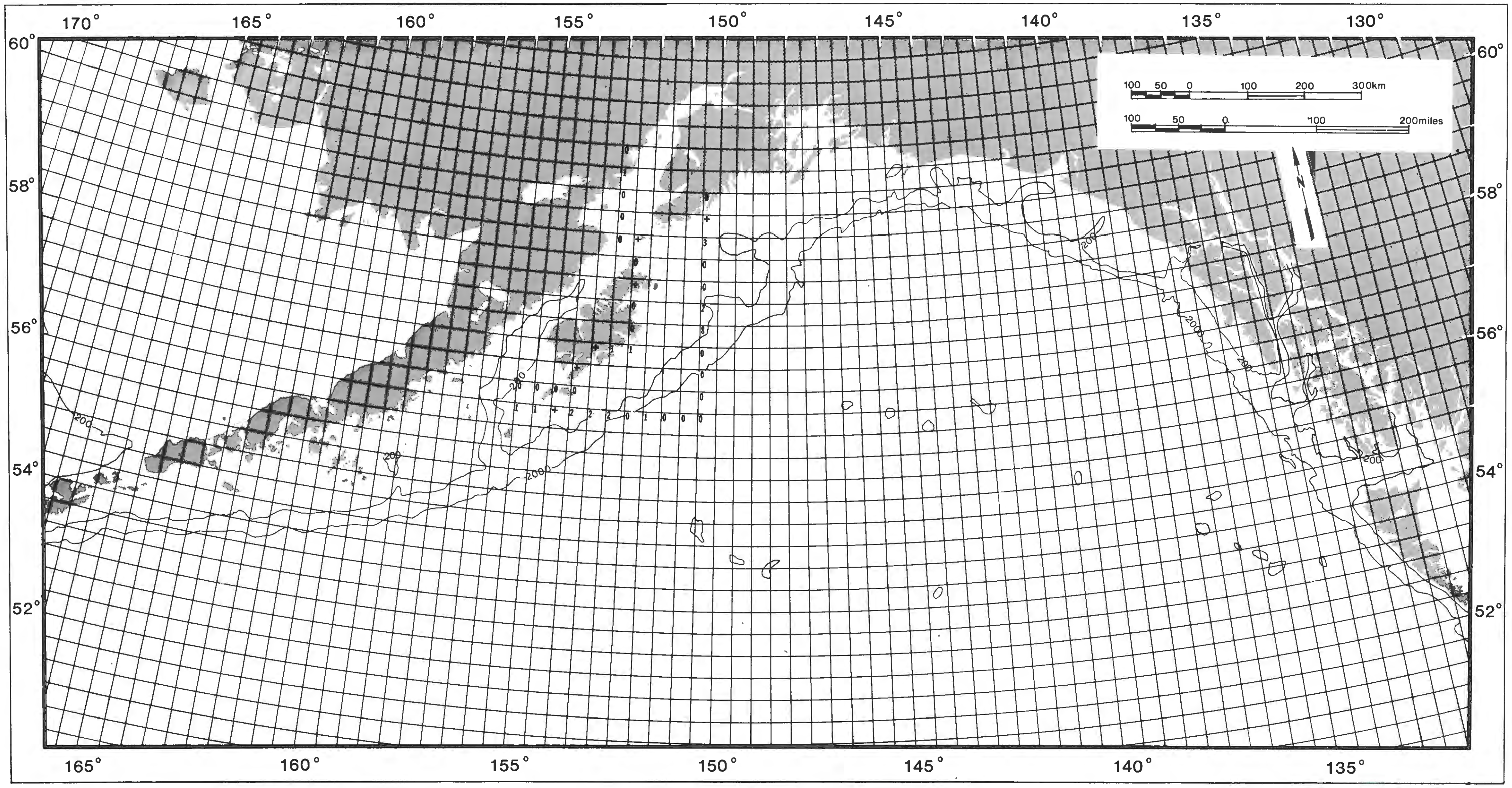

Map 65. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the Gulf of Alaska in fall.



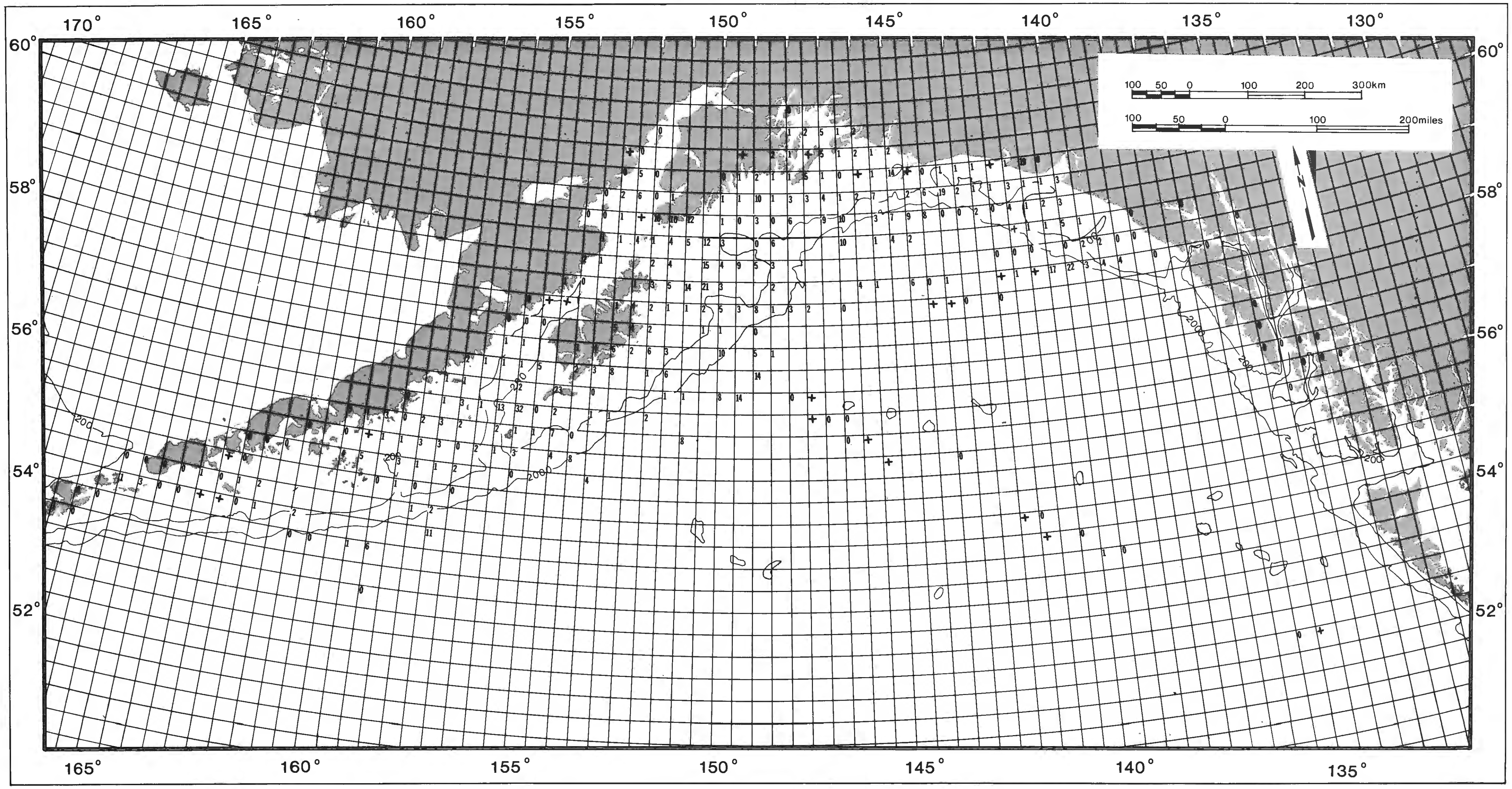

Map 66. Density indices of Glaucous-winged Gull obtained from aerial surveys of the Gulf of Alaska in fall.



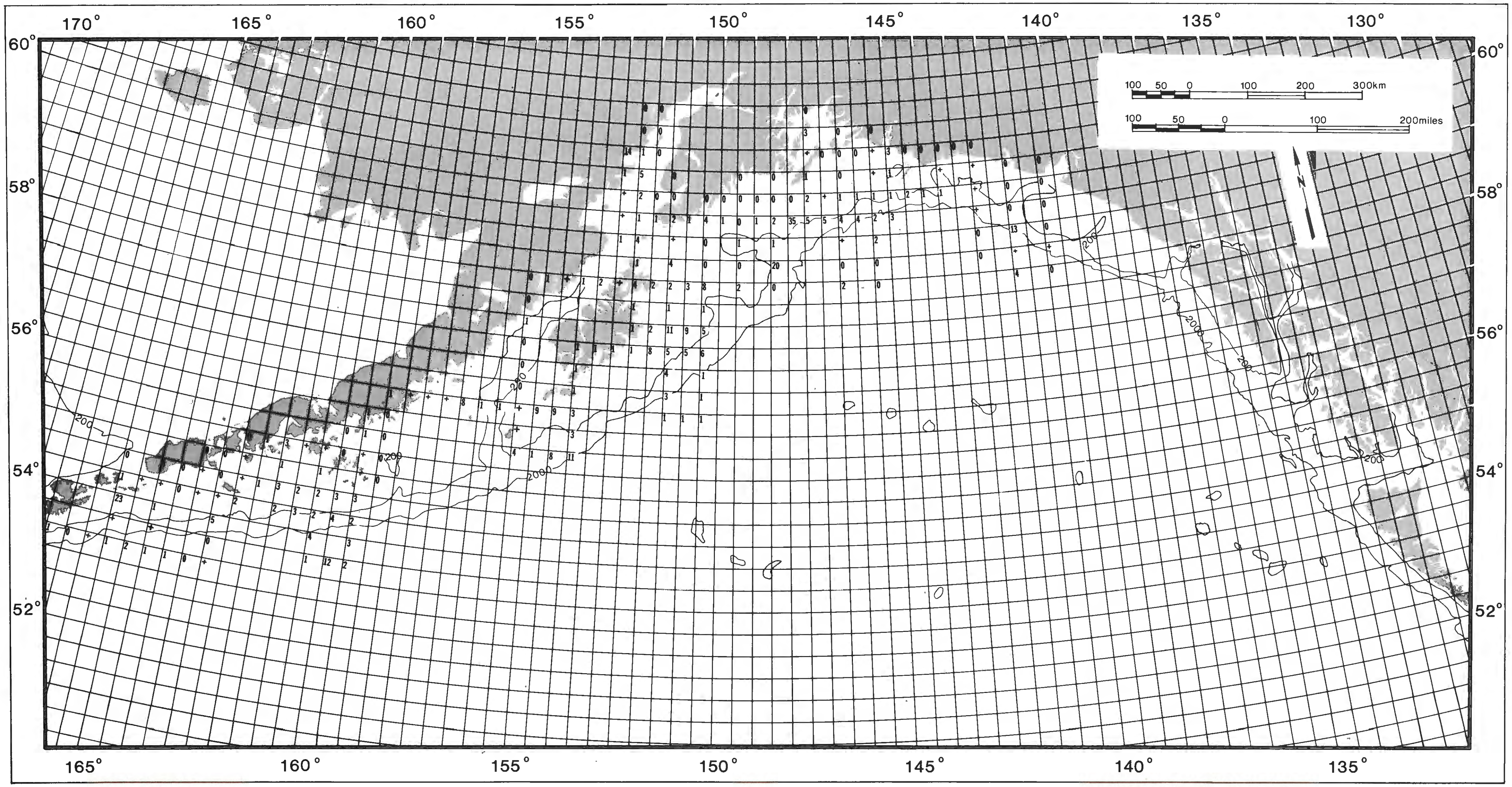

Map 67. Density indices of total kittiwakes obtained from shipboard surveys of the Gulf of Alaska in winter.



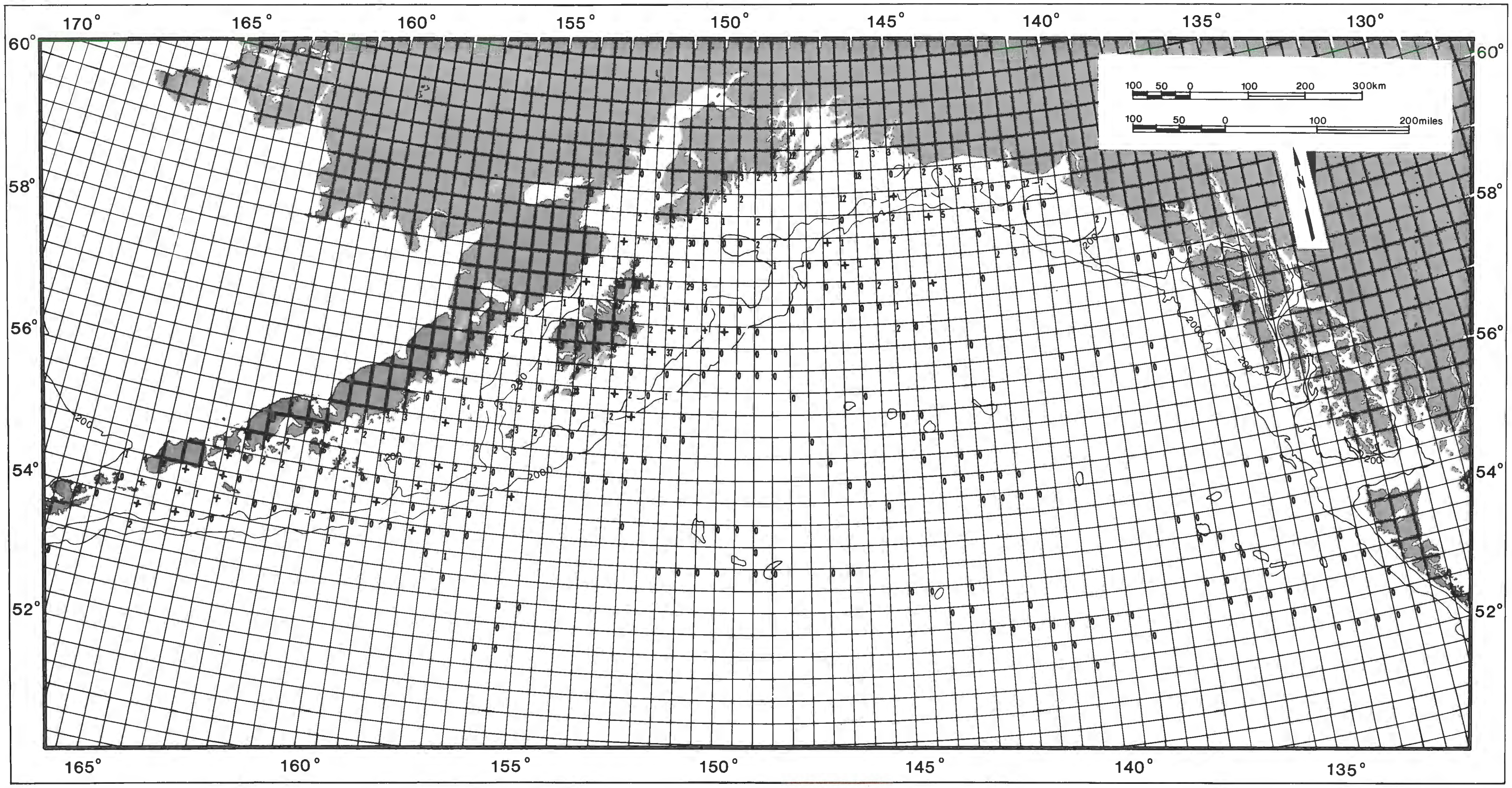

Map 68. Density indices of total kittiwakes obtained from aerial surveys of the Gulf of Alaska in winter.



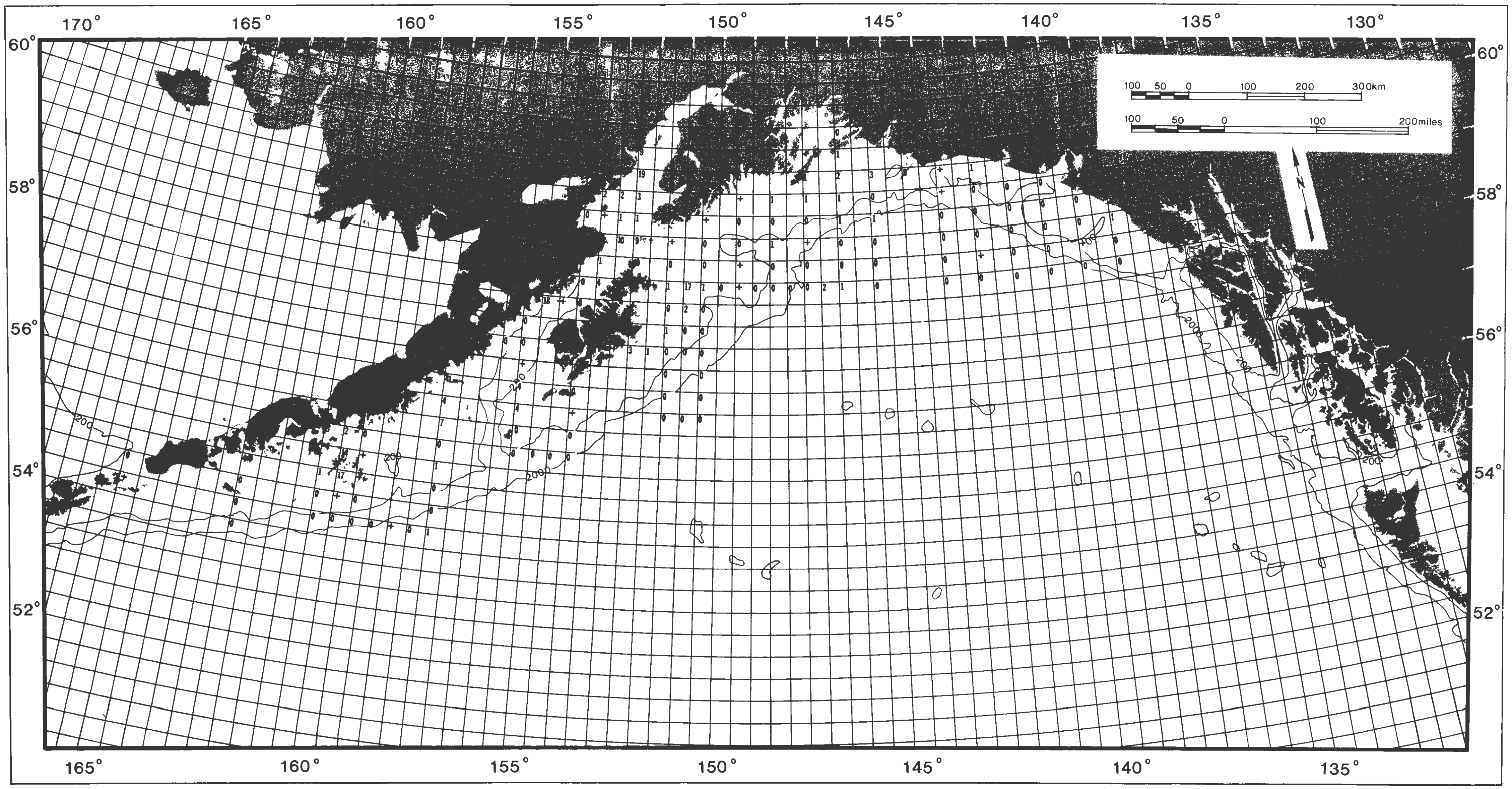

Map 69. Density indices of total kittiwakes obtained from shipboard surveys of the Gulf of Alaska in spring.



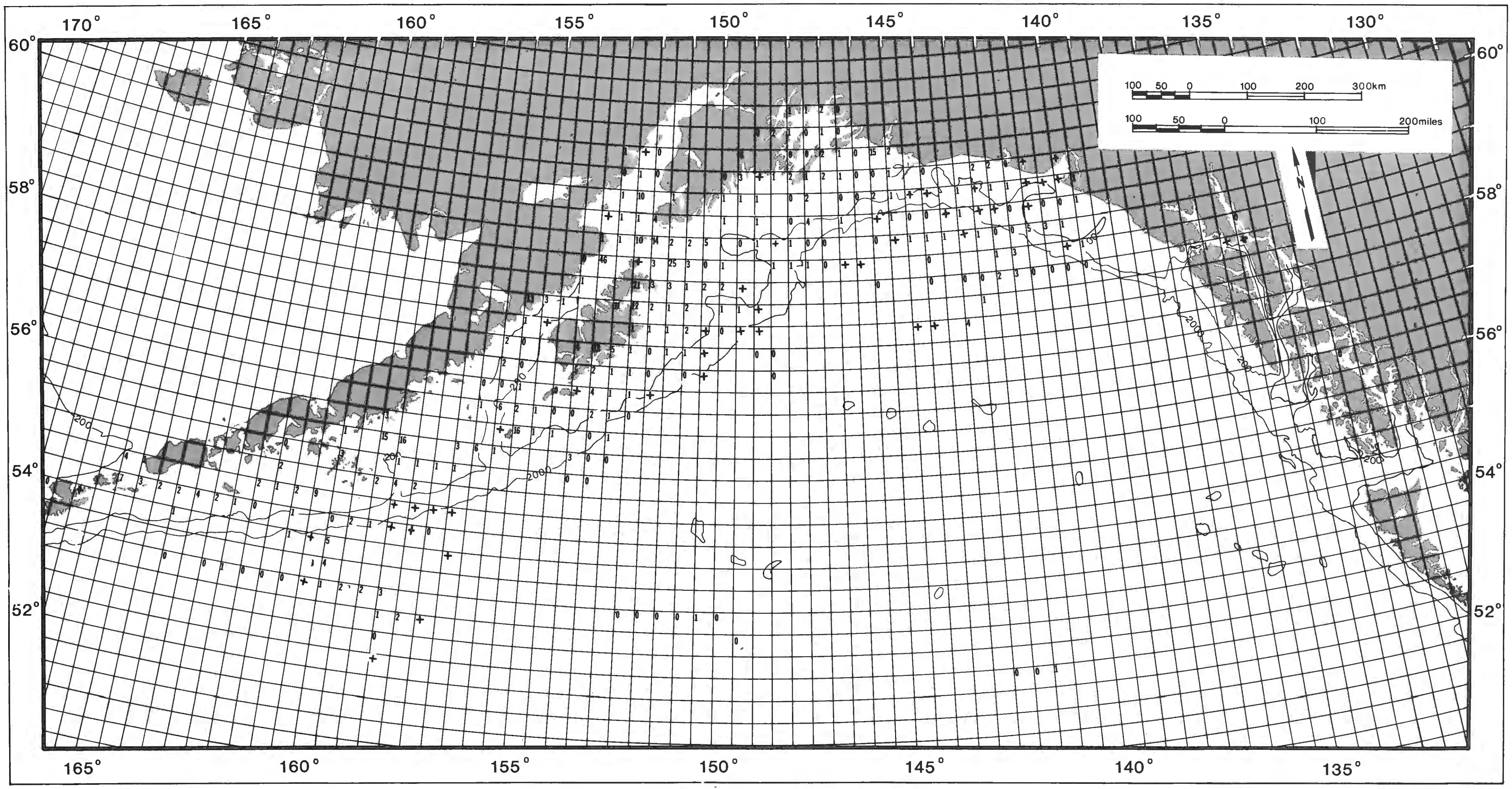

Map 70. Density indices of total kittiwakes obtained from aerial surveys of the Gulf of Alaska in spring.



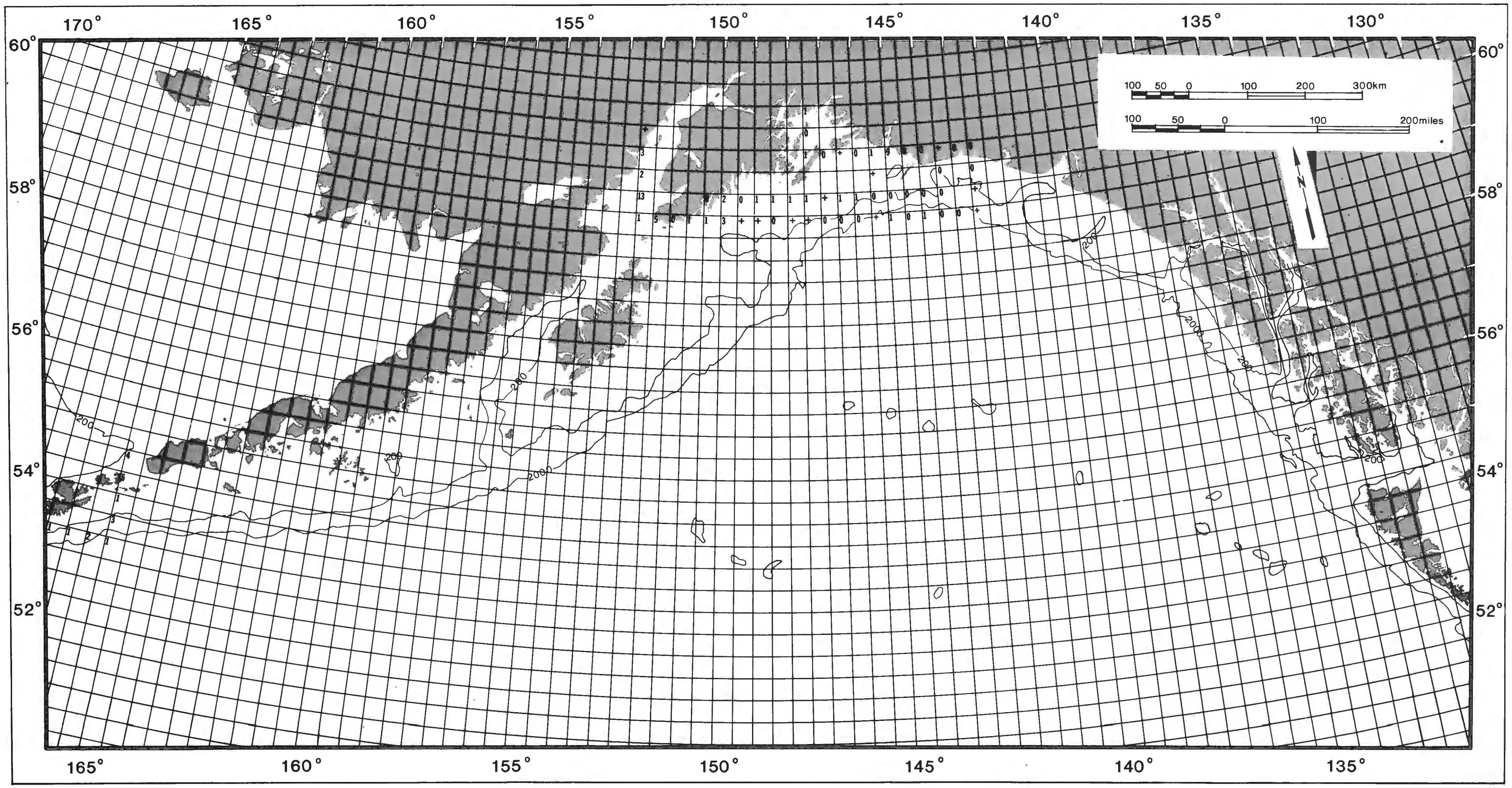

Map 71. Density indices of total kittiwakes obtained from shipboard surveys of the Gulf of Alaska in summer.



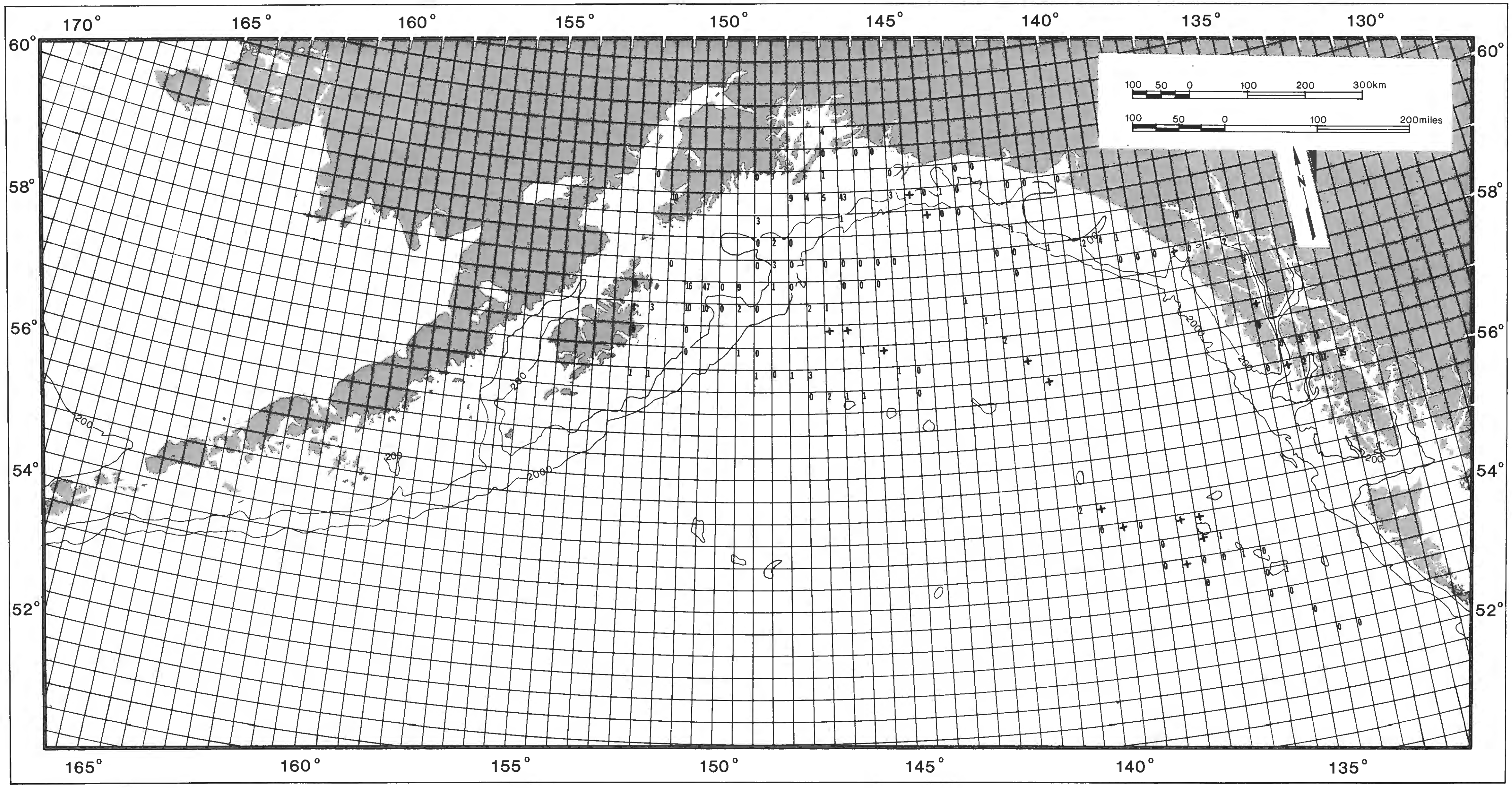

Map 72. Density indices of total kittiwakes obtained from aerial surveys of the Gulf of Alaska in summer.



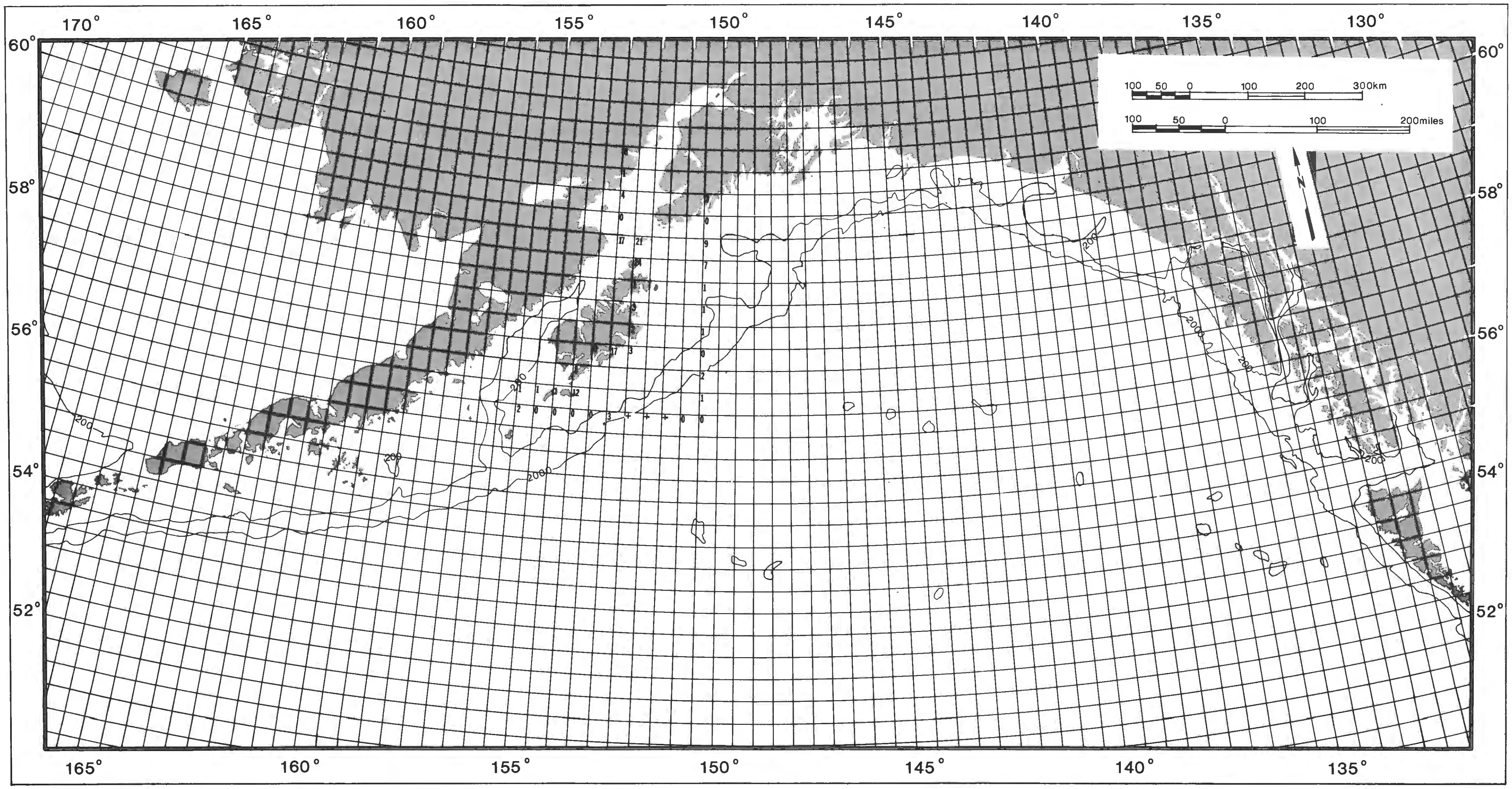

Map 73. Density indices of total kittiwakes obtained from shipboard surveys of the Gulf of Alaskas in fall.



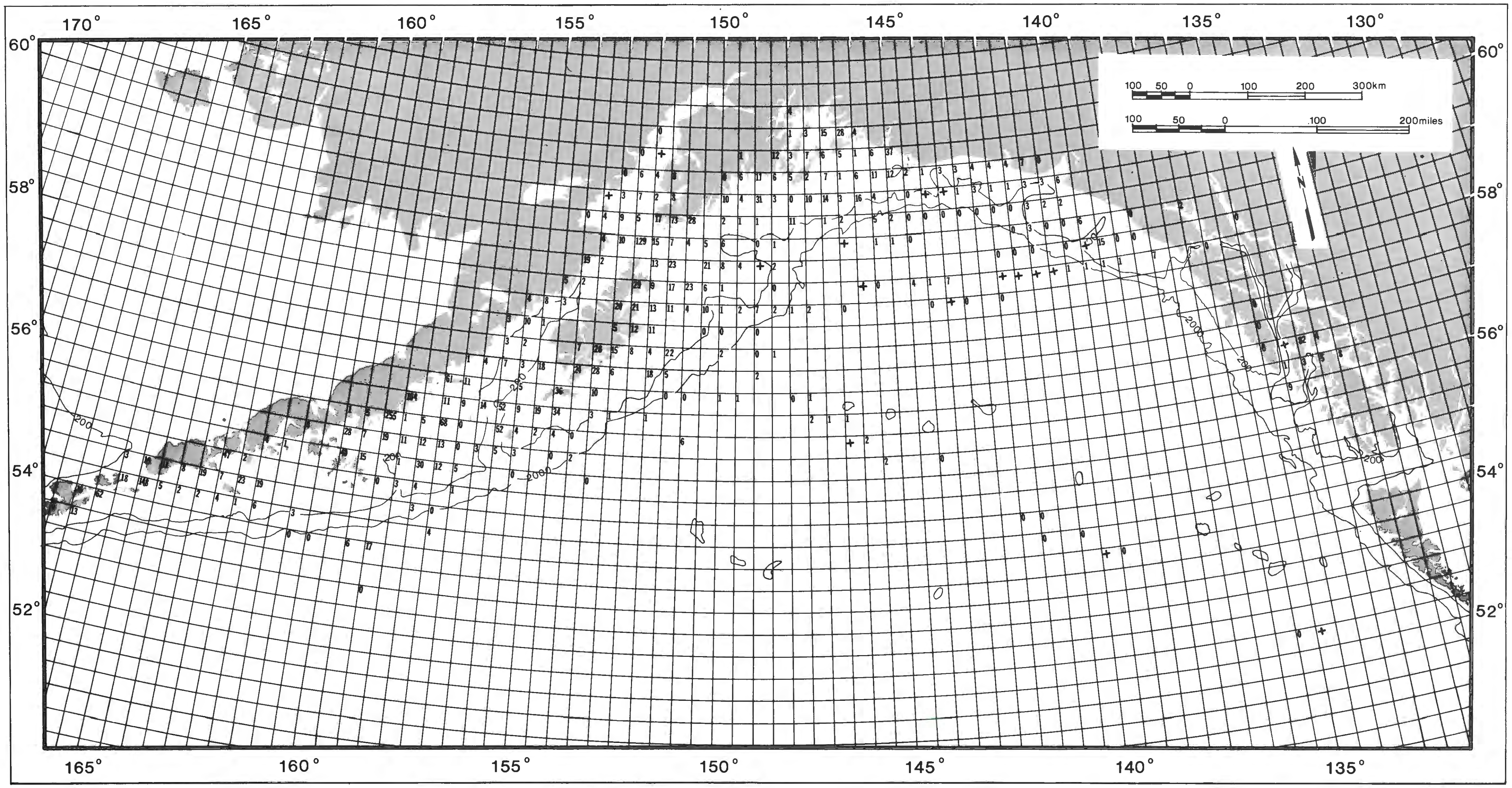

Map 74. Density indices of total kittiwakes obtained from aerial surveys of the Gulf of Alaska in fall.



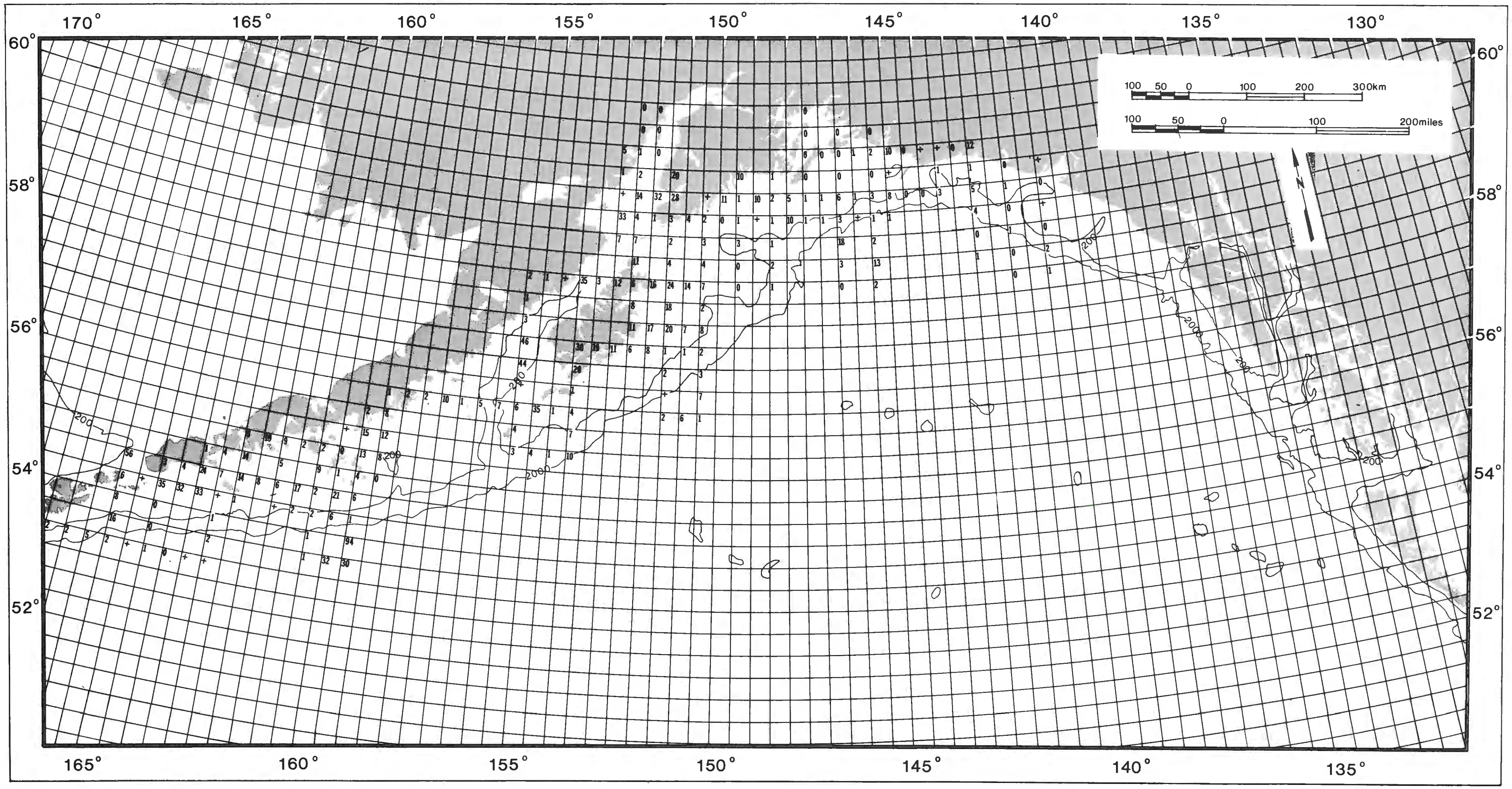

Map 75. Density indices of total alcids obtained from shipboard surveys of the Gulf of Alaska in winter.



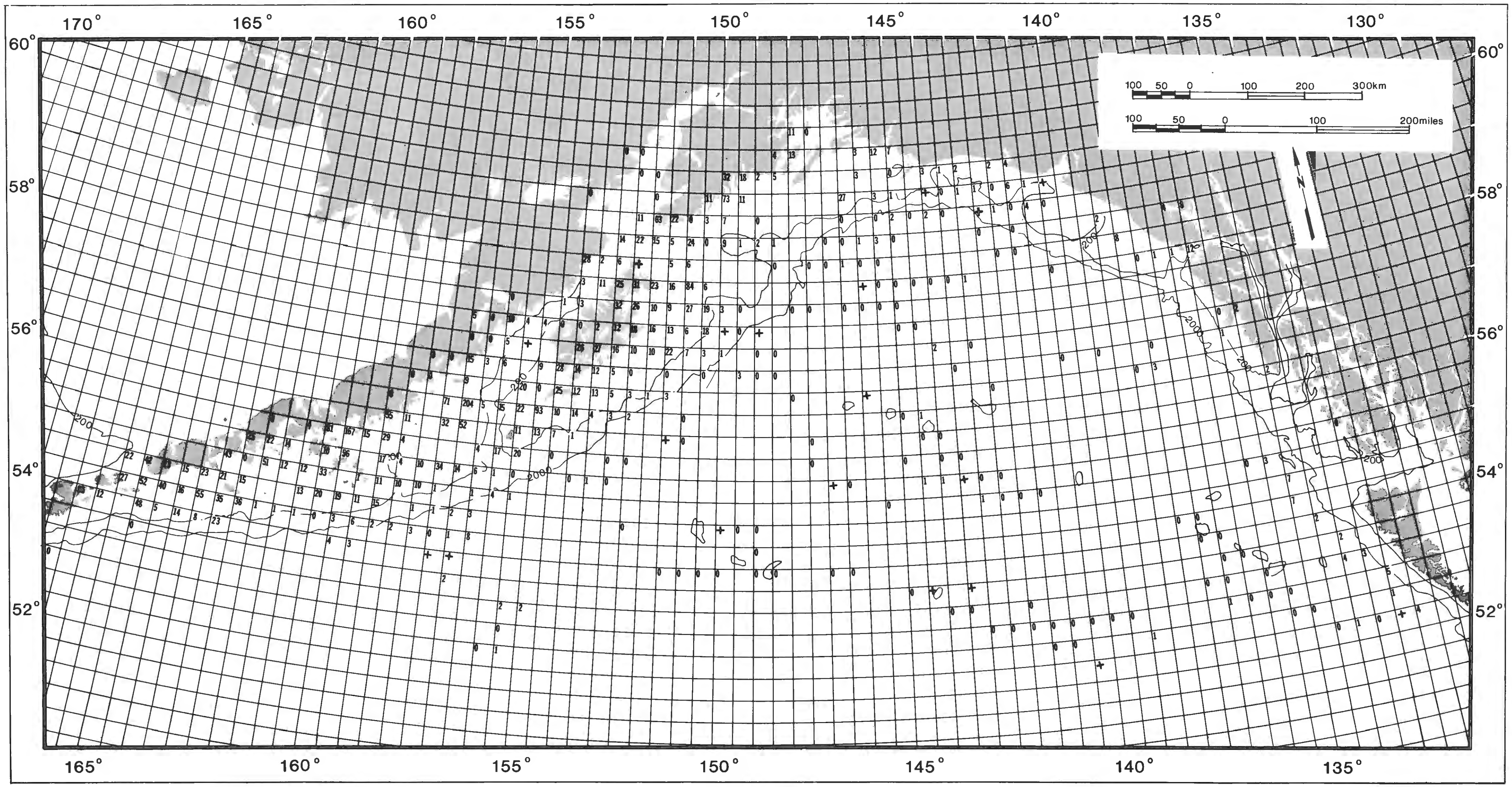

Map 76. Density indices of total alcids obtained from aerial surveys of the Gulf of Alaska in winter.



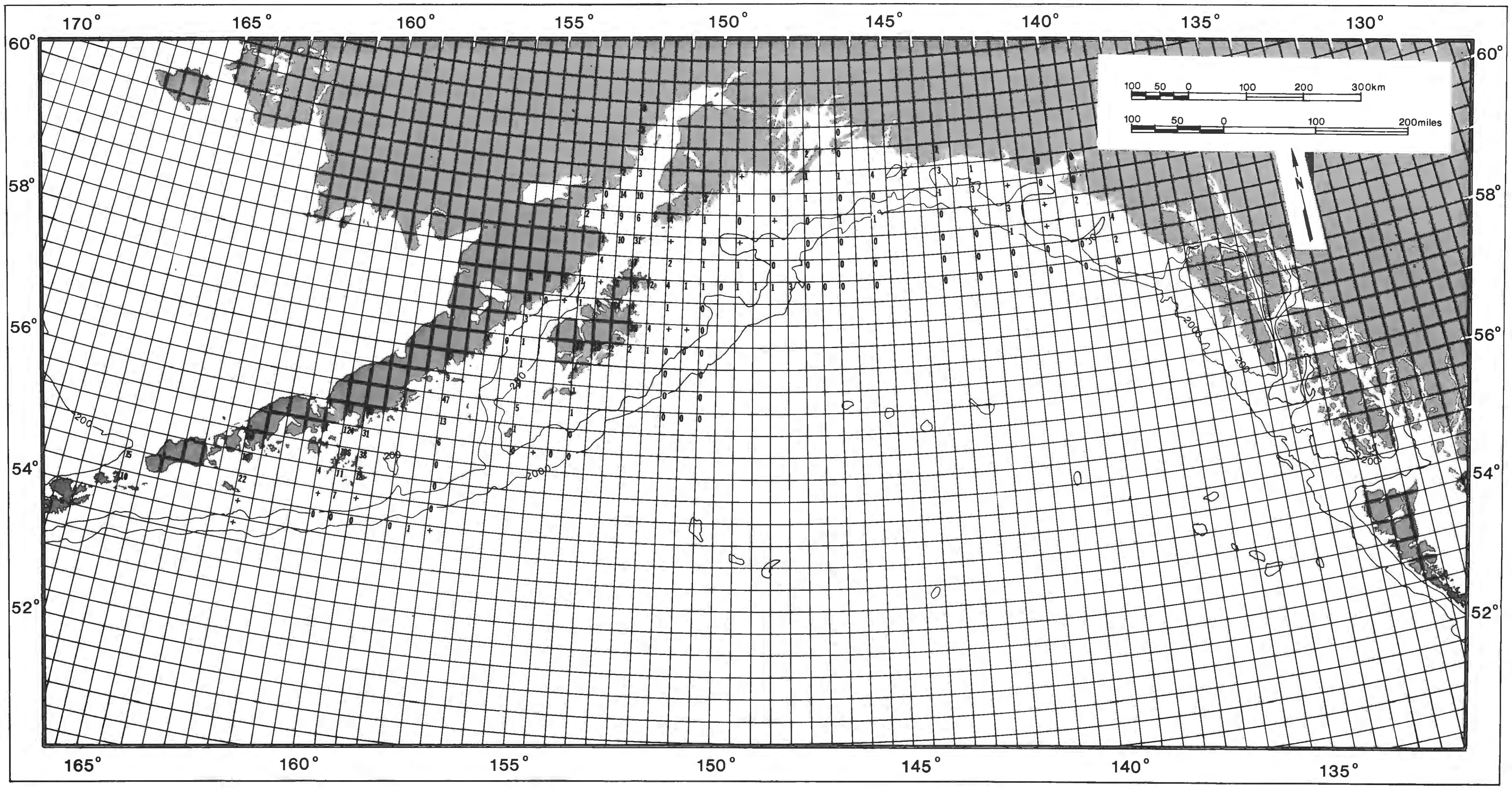

Map 77. Density indices of total alcids obtained from shipboard surveys of the Gulf of Alaska in spring.



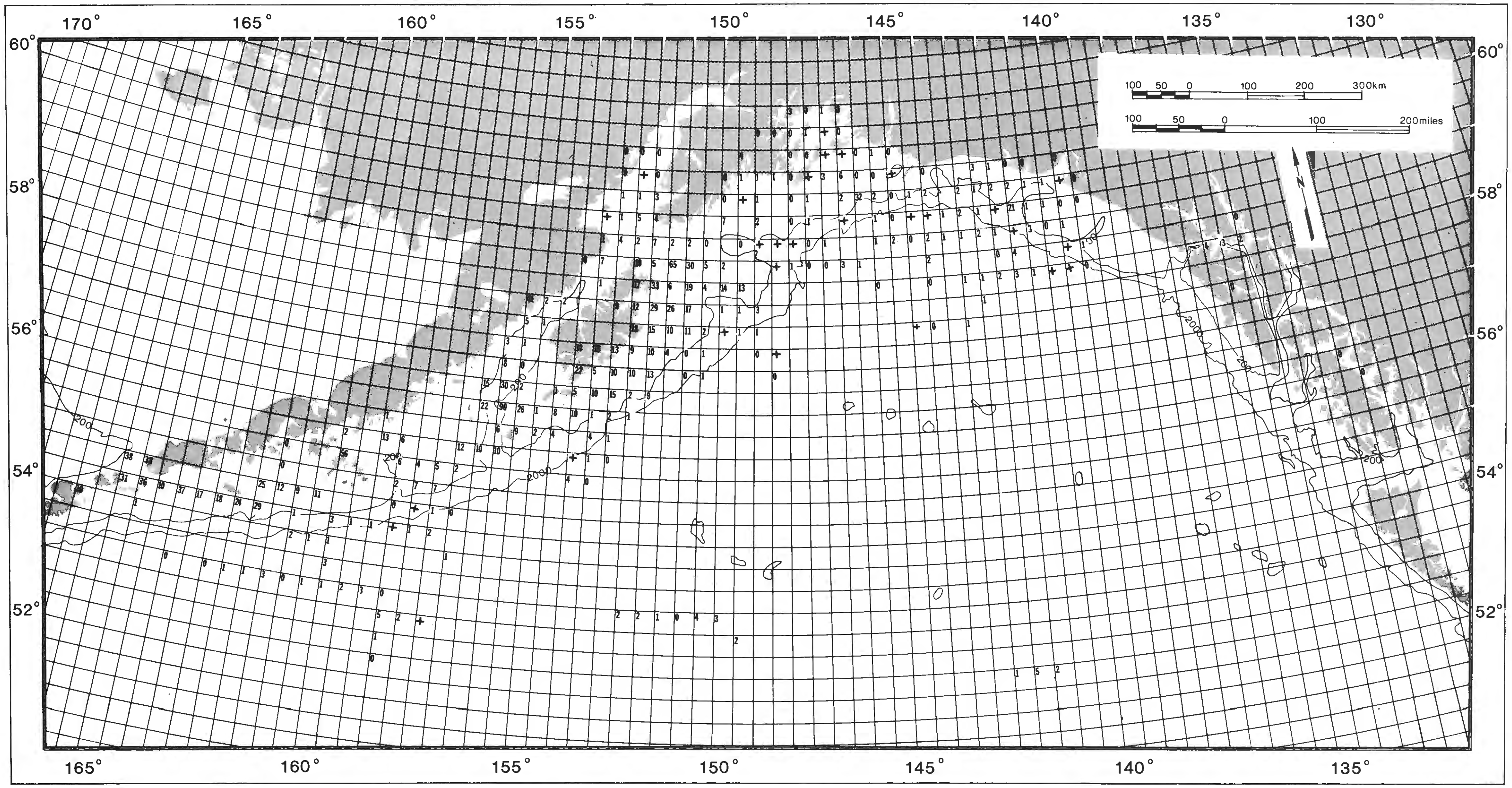

Map 78. Density indices of total alcids obtained from aerial surveys of the Gulf of Alaska in spring.



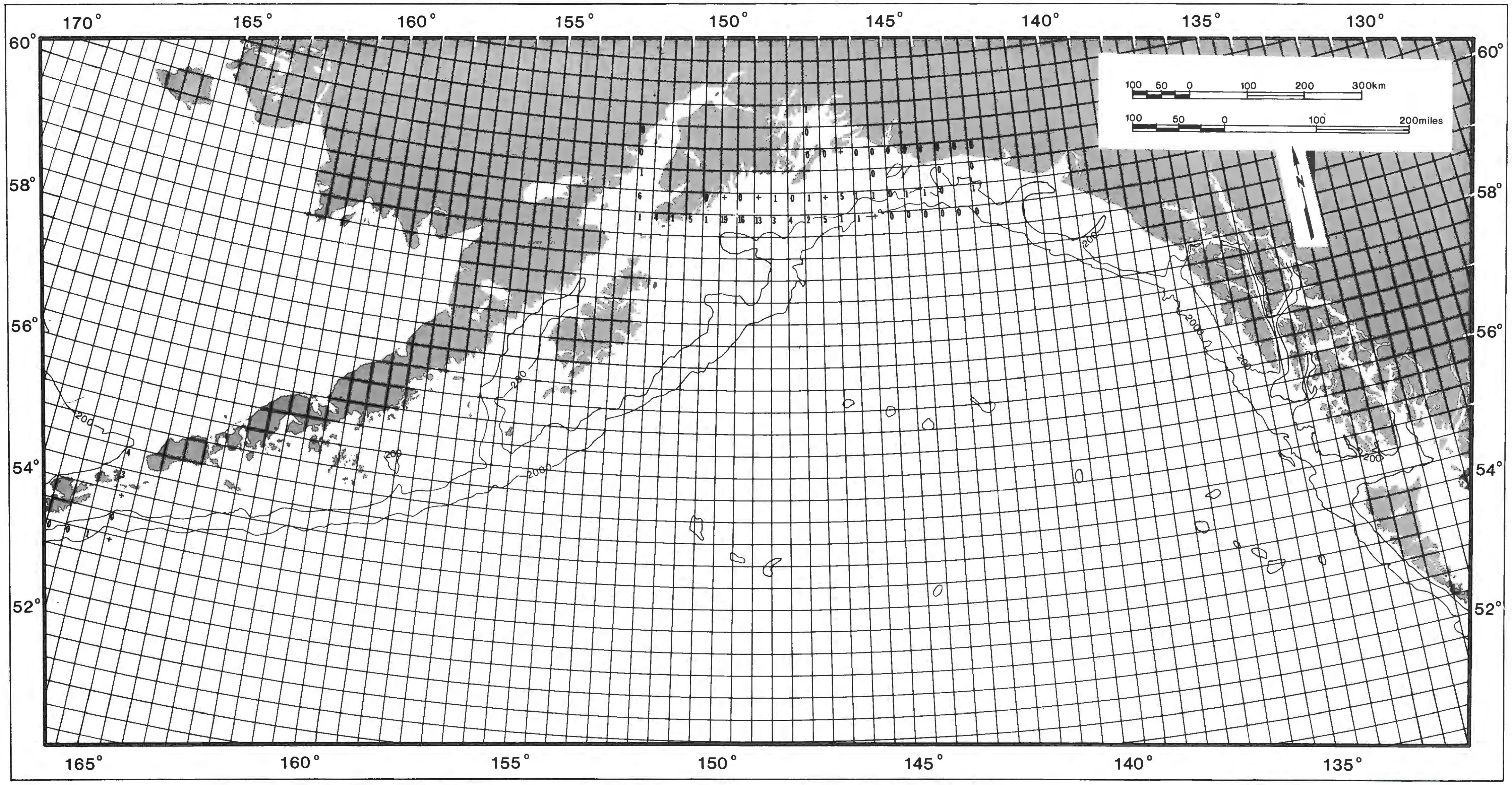

Map 79. Density indices of total alcids obtained from shipboard surveys of the Gulf of Alaska in summer.



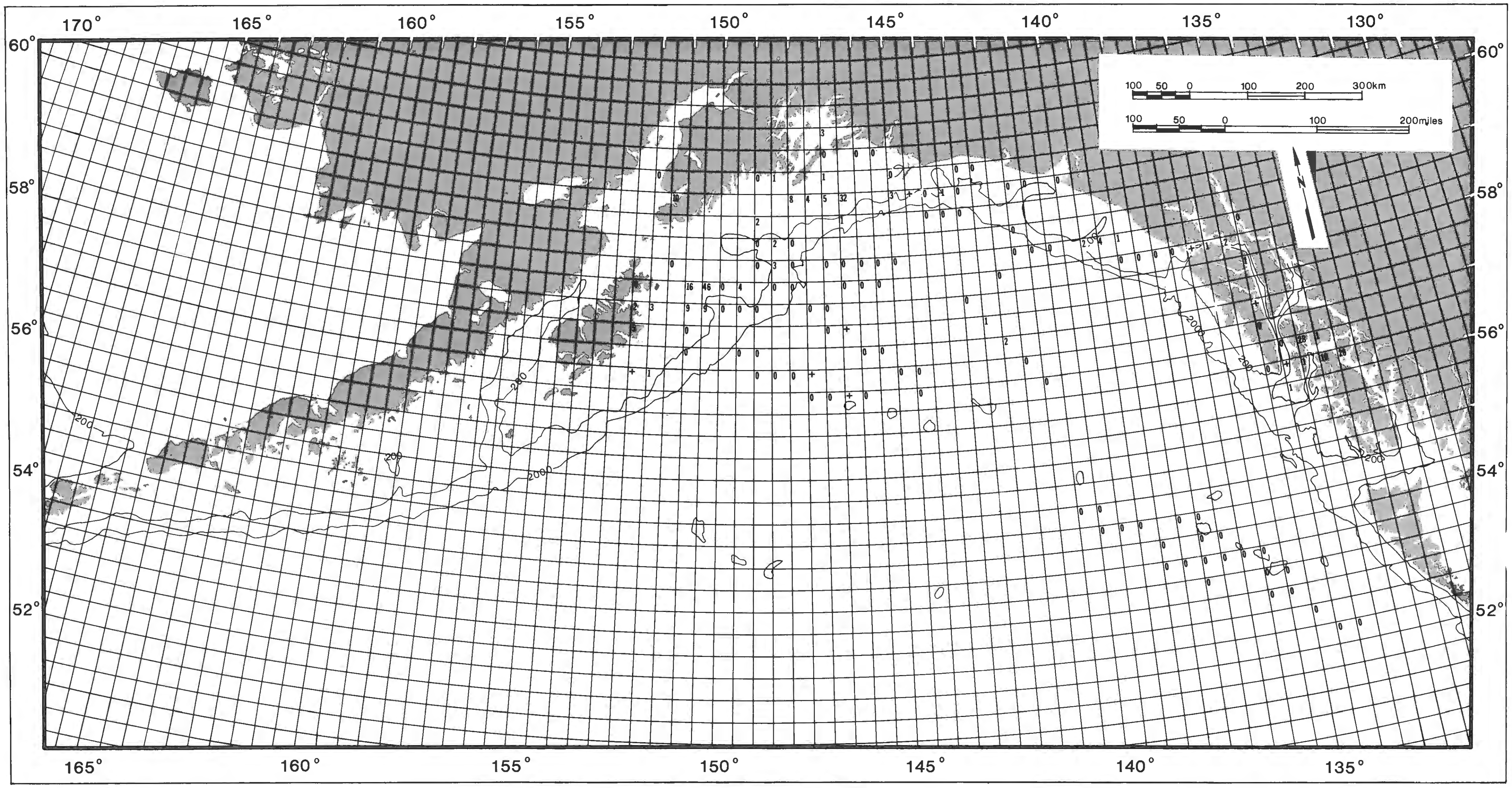

Map 80. Density indices of total alcids obtained from aerial surveys of the Gulf of Alaska in summer.



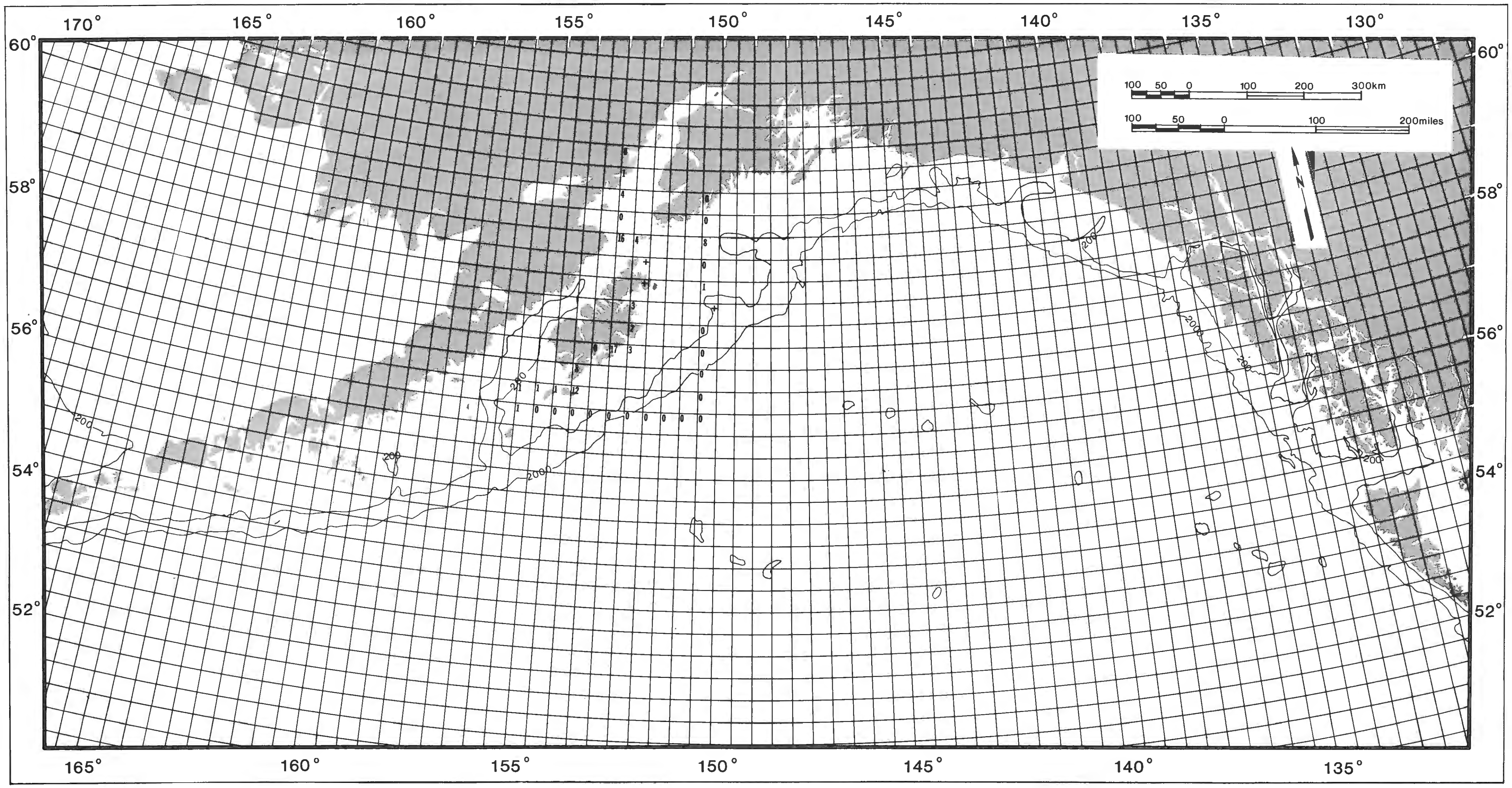

Map 81. Density indices of total alcids obtained from shipboard surveys of the Gulf of Alaska in fall.



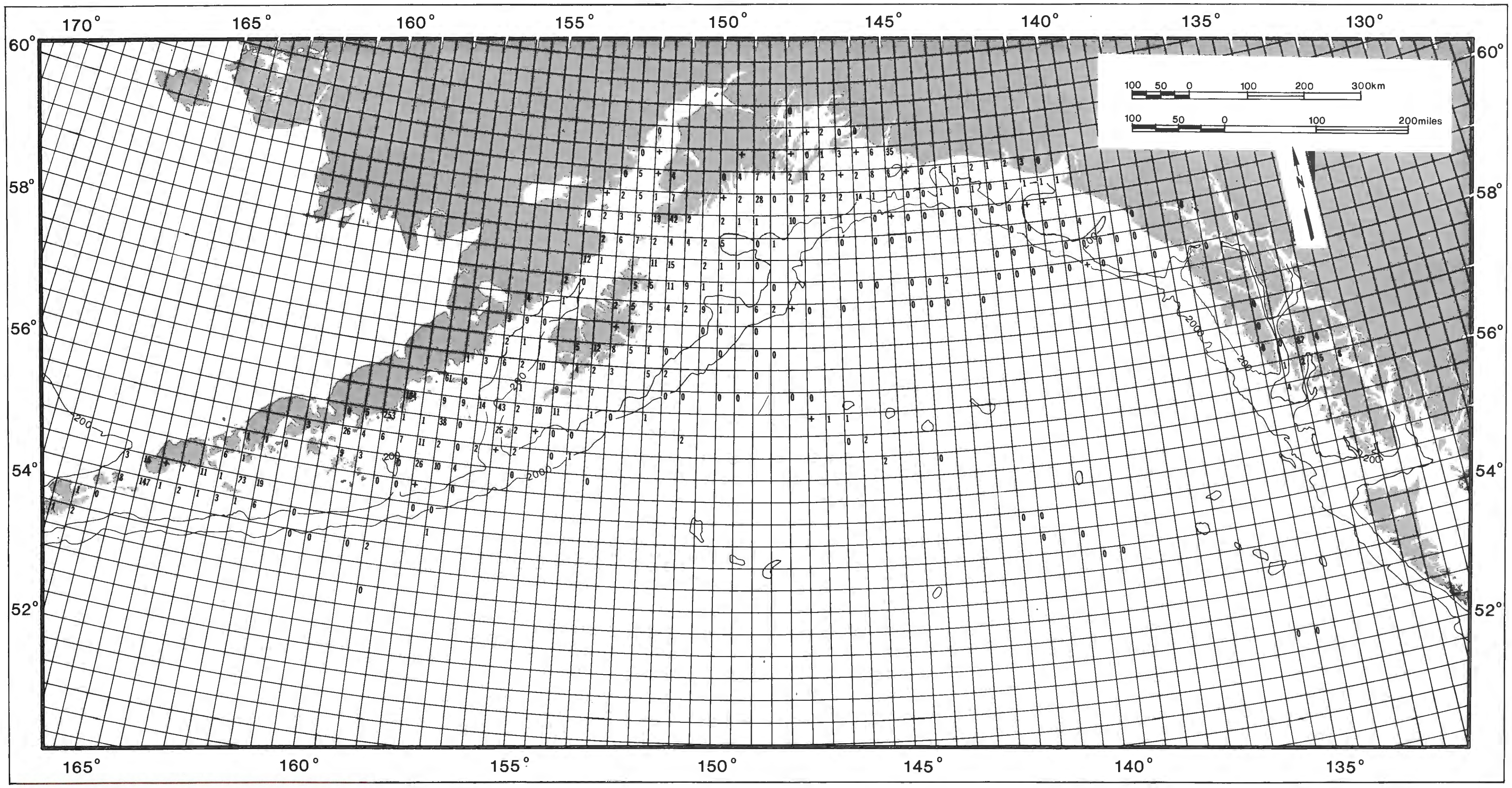

Map 82. Density indices of total alcids obtained from aerial surveys of the Gulf of Alaska in fall.



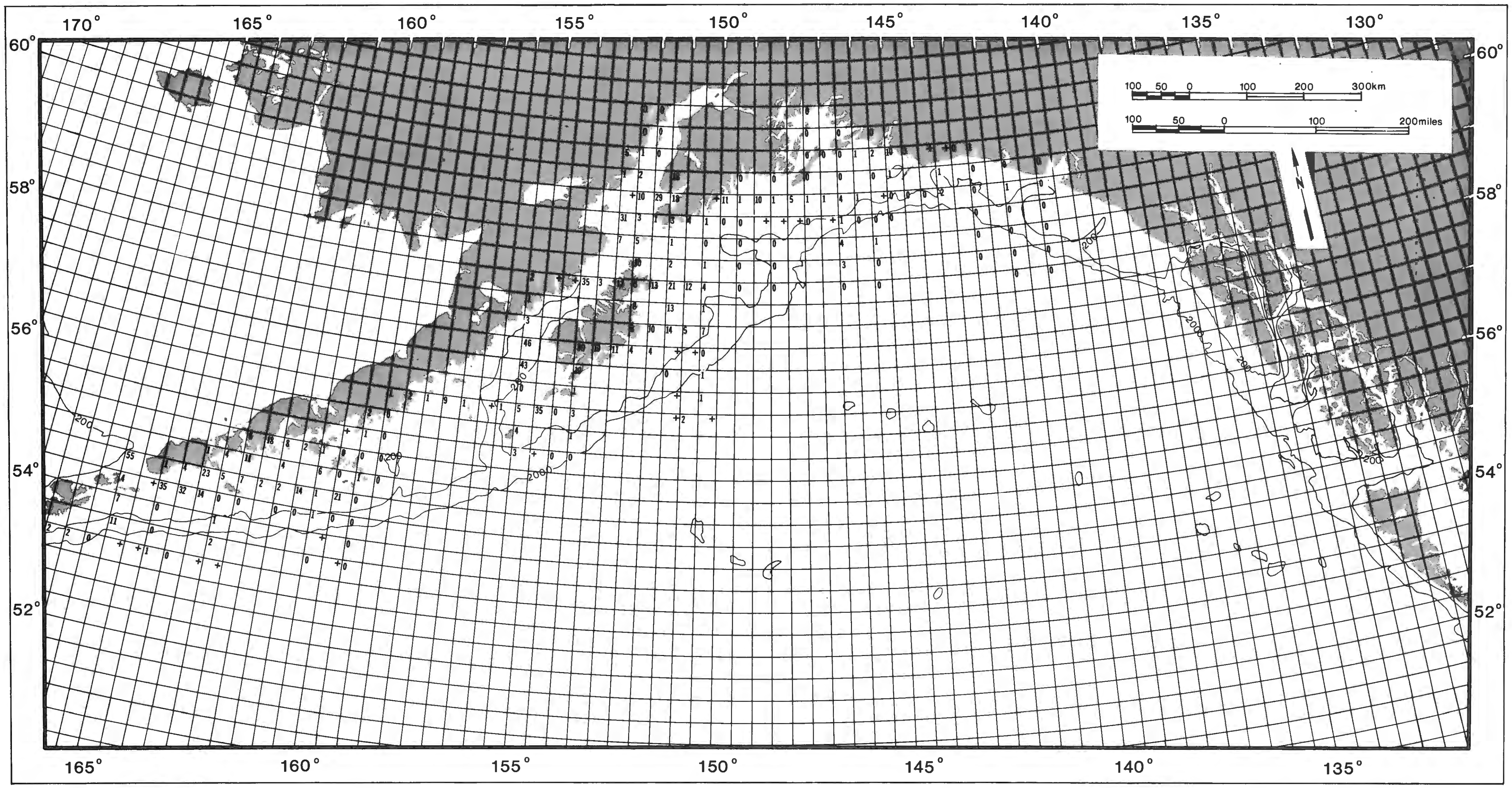

Map 83. Density indices of total murres obtained from shipboard surveys of the Gulf of Alaska in winter.



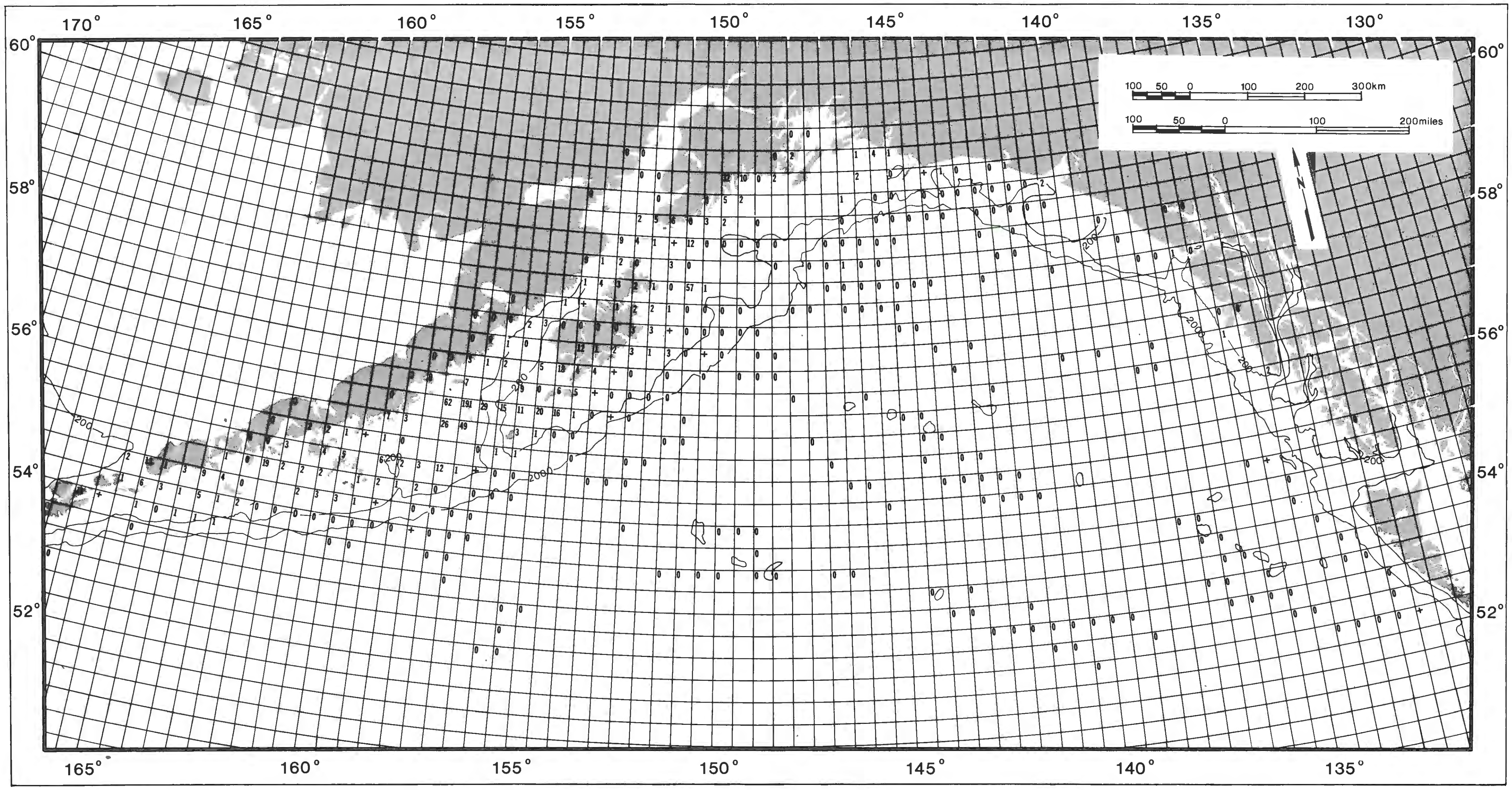

Map 84. Density indices of total murres obtained from aerial surveys of the Gulf of Alaska in winter.



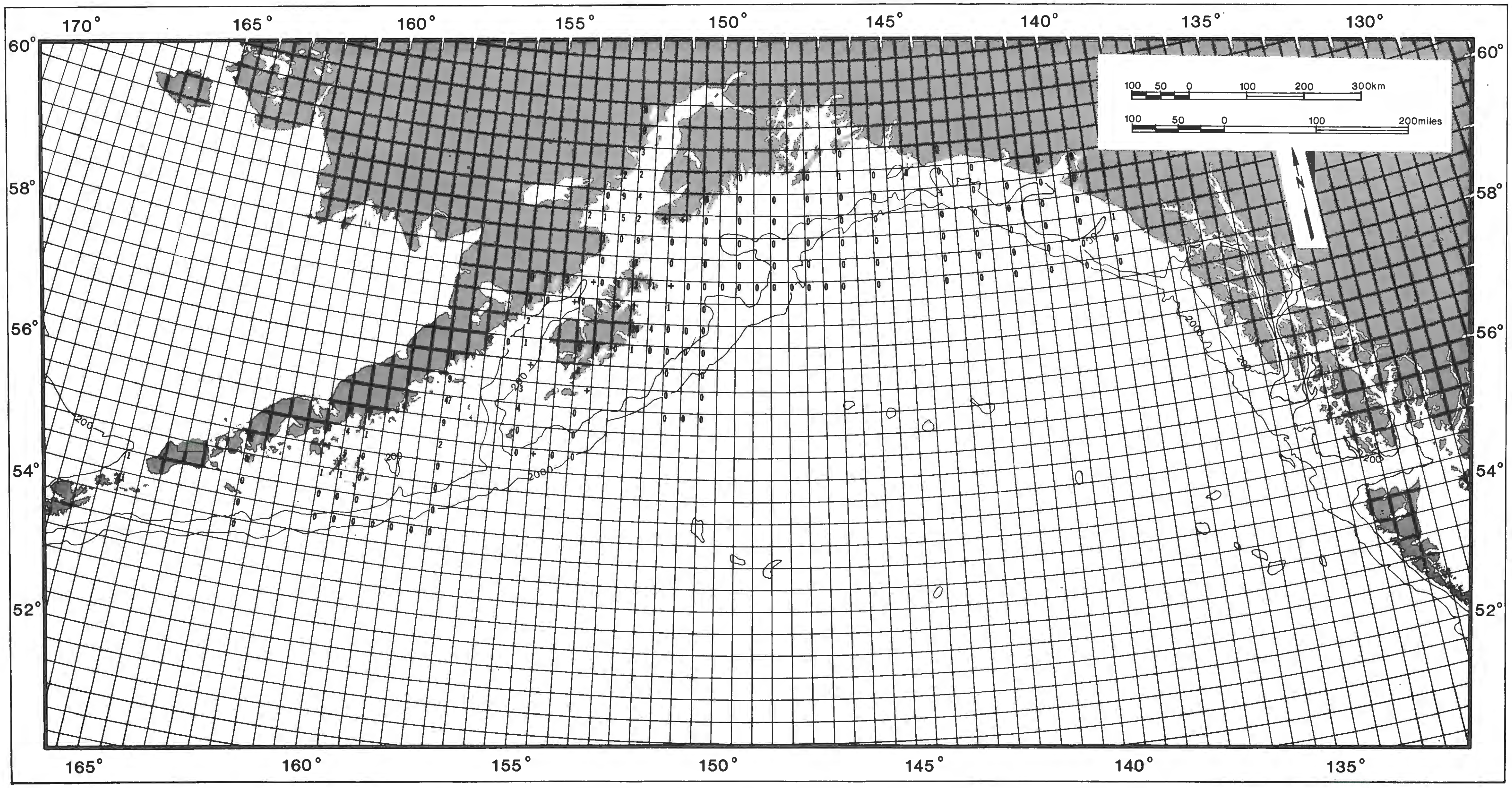

Map 85. Density indices of total murres obtained from shipboard surveys of the Gulf of Alaska in spring.



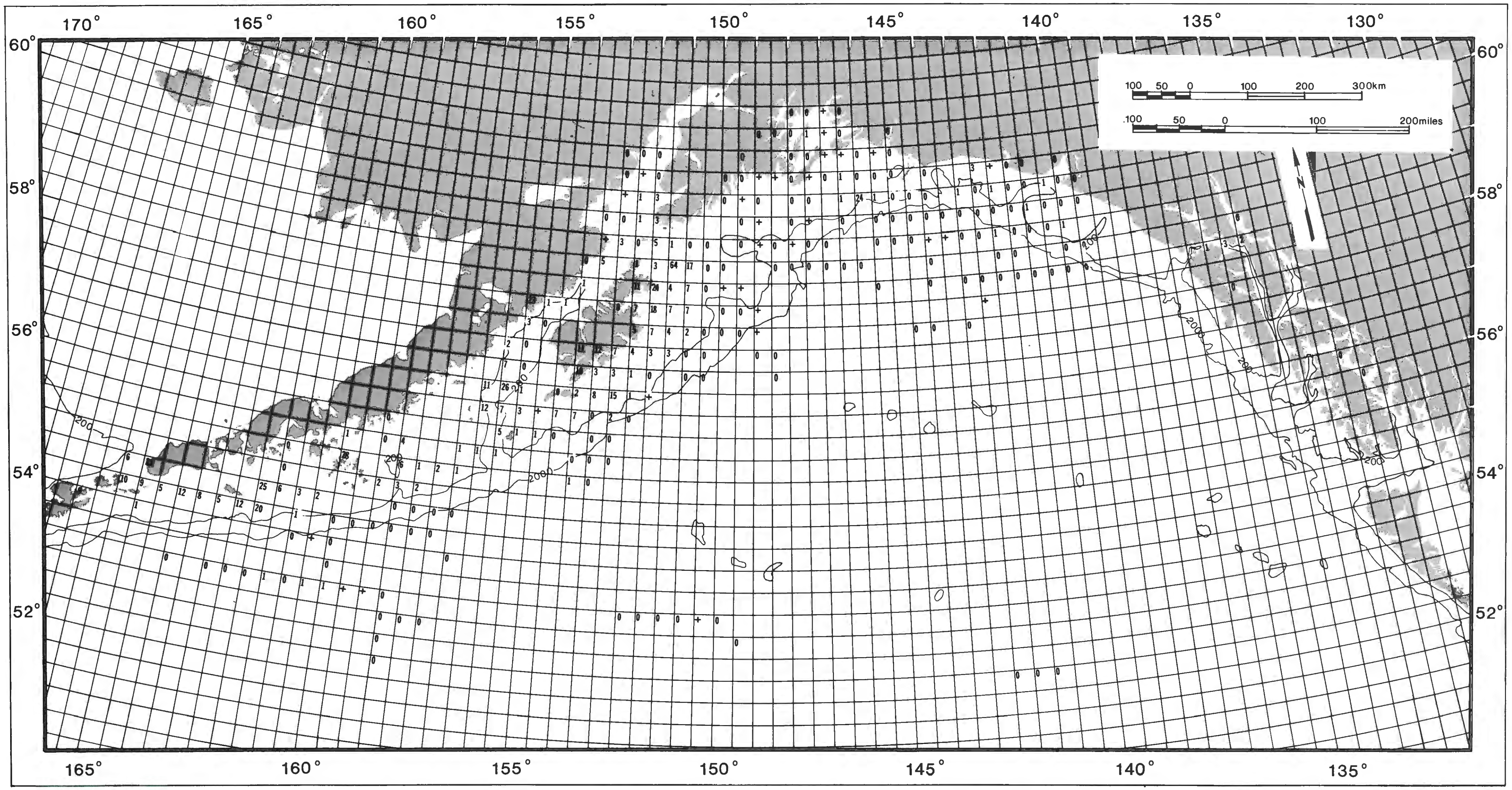

Map 86. Density indices of total murres obtained from aerial surveys of the Gulf of Alaska in spring.



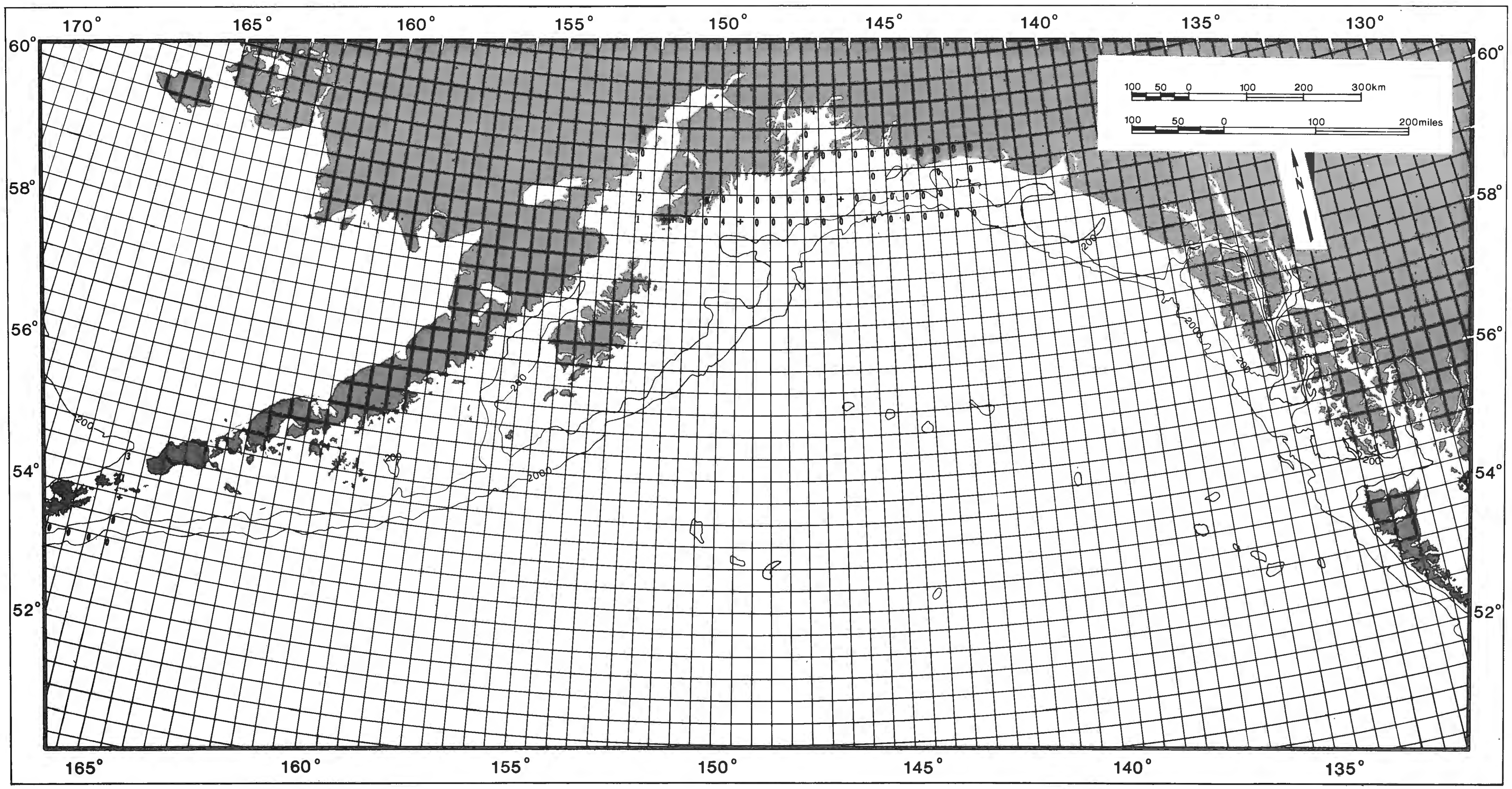

Map 87. Density indices of total murres obtained from shipboard surveys of the Gulf of Alaska in summer.



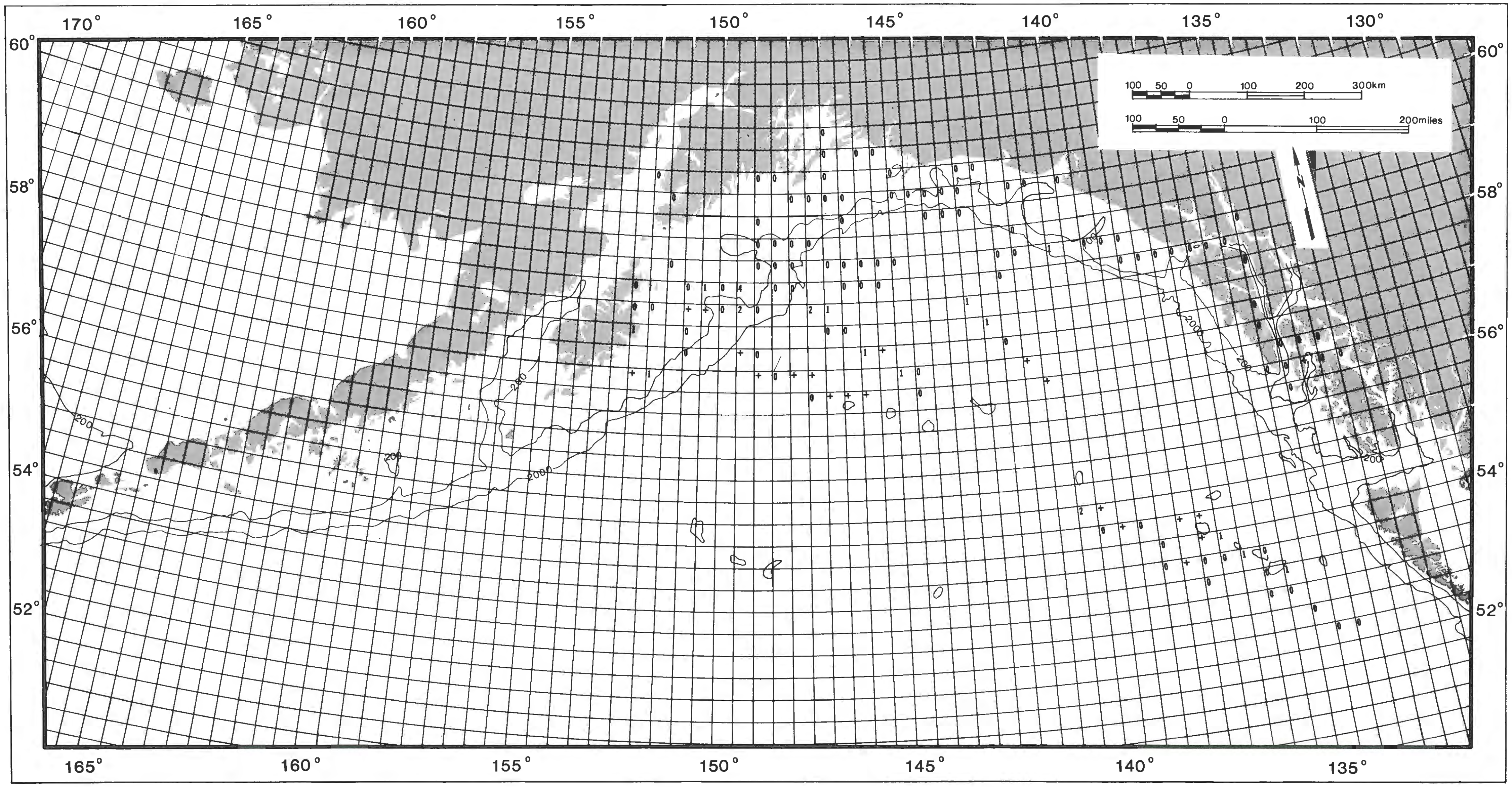

Map 88. Density indices of total marres obtained from aerial surveys of the Gulf of Alaska in summer.



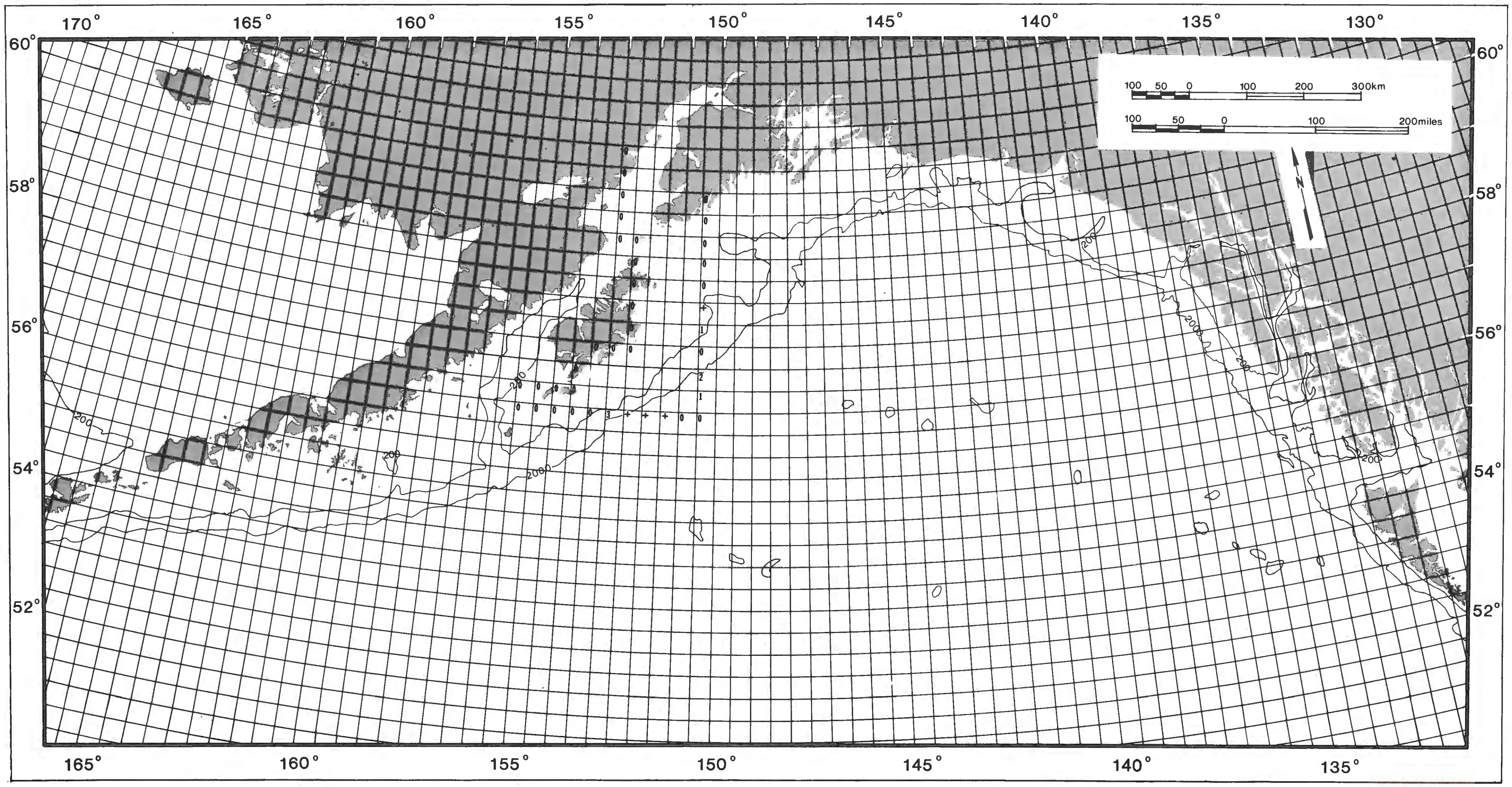

Map 89. Density indices of total murres obtained from shipboard surveys of the Gulf of Alaska in fall...



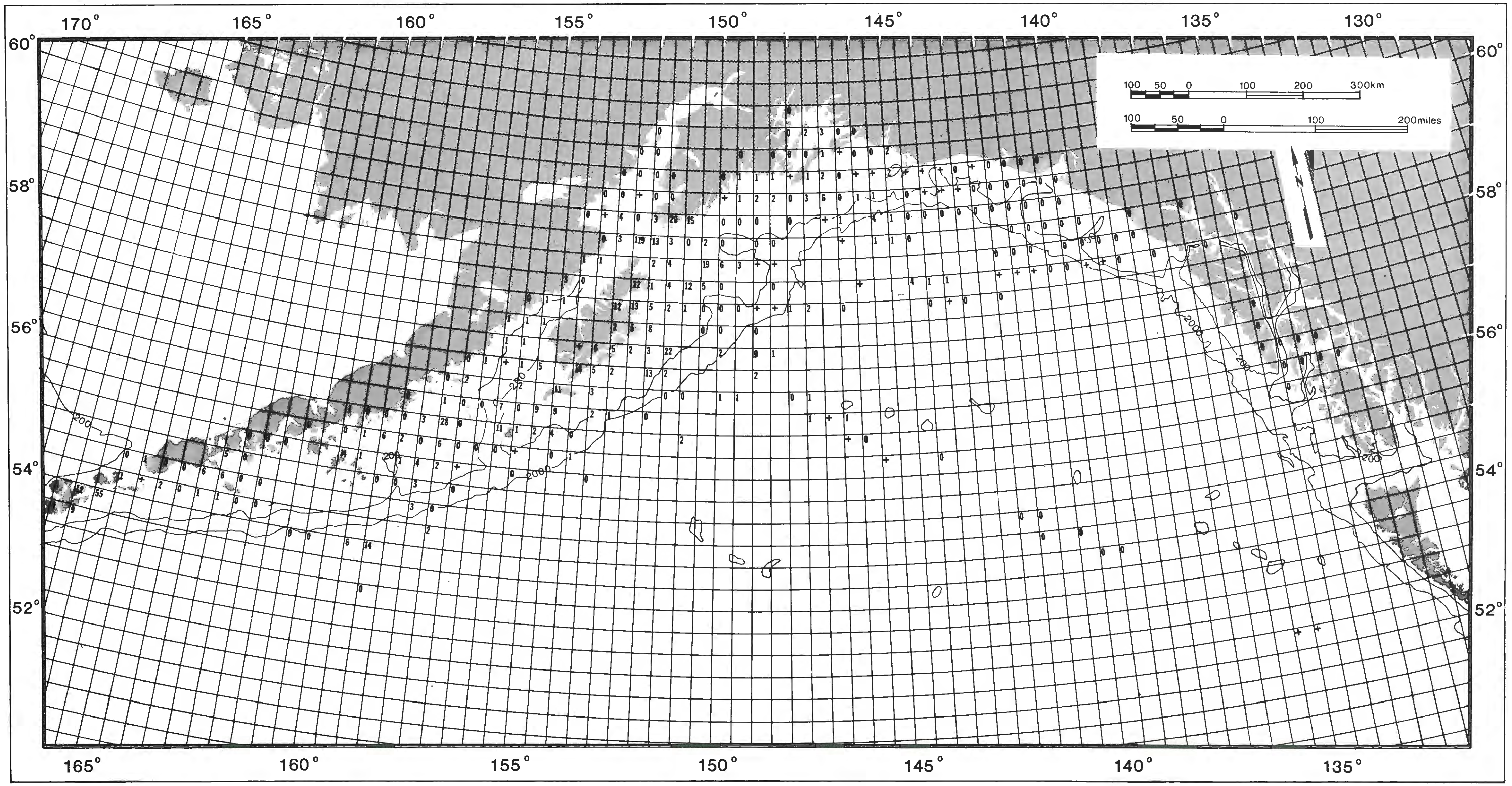

Map 90. Density indices of total murres obtained from aerial surveys of the Gulf of Alaska in fall.



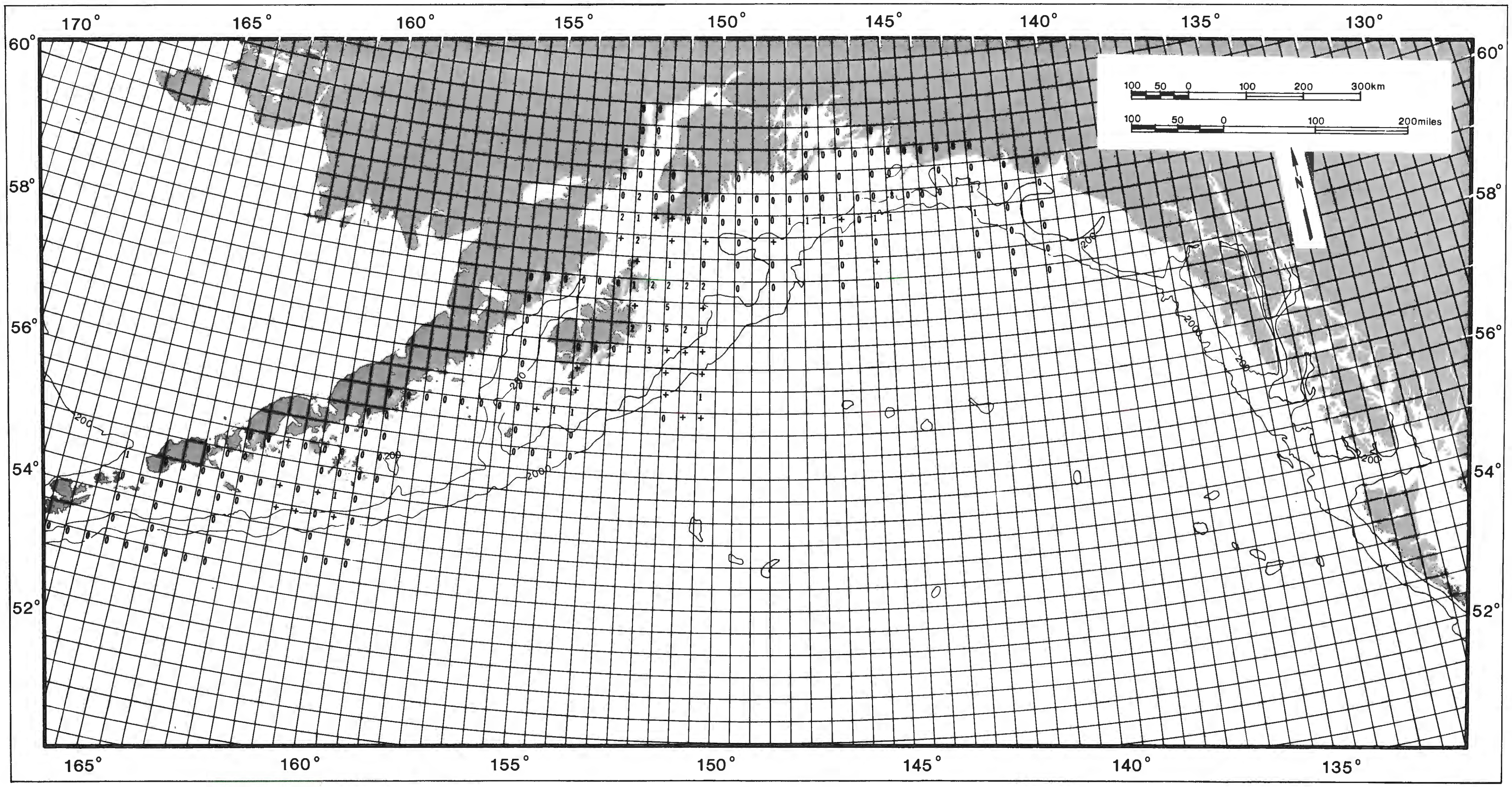

Map 91. Density indices of Tufted Puffin obtained from shipboard surveys of the Gulf of Alaska in winter.



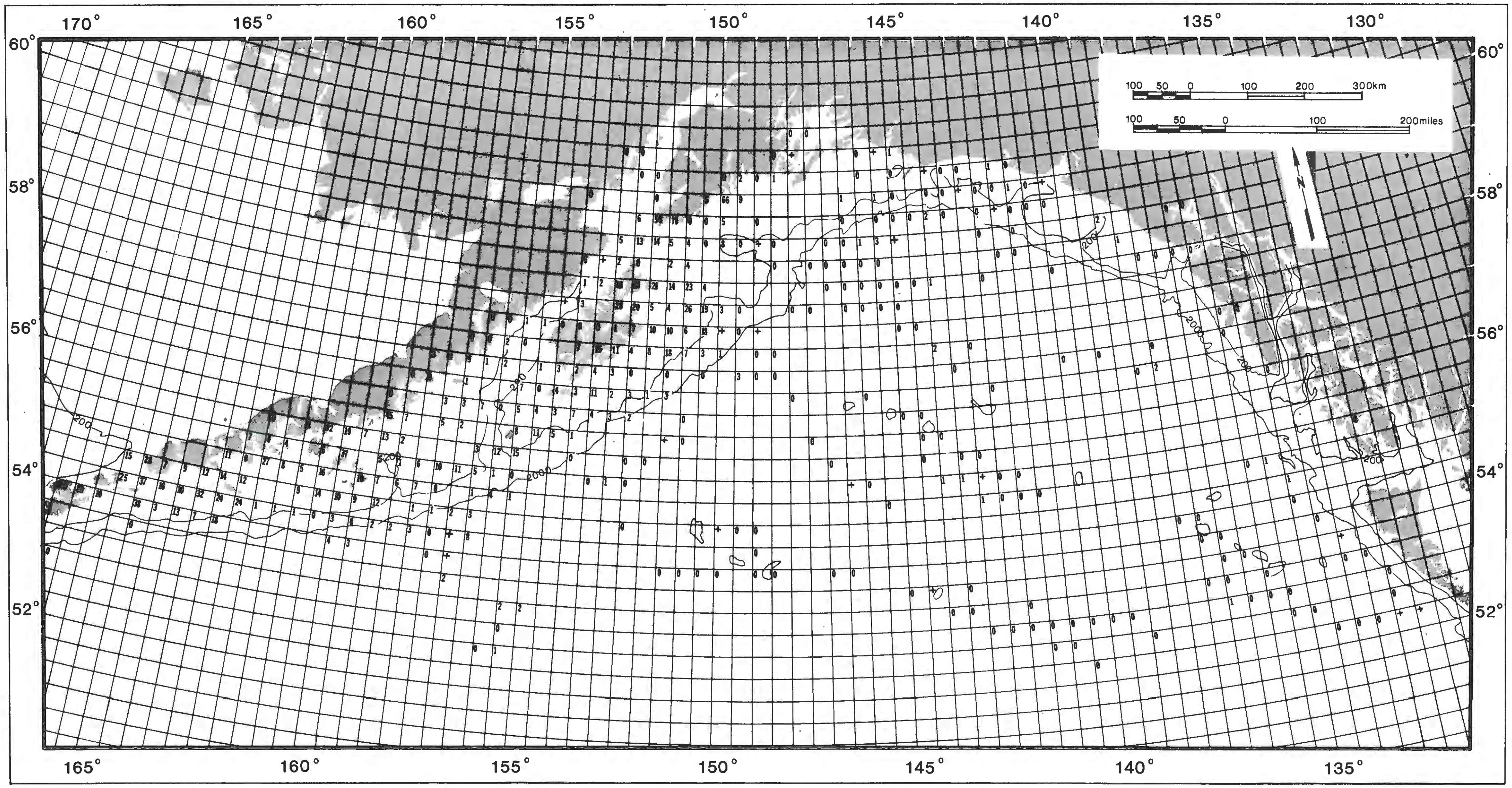

Map 92. Density indices of Tufted Puffin obtained from aerial surveys of the Gulf of Alaska in winter.



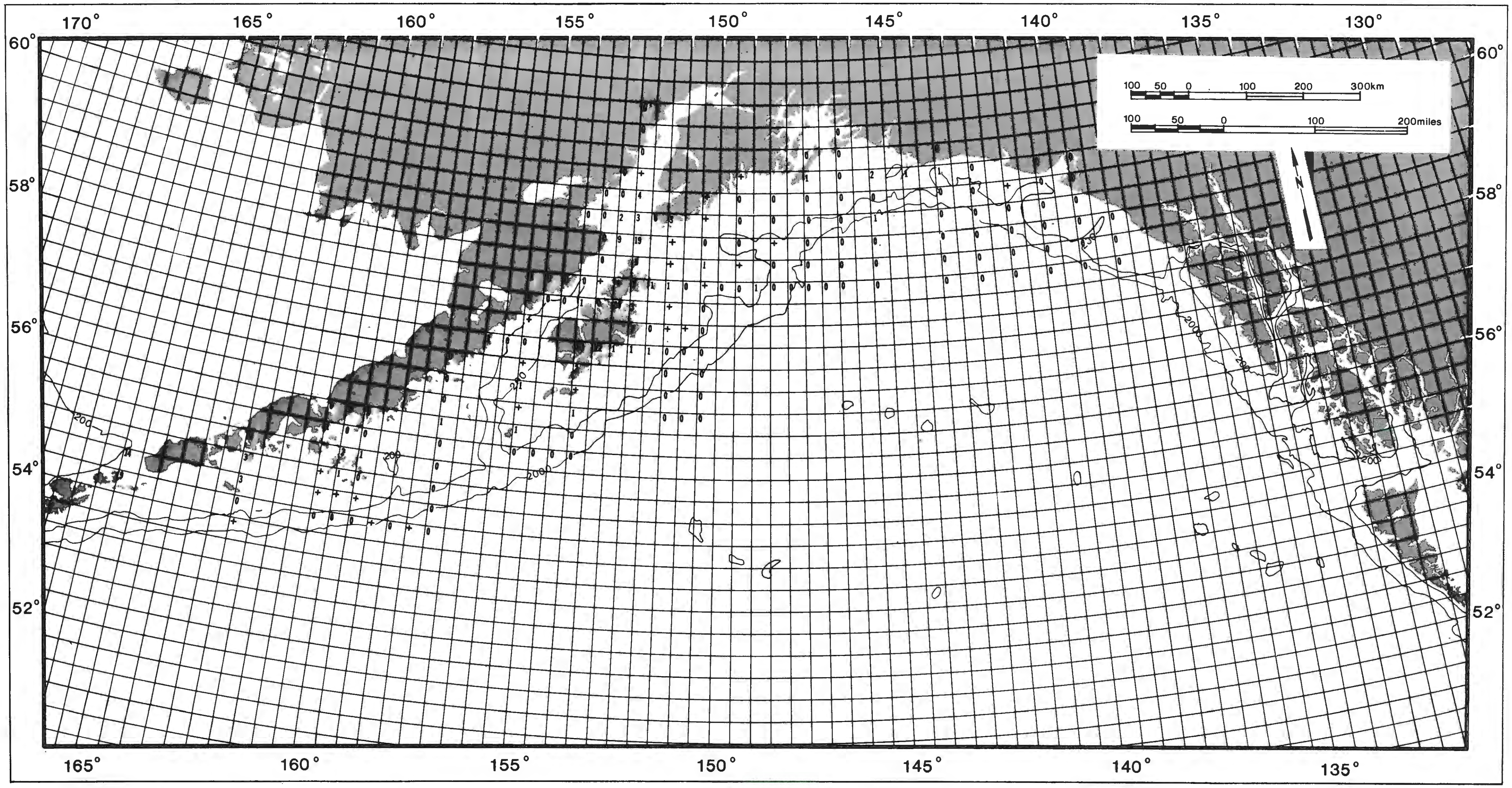

Map 93. Density indices of Tufted Puffin obtained from shipboard surveys of the Gulf of Alaska in spring.



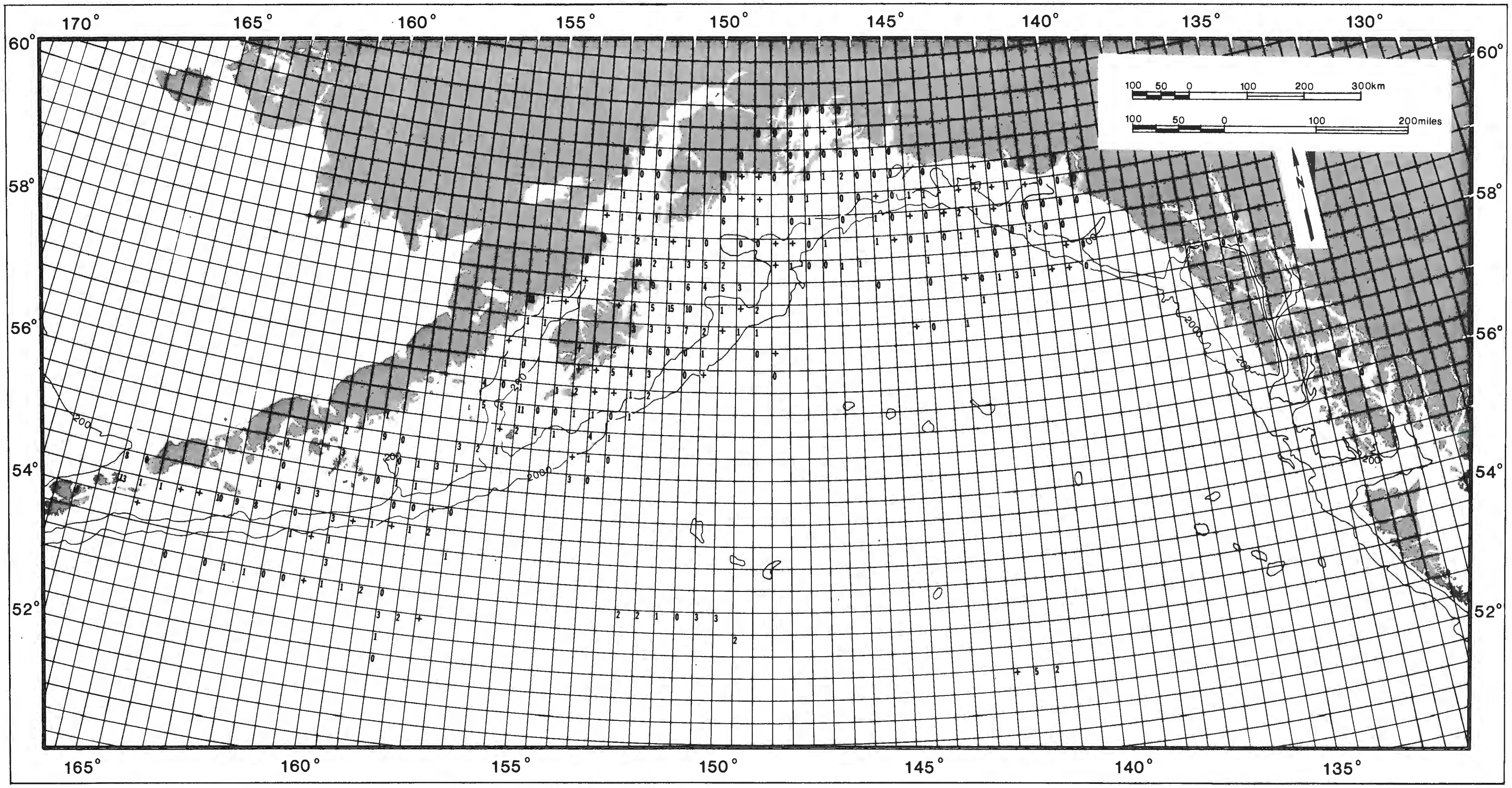

Map 94. Density indices of Tufted Puffin obtained from aerial surveys of the Gulf of Alaska in spring.



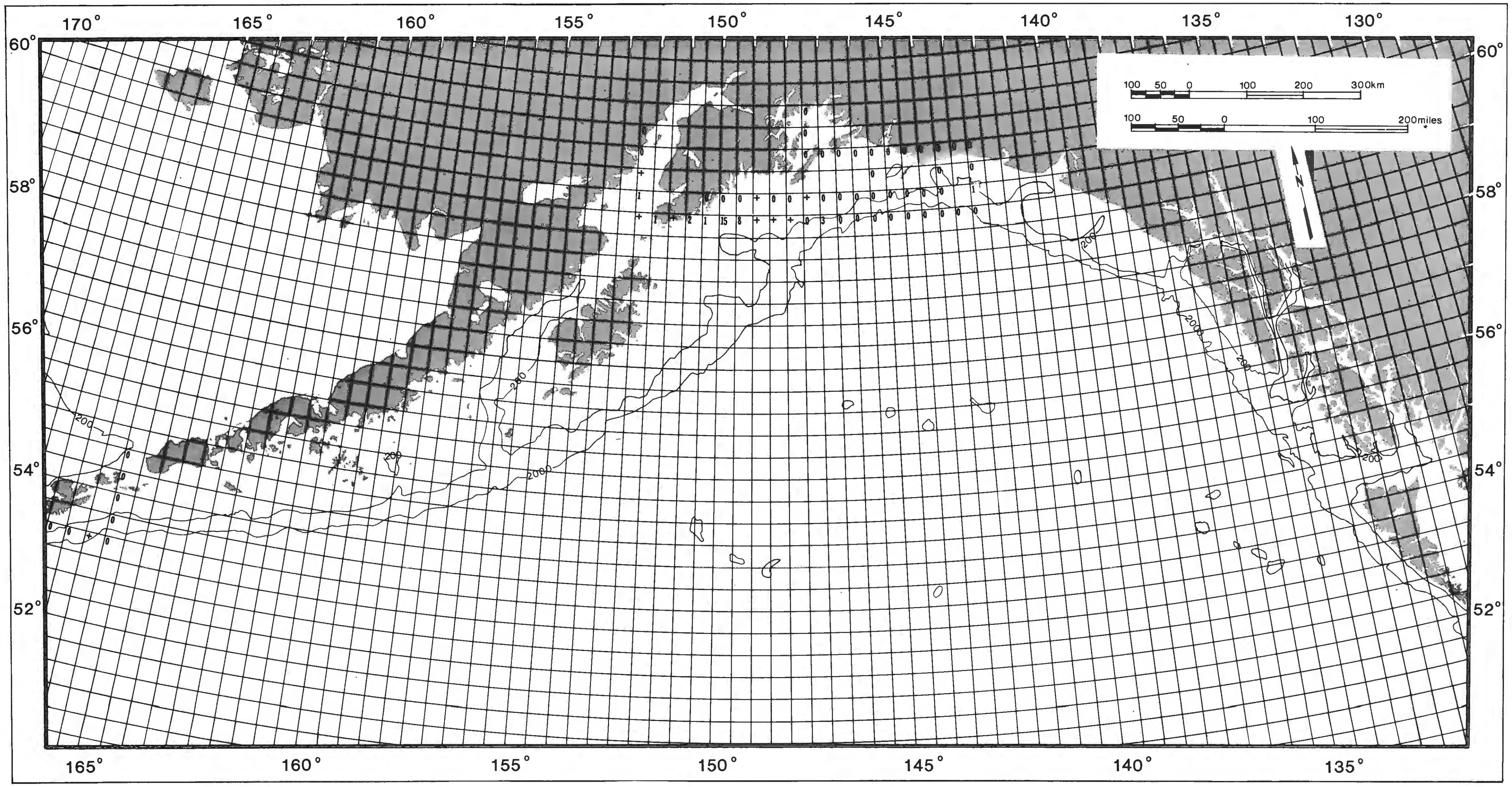

Map 95. Density indices of Tufted Puffin obtained from shipboard surveys of the Gulf of Alaska in summer.



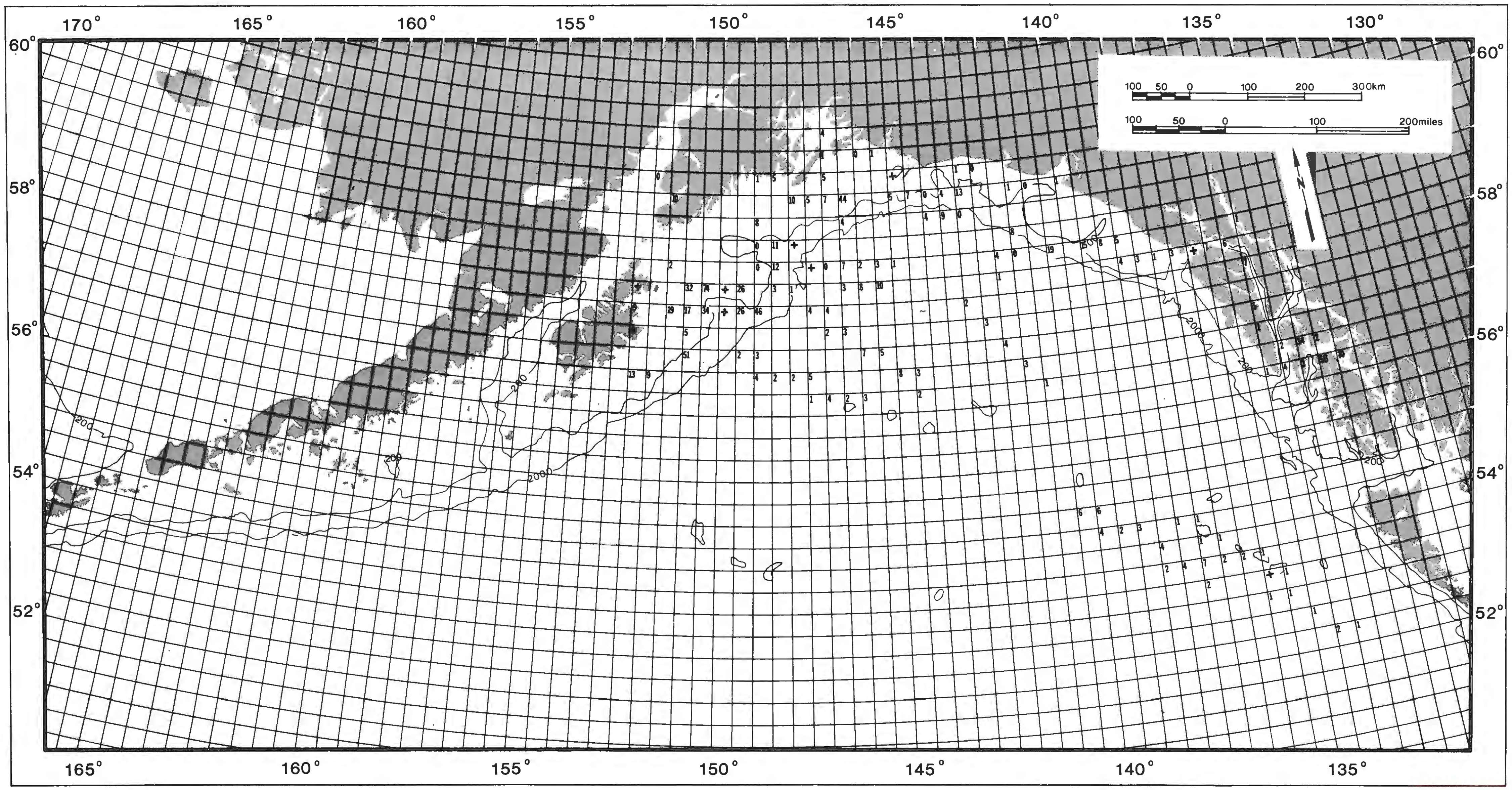

Map 96. Density indices of Tufted Puffin obtained from aerial surveys of the Gulf of Alaska in summer.



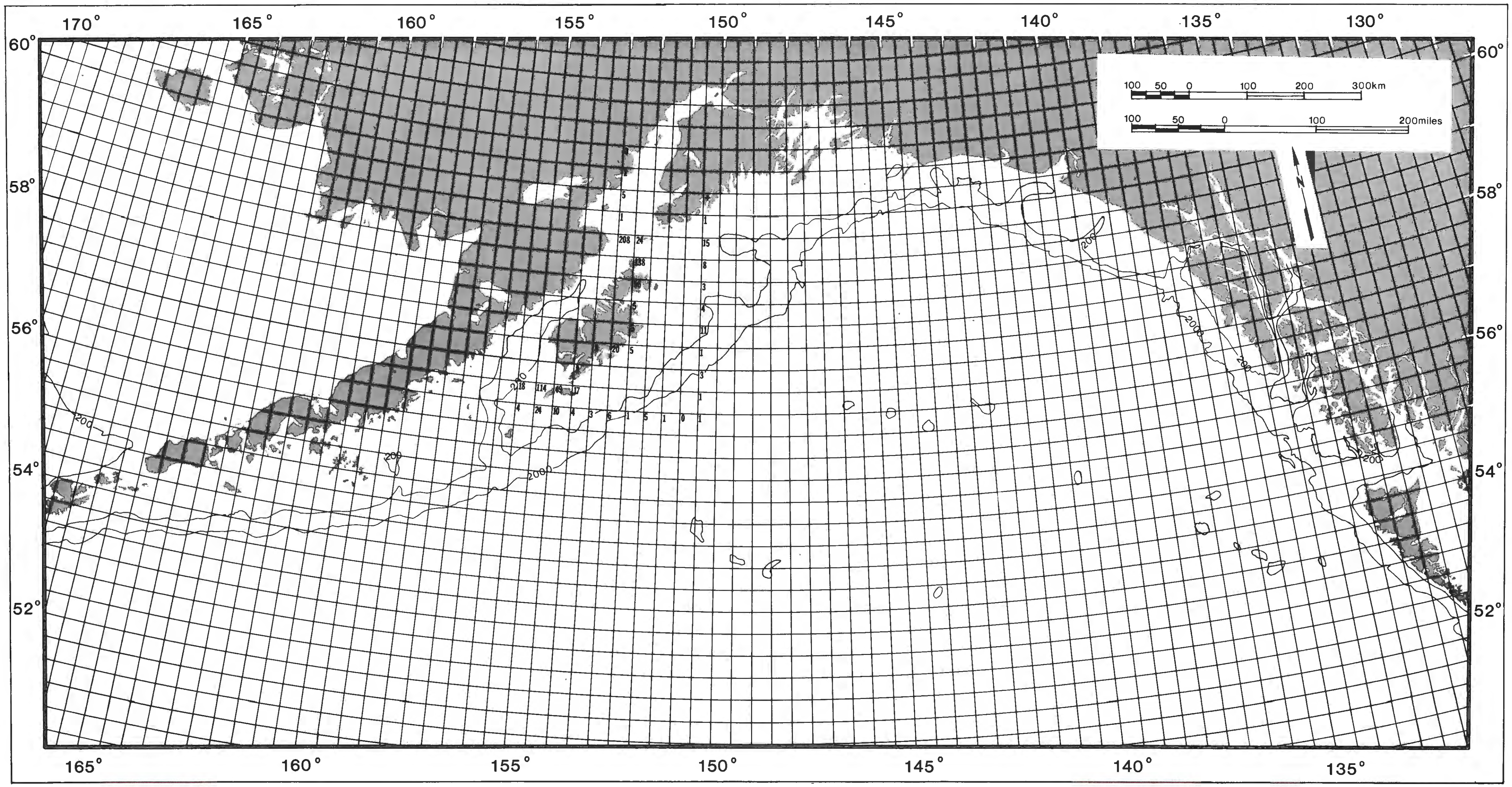

Map 97. Density indices of Tufted Puffin obtained from shipboard surveys of the Gulf of Alaska in fall.



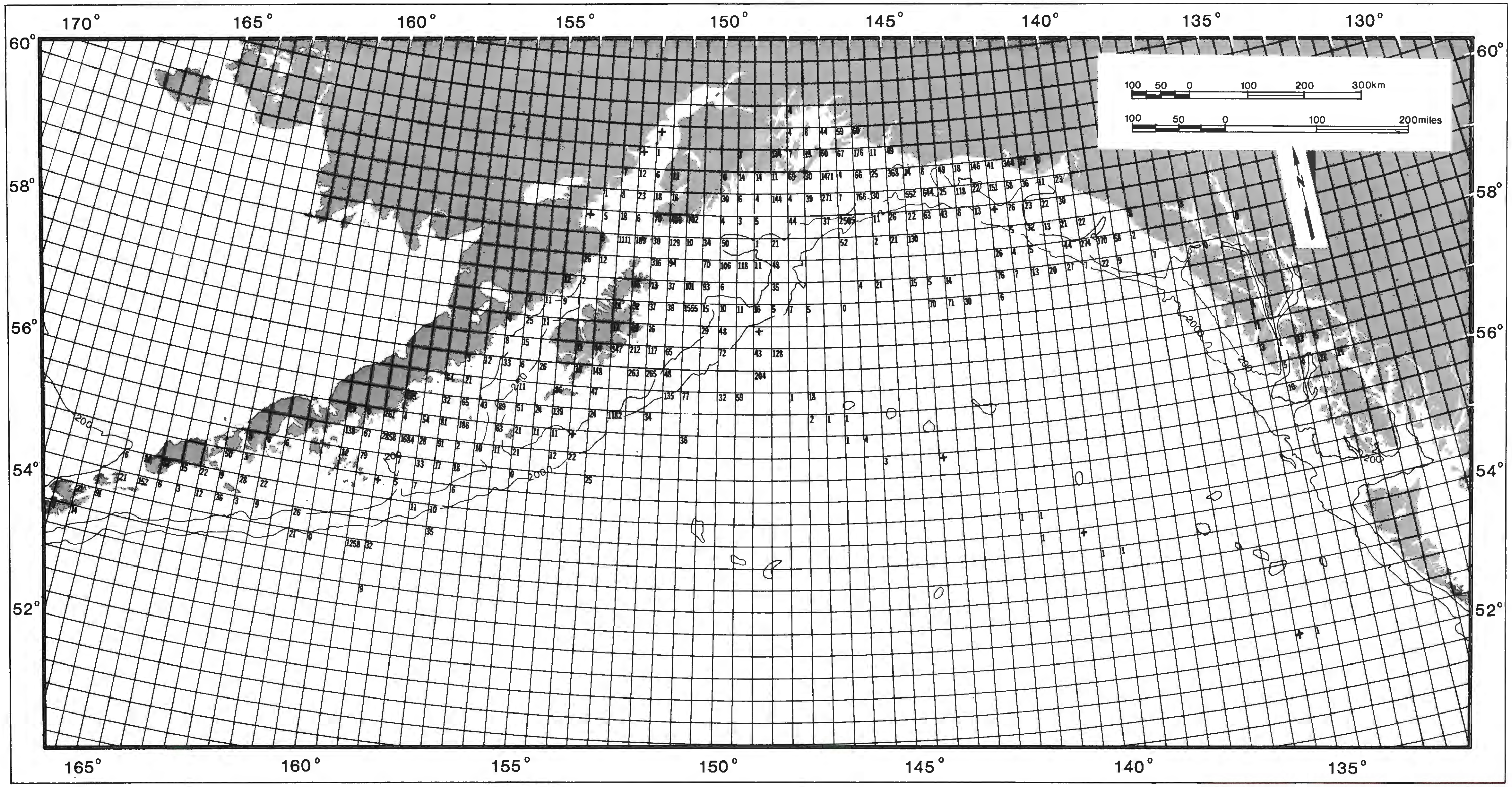

Map 98. Density indices of Tufted Puffin obtained from aerial surveys of the Gulf of Alaska in fall.



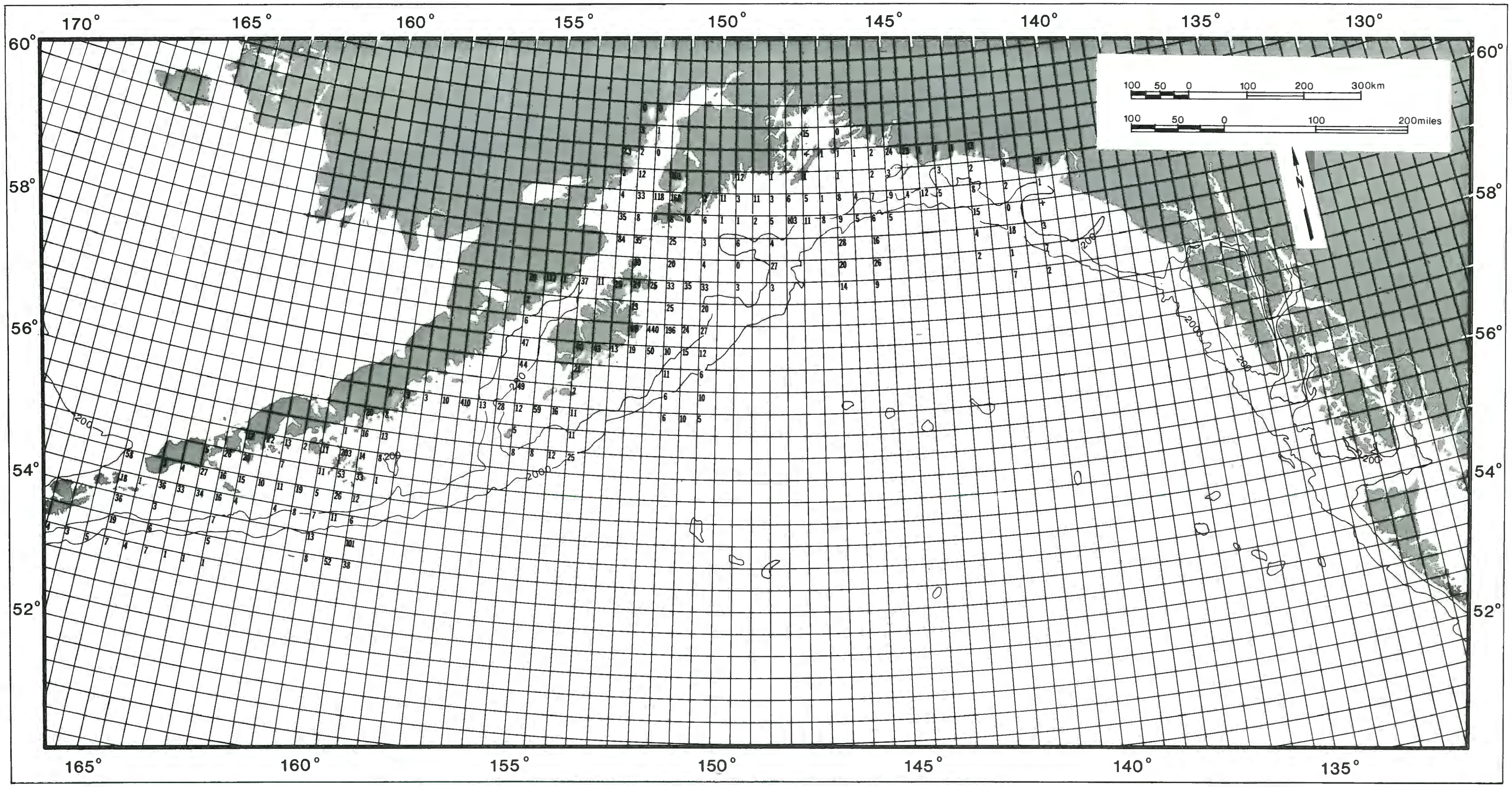

Map 99. Density indices of total birds obtained from shipboard surveys of the Gulf of Alaska in winter.



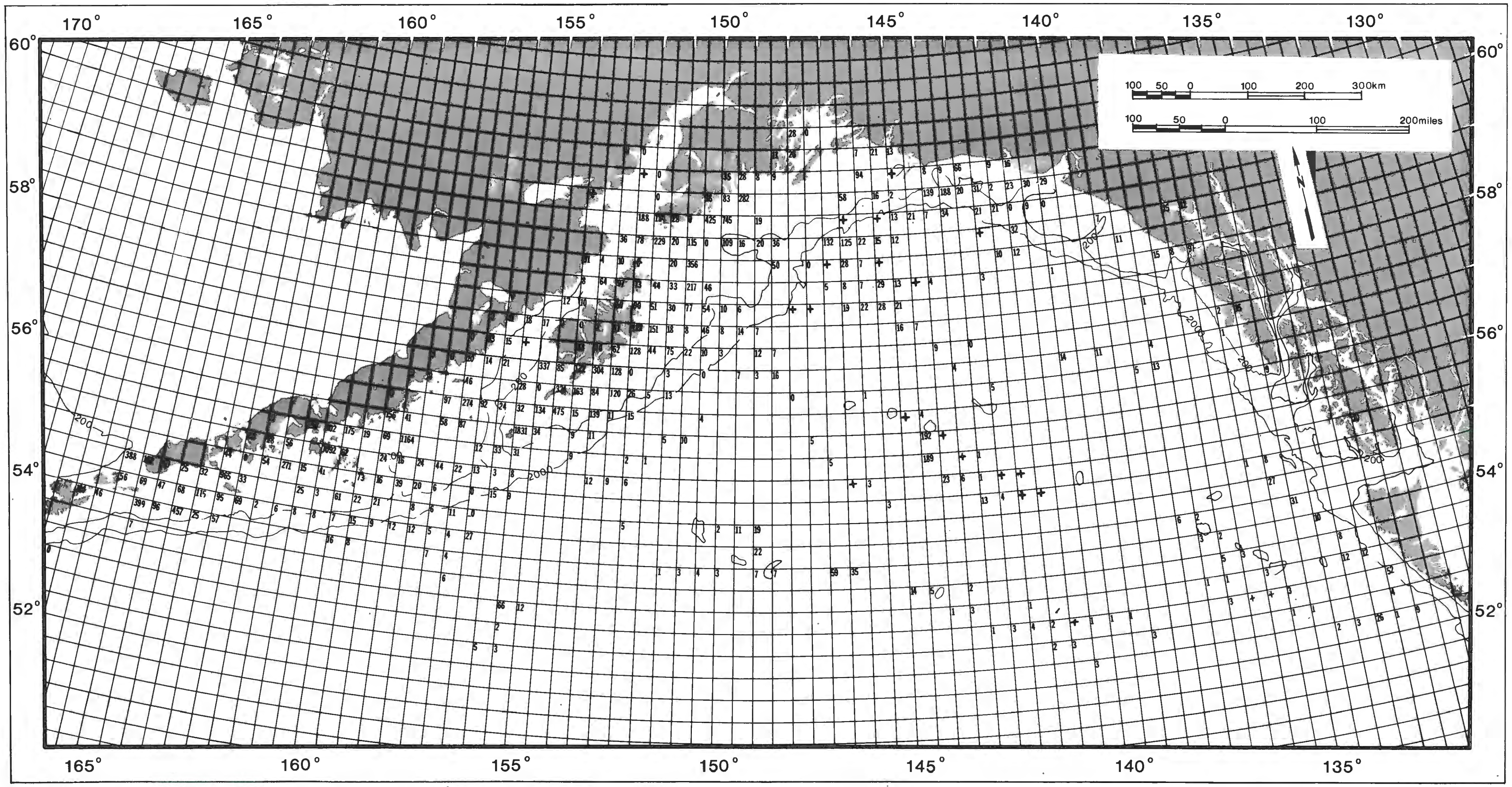

Map 100. Density indices of total birds obtained from aerial surveys of the Gulf of Alaska in winter.



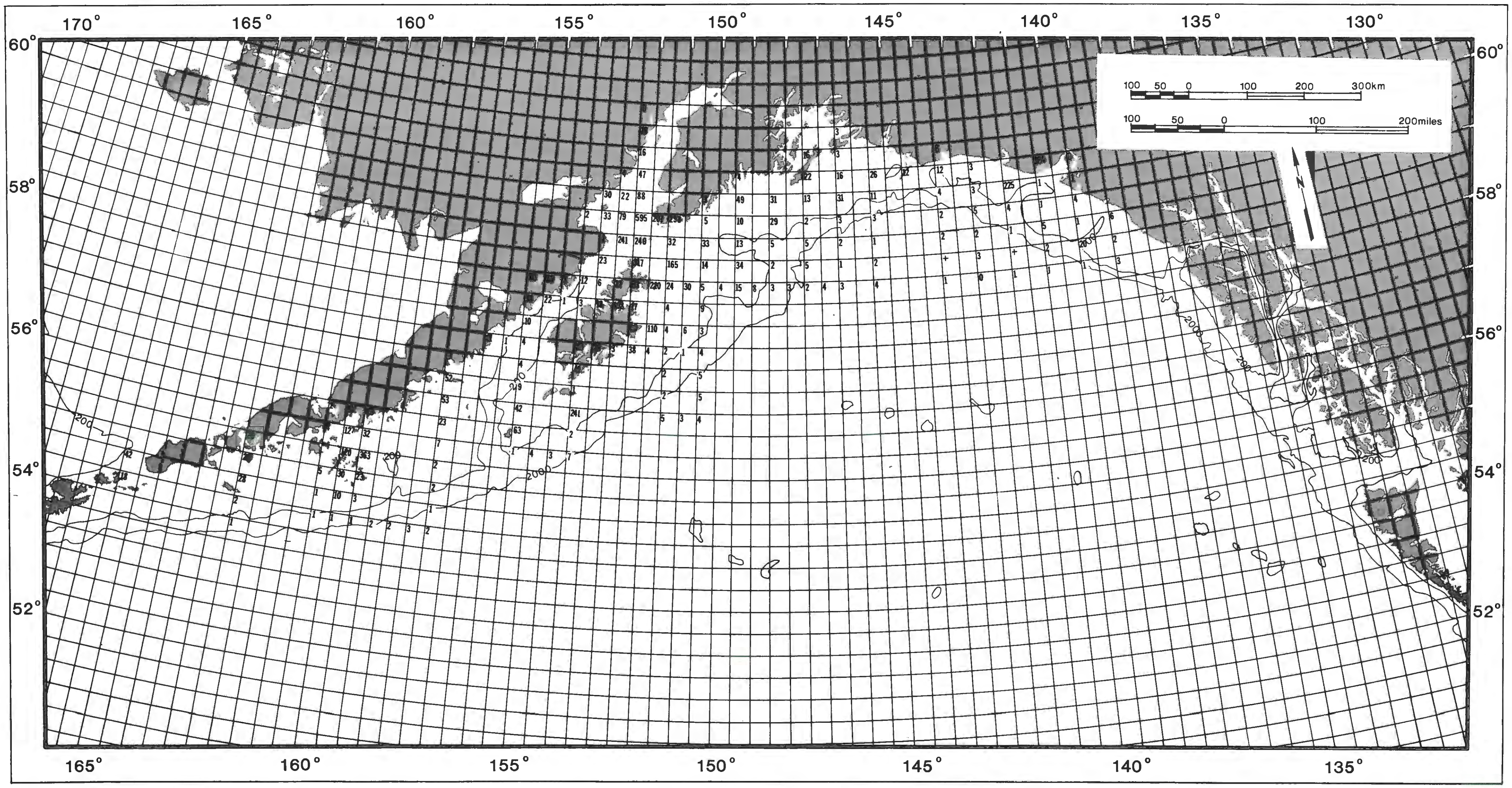

Map 101. Density indices of total birds obtained from shipboard surveys of the Gulf of Alaska in spring.



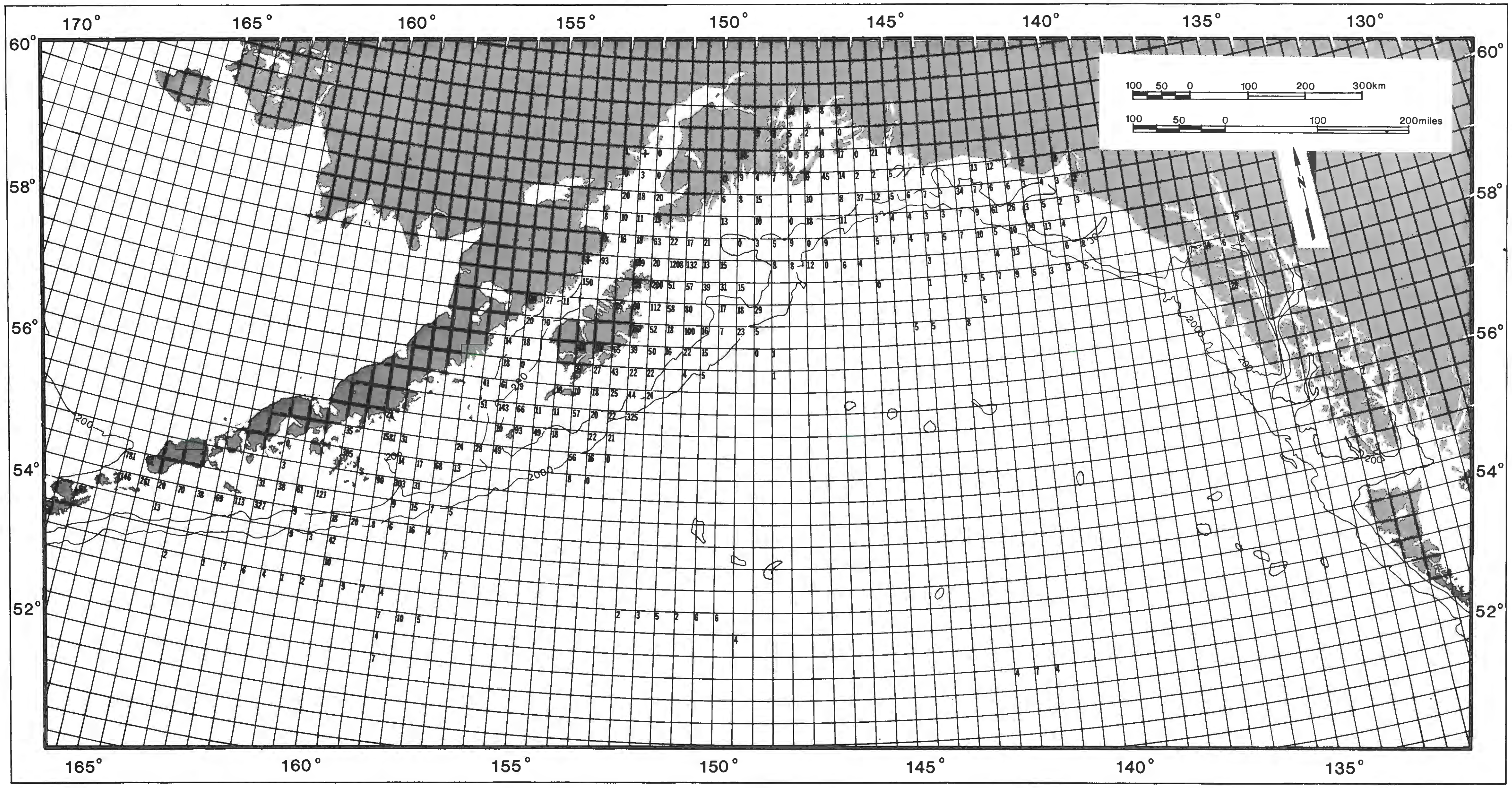

Map 102. Density indices of total birds obtained from aerial surveys of the Gulf of Alaska in spring.



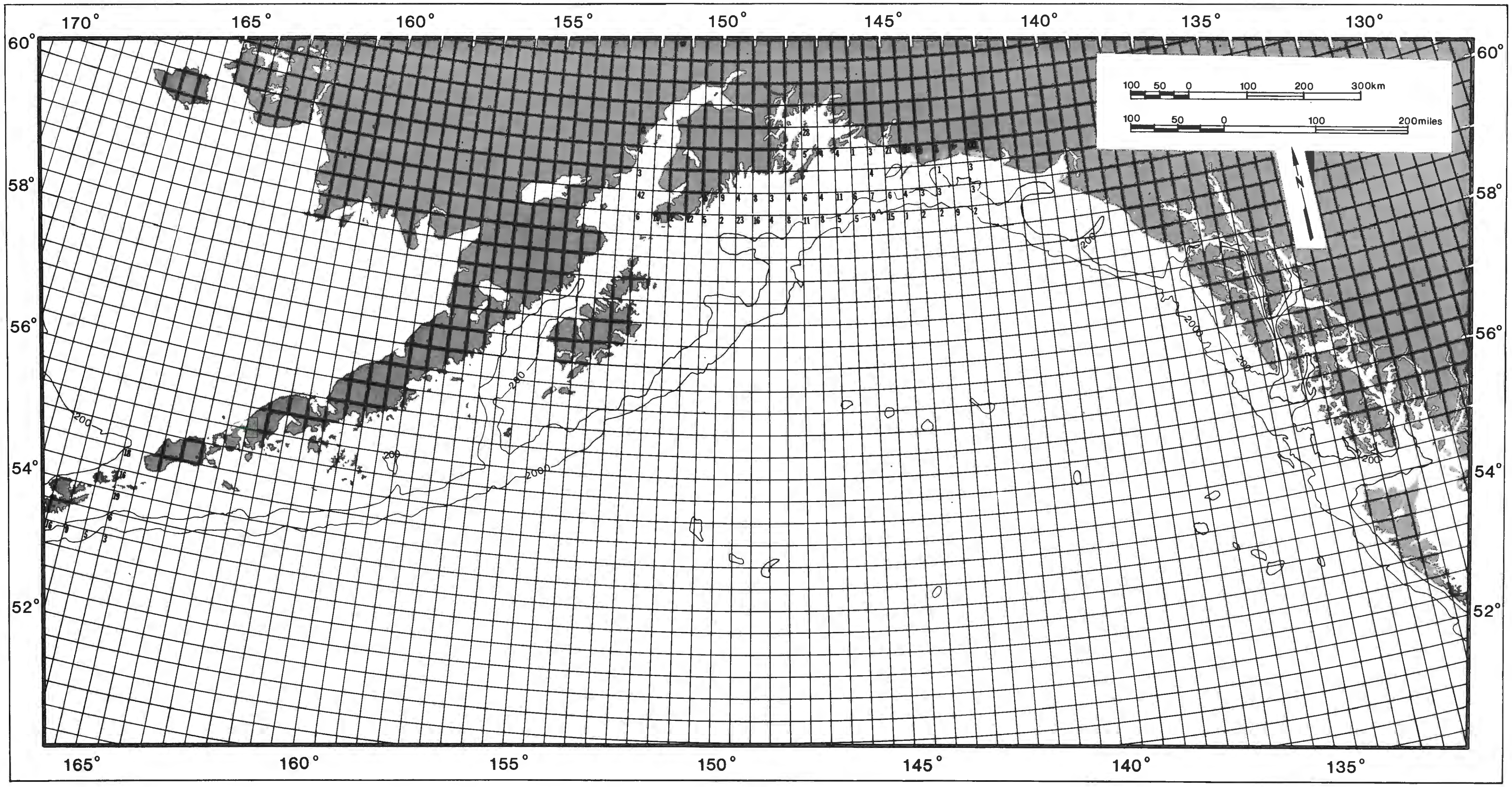

Map 103. Density indices of total birds obtained from shipboard surveys of the Gulf of Alaska in summer.



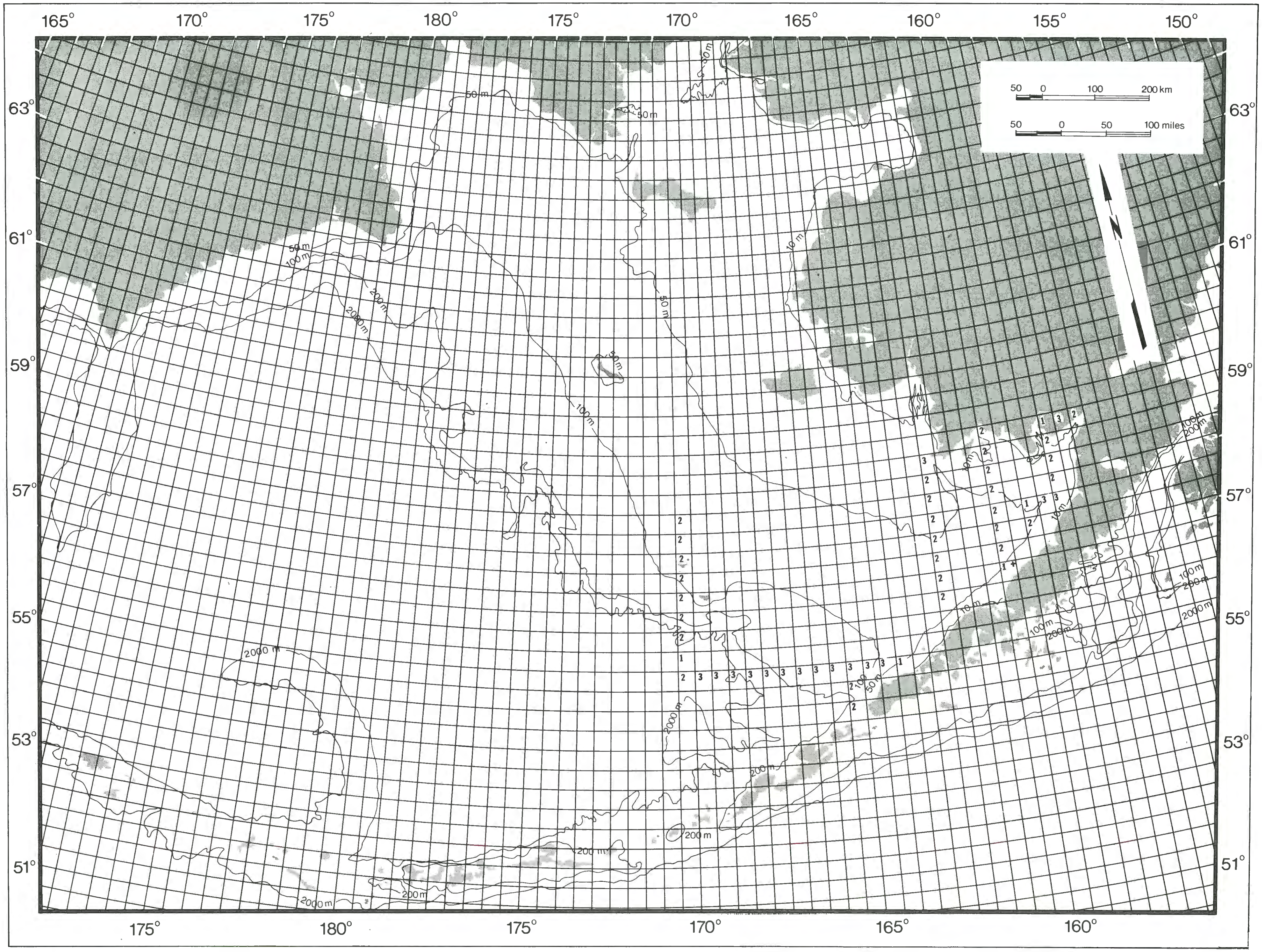

Map 104. Density indices of total birds obtained from aerial surveys of the Gulf of Alaska in summer.



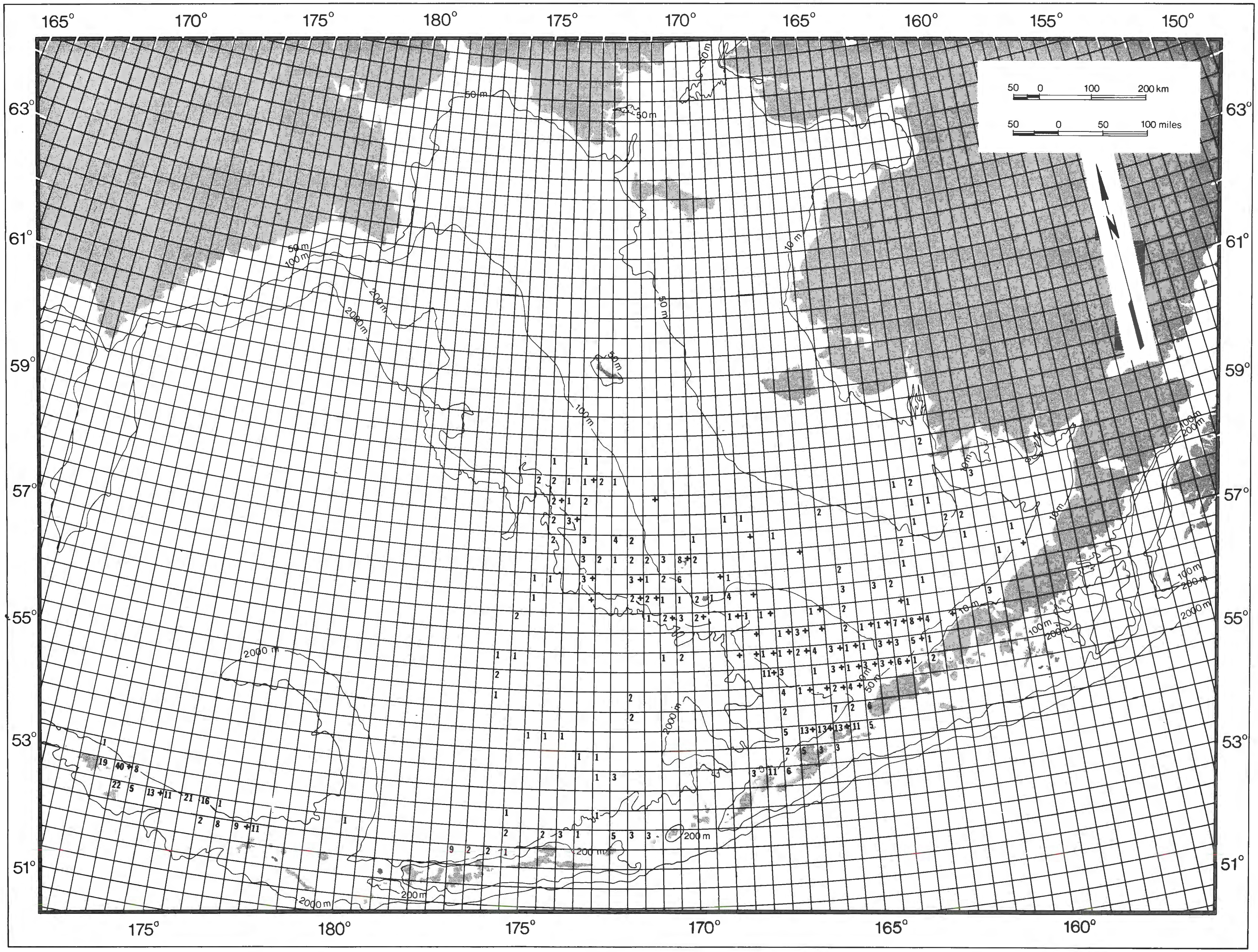

Map 105. Density indices of total birds obtained from shipboard surveys of the Gulf of Alaska in fall.



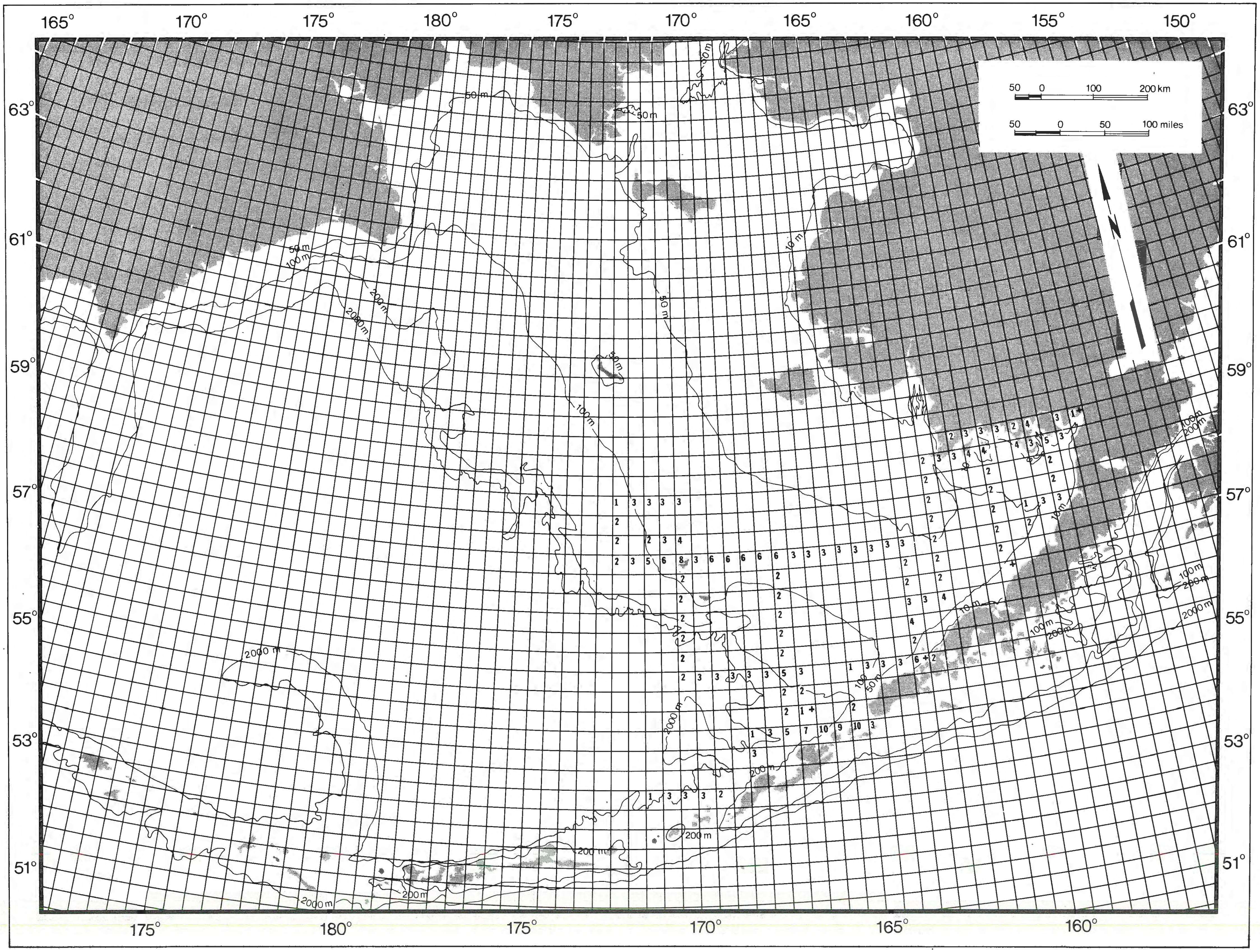

Map 106. Density indices of total birds obtained from aerial surveys of the Gulf of Alaska in fall.



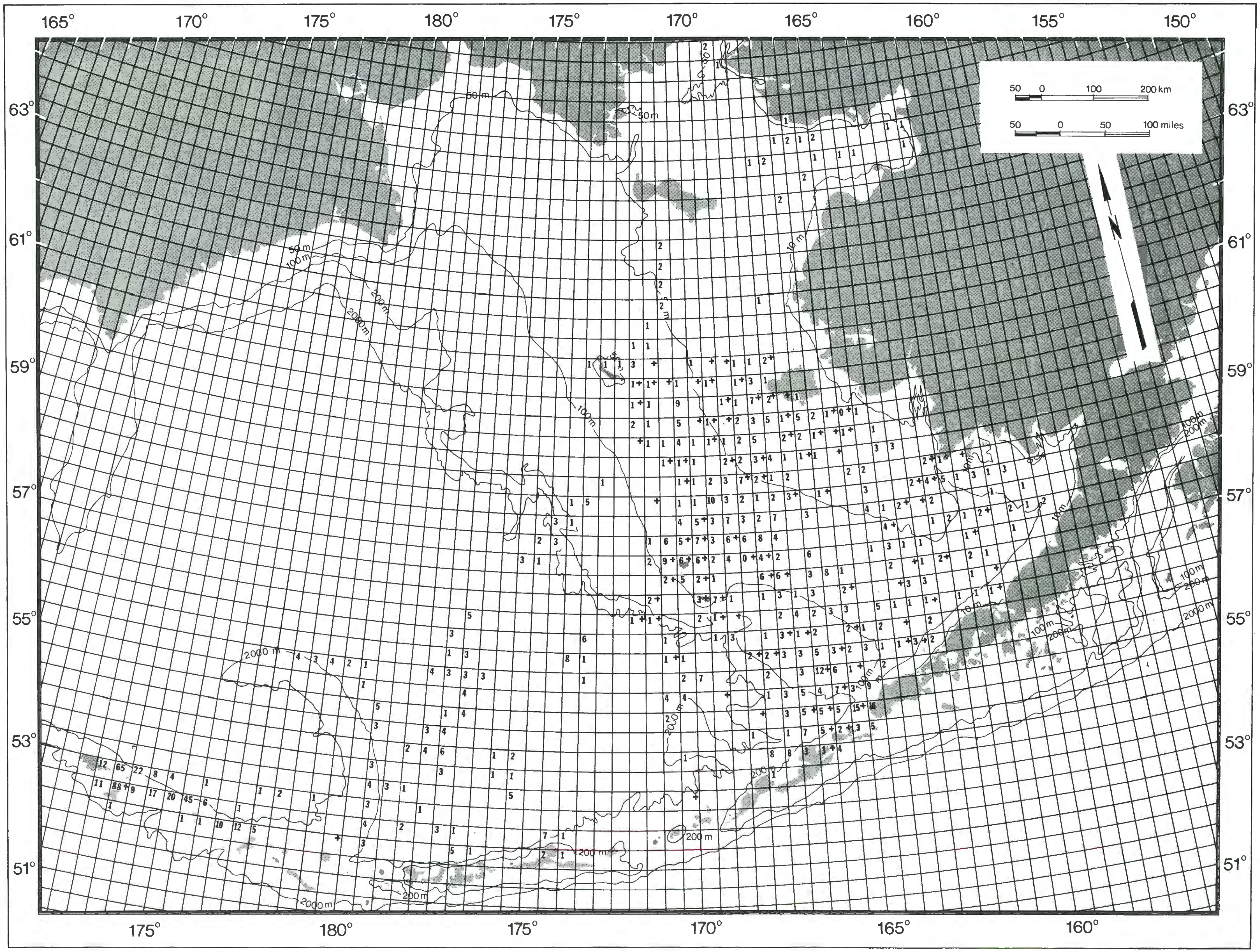

Map 107. Number of transects conducted in aerial surveys of the eastern Bering Sea in winter.



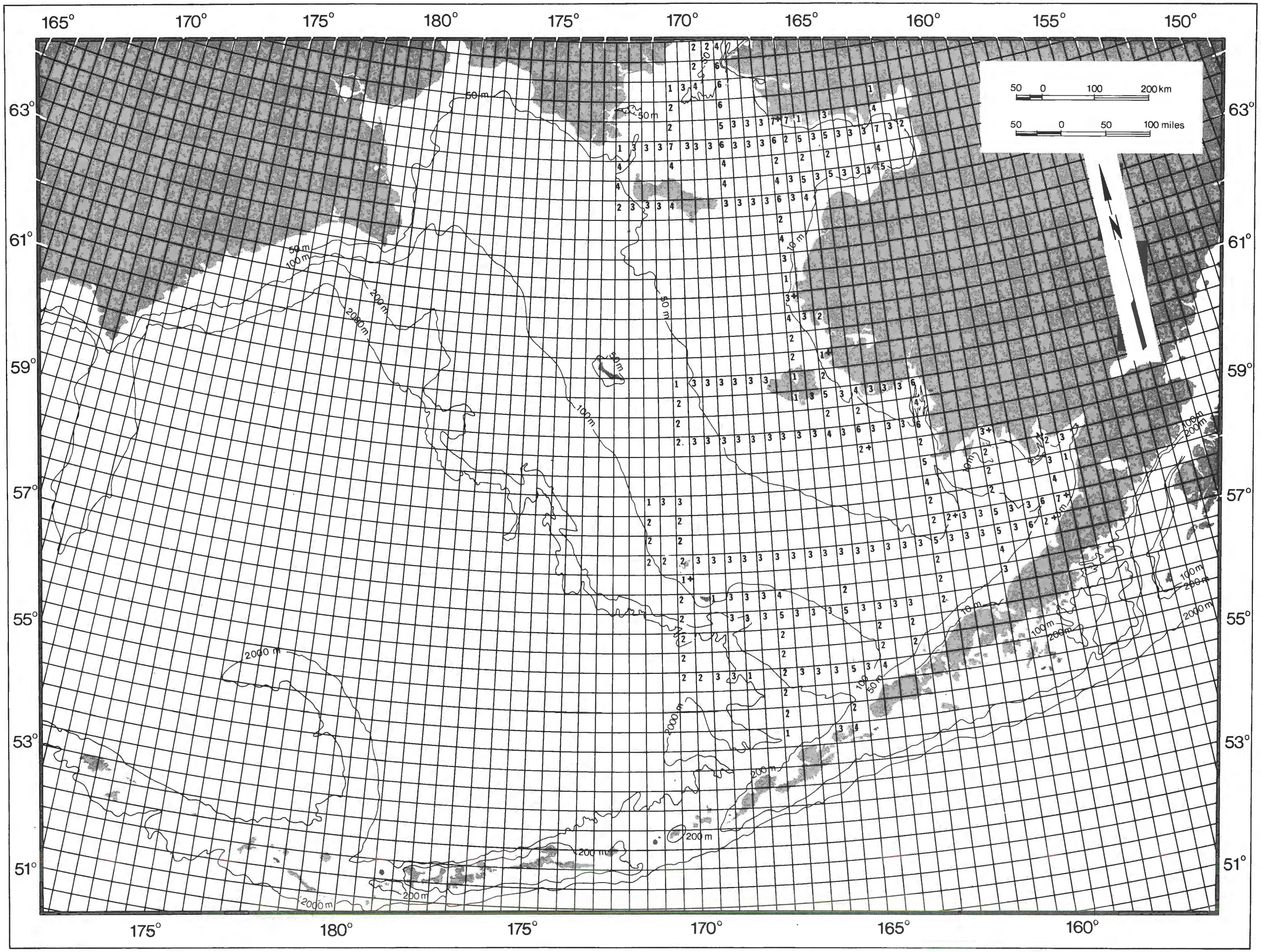

Map 108. Number of transects conducted in shipboard surveys of the eastern Bering Sea in spring.



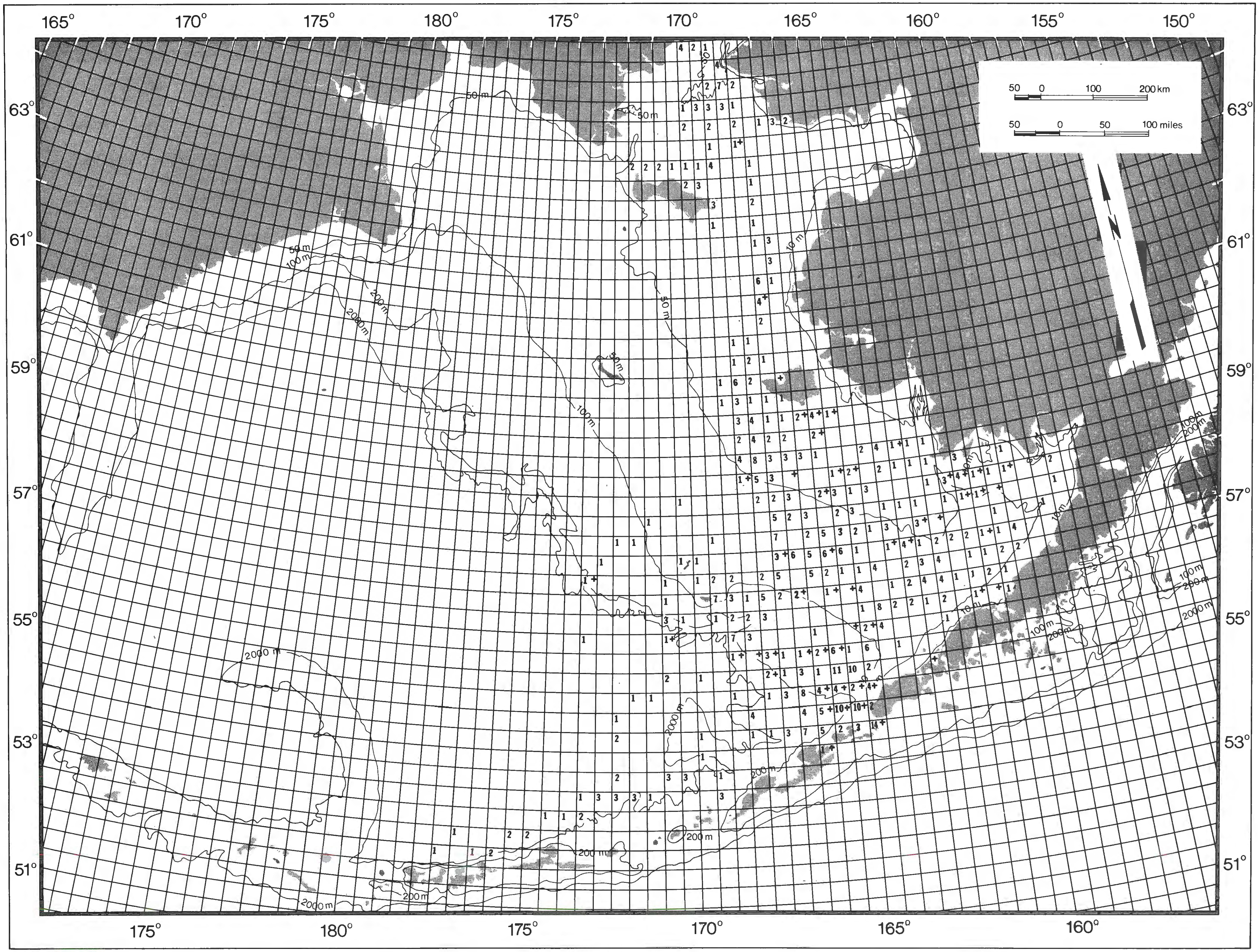

Map 109. Number of transects conducted in aerial surveys of the eastern Bering Sea in spring.



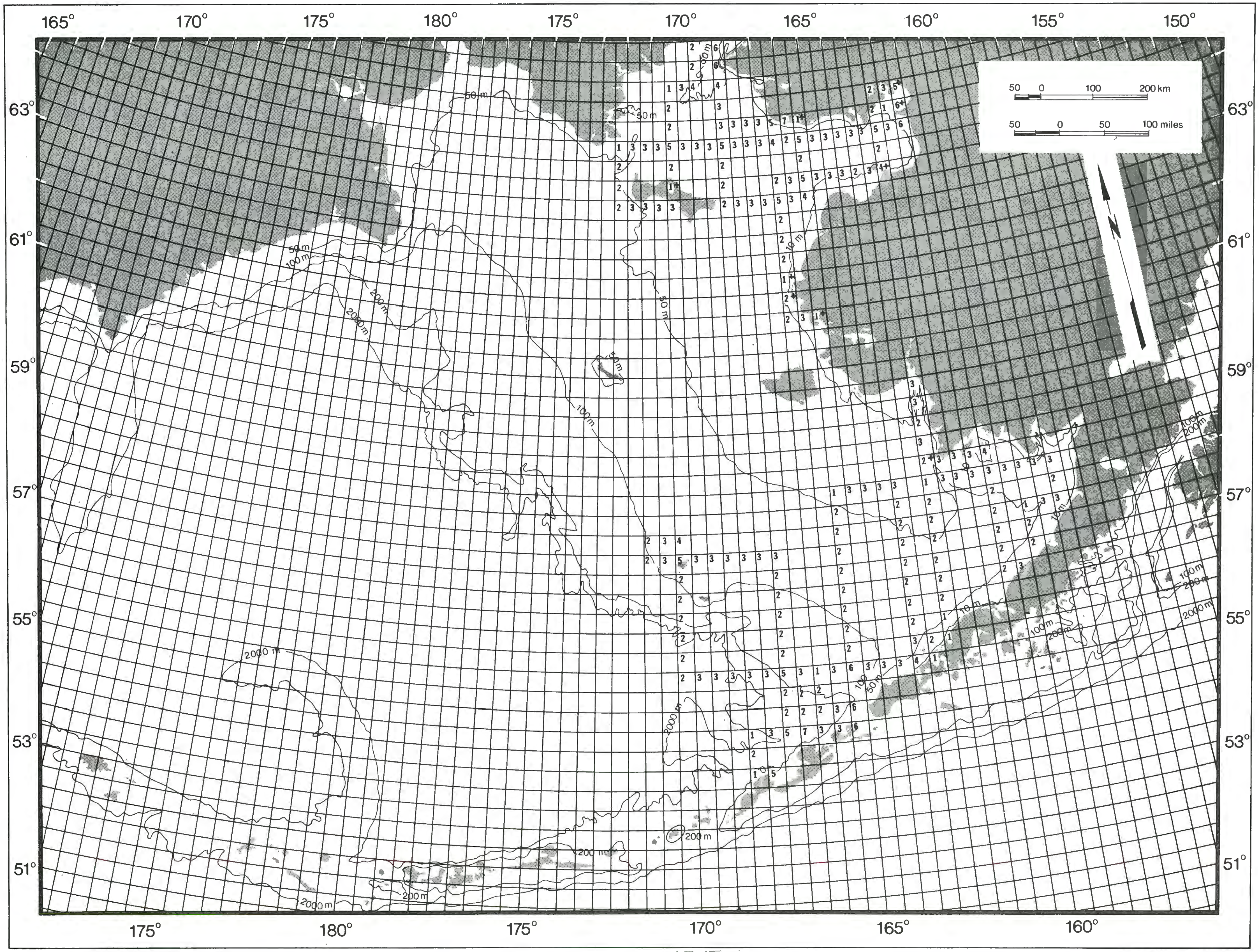

Map 110. Number of transects conducted in shipboard surveys of the eastern Bering Sea in summer.



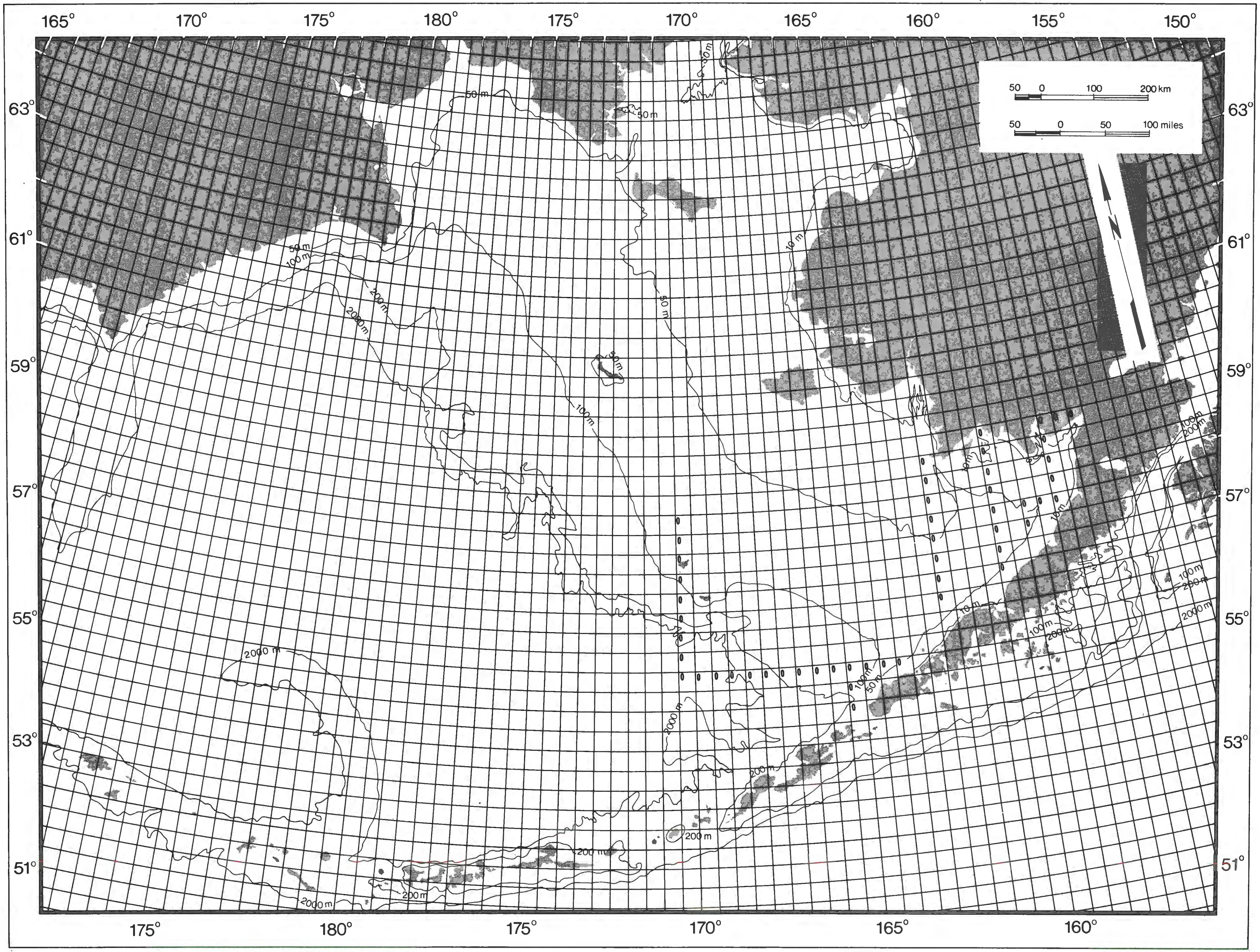

Map 111. Number of transects conducted in aerial surveys of the eastern Bering Sea in summer.



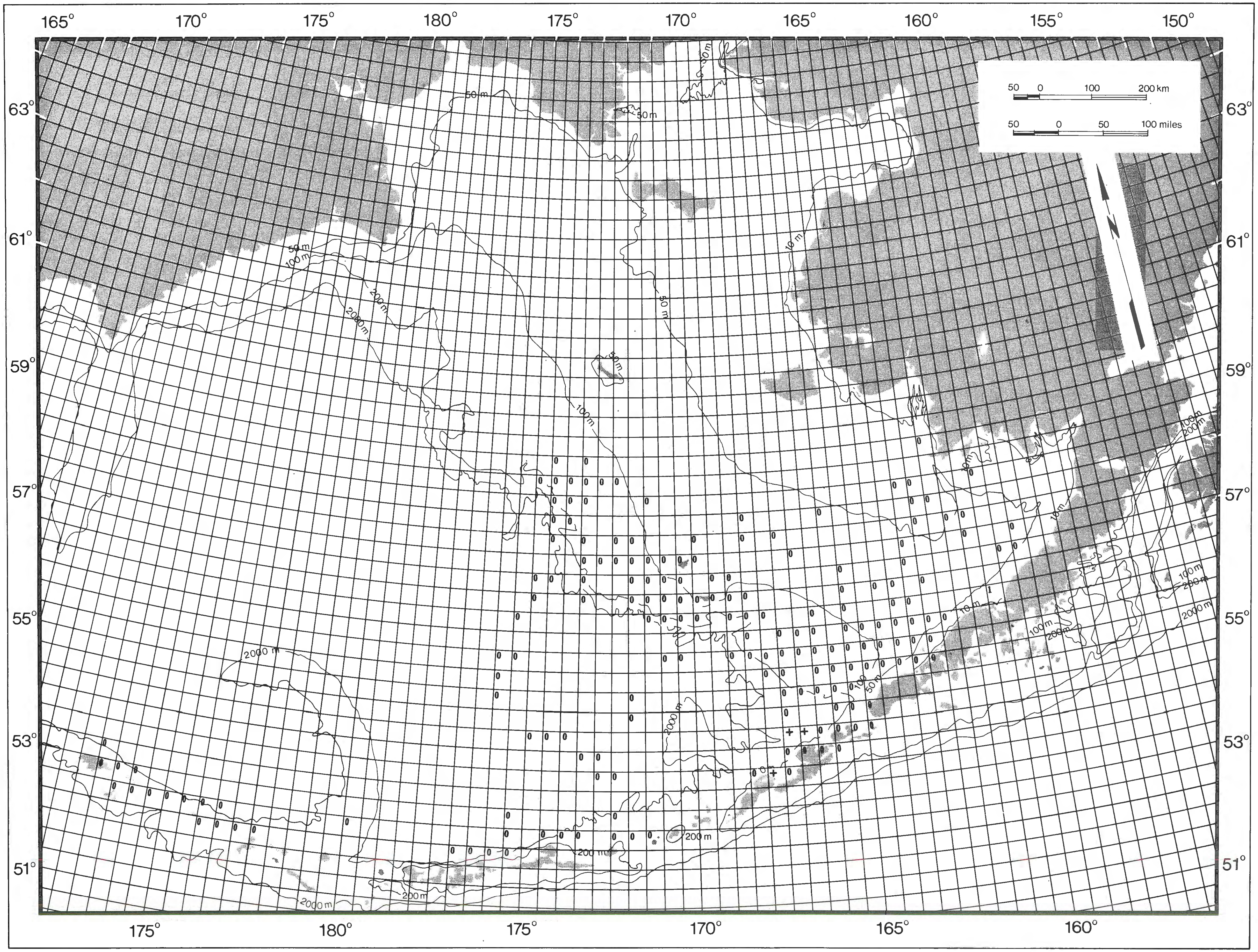

Map 112. Number of transects conducted in shipboard surveys of the eastern Bering Sea in fall.



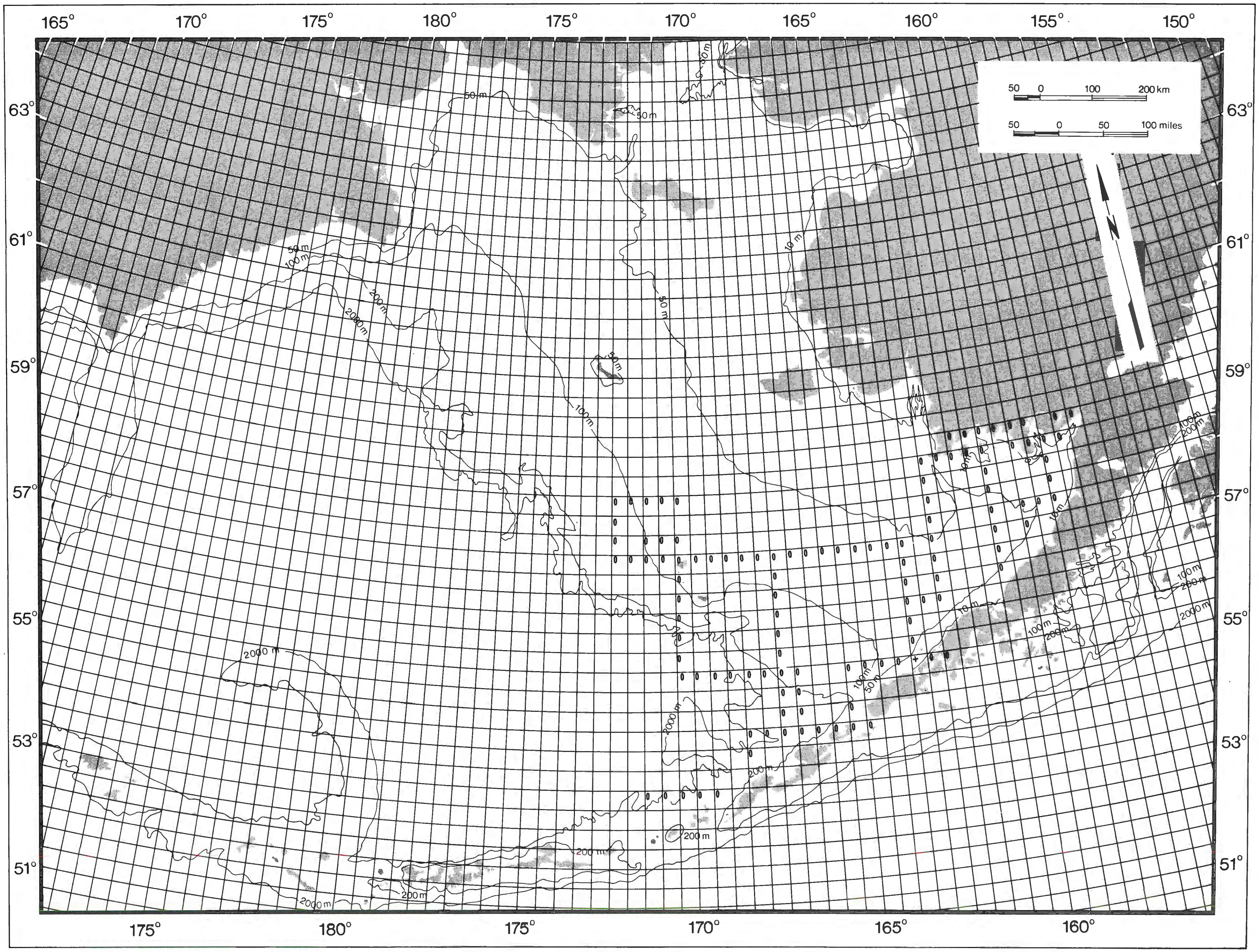

Map 113. Number of transects conducted in aerial surveys of the eastern Bering Sea in fall.



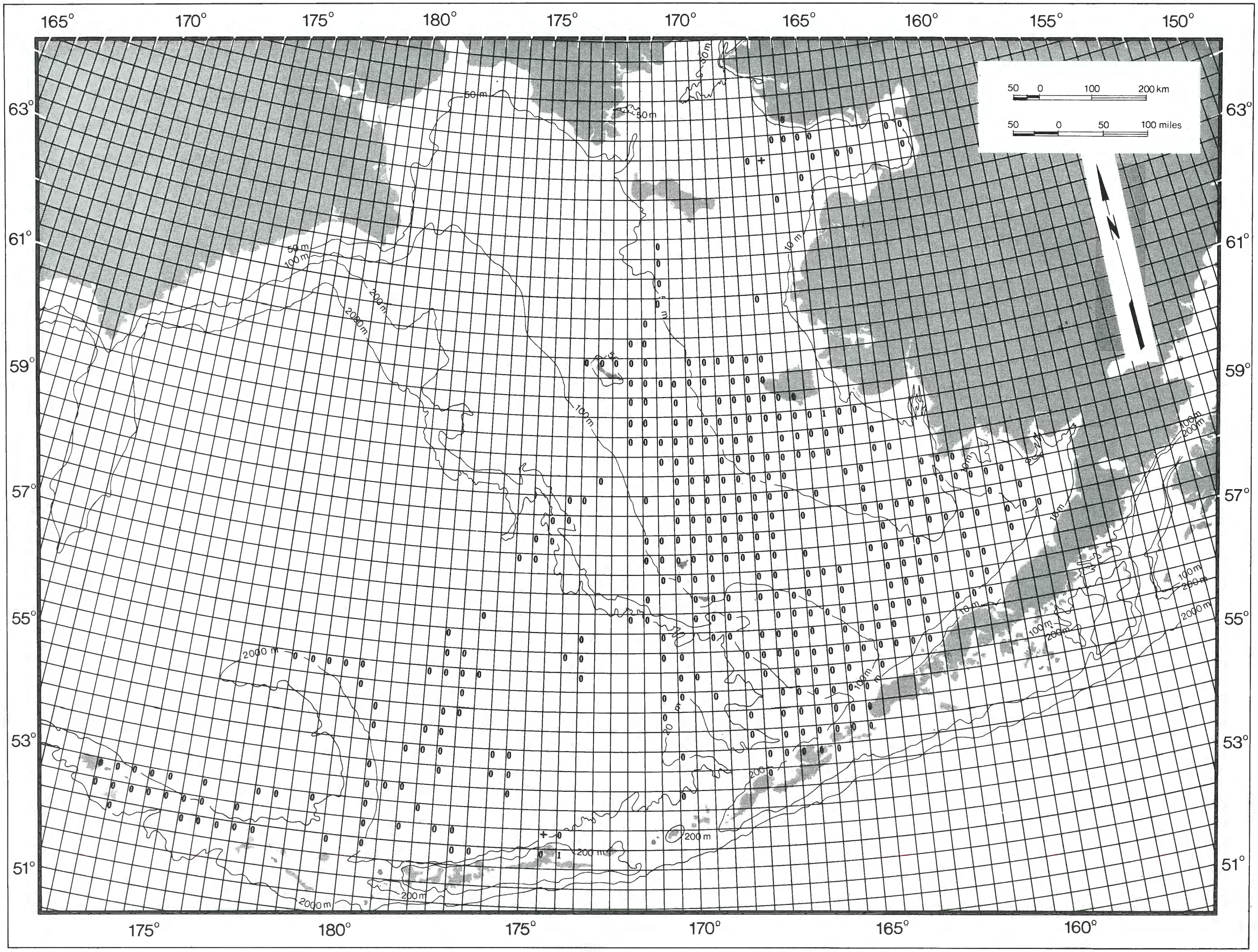

Map 114. Density indices of total loons obtained from aerial surveys of the eastern Bering Sea in winter.



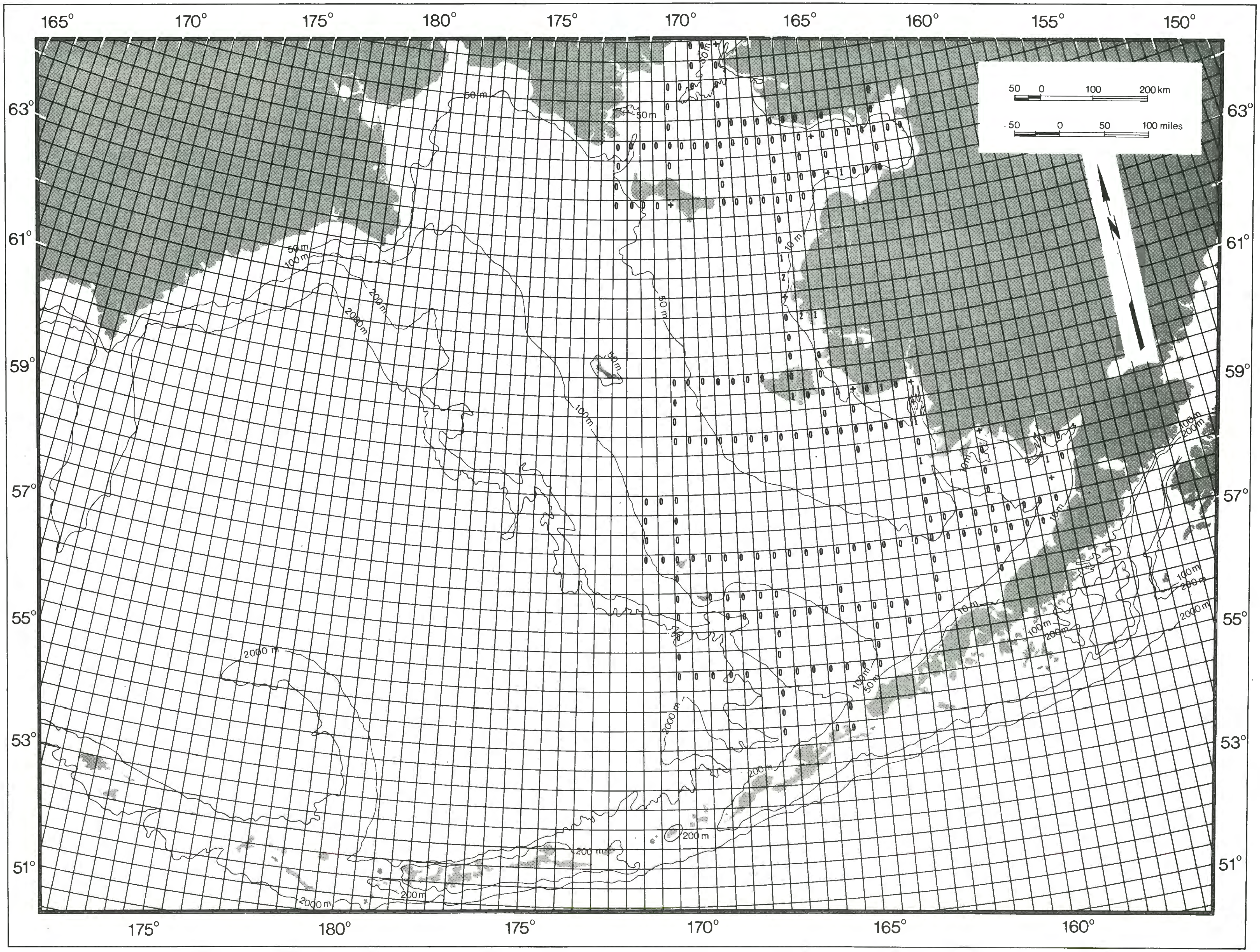

Map 115. Density indices of total loons obtained from shipboard surveys of the eastern Bering Sea in spring.



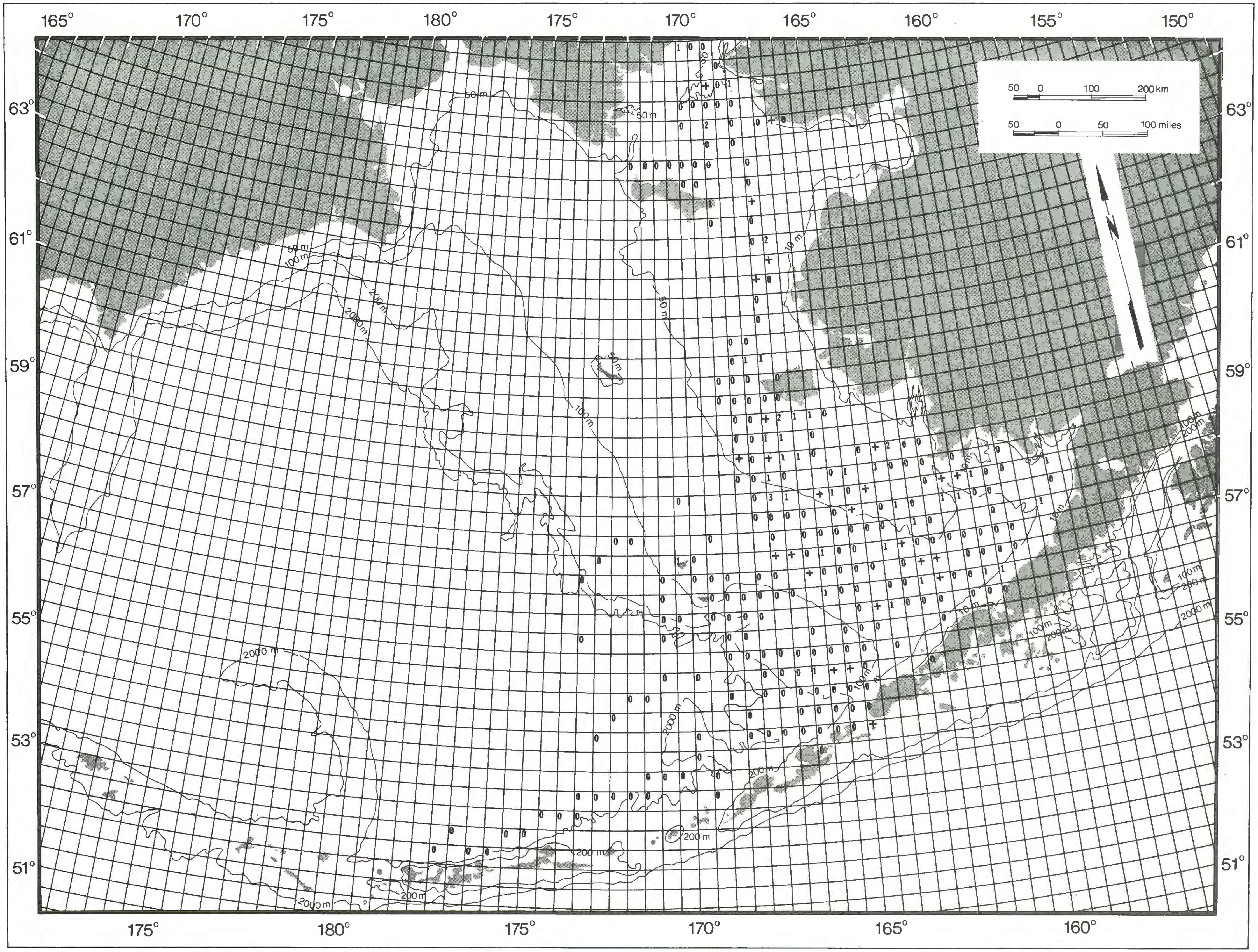

Map 116. Density indices of total loons obtained from aerial surveys of the eastern Bering Sea in spring.



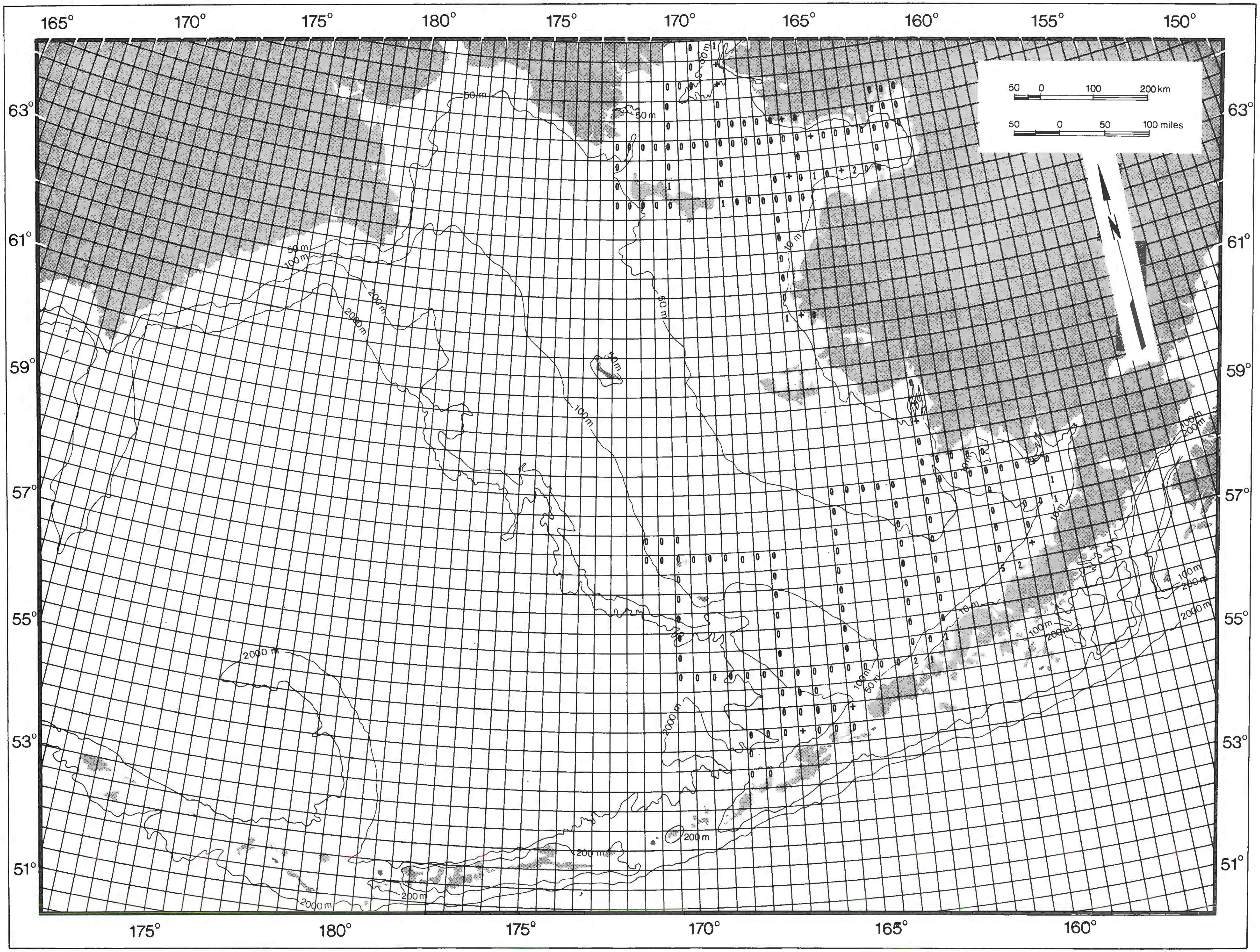

Map 117. Density indices of total loons obtained from shipboard surveys of the eastern Bering Sea in summer.



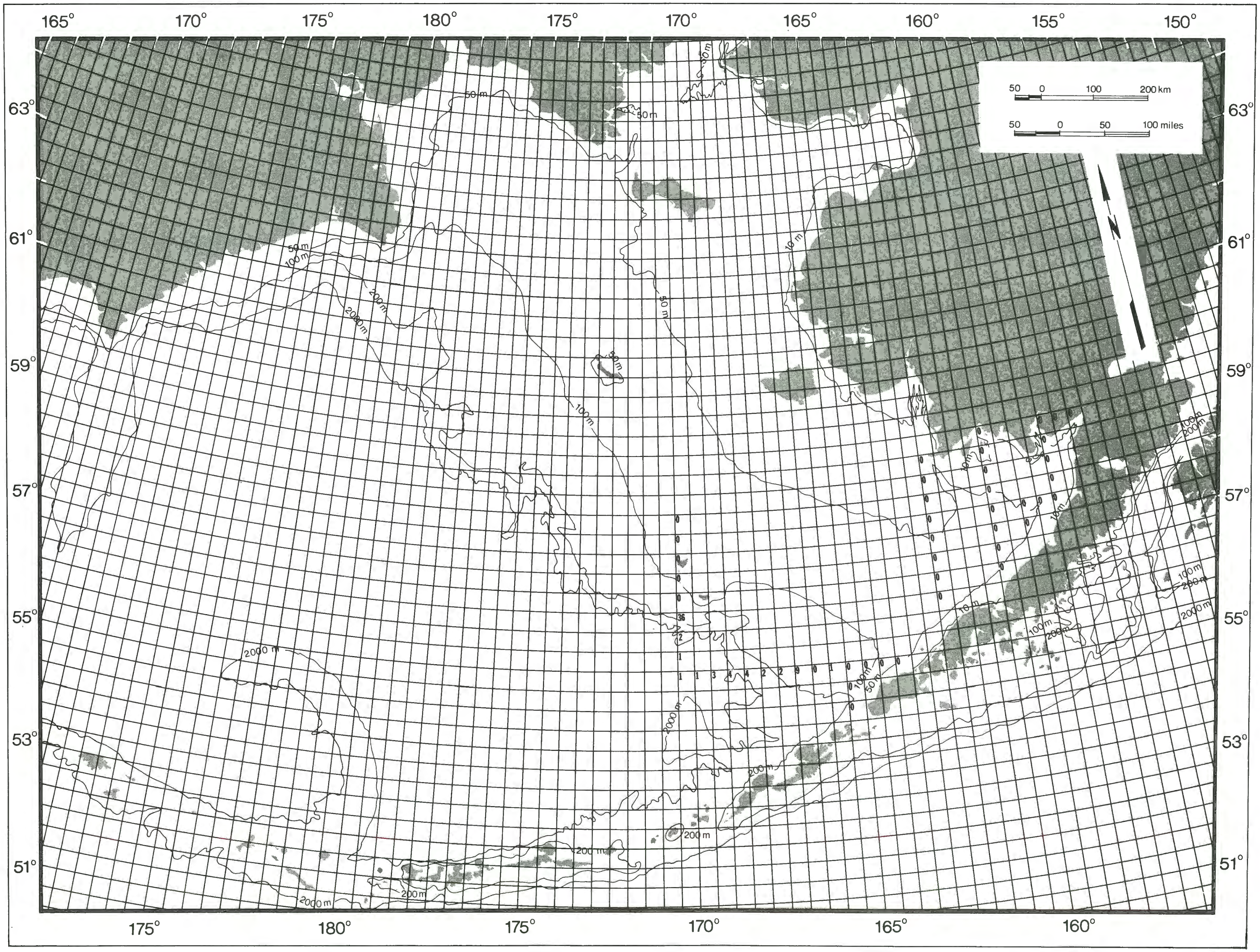

Map 118. Density indices of total loons obtained from aerial surveys of the eastern Bering Sea in summer.



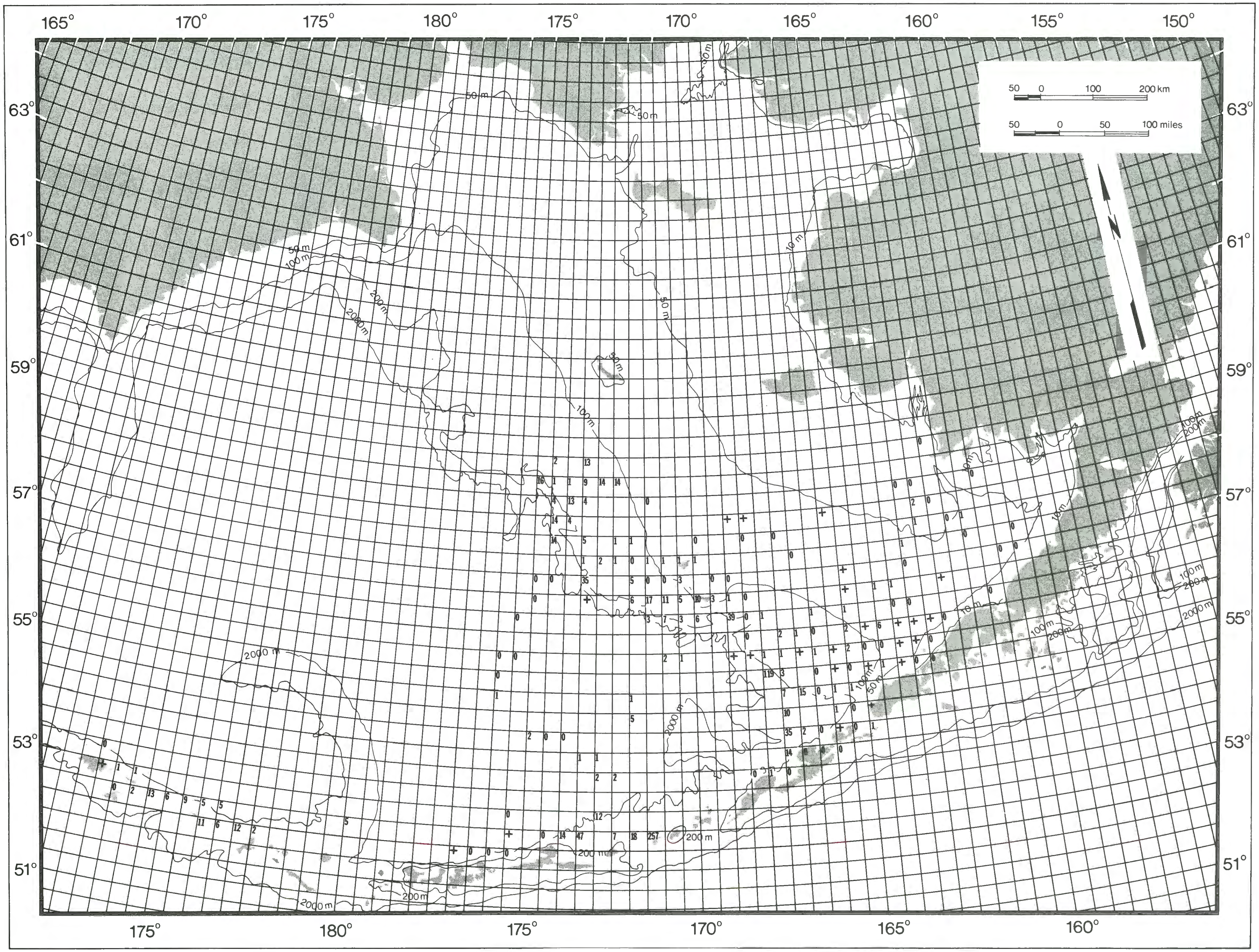

Map 119. Density indices of total loons obtained from shipboard surveys of the eastern Bering Sea in fall.



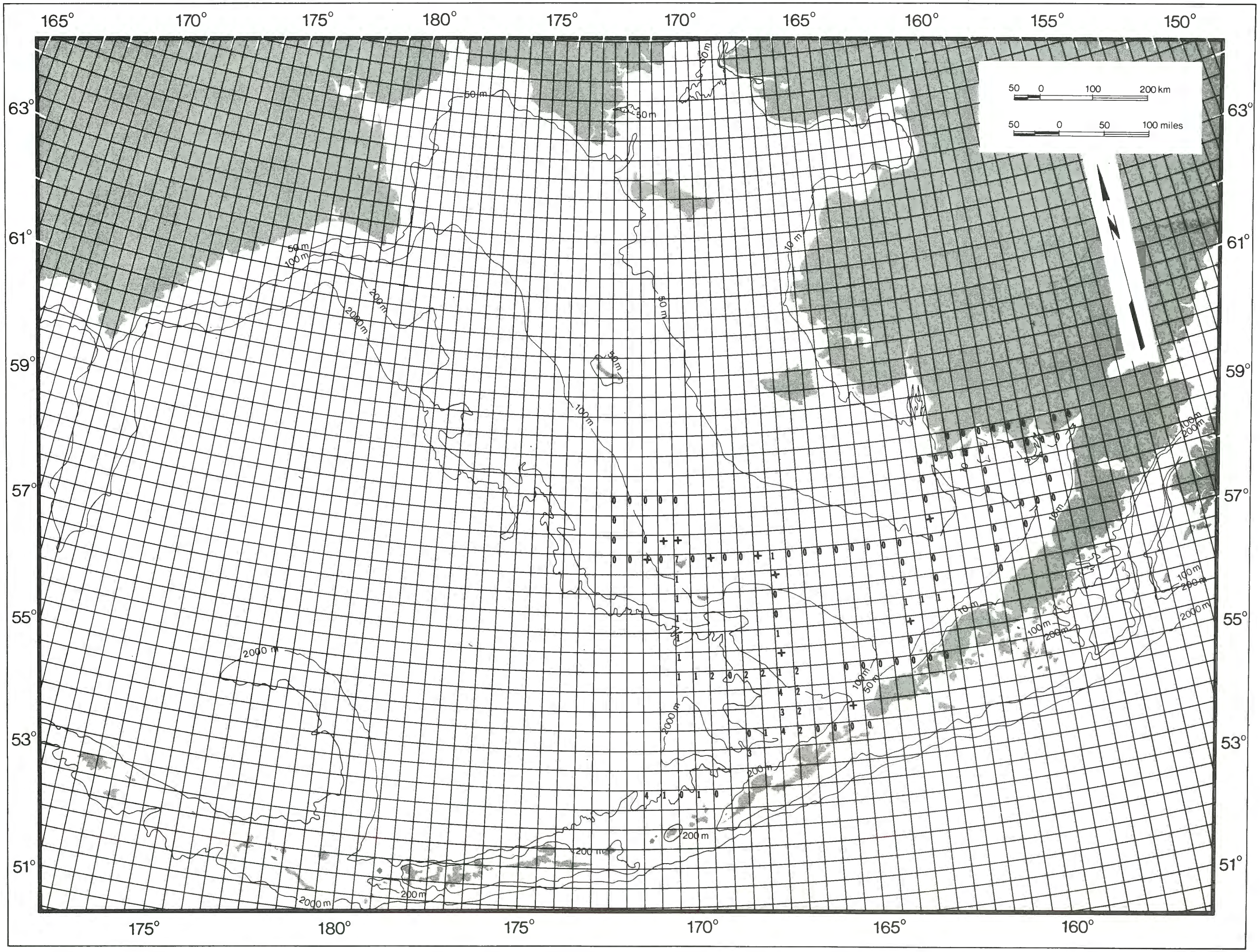

Map 120. Density indices of total loons obtained from aerial surveys of the eastern Bering Sea in fall.



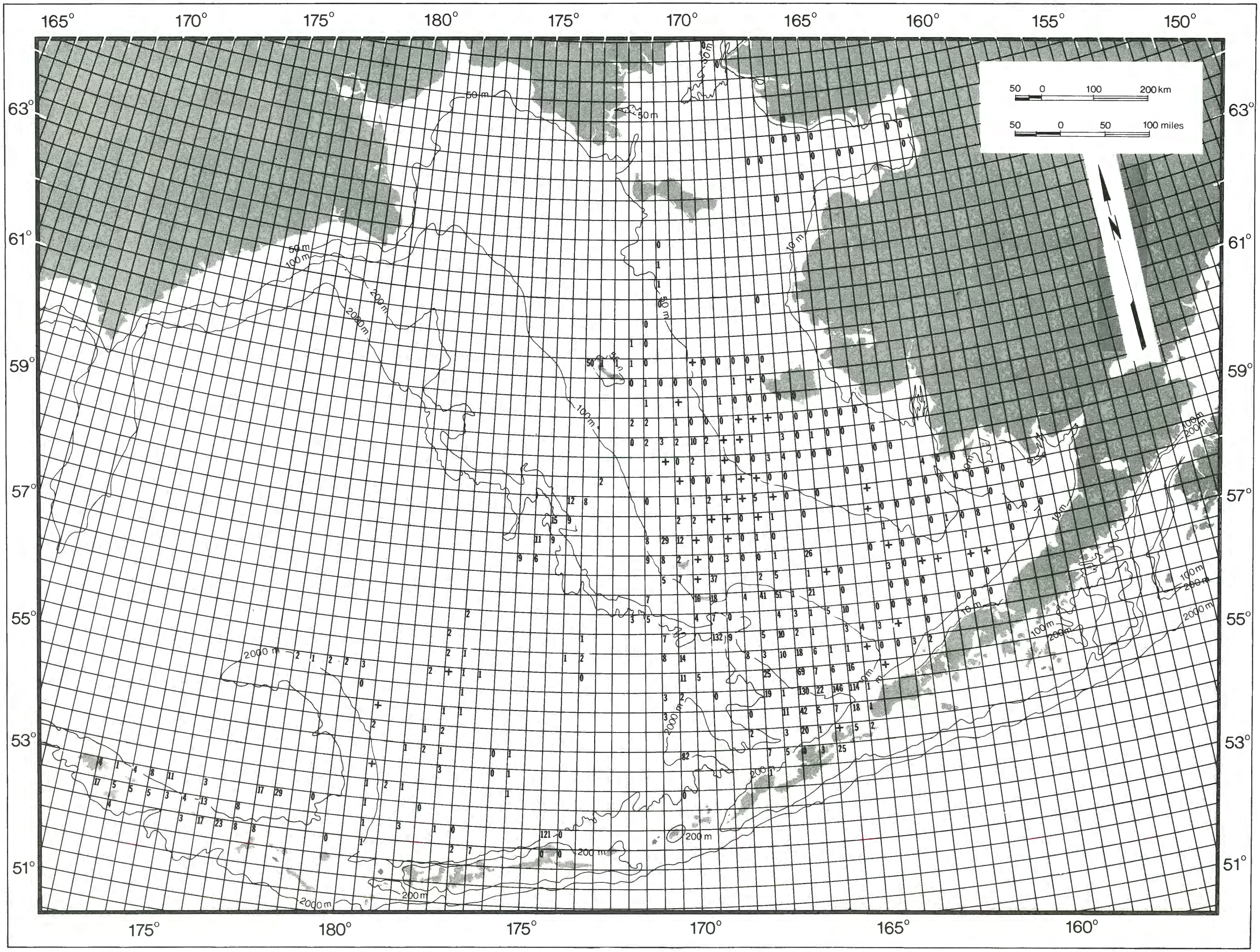

Map 121. Density indices of Northern Fulmar obtained from aerial surveys of the eastern Bering Sea in winter.



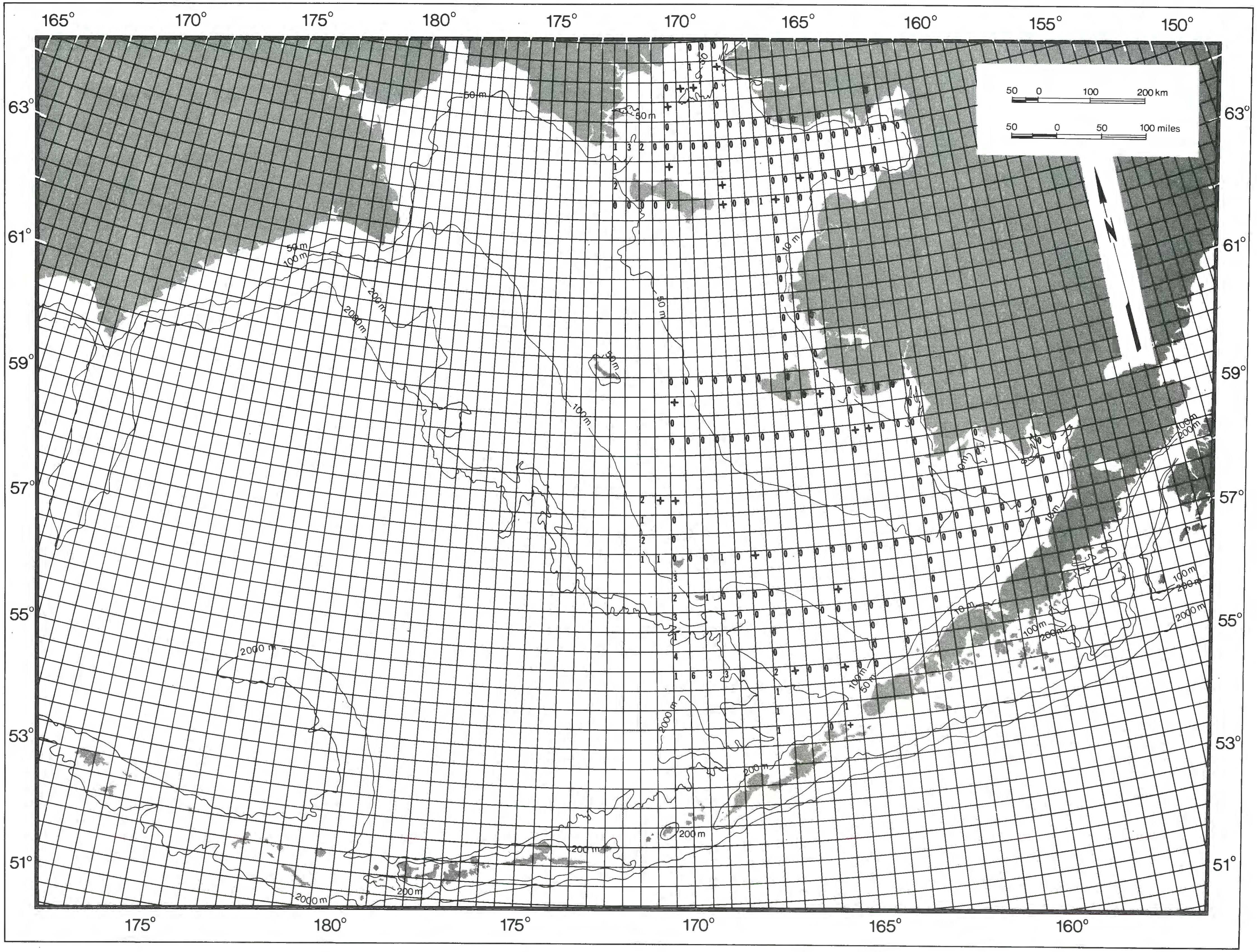

Map 122. Density indices of Northern Fulmar obtained from shipboard surveys of the eastern Bering Sea in spring.



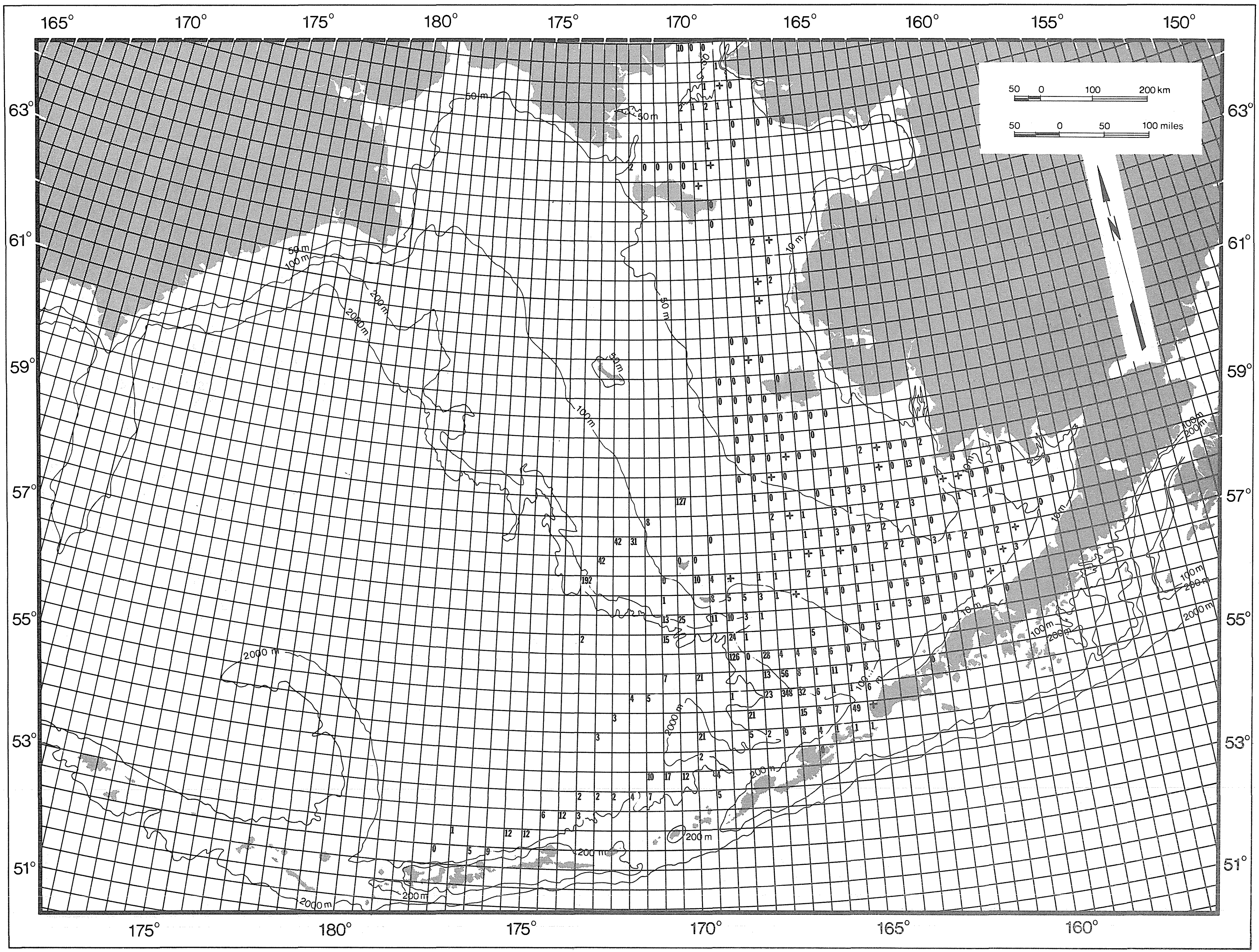

Map 123. Density indices of Northern Fulmar obtained from aerial surveys of the eastern Bering Sea in spring.



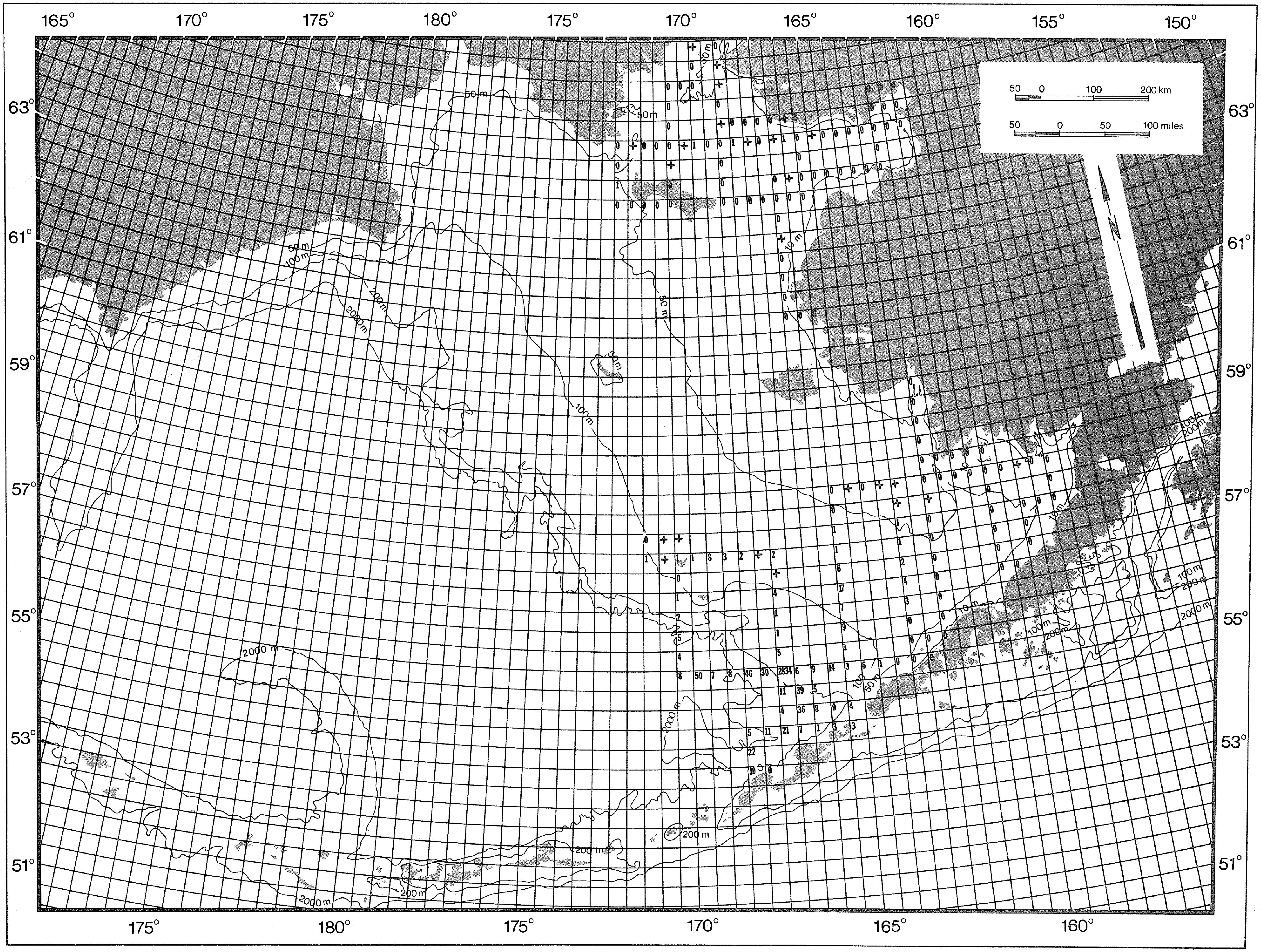

Map 124. Density indices of Northern Fulmar obtained from shipboard surveys of the eastern Bering Sea in summer.



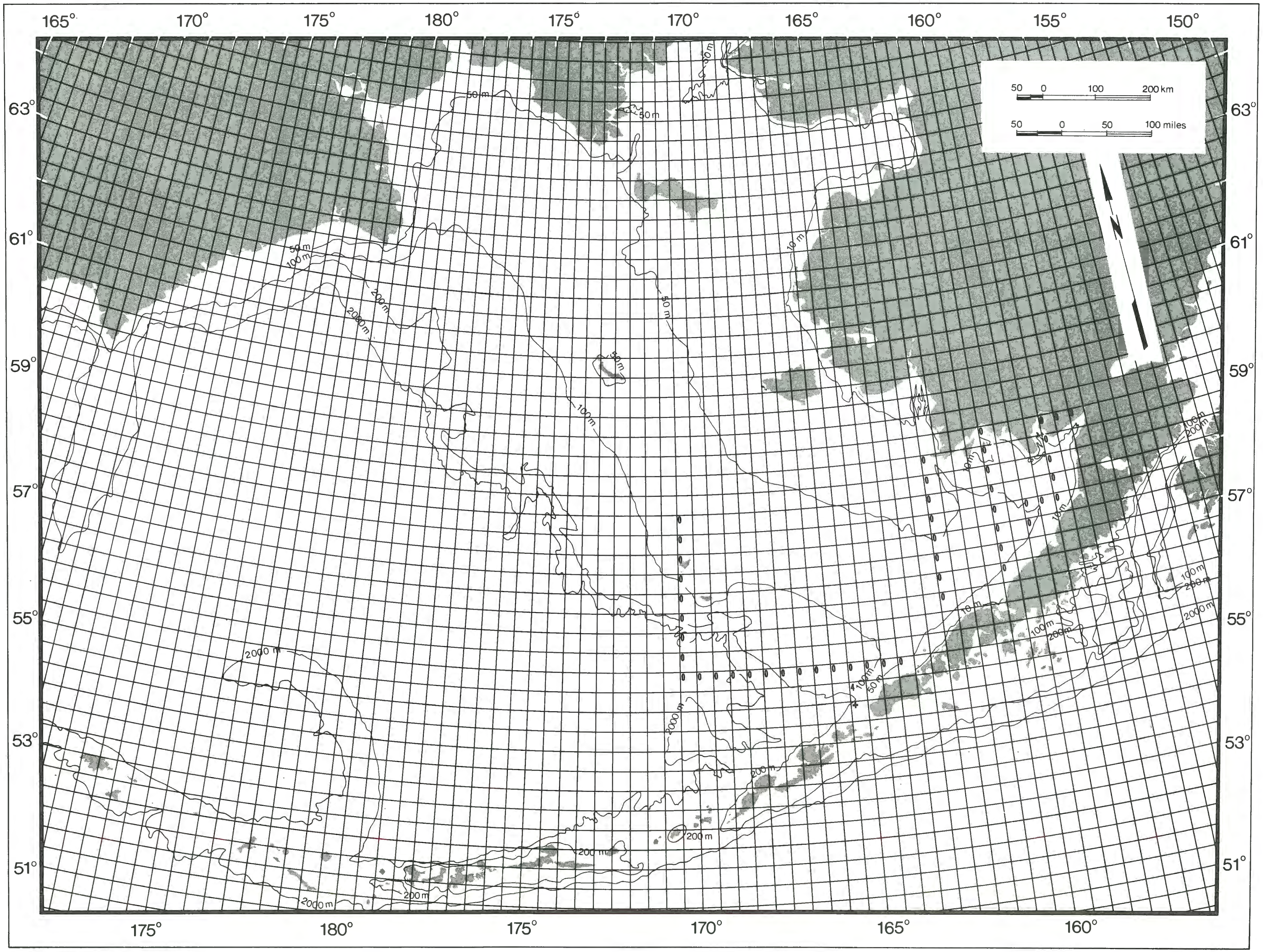

Map 125. Density indices of Northern Fulmar obtained from aerial surveys of the eastern Bering Sea in summer.



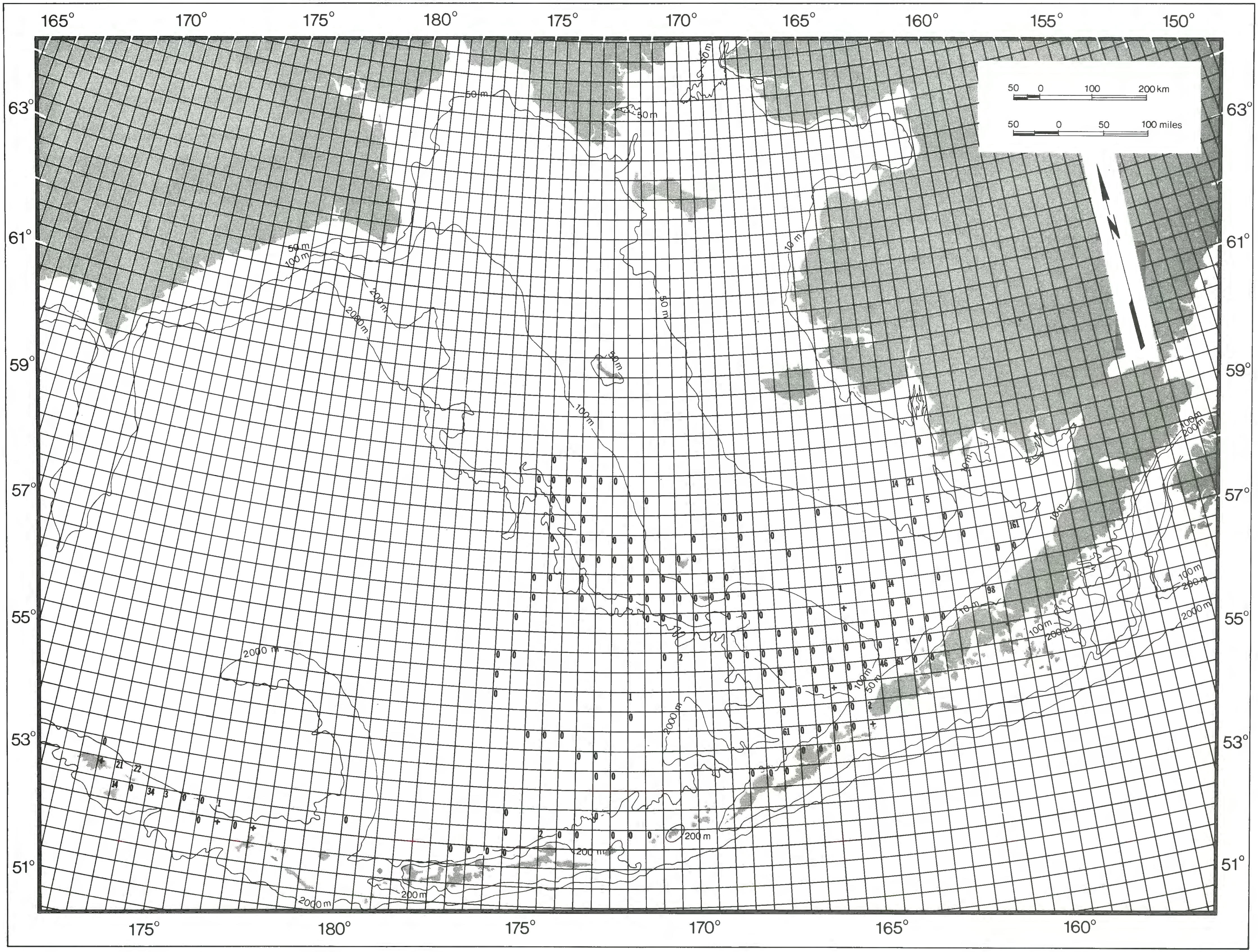
Map 126. Density indices of Northern Fulmar obtained from shipboard surveys of the eastern Bering Sea in fall.



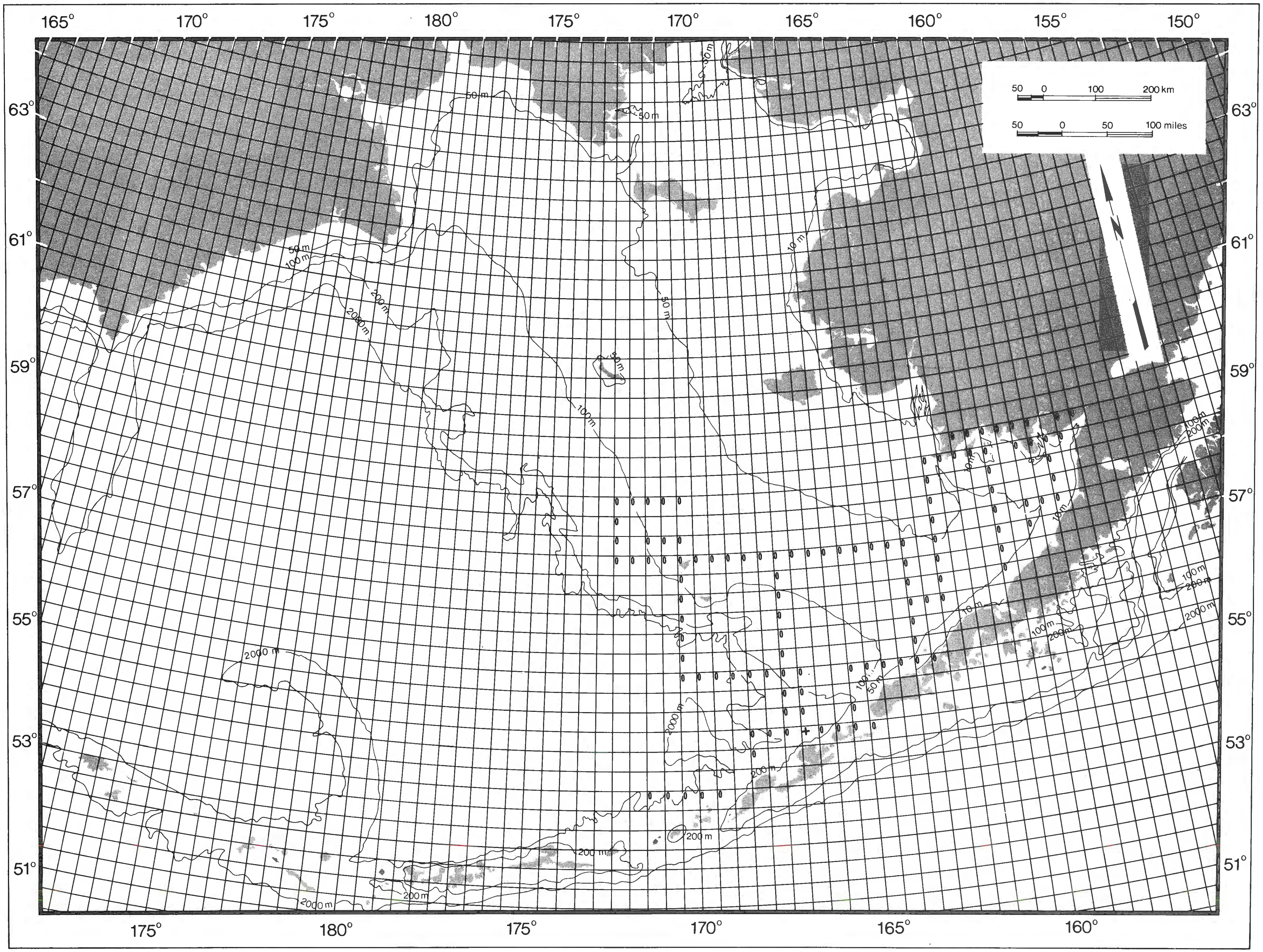

Map 127. Density indices of Northern Fulmar obtained from aerial surveys of the eastern Bering Sea in fall.



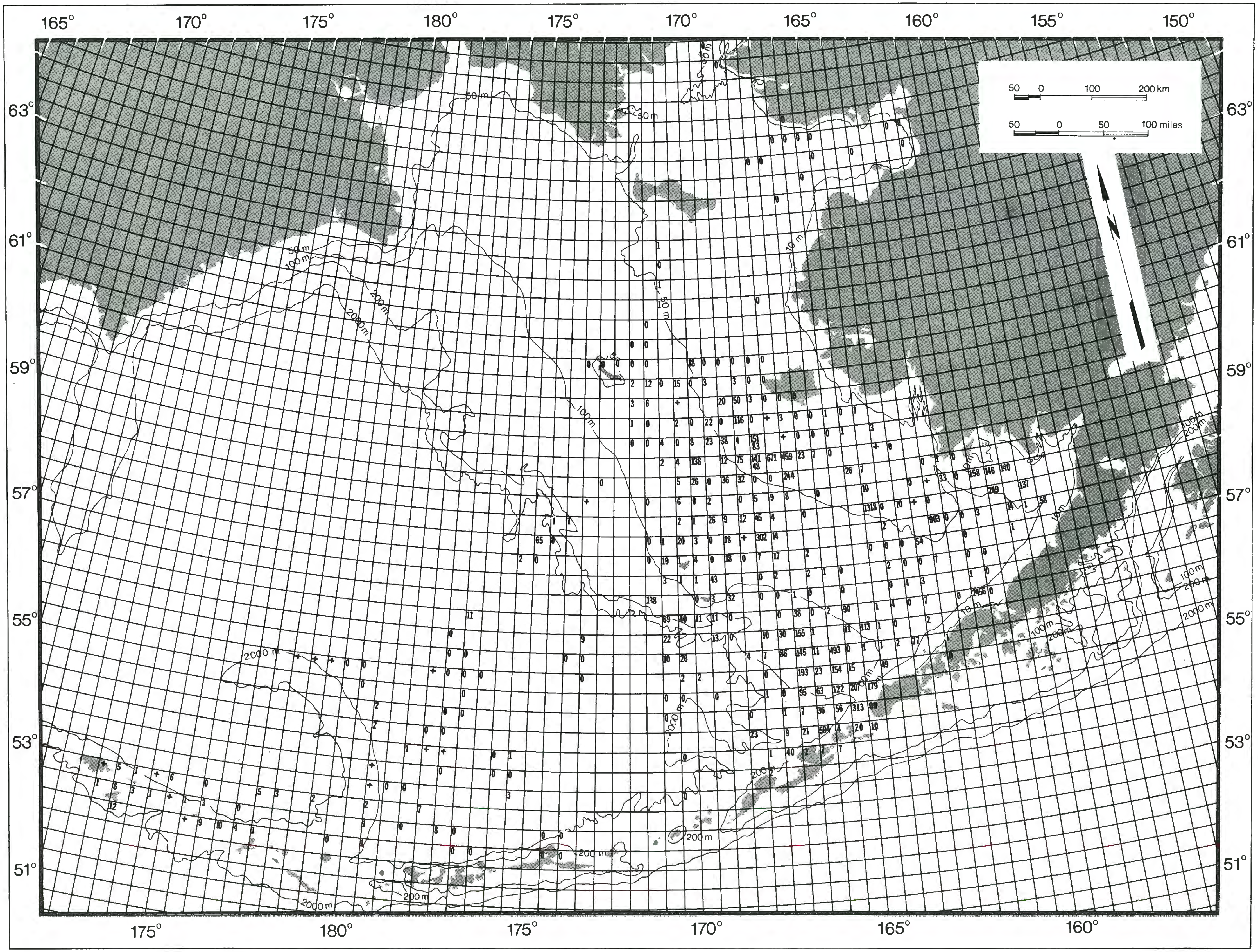

Map 128. Density indices of total shearwaters obtained from aerial surveys of the eastern Bering Sea in winter.



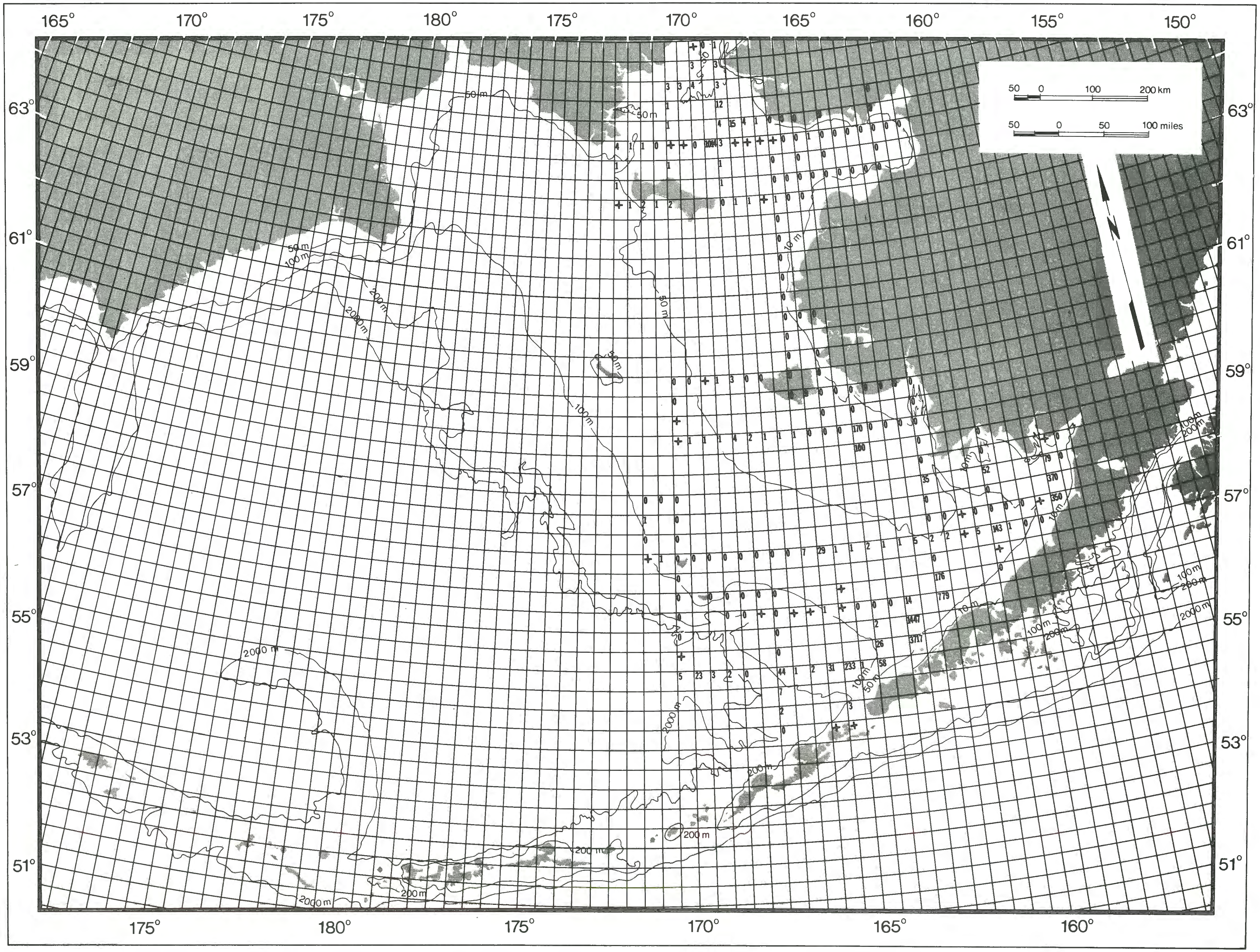

Map 129. Density indices of total shearwaters obtained from shipboard surveys of the eastern Bering Sea in spring.



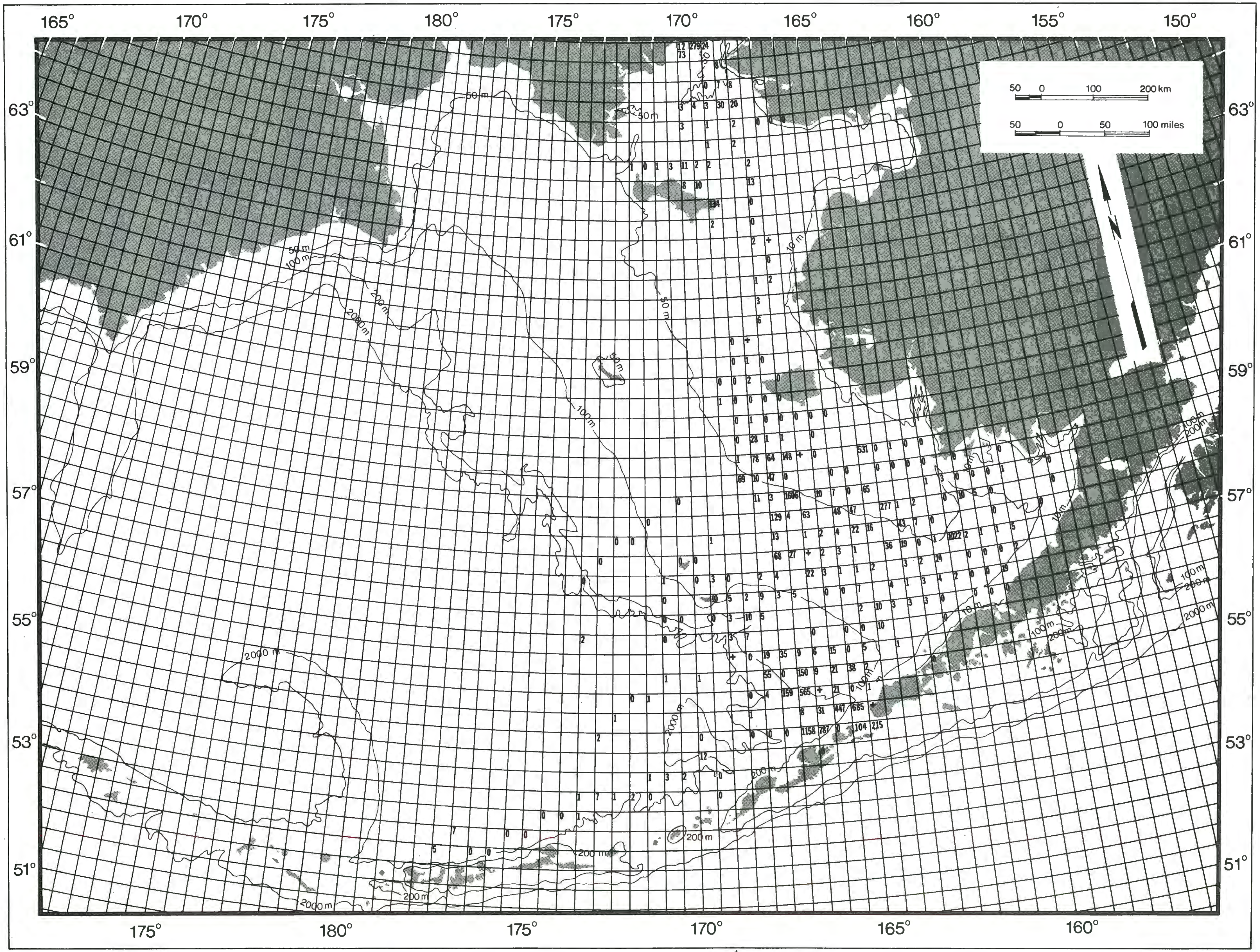

Map 130. Density indices of total shearwaters obtained from aerial surveys of the eastern Bering Sea in spring.



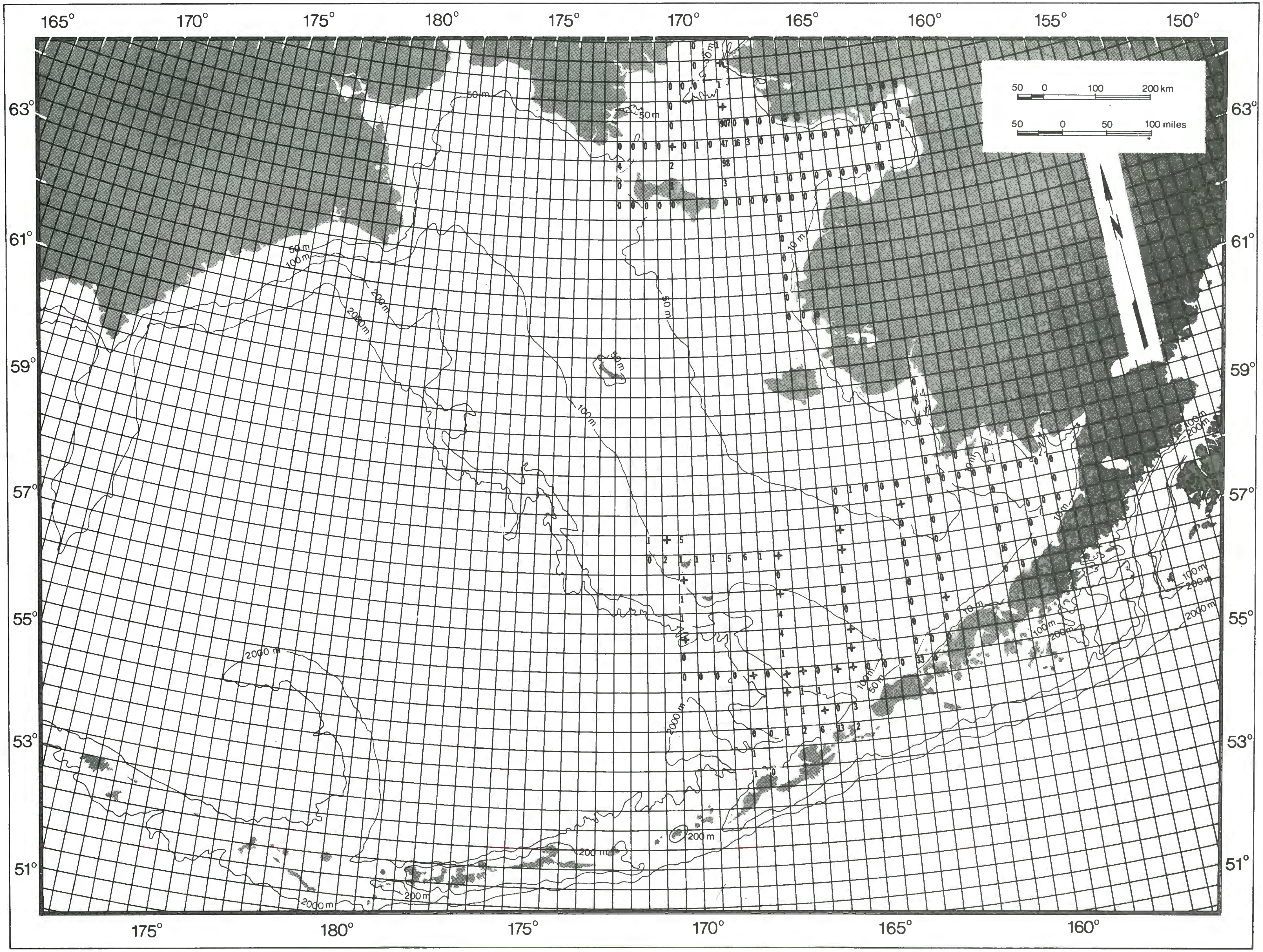

Map 131. Density indices of total shearwaters obtained from shipboard surveys of the eastern Bering Sea in summer.



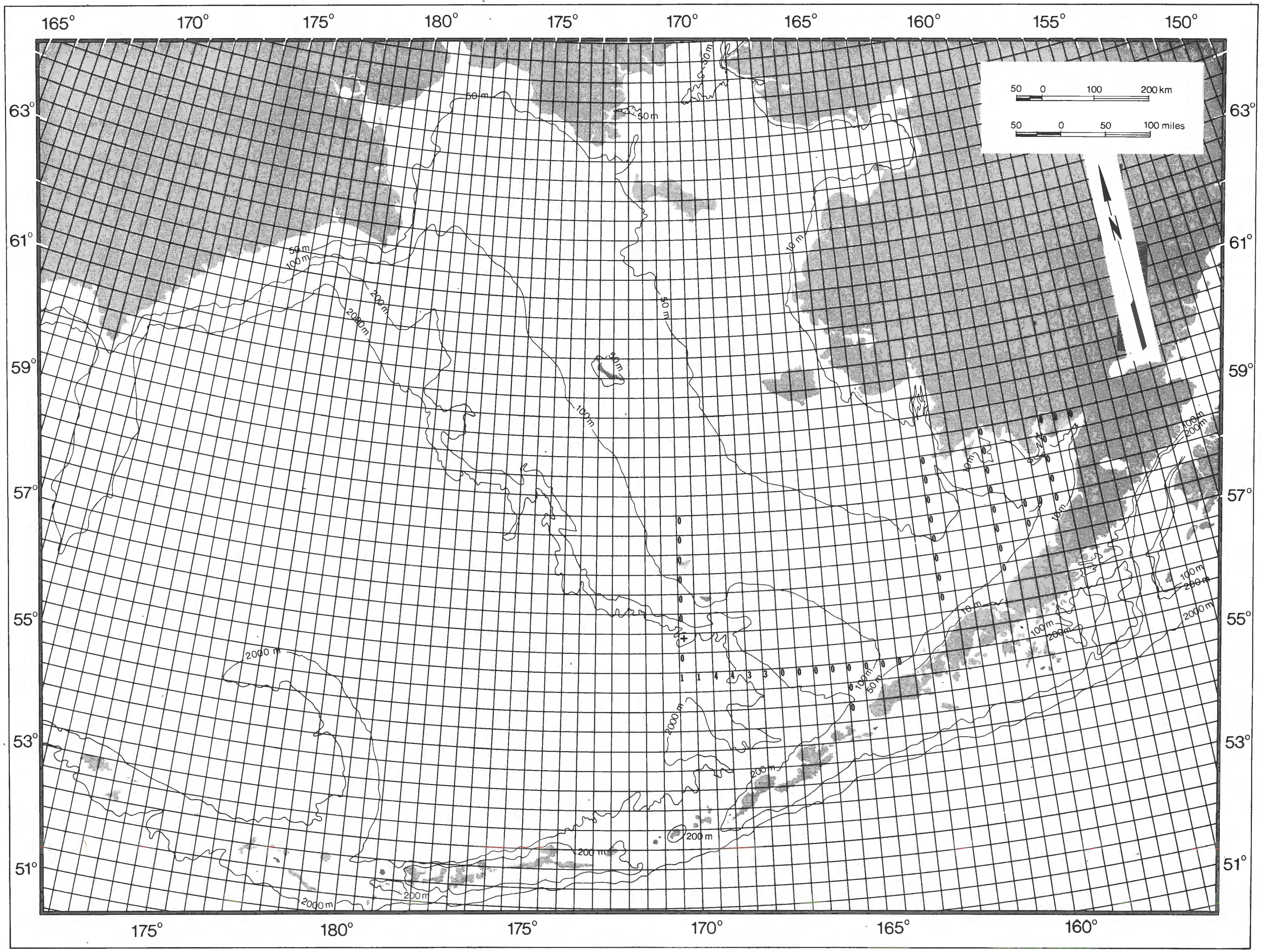

Map 132. Density indices of total shearwaters obtained from aerial surveys of the eastern Bering Sea in summer.



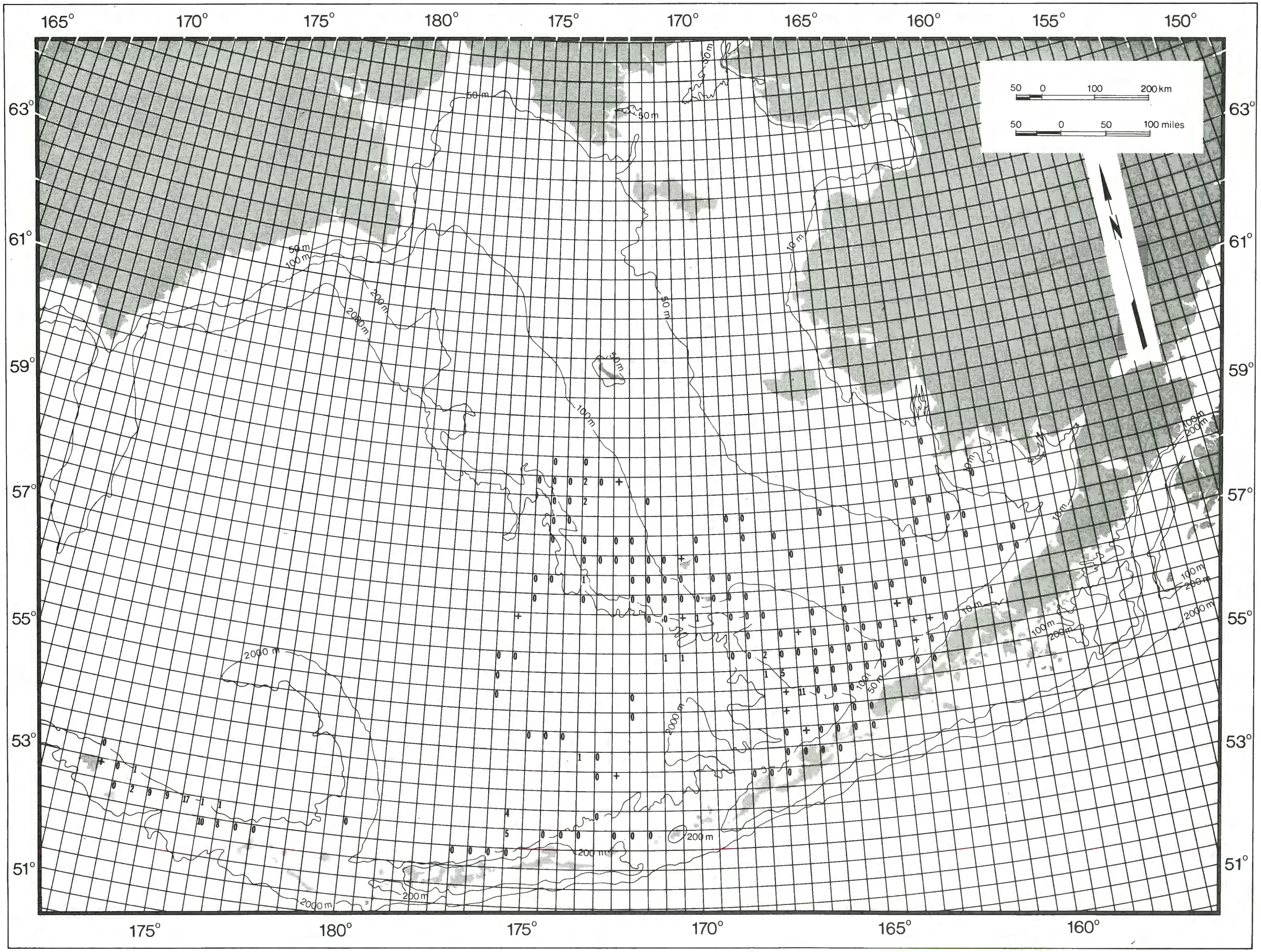

Map 133. Density indices of total shearwaters obtained from shipboard surveys of the eastern Bering Sea in fall.



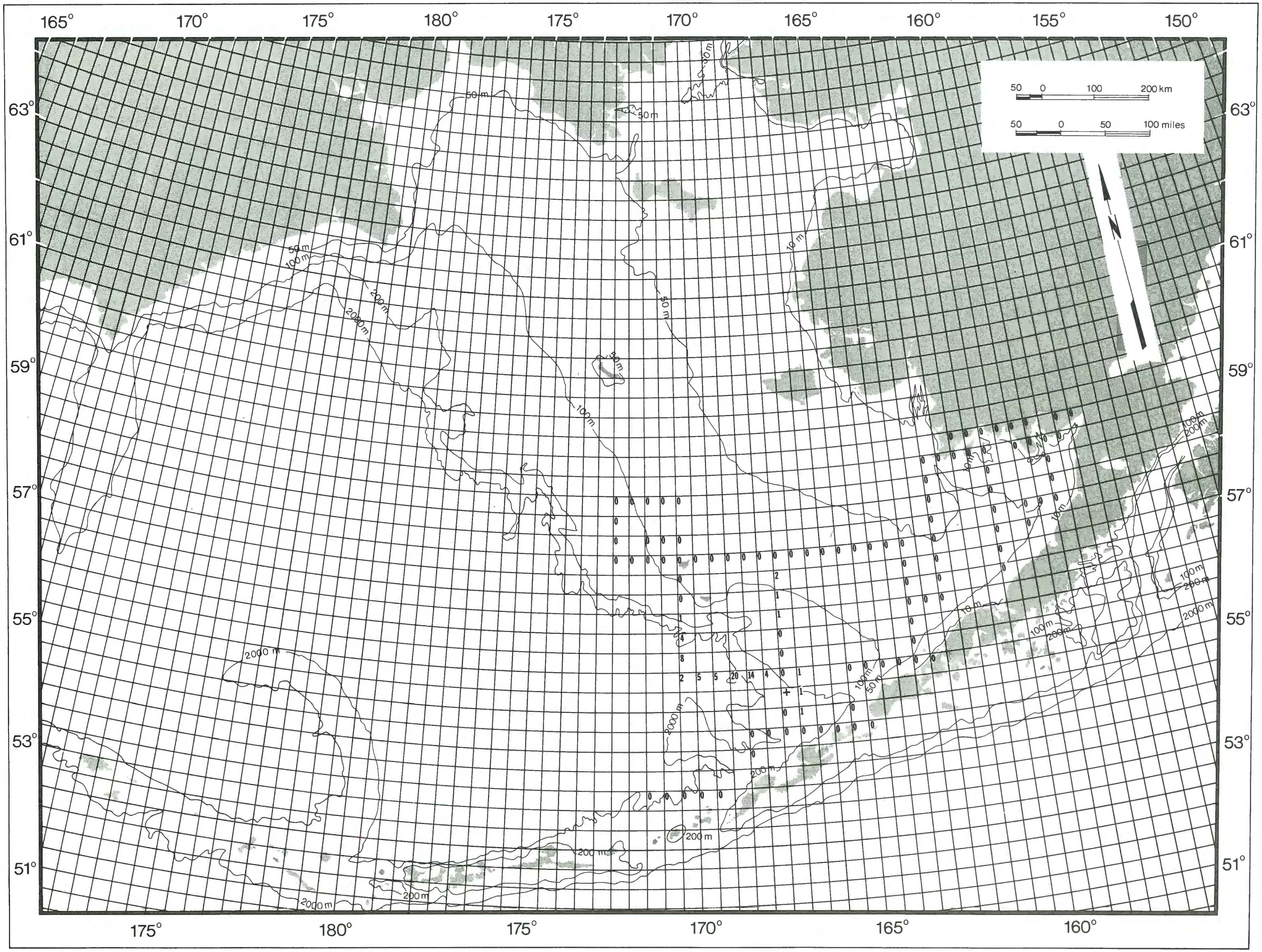

Map 134. Density indices of total shearwates obtained from aerial surveys of the eastern Bering Sea in fall.



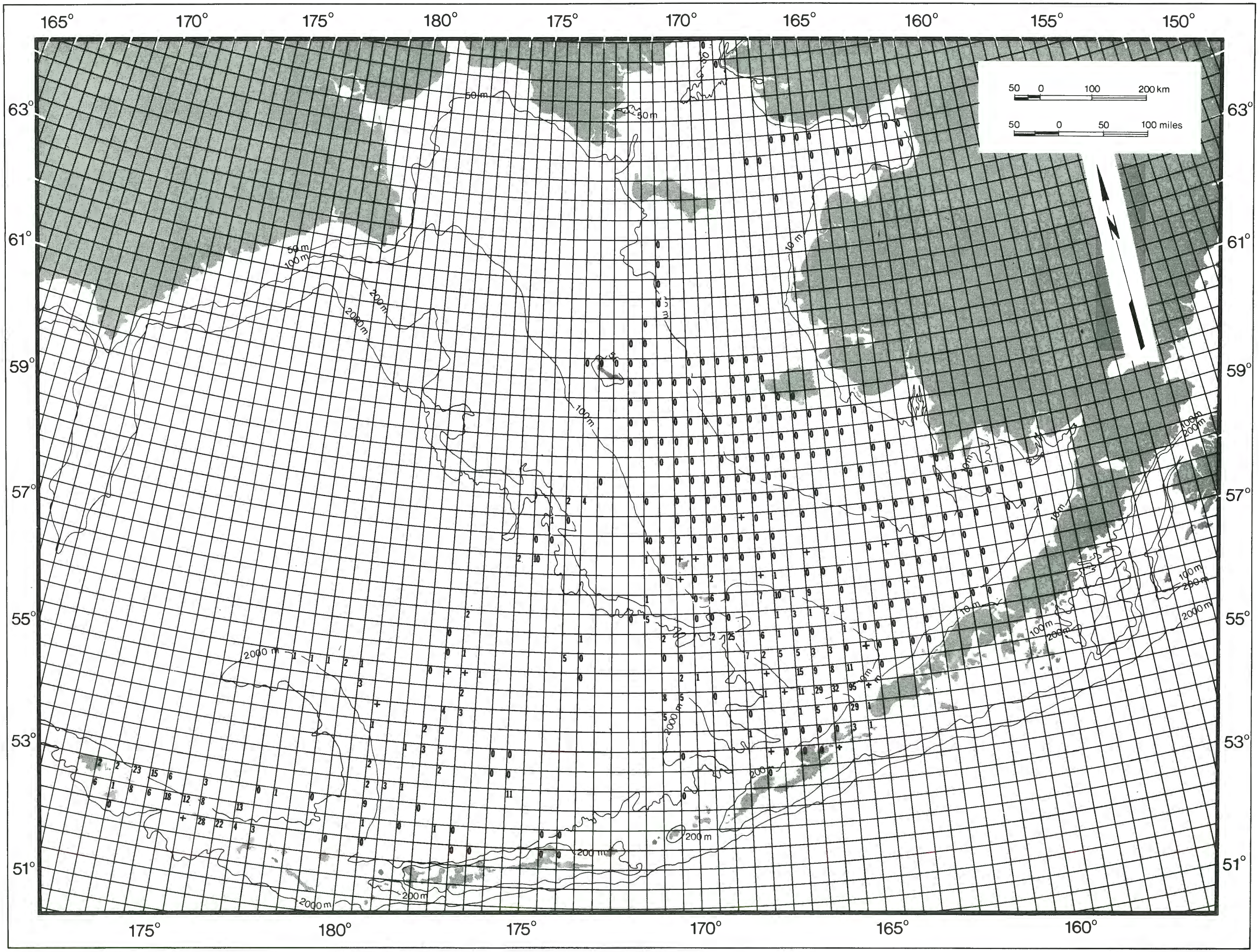

Map 135. Density indices of total storm-petrels obtained from aerial surveys of the eastern Bering Sea in winter.



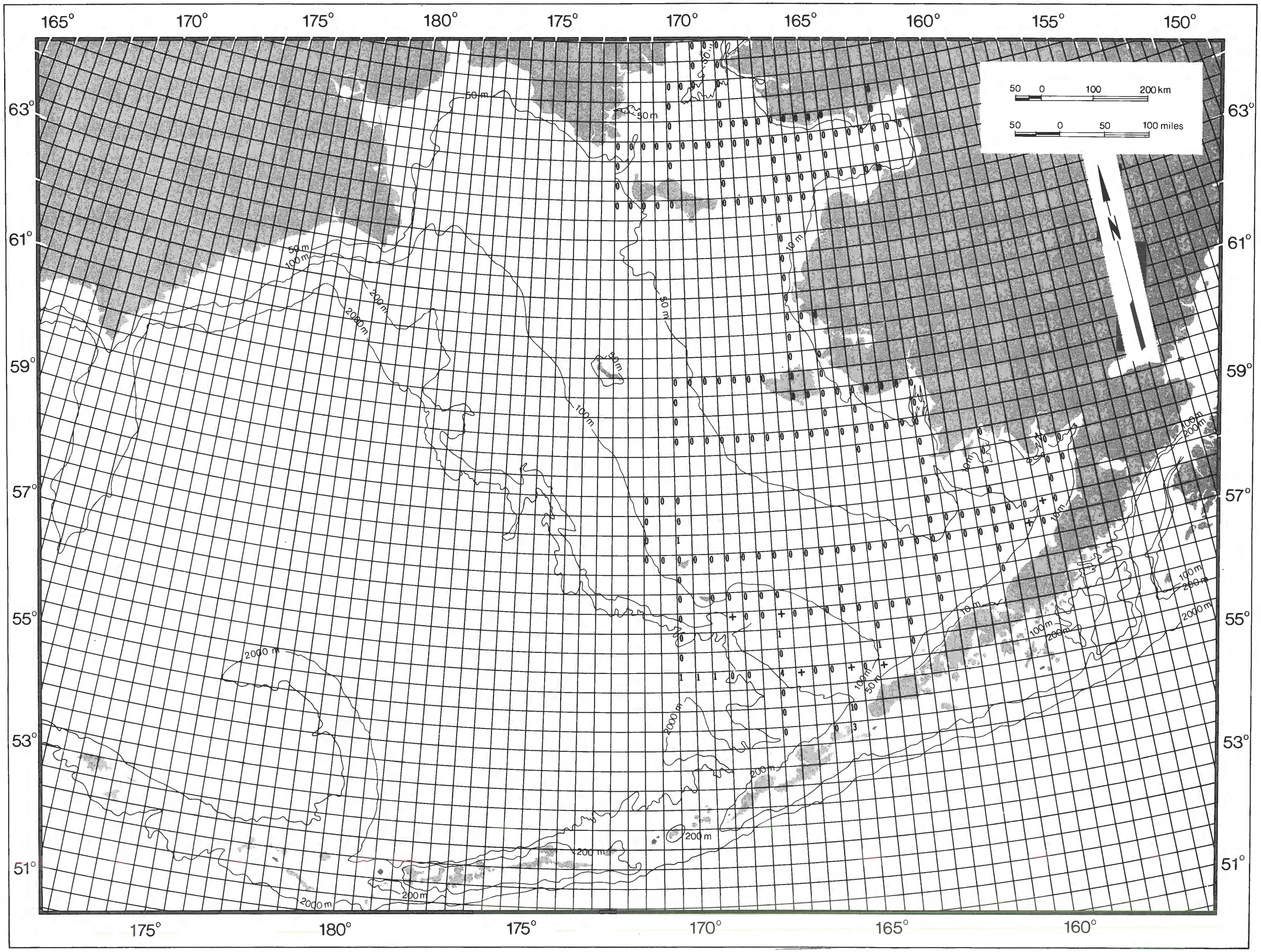

Map 136. Density indices of total storm-petrels obtained from shipboard surveys of the eastern Bering Sea in spring.



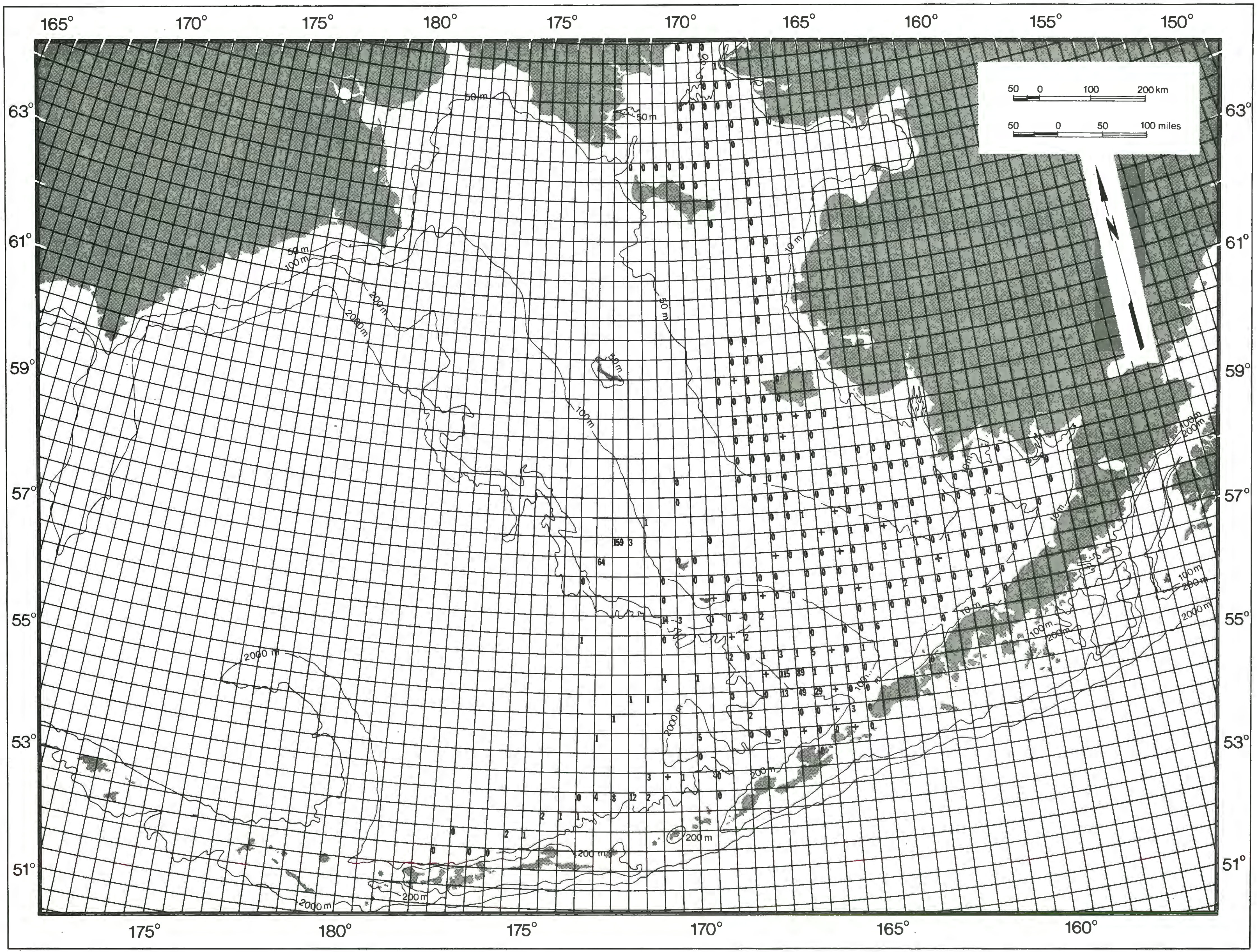

Map 137. Density indices of total storm-petrels obtained from aerial surveys of the eastern Bering Sea in spring.



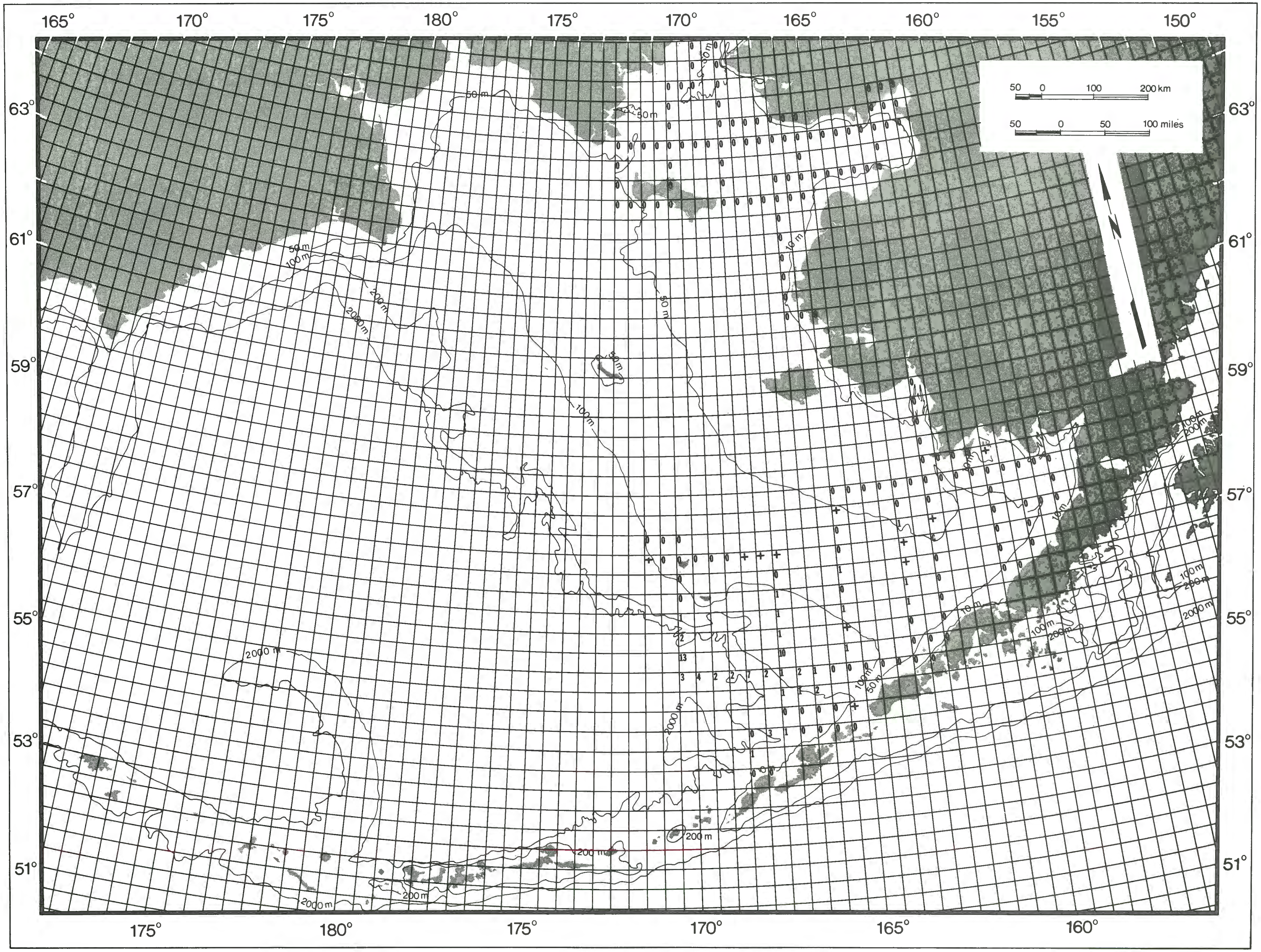

Map 138. Density indices of total storm-petrels obtained from shipboard surveys of the eastern Bering Sea in summer.



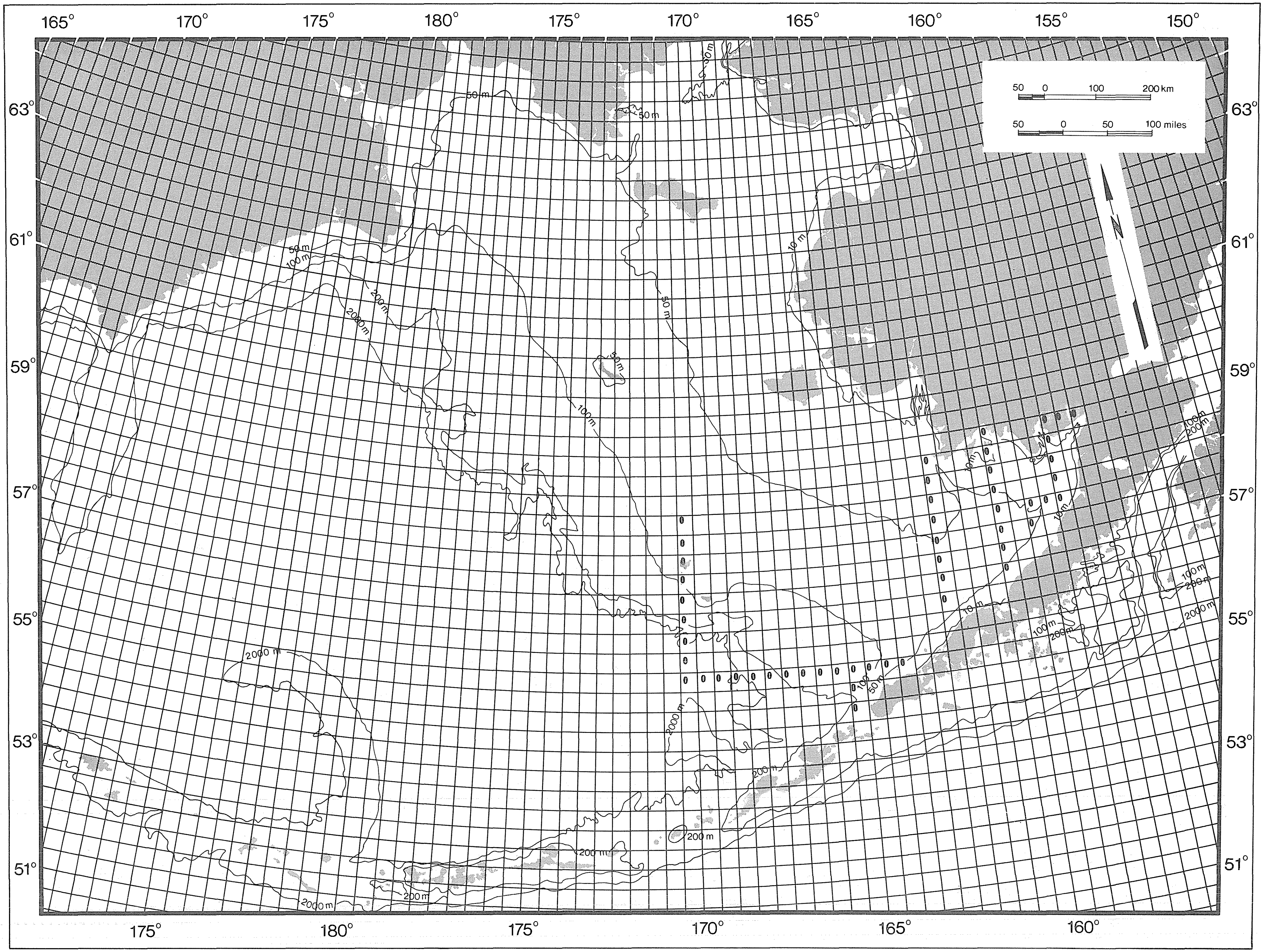

Map 139. Density indices of total storm-petrels obtained from aerial surveys of the eastern Bering Sea in summer.



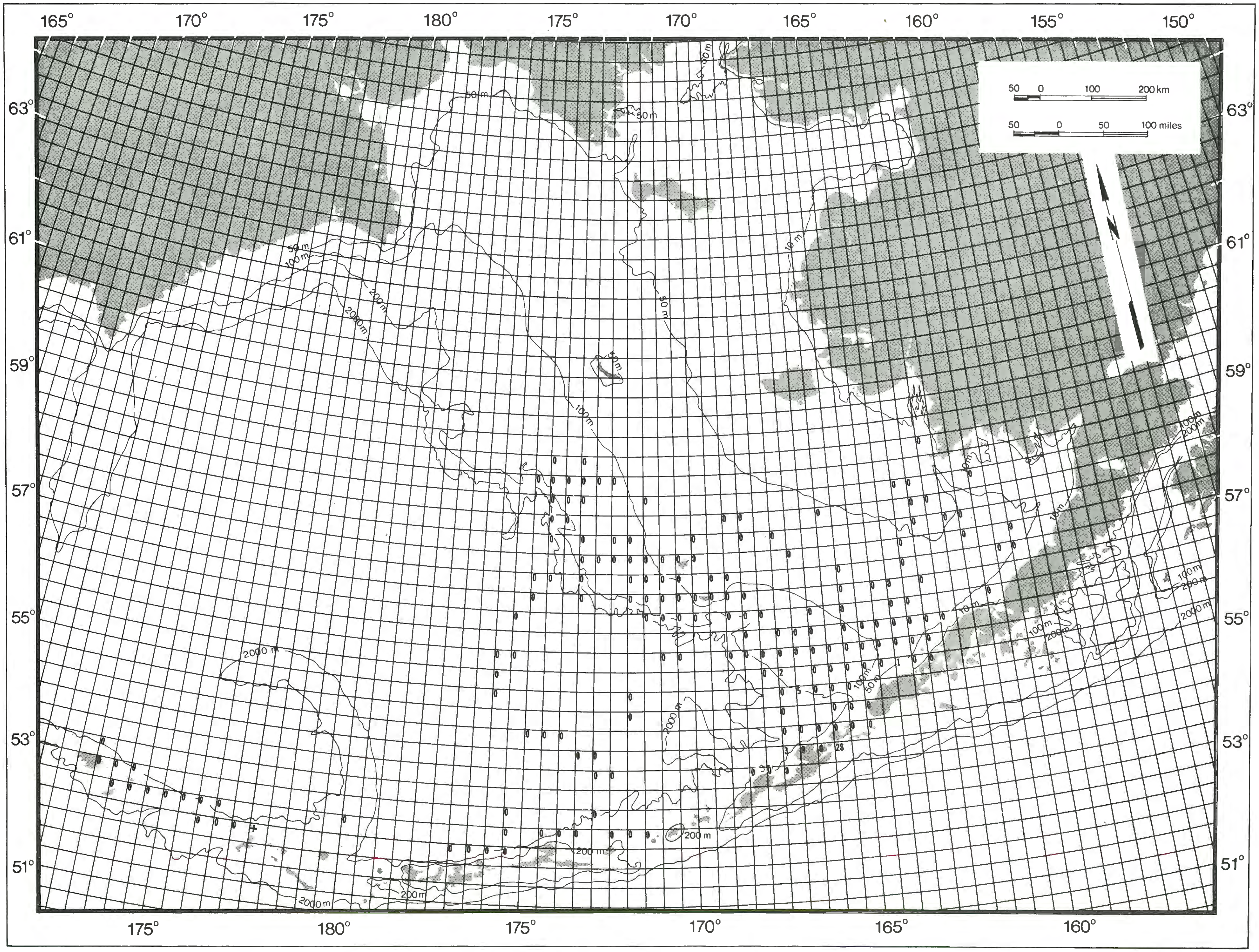

Map 140. Density indices of total storm-petrels obtained from shipboard surveys of the eastern Bering Sea in fall.



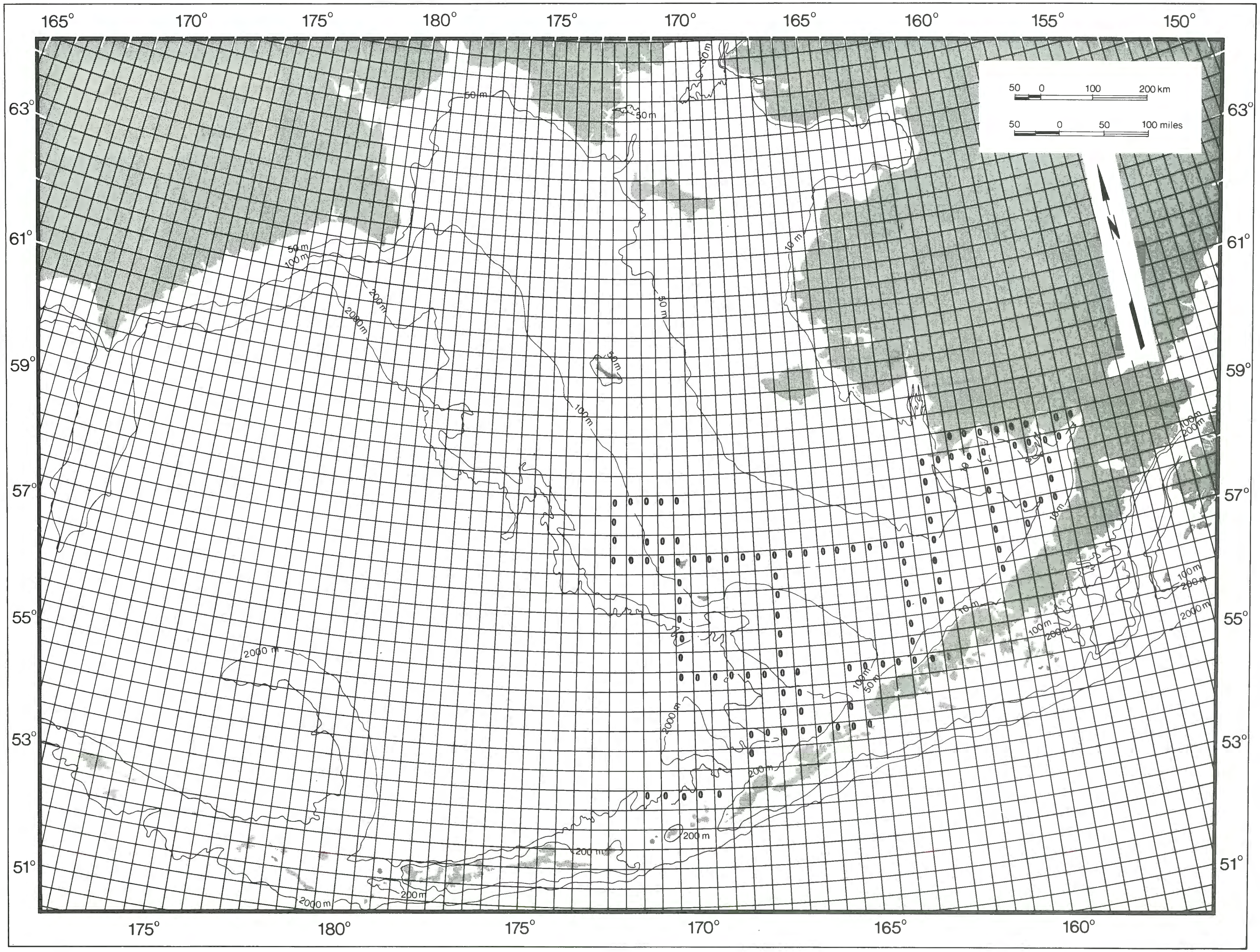

Map 141. Density indices of total storm-petrels obtained from aerial surveys of the eastern Bering Sea in fall.



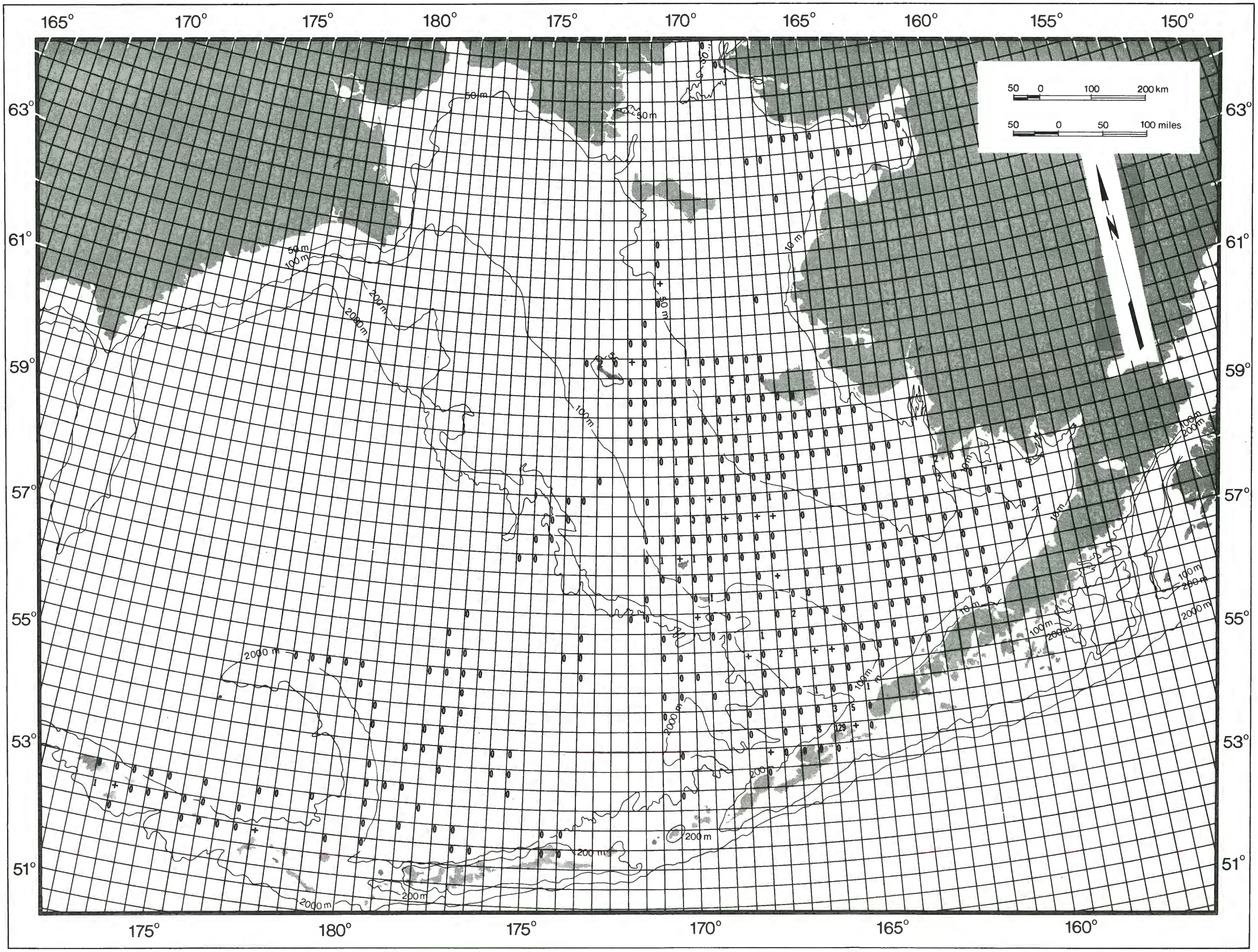

Map 142. Density indices of total phalaropes obtained from aerial surveys of the eastern Bering Sea in winter.



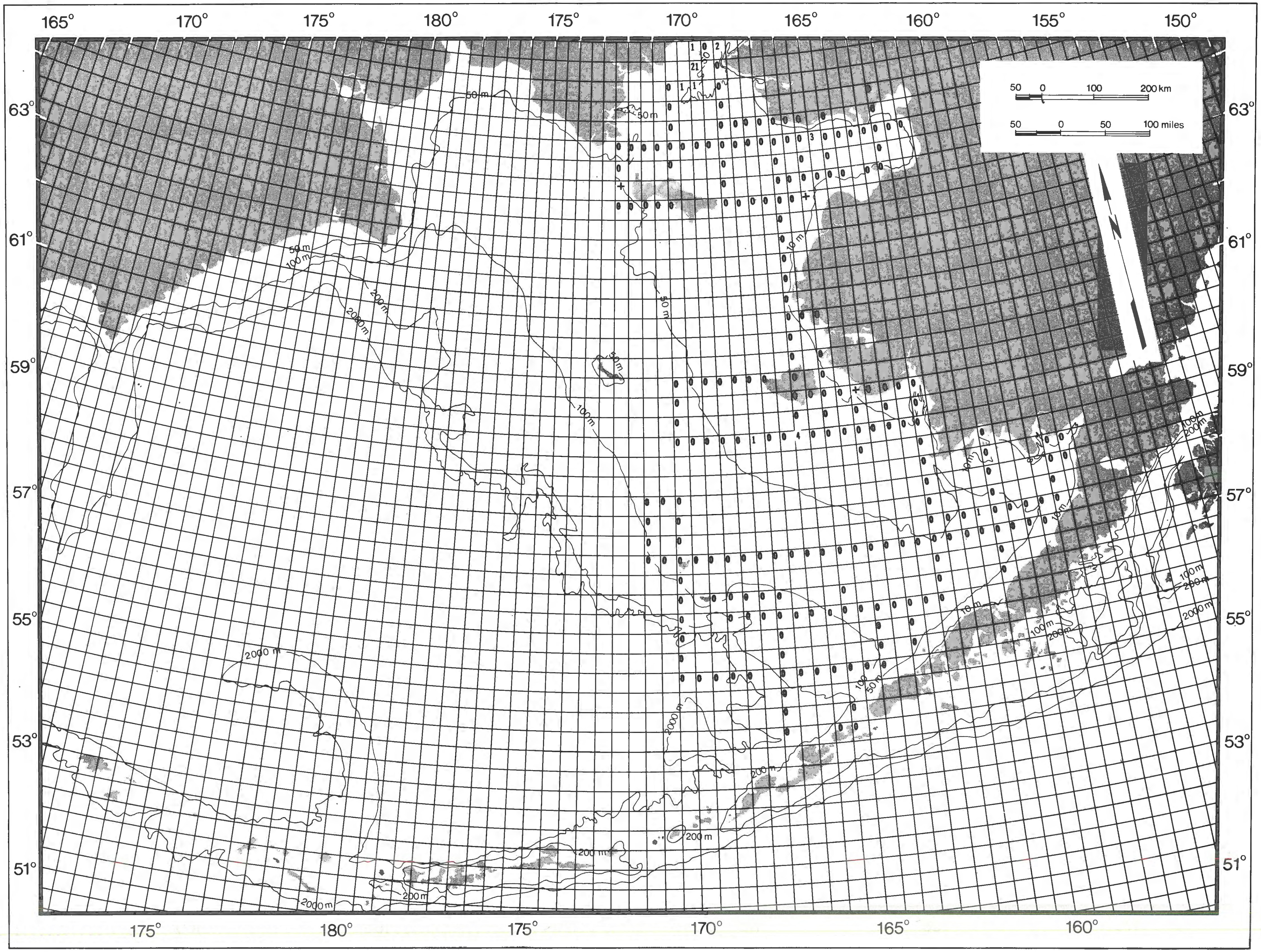

Map 143. Density indices of total phalaropes obtained from shipboard surveys of the eastern Bering Sea in spring.



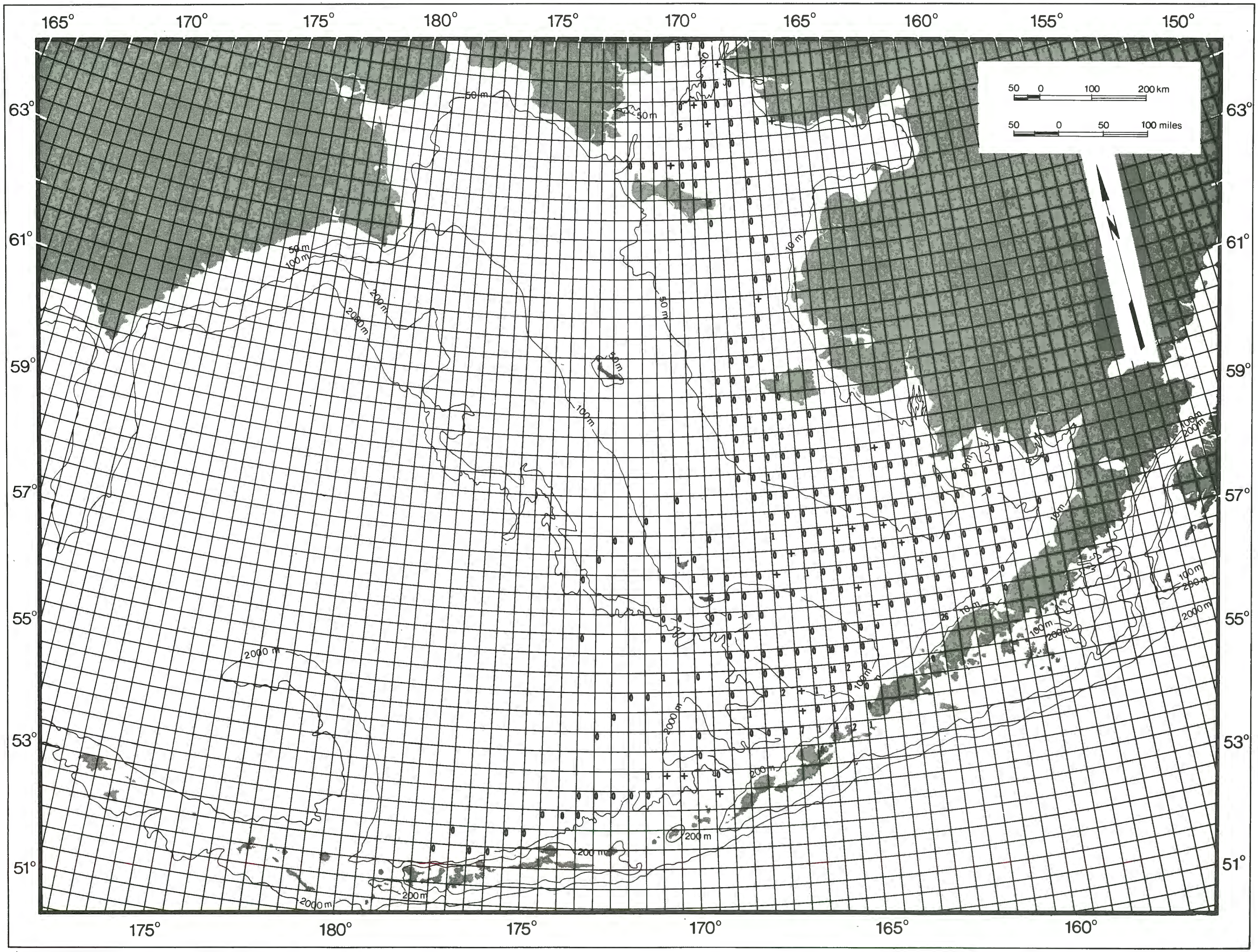

Map 144. Density indices of total phalaropes obtained from aerial surveys of the easten Bering Sea in spring.



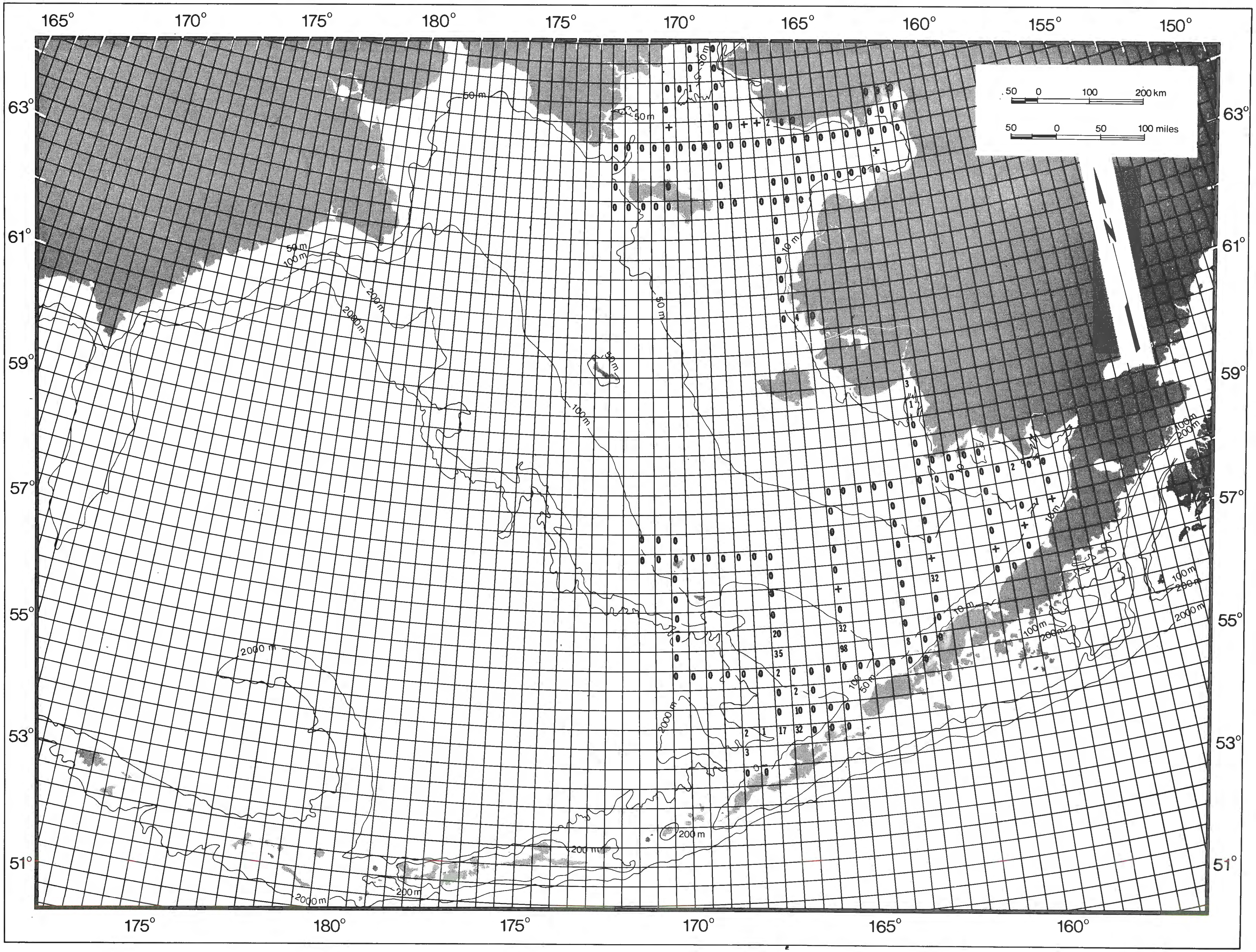

Map 145. Density indices of total phalaropes obtained from shipboard surveys of the eastern Bering Sea in summer.



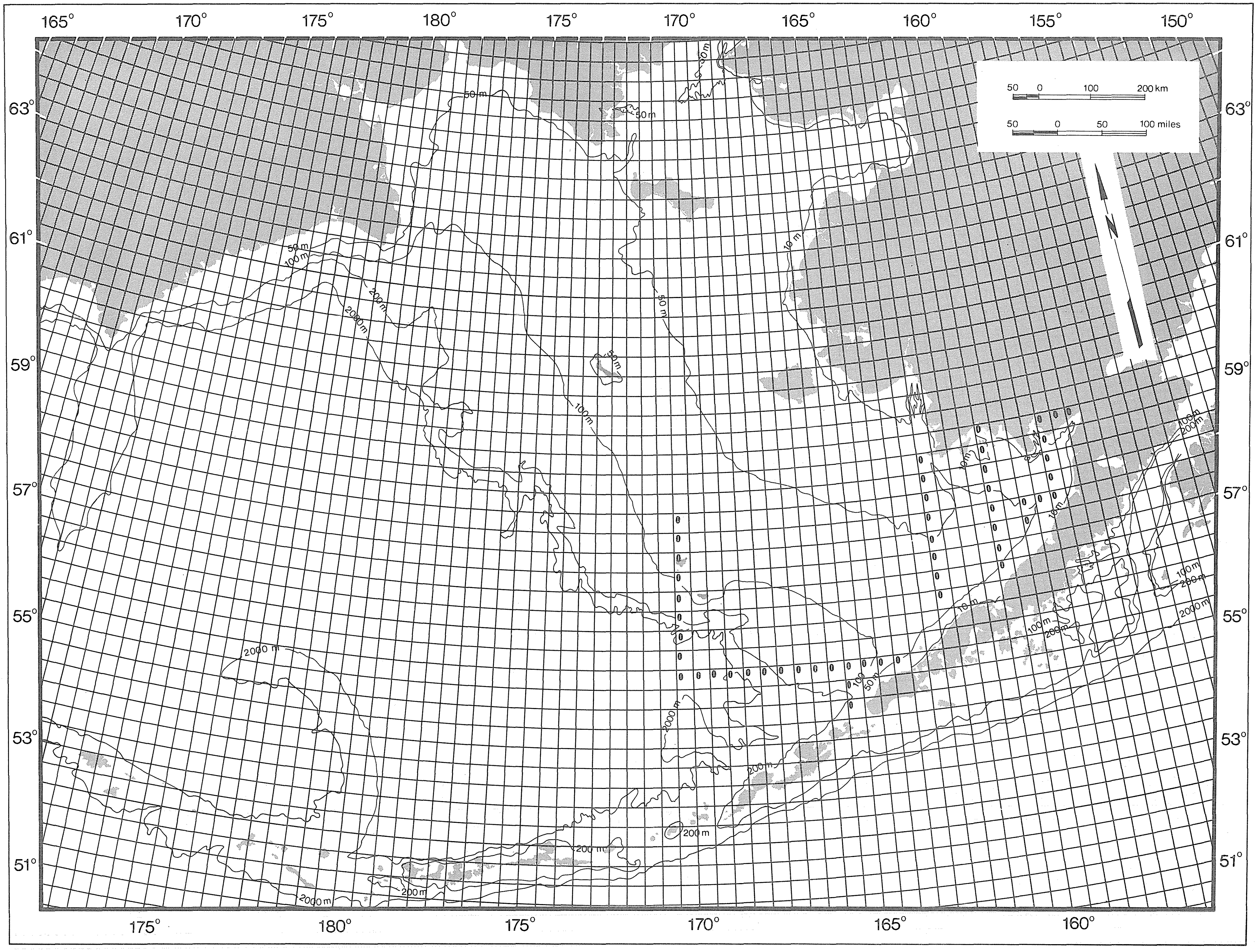

Map 146. Density indices of total phalaropes obtained from aerial surveys of the eastern Bering Sea in summer.



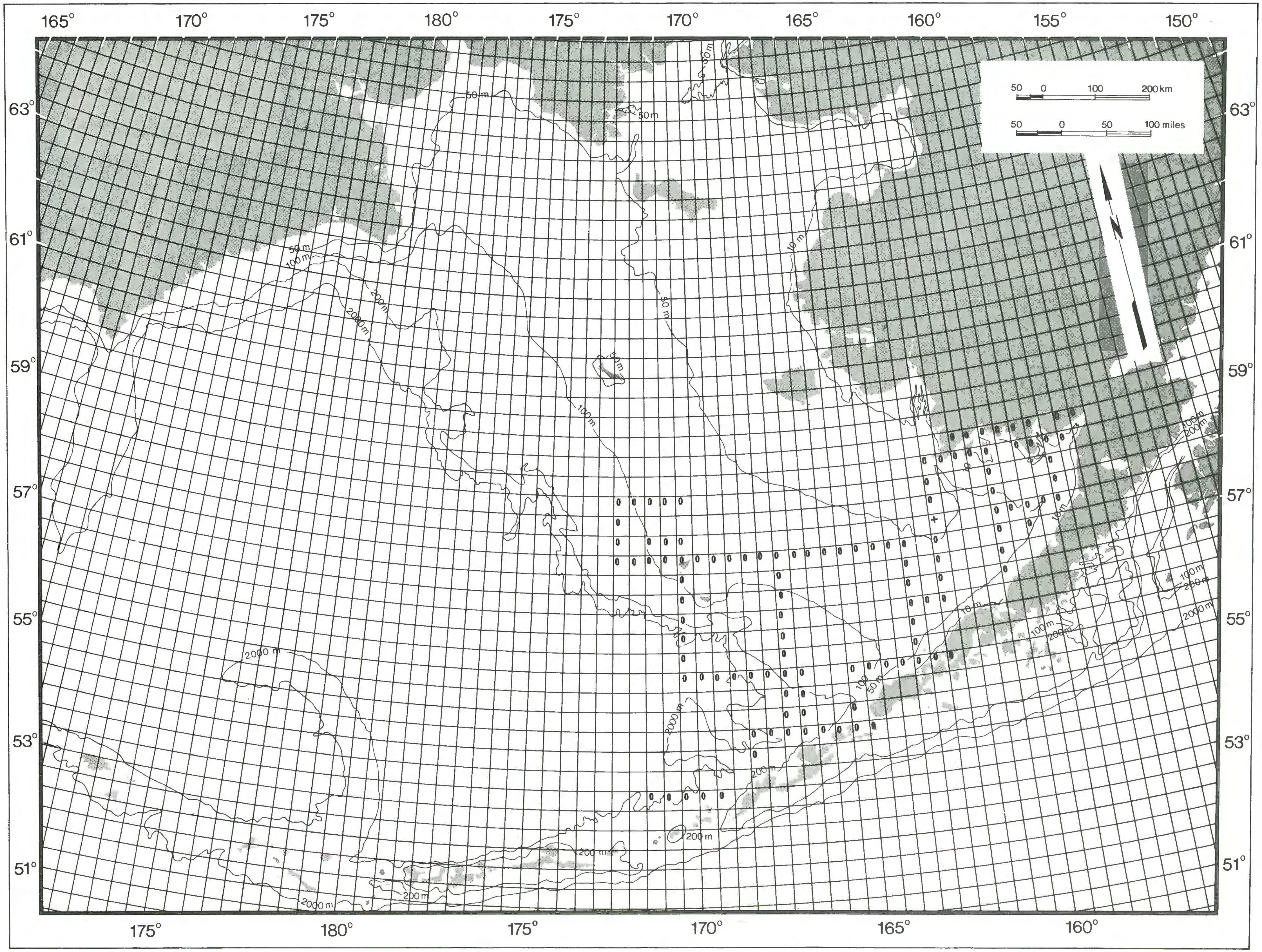

Map 147. Density indices of total phalaropes obtained from shipboard surveys of the eastern Bering Sea in fall.



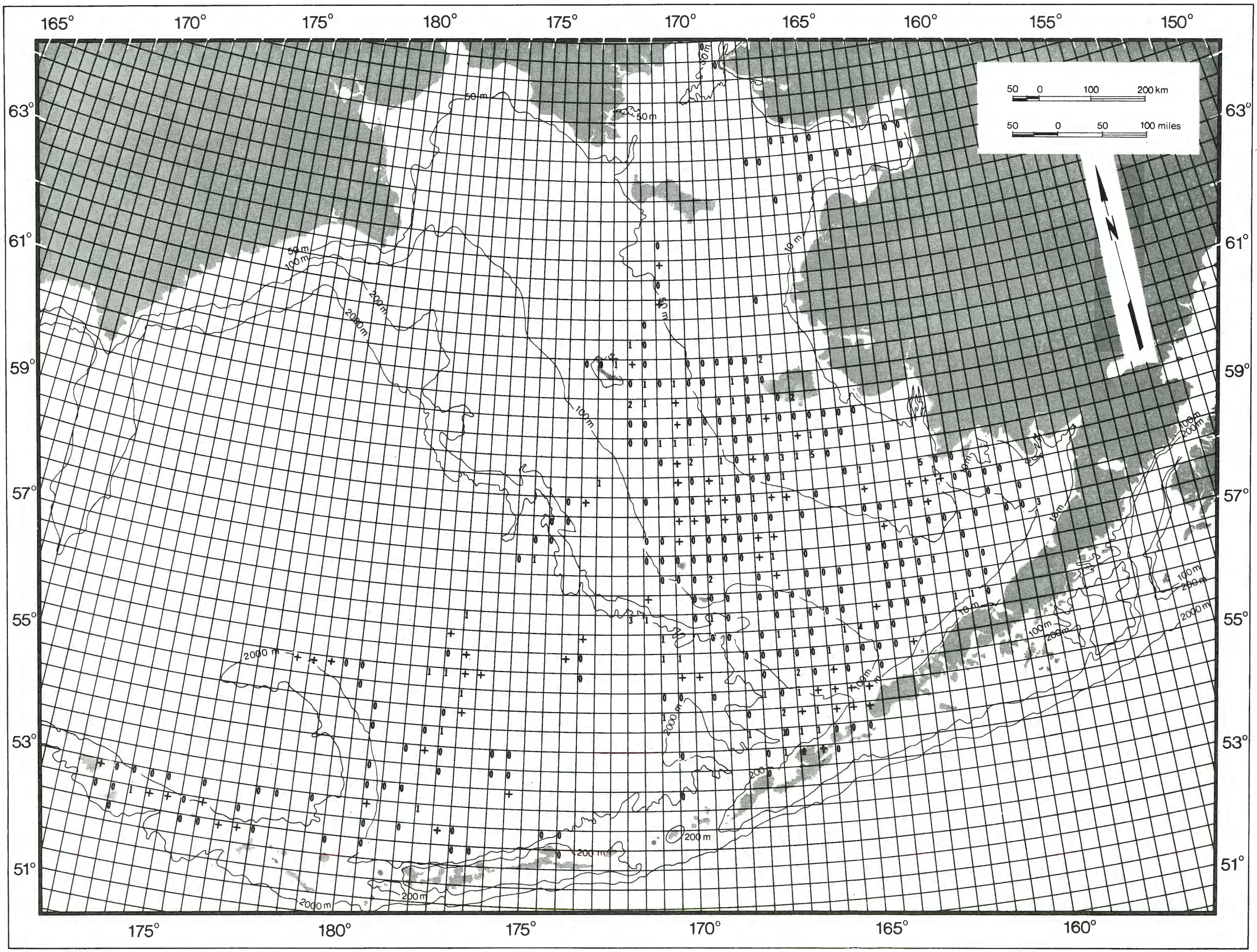

Map 148. Density indices of total phalaropes obtained from aerial surveys of the eastern Bering Sea in fall.



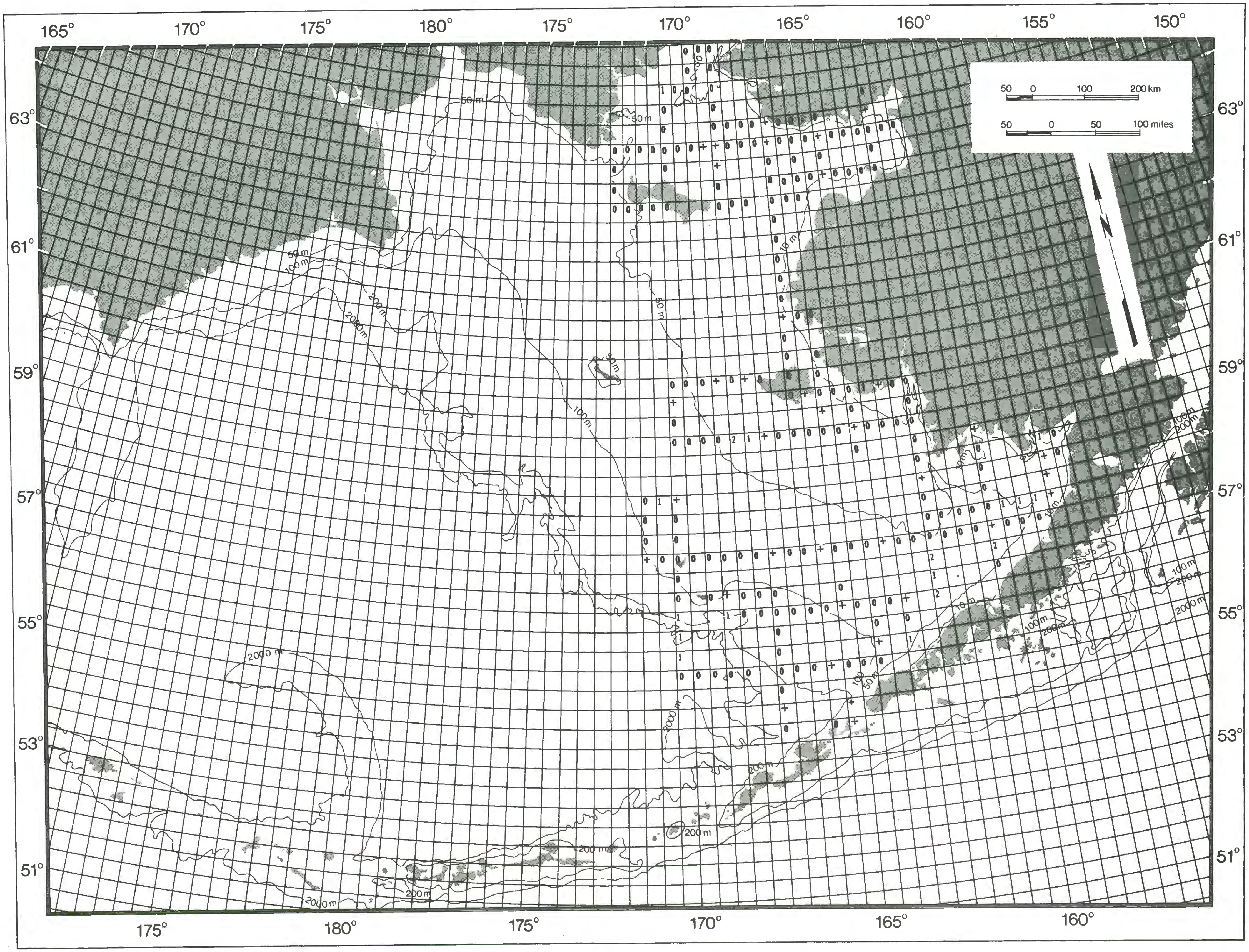

Map 149. Density indices of total jaegers obtained from aerial surveys of the eastern Bering Sea in winter.



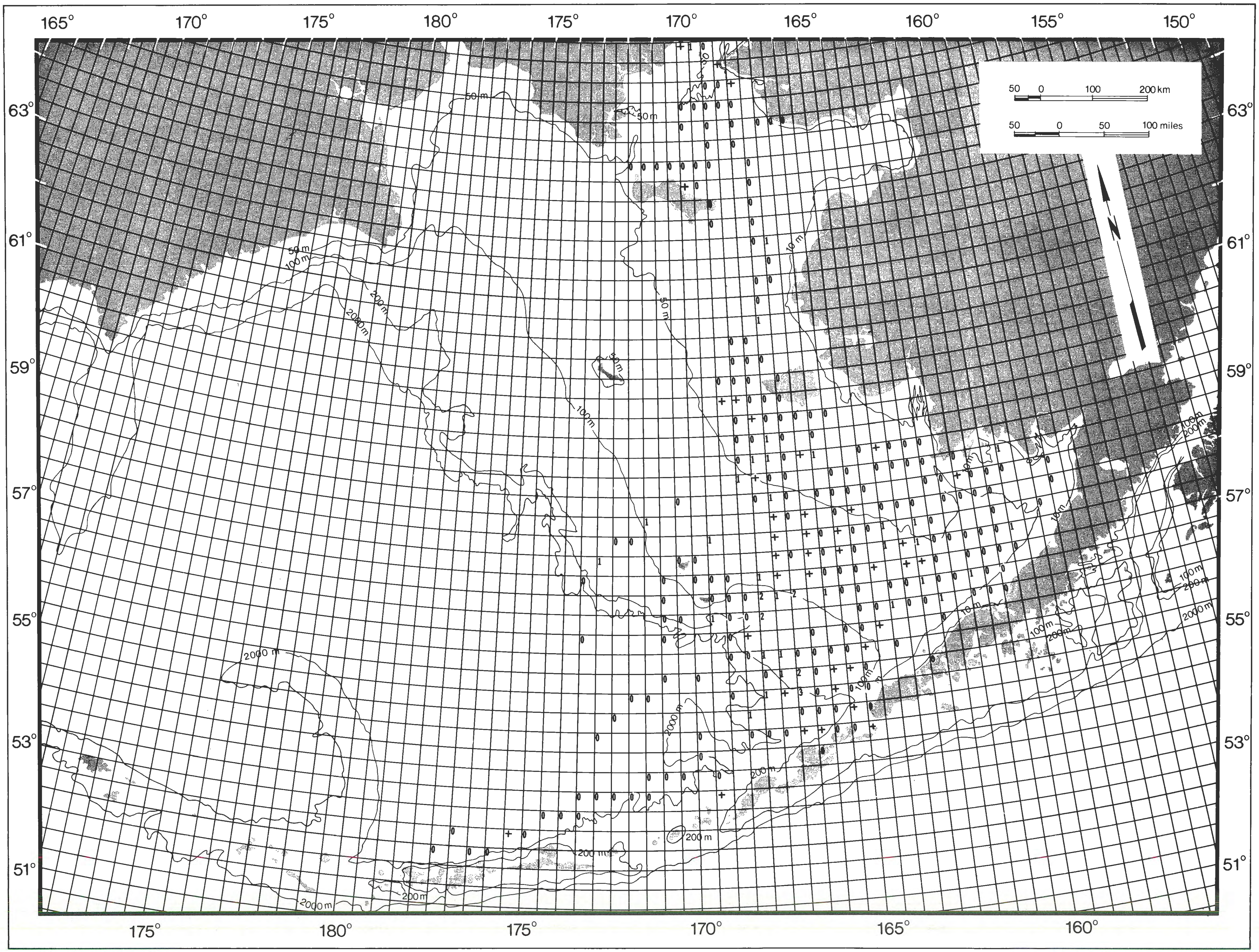

Map 151. Density indices of total jaegers obtained from aerial saveys of the eastern Bering Sea in spring.



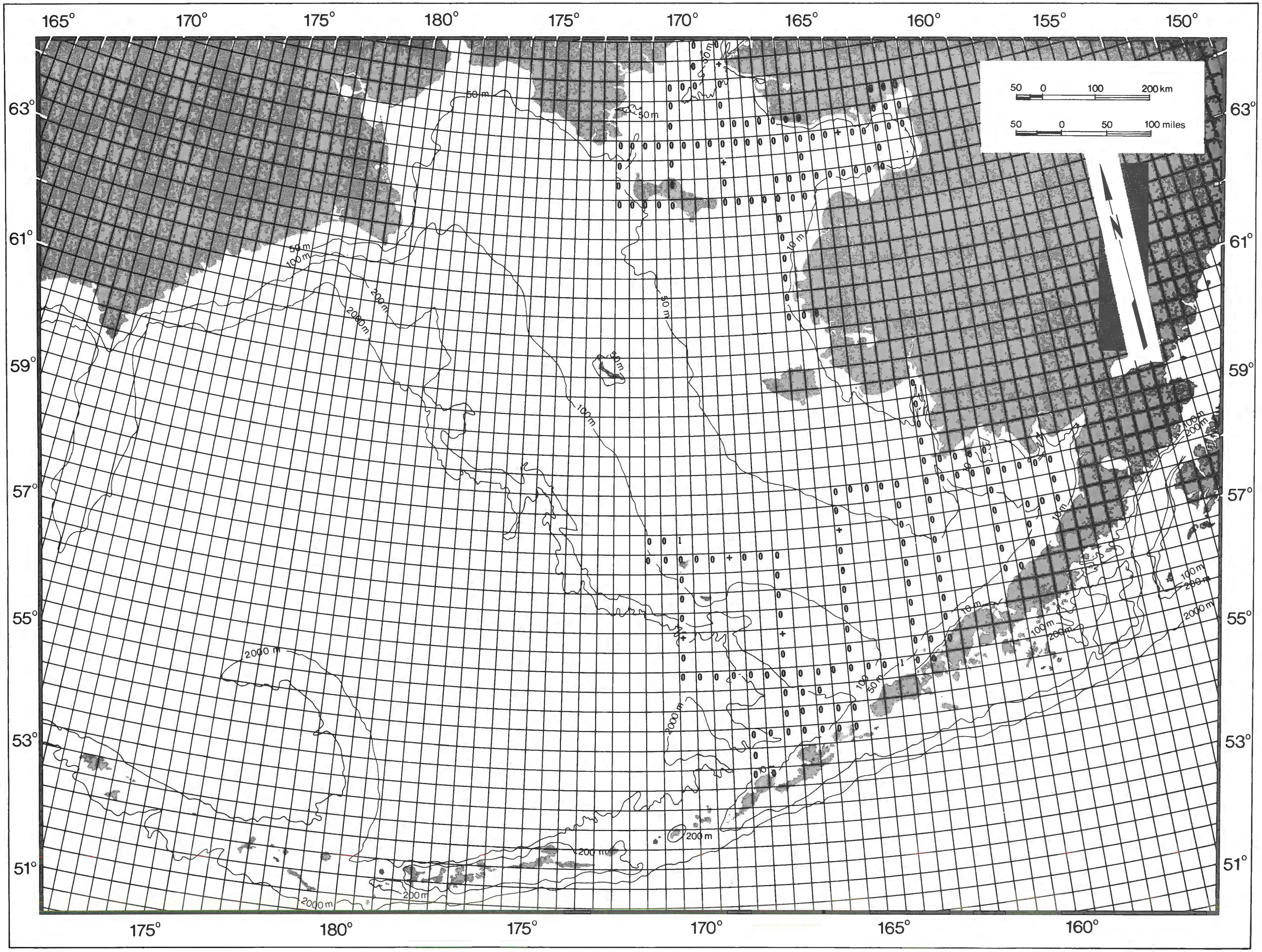

Map 152. Density indices of total jaegers obtained from shipboard surveys of the eastern Bering Sea in summer.



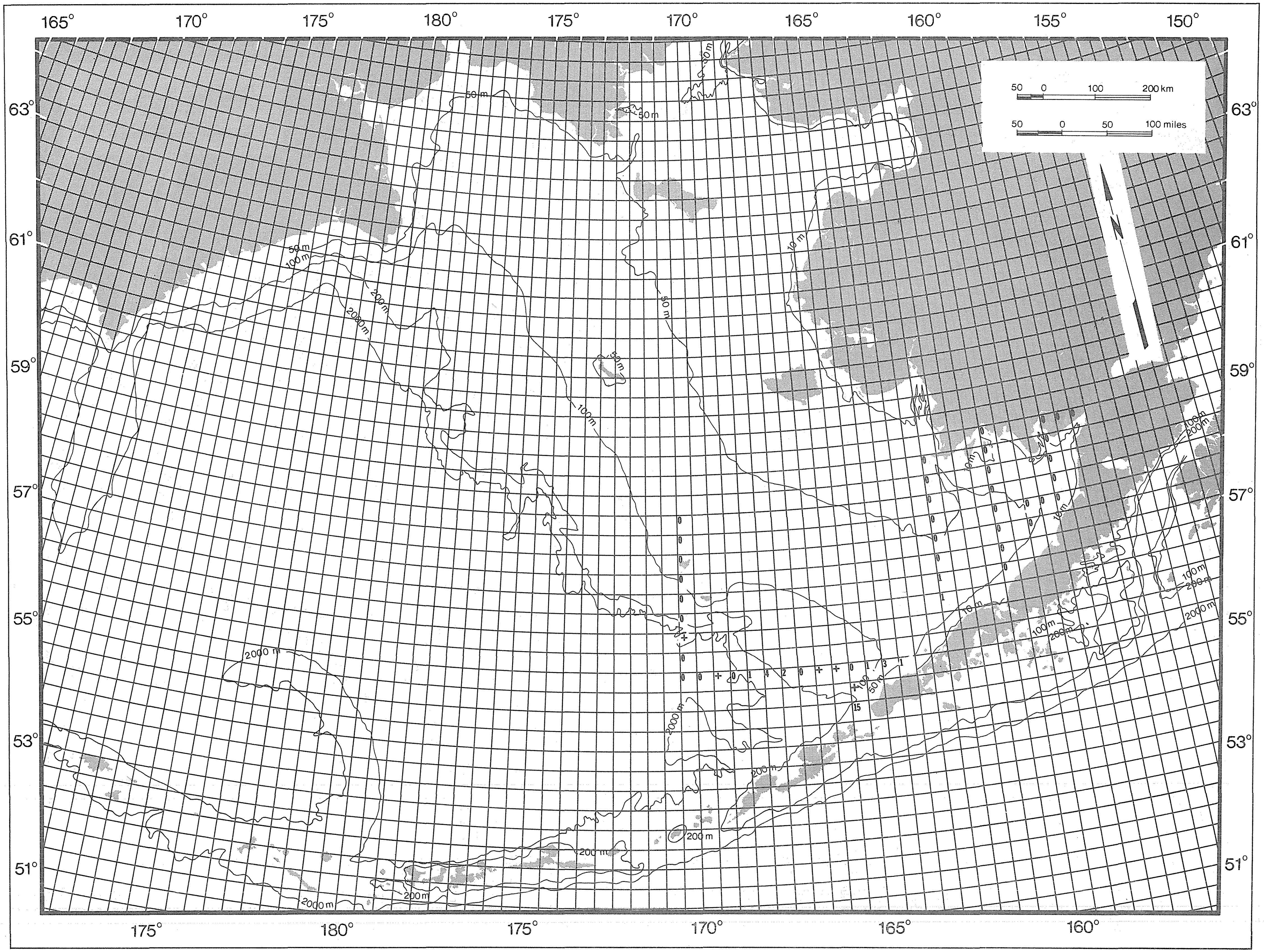

Map 153. Density indices of total jaegers obtained from aerial surveys of the eastern Bering Sea in summer.



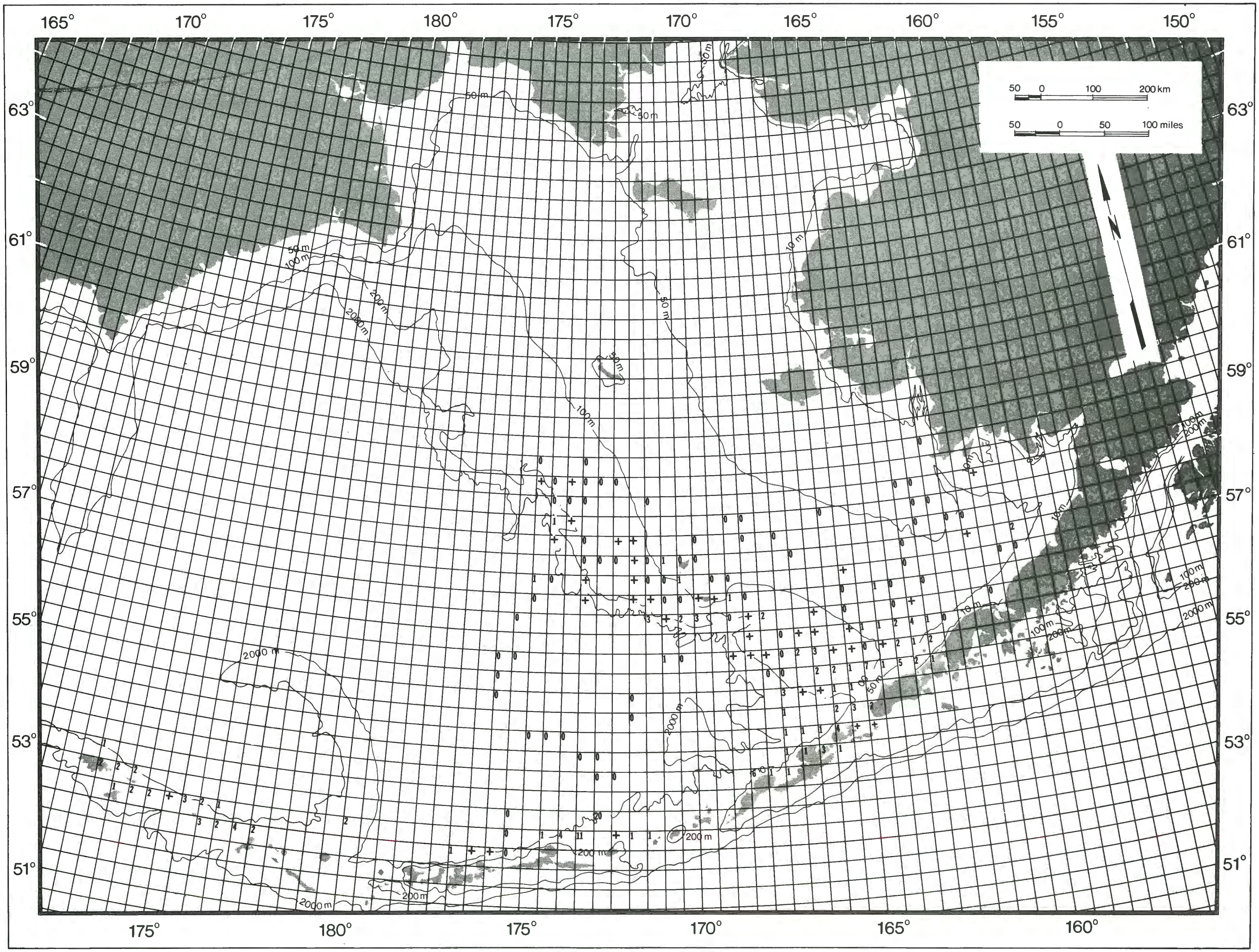

Map 154. Density indices of total jaegers obtained from shipboard surveys of the eastern Bering Sea in fall.



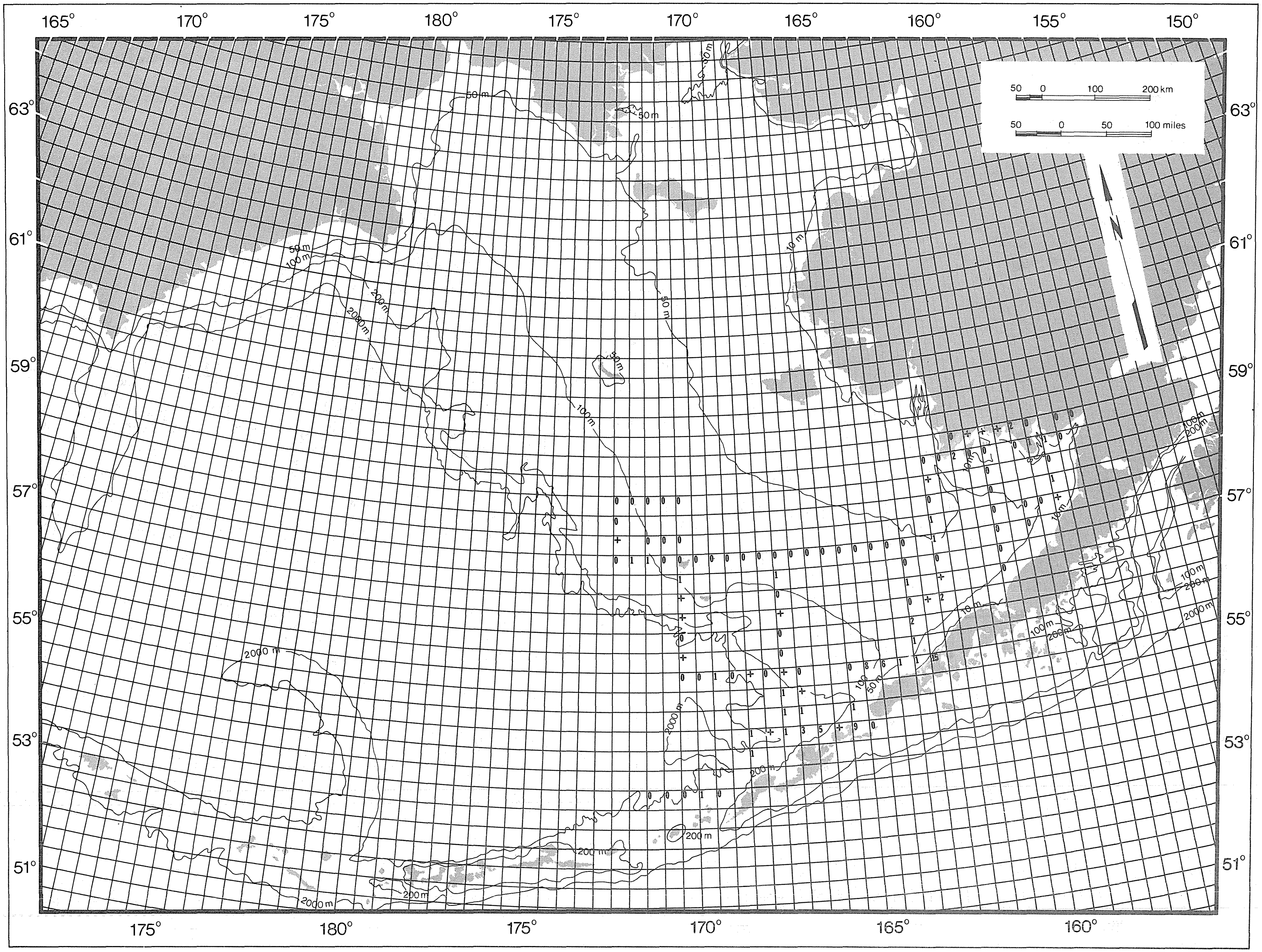

Map 155. Density indices of total jaegers obtained from aerial surveys of the eastern Bering Sea in fall.



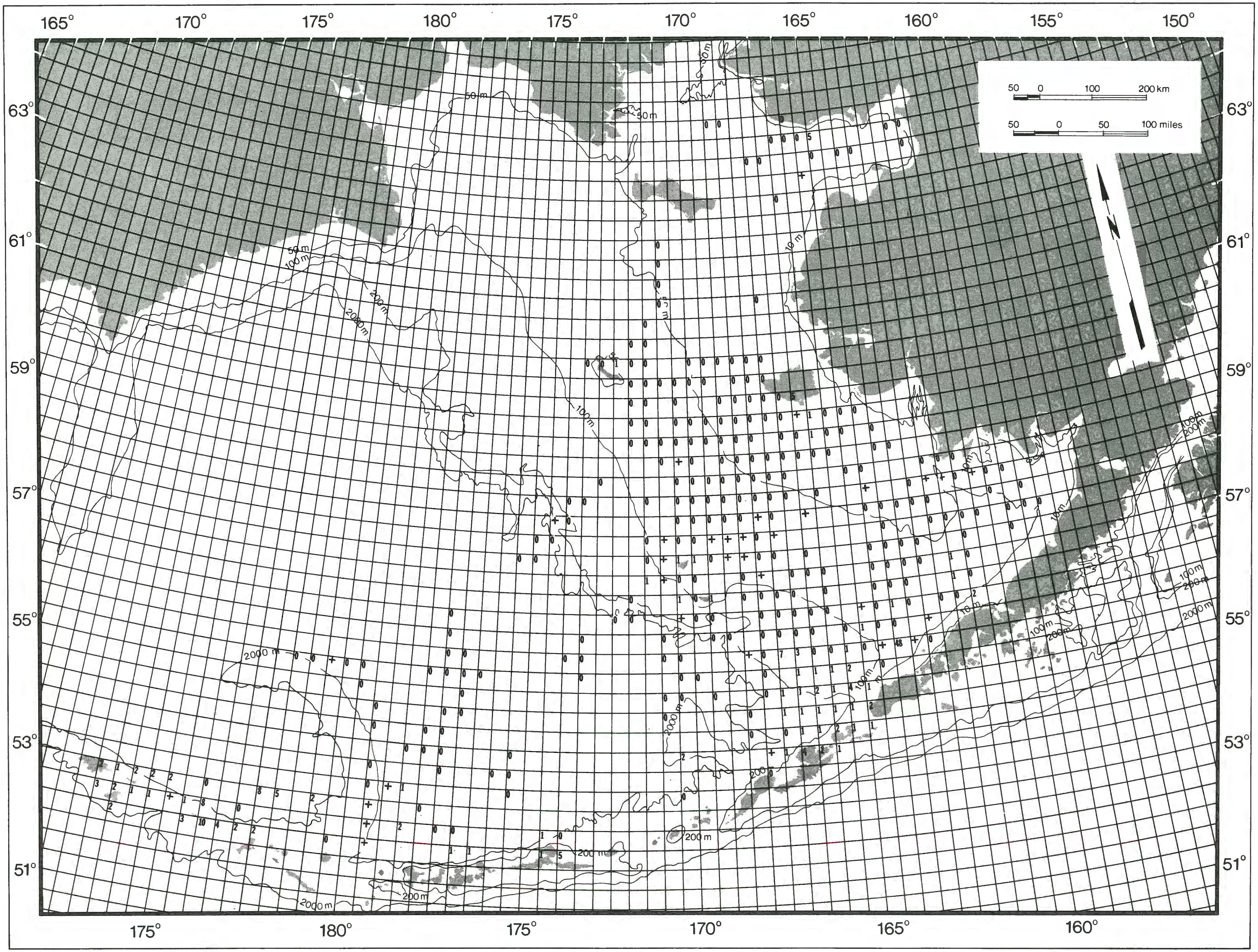

Map 156. Density indices of Glaucous-winged Gull obtained from aerial surveys of the eastern Bering Sea in winter.



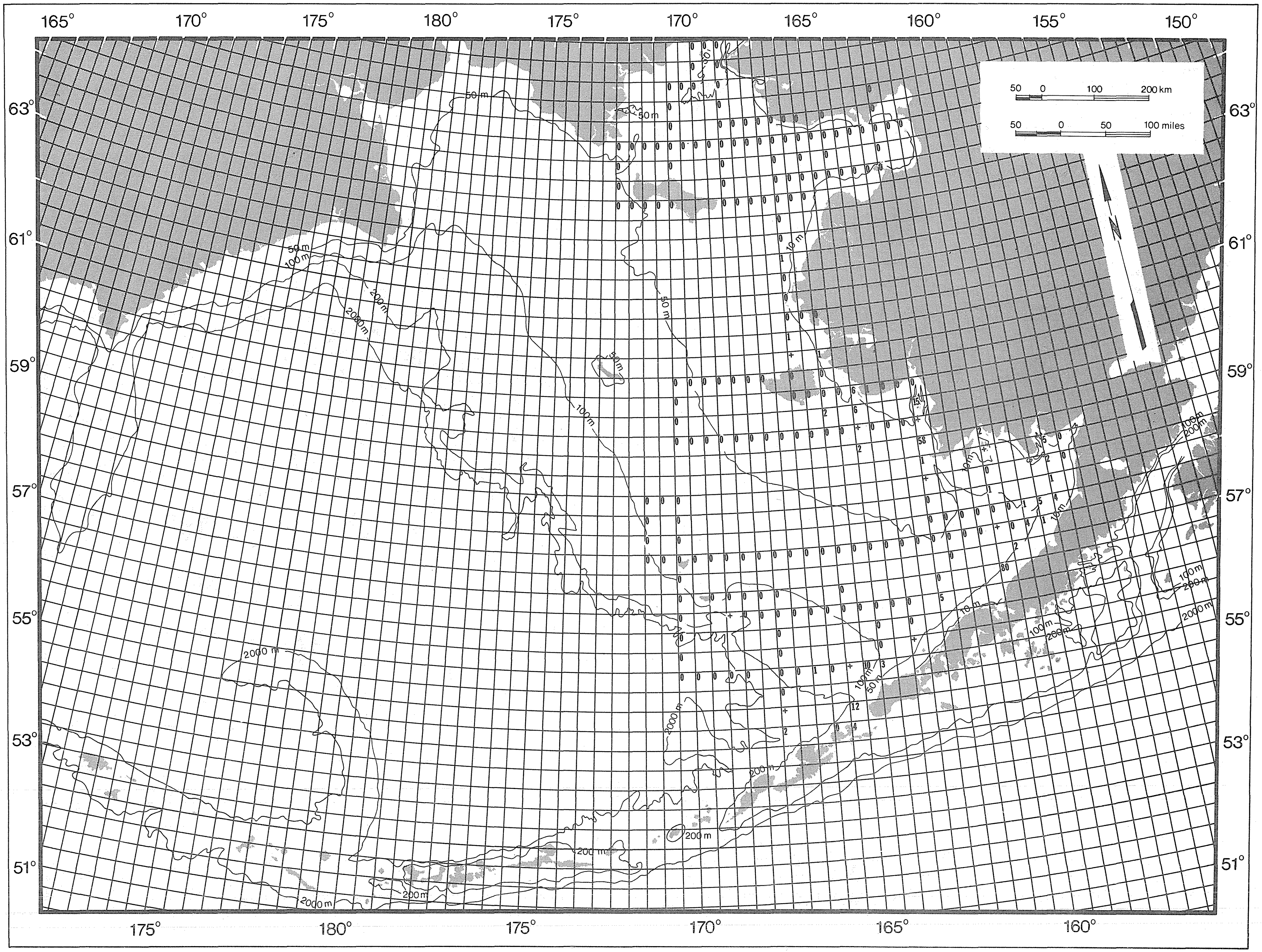

Map 157. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the eastern Bering Sea in spring.



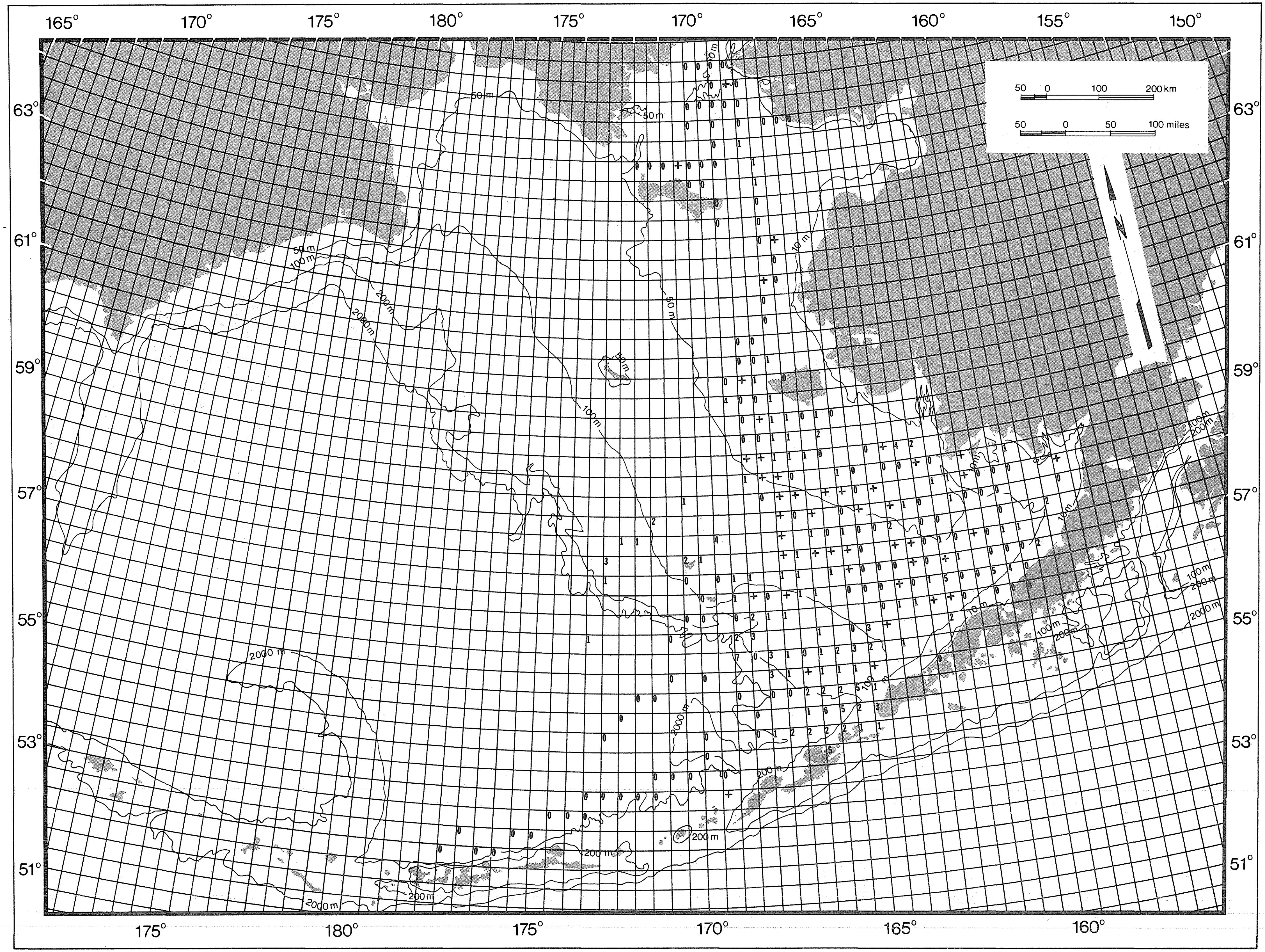

Map 158. Density indices of Glaucous-winged Gull obtained from aerial surveys of the eastern Bering Sea in spring.



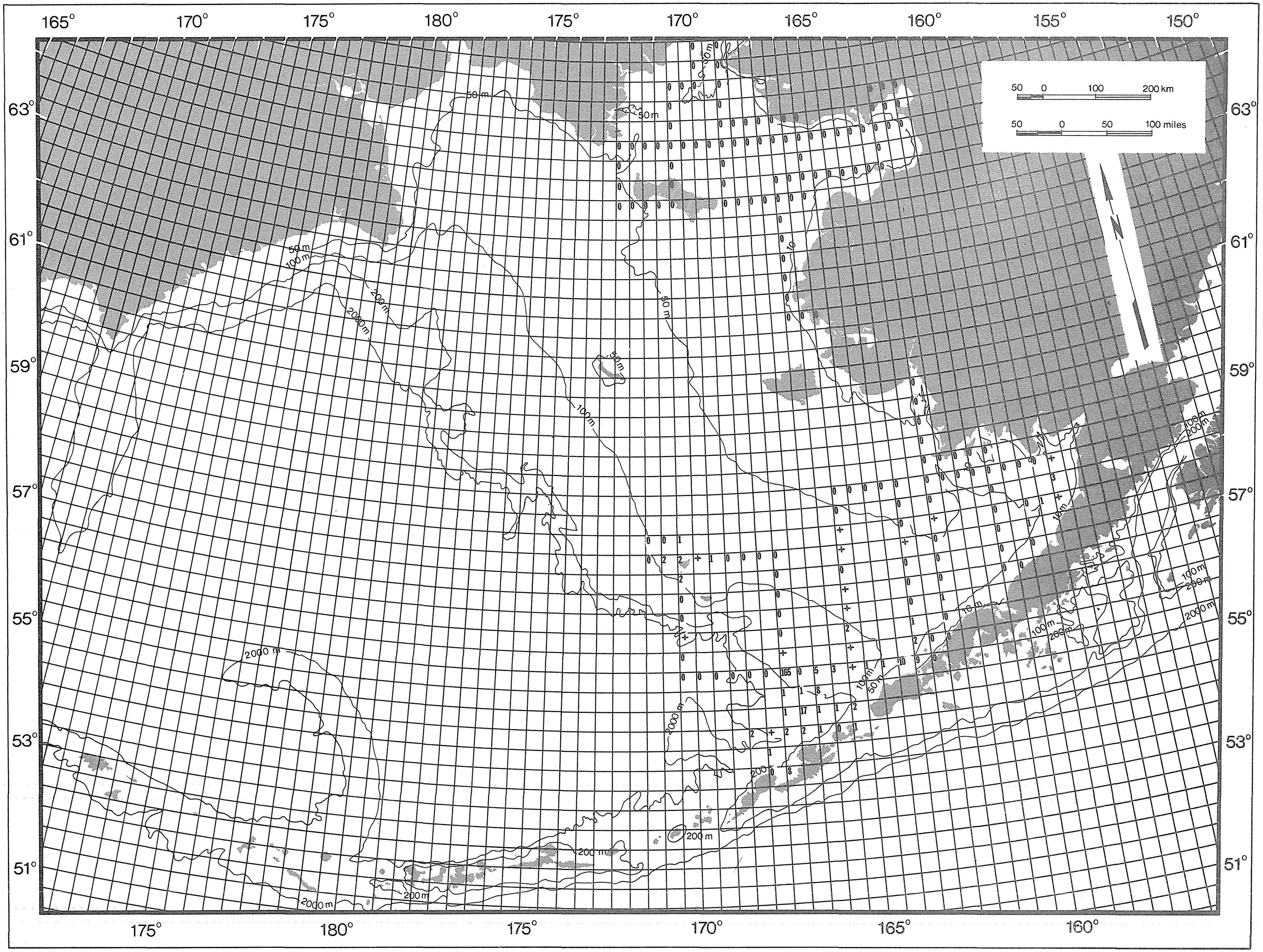

Map 159. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the eastern Bering Sea in summer.



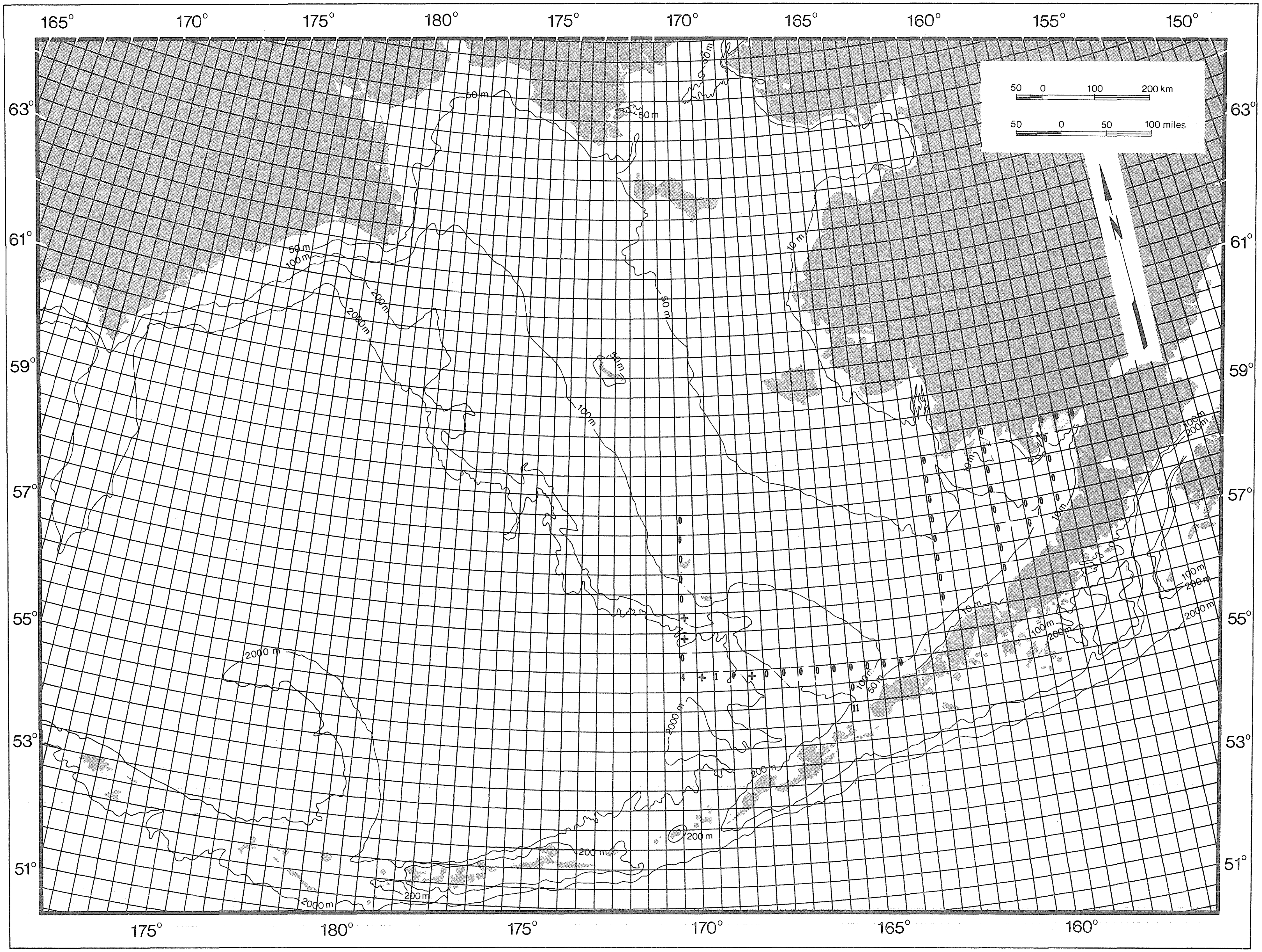

Map 160. Density indices of Glaucous-winged Gull obtained from aerial surveys of the eastern Bering Sea in summer.



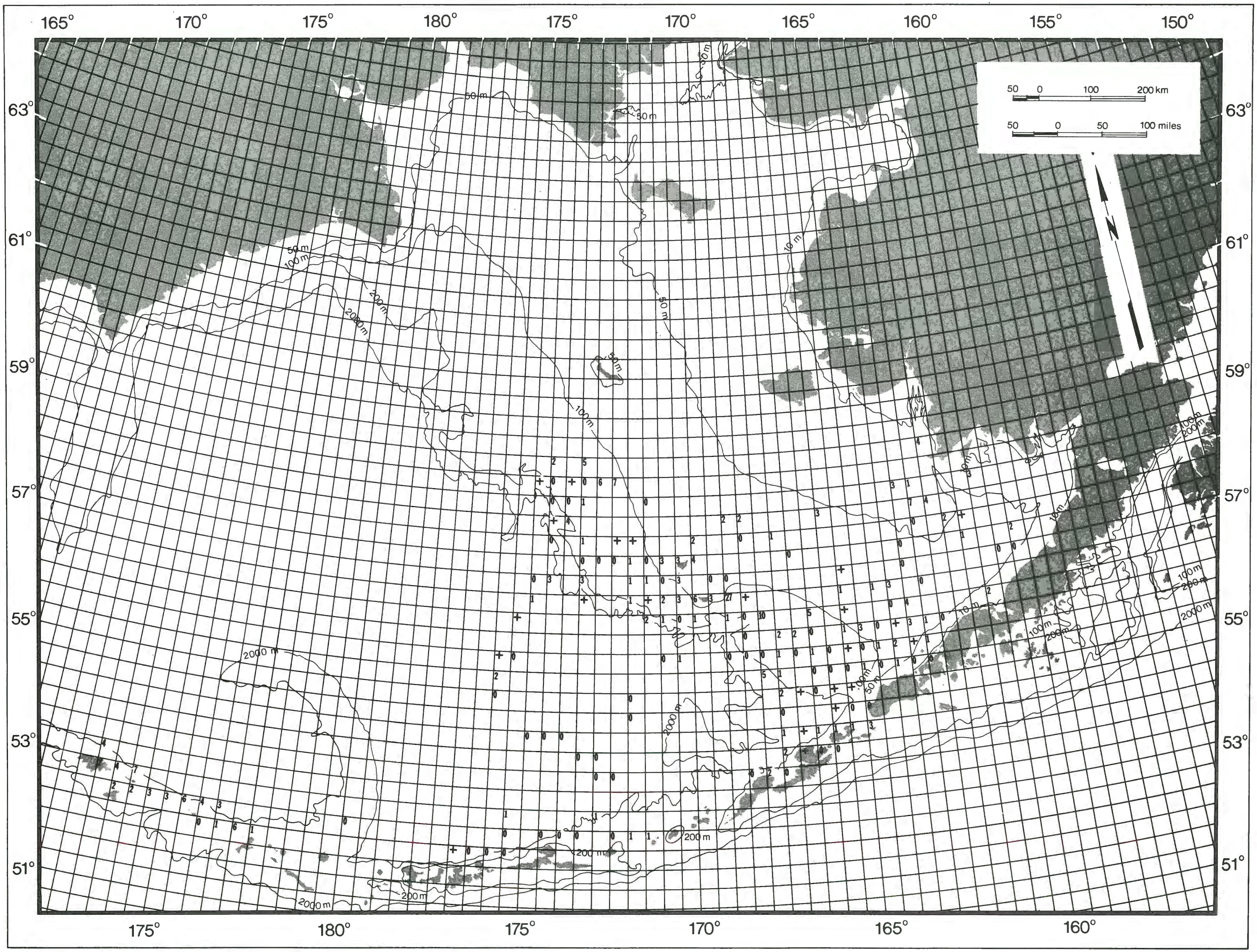

Map 161. Density indices of Glaucous-winged Gull obtained from shipboard surveys of the eastern Bering Sea in fall.



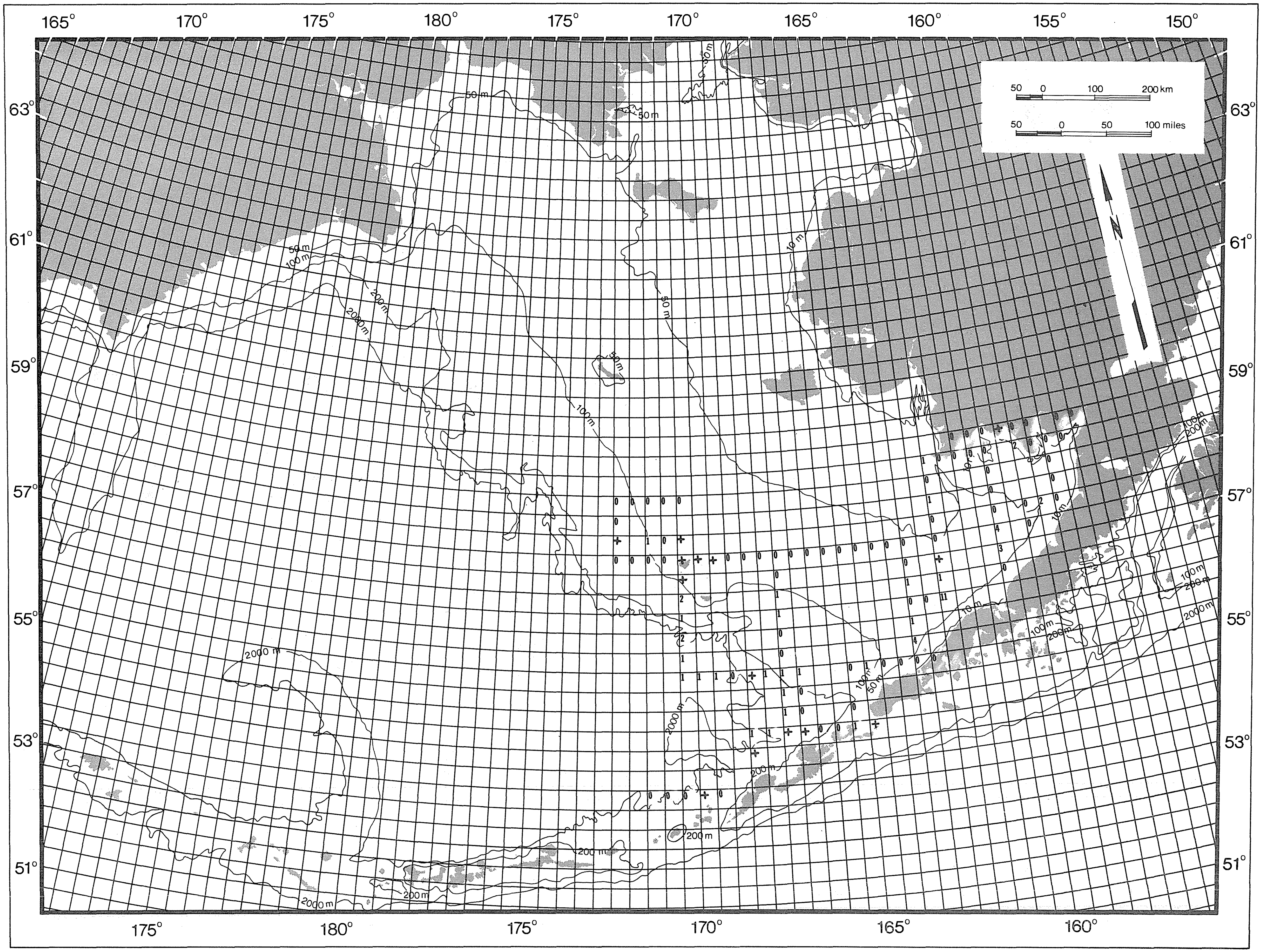

Map 162. Density indices of Glaucous-winged Gull obtained from aerial surveys of the eastern Bering Sea in fall.



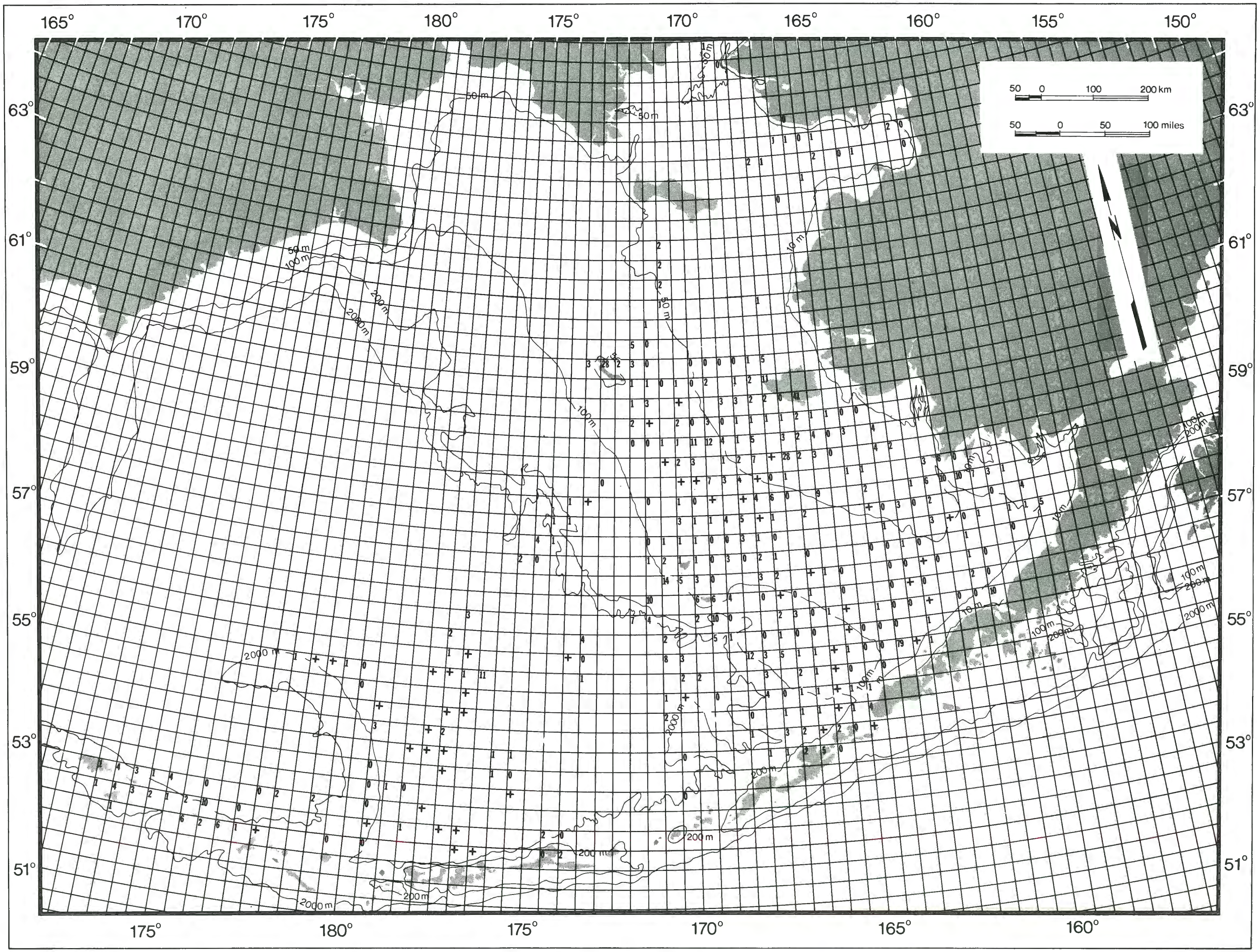

Map 163. Density indices of kittiwakes obtained from aerial surveys of the eastern Bering Sea in winter.



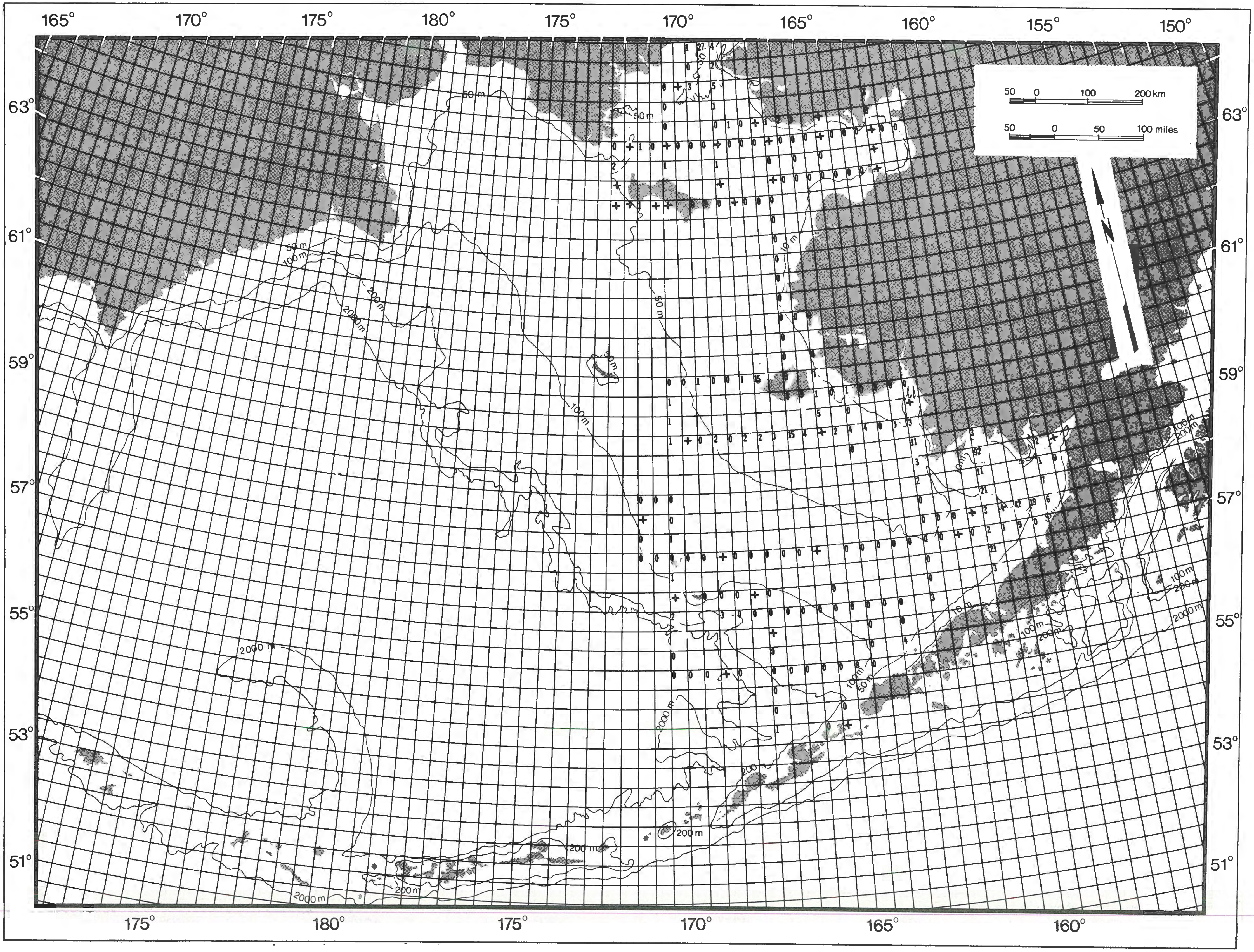

Map 164. Density indices of kittiwakes obtained from shipboard surveys of the eastern Bering Sea in spring.



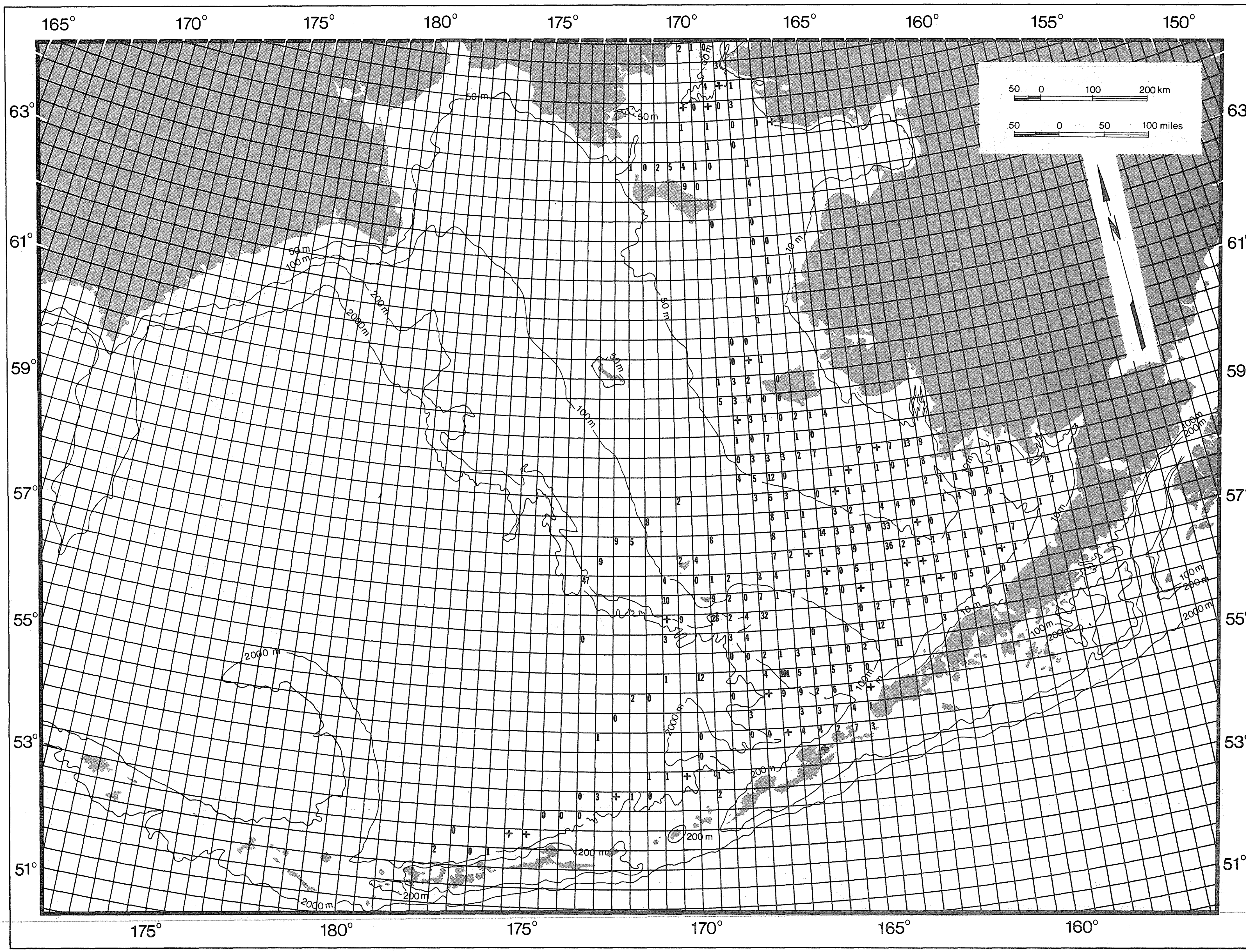

Map 165. Density indices of kittiwakes obtained from aerial surveys of the eastern Bering Sea in spring.



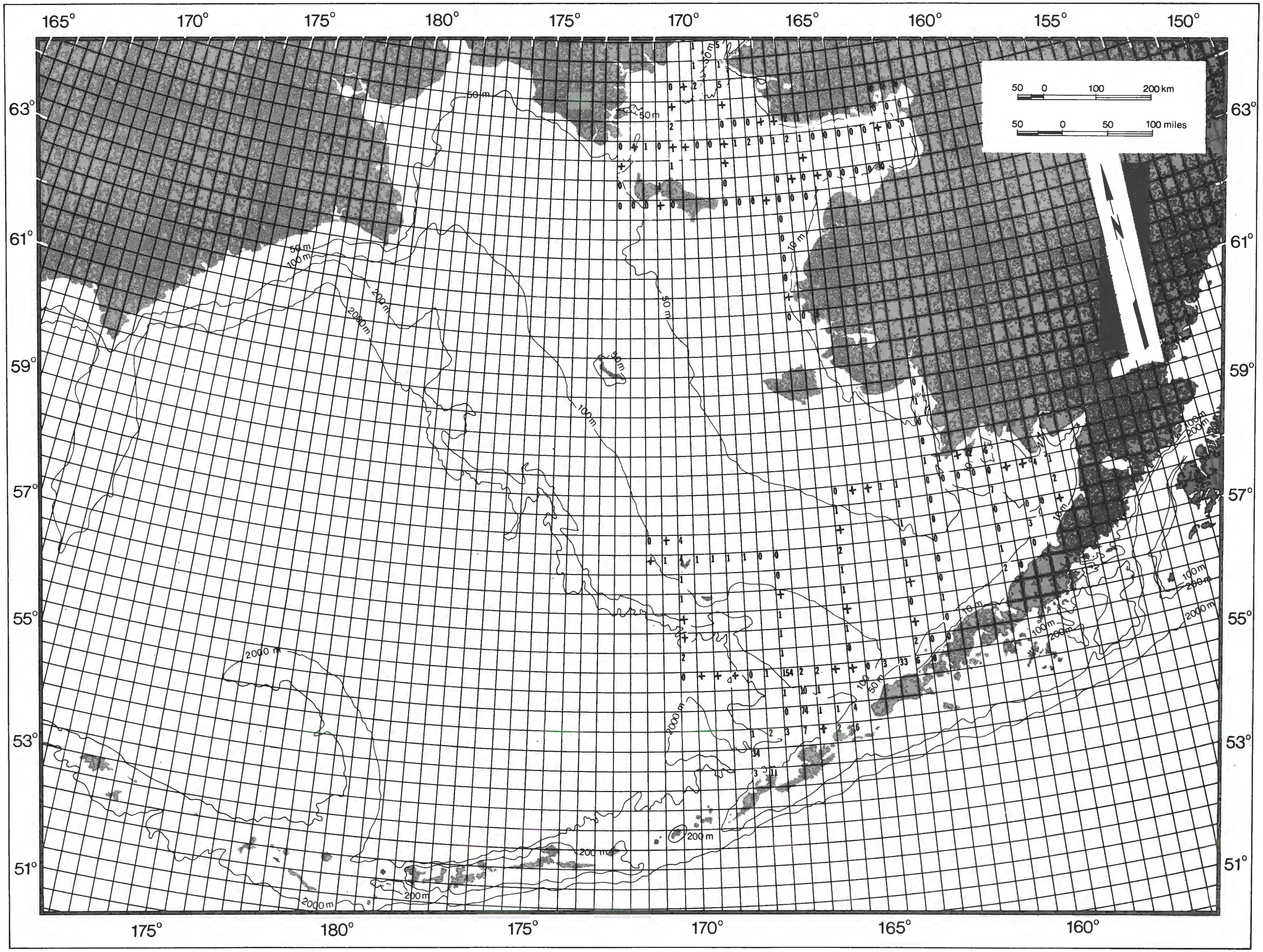

Map 166. Density indices of kittiwakes obtained from shipboard surveys of the eastern Bering Sea in summer.



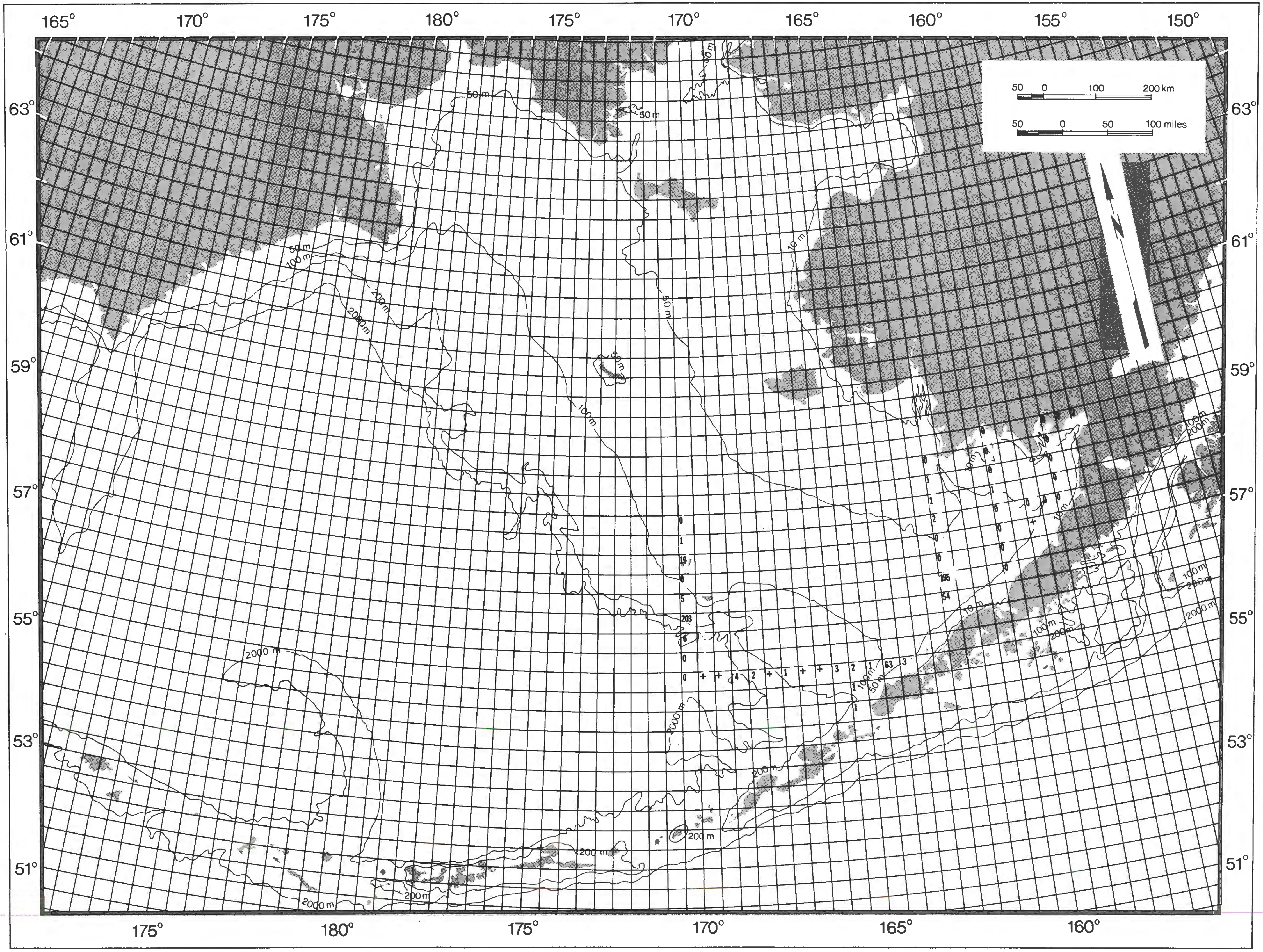

Map 167. Density indices of kittiwakes obtained from aerial surveys of the eastern Bering Sea in summer.



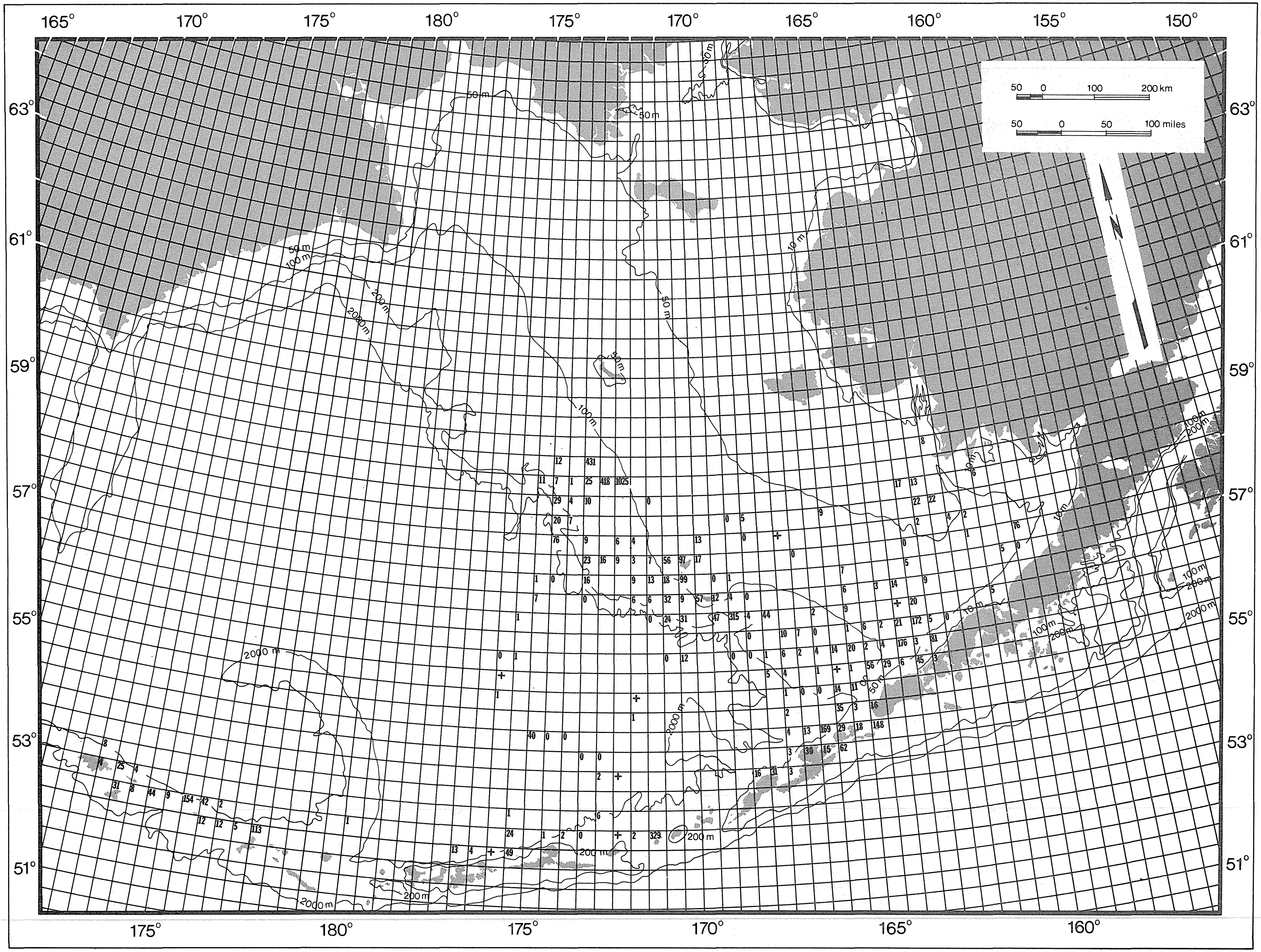

Map 168. Density indices of kittiwakes obtained from shipboard surveys of the eastern Bering Sea in fall.



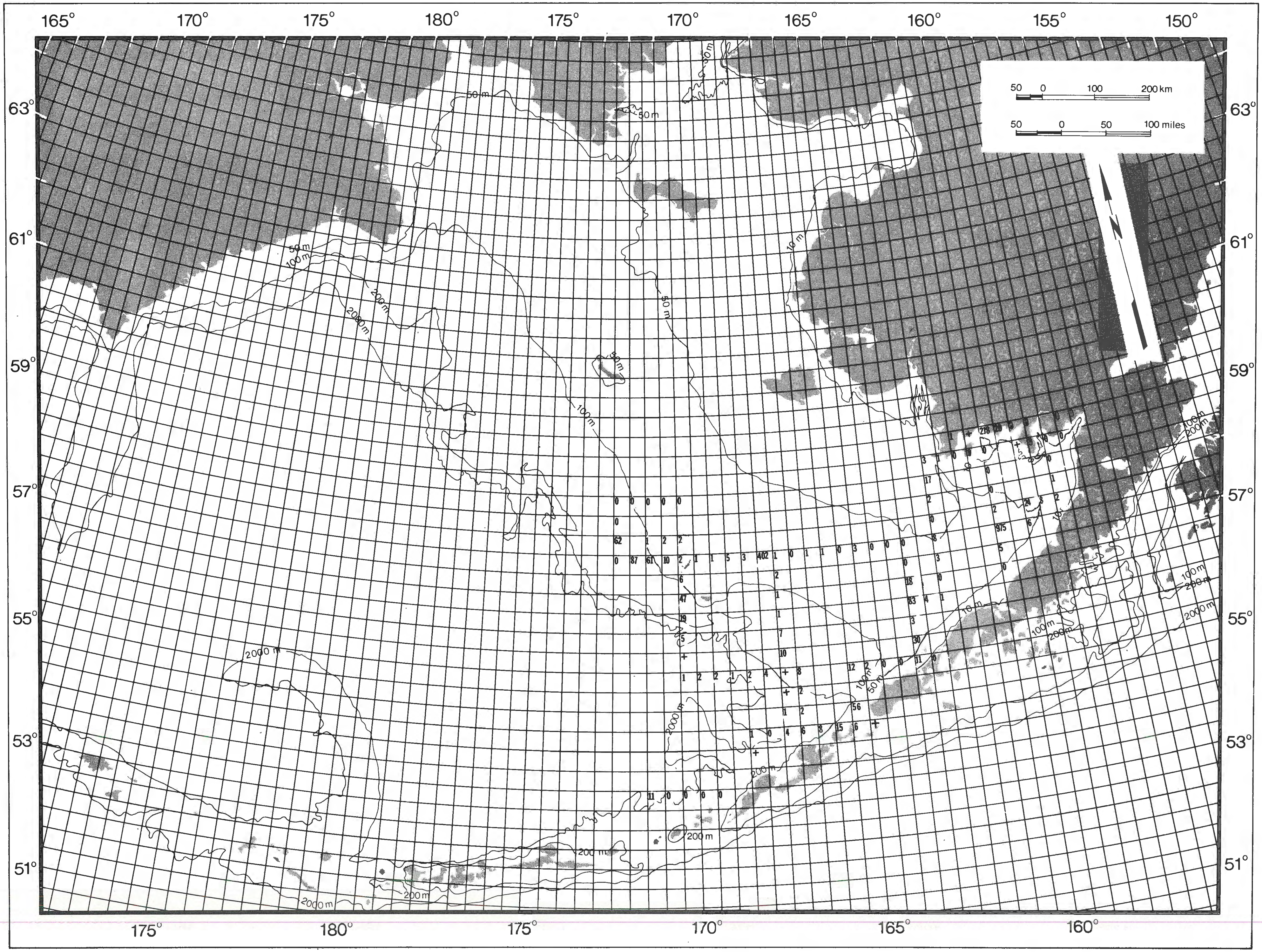

Map 169. Density indices of kittiwakes obtained from aerial surveys of the eastern Bering Sea in fall.



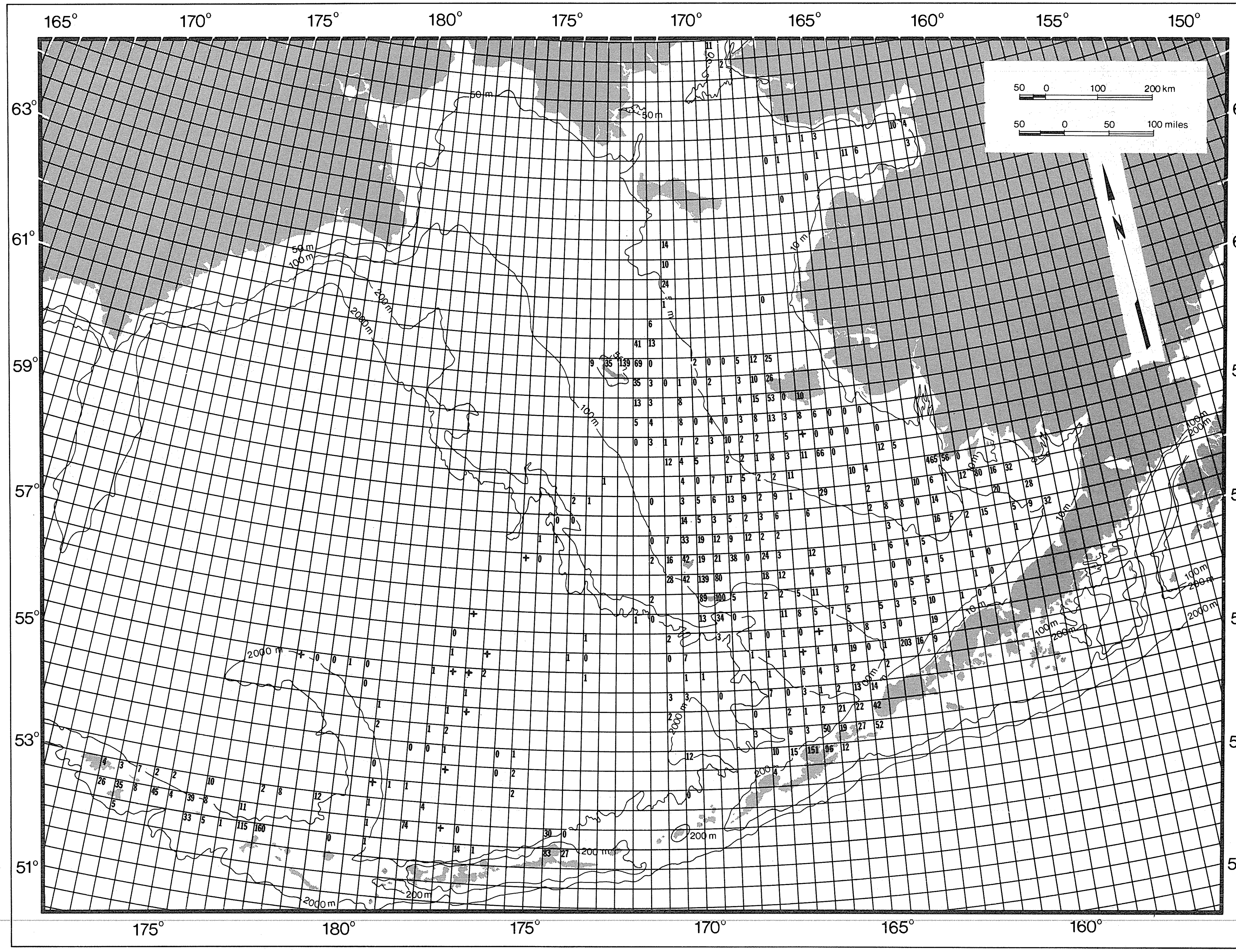

Map 170. Density indices of total alcids obtained from aerial surveys of the eastern Bering Sea in winter.



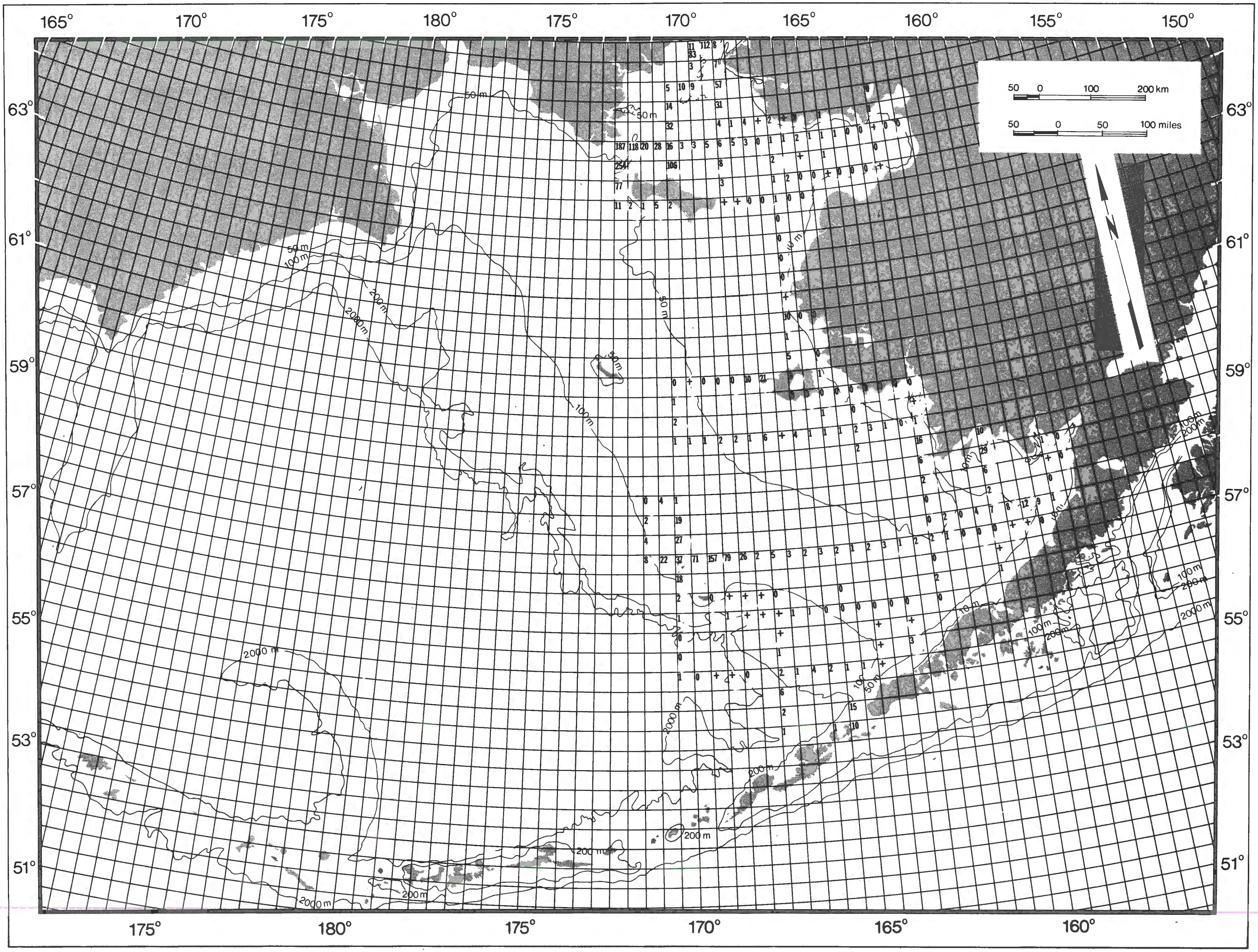

Map 171. Density indices of total alcids obtained from shipboard surveys of the eastern Bering Sea in spring.



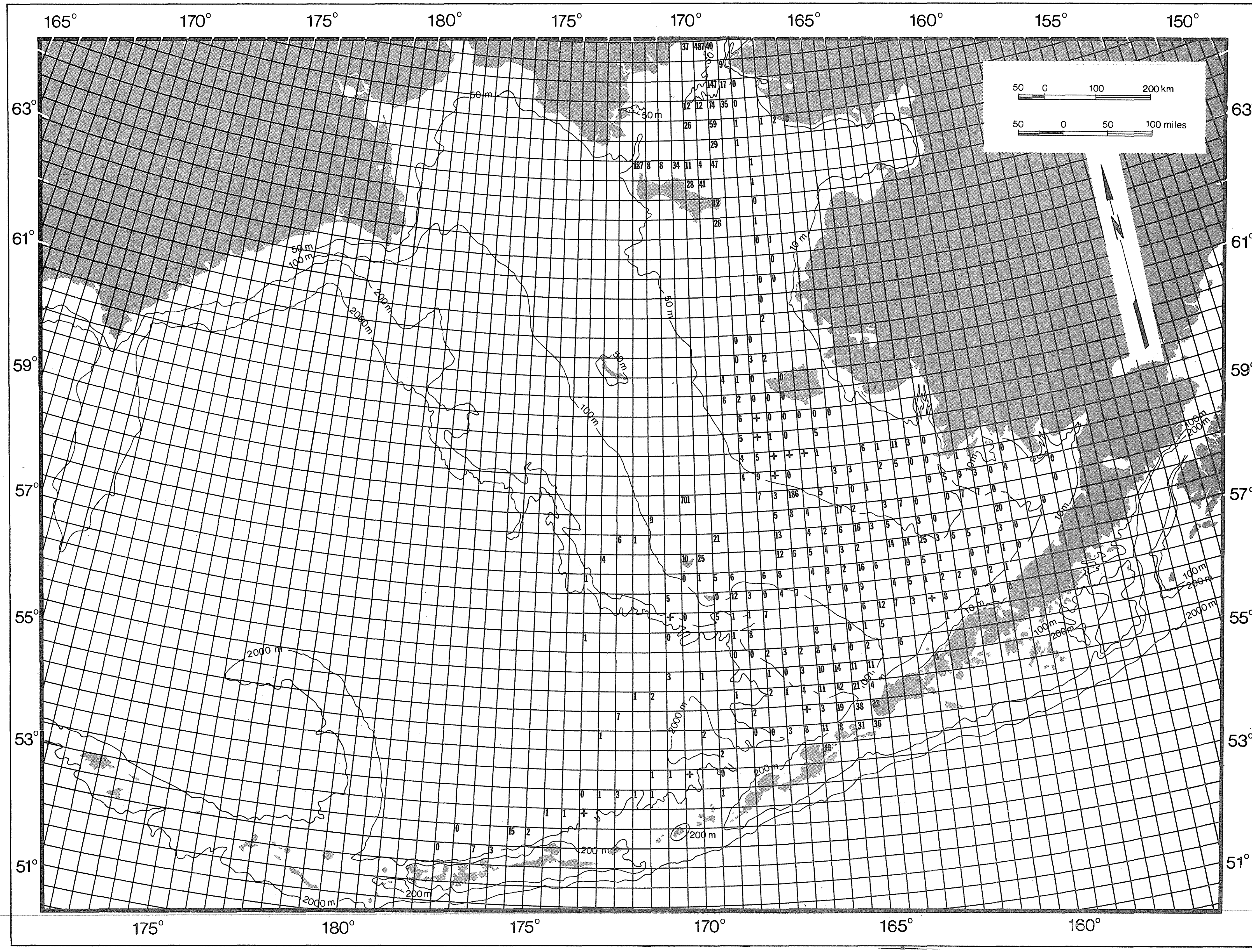

Map 172. Density indices of total alcids obtained from aerial surveys of the eastern Bering Sea in spring.



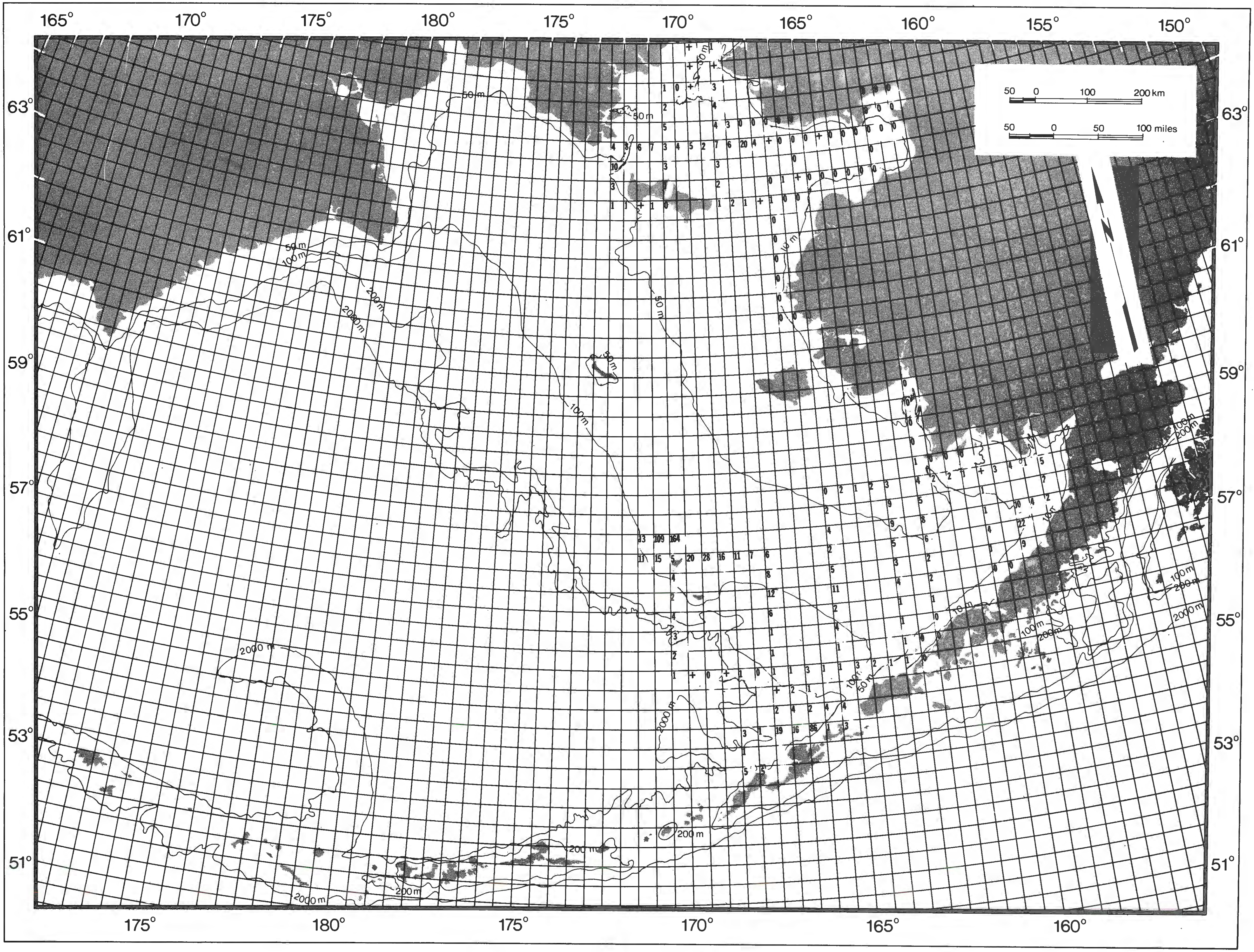

Map 173. Density indices of total alcids obtained from shipboard surveys of the eastern Bering Sea in summer.



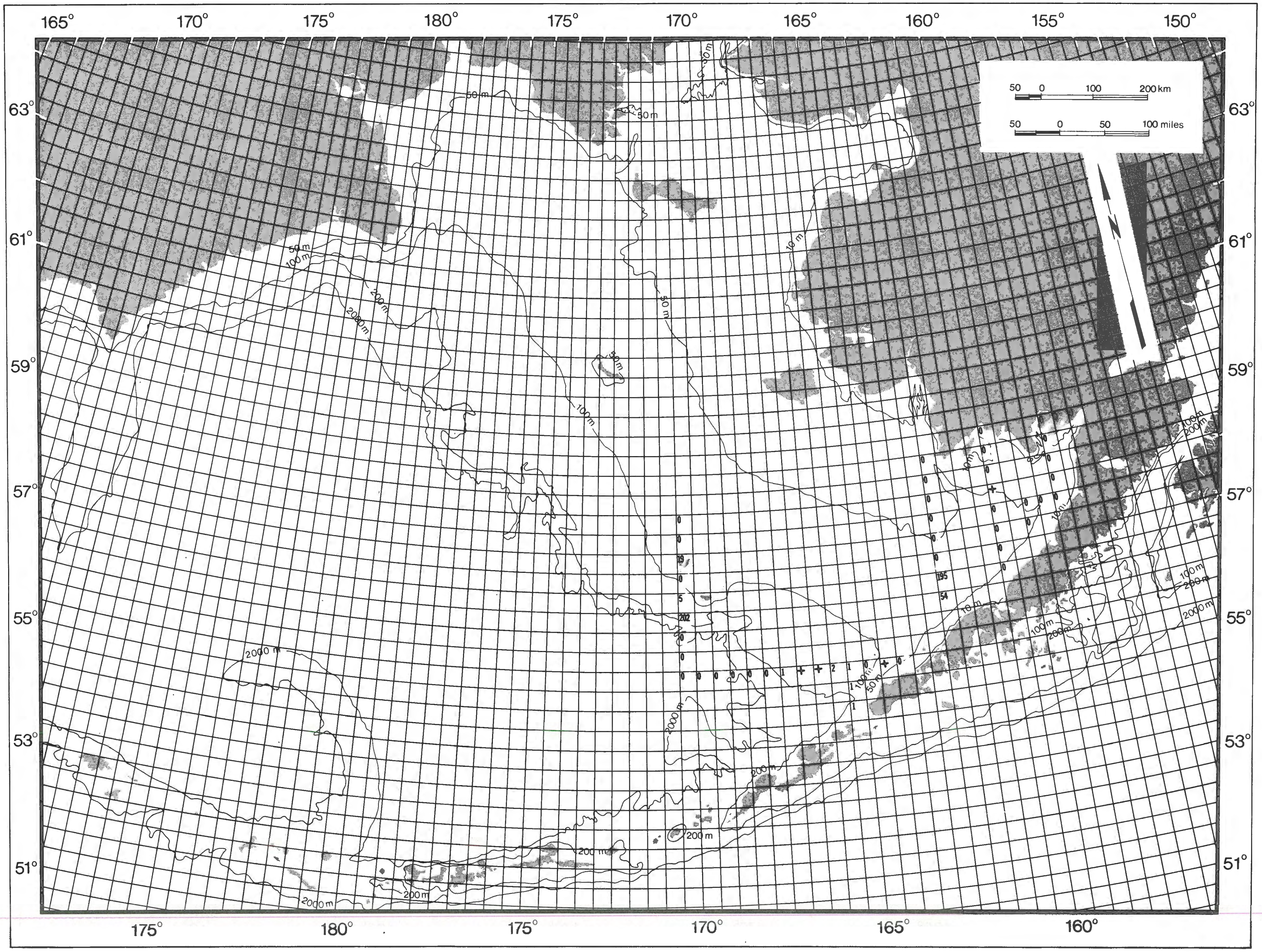

Map 174. Density indices of total alcids obtained from aerial surveys of the eastern Bering Sea in summer.



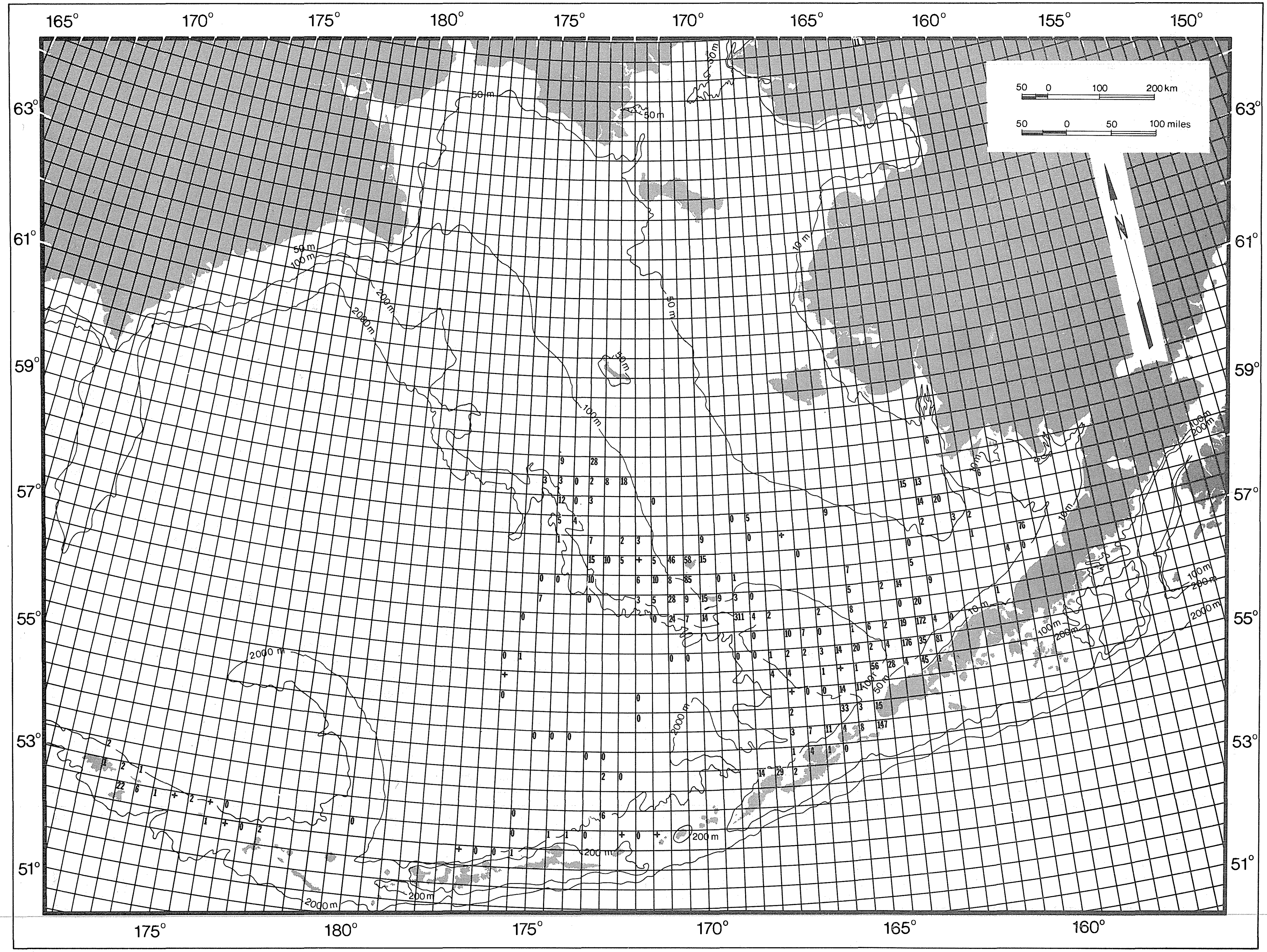

Map 175. Density indices of total alcids obtained from shipboard surveys of the eastern Bering Sea in fall.



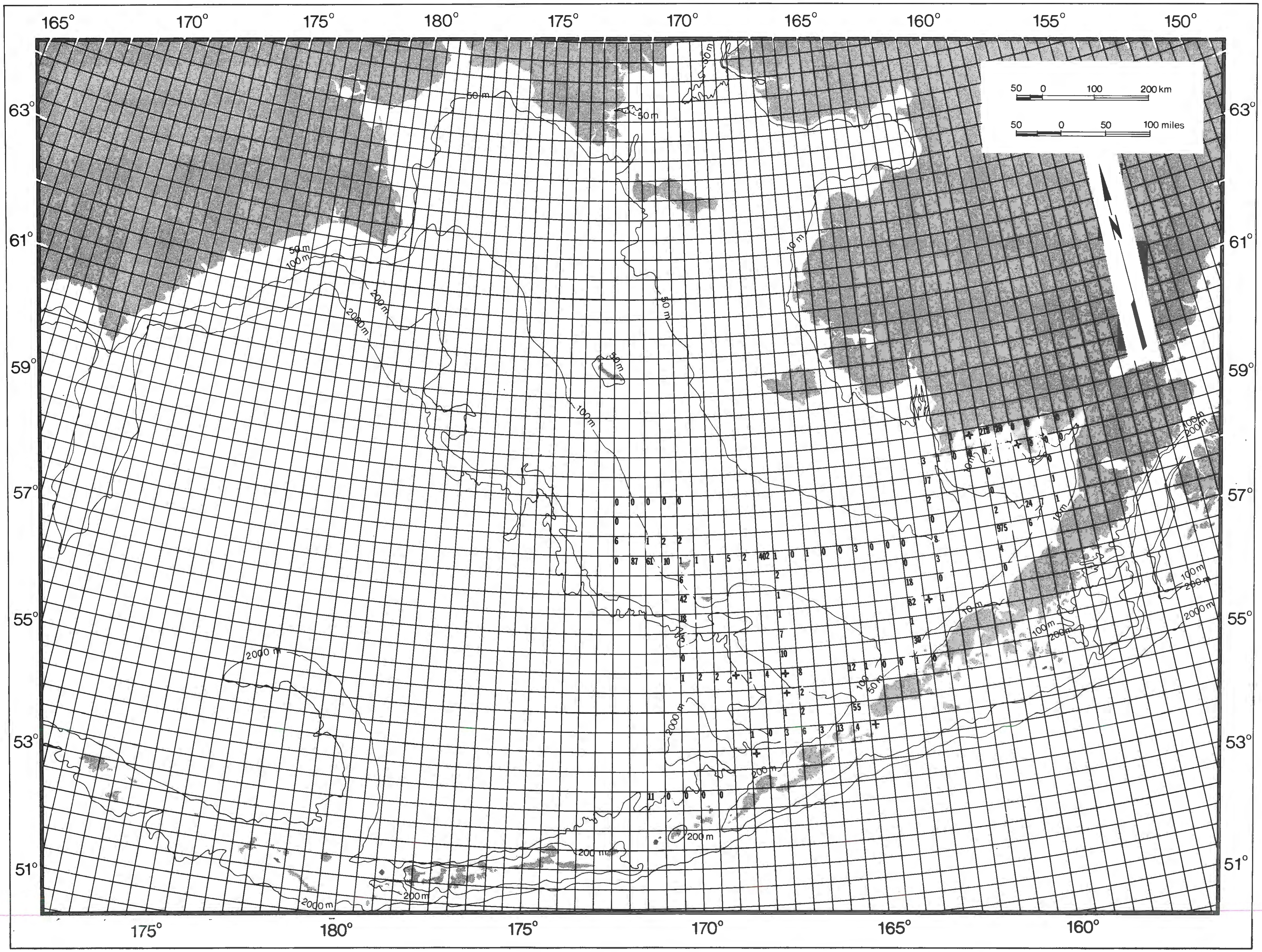

Map 176. Density indices of total alcids obtained from aerial surveys of the eastern Bering Sea in fall.



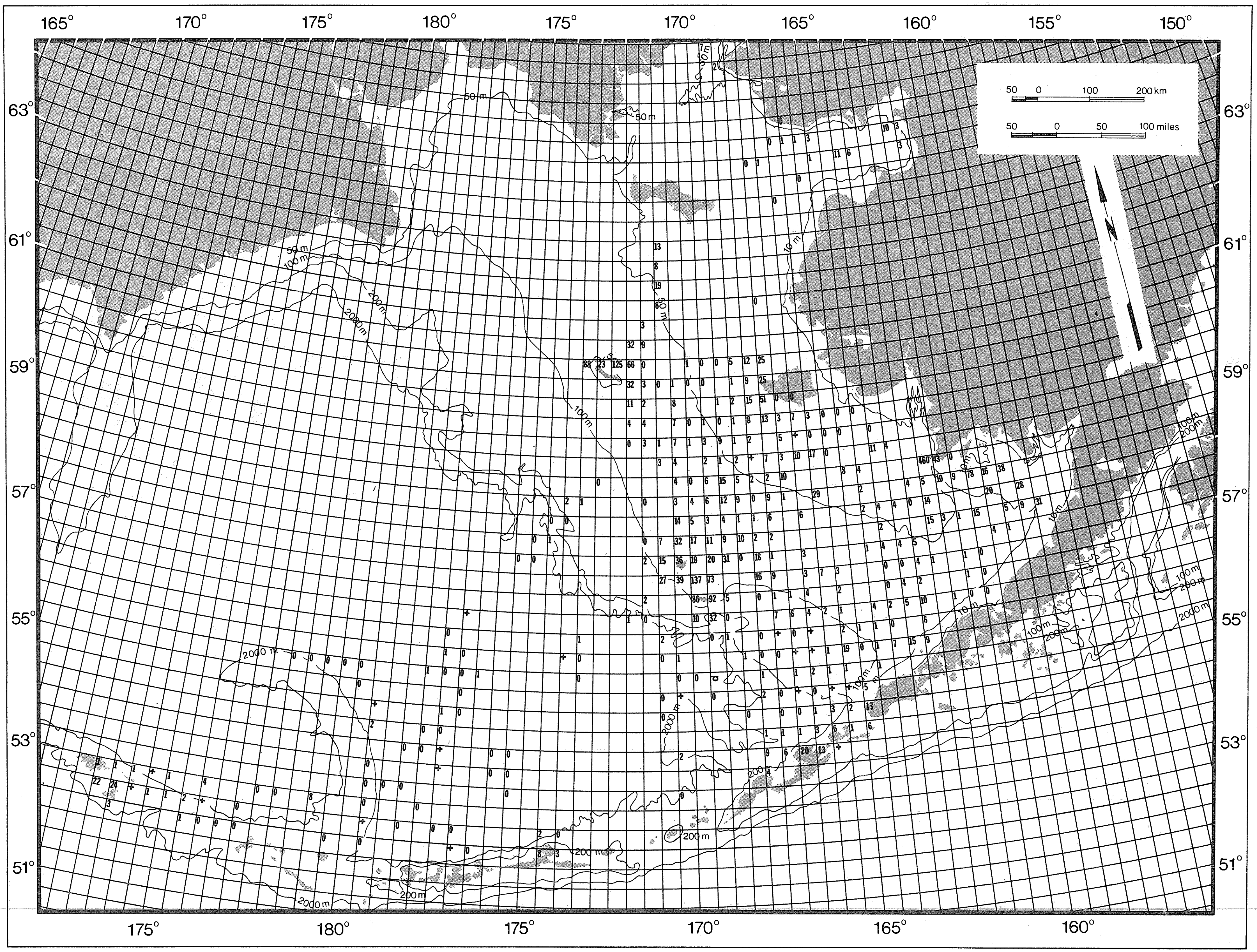

Map 177. Density indices of total murres obtained from aerial surveys of the eastern Bering Sea in winter.



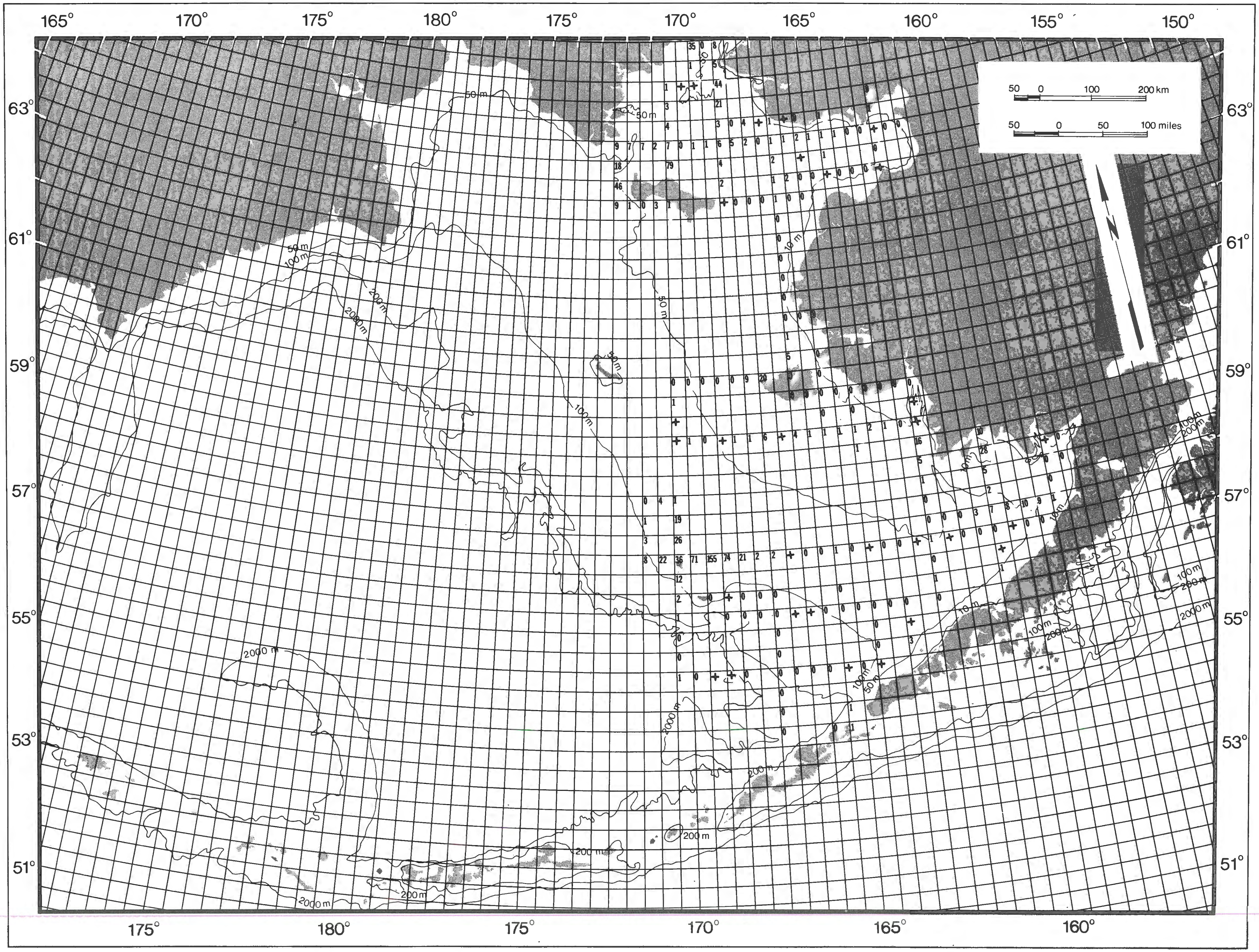

Map 178. Density indices of total murres obtained from shipboard surveys of the eastern Bering Sea in spring.



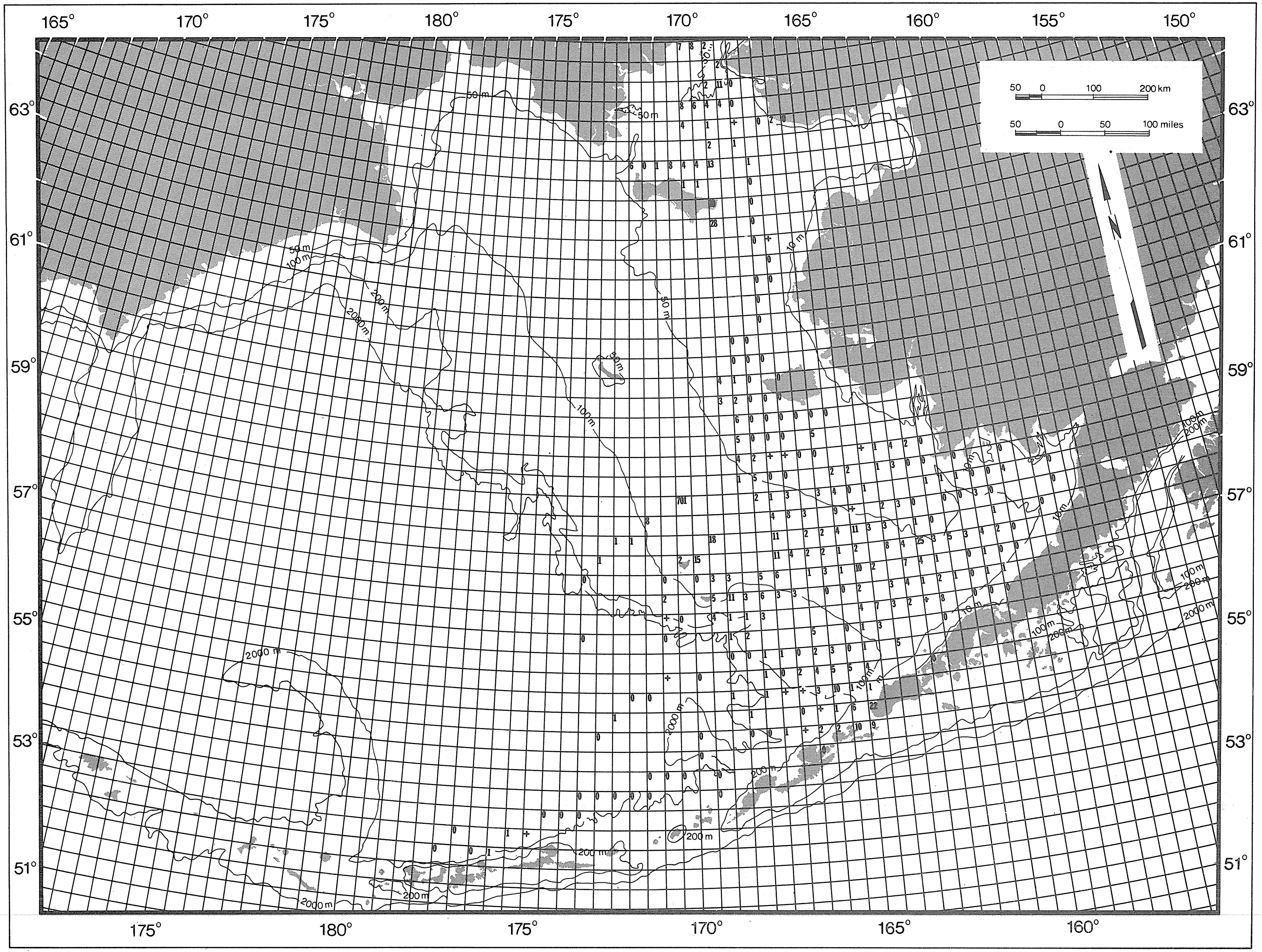

Map 179. Density indices of total murres obtaind from aerial surveys of the eastern Bering Sea in spring.



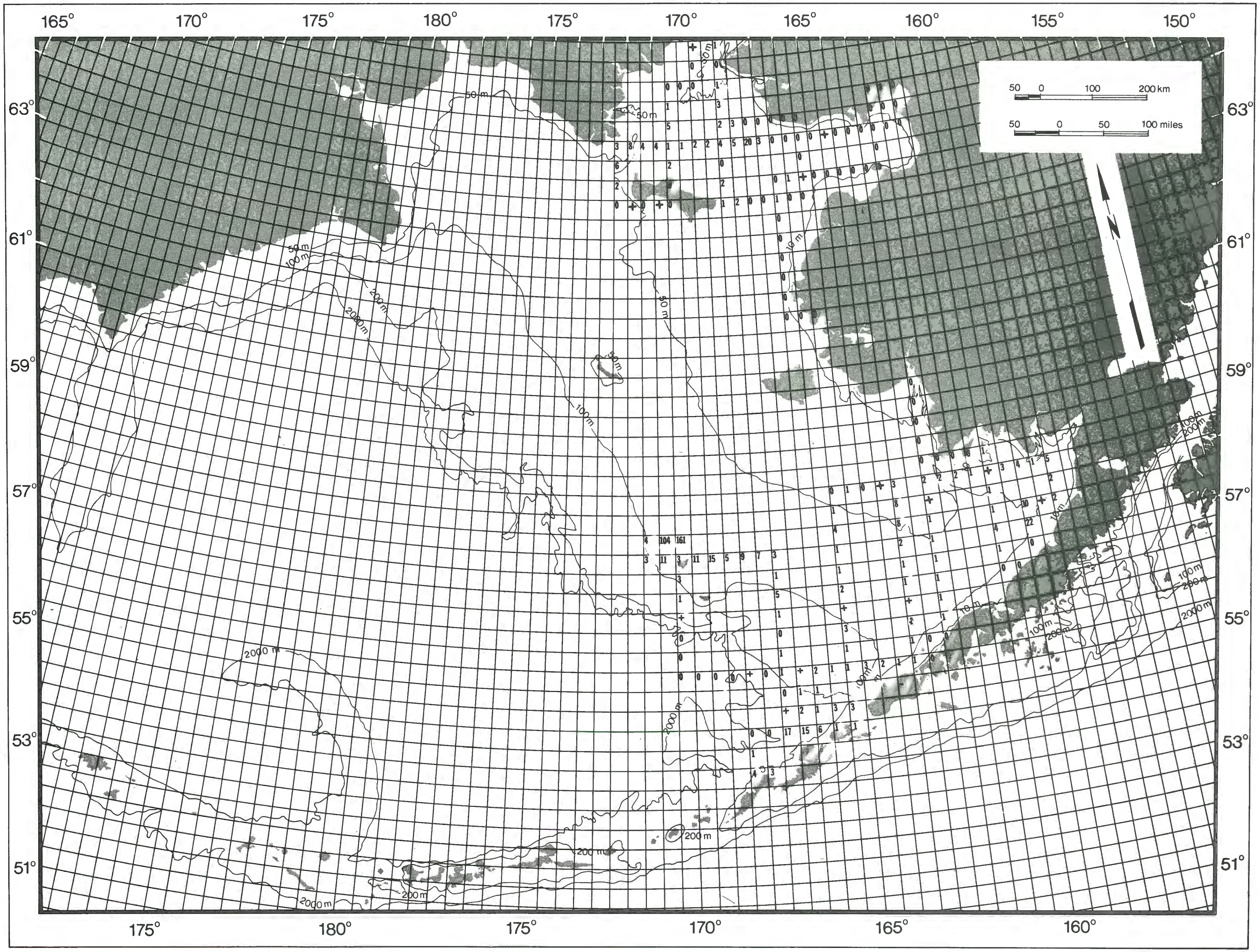

Map 180. Density indices of total murres obtained from shipboard surveys of the eastern Bering Sea in summer.



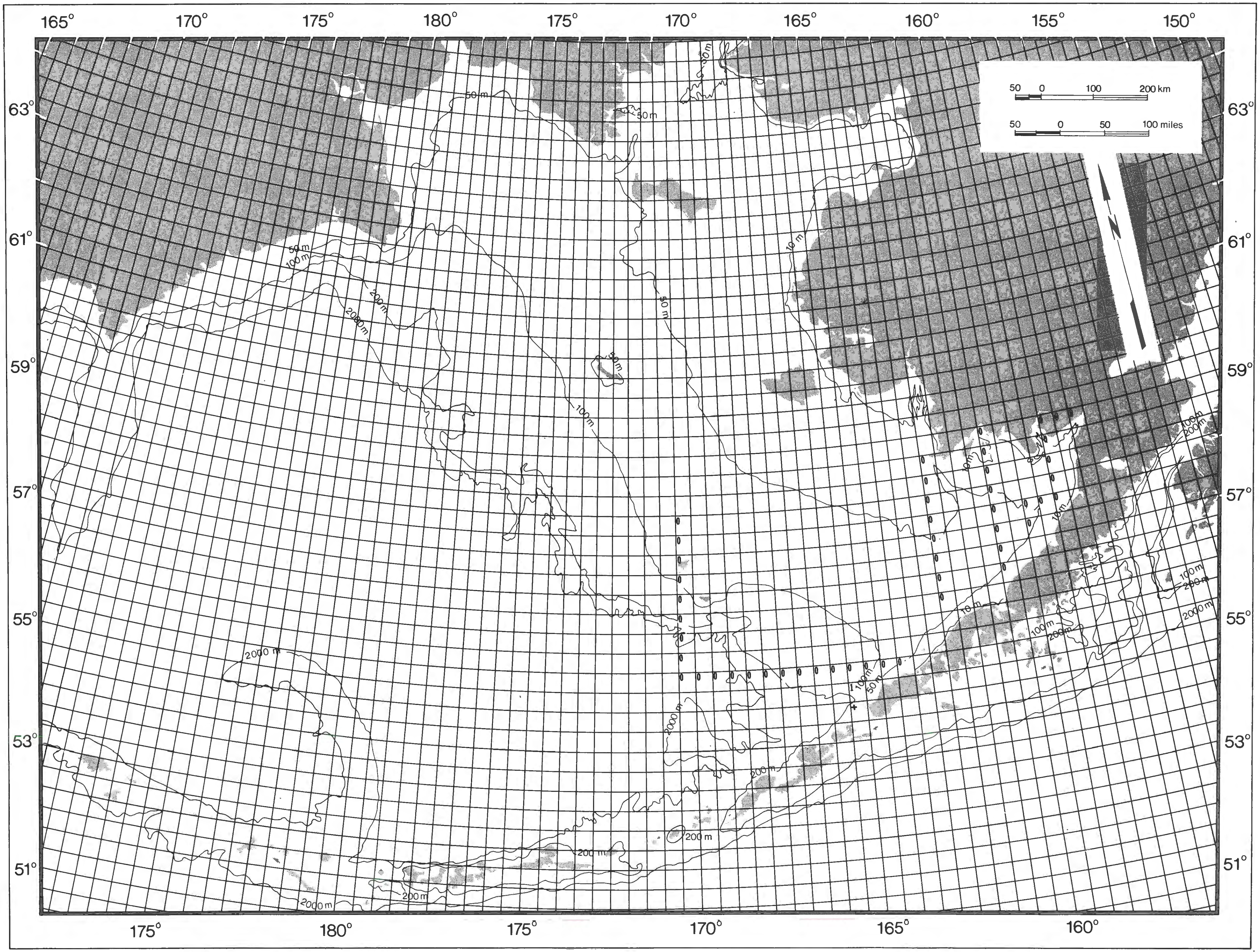

Map 181. Density indices of total murres obtained from aerial surveys of the eastern Bering Sea in summer.



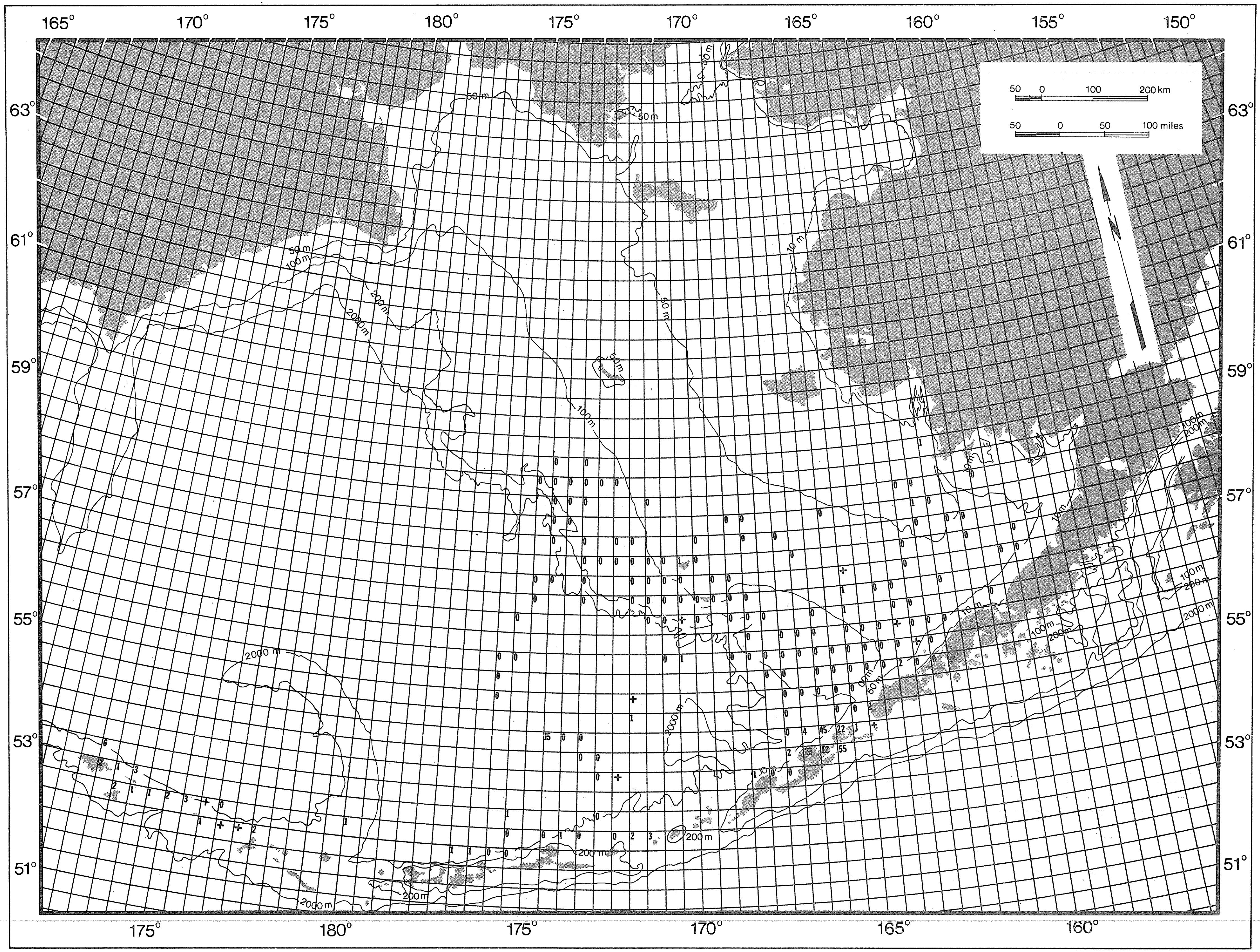

Map 182. Density indices of total murres obtained from shipboard surveys of the eastern Bering Sea in fall.



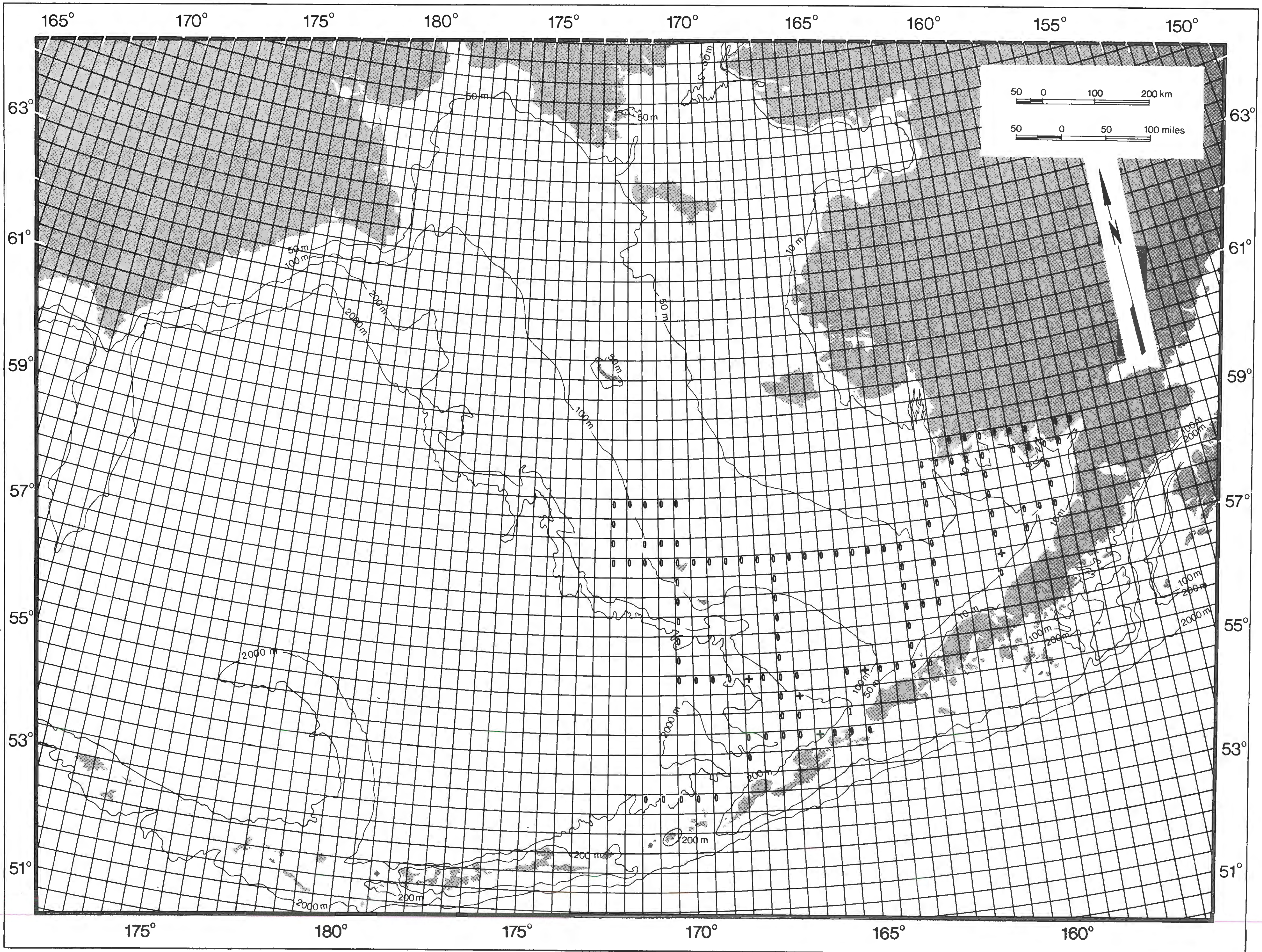

Map 183. Density indices of total murres obtained from aerial surveys of the eastern Bering Sea in fall.



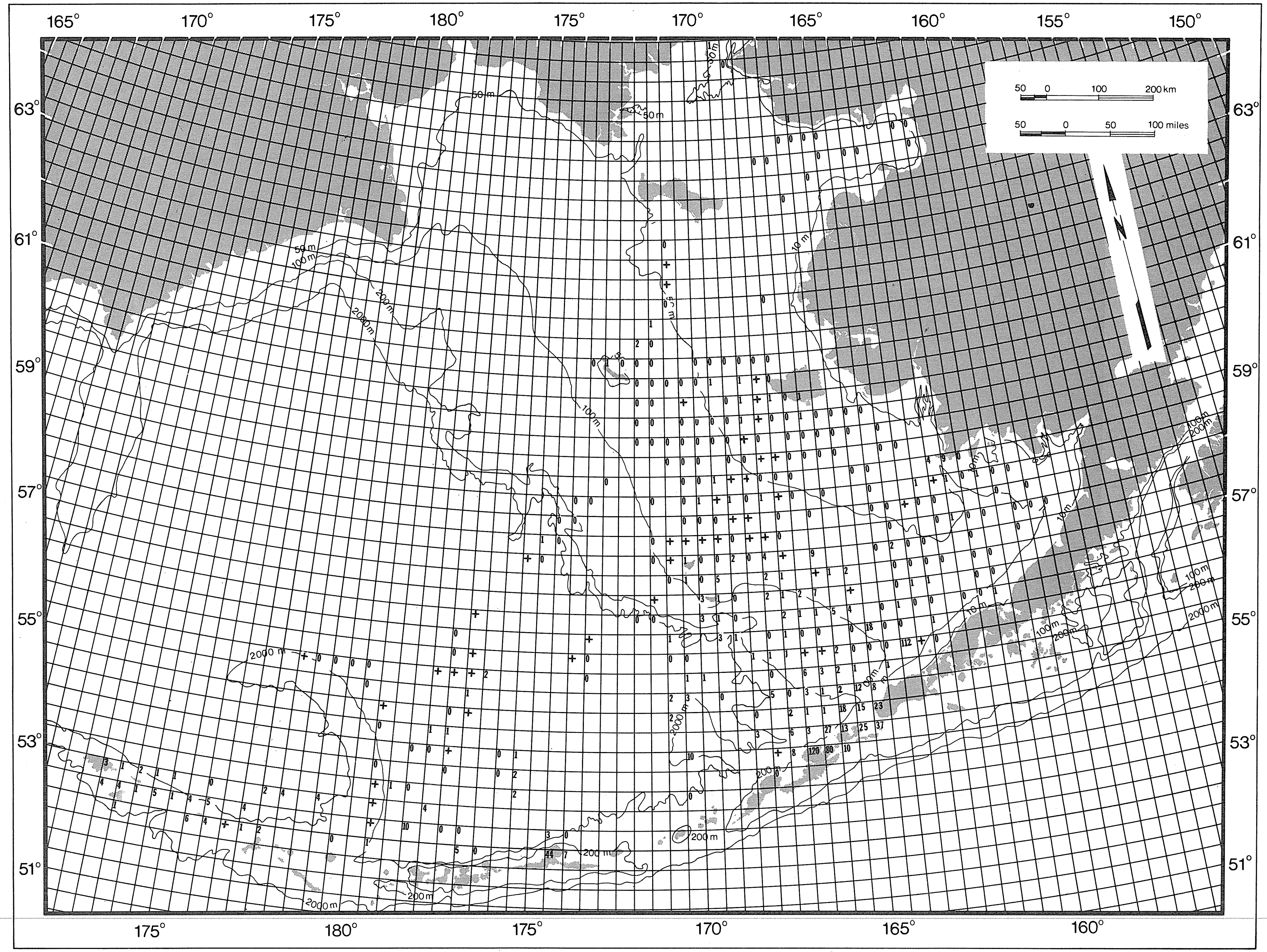

Map 184. Density indices of Tufted Puffin obtained from aerial surveys of the eastern Bering Sea in winter.



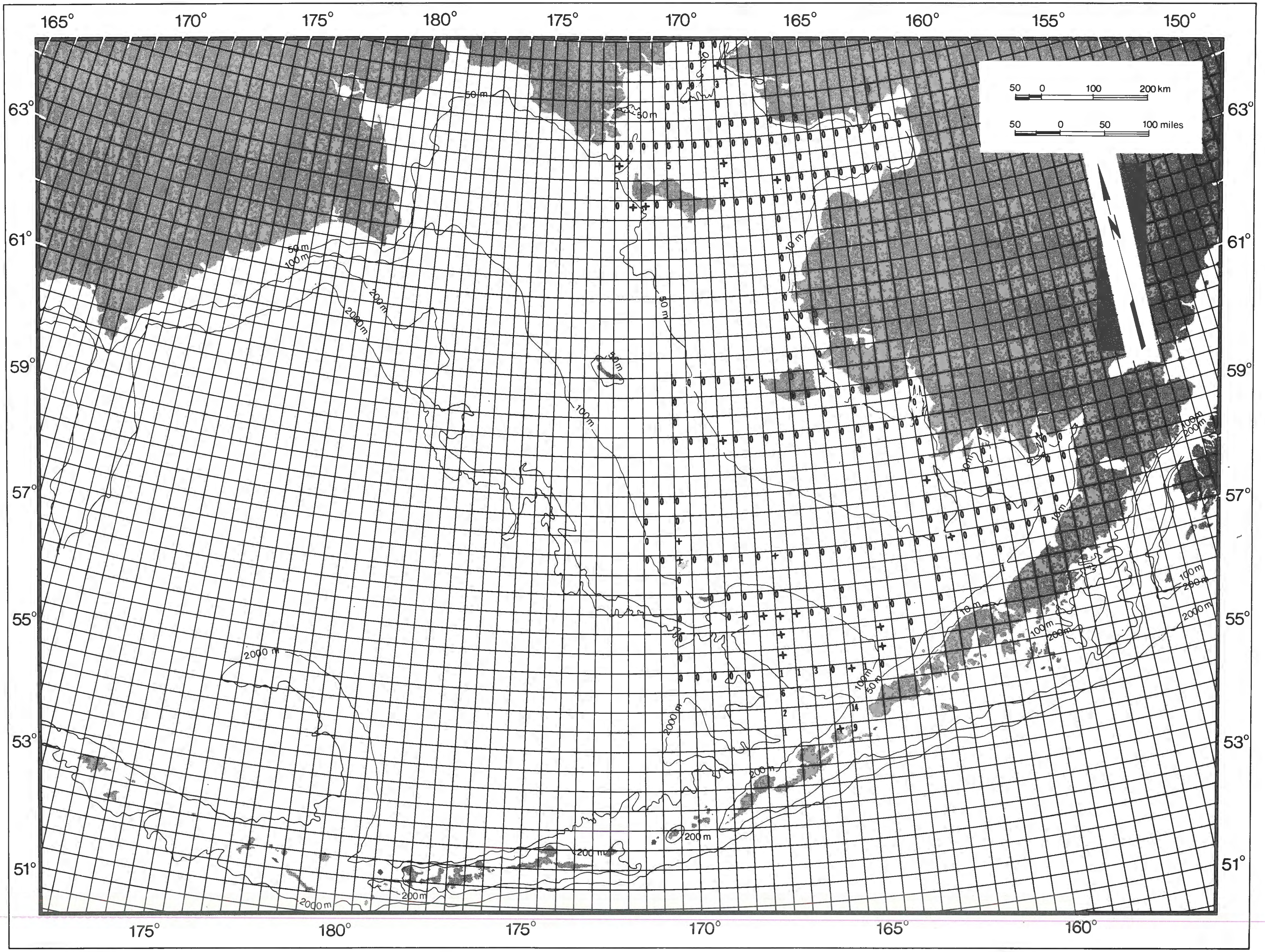

Map 185. Density indices of Tufted Puffin obtained from shipboard surveys of the eastern Bering Sea in spring.



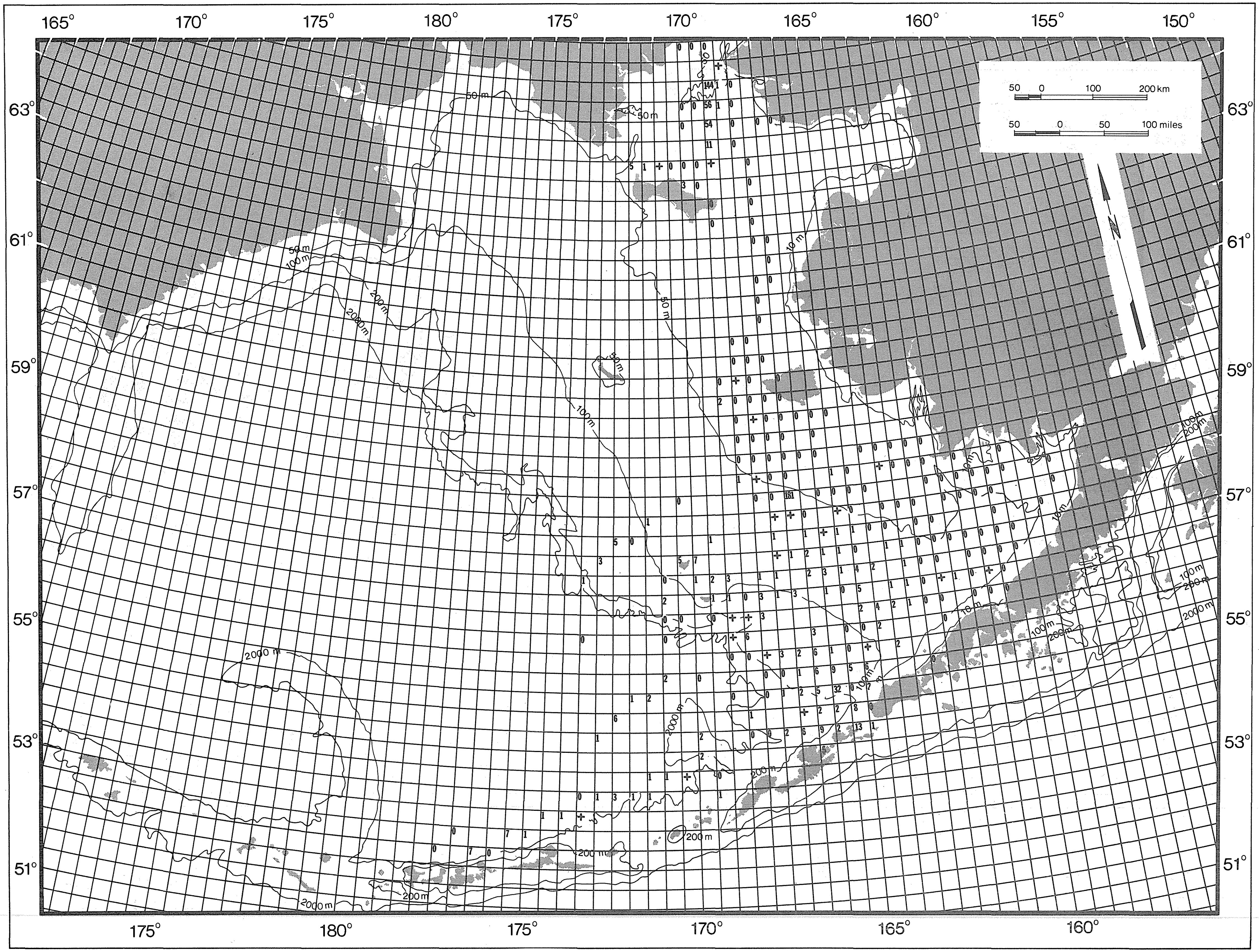

Map 186. Density indices of Tufted Puffin obtained from aerial surveys of the eastern Bering Sea in spring.



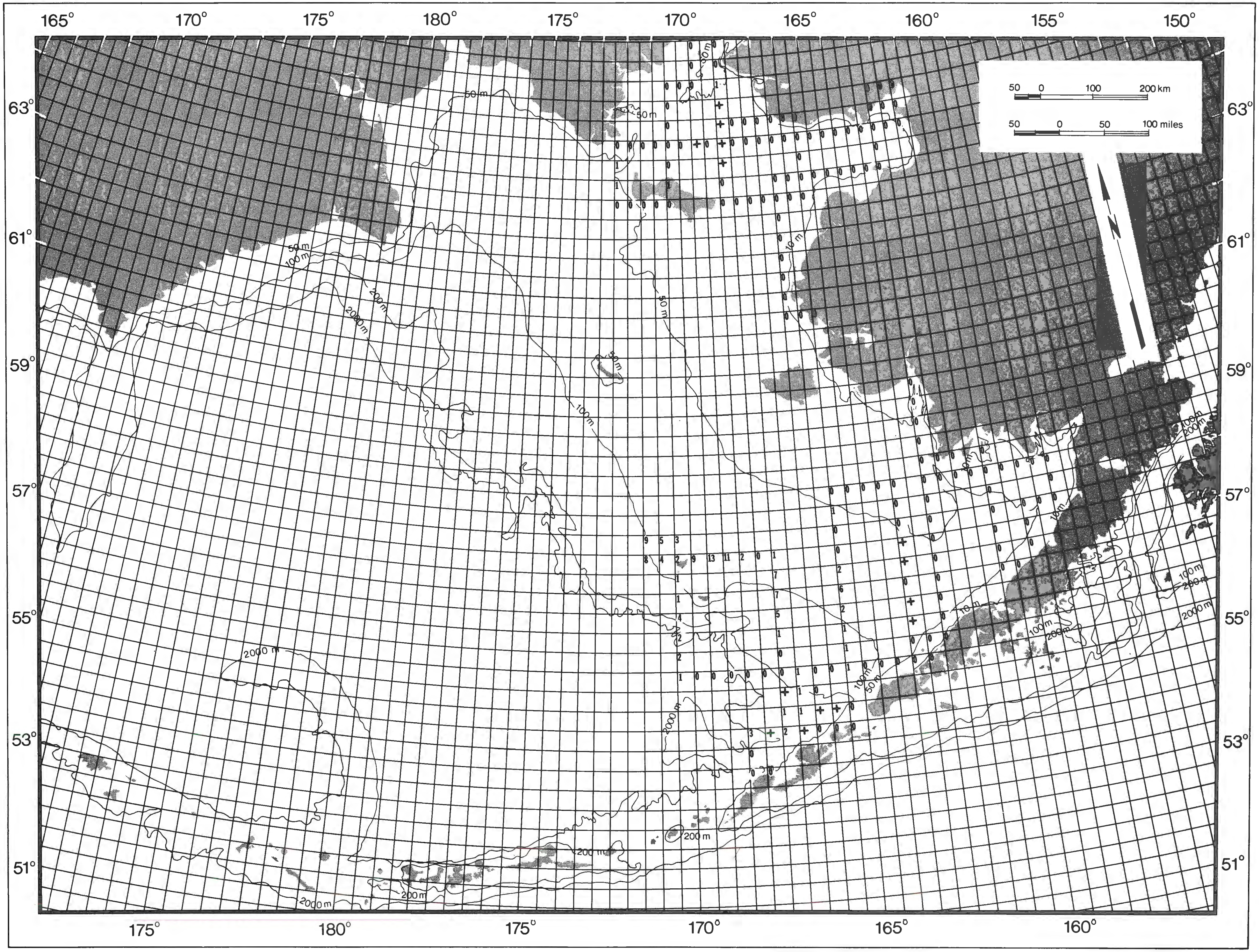

Map 187. Density indices of Tufted Puffin obtained from shipboard surveys of the eastern Bering Sea in summer.



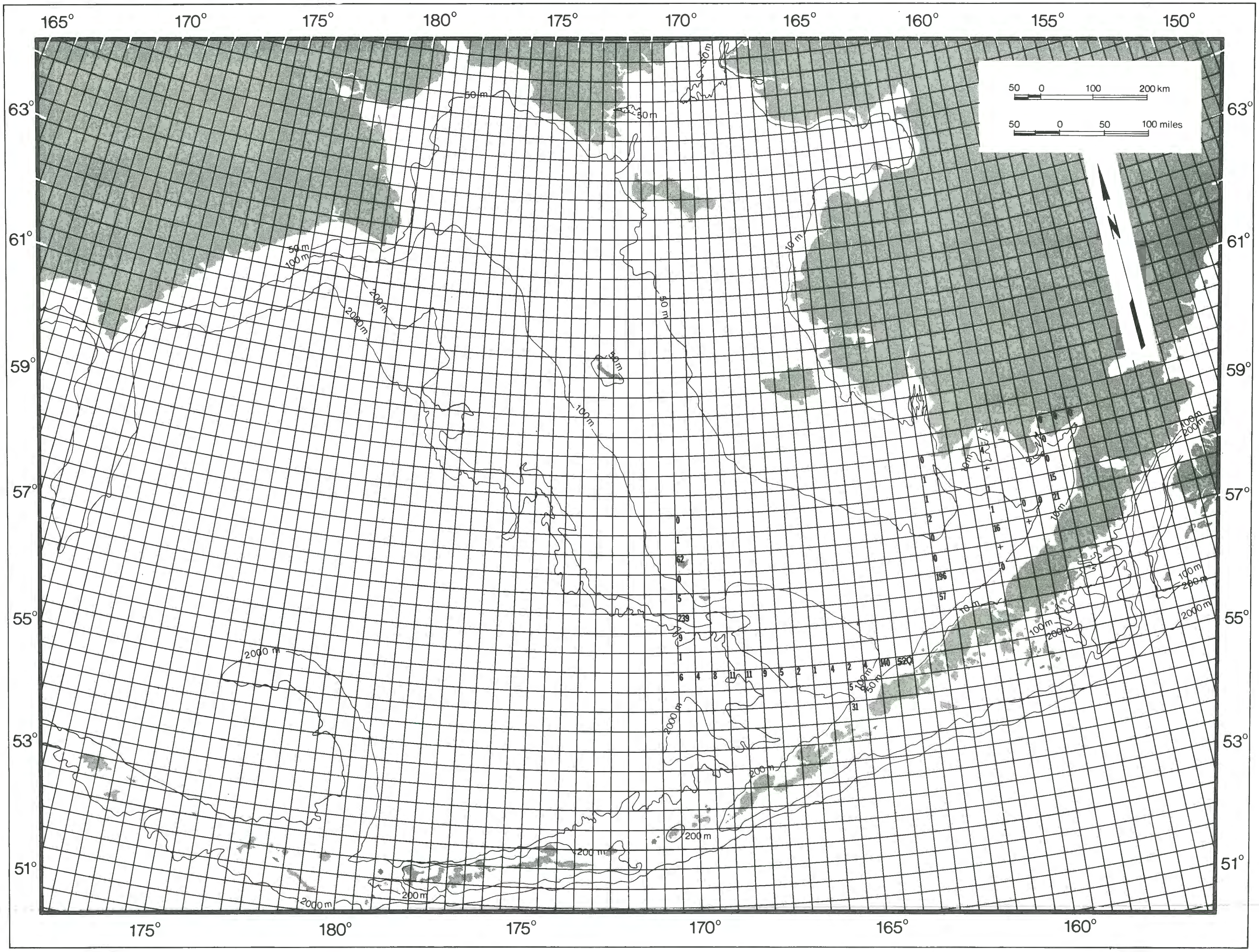

Map 188. Density indices of Tufted Puffin obtained from aerial surveys of the eastern Bering Sea in summer.



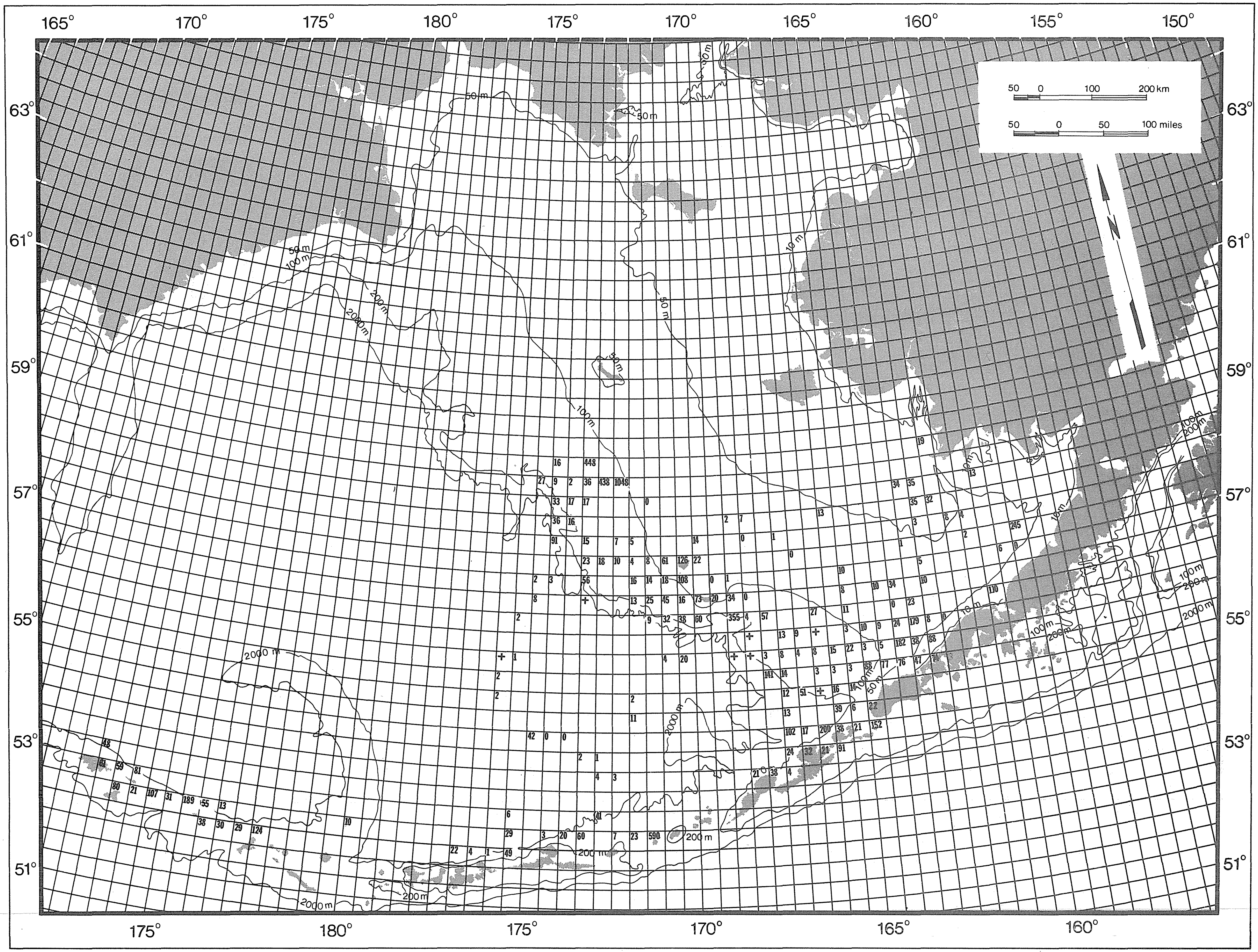

Map 189. Density indices of Tufted Puffin obtained from shipboard surveys of the eastern Bering sea in fall.



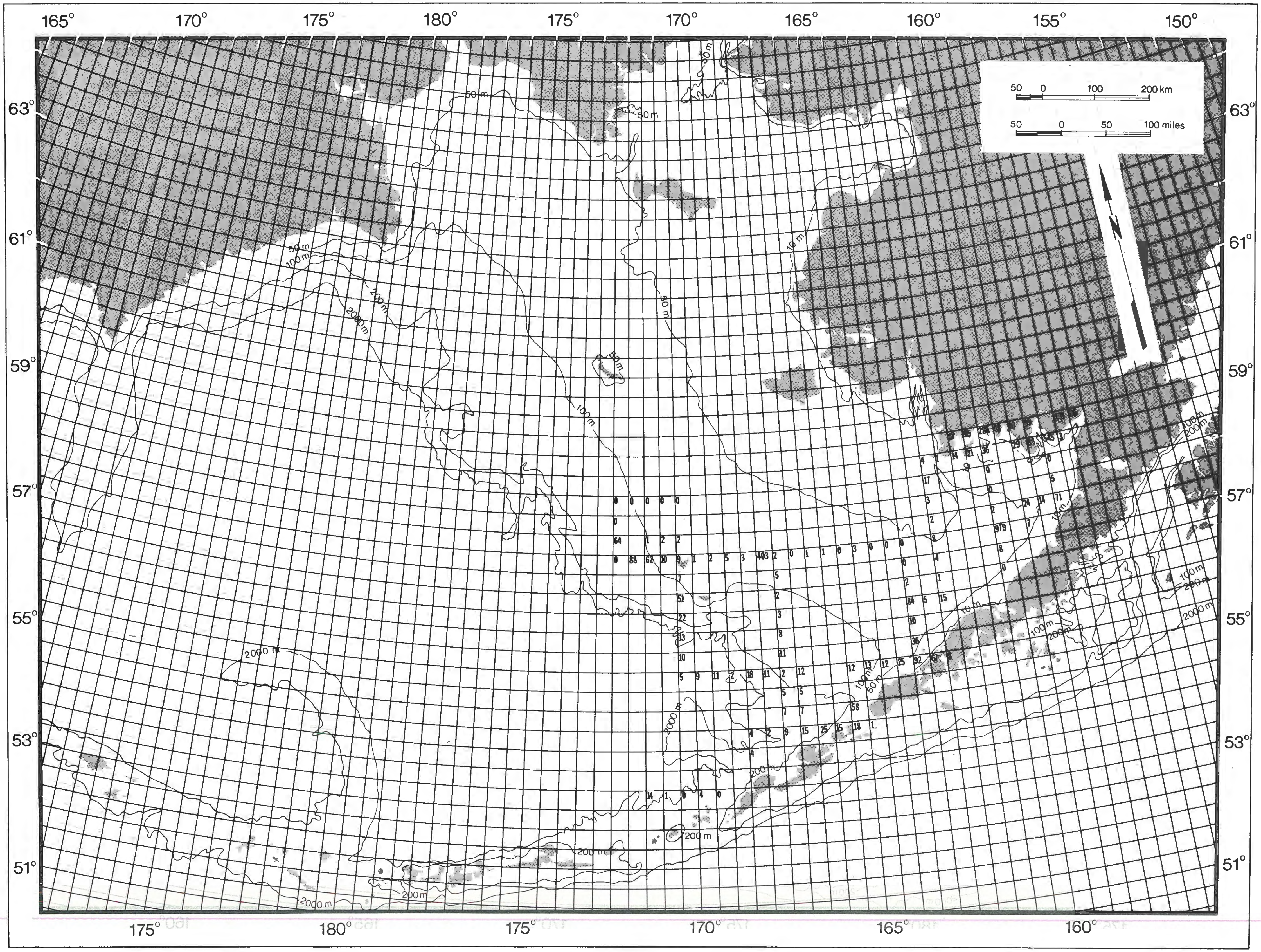

Map 190. Density indices of Tufted Puffin obtained from aerial surveys of the eastern Bering Sea in fall.



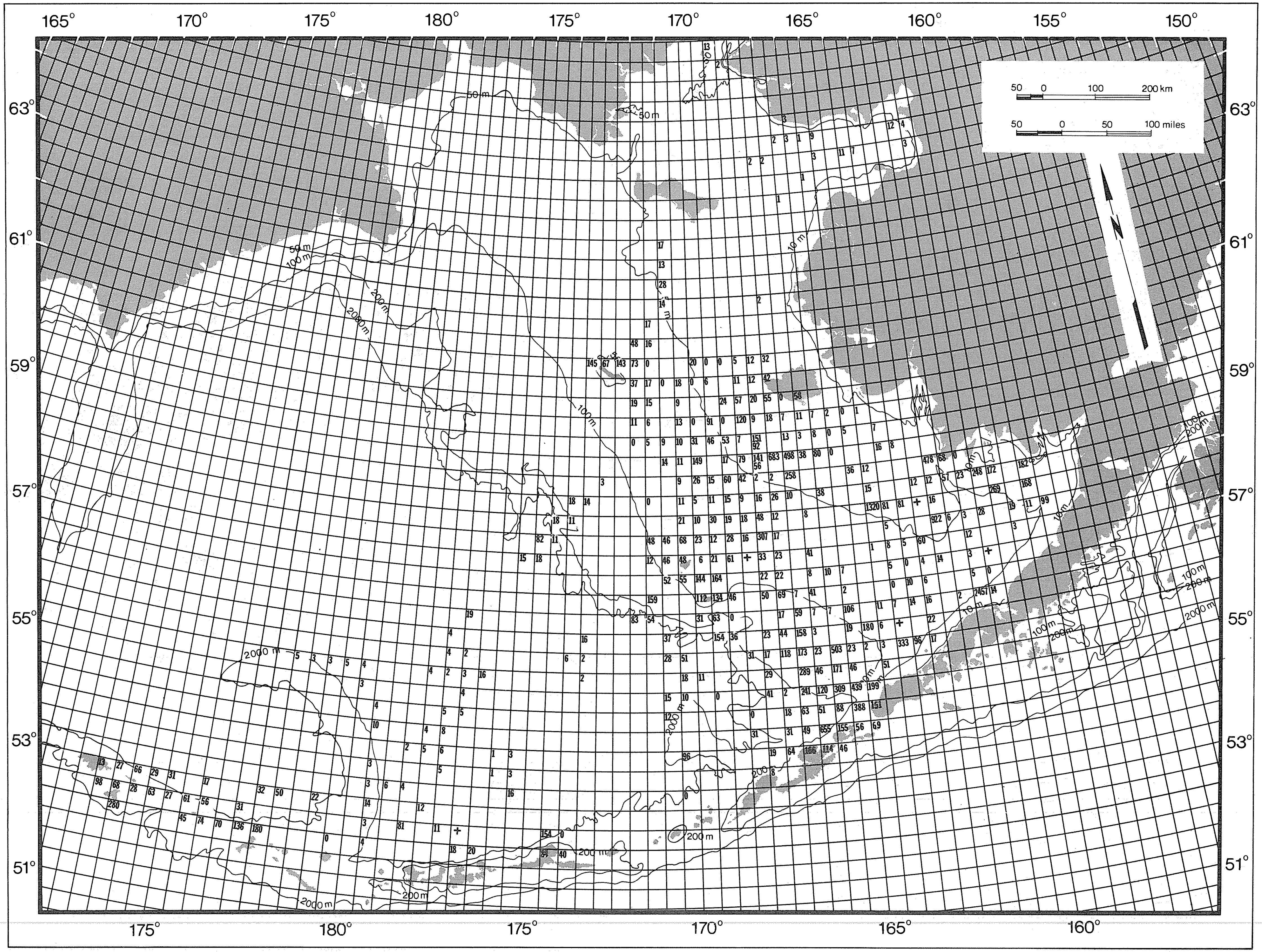

Map 191. Density indices of total birds obtained from aerial surveys of the eastern Bering Sea in winter.



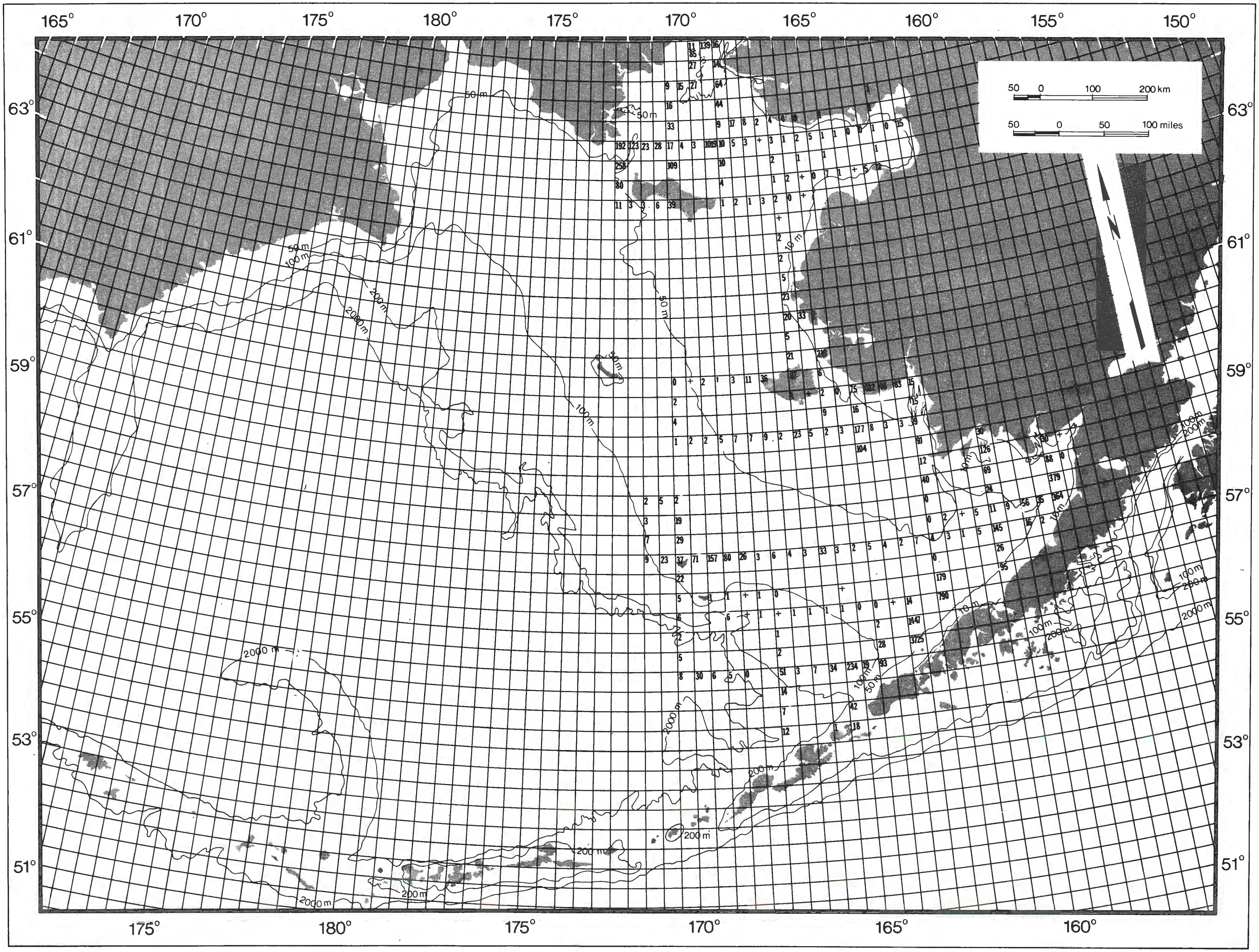

Map 192. Density indices of total birds obtained from shipboard surveys of the eastern Bering sea in spring.



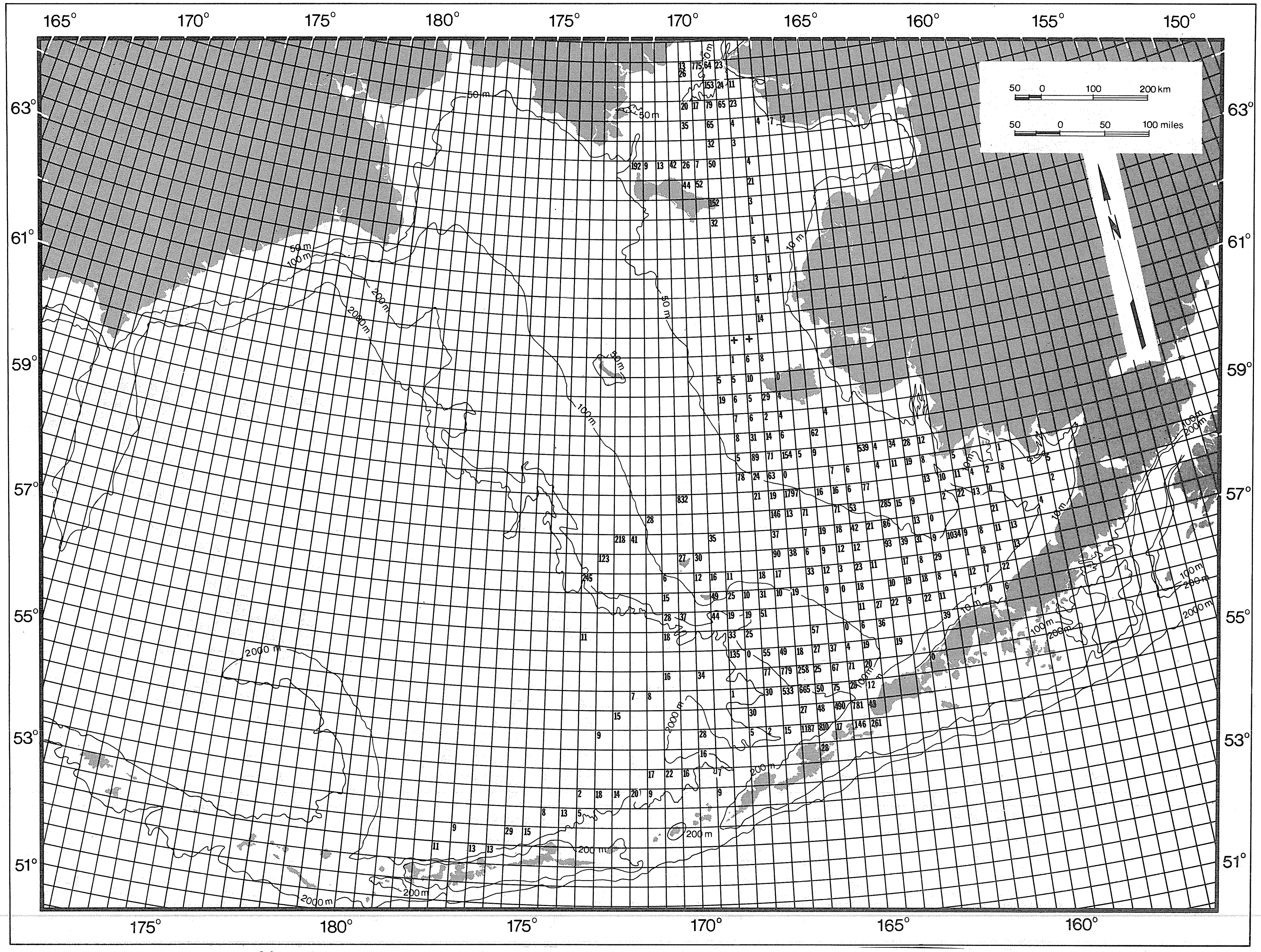

Map 193. Density indices of total birds obtained from aerial surveys of the eastern Bering Sea in spring.



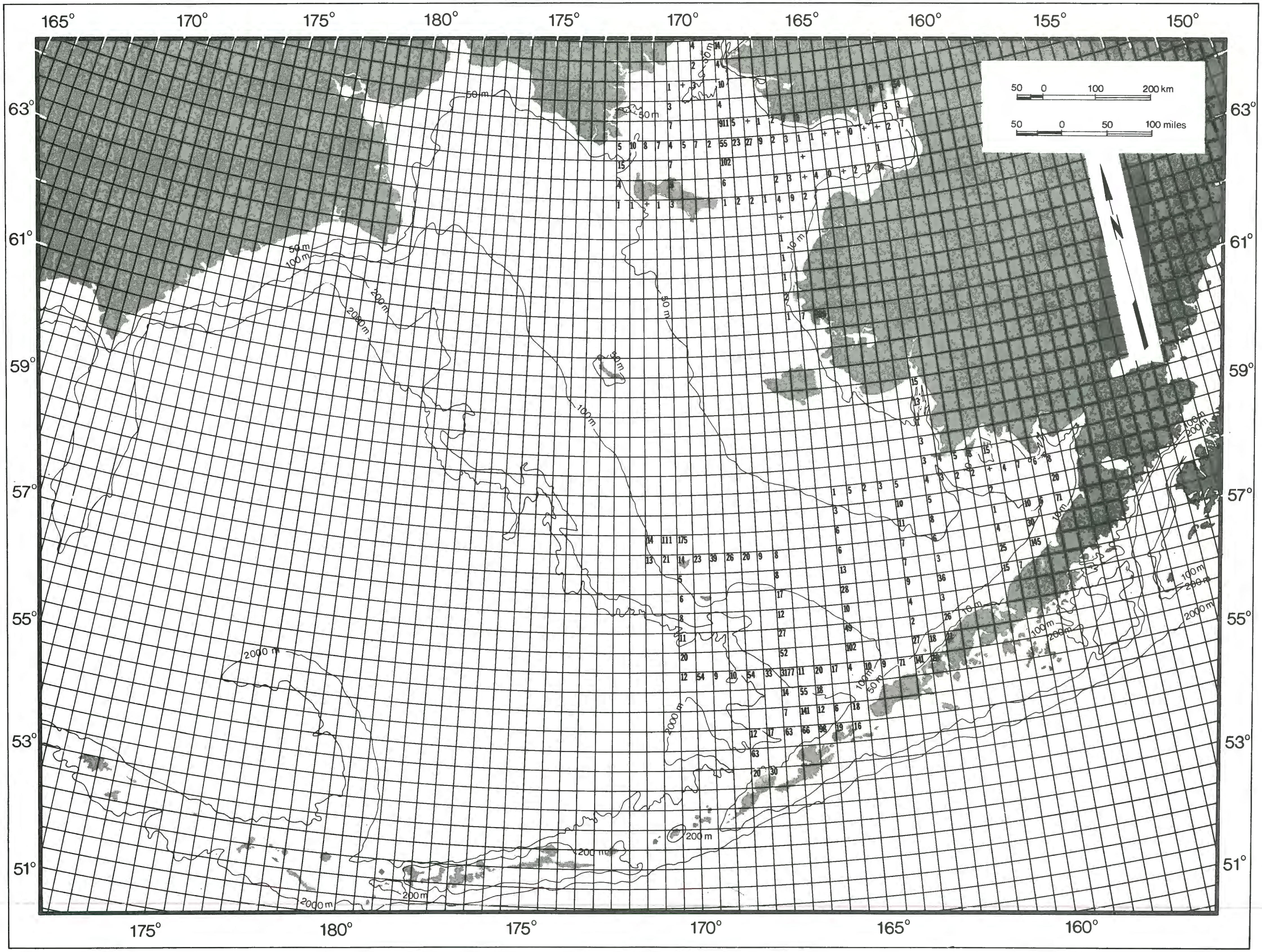

Map 194. Density indices of total birds obtained from shipboard surveys of the eastern Bering Sea in summer.




Map 195. Density indices of total birds obtained from aerial surveys of the eastern Bering Sea in summer.




Map 196. Density indices of total birds obtained from shipboard surveys of the eastern Bering Sea in fall.




Map 197. Density indices of total birds obtained from aerial surveys of the eastern Bering Sea in fall.

## APPENDIX A

## FORMATS, CODES AND DIGITAL DATA

During surveys, each observer collects as much data as time, conditions and initiative permit. Observations are either recorded on tape and later transferred, or recorded directly onto coding forms conforming to File Type 033 (Table A1) of the National Oceanographic Data Center (NODC). NODC codes are used in all cases, although the nature of our data on weather and behavior require selecting appropriate codes as representative of general patterns (Table A2). Coded data are then processed through a series of validation stages and stored on magnetic tapes (Table A3). Although we applied this rather rigorous verification program to the database, we were unable to eliminate all errors. The database currently has an error content of less than one pecent and most errors appear to be in non-critical data. In total, we completed about 13,000 transects in the Gulf of Alaska and Bering Sea, each transect covering an average area of 1.35 $km^2$. In addition, our records contain information counts from about 1,600 stations and general observations not included in either transects or stations. Each transect contained about 30 pieces of information (e.g., time, location, water depth, number of birds, etc.), on from 1 to 10 or more species of marine birds. This translates to over 2 million major pieces of information that needed to be sorted and analyzed.

Table A1. NODC format of information fields for digital data.

---

### HEADER CARD

File Type (1-3): Always 033

File Identifier (4-9): This number is assigned before each field operation.

Station Number (11-13): A sequential number beginning with 001 for each field operation. This number is not duplicated during any one field operation.

Station Type (14-15): Codes 1 and 2 (Table A2). Column 14 indicates the platform type and column 15 indicates the observation type. The criteria for a station are that the platform is stationary and that all birds are counted in a 360° circle of the platform. The criteria for a transect are a visability of at least 1,000 m and a moving platform with a constant speed and direction. Experimental stations and transects identify special cases which the observer may want to analyze separately at a later date. A Coastline Survey is one made within 500 m of the shore. A Bay or Fjord Survey is one made within well defined headlands but where the end zone of the observation is over 500 m from the shore.

Record Type (10): Code 3 (Table A2). Distinguishes information pertaining to location, environment, ice condition, descriptive text and census data.

### RECORD TYPE 1

Start Latitude (16-22)
Start Longitude (23-30): Position of platform at the start of observations.

Date (31-36): Year, month and date at start of observations. Always in GMT.

Time (37-40): Hour and minute at start of observations. Always in GMT and on a 24 hour clock.

End Latitude (41-47)
End Longitude (48-55): Position of platform at end of observations. This field is used only for aerial surveys or if observations last 30 minutes or longer.

Elapsed Time (56-57: Length of survey in minutes (temporal).

Time Zone (58-60): Relates GMT time to local time.

Speed (61-63): Platform speed made good in whole knots.

Course (64-65): Platform course made good in 10's of whole degrees.

Height 66-68): Height of observer's eye above water in whole meters.

Observation Conditions (75): Code 4 (Table A2). A subjective evaluation of observing conditions made by the observer.

Transect Width (81-83): Width of counting zone in whole meters.

### RECORD TYPE 2

Depth (16-19): Depth of water column in whole meters at start of observations.

Surface Temperature (23-26): Surface temperature of water to nearest 1/10 degree centigrade. Column 23 indicates positive or negative degrees.

Surface Salinity (27-29): Surface salinity to nearest tenth in parts per hundred.

Barometer (40-44): Barometric pressure to nearest 1/10 milibar. First digit of 1,000 or more is not entered. Column 44 uses + for rising, 0 for steady, and - for falling.

Wind Direction (45-46): The true direction of wind in 10's of degrees.

Wind Speed (47-48): True speed of wind in whole knots.

Sea State (49): Code 5 (Table A2).

Weather (55-56): Code 6 (Table A2).

RECORD TYPE 5

Common Name (----): These columns are for the convenience of the recorder and are usually used for checking the accuracy of the Taxonomic Code. They are not usually included on the final magnetic tape. We use the first two letters of each common name (Common Murre = COMU). If one of the names is hyphenated we use the first letter of each name (Red-legged Kittiwake = RLKI). UN is used for unknown (unidentified gull = UNGU). UALB is used for unidentified albatross.

Taxonomic Code (18-29): We use the NODC codes.

Species Group (30-31): We use the NODC codes.

Age (31): Code 7 (Table A2).

Sex (33): Code 8 (Table A2).

Color Phase (34): Code 9 (Table A2).

Group Size (------): Used for internal analysis and not included on NODC record. Indicates the number of birds for each sighting. The total number is then put in the Number Field.

Number (37-41): Number of birds recorded within the parameters desginated in Transect Width and Outside Zone columns.

Flight Direction (48-49): Direction of birds flight in 10's of degrees.

Linkage (51-53): These columns are used to unite two or more cards into a single sighting. For example, if 100,000 birds are recorded in one flock then two cards each of 50,000 are needed. Each of these cards would have "001" in the linkage columns. If two or more linkages occur in one transect or survey, then the second linkage would have "002" on each card, etc.

Behavior (56-57): Codes 10 and 11 (Table A2).

Sequence Number (78-80): These prerecorded numbers make each record record unique.

Outside Zone (81): Code 12 (Table A2). Any number other than "0" indicates that the record is not to be used for estimating densities.

Table A2. Description of codes.

Code 1. Platform Type (14)

1 = P2V aircraft
2 = Goose aircraft
3 = Single engine aircraft
4 = Helicopter
5 = Fixed at-sea platform
6 = Ship greater than 100 feet
7 = Ship less than 100 feet
8 = Small boat with outboard motor
9 = Other

Code 2. Survey Type (15)

1 = General observations
2 = Inland waterway transect
3 = Bay or fjord transect
4 = Coastline survey
5 = Ship-follower survey
6 = Experimental station
7 = Standard station
8 = Experimental transect
9 = Standard transect

Code 3. Record Type (10)

1 = Location data
2 = Environment data
3 = Ice data
4 = Text
5 = Bird data

Code 4. Observation Conditions

1 = Marginal
2 = Poor
3 = Fair
4 = Average
5 = Good
6 = Excellent
7 = Near optimum

Code 5. Sea State (49)

0 = Calm
1 = Rippled
2 = Wavelet
3 = Slight (2-4 feet)
4 = Moderate (4-8 feet)
5 = Rough (8-13 feet)
6 = Very rough (13-20 feet)
7 = High (20-30-feet)
8 = Over 30 feet

Code 6. Weather (55-56)

00 = Clear to partly cloudy, less than 50% clouds.
03 = Cloudy to overcast, more than 50% clouds.
41 = Fog, patchy
43 = Fog, solid
68 = Rain, light
69 = Rain, heavy
87 = Hail, light
88 = Hail, heavy
71 = Snow, light
73 = Snow, heavy

Code 7. Age (32)

0 = Indeterminable
1 = After Hatching Year (AHY): first year after hatching year, January 1 to December 31.
2 = Hatching Year (HY): hatching date to December 31. A bird capable of sustained flight.
3 = (not used)
4 = Local (L): a young bird incapable of sustained flight.
5 = Second Year (SY)
6 = After Second year (ASY)
7 = Third Year (TY)
8 = After Third Year (ATY)
J = HY or AHY
K = HY or AHY or ASY
L = AHY or ASY
M = HY or AHY or ASY or ATY
N = AHY or ASY or ATY: immature
P = ASY or ATY
Q = Adult

## Code 9. Color Phase (34)

1 = Double light
2 = Light
3 = Between light and intermediate
4 = Intermediate
5 = Between intermediate and dark
6 = Dark
7 = Double dark
8 = Special (e.g., bridled)

## Code 8. Sex (33)

1 = Male 2 = Female

## Code 10. Bird Behavior (56-57)

01 = Sitting on water
02 = Sitting, diving
03 = Sitting, then flying
07 = Patter flush
10 = Sitting on a floating object
14 = Sitting on ice
20 = Flying in direct and consistent heading
29 = Flying, height variable
31 = Flying, circling ship
32 = Flying, following ship
35 = Flying, milling or circling
48 = Flying, meandering
61 = Feeding at or near surface while flying
65 = Feeding at surface, scavenging
66 = Feeding at or near surface, not diving or flying
70 = Feeding below surface, diving
82 = Feeding above surface, pirating
90 = Courtship display
99 = Other

## Code 11. Mammal Behavior (56-57)

01 = Leaping
02 = Feeding
03 = Mother w/ young
04 = Synchronous diving
05 = Bow ridinig
06 = Porpoising
07 = Hauled out
08 = Sleeping
09 = Avoidance
10 = Play/contact
11 = Aggressive
12 = Tail lobing
13 = (not assigned)
14 = Curious/following
15 = Cetacea/pinniped
16 = Pinniped/bird
17 = Cetacea/birds
18 = Breeding/copulation
19 = Moribund/dead
20 = No behavior observed

## Code 12. Outside Zone (83)

0 = Bird within counting zone
1 = Ship follower
2 = Bird seen outside of counting zone during a transect or survey
3 = Bird seen within 1/2 hour before or after a transect or survey
4 = Bird on or over land during a transect or survey
5 = Bird on or over land before or after a transect or survey
6 = Bird found on ship before or after a transect or survey
7 = Not assigned
8 = Not assigned
9 = Not assigned

Table A3. Data processing and validation scenario.

```
FIELD WORK
    .
    .
DATA TRANSCRIPTION . . . . . . . . . . . . . . . . .
                                                    .
    . . . . . . . . . . . . . . . . . . . . DATA VALIDATION I
    .
KEYPUNCHING . . . . . . . . . . . . . . . . . . . .
                                                    .
    . . . . . . . . . . . . . . . . . . . . DATA VALIDATION II
    .
MAGNETIC TAPE . . . . . . . . . . . . . . . . . . .
                                                    .
    . . . . . . . . . . . . . . . . . . . . DATA VALIDATION III
    .
FINAL TAPE
    .
    .
DATA ANALYSIS . . . . . . . . . . . . . . . . . . .
                                                    .
    . . . . . . . . . . . . . . . . . . . . DATA VALIDATION IV
    .
REPORT PREPARATION
```

Data Validation I: Visual checking for gross errors and content.

Data Validation II: Visual checking of computer printouts for consistency and symmatry errors and a sort program for taxonomic codes.

Data Validation III: Computer program based on pre-established data and code parameters.

Data Validation IV: Inconsistent or intuitively erroneous results resolved by rechecking raw data stored in files.

## APPENDIX B

## MARINE BIRDS OF ALASKA

Common Loon (Gavia immer)

Common Loons breed in the Nearctic (ca. 42°N-65°N), and winter mainly in coastal areas from southern Alaska to Baja California, from Newfoundland to Florida, and from the British Isles to the Black Sea (ca. 25°N-62°N). They are widely distributed in Alaska during the summer, and there are breeding records from the Yukon Valley, Kenai Peninsula, Prince William Sound, and the Aleutian Islands. In Alaska they winter from the eastern Aleutian Islands to the Canadian border in the southeast.

Yellow-billed Loon (Gavia adamsii)

Yellow-billed Loons breed in northern areas of Finland, Siberia, and Canada (ca. 63°N-72°N). They winter off the coast of Norway in the Atlantic, and from the Gulf of Alaska south to British Columbia, Japan and China (ca. 23°N60°N) in the Pacific. In Alaska they breed from Cape Prince of Wales north and east to the Canadian border and winter from Kodiak Island and Prince William Sound south to Ketchikan, principally in the Alexander Archipelago.

Arctic Loon (Gavia arctica)

Arctic Loons breed in the Holarctic region with the exception of Greenland and Iceland (ca. 50°N-65°N) and winter south to southern Baja California, Portugal, and India (ca. 23°N-59°N). In Alaska, they breed from Cape Prince of Wales and Baffin Island south to the Alaska Peninsula and winter south and east of Cape Spencer.

Red-throated Loon (Gavia stellata)

Red-throated Loons are Holarctic breeders (ca. 52°N-81°N), and winter from the southern part of their breeding range to Baja California, Florida, the Mediterranean, Black and Caspian Seas, China, Formosa, and Japan (ca. 23°N-58°N). In Alaska the breeding range extends from Cape Prince of Wales south to the Aleutian Islands and east to southeast Alaska. Wintering birds may be found throughout coastal areas of the Aleutian Islands and Gulf of Alaska.

Red-necked Grebe (Podiceps grisegena)

Red-necked Grebes breed in Alaska, western and central Canada, northwestern United States, and Eurasia (ca. 47°N-65°N), and winter from the southern part of their breeding range to central California, Florida, South Africa, northern Iran, and Japan (ca. 24°N-59°N). In Alaska, they breed from the Arctic and Bering Sea coasts south to the Alaska and Kenai peninsulas, Kodiak Island, and the Canadian border. In winter they occur most commonly in southeastern Alaska but may be found to the west through Kodiak and the Aleutian Islands.

Horned Grebe (Podiceps auritus)

Horned Grebes breed in central and southern Alaska, Canada, northwestern United States, Iceland, and Eurasia (ca. 47°N-66°N), and winter south to southern California, Florida, the Mediterranean Sea, Turkestan, and Japan (ca. 26°N-52°N). They breed in central Alaska from the Bering Sea to the eastern border, and winter throughout the Aleutian chain east to the Canadian border.

Western Grebe (Aechmophorus occidentalis)

Western Grebes breed from interior western Canada south to central California and southwestern Minnesota (ca. 38°N-58°N). Wintering birds may be found from southcoastal Alaska south to central and western Mexico (ca. 19°N-61°N). This species is a casual fall and winter visitor to southcoastal Alaska and a locally common winter visitor to southeastern Alaska.

Pied-billed Grebe (Podilymbus podiceps)

Pied-billed Grebes breed from Vancouver Island, central British Columbia, and southern Mackenzie, east to central New Brunswick and Newfoundland, and south to central Argentina (ca. 43°S-60°N). The North American subspecies, P. p. podiceps, breeds as far south as central Mexico (ca. 22°N). Wintering populations are found from Vancouver Island, southern British Columbia, Arizona, Tennessee, and Maryland south to central Argentina (43°S-50°N). Pied-billed Grebes are rare fall migrants and winter visitors to southeast Alaska and casual summer and fall visitors to southcoastal Alaska (Kessel and Gibson 1978).

Short-tailed Albatross (Diomedea albatrus)

The endangered Short-tailed Albatross is now confined as a breeding species to Torishima Island, Japan, where 73 birds were counted in November 1977 (Hasegawa 1978). The species formerly ranged to the China coast, the Japan and Okhotsk seas, the Bering Sea, and from Alaska to Baja California (ca. 30°N-65°N). In Alaska, it was formerly found from the Gulf of Alaska to St. Lawrence Island, being most common in the Aleutian Islands. Bones of the Short-tailed Albatross are frequently found in Aleut middens of the Aleutian Islands (Yesner 1976).

Black-footed Albatross (Diomedea nigripes)

Black-footed Albatrosses breed primarily on the Leeward Islands of the Hawaiian chain but are increasing on islands to the west, including Torishima in the Izu group (ca. 22°N-30°N). Breeding occurs in the Northern Hemisphere winter. The species ranges at sea to the coast of China, the Ryuku Islands, the Pacific coast of Japan, the Kurile Islands and Kamchatka, east through the southern Bering Sea, Aleutian Islands, and Gulf of Alaska, and south along the Pacific coast to Baja California and the Revillagigedo Islands (ca. 20°N-57°N). The species is mainly a summer visitor to Alaskan waters. The breeding population is reported to be about 107,700 birds (Palmer 1962).

Laysan Albatross (Diomedea immutabilis)

The Leeward Islands of the Hawaiian chain are the principal breeding grounds of this species, but Laysans have also recently been reported to breed on Torishima in the Izu group, Japan (ca. 22°N-30°N). Breeding occurs in the Northern Hemisphere winter. The Laysan Albatross ranges the Pacific from the coasts of Japan and Kamchatka, east through the Aleutian Islands, southern Bering Sea, and Gulf of Alaska, and south to northern Baja California (20°N-57°N). The species is mainly a summer visitor to Alaskan waters. The worldwide breeding population of this species is estimated to be about 565,000 birds (Palmer 1962).

Northern Fulmar (Fulmarus glacialis)

Northern Fulmars breed throughout the North Atlantic in the Canadian Arctic, Greenland, Iceland, Nova Zemlya, Spitsbergen, coastal Norway, and the British Isles. In the Pacific, they breed from St. Matthew Island south to the Kurile, Komandorskie, and Aleutian islands, and east to the Semidi, Barren, and Chiswell islands (ca. 45°N-72°N). In the Pacific, wintering fulmars are found from the ice edge south to Japan and Baja California (ca. 30°N-57°N). Distribution of fulmars in the Bering Sea and Gulf of Alaska is strongly influenced by foreign fishing vessels. Populations of Northern Fulmars in the North Atlantic have greatly increased in recent years (Cramp et al. 1974). The Alaska population is estimated at 2 million birds (Sowls et al. 1978).

Pale-footed Shearwater (Puffinus carneipes)

Pale-footed Shearwaters breed on islands off of southwestern Australia, northern New Zealand, and Lord Howe Island (ca. 37°S-31°S). During the non-breeding season (the Boreal summer), they range north, primarily in the western Pacific, to Japan and occasionally to southwestern and southcoastal Alaska (ca. 40°S-56°N).

Pink-footed Shearwater (Puffinus creatopus)

Pink-footed Shearwaters breed along the coast of Chile, on Mocha Island, and in the Juan Fernandez Islands (ca. 37°S-33°S). During the non-breeding season (the boreal summer), they range north, principally in the eastern Pacific, to northern California and occasionally to southeastern and southcoastal Alaska (ca. 30°S-58°N).

New Zealand Shearwater (Puffinus bulleri)

New Zealand Shearwaters breed on islets off of northern New Zealand (ca. 38°S-34°S). In the non-breeding season (the boreal summer) they migrate north to coastal Japan, Oregon and casually to southcoastal Alaska (ca. 20°N-58°N).

Sooty Shearwater (Puffinus griseus)

Sooty Shearwaters breed on islands off Tasmania, Cape Horn, Tierra del Fuego, and Chile (ca. 60°S-30°S). In the non-breeding season (the boreal summer) they move into the North Pacific and North Atlantic generally dispersing north of 30°N. The exact distribution and abundance of this species in Alaskan waters is complicated by the problems inherent in separating them from the Short-tailed Shearwater in the field. The pattern is also confused by the presence of two breeding populations (Chile versus Australia), each of which uses a different migration route and possibly different time schedules and non-breeding ranges. The Sooty Shearwater is abundant over the continental shelf of the Gulf of Alaska, but apparently uncommon in the Bering Sea.

Short-tailed Shearwater (Puffinus tenuirostris)

Short-tailed Shearwaters breed on coastal islands of south Australia, Victoria, and in the Bounty Islands (ca. 45°S-35°S). This species is a trans-equatorial migrant and spends the nonbreeding season (the boreal summer) north of the Subarctic Convergence zone (ca. 42°N-70°N). It is abundant along Kamchatka, in the Bering Sea north into the Chukchi Sea, and in the Gulf of Alaska.

Manx Shearwater (Puffinus puffinus)

The Manx Shearwater is one of the most widespread of the Procellariiformes; it has breeding populations in the Mediterranean Sea and eastern North Atlantic (ca. 27°N-65°N), the Pacific Islands off Baja California and the Revillagigedo Islands (ca. 19°N-32°N), the Hawaiian Islands (ca. 19°N-22°N), and in New Zealand (ca. 47°S-37°S). Palmer (1962) recognized eight subspecies. The marine range of this species includes the Mediterranean Sea, the North Atlantic south along the Atlantic coast of South America (ca.47°S-70°N), and the Pacific Ocean (ca. 35°S-42°N). This species is a trans-equatorial migrant, but an uncommon visitant to southcoastal Alaska (Kessel and Gibson 1978).

Scaled Petrel (Pterodroma inexpectata)

Scaled Petrels breed in New Zealand and on Bounty and Chatham Islands (ca. 47°S-35°S), but may range as far south as 68°S. They move north in the non-breeding season (boreal summer) to the cold waters north of the Subarctic Convergence. They occasionally occur in the Bering Sea but are most abundant in deep waters south of the Aleutian Islands and in the Gulf of Alaska (ca. 45°N-58°N).

Cook's Petrel (Pterodroma cookii)

Cook's Petrels breed on islands in the New Zealand area (ca.

47°S-30°S). Non-breeding birds have been recorded north in the Pacific to Baja California, the Hawaiian Islands, and one specimen from near Adak, Alaska.

Fork-tailed Storm-Petrel (Oceanodroma furcata)

Fork-tailed Storm-Petrels breed from the Kurile, Komandorskie, and Aleutian Islands southeast to northern California (ca. 37°N-60°N). They may range as far north as 67°N in the summer. The species winters from the ice edge in the Bering Sea south to about 35°N. In Alaska, large colonies have been found on Buldir Island, the Barren Islands, and Petrel Island in the southeast. The Alaska population has been estimated to be 5 million birds (Sowls et al. 1978).

Leach's Storm-Petrel (Oceanodroma leucorhoa)

In the Pacific, Leach's Storm-Petrels breed from northern Japan, through the Kurile and Aleutian Islands, southeast to Baja California (ca. 25°N-60°N). In the Atlantic, this species breeds from southern Labrador, southern Iceland, and the Faroes south to Massachusetts and the northern British Isles (ca. 42°N-65°N). Wintering birds can be found as far south as 15°S in the Pacific and to the Cape of Good Hope and the Carribean in the Atlantic. Large colonies in Alaska have been found on Petrel Island in the southeast and Buldir Island in the Aleutians. The Alaska population has been estimated to be 4 million birds (Sowls et al. 1978).

Double-crested Cormorant (Phalacrocorax auritus)

Double-crested Cormorants breed from southwestern Alaska to Baja California, across North America as far north as central Manitoba, and from Newfoundland to Cuba and the Bahamas (ca. 25°N-61°N). In general, wintering birds remain within the breeding range with some movement to the south. In Alaska, the species is most abundant in the Bristol Bay region and the western Gulf of Alaska. Alaskan birds winter as far north as open water south to the coast of British Columbia (ca. 48°N-60°N). The Alaska population is estimated to be 7,000 birds (Sowls et al. 1978).

Brandt's Cormorant (Phalacrocorax penicillatus)

Brandt's Cormorants breed from British Columbia south to San Cristobal Bay, Baja California (ca. 27°N-57°N), and are generally resident throughout that range. A colony of up to 21 adults was found at the entrance to Prince William Sound in 1972 (Isleib and Kessel 1973), the only breeding record for the state of Alaska.

Pelagic Cormorant (Phalacrocorax pelagicus)

Pelagic Cormorants breed from northeastern Siberia to Japan and southern China and from Alaska to Baja California (ca. 28°N-68°N). In Alaska, they breed from Cape Lisburne south through the Aleutians and southeast to British Columbia. They winter throughout the breeding range whenever open water permits, south through Baja California and south China (ca. 27°N-60°N). Significant populations of Pelagic Cormorants in Alaska are found on Middleton Island and Walrus Island. The population in Alaska has been estimated to be 90,000 birds (Sowls et al. 1978).

Red-faced Cormorant (Phalacrocorax urile)

Red-faced Cormorants breed on the Komandorskie Islands, the Aleutian Islands, the Pribilof Islands, and in the Gulf of Alaska (ca. 52°N-58°N). It is a resident species wherever there is open water. This is the most abundant cormorant in Alaska. Its center of abundance in Alaska is from the Shumagin Islands west through the Aleutian Islands. The Alaska population is about 130,000 birds (Sowls et al. 1978).

Common Goldeneye (Bucephala clangula)

Common Goldeneyes are Holarctic breeders, nesting in the tree zone as far south as Germany, Rumania, Mongolia, British Columbia, Montana, Minnesota, and New Brunswick (ca. 42°N-65°N). They winter on the northern coasts of the Mediterreanean and Black seas, India China, Japan, and in America south to Baja California and the Gulf States (ca. 30°N-60°N). In Alaska, breeding birds are concentrated in the Yukon and Kuskokwim river valleys. Wintering birds are most abundant in the Aleutians and southeast Alaska. The North American population is about 1.25 million birds (Bellrose 1976).

Barrow's Goldeneye (Bucephala islandica)

Barrow's Goldeneye breed in southcentral and southeastern Alaska, northern Mackenzie south to eastern Washington, Oregon, central Sierra Nevada, northern Quebec, western Greenland, and Iceland (ca. 42°N-65°N). This species winters from southern Alaska south along the Pacific coast to central California and on the Atlantic coast from the Gulf of St. Lawrence south to Long Island (ca. 40°N-60°N). In Alaska, Barrow's Goldeneye breed from Yakutat to the upper Nushagak River, northeast to the Porcupine River. Bellrose (1976) estimated about 125,000 birds for Alaska and British Columbia.

Bufflehead (Bucephala albeola)

Bufflehead breed in forested areas from central Alaska through the southern Canadian provinces into the northern U.S. (ca. 47°N-65°N), and winter from the Aleutian Islands south to Baja California, the gulf coast, mainland Mexico, and on the Atlantic coast from Maine to Florida (ca. 20°N-60°N). In Alaska, Buffleheads concentrate along the upper reaches of the Kuskokwim River, the Yukon Flats, and the Porcupine River drainage. They are abundant wintering birds in southeast Alaska but also have been found from Kodiak Island west through the Aleutians. Bellrose (1976) estimated the North American prebreeding population to be 745,000 birds.

Oldsquaw (Clangula hyemalis)

The Oldsquaw is a circumpolar breeder (ca. 60°N-83°N) and winters south to the Mediterranean Sea, northeast China, Japan, Alaska to southern California, the Great Lakes, and from south Greenland to South Carolina (ca. 30°N-60°N). These are tundra nesting birds throughout Alaska, primarily north of the Aleutian Islands and coast ranges and along the Bering Sea and Arctic coasts. Wintering concentrations can be found in the Aleutians, along the Alaska Peninsula, the Gulf of Alaska, and in southeastern Alaska. This is one of Alaska's most numerous species of waterfowl. Bellrose (1976) estimated the North American population at 3 to 4 million birds.

Harlequin Duck (Histrionicus histrionicus)

Harlequin Ducks breed from Lake Baikal in Siberia east to Kamchatka, the Aleutians and mainland Alaska, and south to Idaho and the Sierra Nevadas. Harlequins also breed in Iceland, west Greenland, eastern Quebec, and central Labrador (ca. 40°N-67°N). Wintering birds are found from Kamchatka, the Aleutians, and the Alaska Peninsula, south to Japan and California, and from Labrador to Massachusetts (ca. 38°N-60°N). Harlequins breed over much of south and southeast Alaska, north to Anaktuvuk Pass. There are, however, no breeding records from the Aleutian Islands, even though the species is common there throughout the year. Population estimates are lacking but fall and spring counts in the Aleutian Islands have revealed 0.6 to 1 million birds (Bellrose 1976).

Steller's Eider (Polysticta stelleri)

Steller's Eiders breed along the arctic coast of Siberia eastward of the New Siberian Islands and along the arctic coast of Alaska to the Mackenzie River, south along the coast of the Bering Sea to Hooper Bay (ca. 60°N-75°N). They winter along the coast of Denmark and northern Siberia south to the Kurile Islands and east through the Aleutians to Kodiak Island (ca. 53°N-72°N). Large concentrations form along the north coast of the Alaska Peninsula in fall and winter.

Common Eider (Somateria mollissima)

Common Eiders are a Holarctic breeding species (ca. 43°N-80°N) and winter as far north as open water south to British Columbia, New Jersey, Long Island, the British Isles, France, and southern Russia (ca. 40°N-70°N). In Alaska, Common Eiders breed chiefly along the Bering Sea and Arctic coasts, but also from the Aleutian Islands east to Kodiak Island. Gabrielson and Lincoln (1959) stated that the Common Eider winters chiefly in the southern Bering Sea and the Aleutian region. The Alaska population is about 105,000 birds (King and Lensink 1971).

King Eider (Somateria spectabilis)

King Eiders breed from Spitsbergen, along the northern Russian coast to St. Lawrence Island, arctic Alaska, the arctic coast of Canada, east to Hudson Bay, northern Labrador, and both coasts of Greenland (ca. 65°N-82°N). Wintering birds are found as far north as open water will allow, south to the Gulf of Alaska, southern Greenland, Newfoundland, Massachusetts, Finland, Iceland, and the Faroes (ca. south to 42°N). In Alaska, the principal nesting area is along the coast of the Beaufort Sea. Large numbers of birds migrate down the Bering Sea coast to wintering areas in the Bering Sea, the Aleutian Islands west to Atka Pass, and the Gulf of Alaska. Bellrose (1976) estimated the North American population at 1.0-1.5 million birds.

Spectacled Eider (Somateria fisheri)

Spectacled Eiders breed along the arctic coast of Siberia and northwestern Alaska south to the Kuskokwim River Delta (ca. 60°N-76°N). The wintering range of this species has not been determined but it is suspected to be in open water south of Nunivak, St. Matthew, and St. Lawrence Islands and along the east coast of Siberia (Dau and Kistchinski 1977). During the summer, the species is most abundant from the Kuskokwim River Delta to Norton Sound.

White-winged Scoter (Melanitta fusca)

White-winged Scoters (Velvet Scoter in Europe) breed across northern Eurasia, and in North America from northwestern Alaska and the Mackenzie River delta to Hudson Bay, south through British Columbia, Alberta, Saskatchewan, and Manitoba (ca. 48°N-70°N). Wintering birds are found from the North Sea, Alaska, and Labrador south to northern Spain, the Caspian Sea, Baja California, and the Carolinas (ca. 30°N-62°N). Within Alaska, the White-winged Scoter breeds in the Interior, with its center of abundance in the Fort Yukon area. Southeast Alaska appears to be its center of winter abundance, although large congregations can be found west through the eastern Aleutians. The total for North America is about 600,000 birds (Bellrose 1976).

Surf Scoter (Melanitta perspicillata)

Surf Scoters breed from western Alaska east through northwest Canada to Hudson Bay and Labrador, and south to northern British Columbia, Alberta, Saskatchewan, Manitoba, and Ontario (ca. 53°N-70°N). They winter primarily on the coast from Alaska to the Gulf of California, the Great Lakes, and from the Bay of Fundy to Florida (ca. 30°N-60°N). Breeding records in Alaska are from the Bering Sea coast, the Arctic coast, and the Yukon Valley. Wintering birds in Alaska are found in the Aleutians west to southeast Alaska. The minimum North American population is 257,000 birds (Bellrose 1976).

Black Scoter (Melanitta nigra)

Black Scoters breed in Iceland, northern Europe, Siberia, northern Alaska and Ungava, Canada, south to Scotland, north-central Siberia, and the Alaska Peninsula (ca. 57°N-70°N). They winter mainly in Alaska, but small numbers reach the Mediterranean Sea, Korea, Japan, southern California, the Great Lakes, and Florida (ca. 32°N-60°N). The breeding range in Alaska is primarily coastal, from the Alaska Peninsula north to Kotzebue Sound. They winter from the Aleutians to southeast Alaska. About 540,000 Black Scoters are estimated for North American (Bellrose 1976).

Ruddy Duck (Oxyura jamaicensis)

Ruddy Ducks breed at a few localities in central Alaska and from British Columbia, northern Manitoba, and Nova Scotia south to Guatemala, the West Indies, and some areas of central and eastern Columbia (ca. 5°N-60°N). They winter mainly mainly in the region from British Columbia and the Central U.S. southward (ca. 5°N-50°N). In Alaska, breeding has been recorded in central southeastern areas, and birds are occasionally found in southeastern Alaska as migrants or winter visitors.

Smew (Mergus albellus)

Smews breed in the northern Palearctic region from northern Norway and Kamchatka south to Semipalatinsk (ca. 50°N-70°N) and winter south to the Mediterranean, Northern India, China, and Japan (ca. 35°N-70°N). This species is a rare migrant and visitor to Alaska, with most records being from the Aleutian Islands.

Hooded Merganser (Mergus cucullatus)

Hooded Mergansers are a Nearctic species, breeding from southeast Alaska to central Alberta, south to northern California, and from Manitoba east to New Brunswick and south to Tennessee (ca. 32°N-54°N). They winter from southern Canada south to Baja California, mainland Mexico, and the Gulf States (ca. 25°N-50°N). In Alaska, Hooded Mergansers are uncommon breeders in the southeast and uncommon visitors to southwestern and southcoastal areas. The North American population is estimated at 76,000 birds (Bellrose 1976).

Red-breasted Merganser (Mergus serrator)

The Red-breasted Merganser is a Holarctic breeding species (ca. 45°N-73°N) that winters south to Greece, Egypt, southeast China, Baja California, and the Gulf of Mexico (ca. 25°N-68°N). It breeds over much of Alaska including the Aleutians but is concentrated along the coast. Red-breasted Mergansers winter throughout the Aleutian Islands and southcentral Alaska. The North American population is estimated at 237,000 birds (Bellrose 1976).

Common Merganser (Mergus merganser)

The Common Merganser is a Holarctic breeding species (ca. 35°-65°N) and winters south to the northern Mediterranean, Iran, northern Indochina, Japan, Baja California, mainland Mexico, and the Gulf States (ca. 26°N-58°N). In Alaska, it breeds from the southern interior and Kodiak Island through southeast Alaska, where it is a resident species. The North American population is estimated to be 641,000 birds (Bellrose 1976).

Red Phalarope (Phalaropus fulicarius)

Red Phalaropes are circumpolar in their breeding distribution (ca. 62°N-75°N) and winter at sea off western Africa, South America, and New Zealand (ca. 50°S-10°S). The Alaskan breeding range extends from the arctic coast south to the northern coast of Bristol Bay.

Wilson's Phalarope (Steganopus tricolor)

Wilson's Phalaropes breed from interior southwestern Canada and locally in southern Ontario south to south-central California, northeastern Colorado, and northern Indiana (ca. 36°N-55°N). They winter mainly in Argentina and Chile (ca. 55°S-23°S). They are casual visitors to southeast and east-central Alaska in the spring and summer and accidental elsewhere in the state.

Northern Phalarope (Lobipes lobatus)

Northern Phalaropes have a circumpolar breeding distribution (ca. 52°N-75°N). These birds winter at sea from the Galapagos to southern Argentina, from southern Japan to New Zealand, and off India, Arabia, and North Africa (ca. 45°S-35°N). Breeding in Alaska occurs from Demarcation Point on the arctic coast, south throughout the Aleutian Islands to the west, and to at least Yakutat Bay in the east.

Pomarine Jaeger (Stercorarius pomarinus)

Pomarine Jaegers have a circumpolar breeding distribution (ca. 61°N-75°N). They migrate south in winter and range from southern California to Peru, Cape Hatteras to the West Indies, the Hawaiian Islands, and eastern Australia (ca. 20°S-35°N). In Alaska, Pomarine Jaegers breed from the arctic coast south to Hooper Bay in the eastern Bering Sea.

Parasitic Jaeger (Stercorarius parasiticus)

Parasitic Jaegers are Holarctic in their breeding distribution (ca. 50°N-78°N). Their wintering quarters lie from southern California to southern Chile, Australia, and New Zealand to Chatham Island, Maine to Argentina, and Britain to the Cape of Good Hope (ca. 50°S-50°N). In Alaska, they breed from the arctic coast south through the Aleutian Islands to the west and to Glacier Bay, in the east.

Long-tailed Jaeger (Stercorarius longicaudus)

Long-tailed Jaegers have a circumpolar breeding range (ca. 65°N-80°N). Wintering birds are found at sea in the Atlantic (ca. 50°S-40°N) and Pacific (ca. 50°S-10°N) Oceans. Alaskan breeding populations tend to be inland and range from Point Barrow south to St. Matthew Island and Bethel. All birds leave Alaska during the winter.

South Polar Skua (Catharacta maccormicki)

South Polar Skuas breed from Chile, the Falklands, and New Zealand, south to the islands of Antarctica (ca. 60°S-40°S), and winter from the Straits of Magellan and south Australia north in the Atlantic to ca. 20°S and in the Pacific to southern British Columbia (ca. 55°S-50°N). This species occurs in Alaska only as a nonbreeding vagrant.

Glaucous Gull (Larus hyperboreus)

Glaucous Gulls have a circumpolar breeding distribution (ca. 57°N-80°N). In winter they occur throughout the southern part of their breeding range, some birds moving south to southern California, New York, the British Islands, China, and Japan (ca. 40°N-60°N). In Alaska, breeding occurs along the islands and coasts from the Beaufort Sea southwest to St. Matthew Island in the Bering Sea and the Walrus Islands in northern Bristol Bay. There is no noticeable center of Alaskan breeding abundance. Relatively large colonies are found from Prudhoe Bay south to St. Matthew Island. Wintering birds are found scattered throughout the southern part of their breeding range and throughout coastal areas of southern Alaska. Sowls et al. (1978) give a rough estimate of 20,000 birds in Alaska.

Glaucous-winged Gull (Larus glaucescens)

Glaucous-winged gulls breed in the Bering Sea and north Pacific Ocean from Nunivak Island south to the Komandorskie Islands and northwestern Washington (ca. 47°N-64°N). In winter they are found throughout their breeding range, and some birds disperse southward to Hokkaido and southern Baja California (ca. 23°N-64°N). Nesting occurs throughout coastal southern Alaska, occasionally as far north as St. Lawrence Island and Cape Denbigh in Norton Sound. The center of breeding abundance lies between Egg Island in the Copper River Delta and Amagat Island in the False Pass area of the Alaska Peninsula. There is a general southward withdrawal in winter, many birds wintering along the entire southern coast of Alaska. Hybridization with Herring Gulls occurs in southcentral and eastern Alaska (Hoffman et al. 1978). Sowls et al. (1978) gave a rough estimate of 500,000 birds in Alaska.

Slaty-backed Gull (Larus schistisagus)

Slaty-backed Gulls breed on the arctic coast of eastern Russia south to Japan (ca. 45°N-65°N). In winter they are found from Kamchatka south to China (ca. 25°N-55°N). These birds do not breed in Alaska but may be found as vagrants, especially in the Aleutian Islands.

Western Gull (Larus occidentalis)

Western Gulls breed from northern Washington south along the coast to Baja California (ca. 23°N-48°N), and winter from Vancouver Island south throughout the breeding range to the west coast of central Mexico (ca. 22°N-51°N). This species is accidental in Alaska.

Herring Gull (Larus argentatus)

Herring Gulls breed throughout most of the arctic and temperate regions of the Northern Hemisphere (ca. 40°N-80°N). Winter dispersal is southward, with birds reaching the West Indies, Panama, central Africa, Indochina, and the northern Phillipines (ca. 10°N-55°N). Breeding in Alaska is generally restricted to inland or fresh water situations from the Yukon Valley and Yakutat-Dry Bay areas eastward. The race L. a. vegae breeds on St. Lawrence Island and in eastern Siberia. Wintering birds in Alaska may be found scattered throughout the southern part of their breeding range.

Thayer's Gull (Larus thayeri)

Thayer's Gulls breed in arctic Canada and northwest Greenland (ca. 67°N-77°N). They winter along the Pacific coast of North America from British Columbia south to southern California (ca. 32°N-60°N). Only small numbers of migrants and occasional nonbreeding vagrants have been found in Alaskan waters.

California Gull (Larus californicus)

California Gulls breed from central Canada south to northern California, central Montana, and central North Dakota (ca. 40°N-63°N). In winter, they may be found from southern Washington south to Guatemala (ca. 15°N-47°N). This bird is an uncommon visitor to southeastern Alaska.

Ring-billed Gull (Larus delawarensis)

Ring-billed Gulls breed from central Canada and parts of eastern Canada south to northern California, central Colorado, and northern New York (ca. 40°N-60°N). They winter from southern Canada south to southern Mexico, the Gulf States, and Cuba (ca. 20°N-50°N). They are occasional visitors to central and southeastern Alaska.

Mew Gull (Larus canus)

Mew Gulls have a broad circumpolar distribution (ca. 40°N-70°N). In winter they are found from the central part of their breeding range south to southern California, the Mediterranean Sea, and Formosa (ca. 25°N-62°N). In Alaska, these birds breed in the interior and coastal areas, from Kotzebue Sound south to Sanak Island and east to southeastern Alaska. Sowls et al. (1978) estimated that there are 10,000 Mew Gulls in Alaska.

Black-headed Gull (Larus ridibundus)

Black-headed Gulls breed in Iceland, the Faroes, Scandinavia, and across northern Russia south to central Russia, northwestern Mongolia, and Kamchatka (ca. 50°N-74°N). This species winters from the southern part of its breeding range to the Azores, north Africa, India, Indochina, Japan, and the Philippines (ca. 10°N-50°N). It is a rare spring and fall migrant to the Aleutians and the Pribilof islands and a rare visitor to southwestern Alaska.

Franklin's Gull (Larus pipixcan)

Franklin's Gulls breed from southern Canada south to central Oregon, central Montana, and northern Iowa (ca. 43°N-58°N), and winter in the Pacific from Guatemala south to the Gulf states and Chile (ca. 40°S-58°N). They are spring and summer vagrants in southcoastal and southwestern Alaska.

Bonaparte's Gull (Larus philadelphia)

Bonaparte's Gulls breed in the interior from western Alaska to central Canada (ca. 50°N-70°N). Wintering areas are from the northern United States south to central Mexico (ca. 20°N-50°N). In Alaska this species breeds from the Kobuk Delta south to the head of Bristol Bay and east to Yakutat Bay.

Ivory Gull (Pagophila eburnea)

Ivory Gulls breed in the high arctic from Canada east to Siberia (ca. 70°N-80°N). They winter over arctic drift ice south to southern Greenland, Iceland, Finland, northeast Siberia, and the Komandorskie Islands (ca. 50°N-75°N). This species does not breed in Alaska but is occasionally recorded in the Beaufort and Chukchi seas.

Black-legged Kittiwake (Rissa tridactyla)

Black-legged Kittiwakes have a broad circumpolar breeding distribution (ca. 51°N-82°N). Their winter dispersal is to the south; although a few birds remain in ice-free northern areas, many reach Baja California, Korea, Northwest Africa, and the mid-eastern United States (ca. 30°N-60°N). In Alaska, Black-legged Kittiwakes breed from Cape Lisburne south, throughout the Aleutian Islands, to the west and to Glacier Bay, in the east. The center of breeding abundance lies between Middleton Island in the north-central Gulf of Alaska and Cape Peirce and the Pribilof Islands in the Bering Sea. Wintering birds are concentrated over the continental shelf and oceanic waters of the northwestern Gulf of Alaska, although a few birds may be found throughout all ice-free Alaskan waters.

J. C. Coulson (in Cramp et al. 1974) gave the censused number of breeding birds in Britain and Ireland as 939,400. Sowls et al. (1978) gave a rough estimate of 2.5 million birds for Alaska. Nettleship (1977) estimated the number of Black-legged Kittiwakes in the eastern Canadian arctic and Atlantic Canada to be 427,524. What is apparently the largest colony in the world is located on the Sverholt-Klubben cliffs of Norway, where an estimated 360,000 kittiwakes nest (Dement'ev et al. 1951). These figures indicate that the world population, including non-breeding birds, probably exceeds 5 million.

Red-legged Kittiwake (Rissa brevirostris)

Red-legged Kittiwakes breed in the Bering Sea (ca. 52°N-57°N). The only known colonies are on the Komandorskie, Pribilof, Buldir, and Bogoslof islands. In winter, all birds move into open waters but the extent of this dispersal is unknown. Sowls et al. (1978) provided an estimate of 230,000 birds for the Alaskan population. This represents almost the entire world population, since the only colony outside Alaska is a small one on the Komandorskie Islands.

Ross' Gull (Rhodostethia rosea)

Ross' Gulls breed in northeastern Siberia (ca. 67°N-70°N), primarily on the Kolyma River delta. In fall, they move east to Point Barrow and more rarely south into the Bering Sea (ca. 57°N-72°N). The winter range is poorly known but it probably is over open water in Arctic regions. These gulls do not breed in Alaska but are fairly regular fall visitors to the Chukchi Sea area.

Sabine's Gull (Xema sabini)

Sabine's Gulls are a holarctic breeding species (ca. 63°N-75°N) but little is known of their wintering range. They winter at least to coastal Peru and also in the south Atlantic. In Alaska they breed along the Arctic and Bering Sea coasts from Demarcation Point south to northern Bristol Bay.

Common Tern (Sterna hirundo)

Common Terns breed across central and southern Canada from southern Mackenzie and Nova Scotia south to Montana, southern Michigan, northern New York, and along the eastern coast to the Dry Tortugas (ca. 25°N-63°N). In the old world, they breed from the British Islands east to northcentral Siberia and Mongolia south to the Canary Islands, Medditerranean Sea, Iran, and Tibet (ca. 30°N-60°N). They winter from the southern part of their breeding range south to Argentina, southern Africa, and New Guinea (ca. 57°S-32°N). The asiatic race of this species (S. h. longipennis) is a rare visitor and migrant in western Alaska.

Arctic Tern (Sterna paradisaea)

Arctic Terns have a circumpolar breeding distribution (ca. 40°N-82°). Wintering birds occur in antarctic and subantarctic waters of the Atlantic, Pacific, and Indian oceans (ca. 30°S-70°S).

This species breeds throughout Alaska, with the possible exception of extreme southeast Alaska. Sowls et al. (1978) estimate the coastal Alaska population at 25,000 birds.

Aleutian Tern (Sterna aleutica)

Aleutian Terns breed at scattered locations on islands and coastlines of the subarctic Pacific Ocean and Bering Sea (ca. 52°N-67°N). They winter in the northwest Pacific (ca. 35°N-55°N). In Alaska, scattered colonies are found from Cape Krusenstern south to the Alaska Peninsula, west through the Aleutians, and east to Dry Bay. None appear to winter in Alaska. Sowls et al. (1978) gave an estimate of 10,000 birds for Alaska, which probably represents a large part of the world population.

Common Murre (Uria aalge)

Common Murres breed on islands and coasts of the North Atlantic and North Pacific oceans (ca. 38°N-75°N) and winter in open water throughout most of that range. Breeding occurs in suitable habitat throughout Alaska north to Cape Lisburne. Sowls et al. (1978) gave an estimate of 5 million birds for Alaska. Estimates based on censuses in Britain and Ireland indicate nearly 577,000 pairs in that area (Cramp et al. 1974). Nettleship (1977) estimated nearly 1.3 million birds for the eastern Canadian arctic and the Canadian North Atlantic. These figures indicate a possible world population of 10 million birds.

Thick-billed Murre (Uria lomvia)

Thick-billed Murres breed in Arctic and subarctic areas of North America and Eurasia (ca. 50°N-75°N). Their wintering quarters are generally within the breeding range south to Japan, British Columbia, and northern France (ca. 50°N-75°N). In Alaska, these birds breed from Cape Lisburne south throughout the Aleutians to the west, and Middleton Island to the east. Sowls et al. (1978) gave a rough estimate of 5 million birds in Alaska and Nettleship (1977) estimated more than 5.1 million in the eastern Canadian arctic and the Canadian Atlantic. These estimates suggest a world population of probably over 12 million birds, if Soviet birds are included.

Dovekie (Alle alle)

Dovekies breed in the eastern Canadian Arctic east to Spitsbergen, Nova Zemlya, and the New Siberian Islands (ca. 70°N-82°N), and winter south of the breeding range to New Jersey, the Azores, northern France, and the Baltic Sea (ca. 40°N-65°N). In Alaska, this species has appeared in small numbers on Little Diomede and St. Lawrence islands.

Black Guillemot (Cepphus grylle)

The Black Guillemot is a Holarctic breeding species (ca. 45°N-80°N) that winters south to Massachusetts, northern France, the Netherlands, southern Norway, and along the arctic coast of Alaska in open leads south to the Pribilof Islands (ca. 42°N-70°N). In Alaska it breeds along the Beaufort Sea coast and rarely south to Cape Thompson. The Alaska population has been estimated at 400 birds (Sowls et al. 1978).

Pigeon Guillemot (Cepphus columba)

Pigeon Guillemots breed in temperate and arctic waters of the North Pacific Ocean (ca. 32°N-69°N). Birds winter in open waters within their breeding range (ca. 32°N-55°N). Breeding populations in Alaska occur throughout coastal areas from Cape Lisburne southward. Sowls et al. (1978) gave a rough estimate of 200,000 birds in Alaskan waters.

Marbled Murrelet (Brachyramphus marmoratum)

Marbled Murrelets breed from southern Alaska south to northwestern California (ca. 40°N-61°N). They winter throughout their breeding range south to southern California (ca. 33°N-61°N). The breeding range in Alaska is not fully known, but probably includes all of southern Alaska from the Aleutian Islands and Prince William Sound south through southeast Alaska.

Kittlitz's Murrelet (Bachyramphus brevirostris)

Kittlitz's Murrelet breeds in Alaska from probably the Cape Lisburne area south to Lecomte Bay in southeast Alaska (ca. 57°N-66°N) and in northeast Siberia, including the Sea of Okhotsk and the Komandorskie Islands. It winters in the southern part of its breeding range (ca. 57°N-61°N).

Ancient Murrelet (Synthliboramphus antiquus)

The Ancient Murrelet breeds from the Komandorskie Islands and Kamchatka south to Sakhalin, the Kuriles, and Korea, and from the Aleutian Islands east to Langara Island, British Columbia (ca. 40°N-58°N). Its wintering area extends from the southern Bering Sea south to Formosa and Baja California (ca. 29°N-56°N). The largest colonies found in Alaska to date are at Forrester Island in southeast Alaska and Castle Rock in the Shumagin Islands, but because it is nocturnal at the colonies, information on distribution and abundance is not complete. Sowls et al. (1978) estimated the Alaska population to be 400,000 birds.

Cassin's Auklet (Ptychoramphus aleuticus)

Cassin's Auklets breed from Buldir Island in the western Aleutian Islands, east to Forrester Island in southeast Alaska, and south to Baja California (ca. 30°N-55°N), and winter throughout the breeding range. The species is widespread in Alaska, but half of its known breeding sites and over two-thirds of the recorded population are in the western Gulf of Alaska. Sowls et al. (1978)

conservatively estimated the Alaska population at 600,000 birds. Populations of this species have been devastated by foxes, which were introduced to offshore islands during the early part of this century.

Parakeet Auklet (*Cyclorrhynchus psittacula*)

Parakeet Auklets breed from the Diomede Islands south through the islands of the Bering Sea and the Komandorski and Aleutian islands, east to Prince William Sound (ca. 52°N-67°N). In winter, the species is observed off of Japan and California, but most of the population probably remains in ice-free areas within the breeding range (ca. 44°N-60°N). Large colonies occur on islands in the Bering Sea, western Gulf of Alaska, and throughout the Aleutian Islands. The Alaska population is estimated at 800,000 individuals (Sowls et al. 1978).

Crested Auklet (*Aethia cristatella*)

Crested Auklets breed on the Diomede Islands and the islands of the Bering Sea, west through the Aleutians to the Kuriles, and east to the Semidi Islands (ca. 50°N-67°N). In winter, the species is common in ice-free areas throughout its breeding range and south to Japan (ca. north of 40°N). Kodiak Island is recognized as an important wintering area for Crested Auklets. Large colonies are found in the Aleutian Islands and St. Matthew, Hall, and St. Lawrence islands in the Bering Sea. The Alaska population, which includes the bulk of the world population, is an estimated 2 million birds (Sowls et al. 1978).

Least Auklet (*Aethia pussilla*)

Least Auklets breed from the Diomede Islands south to the Aleutian Islands, and east to the Semidi Islands (ca. 52°N-68°N). Large colonies are found on Little Diomede Island, St. Lawrence Island, the Pribilofs, and in the Aleutian Islands. Wintering birds are found in ice-free waters throughout their breeding range and south to Japan (ca. 40°N-57°N). The Alaska population has been estimated to total 6 million birds (Sowls et al. 1978).

Whiskered Auklet (*Aethia pygmaea*)

The limited breeding distribution of the Whiskered Auklet includes the Aleutian Islands and, at least historically, the Kurile and Komandorskie islands (ca. 47°N-54°N). The largest known colony is about 3,000 birds on Buldir Island. Notable but smaller colonies are found on Yunaska, Koniuji, Chagulak, and Herbert islands in the Aleutian chain. The species is believed to winter within its breeding range. Sowls et al. (1978) estimated the Alaskan population at 20,000 birds.

Rhinoceros Auklet (*Cerorhinca monocerata*)

Rhinoceros Auklets breed from northern California north to the Gulf of Alaska, west to Buldir Island, the Kuriles, Japan, and Korea (ca. 36°N-59°N). They winter from Alaska southward to Japan, Korea, and Baja California (ca. 30°N-59°N). The largest colony in Alaska is at Forrester Island in the southeast part of the state. Several colonies in Alaska were probably destroyed by foxes introduced in the earlier part of this century. The Alaska population has been estimated at 200,000 (Sowls et al. 1978).

Horned Puffin (*Fratercula corniculata*)

Horned Puffins breed from Cape Lisburne south along the Alaska coast to British Columbia, through the Aleutian and Komandorskie islands, and from northern Siberia south to the northern Kurile Islands (ca. 50°N-70°N). Wintering birds may be found in open water throughout their breeding range but generally occur at sea as far south as Oregon and Honshu, Japan (ca. 35°N). The center of abundance of Horned Puffins in Alaska is from the Semidi Islands in the Gulf of Alaska west to False Pass. Sowls et al. (1978) estimate the Alaska population at 1.5 million birds.

Tufted Puffin (*Lunda cirrhata*)

Tufted Puffins breed in the North Pacific from Cape Lisburne in the north to Hokkaido, Japan, in the west, and to southern California in the east (ca. 35°N-68°N). Generally, birds move out to sea during the winter, but small numbers may be found throughout the breeding range wherever open water occurs. Most of the Tufted Puffins in Alaska breed from the north-central Gulf of Alaska west through the Aleutians. Their numbers decrease progressively to the north in the Bering Sea. The Alaska population is estimated at 4 million birds (Sowls et al. 1978).

TABLE C1
Number of transects conducted on shipboard surveys in the Gulf of Alaska.

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| Kodiak | | | | |
| Winter | No Surveys | 32/14[a] | 8/ 0 | No Surveys |
| Spring | 113/ 2 | 337/ 34 | 26/ 8 | 12/ 6 |
| Summer | 422/41 | 847/116 | 53/10 | 21/ 2 |
| Fall | 141/ 8 | 336/ 10 | 47/ 5 | 20/ 4 |
| Northeast Gulf | | | | |
| Winter | 1/ 8 | 25/ 4 | 11/ 5 | 17/11 |
| Spring | 14/ 0 | 339/140 | 112/28 | 86/10 |
| Summer | No Surveys | 41/ 59 | 22/12 | 59/15 |
| Fall | 12/ 4 | 119/ 44 | 51/22 | 77/20 |
| Gulf of Alaska | | | | |
| Winter | 29/ 0 | 79/ 21 | 43/24 | 173/11 |
| Spring | 216/ 7 | 1168/348 | 273/89 | 184/23 |
| Summer | 442/49 | 1199/251 | 159/27 | 299/21 |
| Fall | 221/24 | 697/107 | 196/64 | 215/46 |

[a] Number of valid transects used to derive density indices/ Number of station counts, low quality transects, and general observations.

TABLE C2
Number of transects conducted on aerial surveys in the Gulf of Alaska.

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| Kodiak | | | |
| Winter | 44/0[a] | 11/0 | 23/1 |
| Spring | 261/2 | 80/0 | 70/0 |
| Summer | 102/2 | 27/0 | 22/0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 79/ 2 | 26/0 | 55/0 |
| Summer | 40/ 3 | 13/0 | 40/0 |
| Fall | 56/ 2 | 19/0 | 37/0 |
| Gulf of Alaska | | | |
| Winter | 66/ 0 | 12/0 | 23/0 |
| Spring | 727/11 | 177/0 | 193/0 |
| Summer | 343/13 | 79/0 | 95/0 |
| Fall | 149/ 5 | 48/0 | 55/0 |

[a] Number of valid transects used to derive density indices/ Number of station counts, low quality transects, and general observations.

TABLE C3
Number of square kilometers covered by shipboard surveys in the Gulf of Alaska.

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| Kodiak | | | | |
| Winter | No Surveys | 34.15 | 8.33 | No Surveys |
| Spring | 114.78 | 428.32 | 30.87 | 12.12 |
| Summer | 404.92 | 843.20 | 71.45 | 22.58 |
| Fall | 128.35 | 400.53 | 53.22 | 24.07 |
| Northeast Gulf | | | | |
| Winter | 1.25 | 48.41 | 27.22 | 24.71 |
| Spring | 20.97 | 384.08 | 117.55 | 95.14 |
| Summer | No Surveys | 69.15 | 36.93 | 88.99 |
| Fall | 22.12 | 172.99 | 90.16 | 120.42 |
| Gulf of Alaska | | | | |
| Winter | 64.69 | 123.53 | 68.41 | 215.55 |
| Spring | 240.29 | 1361.64 | 334.89 | 224.72 |
| Summer | 434.87 | 1305.44 | 246.17 | 499.30 |
| Fall | 267.76 | 918.81 | 285.00 | 333.17 |

TABLE C4
Number of square kilometers covered by aerial surveys the Gulf of Alaska.

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| Kodiak | | | |
| Winter | 54.14 | 17.10 | 26.99 |
| Spring | 351.01 | 101.69 | 100.90 |
| Summer | 136.60 | 35.78 | 30.94 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 99.29 | 34.23 | 68.66 |
| Summer | 69.25 | 23.33 | 68.98 |
| Fall | 60.74 | 23.33 | 37.06 |
| Gulf of Alaska | | | |
| Winter | 96.84 | 18.96 | 26.99 |
| Spring | 997.93 | 213.57 | 257.66 |
| Summer | 507.88 | 119.31 | 143.86 |
| Fall | 188.52 | 56.32 | 58.46 |

TABLE C5
Total loons in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| MEAN DENSITY | | | | |
| Kodiak | | | | |
| Winter | No Surveys | + | 0 | No Surveys |
| Spring | + | + | 0 | 0 |
| Summer | + | + | 0 | 0 |
| Fall | + | + | + | + |
| Northeast Gulf | | | | |
| Winter | 0 | + | 0 | 0 |
| Spring | 1.5 ± 1.0 | 0.8 ± 0.3 | 0.2 ± 0.1 | + |
| Summer | No Surveys | 0.1 ± 0.1 | + | 0 |
| Fall | 0.1 ± 0.1 | + | + | 0 |
| Gulf of Alaska | | | | |
| Winter | 0.1 ± 0.1 | + | 0 | 0 |
| Spring | 0.2 ± 0.1 | 0.3 ± 0.1 | 0.1 ± 0.1 | + |
| Summer | + | + | + | 0 |
| Fall | + | + | + | + |
| HIGHEST SINGLE TRANSECT DENSITY | | | | |
| Kodiak | | | | |
| Winter | No Surveys | + | 0 | No Surveys |
| Spring | 2.2 | 2.0 | 0 | 0 |
| Summer | 3.4 | 1.0 | 0 | 0 |
| Fall | 1.0 | 2.5 | 0.9 | 0.7 |
| Northeast Gulf | | | | |
| Winter | 0 | 0.3 | 0 | 0 |
| Spring | 6.2 | 23.1 | 5.8 | 1.0 |
| Summer | No Surveys | 1.5 | 0.5 | 0 |
| Fall | 0.5 | 2.0 | 0.7 | 0 |
| Gulf of Alaska | | | | |
| Winter | 0.9 | 0.3 | 0 | 0 |
| Spring | 9.8 | 23.1 | 5.8 | 1.0 |
| Summer | 3.4 | 4.3 | 0.5 | 0 |
| Fall | 1.4 | 2.5 | 0.9 | 0.7 |
| FREQUENCY OF OCCURRENCE | | | | |
| Kodiak | | | | |
| Winter | No Surveys | + | 0 | No Surveys |
| Spring | 4 | 2 | 0 | 0 |
| Summer | + | + | 0 | 0 |
| Fall | 1 | 2 | 4 | 5 |
| Northeast Gulf | | | | |
| Winter | 0 | 4 | 0 | 0 |
| Spring | 57 | 17 | 7 | 1 |
| Summer | No Surveys | 17 | 9 | 0 |
| Fall | 17 | 3 | 2 | 0 |
| Gulf of Alaska | | | | |
| Winter | 14 | 1 | 0 | 0 |
| Spring | 9 | 7 | 4 | 1 |
| Summer | 1 | 1 | 1 | 0 |
| Fall | 4 | 2 | 2 | 1 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| MEAN DENSITY | | | |
| Kodiak | | | |
| Winter | + | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | + | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | + | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | + | 0 | 0 |
| HIGHEST SINGLE TRANSECT DENSITY | | | |
| Kodiak | | | |
| Winter | 1.0 | 0 | 0 |
| Spring | 2.0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.8 | 0 | 0 |
| Summer | 1.1 | 0 | 0 |
| Fall | 1.1 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 1.0 | 0 | 0 |
| Spring | 2.4 | 0 | 0 |
| Summer | 1.1 | 0 | 0 |
| Fall | 2.2 | 0 | 0 |
| FREQUENCY OF OCCURRENCE | | | |
| Kodiak | | | |
| Winter | 5 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1 | 0 | 0 |
| Summer | 3 | 0 | 0 |
| Fall | 4 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 3 | 0 | 0 |
| Spring | 1 | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | 3 | 0 | 0 |

TABLE C6
Northern Fulmar in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 4.7 ± 2.7 | 5.7 ± 2.9 | No Surveys |
| Spring | + | 2.0 ± 1.8 | 5.6 ± 3.8 | 10.2 ± 4.6 |
| Summer | 0.2 ± 0.2 | 1.2 ± 0.2 | 5.3 ± 1.7 | 2.5 ± 0.9 |
| Fall | 0.1 ± 0.1 | 2.0 ± 0.7 | 16.6 ± 10.6 | 1.4 ± 0.7 |
| Northeast Gulf | | | | |
| Winter | 0 | 0.8 ± 0.5 | 8.1 ± 4.6 | 1.2 ± 0.8 |
| Spring | 0 | 1.8 ± 1.0 | 3.2 ± 1.1 | 0.7 ± 0.2 |
| Summer | No Surveys | 1.5 ± 0.9 | 2.3 ± 1.6 | 1.5 ± 0.5 |
| Fall | 0.1 ± 0.1 | 0.4 ± 0.2 | 5.3 ± 3.5 | 2.2 ± 0.6 |
| Gulf of Alaska | | | | |
| Winter | 0 | 2.6 ± 1.1 | 4.9 ± 1.7 | 1.1 ± 0.2 |
| Spring | + | 2.6 ± 1.1 | 25.9 ± 26.6 | 1.4 ± 0.5 |
| Summer | 0.2 ± 0.2 | 2.6 ± 0.7 | 4.2 ± 0.9 | 1.5 ± 0.3 |
| Fall | 0.1 ± 0.1 | 1.6 ± 0.4 | 7.8 ± 2.7 | 2.0 ± 0.4 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 50.0 | 15.3 | No Surveys |
| Spring | 1.2 | 416.2 | 44.2 | 37.3 |
| Summer | 67.0 | 90.4 | 33.4 | 8.6 |
| Fall | 6.8 | 110.4 | 238.9 | 5.2 |
| Northeast Gulf | | | | |
| Winter | 0 | 6.4 | 23.8 | 6.5 |
| Spring | 0 | 144.1 | 62.0 | 8.6 |
| Summer | No Surveys | 14.1 | 18.0 | 15.0 |
| Fall | 0.7 | 5.8 | 104.7 | 23.6 |
| Gulf of Alaska | | | | |
| Winter | 0 | 50.0 | 23.8 | 10.8 |
| Spring | 1.2 | 540.3 | 4086.4 | 37.3 |
| Summer | 67.0 | 420.2 | 33.4 | 21.0 |
| Fall | 6.8 | 110.4 | 238.9 | 32.4 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 69 | 88 | No Surveys |
| Spring | 1 | 18 | 58 | 100 |
| Summer | 2 | 33 | 72 | 81 |
| Fall | 1 | 44 | 81 | 50 |
| Northeast Gulf | | | | |
| Winter | 0 | 32 | 73 | 59 |
| Spring | 0 | 13 | 46 | 29 |
| Summer | No Surveys | 42 | 46 | 49 |
| Fall | 8 | 26 | 80 | 68 |
| Gulf of Alaska | | | | |
| Winter | 0 | 51 | 65 | 53 |
| Spring | 1 | 15 | 47 | 41 |
| Summer | 3 | 38 | 67 | 50 |
| Fall | 2 | 40 | 77 | 68 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 1.1 ± 1.1 | 0.6 ± 0.4 | 0.8 ± 0.6 |
| Spring | 0.7 ± 0.2 | 1.0 ± 0.3 | 1.3 ± 0.8 |
| Summer | 3.3 ± 2.2 | 0.5 ± 0.3 | 0.6 ± 0.3 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.1 ± 0.1 | 2.1 ± 1.4 | 1.1 ± 0.3 |
| Summer | 0.6 ± 0.4 | 1.3 ± 0.7 | 0.4 ± 0.2 |
| Fall | 1.0 ± 0.5 | 1.5 ± 0.5 | 1.9 ± 0.6 |
| Gulf of Alaska | | | |
| Winter | 0.7 ± 0.8 | 0.6 ± 0.3 | 0.8 ± 0.6 |
| Spring | 3.7 ± 4.7 | 1.9 ± 1.0 | 1.1 ± 0.3 |
| Summer | 1.8 ± 0.9 | 0.9 ± 0.2 | 0.5 ± 0.2 |
| Fall | 1.8 ± 0.6 | 2.9 ± 1.4 | 1.8 ± 0.4 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 30.9 | 2.2 | 6.8 |
| Spring | 25.1 | 13.1 | 32.7 |
| Summer | 124.7 | 2.9 | 2.9 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.7 | 17.0 | 6.3 |
| Summer | 8.1 | 5.4 | 3.2 |
| Fall | 11.7 | 4.3 | 10.5 |
| Gulf of Alaska | | | |
| Winter | 30.9 | 2.2 | 6.8 |
| Spring | 2050.2 | 112.3 | 32.7 |
| Summer | 124.7 | 9.2 | 3.9 |
| Fall | 29.2 | 36.1 | 10.5 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 21 | 36 | 48 |
| Spring | 23 | 56 | 64 |
| Summer | 53 | 37 | 55 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 4 | 54 | 55 |
| Summer | 20 | 62 | 50 |
| Fall | 39 | 79 | 84 |
| Gulf of Alaska | | | |
| Winter | 14 | 42 | 48 |
| Spring | 15 | 58 | 58 |
| Summer | 35 | 51 | 48 |
| Fall | 44 | 77 | 82 |

## TABLE C7

### Total shearwaters in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

#### SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| **Kodiak** | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0.4 ± 0.4 | 164.9 ± 133.8 | 21.4 ± 31.6 | 115.9 ± 154.1 |
| Summer | 13.2 ± 5.4 | 123.3 ± 32.4 | 35.5 ± 34.3 | 0.7 ± 0.5 |
| Fall | 12.9 ± 7.3 | 47.0 ± 15.3 | 9.7 ± 5.1 | 3.1 ± 1.1 |
| **Northeast Gulf** | | | | |
| Winter | 0 | 0 | + | 0 |
| Spring | 36.7 ± 60.5 | 200.1 ± 140.7 | 34.3 ± 22.2 | 13.0 ± 9.0 |
| Summer | No Surveys | 4.9 ± 5.3 | 39.9 ± 39.8 | 21.2 ± 15.8 |
| Fall | 3.7 ± 3.9 | 3.8 ± 2.8 | 1.0 ± 0.4 | 0.8 ± 0.2 |
| **Gulf of Alaska** | | | | |
| Winter | 0 | + | + | + |
| Spring | 2.6 ± 3.9 | 130.4 ± 61.2 | 18.9 ± 9.9 | 34.1 ± 24.7 |
| Summer | 12.7 ± 5.1 | 104.8 ± 24.6 | 31.3 ± 17.0 | 8.4 ± 4.3 |
| Fall | 10.7 ± 5.5 | 43.0 ± 13.3 | 4.2 ± 1.6 | 1.3 ± 0.3 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| **Kodiak** | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 18.0 | 23055.0 | 501.0 | 1139.5 |
| Summer | 1083.2 | 10357.3 | 1011.8 | 4.8 |
| Fall | 448.6 | 2160.5 | 109.2 | 11.1 |
| **Northeast Gulf** | | | | |
| Winter | 0 | 0 | 0.3 | 0 |
| Spring | 514.4 | 27207.2 | 1286.0 | 443.7 |
| Summer | No Surveys | 129.1 | 514.4 | 495.9 |
| Fall | 26.2 | 198.8 | 8.7 | 5.4 |
| **Gulf of Alaska** | | | | |
| Winter | 0 | 3.1 | 0.3 | 0.5 |
| Spring | 514.4 | 27207.2 | 1286.0 | 2469.5 |
| Summer | 1083.2 | 10357.3 | 1011.8 | 495.9 |
| Fall | 448.6 | 3603.0 | 109.2 | 26.4 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| **Kodiak** | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 5 | 42 | 31 | 67 |
| Summer | 32 | 84 | 47 | 38 |
| Fall | 45 | 74 | 53 | 75 |
| **Northeast Gulf** | | | | |
| Winter | 0 | 0 | 9 | 0 |
| Spring | 7 | 35 | 43 | 50 |
| Summer | No Surveys | 51 | 59 | 75 |
| Fall | 25 | 55 | 45 | 45 |
| **Gulf of Alaska** | | | | |
| Winter | 0 | 1 | 2 | 1 |
| Spring | 3 | 29 | 27 | 45 |
| Summer | 31 | 71 | 43 | 44 |
| Fall | 32 | 62 | 52 | 44 |

#### AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| **Kodiak** | | | |
| Winter | 0.5 ± 0.8 | + | 0.1 ± 0.1 |
| Spring | 40.1 ± 29.2 | 5.9 ± 3.5 | 0.8 ± 0.5 |
| Summer | 30.5 ± 16.7 | 1.5 ± 2.0 | 0.2 ± 0.1 |
| Fall | No Surveys | No Surveys | No Surveys |
| **Northeast Gulf** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0.2 ± 0.1 |
| Summer | 2.9 ± 2.0 | 0.5 ± 0.4 | 0.2 ± 0.1 |
| Fall | 0.1 ± 0.1 | 0.4 ± 0.2 | 0.2 ± 0.1 |
| **Gulf of Alaska** | | | |
| Winter | 0.5 ± 0.5 | + | 0.1 ± 0.1 |
| Spring | 14.8 ± 10.6 | 2.7 ± 1.6 | 0.3 ± 0.2 |
| Summer | 43.1 ± 27.4 | 0.8 ± 0.7 | 0.2 ± 0.1 |
| Fall | 0.7 ± 0.3 | 0.6 ± 0.3 | 0.3 ± 0.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| **Kodiak** | | | |
| Winter | 20.3 | 0.5 | 1.0 |
| Spring | 3021.1 | 120.0 | 18.9 |
| Summer | 596.3 | 33.5 | 1.1 |
| Fall | No Surveys | No Surveys | No Surveys |
| **Northeast Gulf** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 3.1 |
| Summer | 40.5 | 3.2 | 2.2 |
| Fall | 2.2 | 2.7 | 2.1 |
| **Gulf of Alaska** | | | |
| Winter | 20.3 | 0.5 | 1.0 |
| Spring | 3021.1 | 120.0 | 18.9 |
| Summer | 5453.0 | 33.5 | 2.2 |
| Fall | 17.8 | 4.2 | 2.7 |
| **FREQUENCY OF OCCURRENCE** | | | |
| **Kodiak** | | | |
| Winter | 5 | 9 | 13 |
| Spring | 38 | 51 | 30 |
| Summer | 58 | 26 | 23 |
| Fall | No Surveys | No Surveys | No Surveys |
| **Northeast Gulf** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 13 |
| Summer | 35 | 38 | 23 |
| Fall | 9 | 32 | 14 |
| **Gulf of Alaska** | | | |
| Winter | 8 | 8 | 13 |
| Spring | 16 | 25 | 16 |
| Summer | 49 | 32 | 22 |
| Fall | 22 | 35 | 24 |

TABLE C8
Total Storm-petrels in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0 | 1.5 ± 0.7 | 0.7 ± 0.7 | 0.9 ± 0.4 |
| Summer | 0.6 ± 0.2 | 0.7 ± 0.3 | 3.5 ± 1.7 | 1.8 ± 0.8 |
| Fall | + | 0.2 ± 0.1 | 4.1 ± 2.8 | 0.8 ± 0.3 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0.2 ± 0.2 |
| Spring | 0 | 0.1 ± + | 0.5 ± 0.3 | 1.4 ± 0.8 |
| Summer | No Surveys | 0.3 ± 0.3 | 3.0 ± 1.7 | 3.6 ± 1.0 |
| Fall | 0.2 ± 0.2 | 0.1 ± 0.1 | 3.2 ± 4.4 | 0.3 ± 0.1 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0.1 ± + | 0.5 ± 0.1 |
| Spring | + | 1.3 ± 0.6 | 0.6 ± 0.3 | 2.4 ± 0.8 |
| Summer | 0.6 ± 0.2 | 1.8 ± 0.5 | 5.5 ± 1.7 | 2.4 ± 0.3 |
| Fall | 0.2 ± 0.1 | 0.7 ± 0.3 | 3.5 ± 1.8 | 0.8 ± 0.2 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0 | 82.6 | 9.8 | 2.0 |
| Summer | 33.6 | 87.5 | 49.1 | 8.3 |
| Fall | 4.1 | 6.0 | 67.5 | 2.0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 2.0 |
| Spring | 0 | 4.3 | 14.1 | 33.4 |
| Summer | No Surveys | 5.0 | 19.0 | 21.1 |
| Fall | 1.0 | 4.8 | 135.3 | 2.6 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0.7 | 7.7 |
| Spring | 2.0 | 286.5 | 33.5 | 61.9 |
| Summer | 33.6 | 270.1 | 97.2 | 26.0 |
| Fall | 10.8 | 96.3 | 135.3 | 9.6 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0 | 8 | 15 | 58 |
| Summer | 14 | 20 | 60 | 67 |
| Fall | 1 | 13 | 36 | 65 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 18 |
| Spring | 0 | 5 | 12 | 36 |
| Summer | No Surveys | 17 | 68 | 83 |
| Fall | 33 | 4 | 35 | 29 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 9 | 36 |
| Spring | 1 | 6 | 11 | 40 |
| Summer | 14 | 23 | 63 | 72 |
| Fall | 10 | 15 | 43 | 46 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.5 ± 0.7 | 4.0 ± 2.1 | 1.4 ± 2.3 |
| Summer | 2.9 ± 1.6 | 2.0 ± 0.9 | 1.5 ± 0.5 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 1.1 ± 0.5 |
| Summer | 0.2 ± 0.2 | 0.3 ± 0.3 | 0.6 ± 0.3 |
| Fall | 0.6 ± 0.3 | 0.8 ± 0.3 | 2.5 ± 1.5 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.1 ± 0.7 | 2.1 ± 0.9 | 1.6 ± 0.3 |
| Summer | 4.4 ± 3.1 | 1.5 ± 0.5 | 0.8 ± 0.1 |
| Fall | 0.3 ± 0.2 | 0.7 ± 0.2 | 1.8 ± 1.0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 64.8 | 72.9 | 8.1 |
| Summer | 83.7 | 11.9 | 5.0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.8 | 0 | 8.5 |
| Summer | 3.8 | 2.2 | 4.1 |
| Fall | 6.5 | 2.1 | 26.2 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 307.2 | 72.9 | 17.1 |
| Summer | 637.1 | 17.8 | 5.0 |
| Fall | 6.5 | 4.2 | 26.2 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 18 | 43 | 70 |
| Summer | 32 | 78 | 82 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1 | 0 | 29 |
| Summer | 18 | 31 | 53 |
| Fall | 30 | 68 | 51 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 9 | 25 | 53 |
| Summer | 28 | 56 | 58 |
| Fall | 16 | 54 | 42 |

TABLE C9
Total cormorants in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | + | 0 | No Surveys |
| Spring | 0.6 $\pm$ 0.3 | 0.3 $\pm$ 0.2 | 0 | 0 |
| Summer | 0.4 $\pm$ 0.3 | + | 0 | 0 |
| Fall | 0.4 $\pm$ 0.2 | + | + | 0 |
| Northeast Gulf | | | | |
| Winter | 0.8 $\pm$ + | 0 | + | 0 |
| Spring | 0.2 $\pm$ 0.2 | 0.2 $\pm$ 0.2 | + | 0 |
| Summer | No Surveys | + | + | + |
| Fall | 0.5 $\pm$ 0.6 | 0.8 $\pm$ 0.7 | + | + |
| Gulf of Alaska | | | | |
| Winter | 0.4 $\pm$ 0.3 | + | + | 0 |
| Spring | 0.5 $\pm$ 0.2 | 0.3 $\pm$ 0.1 | + | 0 |
| Summer | 0.4 $\pm$ 0.1 | 0.1 $\pm$ + | + | + |
| Fall | 0.3 $\pm$ 0.1 | 0.2 $\pm$ 0.1 | + | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 1.2 | 0 | No Surveys |
| Spring | 10.8 | 25.7 | 0 | 0 |
| Summer | 18.4 | 10.8 | 0 | 0 |
| Fall | 8.4 | 6.8 | 0.8 | 0 |
| Northeast Gulf | | | | |
| Winter | 0.8 | 0 | 0.3 | 0 |
| Spring | 1.8 | 31.7 | 2.9 | 0 |
| Summer | No Surveys | 0.6 | 0.5 | 1.0 |
| Fall | 4.3 | 37.2 | 0.7 | 0.5 |
| Gulf of Alaska | | | | |
| Winter | 3.6 | 1.2 | 0.3 | 0 |
| Spring | 10.8 | 31.7 | 4.3 | 0 |
| Summer | 18.4 | 13.5 | 1.4 | 1.0 |
| Fall | 8.4 | 37.2 | 1.9 | 0.7 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 3 | 0 | No Surveys |
| Spring | 19 | 7 | 0 | 0 |
| Summer | 19 | 1 | 0 | 0 |
| Fall | 17 | 2 | 2 | 0 |
| Northeast Gulf | | | | |
| Winter | 100 | 0 | 9 | 0 |
| Spring | 14 | 7 | 1 | 0 |
| Summer | No Surveys | 7 | 5 | 2 |
| Fall | 25 | 5 | 4 | 4 |
| Gulf of Alaska | | | | |
| Winter | 34 | 3 | 2 | 0 |
| Spring | 18 | 10 | 3 | 0 |
| Summer | 19 | 3 | 3 | + |
| Fall | 20 | 4 | 3 | 2 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 1.5 $\pm$ 1.6 | 0 | 0 |
| Spring | 0.3 $\pm$ 0.2 | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | + | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 2.9 $\pm$ 2.5 | 0 | 0 |
| Spring | 0.4 $\pm$ 0.2 | 0 | 0 |
| Summer | 0.1 $\pm$ + | 0 | 0 |
| Fall | 0.1 $\pm$ 0.1 | + | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 41.0 | 0 | 0 |
| Spring | 21.8 | 0 | 0 |
| Summer | 1.1 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.5 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 1.1 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 86.4 | 0 | 0 |
| Spring | 65.2 | 0 | 0 |
| Summer | 3.8 | 0 | 0 |
| Fall | 3.6 | 0.9 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 18 | 0 | 0 |
| Spring | 8 | 0 | 0 |
| Summer | 4 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 4 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 2 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 18 | 0 | 0 |
| Spring | 10 | 0 | 0 |
| Summer | 4 | 0 | 0 |
| Fall | 8 | 2 | 0 |

TABLE C10
Total geese and ducks in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 5.7 ± 3.0 | 0.5 ± 0.5 | 0.1 ± 0.1 | 0 |
| Summer | 0.1 ± + | 1.0 ± 1.7 | 0 | 0 |
| Fall | 0.1 ± + | + | 0.3 ± 0.6 | 0 |
| Northeast Gulf | | | | |
| Winter | 0.8 ± + | 0 | 0 | 0 |
| Spring | 0.9 ± 1.2 | 1.2 ± 0.8 | + | 0.3 ± 0.5 |
| Summer | No Surveys | 0.2 ± 0.2 | 0 | 0 |
| Fall | + | 0.1 ± 0.1 | 0.1 ± 0.1 | + |
| Gulf of Alaska | | | | |
| Winter | 0.2 ± 0.2 | + | 0 | + |
| Spring | 3.6 ± 1.6 | 1.4 ± 0.6 | + | 0.3 ± 0.3 |
| Summer | 0.1 ± 0.1 | 0.7 ± 1.2 | 0 | 0 |
| Fall | 0.3 ± 0.3 | 0.1 ± + | 0.1 ± 0.1 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 121.1 | 95.3 | 2.2 | 0 |
| Summer | 7.5 | 873.5 | 0 | 0 |
| Fall | 2.7 | 3.6 | 14.4 | 0 |
| Northeast Gulf | | | | |
| Winter | 0.8 | 0 | 0 | 0 |
| Spring | 9.9 | 99.2 | 2.9 | 25.7 |
| Summer | No Surveys | 3.9 | 0 | 0 |
| Fall | 0.5 | 4.3 | 4.8 | 0.5 |
| Gulf of Alaska | | | | |
| Winter | 2.5 | 0 | 0 | 0.5 |
| Spring | 121.1 | 324.3 | 4.1 | 27.5 |
| Summer | 11.6 | 873.5 | 0 | 0 |
| Fall | 39.2 | 10.8 | 14.4 | 0.5 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 24 | 4 | 4 | 0 |
| Summer | 3 | 1 | 0 | 0 |
| Fall | 6 | 2 | 6 | 0 |
| Northeast Gulf | | | | |
| Winter | 100 | 0 | 0 | 0 |
| Spring | 21 | 9 | 2 | 2 |
| Summer | No Surveys | 12 | 0 | 0 |
| Fall | 8 | 8 | 2 | 4 |
| Gulf of Alaska | | | | |
| Winter | 17 | + | 0 | 1 |
| Spring | 20 | 7 | 2 | 2 |
| Summer | 3 | 1 | 0 | 0 |
| Fall | 10 | 4 | 4 | 1 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 9.7 ± 6.0 | 0 | 0 |
| Spring | 2.7 ± 1.5 | + | 0 |
| Summer | + | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.8 ± 0.8 | 0 | 0 |
| Summer | 0.2 ± 0.2 | 0 | 0 |
| Fall | 5.9 ± 7.0 | 0 | 0.6 ± 0.9 |
| Gulf of Alaska | | | |
| Winter | 13.6 ± 10.3 | 0 | 0 |
| Spring | 5.8 ± 2.9 | + | 0 |
| Summer | 0.1 ± 0.1 | 0 | 0 |
| Fall | 3.0 ± 2.7 | + | 0.4 ± 0.6 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 98.8 | 0 | 0 |
| Spring | 182.0 | 2.0 | 0 |
| Summer | 3.0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 30.3 | 0 | 0 |
| Summer | 6.5 | 0 | 0 |
| Fall | 234.6 | 0 | 21.0 |
| Gulf of Alaska | | | |
| Winter | 378.0 | 0 | 0 |
| Spring | 1122.6 | 2.0 | 0 |
| Summer | 13.5 | 0 | 0 |
| Fall | 234.6 | 0.5 | 21.0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 30 | 0 | 0 |
| Spring | 10 | 3 | 0 |
| Summer | 1 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 9 | 0 | 0 |
| Summer | 3 | 0 | 0 |
| Fall | 16 | 0 | 5 |
| Gulf of Alaska | | | |
| Winter | 24 | 0 | 0 |
| Spring | 13 | 2 | 0 |
| Summer | 3 | 0 | 0 |
| Fall | 15 | 2 | 4 |

TABLE C11
Total phalaropes in the Gulf of Alaska

Density Indices (Mean $B/Km^2$ ± 90% Confidence Intervals), Highest Single Transect Densities ($B/Km^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | + | 0.1 ± 0.1 | 0 | 0 |
| Summer | 1.2 ± 0.4 | 0.6 ± 0.2 | 0.7 ± 0.9 | 0.2 ± 0.3 |
| Fall | 0.5 ± 0.3 | 0.2 ± 0.2 | 0.2 ± 0.4 | 0.3 ± 0.5 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 4.1 ± 6.7 | 1.4 ± 0.5 | 3.4 ± 2.8 | 0.2 ± 0.2 |
| Summer | No Surveys | 0 | 0 | 0.1 ± 0.3 |
| Fall | + | 0.2 ± 0.2 | 0 | + |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | + |
| Spring | 2.7 ± 2.7 | 2.0 ± 1.3 | 2.0 ± 1.3 | 0.1 ± 0.1 |
| Summer | 1.4 ± 0.5 | 1.0 ± 0.6 | 0.6 ± 0.5 | 0.1 ± + |
| Fall | 0.4 ± 0.1 | 0.3 ± 0.2 | 0.1 ± 0.1 | 0.1 ± + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 1.2 | 6.5 | 0 | 0 |
| Summer | 61.9 | 96.0 | 30.0 | 3.9 |
| Fall | 13.8 | 20.7 | 9.9 | 5.4 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 57.3 | 45.6 | 142.7 | 10.0 |
| Summer | No Surveys | 0 | 0 | 7.9 |
| Fall | 0.5 | 16.8 | 0 | 2.2 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | + |
| Spring | 347.2 | 673.5 | 142.7 | 10.0 |
| Summer | 84.1 | 344.7 | 30.0 | 7.9 |
| Fall | 13.8 | 54.1 | 9.9 | 5.4 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 1 | 2 | 0 | 0 |
| Summer | 14 | 7 | 8 | 10 |
| Fall | 16 | 6 | 2 | 5 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 7 | 9 | 13 | 5 |
| Summer | No Surveys | 0 | 0 | 2 |
| Fall | 8 | 5 | 0 | 3 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | + |
| Spring | 4 | 5 | 8 | 2 |
| Summer | 14 | 8 | 6 | 2 |
| Fall | 12 | 5 | 2 | 3 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0.1 ± + | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | + |
| Summer | 0.4 ± 0.4 | 0.8 ± 1.2 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | + | + |
| Summer | 0.1 ± + | 0.1 ± 0.2 | 0 |
| Fall | 0.1 ± 0.1 | 0.1 ± 0.2 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.1 | 0 | 0 |
| Summer | 5.1 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0.8 |
| Summer | 6.5 | 9.7 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 31.2 | 2.2 | 0.8 |
| Summer | 6.5 | 9.7 | 0 |
| Fall | 9.0 | 3.2 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 2 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 2 |
| Summer | 8 | 15 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 2 | 1 |
| Summer | 3 | 5 | 0 |
| Fall | 3 | 6 | 0 |

TABLE C12

Total jaegers in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| | | MEAN DENSITY | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0.1 ± + | 0.1 ± 0.1 | 0 | 0.2 ± 0.2 |
| Summer | 0.3 ± 0.1 | 0.5 ± 0.4 | 0.2 ± 0.2 | 0.1 ± 0.1 |
| Fall | 0.3 ± 0.1 | 0.1 ± + | 0.1 ± + | 0.2 ± 0.2 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 0 | + | 0.1 ± 0.1 | 0.1 ± 0.1 |
| Summer | No Surveys | 0.1 ± 0.1 | 0.1 ± 0.1 | 0.2 ± 0.1 |
| Fall | 0.2 ± 0.2 | 0.1 ± 0.1 | 0.2 ± 0.1 | 0.2 ± 0.1 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | + | 0.1 ± + | 0.1 ± + | 0.1 ± 0.1 |
| Summer | 0.3 ± + | 0.4 ± 0.2 | 0.2 ± 0.1 | 0.2 ± 0.1 |
| Fall | 0.2 ± 0.1 | 0.1 ± + | 0.1 ± + | 0.2 ± 0.1 |
| | | HIGHEST SINGLE TRANSECT DENSITY | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 2.2 | 6.0 | 0 | 2.0 |
| Summer | 8.6 | 205.4 | 3.2 | 1.2 |
| Fall | 4.8 | 3.2 | 1.2 | 1.0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 0 | 2.9 | 2.9 | 2.3 |
| Summer | No Surveys | 2.1 | 1.0 | 1.7 |
| Fall | 1.0 | 1.4 | 2.2 | 1.8 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 2.2 | 6.0 | 5.9 | 2.3 |
| Summer | 8.6 | 205.4 | 3.6 | 4.8 |
| Fall | 4.8 | 3.2 | 2.9 | 3.6 |
| | | FREQUENCY OF OCCURRENCE | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 4 | 6 | 0 | 8 |
| Summer | 10 | 12 | 19 | 5 |
| Fall | 16 | 10 | 6 | 20 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 0 | 4 | 8 | 9 |
| Summer | No Surveys | 15 | 9 | 20 |
| Fall | 25 | 13 | 18 | 19 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 3 | 3 | 4 | 9 |
| Summer | 10 | 11 | 14 | 17 |
| Fall | 13 | 9 | 10 | 16 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | MEAN DENSITY | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0.1 ± 0.1 | + | 0.1 + 0.1 |
| Summer | + | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 0.1 ± 0.1 | 0 | + |
| Fall | + | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | + | + |
| Summer | + | + | + |
| Fall | + | + | + |
| | HIGHEST SINGLE TRANSECT DENSITY | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.6 | 1.0 | 2.9 |
| Summer | 1.0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 1.1 | 0 | 0.5 |
| Fall | 1.1 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 2.1 | 1.0 | 2.9 |
| Summer | 1.6 | 1.0 | 0.5 |
| Fall | 1.1 | 2.1 | 0.9 |
| | FREQUENCY OF OCCURRENCE | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 6 | 5 | 6 |
| Summer | 2 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 8 | 0 | 3 |
| Fall | 4 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 3 | 2 | 2 |
| Summer | 4 | 1 | 2 |
| Fall | 3 | 2 | 2 |

TABLE C13
Total *Larus* gulls in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 7.4 ± 3.2 | 10.9 ± 7.5 | No Surveys |
| Spring | 1.7 ± 0.8 | 1.1 ± 0.3 | 0.9 ± 0.4 | 1.0 ± 0.4 |
| Summer | 2.1 ± 1.5 | 0.3 ± 0.1 | 0.1 ± 0.1 | 0.1 ± 0.1 |
| Fall | 3.9 ± 1.7 | 0.9 ± 0.2 | 2.3 ± 1.1 | + |
| Northeast Gulf | | | | |
| Winter | 0 | 1.1 ± 0.4 | 1.2 ± 0.7 | 1.8 ± 1.0 |
| Spring | 4.1 ± 1.6 | 2.7 ± 0.4 | 4.1 ± 0.9 | 1.3 ± 0.4 |
| Summer | No Surveys | 1.0 ± 0.4 | 0.5 ± 0.3 | 0.2 ± 0.2 |
| Fall | 1.4 ± 0.6 | 0.7 ± 0.2 | 1.0 ± 0.4 | 0.5 ± 0.2 |
| Gulf of Alaska | | | | |
| Winter | 6.1 ± 4.8 | 4.0 ± 1.4 | 4.7 ± 2.0 | 0.3 ± 0.1 |
| Spring | 2.7 ± 0.6 | 1.8 ± 0.2 | 2.6 ± 0.5 | 1.0 ± 0.3 |
| Summer | 2.1 ± 0.5 | 0.5 ± 0.1 | 0.3 ± 0.1 | + |
| Fall | 4.3 ± 1.5 | 1.3 ± 0.2 | 1.3 ± 0.3 | 0.4 ± 0.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 56.0 | 34.8 | No Surveys |
| Spring | 50.8 | 33.5 | 4.1 | 2.2 |
| Summer | 80.1 | 18.4 | 2.2 | 1.1 |
| Fall | 129.7 | 12.3 | 19.2 | 0.7 |
| Northeast Gulf | | | | |
| Winter | 0.0 | 5.2 | 3.6 | 8.5 |
| Spring | 10.8 | 30.3 | 35.8 | 10.8 |
| Summer | No Surveys | 5.8 | 3.1 | 6.9 |
| Fall | 3.6 | 4.8 | 8.6 | 4.6 |
| Gulf of Alaska | | | | |
| Winter | 76.7 | 56.0 | 34.8 | 8.5 |
| Spring | 50.8 | 44.3 | 25.8 | 10.8 |
| Summer | 80.1 | 29.4 | 4.1 | 6.9 |
| Fall | 129.7 | 36.5 | 19.2 | 6.8 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 84 | 100 | No Surveys |
| Spring | 53 | 46 | 54 | 67 |
| Summer | 43 | 15 | 8 | 10 |
| Fall | 57 | 40 | 47 | 5 |
| Northeast Gulf | | | | |
| Winter | 0 | 84 | 73 | 71 |
| Spring | 86 | 65 | 63 | 47 |
| Summer | No Surveys | 59 | 36 | 8 |
| Fall | 75 | 43 | 53 | 31 |
| Gulf of Alaska | | | | |
| Winter | 66 | 80 | 79 | 24 |
| Spring | 67 | 55 | 63 | 43 |
| Summer | 44 | 22 | 20 | 3 |
| Fall | 64 | 43 | 49 | 23 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 5.2 ± 4.4 | 0.6 ± 0.4 | 0 |
| Spring | 0.8 ± 0.3 | 0.5 ± 0.2 | 0.1 ± 0.1 |
| Summer | 1.0 ± 0.7 | + | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.9 ± 0.5 | 1.3 ± 0.7 | 1.4 ± 0.7 |
| Summer | 5.6 ± 8.0 | 34.7 ± 57.0 | 0.1 ± 0.3 |
| Fall | 1.7 ± 1.0 | 0.4 ± 0.3 | + |
| Gulf of Alaska | | | |
| Winter | 4.4 ± 3.0 | 0.6 ± 0.4 | 0 |
| Spring | 1.2 ± 0.4 | 0.7 ± 0.4 | 0.5 ± 0.2 |
| Summer | 2.9 ± 1.3 | 5.8 ± 9.4 | 0.1 ± 0.2 |
| Fall | 1.4 ± 0.5 | 0.3 ± 0.2 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 114.5 | 1.9 | 0 |
| Spring | 29.7 | 5.7 | 2.2 |
| Summer | 34.7 | 1.1 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 15.4 | 8.1 | 16.7 |
| Summer | 192.9 | 450.0 | 5.9 |
| Fall | 27.0 | 3.2 | 0.5 |
| Gulf of Alaska | | | |
| Winter | 114.5 | 1.9 | 0 |
| Spring | 83.7 | 31.5 | 16.7 |
| Summer | 192.9 | 450.0 | 5.9 |
| Fall | 27.0 | 3.2 | 0.9 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 59 | 55 | 0 |
| Spring | 28 | 24 | 4 |
| Summer | 21 | 4 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 38 | 46 | 36 |
| Summer | 30 | 23 | 3 |
| Fall | 45 | 26 | 3 |
| Gulf of Alaska | | | |
| Winter | 58 | 50 | 0 |
| Spring | 35 | 26 | 13 |
| Summer | 32 | 9 | 3 |
| Fall | 42 | 17 | 5 |

TABLE C14

Glaucous-winged Gull in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 4.1 ± 1.6 | 9.7 ± 7.7 | No Surveys |
| Spring | 1.4 ± 0.8 | 1.1 ± 0.2 | 0.7 ± 0.3 | 0.8 ± 0.4 |
| Summer | 2.1 ± 0.4 | 0.3 ± 0.1 | 0.1 ± 0.1 | + |
| Fall | 3.3 ± 1.4 | 0.7 ± 0.1 | 2.0 ± 0.9 | + |
| Northeast Gulf | | | | |
| Winter | 0 | 0.9 ± 0.4 | 1.2 ± 0.6 | 1.3 ± 0.3 |
| Spring | 3.0 ± 1.2 | 1.6 ± 0.3 | 1.4 ± 0.5 | 0.8 ± 0.3 |
| Summer | No Surveys | 0.3 ± 0.3 | 0.1 ± 0.2 | 0.1 ± 0.2 |
| Fall | 0.9 ± 0.5 | 0.4 ± 0.1 | 0.6 ± 0.3 | 0.4 ± 0.2 |
| Gulf of Alaska | | | | |
| Winter | 0.9 ± 0.9 | 2.4 ± 0.7 | 3.5 ± 1.9 | 0.2 ± 0.1 |
| Spring | 2.0 ± 0.5 | 1.4 ± 0.2 | 1.2 ± 0.3 | 0.7 ± 0.1 |
| Summer | 2.0 ± 0.5 | 0.4 ± 0.1 | 0.2 ± 0.1 | + |
| Fall | 2.4 ± 0.9 | 1.1 ± 0.3 | 1.0 ± 0.3 | 0.3 ± 0.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 24.0 | 33.6 | No Surveys |
| Spring | 50.8 | 33.5 | 4.1 | 2.0 |
| Summer | 80.1 | 17.3 | 2.2 | 0.8 |
| Fall | 99.6 | 8.5 | 19.2 | 0.7 |
| Northeast Gulf | | | | |
| Winter | 0 | 5.2 | 3.0 | 2.0 |
| Spring | 8.6 | 23.1 | 23.3 | 8.6 |
| Summer | No Surveys | 5.1 | 2.6 | 6.9 |
| Fall | 2.9 | 4.8 | 6.3 | 4.6 |
| Gulf of Alaska | | | | |
| Winter | 16.2 | 24.0 | 33.6 | 5.2 |
| Spring | 50.8 | 44.3 | 23.3 | 8.6 |
| Summer | 80.1 | 29.4 | 4.1 | 6.9 |
| Fall | 99.6 | 36.5 | 19.2 | 6.8 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 78 | 75 | No Surveys |
| Spring | 47 | 44 | 42 | 58 |
| Summer | 42 | 14 | 8 | 5 |
| Fall | 54 | 39 | 47 | 5 |
| Northeast Gulf | | | | |
| Winter | 0 | 68 | 73 | 71 |
| Spring | 86 | 47 | 38 | 33 |
| Summer | No Surveys | 15 | 5 | 5 |
| Fall | 67 | 27 | 35 | 23 |
| Gulf of Alaska | | | | |
| Winter | 38 | 67 | 56 | 19 |
| Spring | 56 | 48 | 49 | 33 |
| Summer | 43 | 19 | 15 | 1 |
| Fall | 51 | 38 | 39 | 19 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 5.2 ± 4.4 | 0.6 ± 0.4 | 0 |
| Spring | 0.7 ± 0.3 | 0.5 ± 0.2 | 0.1 + 0.1 |
| Summer | 0.9 ± 0.6 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.7 ± 0.5 | 0.5 ± 0.3 | 0.4 + 0.3 |
| Summer | 0.6 ± 0.5 | + | 0 |
| Fall | 1.7 ± 1.0 | 0.4 ± 0.3 | + |
| Gulf of Alaska | | | |
| Winter | 4.4 ± 3.0 | 0.6 ± 0.3 | 0 |
| Spring | 1.1 ± 0.4 | 0.6 ± 0.3 | 0.2 + 0.1 |
| Summer | 1.9 ± 0.8 | 0.1 ± + | + |
| Fall | 1.4 ± 0.5 | 0.3 ± 0.2 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 114.5 | 1.9 | 0 |
| Spring | 29.7 | 5.7 | 2.2 |
| Summer | 34.7 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 15.4 | 3.1 | 6.9 |
| Summer | 9.7 | 0.5 | 0 |
| Fall | 27.0 | 3.2 | 0.5 |
| Gulf of Alaska | | | |
| Winter | 114.5 | 1.9 | 0 |
| Spring | 83.7 | 31.5 | 10.8 |
| Summer | 145.9 | 2.2 | 1.5 |
| Fall | 27.0 | 3.2 | 0.9 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 57 | 55 | 0 |
| Spring | 25 | 23 | 4 |
| Summer | 19 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 29 | 38 | 16 |
| Summer | 18 | 8 | 0 |
| Fall | 45 | 26 | 3 |
| Gulf of Alaska | | | |
| Winter | 56 | 50 | 0 |
| Spring | 32 | 24 | 7 |
| Summer | 30 | 5 | 1 |
| Fall | 41 | 17 | 4 |

TABLE C15
Total kittiwakes in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| | | MEAN DENSITY | | |
| Kodiak | | | | |
| Winter | No Surveys | 2.0 ± 0.8 | 9.0 ± 4.9 | No Surveys |
| Spring | 3.3 ± 1.0 | 4.4 ± 1.0 | 2.7 ± 1.2 | 3.0 ± 1.7 |
| Summer | 10.3 ± 1.9 | 2.8 ± 0.7 | 1.3 ± 1.0 | 0.1 ± 0.2 |
| Fall | 12.4 ± 2.6 | 1.9 ± 0.6 | 1.0 ± 0.4 | 0.1 ± 0.1 |
| Northeast Gulf | | | | |
| Winter | 0 | 0.4 ± 0.3 | 0.7 ± 0.5 | 1.1 ± 0.9 |
| Spring | 5.9 ± 3.4 | 2.0 ± 0.6 | 4.0 ± 1.1 | 4.0 ± 1.6 |
| Summer | No Surveys | 7.1 ± 4.5 | 1.6 ± 1.0 | 1.5 ± 0.5 |
| Fall | 0.8 ± 0.6 | 1.1 ± 0.4 | 0.8 ± 0.4 | 0.4 ± 0.2 |
| Gulf of Alaska | | | | |
| Winter | 0 | 1.8 ± 0.9 | 2.5 ± 1.3 | 0.9 ± 0.2 |
| Spring | 2.6 ± 0.6 | 2.8 ± 0.4 | 2.8 ± 0.6 | 2.9 ± 0.9 |
| Summer | 10.0 ± 1.8 | 2.6 ± 0.6 | 1.2 ± 0.4 | 0.3 ± 0.1 |
| Fall | 8.4 ± 1.5 | 2.2 ± 0.7 | 1.3 ± 0.3 | 0.5 ± 0.2 |
| | | HIGHEST SINGLE TRANSECT DENSITY | | |
| Kodiak | | | | |
| Winter | No Surveys | 9.0 | 27.9 | No Surveys |
| Spring | 44.8 | 138.4 | 16.7 | 9.9 |
| Summer | 357.8 | 247.7 | 29.7 | 1.7 |
| Fall | 117.6 | 59.4 | 8.4 | 1.0 |
| Northeast Gulf | | | | |
| Winter | 0 | 2.7 | 2.9 | 7.9 |
| Spring | 25.0 | 54.0 | 35.7 | 56.2 |
| Summer | No Surveys | 104.9 | 12.9 | 11.6 |
| Fall | 2.9 | 25.7 | 7.9 | 4.3 |
| Gulf of Alaska | | | | |
| Winter | 0 | 38.6 | 27.9 | 11.5 |
| Spring | 44.8 | 138.4 | 35.7 | 56.2 |
| Summer | 357.8 | 247.7 | 29.7 | 11.6 |
| Fall | 117.6 | 281.1 | 14.4 | 10.2 |
| | | FREQUENCY OF OCCURRENCE | | |
| Kodiak | | | | |
| Winter | No Surveys | 50 | 100 | No Surveys |
| Spring | 57 | 63 | 69 | 83 |
| Summer | 83 | 45 | 36 | 10 |
| Fall | 93 | 51 | 49 | 15 |
| Northeast Gulf | | | | |
| Winter | 0 | 32 | 55 | 41 |
| Spring | 86 | 38 | 60 | 58 |
| Summer | No Surveys | 78 | 50 | 56 |
| Fall | 42 | 40 | 43 | 31 |
| Gulf of Alaska | | | | |
| Winter | 0 | 44 | 56 | 49 |
| Spring | 50 | 45 | 51 | 53 |
| Summer | 81 | 47 | 43 | 15 |
| Fall | 81 | 52 | 50 | 32 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | MEAN DENSITY | | |
| Kodiak | | | |
| Winter | 0.5 ± 0.3 | 2.7 ± 2.4 | 0.4 ± 0.4 |
| Spring | 2.9 ± 0.7 | 5.5 ± 2.6 | 2.6 ± 1.6 |
| Summer | 4.3 ± 2.0 | 0.1 ± 0.1 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.4 ± 0.2 | 0.8 ± 0.4 | 2.8 ± 1.0 |
| Summer | 0.6 ± 0.3 | + | 0.4 ± 0.4 |
| Fall | 0.7 ± 0.5 | 0.1 ± 0.1 | 0.2 ± 0.2 |
| Gulf of Alaska | | | |
| Winter | 0.7 ± 0.5 | 2.5 ± 2.1 | 0.4 ± 0.4 |
| Spring | 1.7 ± 0.4 | 4.1 ± 1.5 | 2.4 ± 0.7 |
| Summer | 3.9 ± 1.0 | 0.3 ± 0.2 | 0.2 ± 0.1 |
| Fall | 1.6 ± 0.5 | 0.6 ± 0.3 | 0.4 ± 0.2 |
| | HIGHEST SINGLE TRANSECT DENSITY | | |
| Kodiak | | | |
| Winter | 6.8 | 15.7 | 5.8 |
| Spring | 64.3 | 87.3 | 59.5 |
| Summer | 87.3 | 2.0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 5.4 | 3.9 | 25.9 |
| Summer | 4.9 | 0.5 | 6.1 |
| Fall | 16.2 | 1.0 | 4.2 |
| Gulf of Alaska | | | |
| Winter | 18.9 | 15.7 | 5.8 |
| Spring | 81.1 | 94.4 | 59.5 |
| Summer | 96.7 | 13.5 | 6.1 |
| Fall | 22.2 | 8.4 | 4.2 |
| | FREQUENCY OF OCCURRENCE | | |
| Kodiak | | | |
| Winter | 25 | 55 | 13 |
| Spring | 54 | 59 | 41 |
| Summer | 50 | 7 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 20 | 50 | 71 |
| Summer | 35 | 8 | 15 |
| Fall | 25 | 5 | 8 |
| Gulf of Alaska | | | |
| Winter | 24 | 50 | 13 |
| Spring | 37 | 55 | 57 |
| Summer | 47 | 11 | 11 |
| Fall | 46 | 31 | 25 |

TABLE C16
Total terns in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 0.3 ± 0.3 | 0.2 ± 0.1 | 0 | 0 |
| Summer | 1.2 ± 0.3 | 0.2 ± 0.1 | 0.3 ± 0.3 | 0.1 ± 0.1 |
| Fall | + | + | + | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 1.8 ± 1.5 | 1.0 ± 0.3 | 0.6 ± 0.3 | 0.3 ± 0.2 |
| Summer | No Surveys | 1.9 ± 0.7 | 1.5 ± 1.3 | 0.7 ± 0.7 |
| Fall | 0 | + | + | 0 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 0.4 ± 0.2 | 0.4 ± 0.1 | 0.2 ± 0.2 | 0.1 ± 0.1 |
| Summer | 1.2 ± 0.2 | 0.2 ± 0.1 | 0.4 ± 0.2 | 0.2 ± 0.1 |
| Fall | + | + | + | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 16.7 | 13.0 | 0 | 0 |
| Summer | 38.9 | 15.1 | 5.0 | 1.2 |
| Fall | 4.3 | 3.2 | 2.0 | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 11.5 | 38.9 | 10.1 | 5.8 |
| Summer | No Surveys | 11.6 | 17.0 | 18.0 |
| Fall | 0 | 0.7 | 0.5 | 0 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 16.7 | 38.9 | 10.1 | 5.8 |
| Summer | 38.9 | 15.1 | 17.0 | 18.0 |
| Fall | 4.3 | 6.5 | 2.4 | 2.2 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 11 | 5 | 0 | 0 |
| Summer | 30 | 8 | 9 | 5 |
| Fall | 1 | 3 | 2 | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 43 | 19 | 17 | 10 |
| Summer | No Surveys | 63 | 41 | 14 |
| Fall | 0 | 1 | 2 | 0 |
| Gulf of Alaska | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 12 | 8 | 8 | 6 |
| Summer | 29 | 9 | 13 | 5 |
| Fall | 1 | 3 | 2 | 2 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0.2 ± 0.1 | 0.2 ± 0.1 | + |
| Summer | + | 0.1 ± 0.1 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 4.6 ± 6.4 | 0 | + |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0.1 ± + | 0.1 ± + | + |
| Summer | 0.8 ± 0.8 | + | + |
| Fall | 0 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 9.0 | 3.1 | 0.5 |
| Summer | 2.0 | 2.2 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 155.1 | 0 | 0.5 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 9.0 | 3.1 | 0.5 |
| Summer | 155.1 | 2.2 | 0.5 |
| Fall | 0 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 9 | 10 | 3 |
| Summer | 4 | 4 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 35 | 0 | 3 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 4 | 5 | 1 |
| Summer | 9 | 3 | 1 |
| Fall | 0 | 0 | 0 |

TABLE C17
Total alcids in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 5.7 ± 3.2 | 46.3 ± 40.6 | No Surveys |
| Spring | 19.5 ± 4.5 | 14.9 ± 1.8 | 6.0 ± 2.9 | 0.7 ± 0.5 |
| Summer | 28.3 ± 3.1 | 13.8 ± 1.9 | 10.1 ± 2.3 | 0.9 ± 0.6 |
| Fall | 14.9 ± 2.3 | 12.7 ± 1.9 | 5.0 ± 1.8 | 1.3 ± 0.6 |
| Northeast Gulf | | | | |
| Winter | 0 | 5.1 ± 5.5 | 0.6 ± 0.5 | 0.1 ± 0.1 |
| Spring | 6.2 ± 2.9 | 5.6 ± 1.2 | 1.5 ± 0.4 | 0.8 ± 0.3 |
| Summer | No Surveys | 6.0 ± 3.1 | 1.6 ± 0.9 | 0.5 ± 0.2 |
| Fall | 0.3 ± 0.2 | 2.0 ± 0.9 | 1.7 ± 0.9 | 1.2 ± 0.3 |
| Gulf of Alaska | | | | |
| Winter | 11.4 ± 8.2 | 5.1 ± 2.2 | 9.7 ± 8.4 | 0.5 ± 0.2 |
| Spring | 13.3 ± 2.6 | 14.2 ± 3.2 | 3.7 ± 1.0 | 1.0 ± 0.3 |
| Summer | 27.6 ± 3.0 | 18.6 ± 2.9 | 10.8 ± 2.5 | 0.8 ± 0.2 |
| Fall | 10.3 ± 1.7 | 10.0 ± 1.3 | 3.4 ± 0.8 | 1.2 ± 0.2 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 59.4 | 195.7 | No Surveys |
| Spring | 188.1 | 228.9 | 39.3 | 2.9 |
| Summer | 356.8 | 842.6 | 36.0 | 6.7 |
| Fall | 96.2 | 212.0 | 29.7 | 4.6 |
| Northeast Gulf | | | | |
| Winter | 0 | 84.5 | 3.0 | 0.7 |
| Spring | 24.5 | 151.3 | 11.9 | 10.0 |
| Summer | No Surveys | 74.8 | 8.9 | 5.4 |
| Fall | 1.2 | 44.6 | 31.7 | 6.9 |
| Gulf of Alaska | | | | |
| Winter | 126.0 | 84.5 | 195.7 | 9.4 |
| Spring | 188.1 | 1409.1 | 97.9 | 16.8 |
| Summer | 356.8 | 1717.9 | 143.5 | 8.3 |
| Fall | 96.2 | 224.9 | 41.4 | 12.2 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 75 | 100 | No Surveys |
| Spring | 92 | 90 | 88 | 42 |
| Summer | 98 | 95 | 91 | 38 |
| Fall | 96 | 93 | 77 | 70 |
| Northeast Gulf | | | | |
| Winter | 0 | 56 | 27 | 18 |
| Spring | 79 | 65 | 44 | 37 |
| Summer | No Surveys | 73 | 64 | 24 |
| Fall | 33 | 45 | 59 | 58 |
| Gulf of Alaska | | | | |
| Winter | 66 | 63 | 60 | 32 |
| Spring | 79 | 77 | 56 | 41 |
| Summer | 97 | 95 | 79 | 32 |
| Fall | 71 | 78 | 67 | 60 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 3.9 ± 2.1 | 1.0 ± 1.0 | 0.7 ± 0.4 |
| Spring | 11.9 ± 2.4 | 3.1 ± 1.4 | 3.4 ± 1.9 |
| Summer | 7.6 ± 4.4 | + | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.6 ± 1.2 | 4.1 ± 2.2 | 2.3 ± 1.3 |
| Summer | 1.4 ± 0.6 | 0.4 ± 0.3 | 0.1 ± + |
| Fall | 0.6 ± 0.7 | 0.5 ± 0.3 | 0.7 ± 0.4 |
| Gulf of Alaska | | | |
| Winter | 5.0 ± 2.0 | 0.9 ± 0.9 | 0.7 ± 0.4 |
| Spring | 8.5 ± 1.2 | 3.8 ± 1.8 | 4.3 ± 1.9 |
| Summer | 7.5 ± 2.1 | 0.6 ± 0.4 | 0.2 ± 0.2 |
| Fall | 1.5 ± 0.5 | 3.0 ± 1.6 | 0.7 ± 0.3 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 43.7 | 7.0 | 4.3 |
| Spring | 189.6 | 57.3 | 59.9 |
| Summer | 249.7 | 1.0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 48.6 | 29.2 | 31.6 |
| Summer | 10.8 | 2.2 | 1.1 |
| Fall | 21.3 | 2.1 | 6.3 |
| Gulf of Alaska | | | |
| Winter | 43.7 | 7.0 | 4.3 |
| Spring | 189.6 | 177.4 | 174.4 |
| Summer | 249.7 | 17.8 | 8.2 |
| Fall | 21.3 | 27.3 | 6.3 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 59 | 45 | 35 |
| Spring | 80 | 58 | 37 |
| Summer | 68 | 4 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Sruveys |
| Spring | 27 | 62 | 45 |
| Summer | 50 | 38 | 8 |
| Fall | 13 | 32 | 32 |
| Gulf of Alaska | | | |
| Winter | 61 | 42 | 35 |
| Spring | 65 | 53 | 45 |
| Summer | 65 | 25 | 11 |
| Fall | 38 | 48 | 36 |

TABLE C18

Total murres in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 5.1 ± 3.2 | 44.6 ± 40.4 | No Surveys |
| Spring | 4.2 ± 1.3 | 7.3 ± 1.4 | 4.2 ± 2.6 | 0.3 ± 0.3 |
| Summer | 2.1 ± 0.5 | 2.7 ± 0.4 | 1.7 ± 1.0 | 0.1 ± 0.1 |
| Fall | 10.5 ± 2.2 | 5.9 ± 1.4 | 1.8 ± 1.2 | 0.2 ± 0.4 |
| Northeast Gulf | | | | |
| Winter | 0 | 4.1 ± 4.0 | 0.3 ± 0.5 | 0.1 ± 0.1 |
| Spring | 0.5 ± 0.5 | 2.6 ± 1.0 | 0.4 ± 0.2 | + |
| Summer | No Surveys | 0.7 ± 0.5 | 0.4 ± 0.4 | + |
| Fall | 0.2 ± 0.2 | 0.2 ± 0.2 | 0.8 ± 1.0 | + |
| Gulf of Alaska | | | | |
| Winter | 9.4 ± 7.4 | 4.0 ± 1.9 | 9.0 ± 8.3 | + |
| Spring | 3.3 ± 1.0 | 7.6 ± 2.4 | 2.2 ± 0.9 | 0.3 ± 0.1 |
| Summer | 2.1 ± 0.4 | 5.4 ± 2.3 | 2.6 ± 1.1 | + |
| Fall | 6.8 ± 1.5 | 4.0 ± 0.8 | 1.3 ± 0.5 | 0.1 ± 0.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 59.4 | 192.1 | No Surveys |
| Spring | 65.9 | 205.8 | 32.4 | 1.1 |
| Summer | 51.9 | 79.0 | 19.6 | 0.8 |
| Fall | 90.8 | 151.2 | 25.7 | 3.9 |
| Northeast Gulf | | | | |
| Winter | 0 | 62.2 | 3.0 | 0.7 |
| Spring | 4.1 | 144.1 | 6.5 | 1.1 |
| Summer | No Surveys | 6.6 | 3.9 | 2.2 |
| Fall | 1.2 | 10.6 | 29.3 | 0.5 |
| Gulf of Alaska | | | | |
| Winter | 116.1 | 62.2 | 192.1 | 3.6 |
| Spring | 89.5 | 1127.6 | 95.5 | 10.8 |
| Summer | 51.9 | 1680.7 | 50.9 | 2.2 |
| Fall | 90.8 | 151.2 | 29.7 | 3.9 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 66 | 88 | No Surveys |
| Spring | 61 | 75 | 65 | 33 |
| Summer | 41 | 46 | 26 | 10 |
| Fall | 72 | 69 | 26 | 10 |
| Northeast Gulf | | | | |
| Winter | 0 | 52 | 18 | 12 |
| Spring | 29 | 36 | 14 | 2 |
| Summer | No Surveys | 34 | 18 | 2 |
| Fall | 25 | 11 | 14 | 1 |
| Gulf of Alaska | | | | |
| Winter | 62 | 57 | 42 | 3 |
| Spring | 48 | 57 | 33 | 11 |
| Summer | 41 | 53 | 33 | 2 |
| Fall | 52 | 52 | 24 | 6 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 3.4 ± 2.1 | 0.7 ± 1.0 | 0 |
| Spring | 9.5 ± 2.2 | 2.0 ± 1.3 | 0.6 ± 0.5 |
| Summer | 2.1 ± 1.4 | + | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.9 ± 0.7 | 0.4 ± 0.3 | 0.5 ± 0.4 |
| Summer | 0.1 ± 0.2 | 0.1 ± 0.1 | 0 |
| Fall | + | 0 | + |
| Gulf of Alaska | | | |
| Winter | 3.1 ± 1.6 | 0.6 ± 1.0 | 0 |
| Spring | 6.7 ± 1.1 | 2.3 ± 1.7 | 0.5 ± 0.2 |
| Summer | 1.8 ± 0.6 | 0.4 ± 0.4 | 0 |
| Fall | 0.4 ± 0.2 | 0.2 ± 0.4 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 43.7 | 7.0 | 0 |
| Spring | 166.2 | 52.3 | 16.4 |
| Summer | 73.4 | 1.0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 27.0 | 4.3 | 9.3 |
| Summer | 4.1 | 1.1 | 0 |
| Fall | 2.1 | 0 | 1.0 |
| Gulf of Alaska | | | |
| Winter | 43.7 | 7.0 | 0 |
| Spring | 181.4 | 177.4 | 16.4 |
| Summer | 73.4 | 14.6 | 0 |
| Fall | 13.4 | 10.5 | 1.0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 52 | 18 | 0 |
| Spring | 65 | 26 | 17 |
| Summer | 31 | 4 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 20 | 15 | 15 |
| Summer | 5 | 8 | 0 |
| Fall | 2 | 0 | 3 |
| Gulf of Alaska | | | |
| Winter | 50 | 17 | 0 |
| Spring | 52 | 25 | 21 |
| Summer | 30 | 10 | 0 |
| Fall | 20 | 4 | 2 |

TABLE C19

Total Brachyramphus murrelets in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 1.3 ± 0.5 | 0.4 ± 0.1 | 0.1 ± 0.2 | 0 |
| Summer | 3.2 ± 0.8 | 0.8 ± 0.2 | 0.2 ± 0.3 | 0 |
| Fall | 0.9 ± 0.3 | + | + | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 1.2 ± 1.1 | 0.4 ± 0.1 | 0.1 ± 0.1 | 0 |
| Summer | No Surveys | 0.2 ± 0.2 | 0.1 ± 0.2 | 0 |
| Fall | 0 | 0.2 ± 0.2 | + | 0 |
| Gulf of Alaska | | | | |
| Winter | 0.5 ± 0.4 | 0 | 0 | 0 |
| Spring | 1.4 ± 0.5 | 0.3 ± 0.1 | 0.2 ± 0.2 | 0 |
| Summer | 3.2 ± 0.7 | 0.6 ± 0.1 | 0.1 ± 0.1 | 0 |
| Fall | 0.6 ± 0.2 | 0.1 ± + | + | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 23.8 | 16.7 | 2.2 | 0 |
| Summer | 121.2 | 35.4 | 6.8 | 0 |
| Fall | 16.8 | 5.4 | 0.8 | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 7.7 | 10.1 | 3.9 | 0 |
| Summer | No Surveys | 2.5 | 2.6 | 0 |
| Fall | 0 | 14.4 | + | 0 |
| Gulf of Alaska | | | | |
| Winter | 6.1 | 0 | 0 | 0 |
| Spring | 34.0 | 16.7 | 14.7 | 0 |
| Summer | 121.2 | 35.4 | 6.8 | 0 |
| Fall | 16.8 | 14.4 | 0.8 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0 | 0 | No Surveys |
| Spring | 26 | 12 | 4 | 0 |
| Summer | 43 | 17 | 6 | 0 |
| Fall | 26 | 1 | 2 | 0 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0 | 0 |
| Spring | 29 | 14 | 5 | 0 |
| Summer | No Surveys | 12 | 5 | 0 |
| Fall | 0 | 5 | + | 0 |
| Gulf of Alaska | | | | |
| Winter | 17 | 0 | 0 | 0 |
| Spring | 25 | 11 | 4 | 0 |
| Summer | 43 | 14 | 3 | 0 |
| Fall | 17 | 2 | 1 | 0 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0.1 ± 0.1 | 0 | 0 |
| Summer | 0.1 ± 0.1 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0.1 ± + | 0 | 0 |
| Fall | 0 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 6.1 | 0 | 0 |
| Summer | 6.0 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 6.1 | 0 | 0 |
| Summer | 6.0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 0 | 0 | 0 |
| Spring | 4 | 0 | 0 |
| Summer | 5 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| Gulf of Alaska | | | |
| Winter | 0 | 0 | 0 |
| Spring | 2 | 0 | 0 |
| Summer | 3 | 0 | 0 |
| Fall | 0 | 0 | 0 |

TABLE C20

Tufted Puffin in the Gulf of Alaska

Density Indices (Mean $B/Km^2$ ± 90% Confidence Intervals), Highest Single Transect Densities ($B/Km^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| MEAN DENSITY | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0.1 ± 0.1 | 1.2 ± 0.6 | No Surveys |
| Spring | 11.9 ± 3.9 | 5.3 ± 0.8 | 1.1 ± 0.6 | 0.3 ± 0.3 |
| Summer | 20.5 ± 2.9 | 6.7 ± 0.6 | 7.0 ± 2.0 | 0.9 ± 0.5 |
| Fall | 1.0 ± 0.3 | 3.0 ± 0.4 | 1.4 ± 0.5 | 1.0 ± 0.4 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 0.2 ± 0.2 | 0 |
| Spring | 0.6 ± 0.7 | 0.4 ± 0.2 | 0.2 ± 0.1 | 0.6 ± 0.3 |
| Summer | No Surveys | 0.4 ± 0.2 | 0.2 ± 0.2 | 0.3 ± 0.2 |
| Fall | 0 | 0.2 ± 0.1 | 0.5 ± 0.2 | 0.7 ± 0.2 |
| Gulf of Alaska | | | | |
| Winter | + | 0.4 ± 0.3 | 0.5 ± 0.2 | 0.2 ± 0.1 |
| Spring | 6.6 ± 2.1 | 2.9 ± 0.5 | 0.5 ± 0.1 | 0.7 ± 0.2 |
| Summer | 19.7 ± 2.8 | 8.4 ± 0.9 | 5.1 ± 1.1 | 0.5 ± 0.2 |
| Fall | 1.0 ± 0.4 | 2.1 ± 0.3 | 1.0 ± 0.3 | 0.8 ± 0.2 |
| HIGHEST SINGLE TRANSECT DENSITY | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 0.8 | 2.4 | No Surveys |
| Spring | 175.1 | 75.7 | 6.9 | 2.0 |
| Summer | 325.4 | 172.9 | 35.1 | 5.8 |
| Fall | 11.9 | 31.6 | 8.6 | 3.9 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 1.8 | 0 |
| Spring | 4.5 | 14.4 | 3.9 | 8.5 |
| Summer | No Surveys | 3.3 | 1.5 | 2.9 |
| Fall | 0 | 2.9 | 3.1 | 3.6 |
| Gulf of Alaska | | | | |
| Winter | 0.7 | 9.9 | 3.9 | 3.6 |
| Spring | 175.1 | 234.9 | 10.8 | 14.4 |
| Summer | 325.4 | 330.1 | 45.0 | 8.2 |
| Fall | 46.8 | 31.6 | 18.0 | 9.5 |
| FREQUENCY OF OCCURRENCE | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 19 | 63 | No Surveys |
| Spring | 58 | 63 | 31 | 25 |
| Summer | 88 | 85 | 81 | 33 |
| Fall | 40 | 60 | 53 | 65 |
| Northeast Gulf | | | | |
| Winter | 0 | 0 | 9 | 0 |
| Spring | 14 | 11 | 13 | 30 |
| Summer | No Surveys | 29 | 18 | 14 |
| Fall | 0 | 15 | 37 | 44 |
| Gulf of Alaska | | | | |
| Winter | 3 | 15 | 23 | 21 |
| Spring | 37 | 32 | 17 | 32 |
| Summer | 85 | 83 | 61 | 24 |
| Fall | 28 | 48 | 45 | 51 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| MEAN DENSITY | | | |
| Kodiak | | | |
| Winter | + | 0.2 ± 0.3 | 0.7 ± 0.4 |
| Spring | 1.7 ± 0.3 | 0.5 ± 0.2 | 0.2 ± 0.1 |
| Summer | 4.9 ± 4.1 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 1.3 ± 1.9 | 0.5 ± 0.3 |
| Summer | 0.2 ± 0.2 | 0 | + |
| Fall | 0 | 0.1 ± 0.1 | 0.2 ± 0.3 |
| Gulf of Alaska | | | |
| Winter | + | 0.2 ± 0.3 | 0.7 ± 0.4 |
| Spring | 0.7 ± 0.1 | 0.5 ± 0.3 | 0.2 ± 0.1 |
| Summer | 2.5 ± 1.3 | + | + |
| Fall | 0.2 ± 0.2 | 1.4 ± 1.0 | 0.2 ± 0.2 |
| HIGHEST SINGLE TRANSECT DENSITY | | | |
| Kodiak | | | |
| Winter | 0.5 | 1.6 | 1.1 |
| Spring | 21.1 | 5.1 | 2.2 |
| Summer | 248.7 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.1 | 29.2 | 8.6 |
| Summer | 3.6 | 0 | 1.1 |
| Fall | 0 | 1.1 | 4.2 |
| Gulf of Alaska | | | |
| Winter | 0.5 | 1.6 | 4.3 |
| Spring | 21.1 | 29.2 | 8.6 |
| Summer | 248.7 | 1.1 | 1.1 |
| Fall | 11.5 | 21.0 | 4.2 |
| FREQUENCY OF OCCURRENCE | | | |
| Kodiak | | | |
| Winter | 2 | 27 | 35 |
| Spring | 36 | 28 | 19 |
| Summer | 48 | 0 | 0 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 3 | 12 | 20 |
| Summer | 13 | 0 | 3 |
| Fall | 0 | 5 | 8 |
| Gulf of Alaska | | | |
| Winter | 6 | 25 | 35 |
| Spring | 16 | 16 | 13 |
| Summer | 35 | 5 | 4 |
| Fall | 10 | 25 | 7 |

TABLE C21
Total birds in the Gulf of Alaska

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay | Shelf | Shelfbreak | Oceanic |
|---|---|---|---|---|
| **MEAN DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 19.8 ± 6.0 | 72.4 ± 50.7 | No Surveys |
| Spring | 32.2 ± 5.3 | 191.4 ± 113.7 | 37.3 ± 34.0 | 133.8 ± 157.6 |
| Summer | 58.2 ± 7.0 | 114.8 ± 32.8 | 57.8 ± 34.3 | 7.5 ± 1.7 |
| Fall | 45.5 ± 8.2 | 65.4 ± 16.2 | 40.7 ± 14.1 | 8.1 ± 2.2 |
| Northeast Gulf | | | | |
| Winter | 1.6 ± + | 7.4 ± 6.6 | 10.7 ± 4.7 | 4.4 ± 1.5 |
| Spring | 61.3 ± 58.4 | 217.8 ± 141.0 | 52.4 ± 22.4 | 22.3 ± 9.1 |
| Summer | No Surveys | 24.4 ± 8.8 | 50.9 ± 40.0 | 29.5 ± 16.4 |
| Fall | 7.5 ± 4.1 | 9.6 ± 3.1 | 13.6 ± 5.8 | 5.8 ± 0.9 |
| Gulf of Alaska | | | | |
| Winter | 18.2 ± 10.9 | 13.7 ± 3.4 | 22.0 ± 11.1 | 3.2 ± 0.4 |
| Spring | 29.0 ± 5.8 | 158.2 ± 61.4 | 57.2 ± 28.2 | 43.8 ± 24.9 |
| Summer | 56.7 ± 6.8 | 134.1 ± 25.1 | 55.8 ± 17.5 | 14.7 ± 4.5 |
| Fall | 35.6 ± 6.3 | 59.9 ± 13.7 | 22.4 ± 4.4 | 6.7 ± 0.8 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 77.4 | 241.3 | No Surveys |
| Spring | 219.5 | 23058.0 | 547.2 | 1181.7 |
| Summer | 1099.5 | 10366.3 | 1016.7 | 17.7 |
| Fall | 478.9 | 2378.1 | 325.3 | 22.3 |
| Northeast Gulf | | | | |
| Winter | 1.6 | 85.8 | 26.6 | 12.4 |
| Spring | 517.0 | 27250.5 | 1294.2 | 449.1 |
| Summer | No Surveys | 177.5 | 522.1 | 526.6 |
| Fall | 30.3 | 207.5 | 153.3 | 35.4 |
| Gulf of Alaska | | | | |
| Winter | 135.9 | 85.8 | 241.3 | 14.4 |
| Spring | 517.0 | 27250.5 | 4087.4 | 2487.2 |
| Summer | 1099.5 | 10366.3 | 1016.7 | 526.6 |
| Fall | 478.9 | 3622.5 | 325.3 | 42.0 |
| **FREQUENCY OF OCCURRENCE** | | | | |
| Kodiak | | | | |
| Winter | No Surveys | 100 | 100 | No Surveys |
| Spring | 100 | 99 | 100 | 100 |
| Summer | 99 | 100 | 100 | 100 |
| Fall | 100 | 100 | 100 | 95 |
| Northeast Gulf | | | | |
| Winter | 100 | 92 | 82 | 94 |
| Spring | 100 | 96 | 100 | 95 |
| Summer | No Surveys | 95 | 95 | 98 |
| Fall | 100 | 95 | 100 | 100 |
| Gulf of Alaska | | | | |
| Winter | 90 | 95 | 93 | 91 |
| Spring | 98 | 95 | 99 | 93 |
| Summer | 99 | 99 | 97 | 89 |
| Fall | 100 | 97 | 99 | 98 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Kodiak | | | |
| Winter | 22.4 ± 9.8 | 4.9 ± 2.9 | 2.0 ± 0.9 |
| Spring | 61.2 ± 29.4 | 20.2 ± 5.5 | 9.8 ± 3.1 |
| Summer | 49.9 ± 17.3 | 4.3 ± 2.3 | 4.1 ± 0.8 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 4.4 ± 2.1 | 8.6 ± 2.9 | 9.4 ± 2.0 |
| Summer | 17.0 ± 14.3 | 38.4 ± 56.5 | 1.9 ± 0.5 |
| Fall | 11.1 ± 7.4 | 3.7 ± 0.9 | 6.2 ± 1.9 |
| Gulf of Alaska | | | |
| Winter | 27.8 ± 12.0 | 4.5 ± 2.8 | 2.0 ± 0.9 |
| Spring | 37.7 ± 12.0 | 15.4 ± 3.8 | 10.5 ± 2.2 |
| Summer | 64.8 ± 27.7 | 10.2 ± 9.3 | 2.5 ± 0.4 |
| Fall | 10.8 ± 3.0 | 8.6 ± 2.3 | 5.6 ± 1.2 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Kodiak | | | |
| Winter | 215.3 | 18.9 | 8.7 |
| Spring | 3036.2 | 204.4 | 94.2 |
| Summer | 608.0 | 37.8 | 9.5 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 62.7 | 31.9 | 38.6 |
| Summer | 349.5 | 450.0 | 7.1 |
| Fall | 235.7 | 9.6 | 27.3 |
| Gulf of Alaska | | | |
| Winter | 378.5 | 18.9 | 8.7 |
| Spring | 3036.2 | 243.4 | 181.4 |
| Summer | 5456.8 | 450.0 | 9.5 |
| Fall | 235.7 | 42.4 | 27.3 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Kodiak | | | |
| Winter | 95 | 82 | 65 |
| Spring | 97 | 97 | 99 |
| Summer | 100 | 93 | 100 |
| Fall | No Surveys | No Surveys | No Surveys |
| Northeast Gulf | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 71 | 92 | 98 |
| Summer | 90 | 100 | 85 |
| Fall | 84 | 95 | 95 |
| Gulf of Alaska | | | |
| Winter | 89 | 83 | 65 |
| Spring | 87 | 97 | 96 |
| Summer | 94 | 94 | 92 |
| Fall | 91 | 94 | 96 |

Table D1. Number of transects conducted on shipboard and aerial surveys in the eastern Bering Sea.

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | SHIPBOARD SURVEYS | | |
| Winter | 0/ 0[a] | 0/ 0 | 0/0 |
| Spring | 406/ 83 | 133/22 | 37/0 |
| Summer | 840/130 | 159/16 | 177/6 |
| Fall | 526/ 77 | 70/15 | 37/2 |
| | AERIAL SURVEYS | | |
| Winter | 81/ 1 | 11/ 0 | 10/0 |
| Spring | 293/ 3 | 36/ 1 | 11/0 |
| Summer | 691/ 10 | 12/ 0 | 11/0 |
| Fall | 502/ 14 | 33/ 0 | 11/0 |

[a] Number of valid transects used to derive density indices/ Number of station counts, low quality transects, and general observations.

Table D2. Number of square kilometers covered by shipboard and aerial surveys in the eastern Bering Sea.

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | SHIPBOARD SURVEYS | | |
| Winter | 0.00 | 0.00 | 0.00 |
| Spring | 515.72 | 178.86 | 45.01 |
| Summer | 1278.17 | 207.71 | 186.30 |
| Fall | 809.72 | 125.93 | 68.08 |
| | AERIAL SURVEYS | | |
| Winter | 125.45 | 12.47 | 13.78 |
| Spring | 394.50 | 46.03 | 15.63 |
| Summer | 901.62 | 16.90 | 78.52 |
| Fall | 687.83 | 46.33 | 15.63 |

Table D3
Total Loons in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ $\pm$ 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | MEAN DENSITY | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | + | 0 |
| Summer | + | 0 | 0 |
| Fall | 0.2 $\pm$ 0.1 | 0 | 0 |
| | HIGHEST SINGLE TRANSECT DENSITY | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.3 | 1.1 | 0 |
| Summer | 1.1 | 0 | 0 |
| Fall | 5.0 | 0 | 0 |
| | FREQUENCY OF OCCURRENCE | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1 | 1 | 0 |
| Summer | + | 0 | 0 |
| Fall | 14 | 0 | 0 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | MEAN DENSITY | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0.1 $\pm$ + | 0 | 0 |
| Fall | 0.1 $\pm$ 0.1 | 0 | 0 |
| | HIGHEST SINGLE TRANSECT DENSITY | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.0 | 0 | 0 |
| Summer | 4.5 | 0 | 0 |
| Fall | 9.2 | 0 | 0 |
| | FREQUENCY OF OCCURRENCE | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 4 | 0 | 0 |
| Fall | 7 | 0 | 0 |

TABLE D4

Northern Fulmar in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 4.0 ± 3.0 | 17.0 ± 11.4 | 2.8 ± 2.6 |
| Summer | 5.9 ± 1.8 | 17.8 ± 6.8 | 3.3 ± 0.7 |
| Fall | 4.1 ± 2.0 | 28.3 ± 23.9 | 7.0 ± 1.7 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 704.6 | 842.7 | 57.3 |
| Summer | 562.2 | 392.9 | 40.0 |
| Fall | 561.7 | 1012.0 | 51.0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 34 | 83 | 51 |
| Summer | 42 | 80 | 78 |
| Fall | 46 | 94 | 97 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 1.0 ± 1.4 | 3.0 ± 1.4 | 1.8 ± 1.1 |
| Spring | 0.4 ± 0.3 | 2.0 ± 0.6 | 1.1 ± 0.4 |
| Summer | 0.1 ± + | 1.2 ± 0.9 | 2.7 ± 1.3 |
| Fall | 26.3 ± 41.7 | 65.0 ± 73.3 | 18.1 ± 13.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 69.7 | 8.5 | 6.6 |
| Spring | 55.6 | 8.1 | 2.8 |
| Summer | 4.9 | 6.6 | 8.5 |
| Fall | 12730.7 | 1484.9 | 74.4 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 7 | 100 | 80 |
| Spring | 12 | 75 | 82 |
| Summer | 8 | 75 | 91 |
| Fall | 22 | 97 | 100 |

TABLE D5

Total Shearwaters in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 5.9 ± 3.8 | 5.9 ± 5.8 | 0.2 ± 0.2 |
| Summer | 177.8 ± 151.8 | 10.6 ± 4.4 | 2.9 ± 1.6 |
| Fall | 55.9 ± 27.7 | 193.3 ± 168.5 | 2.1 ± 1.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 798.9 | 432.4 | 2.7 |
| Summer | 69867.9 | 212.0 | 129.7 |
| Fall | 4911.6 | 4913.6 | 19.1 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 13 | 13 | 11 |
| Summer | 37 | 36 | 25 |
| Fall | 63 | 49 | 62 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | + | 0 |
| Summer | 34.5 ± 29.5 | 2.0 ± 1.3 | 5.8 ± 4.6 |
| Fall | 7.2 ± 8.9 | 0.4 ± 0.3 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0.5 | 0 |
| Summer | 7433.0 | 7.6 | 30.1 |
| Fall | 2700.3 | 4.6 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 3 | 0 |
| Summer | 29 | 50 | 82 |
| Fall | 18 | 42 | 0 |

## TABLE D6
Total storm-petrels in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

### SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.1 ± 0.9 | 2.2 ± 0.7 | 0.7 ± 0.5 |
| Summer | 3.2 ± 1.2 | 9.2 ± 3.6 | 2.9 ± 0.7 |
| Fall | 1.5 ± 1.0 | 8.5 ± 6.5 | 2.3 ± 1.2 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 199.2 | 23.9 | 10.0 |
| Summer | 327.4 | 209.6 | 59.5 |
| Fall | 223.8 | 235.5 | 26.6 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 7 | 32 | 22 |
| Summer | 19 | 57 | 66 |
| Fall | 14 | 36 | 70 |

### AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0 | 2.6 ± 1.2 | 1.6 ± 1.4 |
| Spring | + | 3.4 ± 2.2 | 5.1 ± 1.6 |
| Summer | + | 0.1 ± 0.2 | 0.6 ± 0.5 |
| Fall | 0.1 ± 0.1 | 1.7 ± 1.0 | 4.6 ± 3.6 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0 | 6.6 | 8.5 |
| Spring | 2.2 | 33.9 | 10.3 |
| Summer | 8.1 | 1.0 | 2.8 |
| Fall | 17.3 | 16.9 | 25.4 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 0 | 2 | 50 |
| Spring | 3 | 33 | 100 |
| Summer | 2 | 8 | 36 |
| Fall | 6 | 55 | 91 |

## TABLE D7
Total cormorants in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

### SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 6.5 ± 4.0 | 0.1 ± 0.1 | 1.0 ± 1.4 |
| Summer | 4.0 ± 1.5 | 0.2 ± 0.2 | + |
| Fall | 0.1 ± 0.1 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 864.3 | 2.5 | 31.2 |
| Summer | 455.1 | 17.3 | 3.2 |
| Fall | 9.6 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 30 | 6 | 5 |
| Summer | 13 | 3 | 1 |
| Fall | 6 | 0 | 0 |

### AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0.1 ± 0.2 | 0 | 0 |
| Spring | 0.3 ± 0.2 | 0.1 ± 0.1 | 0 |
| Summer | 0.1 ± 0.1 | 0.7 ± 1.1 | 0 |
| Fall | 0.2 ± 0.1 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 3.8 | 0 | 0 |
| Spring | 16.5 | 1.8 | 0 |
| Summer | 14.6 | 8.1 | 0 |
| Fall | 24.8 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 5 | 0 | 0 |
| Spring | 9 | 3 | 0 |
| Summer | 2 | 8 | 0 |
| Fall | 4 | 0 | 0 |

TABLE D8

Total geese and ducks in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.7 ± 1.2 | 0.5 ± 0.9 | 0.1 ± 0.2 |
| Summer | + | 0 | + |
| Fall | 0.6 ± 0.4 | 0.6 ± 0.6 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 202.2 | 70.5 | 3.6 |
| Summer | 5.9 | 0 | 0.9 |
| Fall | 102.9 | 21.1 | 0.5 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 7 | 2 | 3 |
| Summer | 2 | 0 | 1 |
| Fall | 12 | 6 | 3 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 11.8 ± 11.0 | 0 | 0 |
| Spring | 19.6 ± 15.7 | 0 | 0 |
| Summer | 2.1 ± 0.9 | 0 | 0 |
| Fall | 4.2 ± 3.0 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 515.5 | 0 | 0 |
| Spring | 2699.8 | 0 | 0 |
| Summer | 217.1 | 0 | 0 |
| Fall | 836.1 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 20 | 0 | 0 |
| Spring | 24 | 0 | 0 |
| Summer | 9 | 0 | 0 |
| Fall | 15 | 0 | 0 |

TABLE D9

Total phalaropes in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0.1 ± 0.1 | 0 |
| Summer | 0.6 ± 0.5 | 0.1 ± 0.1 | + |
| Fall | 0.8 ± 0.4 | 1.0 ± 0.8 | 0.1 ± 0.1 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 5.4 | 5.4 | 0 |
| Summer | 257.2 | 9.3 | 3.6 |
| Fall | 83.1 | 25.5 | 1.1 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1 | 2 | 0 |
| Summer | 5 | 2 | 1 |
| Fall | 11 | 19 | 14 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 0.1 ± 0.1 | 0 | 0.1 ± 0.3 |
| Fall | 1.5 ± 1.0 | 3.6 ± 3.8 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 40.5 | 0 | 1.6 |
| Fall | 203.0 | 74.4 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 2 | 0 | 9 |
| Fall | 7 | 27 | 0 |

TABLE D10

Total jeagers in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 0.1 ± + | + | + |
| Summer | 0.2 ± 0.1 | 0.4 ± 0.2 | 0.2 ± 0.1 |
| Fall | 0.2 ± 0.1 | 0.5 ± 0.6 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.2 | 1.4 | + |
| Summer | 10.1 | 9.8 | 2.9 |
| Fall | 3.9 | 26.0 | 0.6 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 5 | 3 | + |
| Summer | 14 | 21 | 14 |
| Fall | 16 | 11 | 3 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 0.1 ± + | 0.3 ± 0.3 | 0.1 ± 0.3 |
| Fall | + | + | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0.5 | 0 | 0 |
| Summer | 8.6 | 1.9 | 1.6 |
| Fall | 2.0 | 2.5 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 0 | 0 | 0 |
| Spring | + | 0 | 0 |
| Summer | 8 | 25 | 9 |
| Fall | 2 | 3 | 0 |

TABLE D11

Total *Larus* gulls in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$_2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.4 ± 0.3 | 2.4 ± 1.3 | 0.7 ± 1.0 |
| Summer | 0.7 ± 0.2 | 1.2 ± 0.4 | 0.3 ± 0.2 |
| Fall | 0.6 ± 0.1 | 1.9 ± 0.6 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 41.8 | 98.2 | 22.0 |
| Summer | 48.4 | 19.5 | 8.6 |
| Fall | 17.6 | 16.2 | 0.6 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 49 | 62 | 16 |
| Summer | 28 | 35 | 11 |
| Fall | 38 | 51 | 3 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0.2 ± 0.1 | 1.4 ± 1.1 | 0.1 ± 0.2 |
| Spring | 0.7 ± 0.3 | 0.5 ± 0.3 | 0.3 ± 0.3 |
| Summer | 2.0 ± 1.1 | 0.3 ± 0.3 | 0 |
| Fall | 2.9 ± 2.6 | 4.5 ± 4.3 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 3.8 | 7.5 | 0.9 |
| Spring | 30.3 | 3.2 | 1.9 |
| Summer | 355.5 | 2.2 | 0 |
| Fall | 736.3 | 83.8 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 14 | 55 | 20 |
| Spring | 22 | 42 | 27 |
| Summer | 15 | 25 | 0 |
| Fall | 28 | 61 | 0 |

TABLE D12
Total Glaucous-winged Gull in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1.3 ± 0.2 | 2.4 ± 1.3 | 0.7 ± 0.9 |
| Summer | 0.6 ± 0.2 | 1.2 ± 0.4 | 0.3 ± 0.2 |
| Fall | 0.6 ± 0.1 | 1.8 ± 0.7 | + |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 41.8 | 98.2 | 21.1 |
| Summer | 48.4 | 19.5 | 8.6 |
| Fall | 16.0 | 16.2 | 0.6 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 45 | 62 | 14 |
| Summer | 25 | 35 | 11 |
| Fall | 34 | 49 | 3 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0.2 ± 0.1 | 1.4 ± 1.1 | 0.1 ± 0.2 |
| Spring | 0.6 ± 0.3 | 0.5 ± 0.3 | 0.3 ± 0.3 |
| Summer | 1.0 ± 0.7 | 0.3 ± 0.3 | 0 |
| Fall | 1.9 ± 2.4 | 4.5 ± 4.3 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 3.8 | 7.5 | 0.9 |
| Spring | 30.3 | 3.2 | 1.9 |
| Summer | 219.5 | 2.2 | 0 |
| Fall | 736.3 | 83.8 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 14 | 55 | 20 |
| Spring | 21 | 42 | 27 |
| Summer | 9 | 25 | 0 |
| Fall | 14 | 61 | 0 |

TABLE D13
Total kittiwakes in the easten Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.2 ± 0.6 | 1.8 ± 0.5 | 1.4 ± 1.7 |
| Summer | 2.3 ± 0.3 | 1.9 ± 0.7 | 1.3 ± 0.4 |
| Fall | 3.5 ± 0.7 | 2.9 ± 1.2 | 0.7 ± 0.4 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 91.9 | 29.5 | 38.8 |
| Summer | 79.2 | 41.1 | 33.4 |
| Fall | 100.8 | 37.8 | 8.0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 51 | 56 | 22 |
| Summer | 55 | 48 | 41 |
| Fall | 66 | 66 | 46 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | + | 0.1 ± 0.1 | 1.0 ± 1.2 |
| Spring | 0.4 ± 0.2 | 0.5 ± 0.2 | 1.0 ± 0.5 |
| Summer | 1.8 ± 0.6 | 0.8 ± 0.8 | + |
| Fall | 2.5 ± 2.4 | 9.3 ± 7.8 | 0.6 ± 0.5 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0.5 | 0.9 | 7.0 |
| Spring | 22.2 | 2.8 | 2.8 |
| Summer | 155.1 | 4.8 | 0.5 |
| Fall | 710.0 | 143.1 | 2.7 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 1 | 9 | 40 |
| Spring | 16 | 33 | 73 |
| Summer | 26 | 33 | 9 |
| Fall | 35 | 61 | 36 |

TABLE D14
Total terns in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 0 |
| Summer | + | 0.4 ± 0.4 | + |
| Fall | 0.1 ± + | 0.2 ± 0.2 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 5.4 | 0 | 0 |
| Summer | 3.4 | 30.3 | 4.8 |
| Fall | 10.5 | 3.9 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 0 |
| Summer | 3 | 5 | 1 |
| Fall | 2 | 6 | 0 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 0.1 ± + | 0 | 0 |
| Fall | 0 | 0 | 0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 14.9 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 0 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 3 | 0 | 0 |
| Fall | 0 | 0 | 0 |

TABLE D15
Total alcids in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 44.3 ± 12.0 | 23.6 ± 10.9 | 5.7 ± 3.5 |
| Summer | 16.7 ± 2.8 | 24.3 ± 13.8 | 2.8 ± 1.3 |
| Fall | 13.4 ± 4.2 | 3.7 ± 1.2 | 1.9 ± 1.0 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1225.3 | 618.3 | 49.4 |
| Summer | 831.4 | 767.6 | 98.4 |
| Fall | 918.5 | 28.2 | 19.8 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 89 | 86 | 49 |
| Summer | 84 | 70 | 45 |
| Fall | 75 | 79 | 78 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| **MEAN DENSITY** | | | |
| Winter | 14.5 ± 11.7 | 1.8 ± 1.5 | 1.4 ± 1.9 |
| Spring | 24.0 ± 14.3 | 2.0 ± 0.9 | 1.3 ± 0.8 |
| Summer | 11.9 ± 5.9 | 1.7 ± 1.5 | 0.3 ± 0.3 |
| Fall | 5.2 ± 2.1 | 3.9 ± 4.2 | 0.8 ± 0.6 |
| **HIGHEST SINGLE TRANSECT DENSITY** | | | |
| Winter | 397.4 | 10.4 | 11.9 |
| Spring | 2004.0 | 10.8 | 3.8 |
| Summer | 2304.0 | 10.8 | 1.9 |
| Fall | 526.6 | 86.4 | 3.2 |
| **FREQUENCY OF OCCURRENCE** | | | |
| Winter | 37 | 73 | 30 |
| Spring | 48 | 56 | 64 |
| Summer | 51 | 67 | 27 |
| Fall | 54 | 64 | 45 |

TABLE D16

Total murres in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 16.2 ± 6.1 | 1.9 ± 0.7 | 0.4 ± 0.4 |
| Summer | 11.3 ± 2.3 | 1.2 ± 0.6 | 0.4 ± 0.2 |
| Fall | 4.3 ± 2.2 | 1.1 ± 0.8 | 0.1 ± 0.1 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1225.3 | 33.2 | 6.9 |
| Summer | 825.6 | 28.1 | 15.3 |
| Fall | 701.4 | 28.2 | 1.2 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 70 | 37 | 19 |
| Summer | 69 | 26 | 14 |
| Fall | 61 | 41 | 11 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | 11.9 ± 11.4 | 0 | 0 |
| Spring | 23.0 ± 14.3 | 1.8 ± 0.8 | 1.2 ± 0.8 |
| Summer | 4.6 ± 1.2 | 0.1 ± 0.1 | 0.2 ± 0.2 |
| Fall | 3.8 ± 2.0 | 3.0 ± 4.2 | 0 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | 397.4 | 0 | 0 |
| Spring | 2004.0 | 10.8 | 3.8 |
| Summer | 284.0 | 0.9 | 0.9 |
| Fall | 522.6 | 83.6 | 0 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | 23 | 0 | 0 |
| Spring | 44 | 50 | 55 |
| Summer | 38 | 8 | 27 |
| Fall | 43 | 27 | 0 |

TABLE D17

Total _Brachyramphus_ murrelets in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ ± 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | + | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | + | 0 | 0 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 4.9 | 0 | 0 |
| Summer | 1.8 | 0 | 0 |
| Fall | 1.7 | 0 | 0 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1 | 0 | 0 |
| Summer | + | 0 | 0 |
| Fall | 1 | 0 | 0 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | + | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | 1.9 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | 2 | 0 | 0 |
| Spring | 0 | 0 | 0 |
| Summer | 0 | 0 | 0 |
| Fall | 0 | 0 | 0 |

TABLE D18

Total Tufted Puffin in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ + 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 2.9 ± 2.3 | 0.7 ± 0.3 | 0.9 ± 0.8 |
| Summer | 1.9 ± 0.4 | 2.7 ± 1.6 | 0.9 ± 0.3 |
| Fall | 3.6 ± 1.9 | 1.9 ± 0.8 | 1.3 ± 0.5 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 526.5 | 12.2 | 15.0 |
| Summer | 111.6 | 140.4 | 18.5 |
| Fall | 540.2 | 25.5 | 9.6 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 24 | 29 | 22 |
| Summer | 37 | 43 | 31 |
| Fall | 34 | 54 | 73 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | 0 | 0 | 0 |
| Spring | + | + | 0 |
| Summer | 0.2 ± 0.1 | 1.4 ± 1.5 | 0 |
| Fall | 0.6 ± 0.2 | 0.7 ± 0.3 | 0.7 ± 0.7 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | 0 | 0 | 0 |
| Spring | 1.8 | 0.9 | 0 |
| Summer | 40.0 | 10.8 | 0 |
| Fall | 21.8 | 4.6 | 3.2 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | 0 | 0 | 0 |
| Spring | 2 | 3 | 0 |
| Summer | 8 | 42 | 0 |
| Fall | 15 | 45 | 36 |

TABLE D19

Total birds in the eastern Bering Sea

Density Indices (Mean B/Km$^2$ + 90% Confidence Intervals), Highest Single Transect Densities (B/Km$^2$), and Frequencies of Occurrence (% of Transects) from Shipboard and Aerial Surveys.

SHIPBOARD SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 67.3 ± 14.7 | 54.2 ± 16.8 | 13.5 ± 6.9 |
| Summer | 211.6 ± 151.8 | 67.7 ± 17.6 | 13.9 ± 2.7 |
| Fall | 81.4 ± 29.2 | 241.0 ± 175.1 | 14.8 ± 2.2 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 1684.4 | 859.5 | 136.6 |
| Summer | 69871.5 | 783.8 | 149.3 |
| Fall | 5342.1 | 4943.0 | 38.2 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | No Surveys | No Surveys | No Surveys |
| Spring | 99 | 99 | 89 |
| Summer | 94 | 90 | 98 |
| Fall | 99 | 100 | 100 |

AERIAL SURVEYS

| | Bay & Shelf | Shelfbreak | Oceanic |
|---|---|---|---|
| | **MEAN DENSITY** | | |
| Winter | 27.7 ± 16.5 | 9.1 ± 2.6 | 6.2 ± 2.5 |
| Spring | 45.5 ± 21.1 | 8.4 ± 2.4 | 8.8 ± 1.9 |
| Summer | 54.8 ± 22.4 | 7.1 ± 2.4 | 9.7 ± 5.3 |
| Fall | 50.3 ± 47.4 | 88.4 ± 79.7 | 24.1 ± 13.4 |
| | **HIGHEST SINGLE TRANSECT DENSITY** | | |
| Winter | 519.5 | 17.9 | 16.2 |
| Spring | 2699.8 | 39.5 | 15.1 |
| Summer | 7435.7 | 17.3 | 33.0 |
| Fall | 14178.0 | 1617.7 | 77.2 |
| | **FREQUENCY OF OCCURRENCE** | | |
| Winter | 54 | 100 | 100 |
| Spring | 71 | 92 | 100 |
| Summer | 80 | 92 | 100 |
| Fall | 84 | 100 | 100 |

## LITERATURE CITED


Alexander, V., and R.T. Cooney. 1979. Ice edge ecosystem study: Primary productivity, nutrient cycling and organic matter transfer. Final Report to the National Oceanic and Atmospheric Administration, Outer Continental Shelf Environmental Assessment Program, Boulder, CO.

Alexander, W.B. 1963. Birds of the ocean. G.P. Putnam's Sons, NY.

A.O.U. (American Ornithologist's Union). 1957. Check-list of North American birds, fifth edition. Lord Baltimore Press, Inc., ML.

Arneson, P.D. 1976. Identification, documentation, and delineation of coastal migratory bird habitat in Alaska, pages 5-54. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Arneson, P.D. 1977. Identification, documentation and delineation of coastal migratory bird habitat in Alaska, pages 1-95. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. II. NOAA, Environ. Res. Lab., Boulder, CO.

Arneson, P.D. 1978. Identification, documentation and delineation of coastal migratory bird habitat in Alaska, pages 431-481. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1978, Vol. I. NOAA, Environ. Res. Lab., Boulder, CO.

Arnold, L.W. 1948. Observations on populations of North Pacific pelagic birds. Auk 65:553-558.

Ashmole, N.P., and M.J. Ashmole. 1967. Comparative feeding ecology of seabirds on a tropical oceanic island. Yale Peabody Mus. Nat. Hist. Bull. No. 24: 131 p.

Bailey, A.M. 1948. Birds of arctic Alaska. Colorado Mus. Nat. Hist., Pop. Ser. No. 8: 317 p.

Bailey, R. 1966. The seabirds of the southeast coast of Arabia. Ibis 108:224-264.

Bailey, R., and W.R.P. Bourne. 1972. Notes on seabirds, 36: counting birds at sea. Ardea 60:124-127.

Baird, P.A., D.B. Barbour, A.R. DeGange, P.J. Gould, M.A. Hatch, S.A. Hatch, R.D. Jones, Jr., L.D Krasnow, D.R. Nysewander, T.W. Pearson, M.R. Petersen, G.A. Sanger, and D.A. Wiswar. 1979. Population dynamics and trophic relationships of marine birds in the Gulf of Alaska, pages 7-516. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1979, Vol. II. NOAA, Environ. Res. Lab., Boulder, CO.

Bartels, R.F. 1971. Waterfowl observations, Western Beaufort Sea Ecological Cruise, 1971. Iowa State Univ., Dept. Zool. Entom., Ames, Iowa. Unpubl. Rept.

Bartels, R.F. 1973. Bird survey techniques on Alaska's north coast. M.S. Thesis, Iowa State Univ., Ames, Iowa.

Bartonek, J.C., and D.D. Gibson. 1972. Summer distribution of pelagic birds in Bristol Bay, Alaska. Condor 74:416-422.

Bartonek, J.C., and C.J. Lensink. 1978. A review of the literature and a selected bibliography of published and unpublished literature on marine birds of Alaska, pages 108-204. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, Vol. 1. NOAA, Environ. Res. Lab., Boulder, CO.

Bartonek, J.C., and D.N. Nettleship (eds.). 1979. Conservation of marine birds of northern North America. U.S. Dept. of Interior, ior, Fish and Wildl. Serv., Wildl. Res. Rept. No. 11, Wash. D.C.

Bedard, J. 1969. The nesting of the Least, Crested and Parakeet auklets around St. Lawrence Island, Alaska. Condor 71:386-398.

Bellrose, F.C. 1976. Ducks, geese and swans of North America. Stackpole, Harrisburg, PA.

Bent, A.C. 1919. Life histories of North American diving birds. U.S. Natl. Mus. Bull. 107.

Bent, A.C. 1921. Life histories of North American gulls and terns. U.S. Natl. Mus. Bull. 113.

Bent, A.C. 1922. Life histories of North American petrels, pelicans, and their allies. U.S. Natl. Mus. Bull. 121.

Bent, A.C. 1923. Life histories of North American wildfowl (Part I). U.S. Natl. Mus. Bull. 126.

Bent, A.C. 1925. Life histories of North American wildfowl (Part II). U.S. Natl. Mus. Bull. 130.

Bent, A.C. 1926. Life histories of North American marsh birds. U.S. Natl. Mus. Bull. 135.

Bourne, W.R.P. 1963. A review of oceanic studies of the biology of seabirds, pages 831-854. In Proceedings 13th International Ornithological Congress.

Brown, R.G.B., F. Cooke, P.K. Kinnear. and E.L. Mills. 1975a. Summer seabird distributions in Drake Passage, the Chilean fjords and off southern South America. Ibis 117:339-356.

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

Caughley G. 1974. Bias in aerial survey. J. Wildl. Mgmt. 38: 921-933.

Clark, A.H. 1910. The birds collected and observed during the cruise of the United States Fisheries Steamer "Albatross" in the North Pacific Ocean and in the Bering, Okhotsk, Japan, and Eastern Seas from April to December 1906. Proc. U.S. Natl. Mus. 38:25-74.

Coachman, L.K., and R.L. Charnell. 1977. Fine structure in outer Bristol Bay, Alaska. Deep Sea Res. 24:869-889.

Coachman, L.K. 1979. On lateral water mass interaction - a case study, Bristol Bay, Alaska. J. Phys. Oceanogr. 9:278-297.

Cooney, R.T. 1976. Zooplankton and micronekton studies in the Bering-Chukchi/Beaufort Seas, pages 95-162. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976. NOAA, Environ. Res. Lab., Boulder, CO.

Cramp, S., W.R.P. Bourne, and D. Saunders. 1974. The seabirds of Britain and Ireland. Taplinger, New York.

Dall, W.H. 1873. Notes on the avifauna of the Aleutian Islands, from Unalaska eastward. Proc. Calif. Acad. Sci. 4:25-35.

Dau, C.P., and S.A. Kistchinski. 1977. Seasonal movements and distribution of the Spectacled Eider. Wildfowl 28:65-75.

Dement'ev, G.P., and N.A. Gladkov. 1951. Birds of the Soviet Union, Vol. 1. (Transl. by Israel Progr. Sci. Transl., 1966).

Dement'ev, G.P., N.A. Gladkov, Yu. A. Isakov, N.N. Kartasheve, S.V. Kikheev, and E.S. Ptushenko. 1952. Birds of the Soviet Union. Vol. 4. (Transl. by Israel Progr. Sci. Transl., 1967).

Dement'ev, G.P., N.A. Gladkov, and E.P. Spageburg. 1951. Birds of the Soviet Union. Vol. 2. (Transl. by Israel Progr. Sci. Transl., 1968).

Divoky, G.J. 1972. The pelagic birds and mammals of the Chukchi Sea in fall. M.S. Thesis, Michigan State Univ., East Lansing, MI.

Divoky, G.J. 1976. The distribution, abundance, and feeding ecology of birds associated with the Bering Sea and Beaufort Sea pack ice ice, pages 53-106. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 3. NOAA, Environ. Res. Lab., Boulder, CO.

Divoky, G.J. 1977. The distribution, abundance and feeding ecology of birds associated with pack ice, pages 525-573. In Environmental Assessment of the Alaskan Continental Shelf. Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Divoky, G.J. 1978a. Identification, documentation and delineation of coastal migratory bird habitat in Alaska, I, Breeding bird use of barrier islands in the northern Chukchi and Beaufort Seas, pages 452-569. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1978, Vol. I. NOAA, Environ. Res. Lab., Boulder, CO.

Divoky, G.J. 1978b. The distribution, abundance and feeding ecology of birds associated with pack ice. pages 167-409. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1978, Vol. II. NOAA, Environ. Res. Lab., Boulder, CO.

Divoky, G.J. 1981. Birds and the ice-edge ecosystem in the Bering Sea, pages 799-804. In (D.W. Hood and J.A. Calder, eds.), the eastern Bering Sea shelf: oceanography and resources, Vol. 2. Office of Mar. Poll. Assess., NOAA, Seattle, WA.

Eberhardt, L.L., D.G. Chapman, and J.R. Gilbert. 1979. A review of marine mammal census methods. Wildlife Monographs No. 63: 46p.

Favorite, F., A.J. Dodimead, and K. Nasu. 1976a. Oceanography of the Subarctic Pacific Region, 1960-1971. Intl. N. Pac. Fish. Comm., Bull. No. 33: 187 p.

Fay, F.H. 1974. The role of ice in the ecology of marine mammals of the Bering Sea, pages 383-399. In (D.W. Hood, and D.J. Kelley eds.), Oceanography of the Bering Sea with emphasis on renewable resources. Inst. Mar. Sci., Occas. Publ. No. 2, Univ. of Alaska, Fairbanks.

Fay, F.H., and T.J. Cade. 1959. An ecological analysis of the avifauna of St. Lawrence Island, Alaska. Univ. Calif. Publ. Zool. 63:73-150.

Flock, W.L. 1972. Radar observations at Cape Prince of Wales. Arctic 25:83-89.

Flock, W.L. 1973. Radar observations of bird movements along the Arctic Coast of Alaska. Wilson Bull. 85:259-275.

Forsell, D.J., and P.J. Gould. 1981. Distribution and abundance of marine birds and mammals wintering in the Kodiak area of Alaska. U.S. Fish Wildl. Serv., Off. Biol. Serv., Wash., D.C. FWS/OBS81/13.

Frame, G.W. 1973. Occurrence of birds in the Beaufort Sea, summer 1969. Auk 90:552-563.

Gabrielson, I.N., and F.C. Lincoln. 1959. The birds of Alaska. Stackpole, Harrisburg, PA.

Gill, R., Jr., C. Handel, and M. Petersen. 1979. Migration of birds in Alaska marine habitats, pages 245-288. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, Vol. 5. NOAA, Environ. Res. Lab., Boulder, CO.

Gould, P.J. 1971. Interactions of seabirds over the open ocean. Ph.D. Dissertation, Univ. of Arizona, Tucson, AZ.

Gould, P.J. 1974. Introduction, pages 1-5. In (W.B. King, ed.) Pelagic Studies of Seabirds in the Central and Eastern Pacific Ocean. Smithsonian Contributions to Zoology 158.

Gould, P.J. 1977a. Shipboard surveys of marine birds. Part I of: Seasonal distribution and abundance of marine birds, pages 192-284. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. III. NOAA, Environ. Res. Lab. Boulder, CO.

Gould, P.J. 1977b. Seabirds--Alaska to Hawaii. Pac. Seabird Group Bull. 4:21. (Abstract).

Gould, P.J., C. Harrison, and D. Forsell, 1978. Distribution and abundance of marine birds-south and east Kodiak Island waters, pages 614-710. In Environmental Assessment of the Alaskan Continental Shelf, Annual Report of Principal Investigators for the Year Ending 1978, Vol. II. NOAA, Environ. Res. Lab., Boulder, CO.

Guzman, J. 1976. Ecology and behavior of southern hemisphere shearwaters (Genus Puffinus) and other seabirds, when over the outer continental shelf of Bering Sea and Gulf of Alaska during the northern summer, pages 1-52. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 3. NOAA, Environ. Res. Lab., Boulder, CO.

Handel, C.M., M.R. Petersen, R.E. Gill, Jr., and C.J. Lensink. 1981. Annotated bibliography of literature on Alaska water birds. U.S. Dept. of Interior, Fish Wildl. Serv., Biol. Serv. Program, Wash, D.C. FWS/OBS - 81/12.

Harrison, C. 1977. Aerial surveys of marine birds. Part II of: Seasonal distribution and abundance of marine birds, pages 285-593. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. III. NOAA, Environ. Res. Lab., Boulder, CO.

Hasegawa, H. 1978. Recent observations of the Short-tailed Albatross Diomedea albatrus on Torishima. Misc. Repts. Yamashina Institute Ornithology 10:58-69.

Hatch, S.A., D.R. Nysewander, A.R. DeGange, M.R. Petersen, P.A. Baird, K.D. Wohl, and C.J. Lensink. 1978. Population dynamics and trophic relationships of marine birds in the Gulf of Alaska and southern Bering Sea, pages 1-908. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1978, Vol. III. NOAA, Environ. Res. Lab., Boulder, CO.

Heinemann, D. 1981. A range finder for pelagic bird censusing. J. Wildl. Mgmt. 42:489-493.

Hoffman, W., D. Heinemann, and J.A. Wiens. 1981. The ecology of seabird feeding flocks in Alaska. Auk 9:437-456.

Hoffman, W., J.A. Wiens, and J.M. Scott. 1978. Hybridization between gulls (Larus glaucescens and L. occidentalis) in the Pacific Northwest. Auk 95:441-458.

Hunt, G.L., Jr. 1976. The reproductive ecology, foods, and foraging areas of seabirds nesting on St. Paul Island, Pribilof Islands, pages 155-270. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Hunt, G.L., Jr. 1977. Reproductive ecology, foods, and foraging areas of seabirds nesting on the Pribilof Islands, pages 196-382. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Hunt, G.L., Jr. 1978. Reproductive ecology, foods, and foraging areas of seabirds nesting on the Pribilof Islands, Pages 570-775. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1978, Vol. 1. NOAA, Environ. Res. Lab., Boulder, CO.

Hunt, G.L., Jr., B. Burgeson, and G.A. Sanger. 1981a. Feeding ecology of seabirds of the eastern Bering Sea, pages 629-647. In (D.W. Hood and J.A. Calder, eds.), The eastern Bering Sea shelf: oceanography and resources, Vol. 2. Office of Mar. Pollut. Assess., NOAA, Seattle, WA.

Hunt, G.L., Jr., Z. Eppley, and W.H. Drury. 1981b. Breeding distribution and reproductive biology of marine birds in the eastern Bering Sea, pages 649-687. In (D.W. Hood and J.A. Calder, eds.), The eastern Bering Sea shelf: oceanography and resources, Vol. 2. Office of Mar. Poll. Assess., NOAA, Seattle, WA.

Hunt, G.L., Jr., P. Gould, D.J. Forsell and H. Peterson, Jr. 1981c. Pelagic distribution of marine birds in the eastern Bering Sea, pages 689-718. In (D.W Wood, and J.A. Calder, eds.), The eastern Bering Sea shelf: oceanography and resources, Vol. 2. Office of Mar. Poll. Assess., NOAA, Seattle, WA.

Ingham, M.C., and C.V.W. Mahnken. 1966. Turbulence and productivity near St. Vincent Island, B.W.I. A preliminary report, Carib. J. Sci. 6:83-87.

Irving, L., C.P. McRoy, and J.J. Burns. 1970. Birds observed during a cruise in ice-covered Bering Sea in March 1968. Condor 72:110-112.

Isleib, M.E., and T. Eberhardt. 1975. Marine bird shipboard survey in the Gulf of Alaska and along ocean route from Seattle, 27 January to 4 March, 1975. U.S. Fish Wildl. Serv. Field Rept., Anchorage, AK.

Isleib, M.E., and B. Kessel. 1973. Birds of the North Gulf Coast-Prince William Sound Region, Alaska. Biol. Papers Univ. Alaska No. 14: 149 p.

Iverson, R.L., L.K. Coachman, R.T. Cooney, T.S. English, J.J. Goering, G.L. Hunt, Jr., M.C. Macauley, C.P. McRoy, W.S. Reeburg, and T.E. Whitledge. 1981. Ecological significance of fronts in the southeastern Bering Sea, pages 437-466. In (R.J. Livingston, ed.), Ecological processes in coastal and marine systems. Plenum Press, N.Y.

Jaques, F.L. 1930. Water birds observed on the Arctic Ocean and the Bering Sea. Auk 47:353-366.

Joiris, C. 1978. Seabirds recorded in the northern North Sea in July: the ecological implications of their distribution. Le Gerfaut 68:419-440.

Karrant, M. 1976. The global navigation system. AOPA Pilot 19: 59-61.

Kendeigh, S.C. 1944. Measurement of bird populations. Ecol. Monogr. 14:67-106.

Kenyon, K.W. 1950. Distribution of albatrosses in the North Pacific and adjacent waters. Condor 52:97-103.

Kenyon, K.W., and R.E. Phillips. 1965. Birds from the Pribilof Islands and vicinity. Auk 82:624-635.

Kessel, B., and D.D. Gibson. 1978. Status and distribution of Alaska birds. Stud. Avian Biol. No. 1.

Kinder, T.H., and L.K. Coachman. 1978. The front overlaying the continental slope in the eastern Bering Sea. J. Geophys. Res. 83:4551-4559.

King, J.E., and R.L. Pyle. 1957. Observations of seabirds in the tropical Pacific. Condor, 59:27-39.

King, J.G., and C.J. Lensink. 1971. An Evaluation of Alaska habitat for migratory birds. U.S. Dept. Interior, Bur. Sport Fish. Wildl., Washington, D.C., Nov. 1971. Unpubl. Admin. Rept.

King, J.G., G.E. Marshall, J.H. Branson, F.H. Fay, and W. Allen. 1974. Alaskan pelagic bird observations and a data bank proposal. U.S. Fish Wildl. Serv., Juneau. Unpubl. Admin. Rept.

King, J.G., and D.E. McKnight. 1969. A water bird survey in Bristol Bay and proposals for future studies. U.S. Bur. Sport Fish. Wildl., and Alaska Dept. Fish and Game, Juneau. Unpubl. Admin. Rept.

King, W.B. 1970. The trade wind zone oceanography pilot study, Part VII: seabird observations March 1964 to June 1965. U.S. Dept. Interior, Spec. Sci. Rept.-Fish. No. 586.

Kuroda, N. 1955. Observations of pelagic birds of the northwest Pacific. Condor 57:290-300.

Kuroda, N. 1957. A brief note on the pelagic migration of the Tubinares. Yamashina Inst. for Ornithol. and Zool., Misc. Repts. 11:10-23.

Kuroda, N. 1960. Analysis of sea bird distribution in the Northwest Pacific Ocean. Pac. Sci. 14:55-67.

Laing, H.M. 1925. Birds collected and observed during the cruise of the Thiepval in the North Pacific, 1924. Canadian Dept. Mines, Mus. Bull. 40: 46 p.

Leatherwood, J.S., and M.W. Platter. 1975. A preliminary assessment of summer stocks of bottlenose dolphins, *Tursiops truncatus*, in coastal waters of Alabama, Mississippi and eastern Louisiana, pages 1-162. In (D.K. O'Dell, D.B. Siniff, and G.W. Waring, eds.) *Tursiops truncatus* workshop Univ. of Miami, RSMAS Publ.

Lensink, C.J., and J.C. Bartonek. 1975. Seasonal distribution and abundance of marine birds, Work Statement: Research Unit No. 337. pages 105-123. In Environmental Assessment of the Alaskan Continental Shelf, Program Work Statement, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Lensink, C.J., 1976a. Migration of birds in Alaskan coastal and marine habitats subject to influence by OCS development, pages 249-320. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 4. NOAA, Environ. Res. Lab., Boulder, CO.

Lensink, C.J., 1976b. Seasonal distribution and abundance of marine birds. Part I of: Shipboard Surveys, pages 107-644. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 3. NOAA, Environ. Res. Lab., Boulder, CO.

Lensink, C.J., J.C. Bartonek, and C. Harrison. 1976. Seasonal distribution and abundance of marine birds, Part II, aerial surveys, pages 1-98. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 4. NOAA, Environ. Res. Lab., Boulder, CO.

LeResche, R.E., and R.A. Rausch. 1974. Accuracy and precision of aerial moose censusing. J. Wildl. Mgmt. 38:175-182.

Maher, W.J. 1974. Ecology of Pomarine Parasitic, and Long-tailed Jaegers in northern Alaska. Pac. Coast Avi. No. 37: 148 p.

Manikowski, S. 1971. The influence of meteorological factors on the behaviour of sea birds. Acta Zool. Cracov. 16:581-667.

Martinson, R.K., and C.F. Kaczynski. 1967. Factors influencing waterfowl counts on aerial surveys, 1961-1966. U.S. Fish and Wildl. Serv., Spec. Sci. Rept.-Wildl., No. 105.

McGregor, R.C. 1902. A list of birds collected in Norton Sound, Alaska. Condor 4:135-144.

McRoy, C.P., and J.J. Goering. 1974. The influence of ice on the primary productivity of the Bering Sea, pages 402-421. In (D.W. Hood and D.J. Kelley, eds.) Oceanography of the Bering Sea with emphasis on renewable resources . Occas. Publ. No. 2., Inst. of Mar. Sci., Univ. of Alaska, Fairbanks.

McRoy, C.P., and J.J. Goering. 1975. Primary production budget for the Bering Sea, pages 97-107. In (D.W. Hood and Y. Takenouti, eds.) Bering Sea Oceanography: an update, 1972-1974. Univ. Alaska Inst. Mar. Sci., Fairbanks, AK.

Miller, L. 1940. Observations of the Black-footed Albatross. Condor 42:229-238.

Montgomery, D.T. 1972. Bristol Bay waterbird survey. U.S. Dept. Interior, Fish Wildl. Serv., Bur. Sport Fish. Wildl., Alaska Area, River Basin Studies, Southeast Alaska, Operation Rept. Unpubl. Admin. Rep.

Murie, O.J. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. U.S. Dept. of Int., Fish Wildl. Serv., N. Amer. Fauna No. 61: 364 p.

Murphy, R.C. 1936. Oceanic birds of South America. 2 Vols. Amer. Mus. Nat. Hist., N. Y.

Myres, M.T., and J. Guzman. 1977. Ecology and behavior of southern hemisphere shearwaters (Genus Puffinus) and other seabirds, when over the outer continental shelf of Bering Sea and Gulf of Alaska during the northern summer, pages 179-191. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. III. NOAA, Environ. Res. Lab., Boulder, CO.

Naarding, J.A. 1980. Study of the Short-tailed Shearwater (Puffinus tenuirostris) in Tasmania. A report prepared for the Nat'l. Parks and Wildl. Serv. of Tasmania and the Australian Nat'l. Parks and Wildl. Serv. 87 pp.

Nakamura, K., and Y. Tanaka. 1977. Distribution and migration of two species of the genus Pterodroma in the North Pacific. Misc. Repts. Yamashina Inst. Ornith. 9:112-120.

Nelson, E.W. 1883. Birds of the Bering Sea and Arctic Ocean, pages 44-120. In Cruise of the revenue-steamer Corwin in Alaska and the N.W. Arctic Ocean. U.S. Treasury Dept. Document 429.

Nettleship, D.N. 1977. Seabird resources of eastern Canada: status, problems and prospects, pages 96-108. In (T. Mosquin and C. Suchal, eds.) Proceedings of the Symposium on Canada's Threatened Species and Habitats. Canadian Nature Federation, Ottawa.

North Pacific Fishery Management Council. 1979. Fishery management plan and final environmental impact statement for the groundfish fishery in the Bering Sea/Aleutian Island area. Anch. AK.

Palmer, R.S. (ed.). 1962. Handbook of North American birds, Vol. 1: Loons through flamingos. Yale Univ. Press, Conn.

Palmer, R.S. (ed.). 1976. Handbook of North American birds, Vols. 2 & 3: Waterfowl. Yale Univ. Press, Conn.

Patten, S., and A.R. Weisbrod. 1974. Sympatry and interbreeding of Herring and Glaucous-winged gulls in Southeastern Alaska. Condor 76:343-344.

Pennycuick, C.J. and D. Western. 1972. An investigation of some sources of bias in aerial transect sampling of large mammal populations. E. Afr. Wildl. J. 10:175-191.

Peterson, R.T. 1961. A field guide to western birds. Houghton Mifflin Co., Boston, Mass.

Pocklington, R. 1979. An oceanographic interpretation of seabird distributions in the Indian Ocean. Mar. Biol. 51:9-21.

Rauzon, M. 1976. Marine bird observations in the Gulf of Alaska and southern Bering Sea, 24 March to 21 April 1976. U.S. Fish Wildl. Serv., Field Rept. No. FW6012, Anchorage, AK.

Reichenow, A. 1909. Birds, pages 240-245. In P. Niedrach, Cruises in the Bering Sea. London.

Rice, D.W., and K.W. Kenyon. 1962. Breeding distribution, history and populations of north Pacific Albatrosses. Auk 79:365-386.

Robbins, C.S., B. Bruun, and H.S. Zim. 1966. Birds of North America. Golden Press, N. Y.

Robbins, C.S., and D.W. Rice. 1974. Recoveries of banded Laysan Albatross (Diomedea immutabilis) and Black-footed Albatross (Diomedea nigripes), pages 232-277. In (W.B. King, ed.) Pelagic studies of sea birds in the Central and Eastern Pacific Ocean. Smithsonian Contrib. Zool., No. 158.

Ronholt, L.L., H.H. Shippen, and E.S. Brown. 1978. Demersal fish and shellfish resources of the Gulf of Alaska from Cape Spencer to Unimak Pass, 1948-1976. A historical review, pages 1-955. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Sanger, G.A. 1972a. Preliminary standing stock and biomass estimates of seabirds in the Subarctic Pacific Region, pages 481-611. In (A.Y. Takenouti, et al., eds.) Biological Oceanography of the northern North Pacific Ocean . Idemitsu Shoten, Tokyo.

Sanger, G.A. 1972b. Checklist of bird observations from the eastern North Pacific Ocean, 1955-1967. The Murrelet 53:16-21.

Sanger, G.A. 1973. Pelagic records of Glaucous-winged and Herring gulls in the north Pacific Ocean. Auk 90:384-393.

Sanger, G.A. 1974a. Black-footed Albatross, pages 96-128. In (W. B. King, ed.) Pelagic studies of seabirds in the central and eastern Pacific Ocean . Smithsonian Contrib. Zool., No. 158.

Sanger, G.A. 1974b. Laysan Albatross, pages 129-153. In (W.B. King, ed.) Pelagic studies of seabirds in the Central and Eastern Pacific Ocean. Smithsonian Contrib. Zool., No. 158.

Schamel, D. 1976. Avifaunal utilization of the offshore island area near Prudhoe Bay, Alaska, pages 409-447. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports, July-September 1976, Final Report, Vol. 1. NOAA, Environ. Res. Lab., Boulder, CO.

Schumacher, J.D., T.H. Kinder, D.J. Pashinski, and R.L. Charnell. 1979. A structural front over the continental shelf of the eastern Bering Sea, J. Phys. Oceanogr. 9:79-87.

Shuntov, V.P. 1963. Summer distribution of the kittiwakes in the Bering Sea. Ornithologiya 6:324-330.

Shuntov, V.P. 1964. Transequatorial migrations of the thin-billed stormy petrel (Short-tailed Shearwater) - Puffinus tenuirostris (Temm.). Zool. Zh. 43:590-598.

Shuntov, V.P. 1968. Some regularities in distribution of albatrosses (Tubinares, Diomedeidae) in the northern Pacific. Zool. Zh. 47:1054-1064.

Shuntov, V.P. 1972. Marine birds and the biological structure of the ocean. Pac. Res. Instit. Fish. Mange. Oceanogr. (TINRO), Far-Eastern Publishers, Vladivostok. 378 p. (Transl. by Agence Tunistienne de Public-relations for U.S. Dept. Int., Bur. Sport Fish. Wildl. and Natl. Sci. Found., 1974.

Sowl, L.W., and J.C. Bartonek. 1974. Seabirds--Alaska's most neglected resource. Trans. N. Amer. Wildl. Natur. Res. Conf. 39:117-126.

Sowls, A.L., S.A. Hatch, and C.J. Lensink. 1978. Catalog of Alaskan seabird colonies. U.S. Fish and Wildl. Serv., Biol. Serv. Program. FWS/OBS 78/78.

Springer, A.M., D.G. Roseneau, and M. Johnson. 1979. Ecological studies of colonial seabirds at Cape Thompson and Cape Lisburne, Alaska, pages 517-574. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1979, Vol. II. NOAA, Environ. Res. Lab., Boulder, CO.

State of Alaska. Annual Publication. Alaska catch and production commercial fisheries statistics. Statistical Leaflets. Alaska Dept. of Fish and Game, Juneau, Alaska.

Swartz, L.G. 1967. Distribution and movements of birds in the Bering and Chukchi seas. Pac. Sci. 21:332-347.

Trapp, J.L. 1975. Distribution and abundance of seabirds along the Aleutian Islands and Alaska Peninsula, fall 1974. U.S. Dept. Int., Fish Wildl. Serv., Aleutian Isl. Natl. Wildl. Refuge, Adak, Alaska. Unpubl. Admin. Rept.

Tuck, G.S., and H. Heinzel. 1979. A field guide to the seabirds of southern Africa and the world. William Collins Sons & CO., Ltd., Glasgow, Great Britain.

Tuck, L.M. 1960. The murres. Canadian Wildl. Serv. Monogr. Ser. 1: 260 p.

Wahl, T.R. 1978. Seabirds in the northwestern Pacific Ocean and south central Bering Sea in June 1975. West. Birds 9:45-66.

Watson, G.E., and G.J. Divoky. 1972. Pelagic bird and mammal observations in the eastern Chukchi Sea, early fall 1970. U.S. Coast Guard Oceanogr. Rept. 50:111-172.

Watson, G.E. 1975. Marine birds in the Beaufort Sea, pages 681-695. In (J.C. Reed and J.E. Sater, eds.) The coast and shelf of the Beaufort Sea . Arctic Inst. No. Amer., Washington, D.C.

Wiens, J.A. 1976. Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska, pages 369-400. In Environmental Assessment of the Alaskan Continental Shelf, Principal Investigators' Reports for the Year Ending March 1976, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Wiens, J.A. 1977. Community structure, distribution, and interrelationships of marine birds in the Gulf of Alaska, pages 383-401. In Environmental Assessment of the Alaskan Continental Shelf, Annual Reports of Principal Investigators for the Year Ending March 1977, Vol. 2. NOAA, Environ. Res. Lab., Boulder, CO.

Wiens, J.A., D. Heinemann, and W. Hoffman. 1978. Community structure, distribution, and interrelationships of marine birds birds in the Gulf of Alaska, pages 1-178. In Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators, Vol. 3. NOAA, Environ. Res. Lab., Boulder, CO.

Williamson, F.S.L., and L.J. Peyton. 1963. Interbreeding of Glaucous-winged and Herring gulls in the Cook Inlet region, Alaska. Condor 65:24-28.

Williamson, F.S.L., M.C. Thompson, and J.Q. Hines. 1966. Avifaunal investigations, pages 437-480. In (N.J. Wilimovsky, and J.N. Wolfe, eds.) Environment of the Cape Thompson Region, Alaska. U.S. Atomic Energy Comm.

Wohl, K. 1975. Sightings of New Zealand Shearwaters in the Northern Gulf of Alaska. Canadian Field-Naturalist 89:320-321.

Wynne-Edwards, V.C. 1935. The habits and distribution of birds on the North Atlantic. Proc. Boston Soc. Nat. Hist. 40:233-346.

Yesner, D.R. 1976. Aleutian Island albatrosses: a population history. Auk 93:263-280.



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