FINAL REPORT
8 February 2002

Aerial Surveys of Molting Waterfowl in the Barrier Island-Lagoon Systems Between Spy Island and Brownlow Point, Alaska, 2000

Prepared for

BP EXPLORATION (ALASKA) INC.
Environmental Studies Group
P.O. Box 196612
Anchorage, Alaska 99519-6612

FINAL REPORT
8 February 2002
P523

Aerial Surveys of Molting Waterfowl in the Barrier Island-Lagoon Systems Between Spy Island and Brownlow Point, Alaska, 2000

by

Lynn E. Noel[1]
Stephen R. Johnson[2]
Robert Rodrigues[1]

[1]**LGL ALASKA RESEARCH ASSOCIATES, INC.**
1101 East 76th Avenue, Suite B
Anchorage, Alaska 99518

[2]**LGL LIMITED, environmental research associates**
9768 Second Street
Sidney British Columbia, Canada
V8L 3Y8

Aerial Surveys of Molting Waterfowl in the Barrier Island-Lagoon Systems Between Spy Island and Brownlow Point, Alaska, 2000

This report was prepared under contract to BP Exploration (Alaska) Inc.
Inquiries about this report may be addressed to:

BP EXPLORATION (ALASKA) INC.
Environmental Studies Group
P.O. Box 196612
Anchorage, Alaska 99519-6612

Cite report as:

Noel, L.E., S.R. Johnson, and R. Rodrigues. 2001. Aerial surveys of molting waterfowl in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 2000. Report for BP Exploration (Alaska) Inc. by LGL Alaska Research Associates, Inc., Anchorage, Alaska. 69 p + Append.

Cover photo by John Warden

ABSTRACT

There is concern over declines in sea duck populations in western North America and Alaska. Aerial survey data for molting sea ducks and other waterfowl in central Alaskan Beaufort Sea barrier island-lagoon systems collected during August 2000 add to the 13 years of long-term monitoring data collected over the 24-year period since 1977. Our study objectives were to determine current distribution and abundance of molting sea ducks and other waterfowl, and to compare current and historical numbers and distributions of long-tailed ducks (*Clangula hyemalis*) in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska. Five low-level aerial strip-transect surveys were conducted during 1-24 August 2000 (3120 km, 1248 km^2). Long-tailed ducks dominated the avian fauna in August 2000, which is consistent with results since 1977. Eiders, primarily common eider (*Somateria mollissima v-nigrum*), were more abundant in the eastern lagoon system (west of the Arctic National Wildlife Refuge; mean density ± standard error; 7.2 ± 1.92 eiders/km^2); while scoters, primarily surf scoter (*Melanitta perspicillata*), were more abundant in the western lagoon system (west of Prudhoe Bay; 4.6 ± 0.53 scoters/km^2). Geese and swans were most abundant along the mainland shoreline in the western lagoon (2.6 ± 0.62 geese/km^2) and tundra south of the eastern lagoon (6.9 ± 0.91 geese/km^2). Gull abundance, primarily glaucous gulls (*Larus hyperboreus*), was consistently higher in the western lagoon system (1.8 ± 0.50 gulls/km^2), compared to the eastern lagoon system (0.6 ± 0.11 gulls/km^2). During August 2000, long-tailed duck density was highest in the eastern lagoon system (52.2 ± 16.34 ducks/km^2), followed by the western lagoon system (36.5 ± 10.94 ducks/km^2), Stefansson Sound (16.2 ± 4.34 ducks/km^2), and tundra (1.5 ± 0.43 ducks/km^2). Both total number and mean flock size for long-tailed ducks declined during the interval between surveys on 8 August (23,562, 60.6 individuals/flock) and on 12 August (7826, 11.4 individuals/flock), possibly as a result of the storm on the 10-11 August 2000. Mean density of long-tailed ducks within this survey area during July and August appears to have declined from 1978-2000 ($y = -4.49x + 175$, $R^2 = 0.295$, $P = 0.055$), without correction for number of km^2 surveyed, regions covered, or variability in survey conditions. Little of the variability in mean long-tailed duck density was explained by consistent change over time. Long-tailed duck distribution among transects in the western lagoon shows a general decline from 1978-2000, with the largest differences among barrier island and mainland shoreline transects.

Key Words: central Alaska Beaufort Sea, *Clangula hyemalis*, eider, glaucous gull, *Larus hyperboreus*, long-tailed duck, marine waterbirds, *Melanitta*, scoter, *Somateria*

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Aerial Surveys of Molting Waterfowl in the Barrier Island-Lagoon Systems Between Spy Island and Brownlow Point, Alaska, 2000

INTRODUCTION

Study Rationale

Tens of thousands of molting/flightless waterfowl aggregate along the mainland and barrier island coastlines in the central Beaufort Sea, Alaska (Figures 1 and 2). Based on several decades of study, we know that these aggregations of molting/flightless ducks, primarily sea ducks and geese, are highly susceptible to disturbance, and to oil or fuel spills (Johnson and Richardson 1981; Johnson 1985, 1990; Johnson and Gazey 1992). Recently, concern has been expressed over the apparent decline in 10 of the 15 species of North American sea ducks (Elliot 1997, USFWS 1999). These include species known to occur within the Spy Island to Brownlow Point barrier island-lagoon systems (Figures 1 and 2): long-tailed duck (*Clangula hyemalis*), common eider (*Somateria mollissima v-nigrum*), king eider (*Somateria spectabilis*), black scoter (*Melanitta nigra americana*), surf scoter (*Melanitta perspicillata*), and white-winged scoter (*Melanitta fusca deglandi*).

Long-tailed ducks are the most abundant molting waterfowl in these barrier island-lagoon systems (Johnson 1990, Johnson and Gazey 1992). During the early 1990s, a monitoring protocol was designed and tested for the U.S. Department of Commerce, Minerals Management Service which was to evaluate changes in abundance and distribution of marine waterfowl, primarily long-tailed ducks, in relation to industrial activities (Figure 1, Johnson and Gazey 1992). In 1998–2000, BP Exploration (Alaska) Inc. (BPXA) and the Point Thomson Unit Owners (PTUO) funded LGL Alaska Research Associates, Inc. (LGL) to collect molting waterfowl distribution and abundance data (Noel et al. 1999a, 1999b) using methods developed and tested for this monitoring protocol (Johnson and Gazey 1992). In 1999–2000, Minerals Management Service funded the U.S. Geological Survey, Alaska Biological Science Center to monitor marine waterfowl using this same protocol. BPXA and the PTUO have continued to fund LGL to collect data using the Johnson and Gazey (1992) protocol, due to concerns over data availability for Environmental Assessments and questions of compatibility with historical data (Petersen et al. 1999).

Study Objectives

This report presents the results of molting waterfowl monitoring surveys during August 2000 between Spy Island and Brownlow Point, Alaska. Objectives for the 2000 study were:

1. Document the distribution and abundance of molting waterfowl in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska.
2. Document the distribution and abundance of molting waterfowl on large lakes along an inland transect between Brownlow Point and the Shaviovik River, Alaska.
3. Compare current and historical numbers and distributions of long-tailed ducks in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska.
4. Document the level of human activity during surveys in the barrier island-lagoon systems throughout the study areas.

Species of Concern in Central Beaufort Sea Lagoons

Long-tailed ducks are the predominant species in central Alaskan Beaufort Sea lagoon systems, and therefore were the focus for the development of a monitoring program which was designed to evaluate changes in abundance and distribution of marine waterfowl in relation to industrial development (Johnson and Gazey 1992). Currently, there is concern over reported declines in long-tailed duck populations in western North America and Alaska (Hodges et al. 1996, Conant et al. 1997). Nesting population trend data for long-tailed ducks on the Arctic Coastal Plain, however, are conflicting. Larned et al. (1999:15) reported a slightly increasing trend in long-tailed ducks on the Arctic Coastal Plain of Alaska from 1992 through 1999. Other authors have reported stable long-tailed duck populations during the same period (Conant et al. 1997, Elliot 1997, Larned and Balogh 1997, USFWS 1999), whereas Mallek and King (2000) reported recent declines in the population.

Common eiders nest on central Alaskan Beaufort Sea barrier islands. Females with young and some males may remain in coastal areas to molt (Johnson and Herter 1989, Johnson 2000). Surf scoters also commonly occur in barrier island-lagoon habitats along the coast of the Beaufort Sea (Johnson and Richardson 1981). Common eider spring migrant counts at Point Barrow, Alaska indicate that the number of eiders nesting in northern Alaska and western Canada may have declined by up to 50% between 1976 and 1994 (Suydam et al. 1999). Similarly, spring migration counts of king eiders passing Point Barrow suggest a 50% decline between 1976 and 1994 (Suydam et al. 1999). Although breeding and winter surveys do not effectively discriminate between black scoters, surf scoters, and white-winged scoters, most indices appear to show declines in populations of these sea ducks as well (Elliot 1997, USFWS 1999). These estimated declines, however, may not adequately incorporate variability inherent in count methodologies and differences in accuracy when comparing historical data to the more accurate methodologies currently employed. Despite these difficulties in interpreting historical data for population trends, the perceptions that these declines are real is widespread and has prompted regulatory concern (Elliot 1997, USFWS 1999).

METHODS

Survey methods and conditions adopted in this study were based on analyses that identified variables that influenced the numbers of long-tailed ducks recorded during low-level aerial surveys (Johnson 1990, Johnson and Gazey 1992). A total of 5 low-level aerial (fixed-wing aircraft) surveys were flown during the period 1-24 August 2000 in the barrier island-lagoon systems from Spy Island in the west to Brownlow Point in the east (Figures 1 and 3). Brownlow Point lies on the mainland just east of Flaxman Island (Figure 1). Sampling was balanced by surveying both sets of lagoons on the same day. Four contiguous transects were surveyed within 4 habitat strata (offshore, barrier island, lagoon, mainland shoreline) in each lagoon. All habitats within a lagoon system were surveyed before continuing to the next lagoon system to reduce the time between sampling these transects, minimizing the possibility of birds moving between transects. In addition to these lagoon transects, tundra transects covered a sample of lakes between the Staines River and the Shaviovik River (Figure 1).

The survey crew consisted of a pilot and two observers in a float equipped Cessna 206 fixed-wing aircraft (Figure 3); one observer sat in the right front seat and the other sat in the left rear seat. Survey altitude was approximately 45 m above ground level and ground speed approximately 180 km/h. Transect width was 400 m total: 200 m on each side of the aircraft. On-transect sightings were within 200 m from the aircraft, and off-transect sightings were more than 200 m from the aircraft. Observers were trained to estimate large numbers of birds in dense concentrations using the simulation program Counting Wildlife© v. 2.0 (Wildlife Counts, Juneau, AK) and using poppy seed scatter trials (Johnson 1990, Johnson and Gazey 1992).

The survey period was focused on the peak of the male long-tailed duck flightless period from mid July to mid to late August, based on progression of the wing molt (Johnson and Richardson 1981). Six to 8 replicate surveys at even intervals during this period were recommended (Johnson and Gazey 1992). Surveys were scheduled as late in the day as practical; at least as late as 1700 h Alaska Daylight Savings Time, because long-tailed ducks have been found to concentrate along the barrier islands in the late afternoon (Johnson and Richardson 1981; Johnson 1982, 1985). Surveys on days with high winds (>37 km/h, 20 kts) were delayed until winds, wave height, and chop diminished, thereby improving sightability of birds on the water (Johnson 1990, Johnson and Gazey 1992). Marginal survey conditions were when winds approached 37 km/h.

Tape recorders were used to record information about observed birds, mammals, habitats, and environmental conditions. Continuous audio-tape recordings were made which included information on transects, sightings, and 30-s intervals (time period) marked by an audio-intervalometer (timer). Variables recorded include: ***Transect*** – start time (h-min-s), general location, transect number, temperature, wind speed, wind direction, Beaufort Sea state, wave height, cloud cover, habitat type, stop time; ***Sighting*** – species, number, behavior, habitat, type, human activity, on- or off-transect; ***Time period*** – time at "beep" sound, ice cover, wave height, glare on the water surface, wind speed, wind direction, any changes in any particular variable. A notebook computer equipped with a Global Positioning System (GPS) receiver coupled with mapping software was used to record the flight line on a map of the area at 1-s intervals during surveys. Observers synchronized their watches with the GPS satellite time, and these times (recorded for transects and time periods) were used to geo-reference the survey data.

RESULTS

Five aerial strip-transect surveys were conducted during 1-24 August 2000 (Table 1); 4 of the surveys were complete and 1 was incomplete. Total survey effort was 3120 km (1248 km^2, Table 2). Results are presented below as a general overview, followed by separate sections for various taxonomic groupings. We rely on graphs, maps, and tables to illustrate relative abundances, distributions, and habitat associations. Areal density maps for taxonomic groups are presented as the number of individuals per km^2 for on-transect data, plotted at the mid-point of each 30-s time period, for each transect. Data for all 5 surveys are presented on a series of 3 maps covering the survey area. Maps for each survey date in 2000 for long-tailed ducks are presented in Appendix A. Maps for other selected species are presented in Appendix B. Habitat and behavior analyses were based on the number of sightings of each species. Sightings are based on flocks rather than individuals. Individuals within a flock behave similarly and respond to others within the flock, and therefore are not independent. Flocks, consisting of 1 or many individuals, were considered independent from one another.

Survey Conditions

General weather conditions in the study area were recorded during each survey and as broadcast by radio operators at the Deadhorse airport or at the Badami Development weather office. Wind speed and direction were assessed by a combination of water surface conditions and pilot observations. Temperatures were either recorded at altitude from the aircraft or from Deadhorse or Badami air-radio broadcast. Wind speed and direction greatly influence sightability and behavior of molting waterfowl (Johnson and Richardson 1981, Johnson 1990, Johnson and Gazey 1992). We attempted to limit survey days to those with winds <37 km/h (Table 1). Strong westerly winds on the night of the 10-11 August caused a storm surge of 1.5 m that flooded low areas of the barrier islands and along the mainland shoreline (Appendix C). Survey conditions were near the acceptable wind conditions on 12 and 14 August 2000. Because of poor visibility offshore on 8 August and high winds on 12 August, we flew the shoreline transects in the Stefansson Sound area on these dates (Figure 1).

Overview

Long-tailed ducks dominated the avian fauna in 2000, both in terms of numbers of individuals and numbers of sightings (Table 3), which is consistent with results since 1977 (Figure 4, Johnson and Gazey 1992). Long-tailed ducks dominated in both the western and eastern lagoon systems (Figure 1, Tables 4 and 5). Relative abundance among other avian groups, however, differed among the 4 survey regions (western lagoon, Stefansson Sound, eastern lagoon, and tundra, Figure 1). Gull relative abundance was highest in the Stefansson Sound region, but was highly variable (Figure 5). Gull relative abundance was consistently higher in the western lagoon, than in the eastern lagoon (Figure 5). Eiders were more abundant in the eastern lagoon; while scoters were more abundant in the western lagoon (Figure 5). Geese and swans were most abundant in the western lagoon and tundra (Figure 5).

Vessel traffic was highest on 14 August 2000 in the Stefansson Sound region (Figure 6). Vessel traffic was more consistent within the western lagoon and Stefansson Sound regions (for island transects) than within the eastern lagoon, although vessel traffic was recorded throughout the survey area (Figure 6; Appendix A, Table A3). Sighting records for human activity including camps, nets, and all vessel traffic during 2000 surveys are presented in Appendix A (Table A3).

Loons

Although there was variability between individual surveys, loons were generally most abundant on tundra transects, followed by the western lagoon, Stefansson Sound, and eastern lagoon (Figure 5). The number of loons per survey ranged within regions from over 160 on 24 August (western lagoon) to less than 20 on 12 August 2000 (eastern lagoon) (Figure 7). Loon density was highest within 3 survey regions on 8 August 2000, and in 1 region on 24 August 2000 (Figure 8). Pacific loons (*Gavia pacifica*) and red-throated loons (*Gavia stellata*) were most common, with the total density of Pacific loons more than twice that of red-throated loons in the survey area (Table 6). Loons were scattered throughout the survey area in low numbers (Figures 9-11). Pacific loons were the most widely distributed across habitat types with a higher proportion of sightings in lagoon and mainland shoreline habitats (Table 7). Red-throated loons occurred more often in mainland shoreline, lagoon, and barrier island habitats, and occurred less often than Pacific loons in tundra habitats (Table 7). Yellow-billed loons (*Gavia adamsii)* occurred primarily along mainland shorelines and the barrier island shorelines (Table 7).

Seabirds

Gulls, primarily glaucous gulls (*Larus hyperboreus*), were the most common seabird group occurring within the survey area (Figure 12).

Arctic Terns

Arctic terns (*Sterna paradisaea)* were not abundant in the survey area, but occurred most frequently in the western lagoon and in the Stefansson Sound regions

(Figures 5 and 12). Arctic tern density was highest on 14 August 2000 in the western lagoon and Stefansson Sound regions (Figure 13). Many sightings were adjacent to the barrier islands (Table 8).

Gulls

Gull density increased in the western lagoon from 1-24 August and was highest in both the western lagoon and Stefansson Sound on 14 August (Figure 14). More than twice the mean density of gulls occurred in the western lagoon than in the eastern lagoon (Figure 5). The greatest concentrations of gulls in the western lagoon occurred near Spy, Leavitt, Bertoncini, and Stump islands (Figure 15). In the Stefansson Sound region, gulls were concentrated at Cross Island (Figure 16). In the eastern lagoon, gulls were scattered throughout the barrier islands, the lagoon, and the mainland shoreline (Figure 17). Sabine's gulls (*Xema sabini*) were recorded along the barrier islands (Table 8) primarily within the western lagoon.

Incidentals

Jaegers occurred as single individuals, along and offshore of the barrier islands in the western lagoon, on all but the 1 August 2000 survey (Figure 18); and with the exception of a single individual on the tundra on 8 August 2000 (Figure 19). Four black guillemot (*Cepphus grylle*) sightings were recorded, 2 offshore, 1 in Prudhoe Bay, and 1 east of Cross Island (Appendix B, Figures B13-B15).

Ducks

Eiders

Eiders were more common in the eastern lagoon with numbers peaking on 8 August (Figures 20–23). Common eiders were the most abundant species in this group, comprising 99% of eiders that were classified to species (Table 3). In the western lagoon, eiders were mostly scattered in small numbers along the barrier islands and in the lagoon with a few groups concentrated around Spy Island (Figure 21). In Stefansson Sound, eiders were concentrated south of Reindeer, Cross, and Narwhal islands (Figure 22). Most of the eiders in the eastern lagoon were south of the Stockton and Maguire islands (Figure 23). Over half of the common eider sightings were adjacent to the barrier islands (Table 9). Eider densities were higher in the eastern lagoon and Stefansson Sound than in the western lagoon or tundra (Figure 5). Density peaked in the eastern lagoon on 8 August (Figure 24). Density appears to fluctuate widely within the Stefansson Sound region, however, the surveys with decreased eider density were flown along the shoreline, because of weather conditions, instead of along the barrier islands (Figure 24).

Scoters

Scoters, primarily surf scoters, were most common in the western lagoon, with the highest density on 8 August 2000 (Figures 5, 25–28). Scoters were far more abundant in the western lagoon than in the eastern lagoon (Figures 5 and 28, Tables 4 and 5), and over 80% of sightings were on mid lagoon transects (Table 10). The largest flocks of scoters were in Simpson Lagoon (Figure 26). Surf scoter was the third most abundant species in the survey area (Table 6).

Long-tailed Duck

The long-tailed duck was the dominant species in the barrier island-lagoon systems between Spy Island and Brownlow Point during 2000 (Table 3), consistent with survey data since 1977 (Figure 4). Mean density of long-tailed ducks within this survey area during July and August appears to have declined from 1977–2000 (Figure 29). Because survey transects were placed closer to the shoreline and directly over the barrier islands during 1977, and surveys only included half of the transects in the western lagoon, we have also evaluated this trend omitting the 1977 data (Figure 30, Johnson and Richardson 1981). Both presentations indicate a decreasing trend in long-tailed duck density, with the trend less pronounced with omission of the 1977 data (Figures 29 and 30). Low values of r^2 for these relationships (0.37 and 0.29), however, indicate that little of the variability in mean long-tailed duck density was explained by consistent change over time (Figures 29 and 30). This summary, however, does not correct for factors which influence mean density such as the total number of km^2 surveyed, regions covered, or variability in survey conditions (Johnson and Gazey 1992).

The molting long-tailed duck population in Beaufort Sea lagoons from 15 July to 19 August is primarily composed of flightless males, as determined by wing measurements (Johnson and Richardson 1981, Johnson 1985). Mean long-tailed duck density among some transects in the western lagoon during this molt period shows a general decline from 1978–1984 to 1998–2000 (Figure 31). The largest differences among transects in the western lagoon from 1978–1984 to 1998–2000 occurred on 1 offshore, 4 barrier island, 2 lagoon, and 2 mainland shoreline transects generally at the western end of Simpson Lagoon (Figure 31). Mean areal density generally declined for these 9 western lagoon transects through the 3 summary time periods between 1978 and 2000 (Figure 31). Only transect 202 declined continuously through this period, however (Figure 31). Mean densities for barrier-island transects 23, 31, and 201 were probably not different from 1978–1984 to 1989–1991 (Figure 31). In the eastern lagoon, mean long-tailed duck density decreased on 3 barrier island and 1 lagoon transect from 1989–1991 to 1998–2000, while 1 lagoon and 2 mainland shoreline transects increased (Figure 32).

Mean areal density was highest in the eastern lagoon (52.2 ± 16.34 ducks/km^2), followed by the western lagoon (36.5 ± 10.94 ducks/km^2), Stefansson Sound (16.2 ± 4.34 ducks/km^2), and tundra (1.5 ± 0.43 ducks/km^2) for surveys in August 2000; although variability (± standard error) was high (Figure 33). Both total number and mean flock size for long-tailed ducks declined between surveys on 8 August (23,562; 60.6 individuals/flock) and on 12 August (7826; 11.4 individuals/flock), possibly as a result of the storm on the 10–11 August 2000 (Figure 34, Appendix C). In the western lagoon, long-tailed ducks were concentrated along the barrier islands and in the lagoon, with few long-tailed ducks along the mainland shoreline (Figure 35, Table 11). The relatively low use of the mainland shoreline in the western lagoon in 2000 is consistent with the distribution of long-tailed ducks observed in 1999 (Figure 36). However, in the eastern lagoon, long-tailed duck distribution was scattered throughout the area with sightings occurring along the barrier island shoreline, throughout the lagoon, and also along the mainland shoreline (Figure 37, Table 12). Long-tailed duck use of the mainland shoreline in the eastern lagoon in 2000 is consistent with distributions observed in 1999 and 1998 (Figures 38 and 39). In Stefansson Sound, long-tailed ducks were concentrated in the lee of Cross Island and the McClure islands, and near the Endicott causeway in 2000 and 1999 (Figures 40 and 41, Table 13). Distribution maps for each region by survey, showing long-tailed duck density by 30-s period and vessel traffic, are presented in Appendix A.

Other Ducks

Aside from scoters, eiders, and long-tailed ducks, only a few other duck species were recorded. Small numbers of red-breasted mergansers (*Mergus serrator)* were recorded on at least one survey date in all 4 survey regions. Scaup (*Aythya spp.)* were recorded on 3 surveys in the western lagoon, and northern pintails (*Anas acuta*) were recorded on all 4 tundra surveys.

Geese and Swans

Within the survey area during 2000, geese and swans were most abundant on tundra and along the mainland shoreline of the lagoons (Figure 5, Table 6), with highest numbers on 1 August 2000 (Figure 42). Goose and swan density was consistently higher and less variable in the western lagoon than in the eastern lagoon (Figures 5, 42–45, Table 4 and 5). Brant (*Branta bernicla)* was the most common species occurring primarily along the coastline in the western lagoon (Figures 43–45, Tables 3-6). Greater white-fronted goose *(Anser albifrons)* was the next most common goose species, occurring primarily on the tundra toward the western end of the tundra transects, and along the mainland shoreline of the lagoon (Figures 43–45, Tables 3-6). Lesser Canada geese (*Branta canadensis*) occurred primarily on the tundra near the western end of the tundra transects near the Shaviovik River (Figure 43–45, Table 14). Tundra swans (*Cygnus columbianus*) occurred on-transect only on the tundra. A few swans were sighted off-transect, on the coastal tundra, in both the eastern and western lagoon systems (Figure 43, Table 14).

DISCUSSION

Survey data for the central Beaufort Sea barrier island-lagoon systems collected during August 2000 supplement the 13 years of long-term monitoring data collected over the 24-year period since 1977. Based on the 2000 data, long-tailed ducks continue to be the most numerous birds in Beaufort Sea barrier island-lagoon systems, where they feed primarily on epibenthic organisms including mysids (*Mysis relicta* and *M. litoralis*) and amphipods (*Onisimus glacialis*) (Johnson 1982). During the flightless molt period from mid July to mid to late August, male long-tailed ducks and some non-breeding females congregate in very large numbers in barrier island-lagoon systems such as Simpson Lagoon, Gwydyr Bay, and south of Flaxman Island. The highest densities of molting flocks generally concentrate immediately south of barrier island shorelines. Barrier islands provide protection from prevailing winds and rough water, provide easy access to roosting areas along leeward beaches, and are close to abundant prey resources in the lagoons (Johnson 1982).

During periods of disturbance (aircraft, boat and humans) and rough water, Johnson (1982) found that long-tailed ducks responded by moving to a nearby location that provided protection from wind and waves. Changes in distribution appeared to be primarily related to weather conditions rather than disturbance, but a decline in overall long-tailed duck numbers within the study area in 1981 (4000 to 2000) indicated that there was a general pattern of movement away from the sources of disturbance (Johnson 1982). This suggests that continuous vessel traffic and aircraft disturbance during molting may lead to displacement of long-tailed ducks. Development and expansion of the oilfields in the Prudhoe Bay region since 1977, with an assumed increase in nearshore traffic may have contributed to the decreased density of long-tailed ducks within the western lagoon systems from 1977–1984 to 1998–2000 (Figure 31). Similarly, since 1998, an assumed increase in vessel and aircraft traffic associated with development of the Badami oilfield, exploration in the Flaxman Island area, and intensive environmental studies may also have contributed to a decrease in density of long-tailed ducks on 3 of 4 barrier island and an increase in density on 2 of 4 mainland shoreline transects from 1989–1991 to 1998–2000 (Figure 32). This may in part be a reflection of sampling intensity, survey timing, and survey weather conditions; but may also be related to increased disturbance within this lagoon system. Mean density of long-tailed ducks within the entire survey area (combined western and eastern lagoons) during July and August appears to have declined from 1978-2000 ($y = -4.49x + 175$, $R^2 = 0.295$, $P = 0.055$), without correction for number of km^2 surveyed, regions covered, or variability in survey conditions. However, little of the variability in mean long-tailed duck density was explained by consistent change over time. A detailed analysis of these data, incorporating disturbance and other environmental variables known to influence the number of long-tailed ducks recorded during monitoring surveys, is beyond the scope of this presentation of our 2000 survey results, but is currently being conducted as a separate deliverable to BPXA.

Undisturbed molting long-tailed ducks typically cycle through a 24-h period of activity, with peak numbers resting and preening in the leeward nearshore and beach habitats during evening and early morning (Johnson 1982, 1985; Flint et al. 2001). During mid-day, long-tailed ducks typically move farther from shore into mid-lagoon habitats to feed (Johnson 1982, Flint et al. 2001). Although molting sea ducks have been found to spend more time in open water when disturbed intermittently by aircraft, swimming, feeding, and population levels appeared to be unaffected (Gollop et al. 1974). Flint et al. (2001) conducted experimental boat disturbances but could not identify changes in location, changes in movement patterns, or changes in feeding frequency associated with these experimental disturbances. Poor resolution for radio triangulated locations, and behavioral differences between experimental and control areas were cited as reasons for an inability to measure a response to experimental disturbances (Flint et al. 2001). Johnson (1982) documented a breakdown in the 24-h activity cycle with disturbance and increased wind; although cyclic movements continued in an adjacent undisturbed sheltered area (Johnson 1982).

Weather conditions influence the total number and distribution of long-tailed ducks recorded during our monitoring surveys (Johnson 1982, Johnson and Gazey 1992). Moderate to strong winds (20–37 km/h) directly influence sightability of birds on the water by increasing wave height and surface disturbance (Johnson and Gazey 1992). During periods of strong southwesterly winds, long-tailed ducks move toward the mainland coast and/or out of the lagoon through the inter-island passes to take shelter in the lee of the mainland coast or north of the barrier islands (Johnson and Richardson 1981). After the storm on the 10–11 of August 2000 with sustained westerly winds of 70 km/h and a storm surge of 1.5 m (Appendix C), density of long-tailed ducks declined across our entire survey area (Tables 11–13). This decline in density was also documented in aerial surveys conducted by the USFWS across the same lagoon systems (Appendix 2 in Flint et al. 2001). Telemetry data after this storm indicated that 9 of 20 long-tailed ducks disappeared from the Cottle Island area (western lagoon), but that 6 of these 9 ducks returned to the area by 15 August 2000 (Flint et al. 2001). To the east however, only 2 ducks left the Flaxman Island area (eastern lagoon) after this storm (Flint et al. 2001).

Keeping in mind that not all islands were searched for nests in 2000, nest locations and aerial sightings of adult birds were loosely associated for species nesting on the barrier islands. Arctic tern nests were recorded on barrier islands in the western lagoon, on Narwhal Island, and on Belvedere Island during July 2000 (Flint et al. 2001, Noel et al. 2001). Arctic tern sightings were adjacent to Spy Island, Leavitt Island and Bertoncini Island in the western lagoon, as well as Narwhal Island (Figures B10–B11). Conversely, Arctic tern nests were found on Belvedere Island, but no sightings were recorded near this island. Over twice the number of glaucous gull nests were recorded in the western lagoon (47) as in the eastern lagoon (19) in 2000 (Flint et al. 2001). This was consistent with our glaucous gull areal densities with twice the glaucous gull density in the western lagoon compared to the eastern lagoon in 2000 (Figure 5). Common eiders were recorded nesting throughout the survey area with 214 nests in the western lagoon, 59 nests on islands in Stefansson Sound, and 337 nests on islands in the eastern lagoon during July 2000 (Flint et al. 2001, Noel et al. 2001). The number of eider crèche sightings (flocks with hens and ducklings) for offshore-mainland transects ($n = 11$; i.e. transects 101, 201, 603, 301, and 401; Figure 1) was positively, but not significantly, correlated ($r = 0.56$, $P = 0.089$) with the number of active common eider nests on islands in these transects.

To address concerns over survey methods and data compatibility, we compared aerial survey data for the Beaufort Sea lagoon systems collected during 1999 and 2000 by the U.S. Fish and Wildlife Service (USFWS; Flint et al. 2001) for the U.S. Geological Survey, Alaska Biological Science Center, and the Minerals Management Service; and by LGL for BPXA. Survey methods were generally similar, with similar aircraft and flight speeds. USFWS used pilot/observers during surveys, LGL uses 2 observers, allowing the pilot to concentrate on following the shorelines and air traffic. Timing of surveys was generally similar, although the survey period flown by USFWS, 22 July to

8 September, was longer than the period, 30 July to 26 August, flown by LGL. We suspect that time of day for flights was different between USFWS and LGL, based on conversations with survey personnel (Tim Tiplady USFWS, pers. comm.) and observations of aircraft made during surveys. LGL surveys were typically flown later in the day than USFWS surveys, as recommended in the survey protocol (Johnson and Gazey 1992). The flight order for survey transects was also different for USFWS and LGL. USFWS flew transects across a single habitat (i.e., all offshore, all island, all lagoon transects) from west to east across the entire survey area. LGL followed the protocol established in Johnson and Gazey (1992) and flew offshore to mainland transects sequentially within each lagoon system (western or eastern). This method reduces the risk of bird movements between transects within a lagoon, due to daily feeding and loafing patterns. In general long-tailed duck densities reported for LGL were an average of 17 ducks/km^2 higher (approximately 3150 long-tailed ducks/survey) than the USFWS reported densities (Figure 46). In most instances, the patterns of long-tailed duck abundance across the survey area appeared to follow similar trends in both data sets; although individual transects varied (Figure 46).

ACKNOWLEDGEMENTS

This study was funded by BP Exploration (Alaska) Inc. (BP). We thank Dave Trudgen and Bill Streever, with the Environmental Studies Group at BP Exploration (Alaska) Inc. for their support and suggestions concerning this study. Bill Streever provided comments which improved this report. Peter Wainwright designed, programmed, and maintains the customized software used for data analysis. Peggy Kircher assisted with document preparation. The survey aircraft was piloted by Jim Helmericks, who has piloted these surveys since 1977.

LITERATURE CITED

Conant, B., D.J. Groves, C. Ferguson, and R.J. King. 1997. Long-tailed duck ducks – toward listing. 7th Alaska Bird Conference, 1–5 December 1997, U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, Alaska.

Elliot, R.D. (ed) 1997. Conservation issues for North American sea ducks. A concept paper for a sea duck joint venture under the North American waterfowl management plan. Report by Canadian Wildlife Service, U.S. Fish & Wildlife Service and U.S. Geological Survey (Biological Resources Div.). Canadian Wildlife Service–Atlantic Region, Sackville, New Brunswick, Canada. 35 p.

Flint, P.L., R.B. Lanctot, J.C. Franson, T. Hollmen, J. Fischer, J.B. Grand, and M. Howell. 2001. Monitoring Beaufort Sea waterfowl and marine birds. Annual Progress Report by U.S. Geological Survey, Alaska Biological Science Center, Anchorage, Alaska. 43 p + appendices.

Gollop, M.A., J.R. Goldsberry, and R.A. Davis. 1974. Aircraft disturbance to moulting sea ducks, Herschel Island, Yukon Territory, August 1972. Arctic Gas Biol. Rep. Ser. 14(5):202-231.

Hodges, J.I., J.B. King, B. Conant, and H.A. Hanson. 1996. Aerial surveys of waterbirds in Alaska 1957–1994: Population trends and observer variability. National Biological Service Information and Technology Report 4. 24 p.

Johnson, S.R. 1982. Continuing investigations of long-tailed ducks (*Clangula hyemalis* L.) during the molt period in the Alaskan Beaufort Sea. Pages 547-563 *in* Environmental Assessment Alaskan Continental Shelf, Final Rep. Princ. Invest. Vol. 23. Bureau of Land Management/National Oceanic & Atmospheric Administration, OCSEAP, Juneau, Alaska.

Johnson, S.R. 1985. Adaptations of the long-tailed duck (*Clangula hyemalis* L.) during the period of molt in Arctic Alaska. Proc. Internat. Ornithol. Congress 18:530-540.

Johnson, S.R. 1990. Monitoring Beaufort Sea waterfowl and marine birds. Report OCS Study MMS 90-0048 by LGL Alaska Research Assoc. Inc. for U.S. Department of Interior, Alaska Outer Continental Shelf Region of the Minerals Management Service, Anchorage, Alaska. 121 p.

Johnson, S.R. 2000. Pacific eider. Pages 259–272 *in* J.C. Truett and S.R. Johnson (eds.). Natural history of an arctic oil field: development and the biota. Academia Press, San Diego, California.

Johnson, S.R. and W. Gazey. 1992. Design and testing of a monitoring program for Beaufort Sea waterfowl and marine birds. Report OCS Study MMS 92-0060 by LGL Alaska Research Associates, Inc. for U.S. Department of Interior, Alaska Outer Continental Shelf Region of the Minerals Management Service, Anchorage, Alaska. 114 p.

Johnson, S.R. and D.R. Herter. 1989. The Birds of the Beaufort Sea. BP Exploration (Alaska) Inc., Anchorage, Alaska. 372 p.

Johnson, S.R. and W.J. Richardson. 1981. Barrier island lagoon ecological process studies: final report, Simpson Lagoon. Part 3, Birds. Pages 109–383 *in* Environmental Assessment of the Alaskan Continental Shelf, Final Reports of Principal Investigators. Volume 7. Biological Studies. Outer Continental Shelf Environmental Assessment Program. U.S. Department of Commerce, National Oceanic & Atmospheric Administration and U.S. Department of the Interior, Bureau of Land Management. Boulder, Colorado. National Technical Information Service PB82-192113/AS.

Larned, W.W. and G.R. Balogh. 1997. Eider Breeding Population Survey Arctic Coastal Plain, Alaska, 1992–1996. Unpublished Report, U.S. Fish and Wildlife Service Migratory Bird Management Division, Anchorage, Alaska. 51 p.

Larned, W., T. Tiplady, R. Platte, and R. Stehn. 1999. Eider breeding population survey, Arctic Coastal Plain, Alaska, 1997-1998. Unpub. report by U.S. Fish & Wildlife Service, Office of Migratory Bird Management, Anchorage, Alaska. 22 p.

Mallek, E.J. and R.J. King. 2000. Aerial breeding pair surveys of the Arctic Coastal Plain of Alaska, 1999. Unpublished report by U.S. Fish and

Wildlife Service, Waterfowl Management, Fairbanks, Alaska. 17 p.

Noel, L.E., S.R. Johnson, and P.F. Wainwright. 1999a. Aerial surveys of molting waterfowl in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1998. Report by LGL Alaska Research Associates, Inc., for BP Exploration (Alaska) Inc., Anchorage, Alaska. 64 p + Append.

Noel, L.E., S.R. Johnson, and P.F. Wainwright. 1999b. Aerial surveys of molting waterfowl in the barrier island-lagoon systems between the Stockton Islands and Flaxman Island, Alaska, 1998. Report by LGL Alaska Research Associates, Inc., for BP Exploration (Alaska) Inc., Anchorage, AK. 53 p.

Noel, L.E., R.J. Rodrigues, and S.R. Johnson. 2001. Nesting status of the common eider and other barrier island nesting birds in the central Alaskan Beaufort Sea, summer 2000. Report by LGL Alaska Research Associates, Inc., for BP Exploration (Alaska) Inc., Anchorage, AK. 34 p + Append.

Petersen, M.R., P.L. Flint, W.W. Larned, and J.B. Grand. 1999. Monitoring Beaufort Sea waterfowl and marine birds. Annual Progress Report. U.S. Geological survey, Alaska Biological Science Center, Anchorage, AK. 33 p.

Pehrsson, O. 1973. Chief prey as a factor regulating populations of eider (*Somateria mollissima)* and long-tailed ducks (*Clangula hyemales).* Zool. Revy 35:98-92

Pehrsson, O. 1974. Nutrition of small ducklings regulating breeding area and reproductive output in the (*Clangula hyemales).* Congr. Internat. Union Game Biol. 11:259-264.

Pehrsson, O. 1985. Duckling production of the Long-tailed duck in relation to spring weather and small-rodent fluctuations. Can. J. Zool. 64:1835-1841.

Suydam, R.S., D.L. Dickson, J.B. Fadely, L.T. Quakenbush. 1999. Population declines of King and Common Eiders of the Beaufort Sea. Condor 102:219-222.

USFWS (U.S. Fish and Wildlife Service). 1999. Population status and trends of sea ducks in Alaska. Unpublished Report. U.S. Fish and Wildlife Service, Migratory Bird Management, Anchorage, AK 137 p.

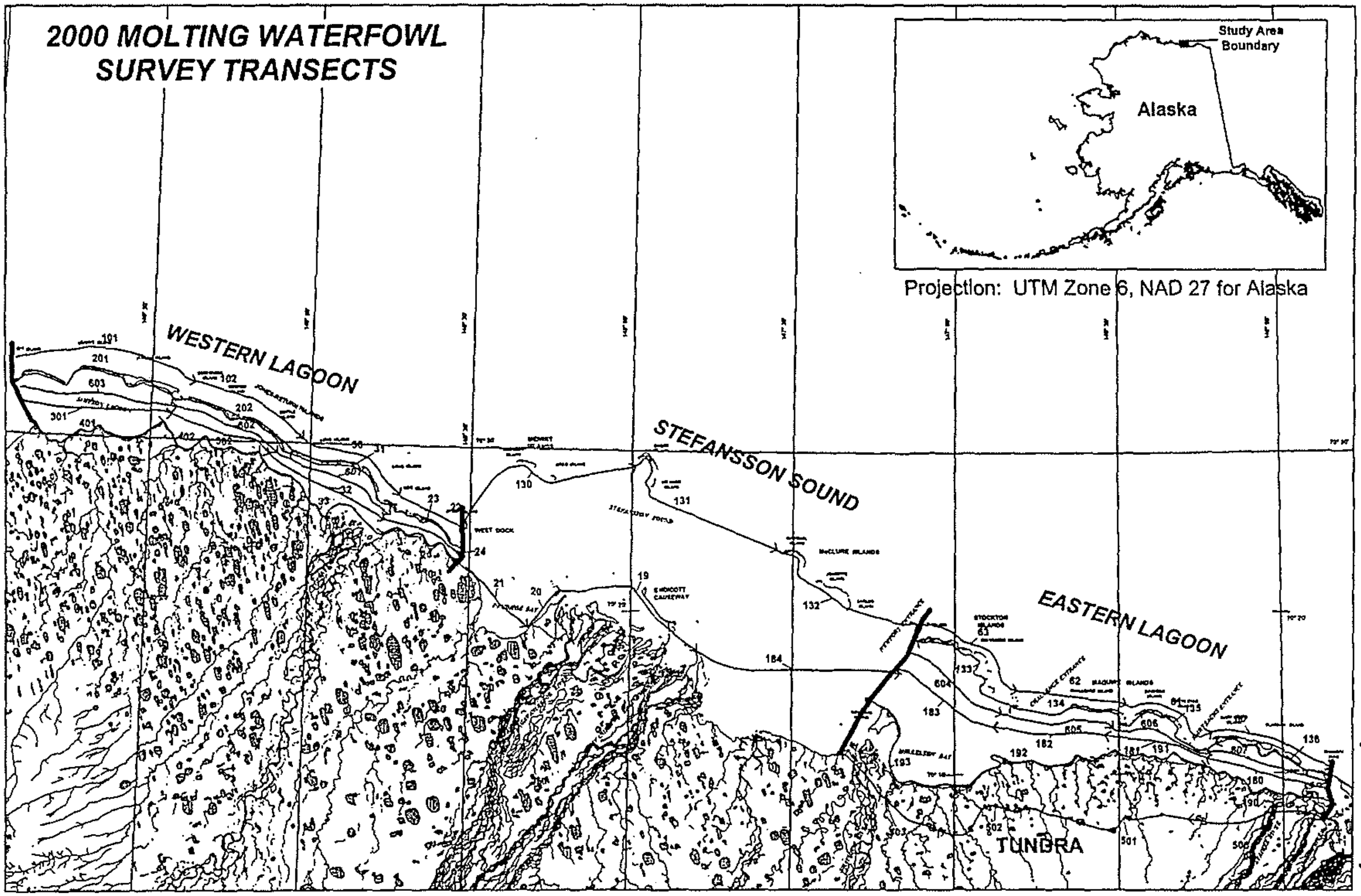


Figure 1. Locations and numbers for aerial survey transects and survey regions in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska. Transect numbering is consistent with Johnson and Gazey (1992).

Photo by John Warden

Male Long-tailed duck (Clangula hyemalis).

Photo BPXA file

Pair of Long-tailed ducks.

Photo by John Warden

Nesting female common eider (*Somateria mollissima v-nigrum*).

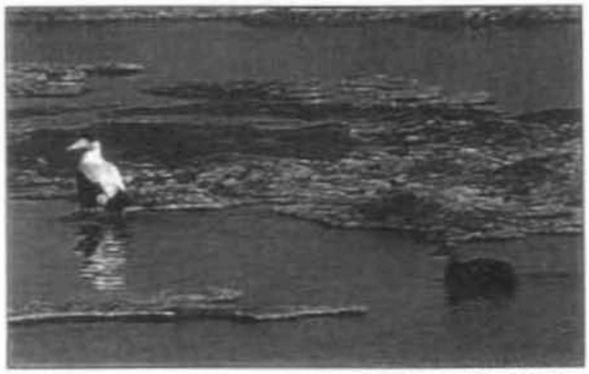


Photo by John Warden

Pair of common eiders.

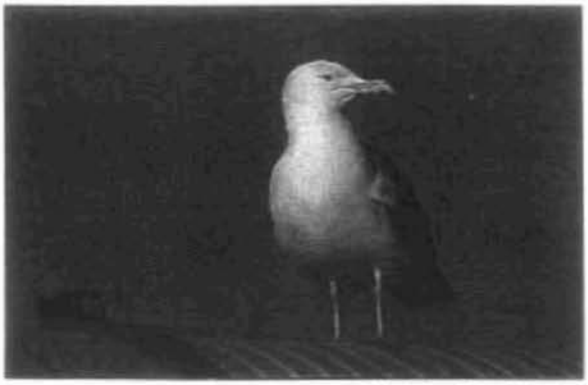


Photo by John Warden

Glaucous gull (*Larus hyperboreas*).

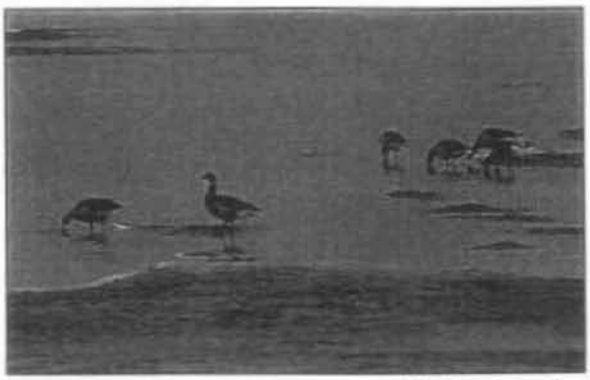


Photo by Lynn Noel

Black brant (*Branta bernicla nigricans*).

Figure 2. Avian species occurring within the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska.

Photo by Lynn Noel

Survey aircraft; float-equipped Cessna 206.

Long-tailed duck molting habitat. *Photo by Steve Johnson*

Photo by Lynn Noel

Common eider nesting habitat-Pole Island.

Figure 3. Survey aircraft and examples of habitats covered in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska.

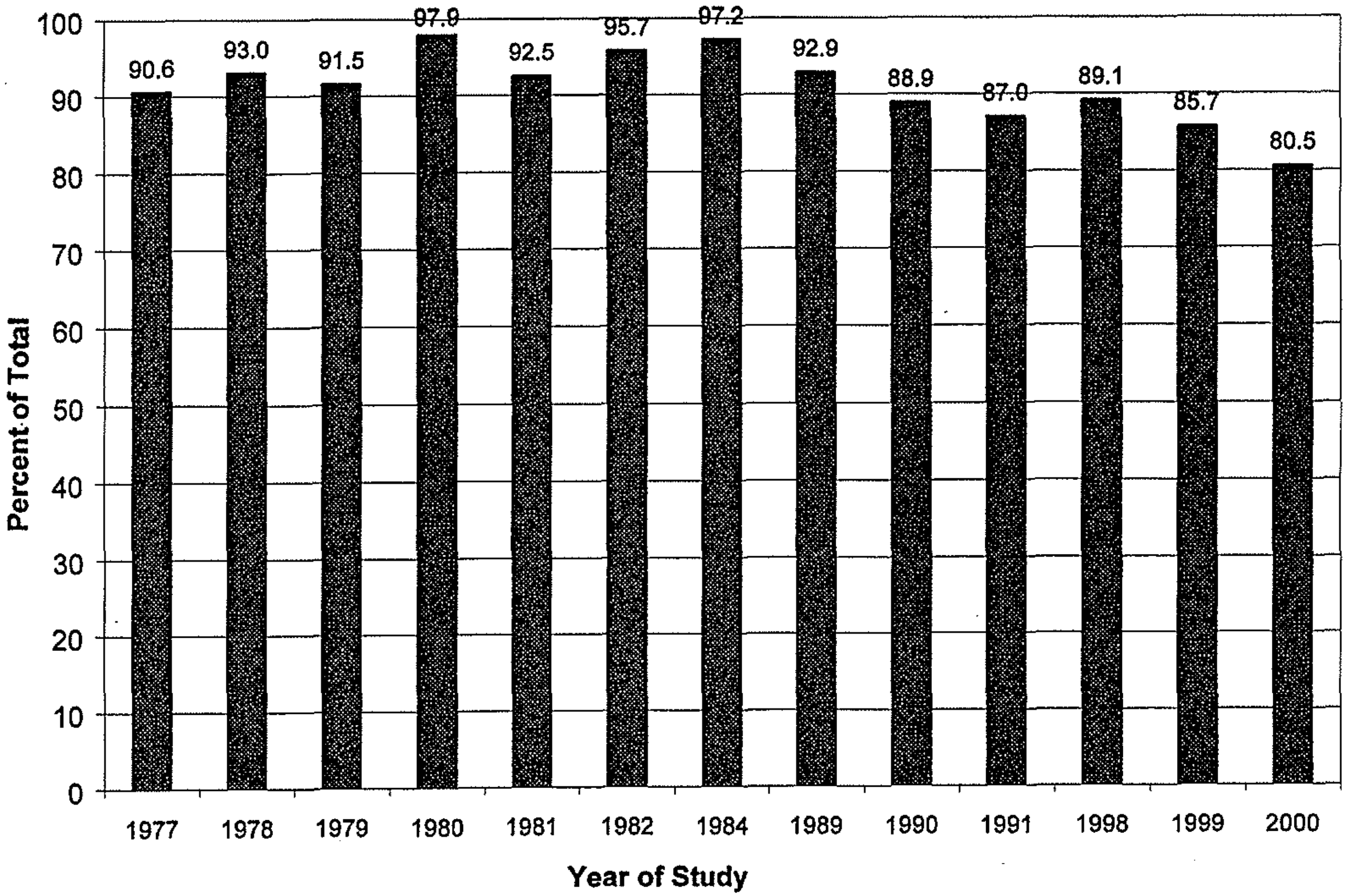


Figure 4. Long-tailed duck sightings as percentage of all bird sightings for aerial surveys in nearshore waters of the central Alaska Beaufort Sea, 1977–2000 (Table A1, Johnson and Gazey 1992; Noel et al. 1999, 2000).

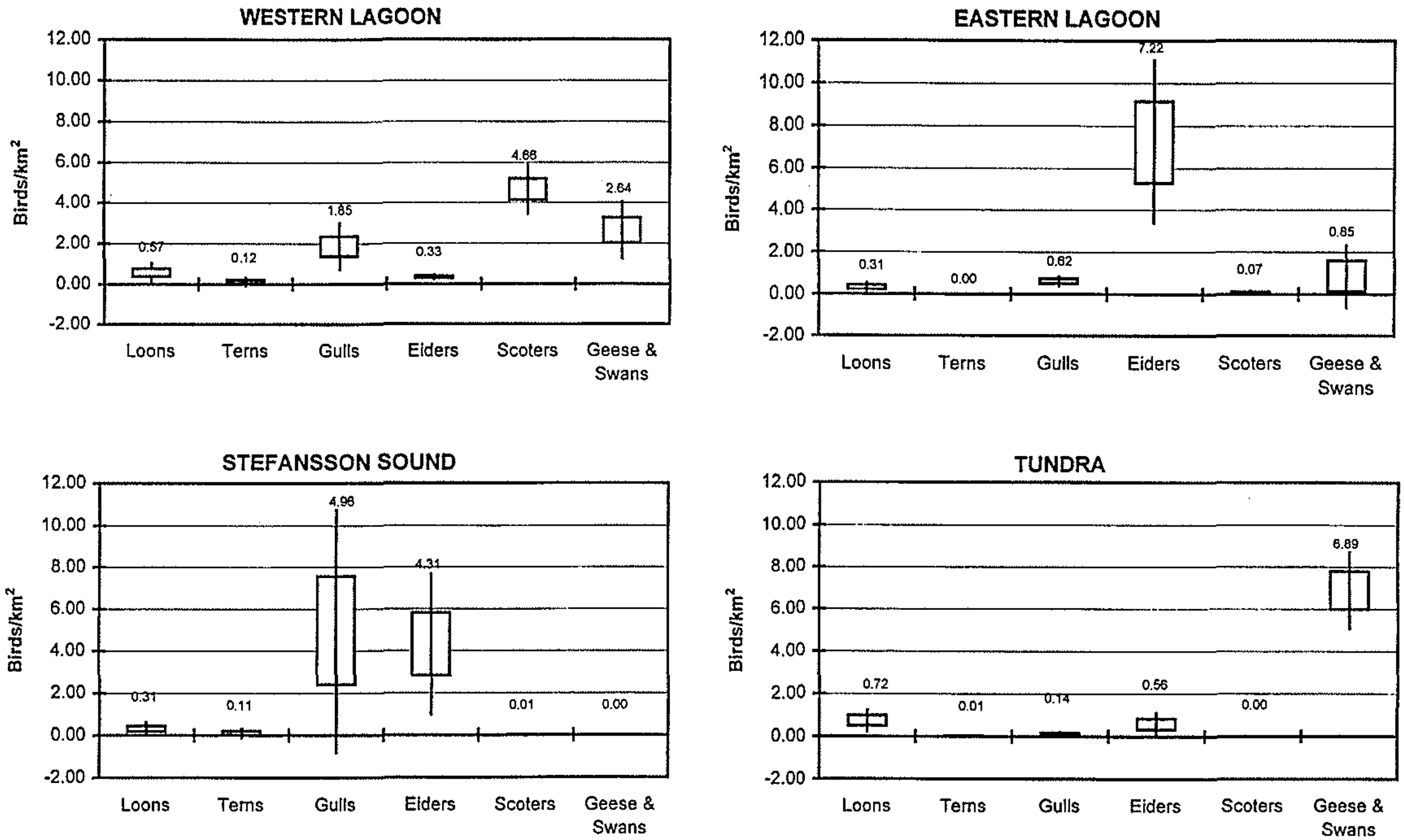


Figure 5. Mean with standard error bar and standard deviation line for areal density of avian groups among survey regions for 4 or 5 aerial survey replicates between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. Western lagoon and Stefansson Sound regions were surveyed on 5 dates. Eastern lagoon and tundra regions were surveyed on 4 dates.

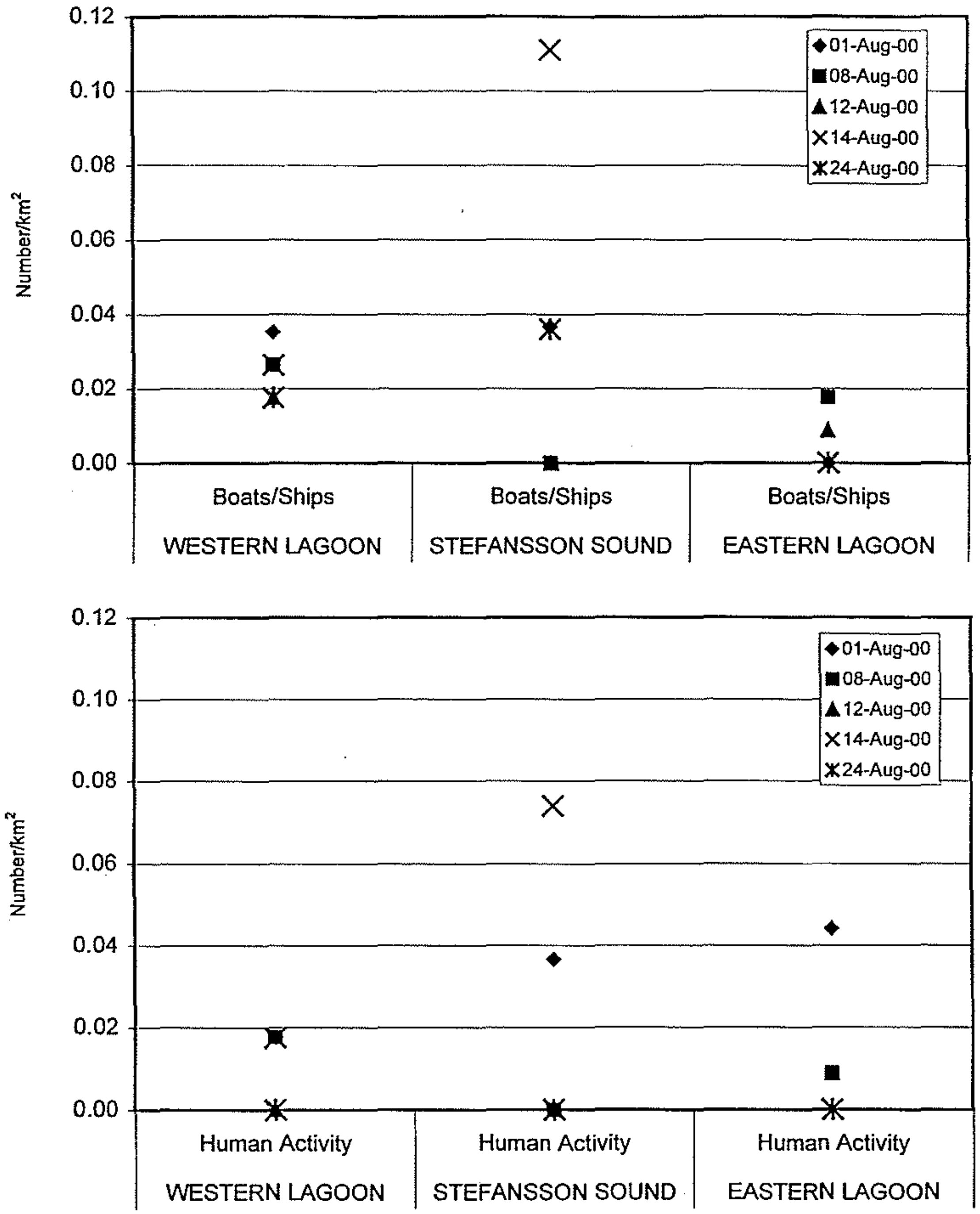


Figure 6. Areal density of vessel traffic and human activity (nets, camps, and/or people) for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon on 14 August 2000.

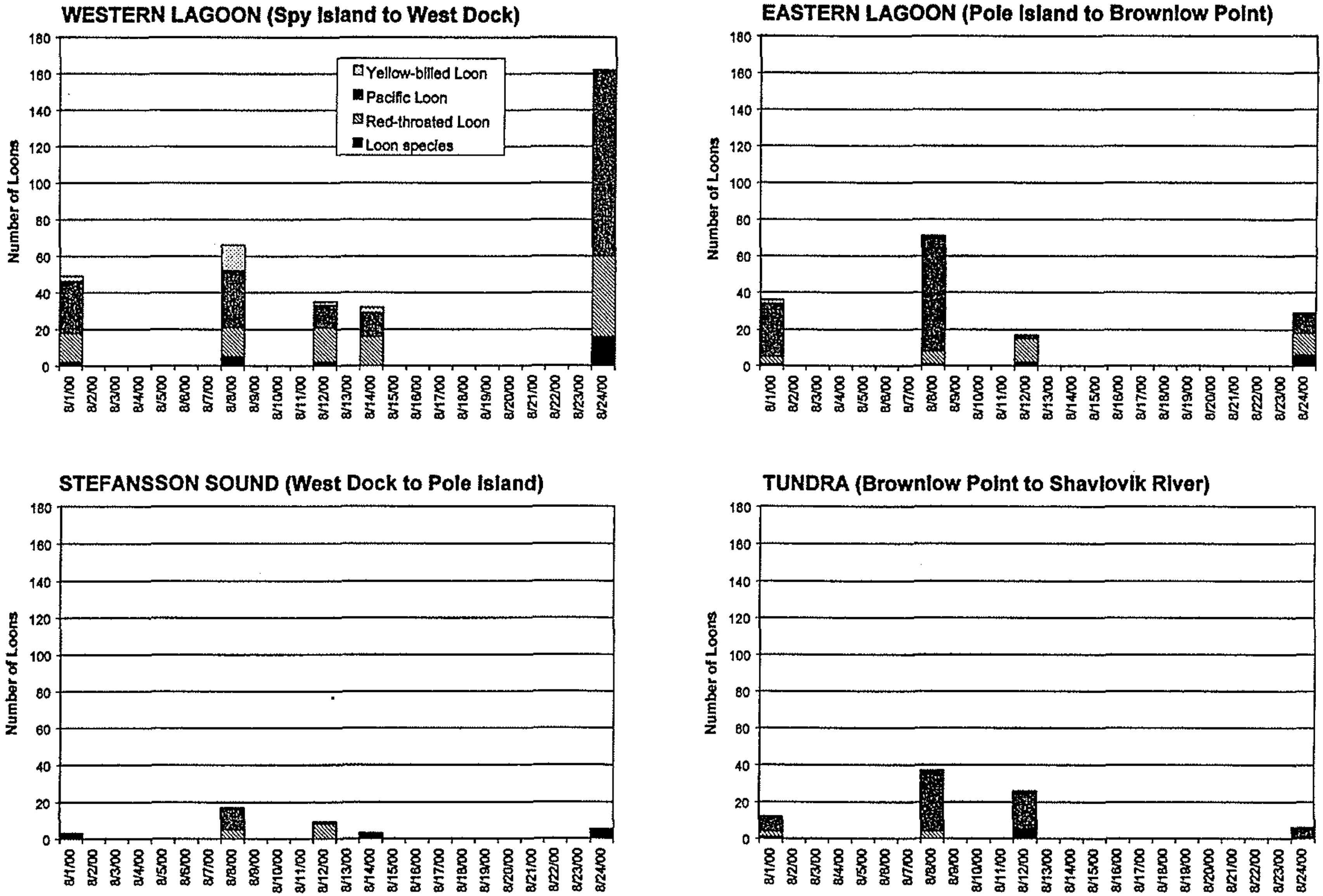


Figure 7. Total number of loons on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the western lagoon and Stefansson Sound areas only.

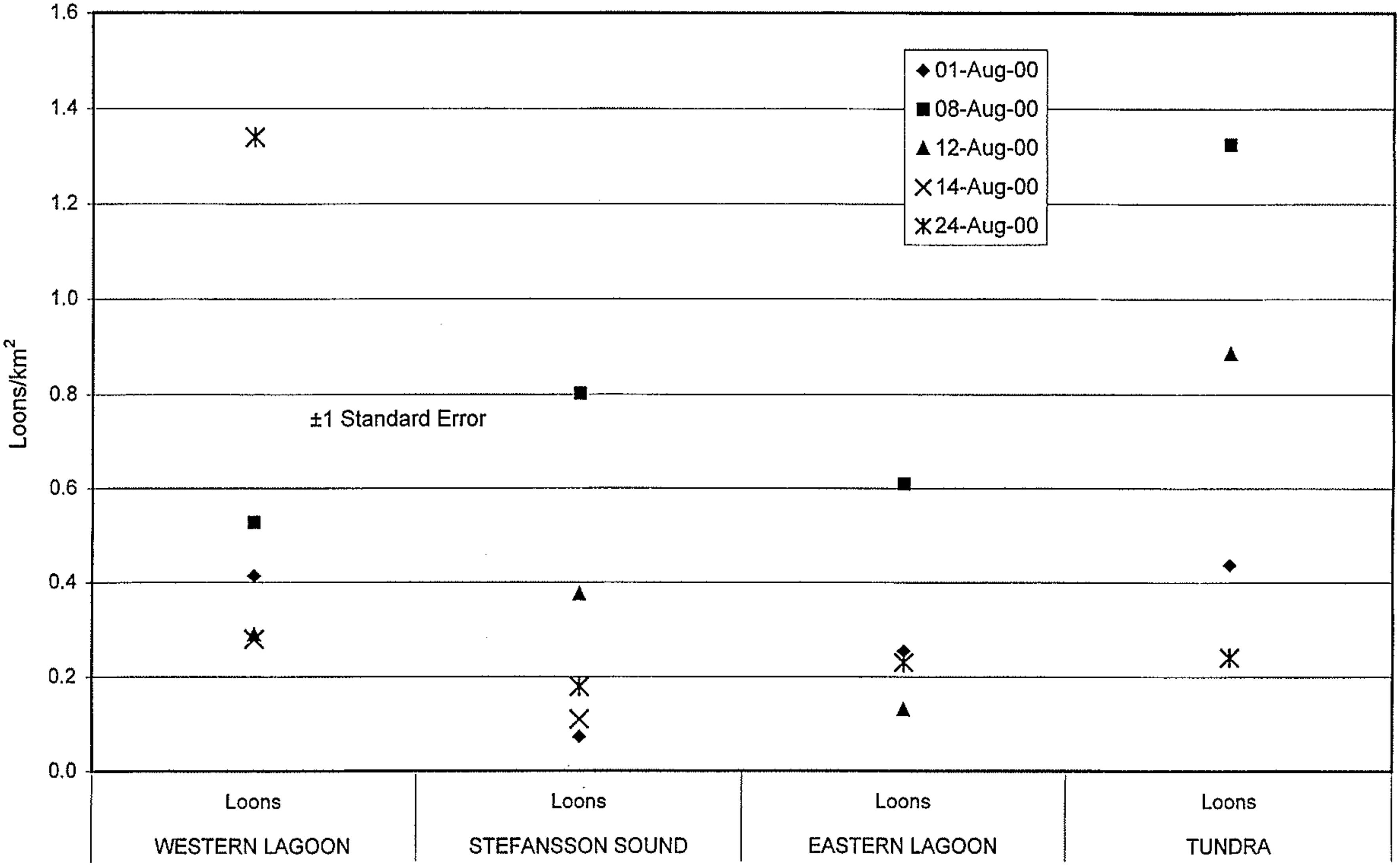


Figure 8. Areal density of loons for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon or tundra on 14 August 2000.

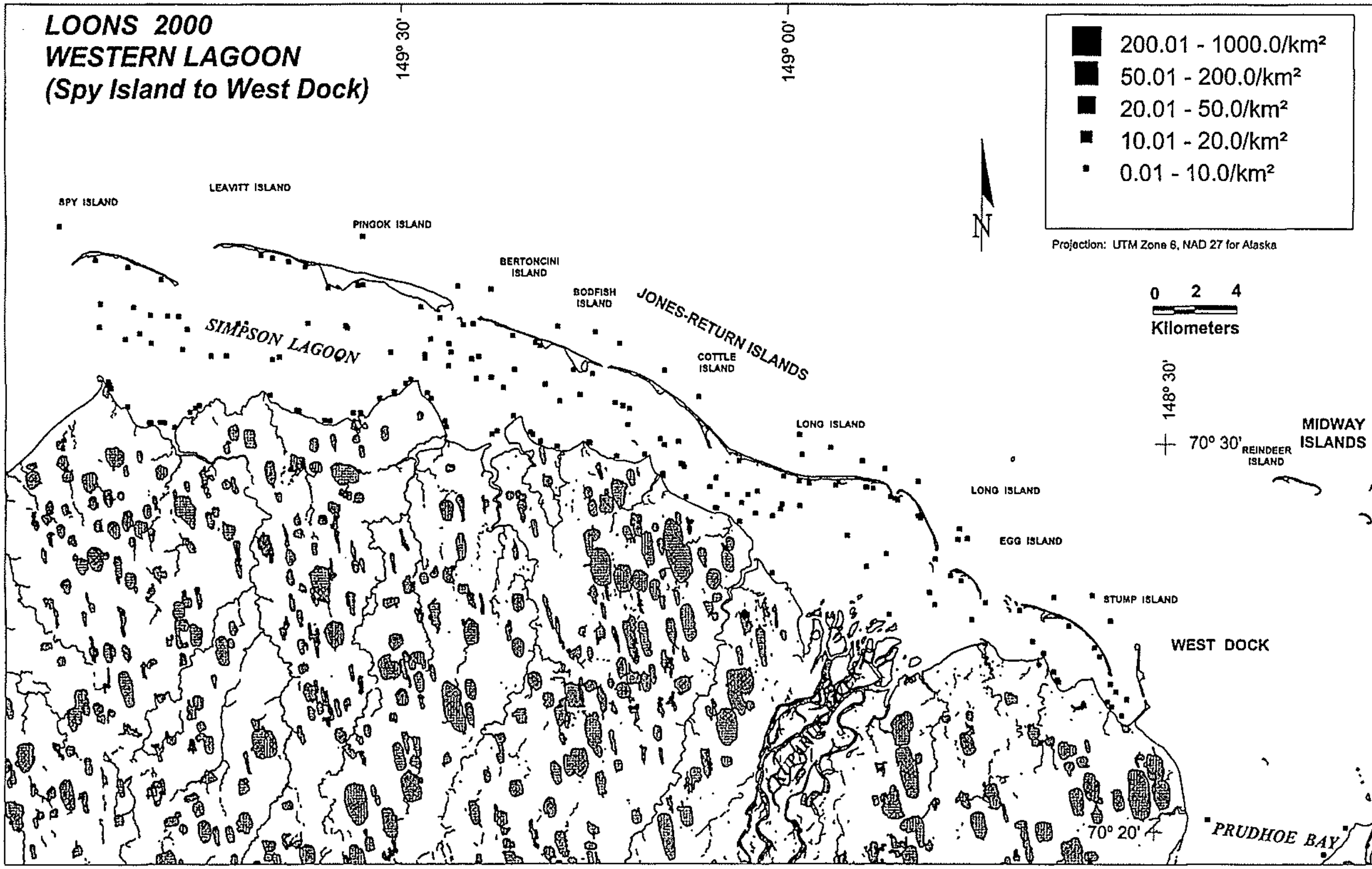


Figure 9. Summary of density for loons by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

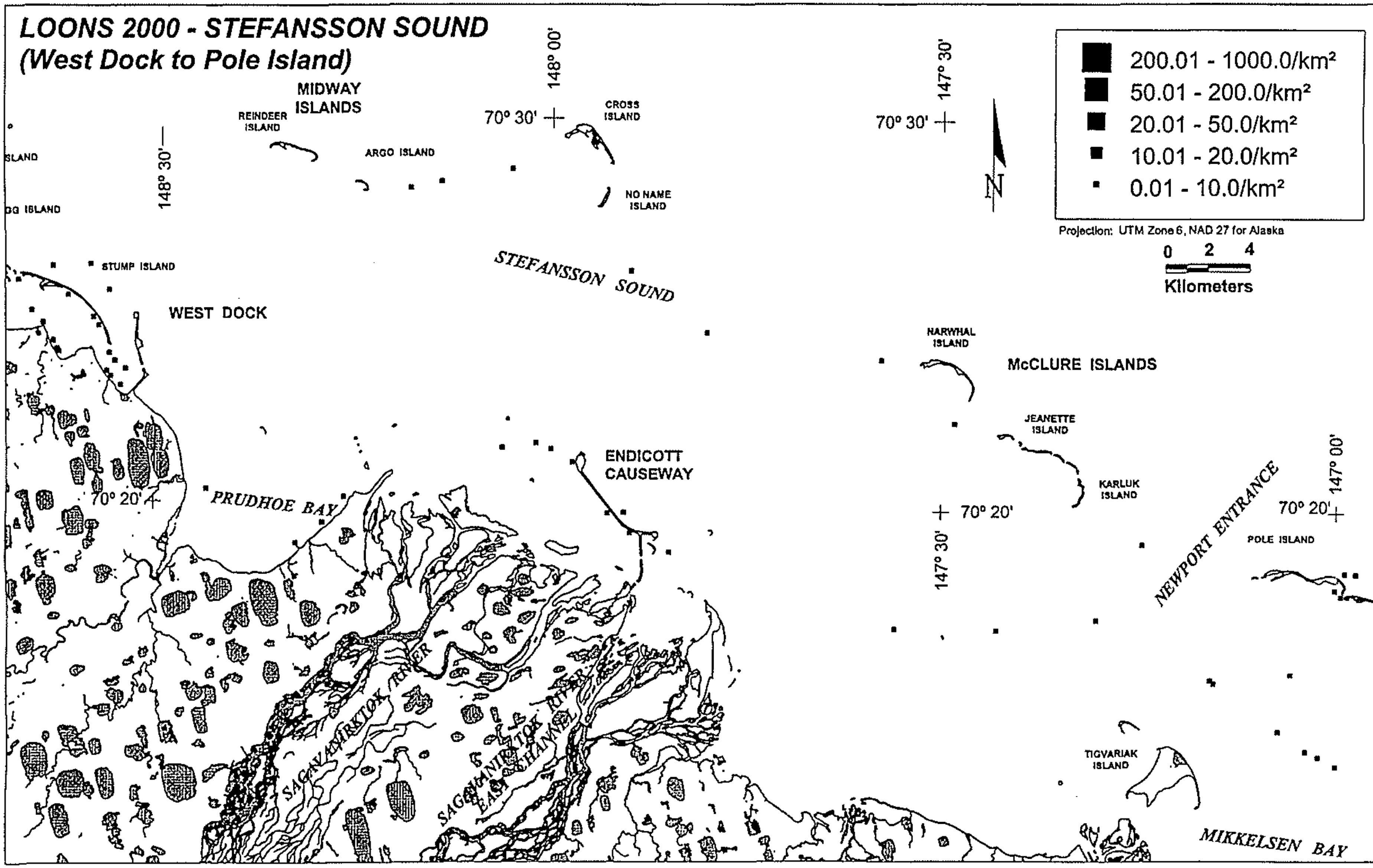


Figure 10. Summary of density for loons by 30-s time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1-24 August 2000.

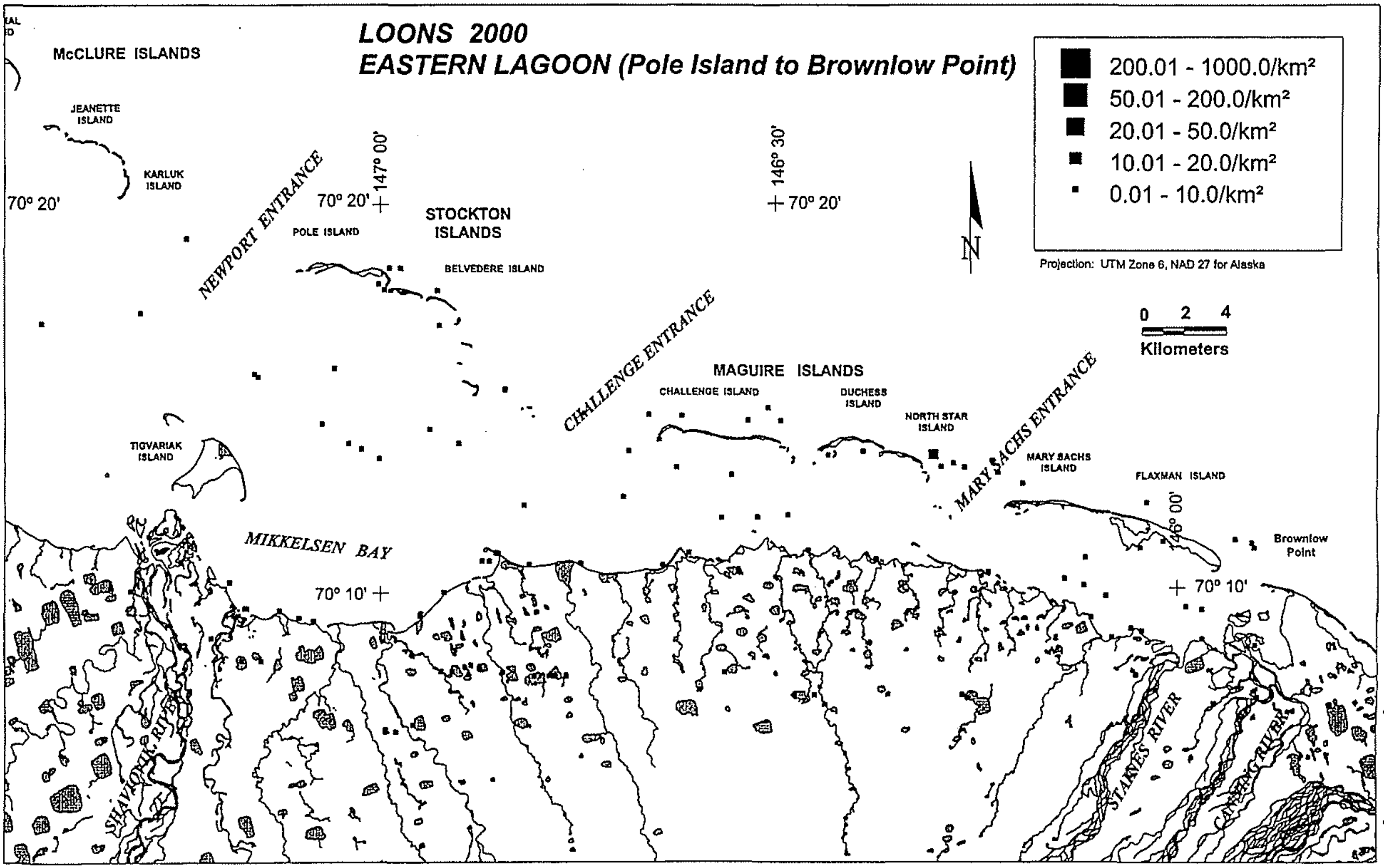


Figure 11. Summary of density for loons by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

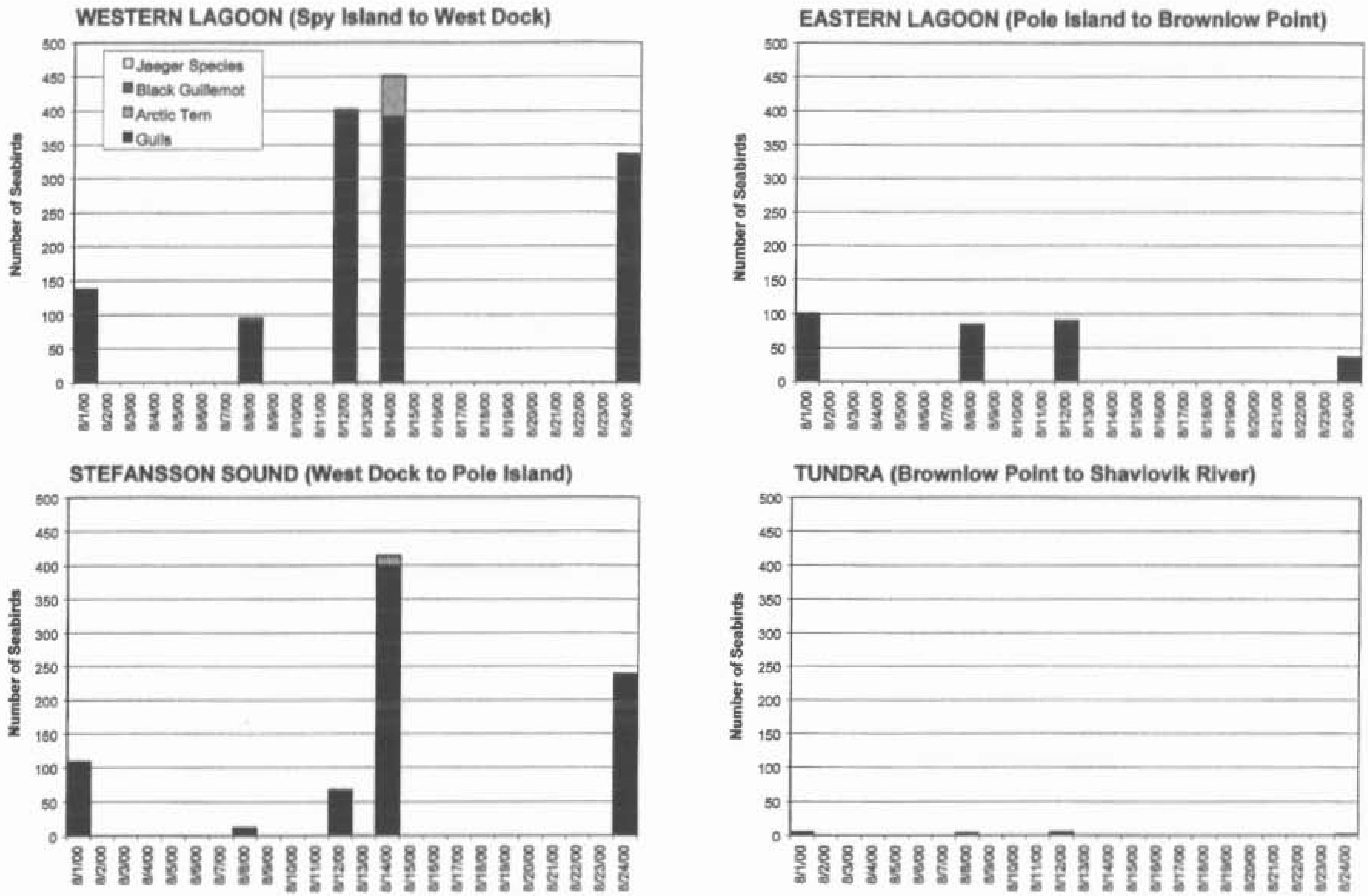


Figure 12. Total number of seabirds on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the western lagoon and Stefansson Sound areas only.

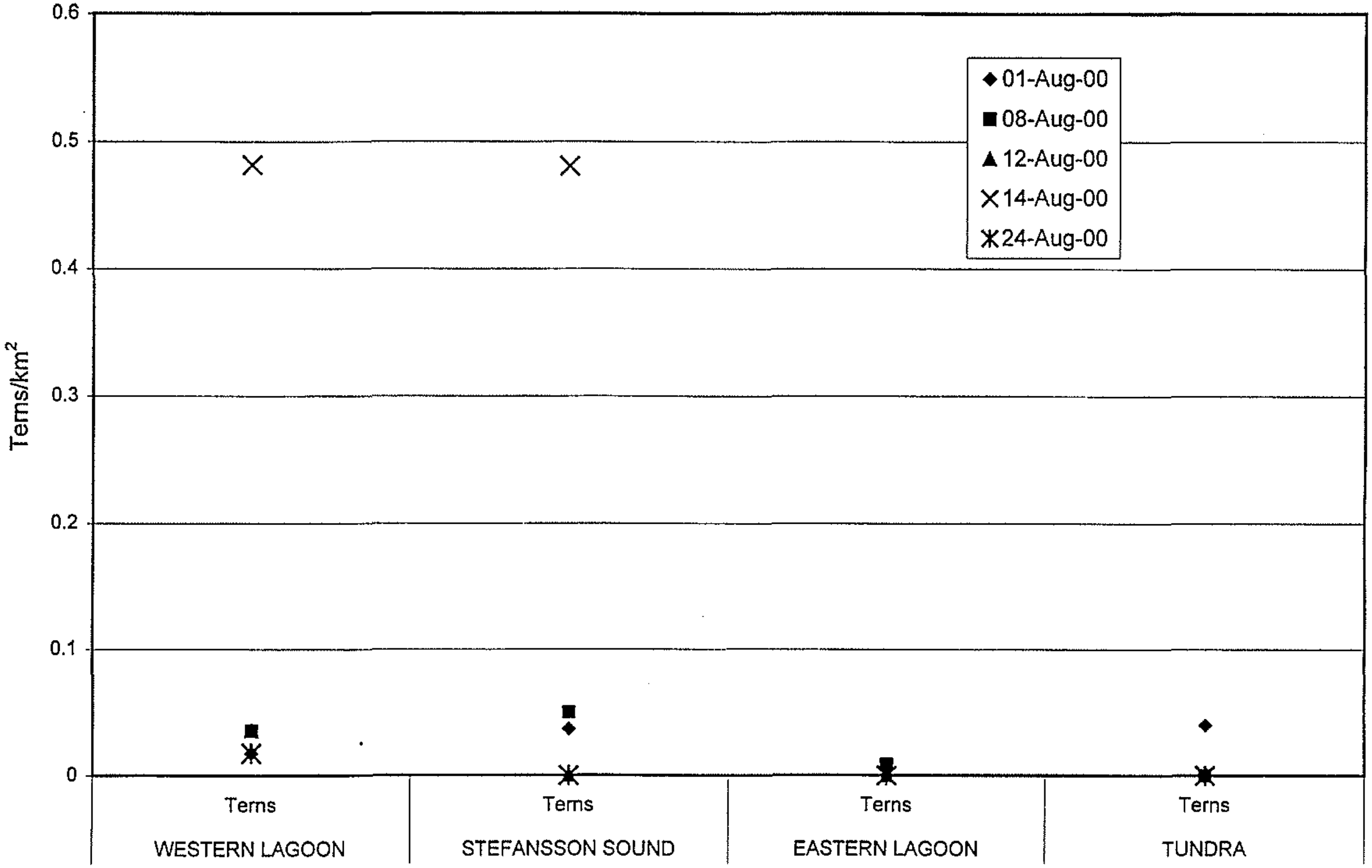


Figure 13. Areal density of terns for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon or tundra on 14 August 2000.

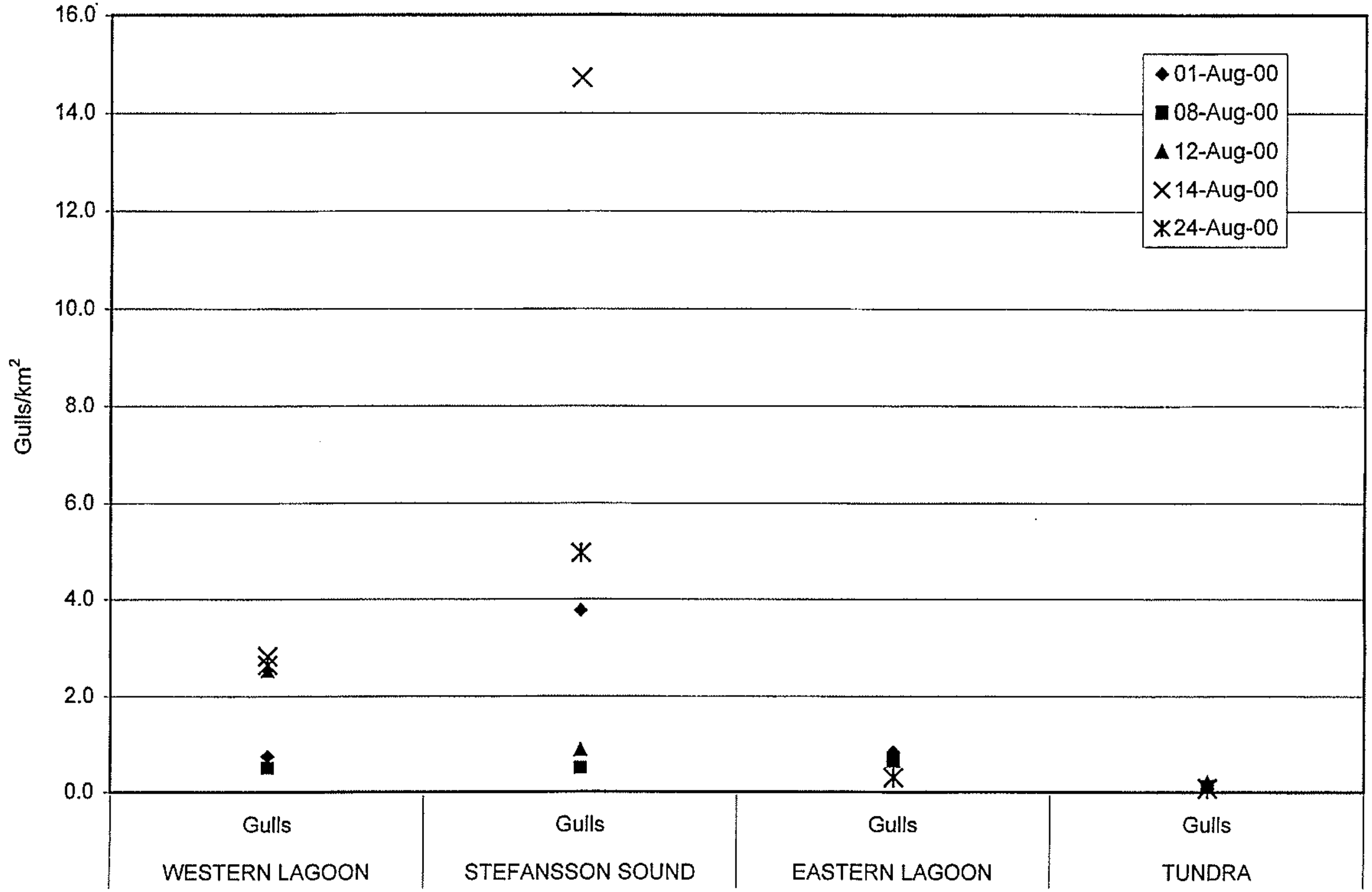


Figure 14. Areal density of gulls for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon or tundra on 14 August 2000.

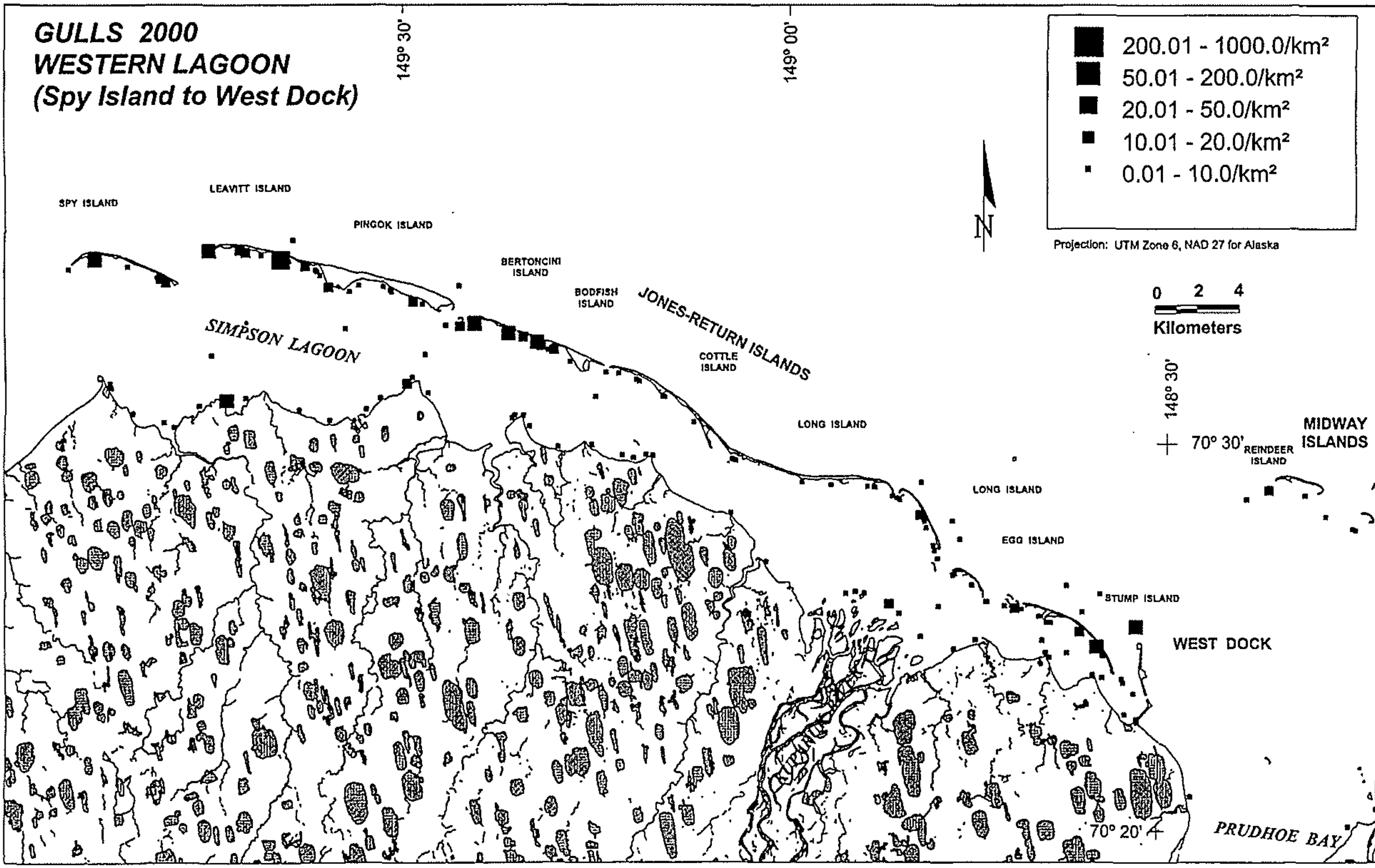


Figure 15. Summary of density for gulls by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

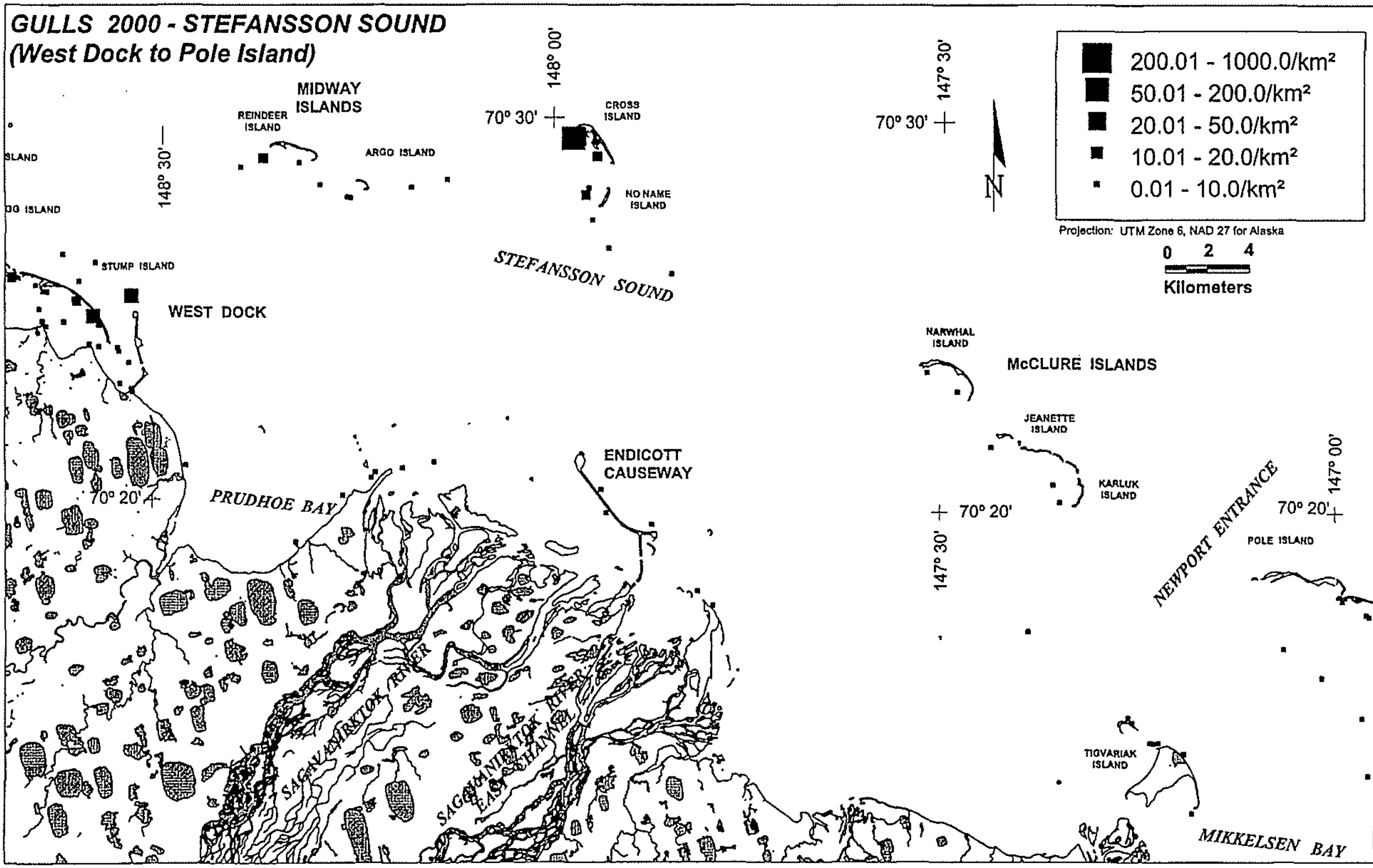


Figure 16. Summary of density for gulls by 30-s time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1-24 August 2000.

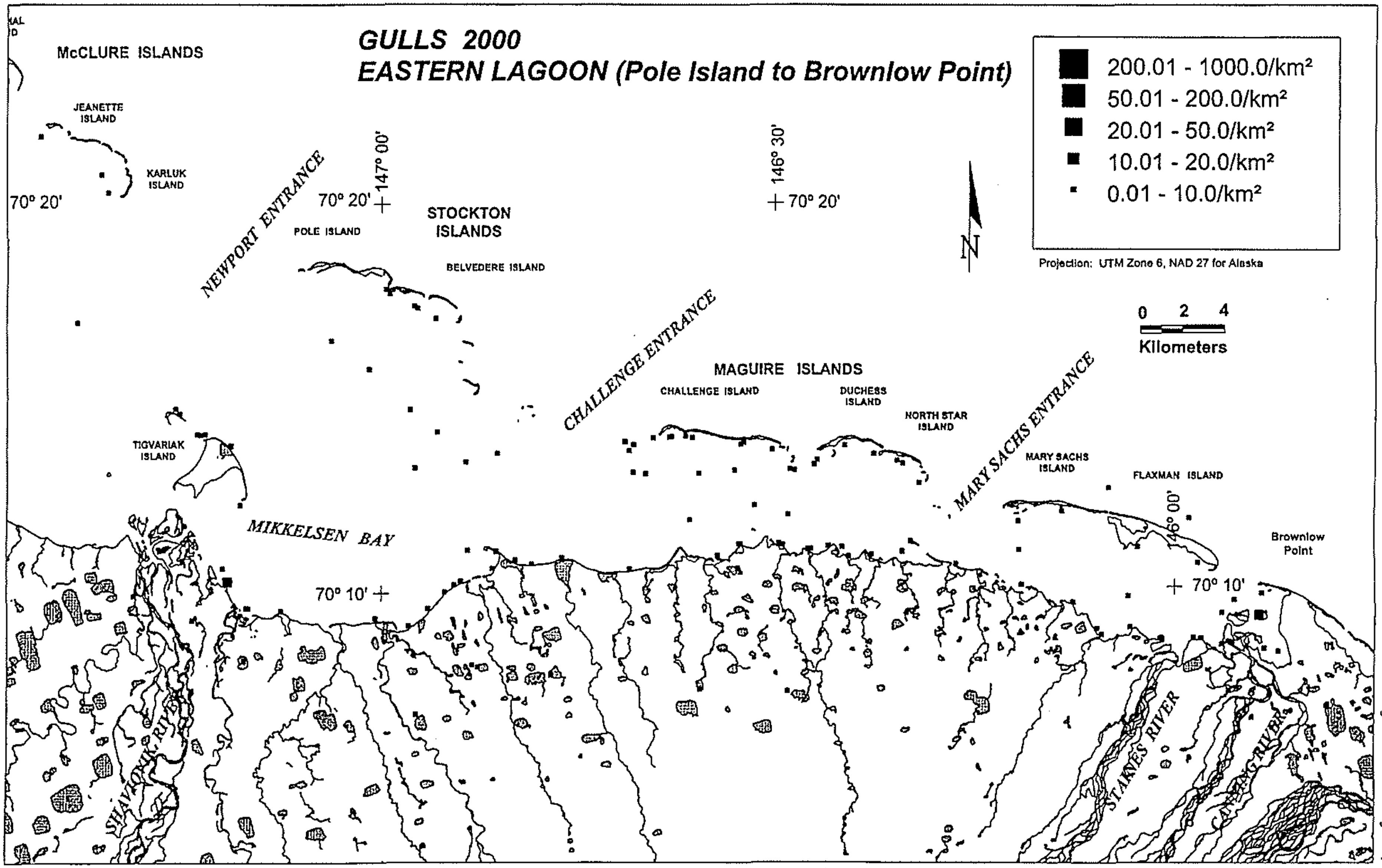


Figure 17. Summary of density for gulls by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

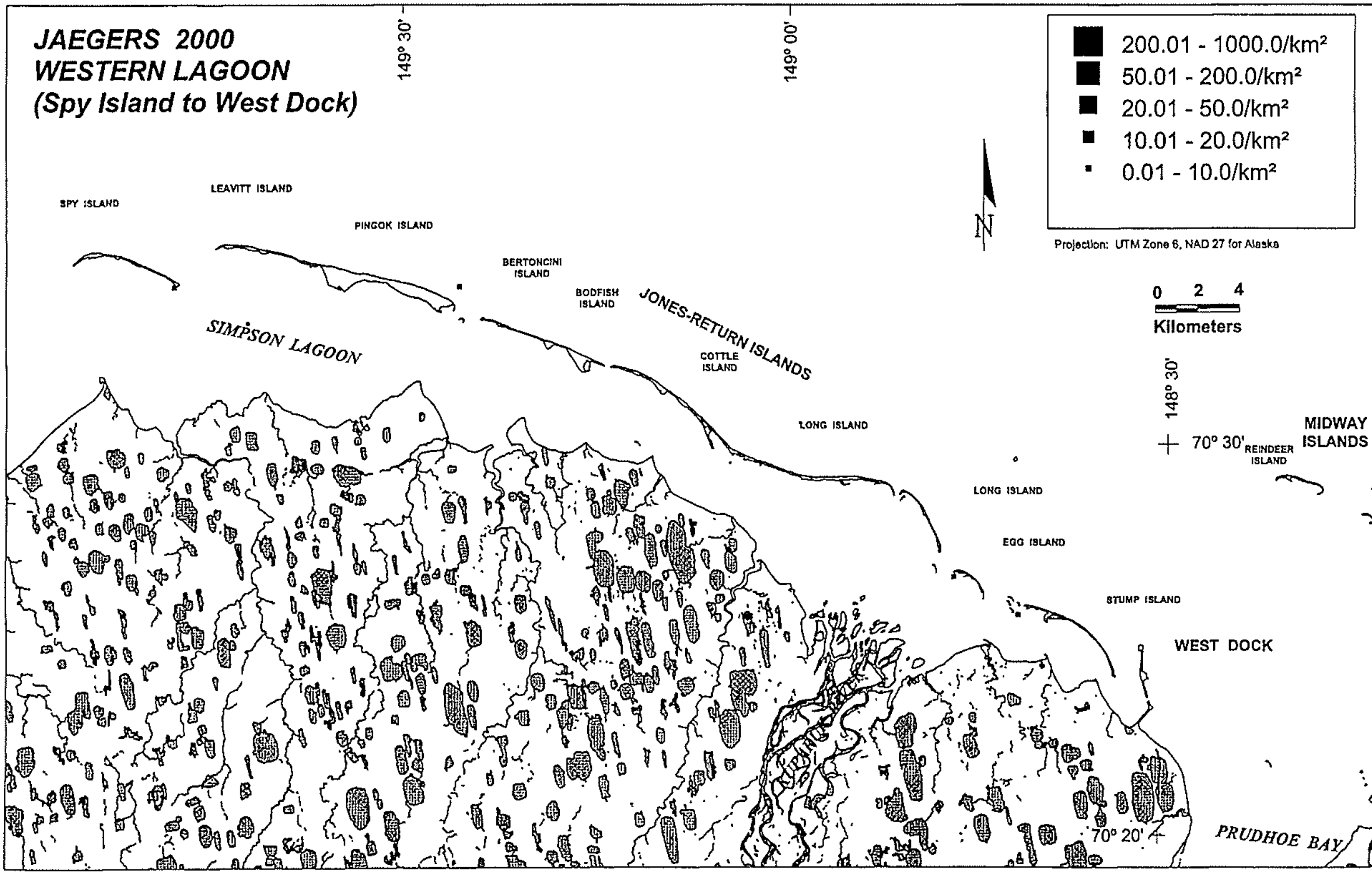


Figure 18. Summary of density for jaegers by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

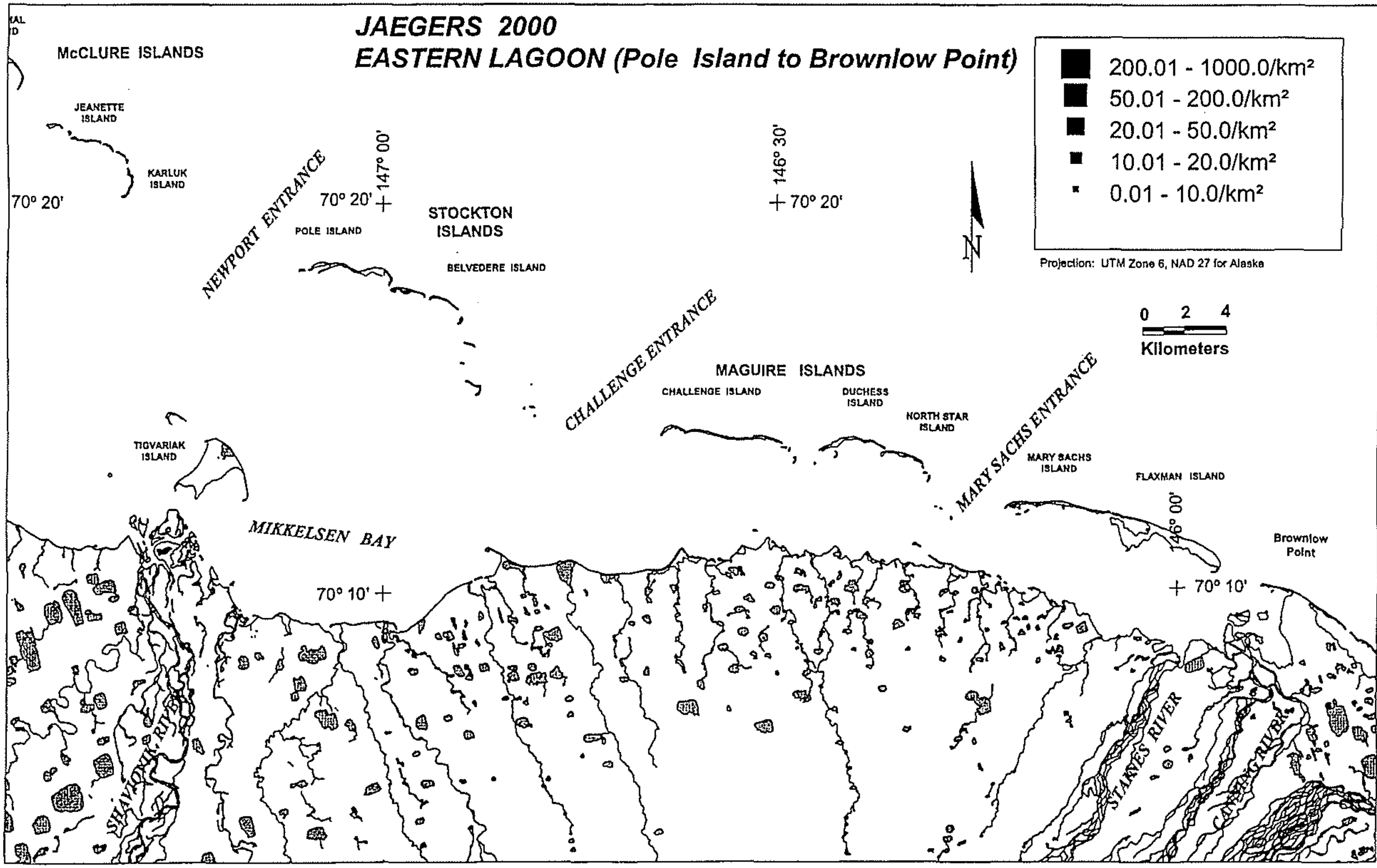


Figure 19. Summary of density for jaegers by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

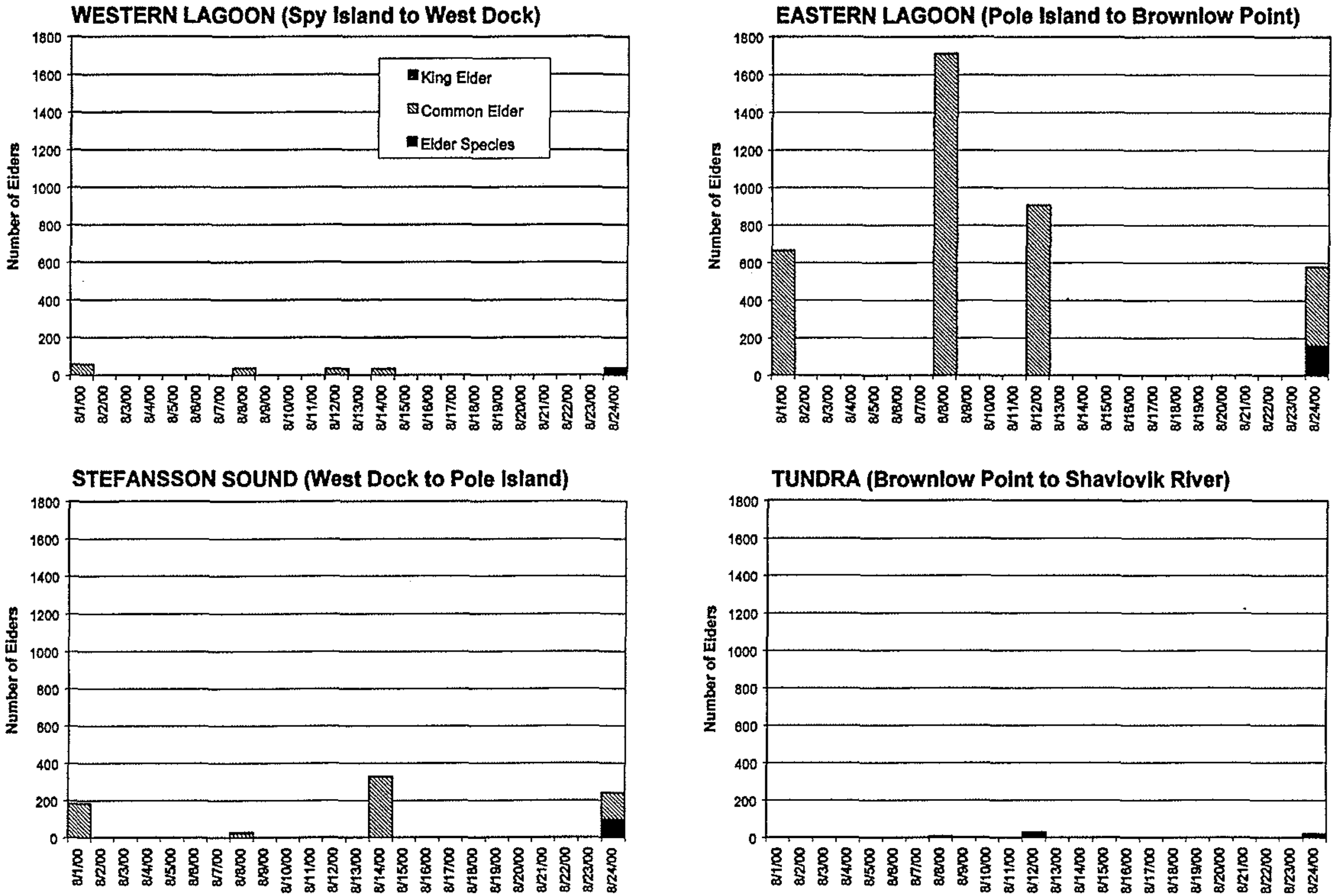


Figure 20. Total number of eiders on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the western lagoon and Stefansson Sound areas only.

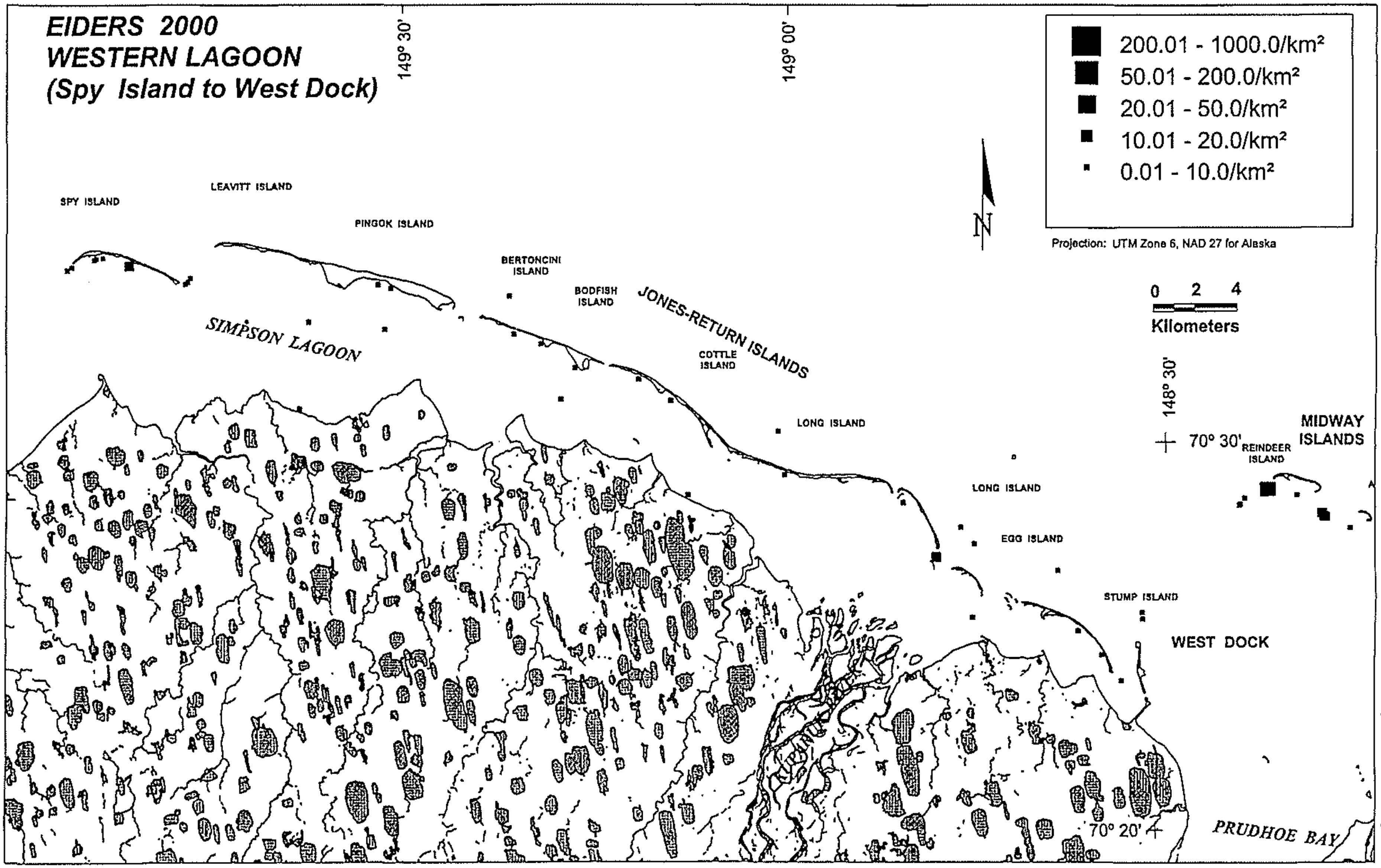


Figure 21. Summary of density for eiders by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

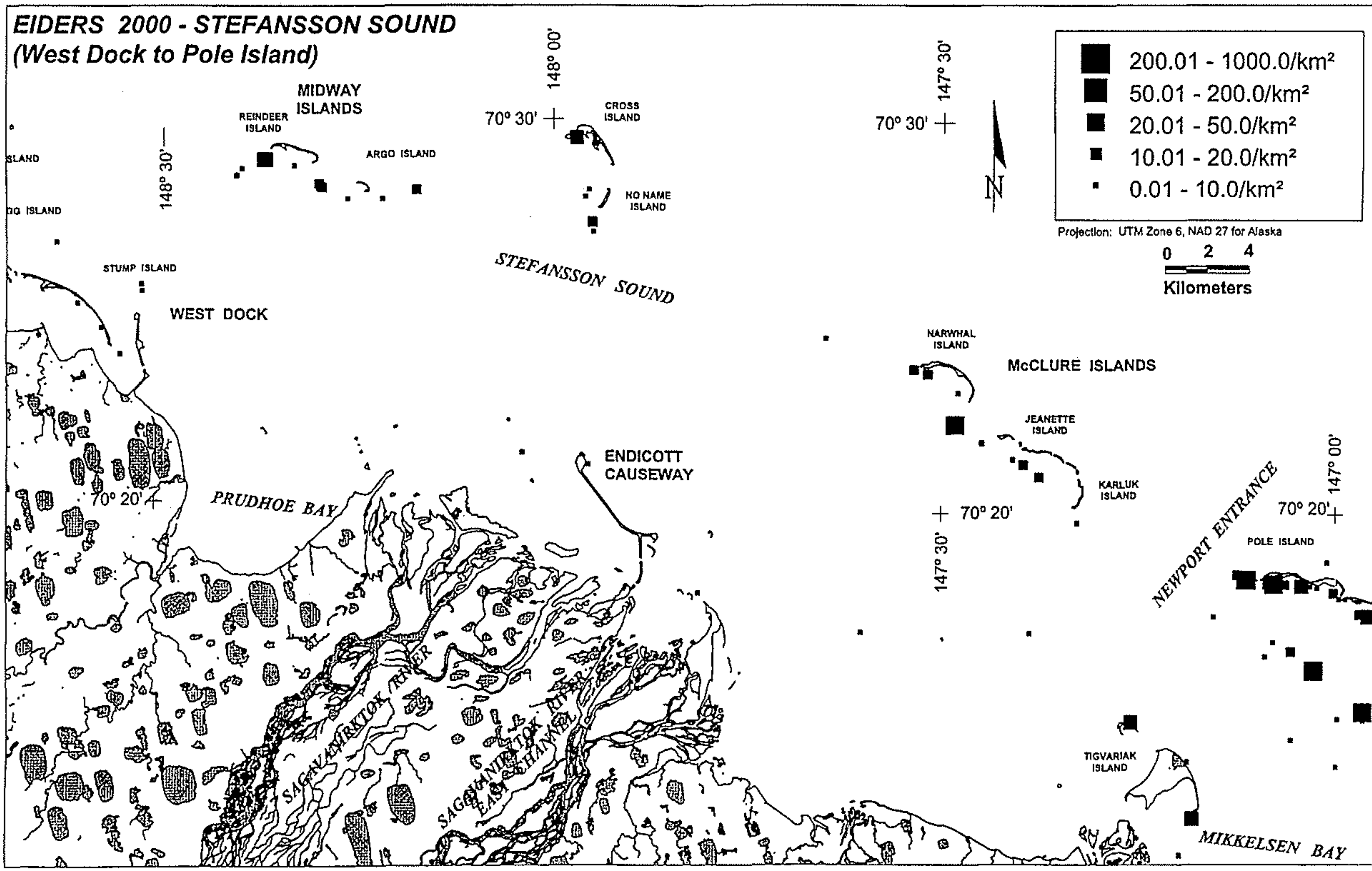


Figure 22. Summary of density for eiders by 30-s time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1-24 August 2000.

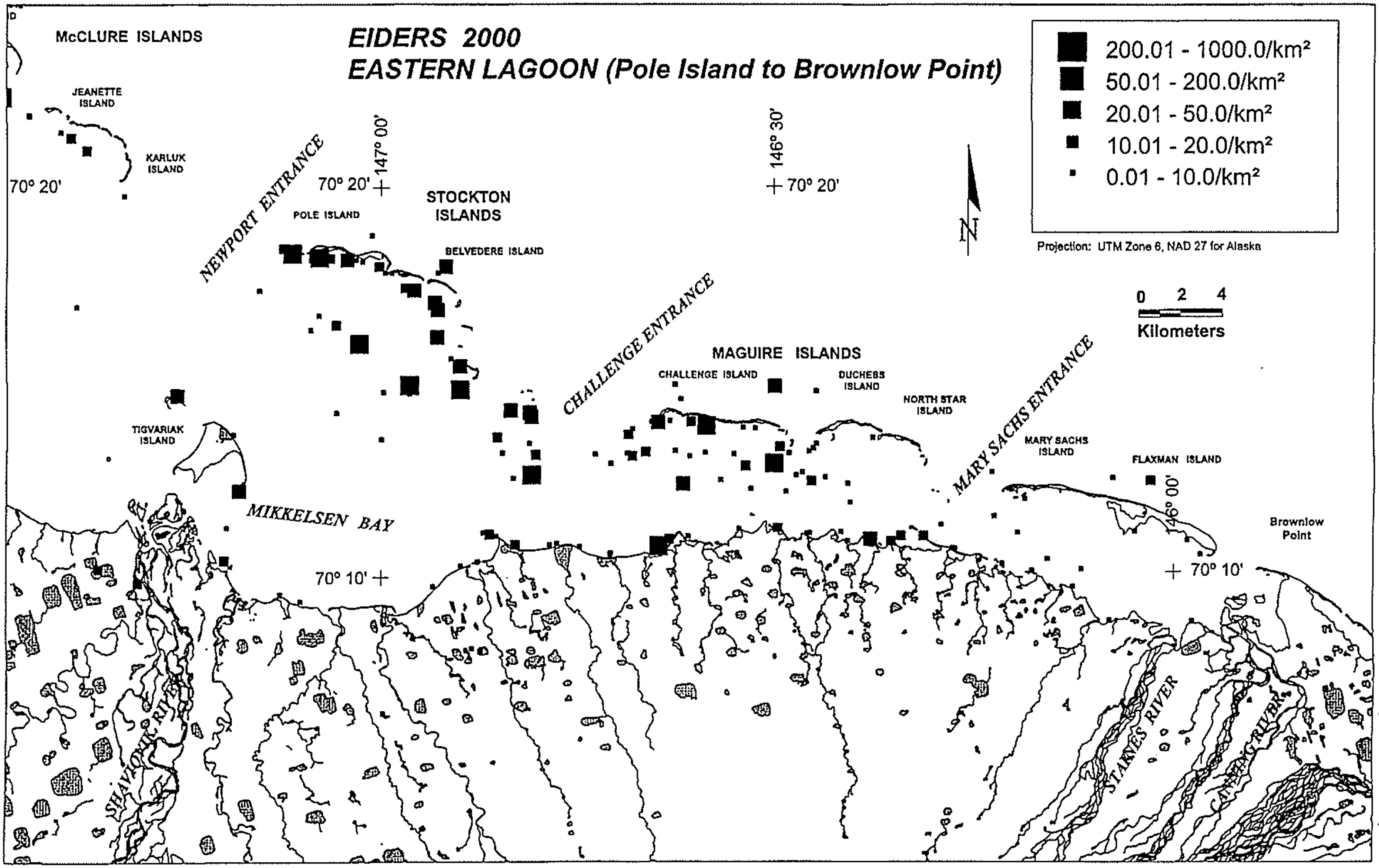


Figure 23. Summary of density for eiders by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

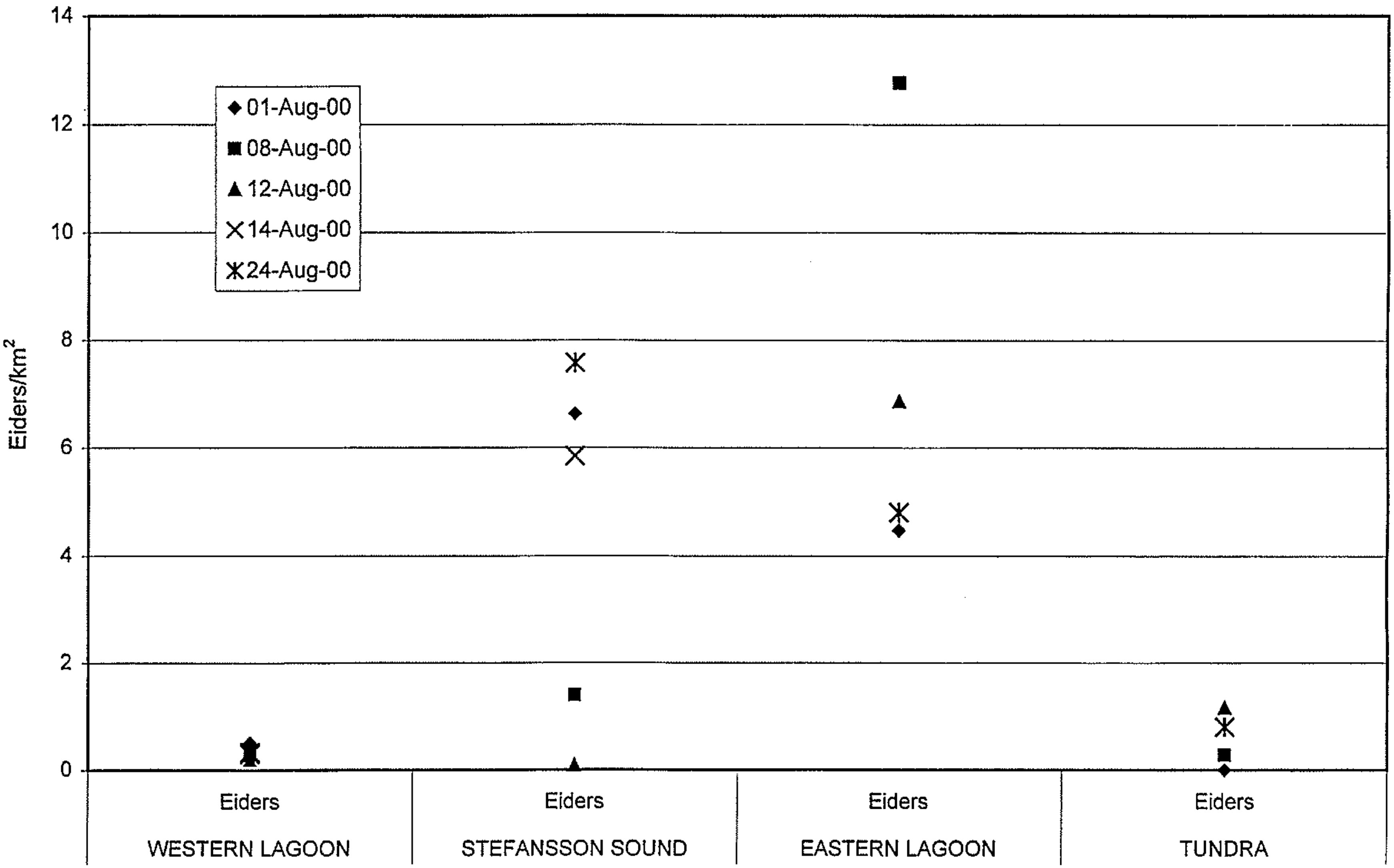
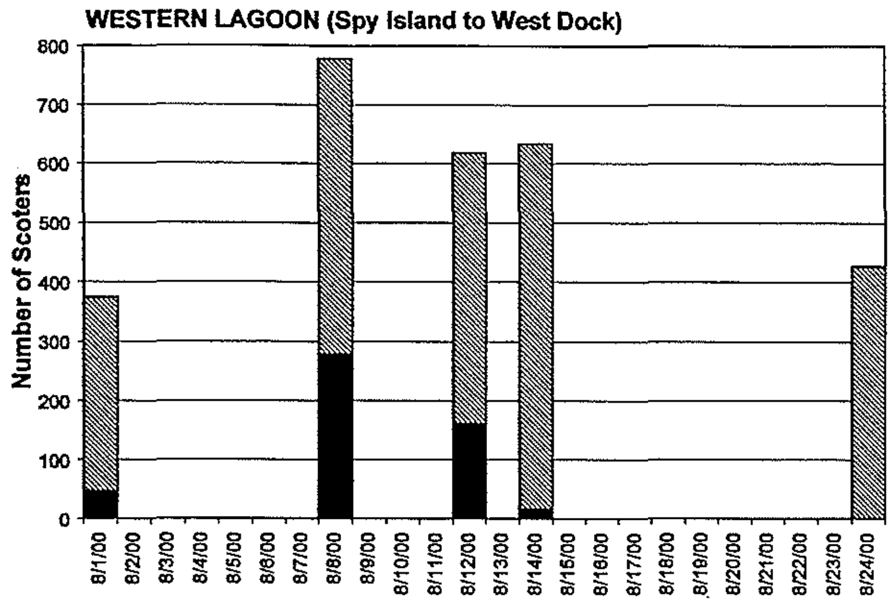


Figure 24. Areal density of eiders for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon or tundra on 14 August 2000.



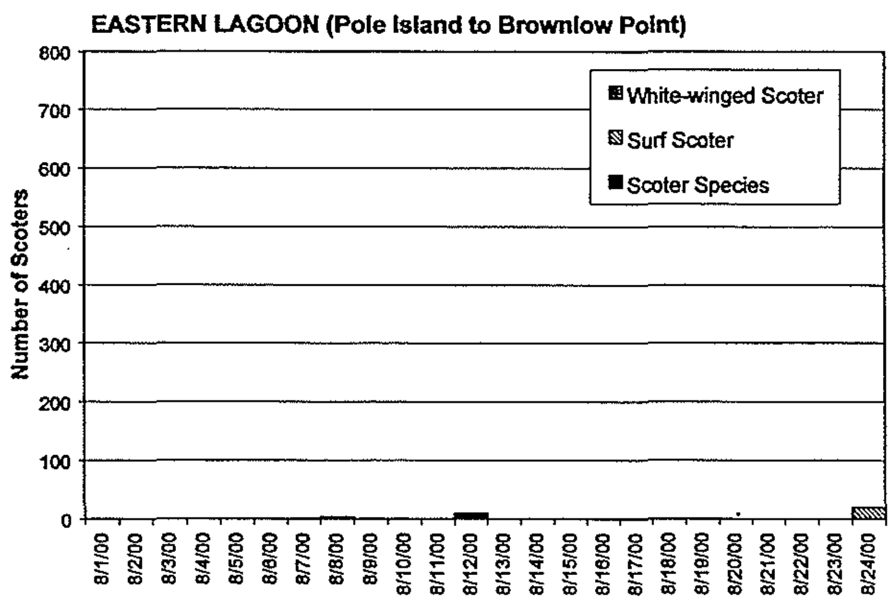


Figure 25. Total number of scoters on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the Western Lagoon and Stefansson Sound areas only.

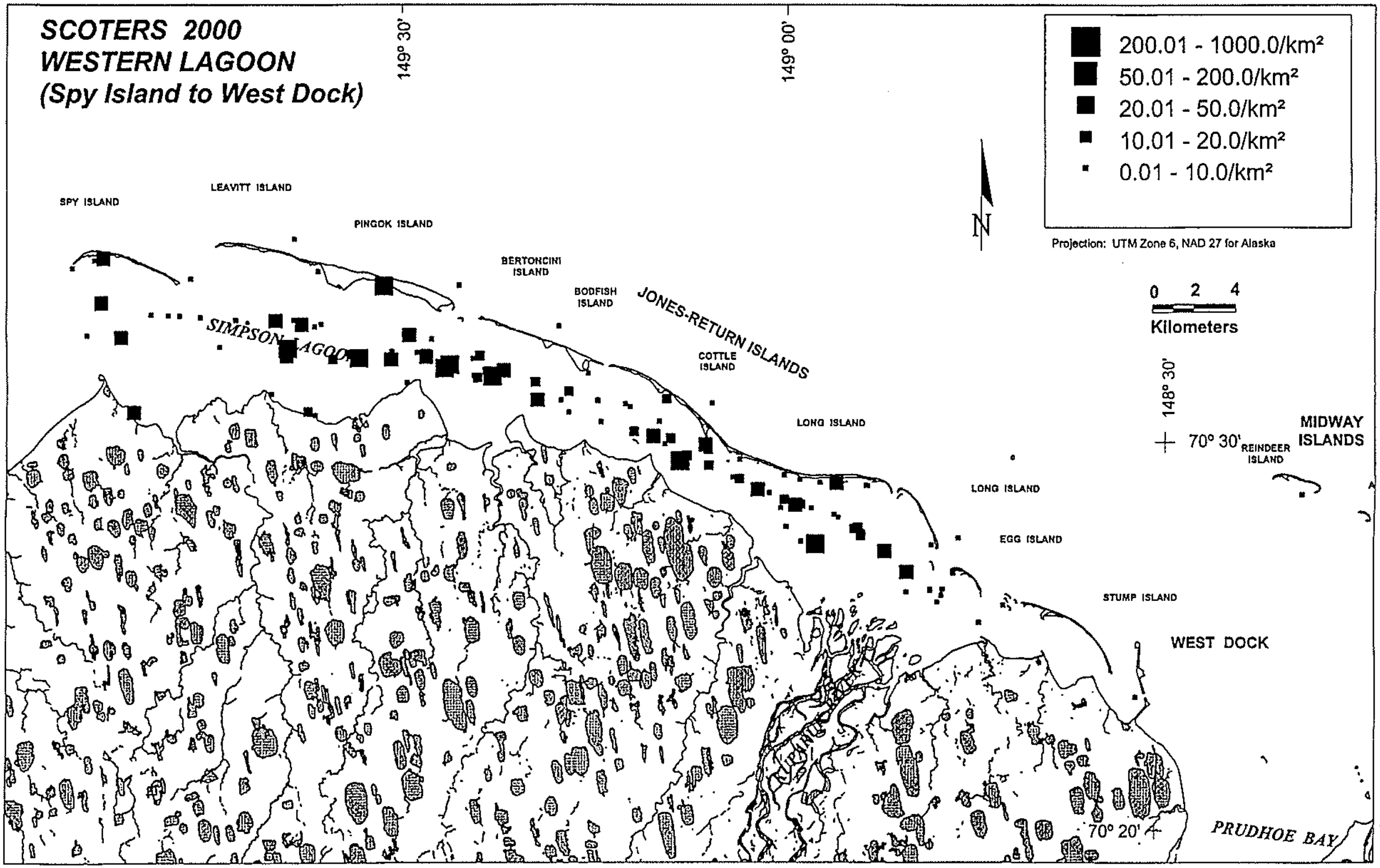


Figure 26. Summary of density for scoters by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

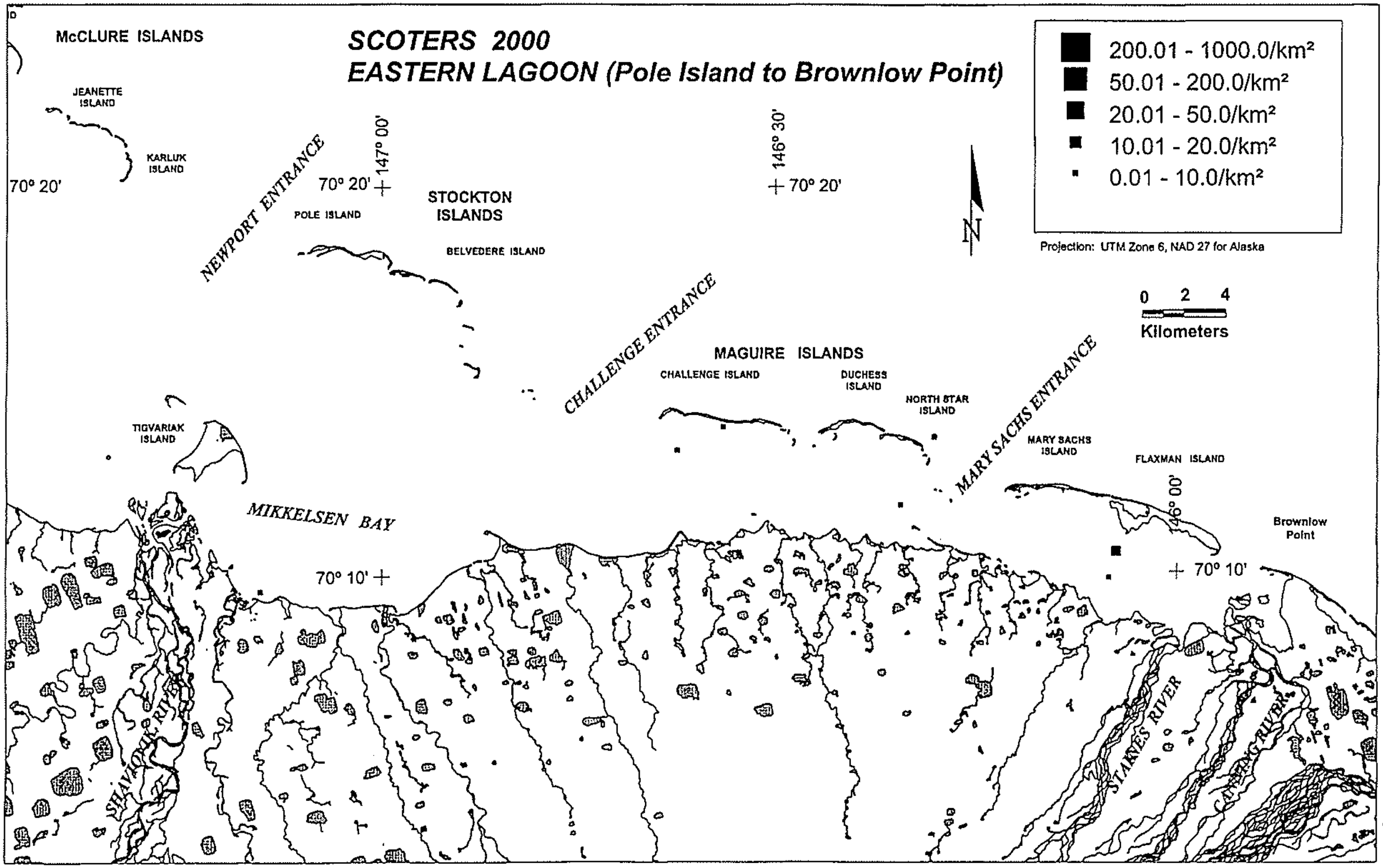


Figure 27. Summary of density for scoters by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

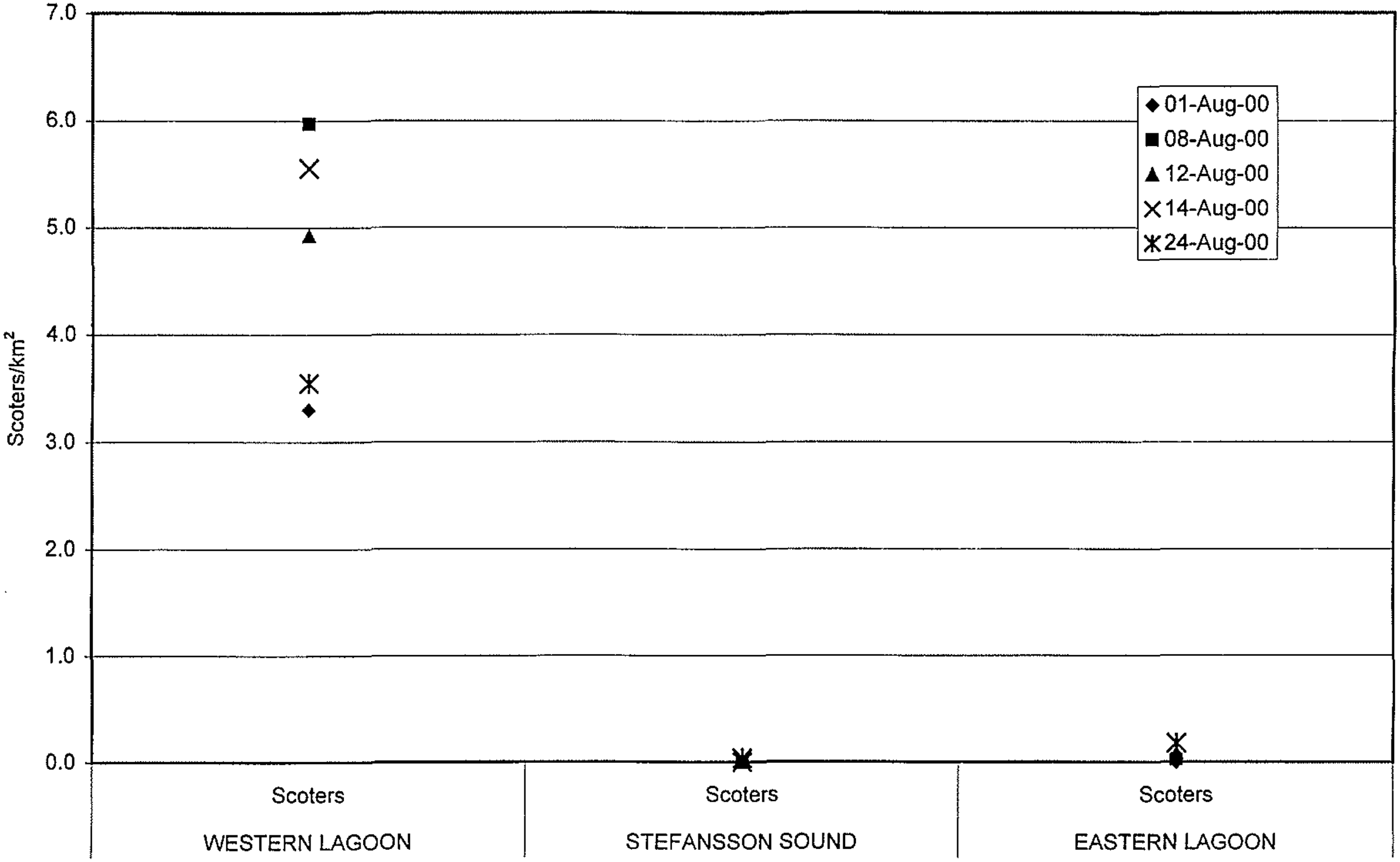


Figure 28. Areal density of scoters for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon on 14 August 2000.

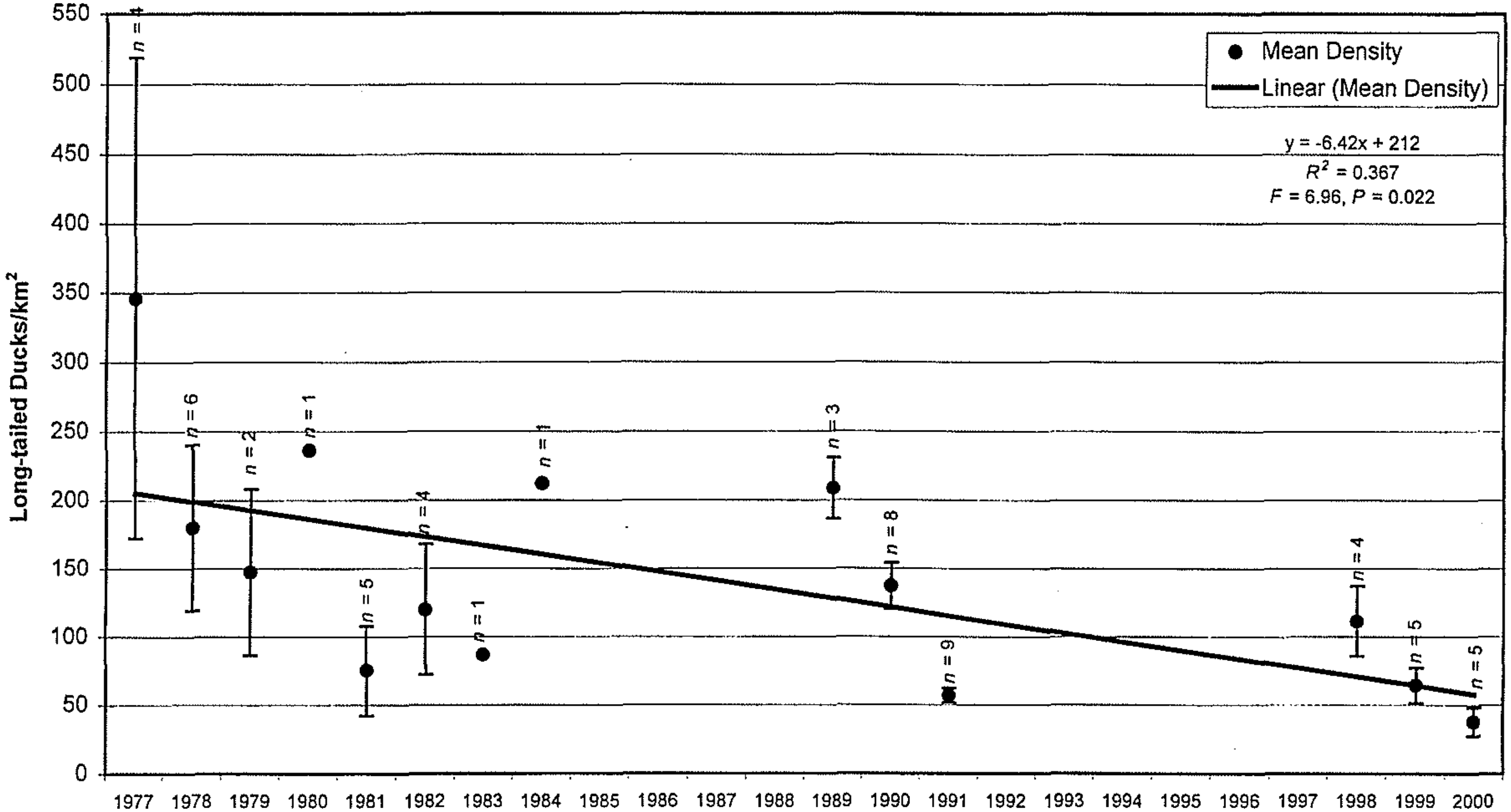


Figure 29. Mean areal long-tailed duck density with standard error by year for aerial surveys in the lagoon systems between Spy Island and Brownlow Point, Alaska, during July and August 1977-2000 (Table A2). Number of surveys is noted above bars. Data includes the western lagoon from Spy Island to West Dock, and the eastern lagoon from Pole Island to Brownlow Point, Alaska. Some surveys did not include all transects.

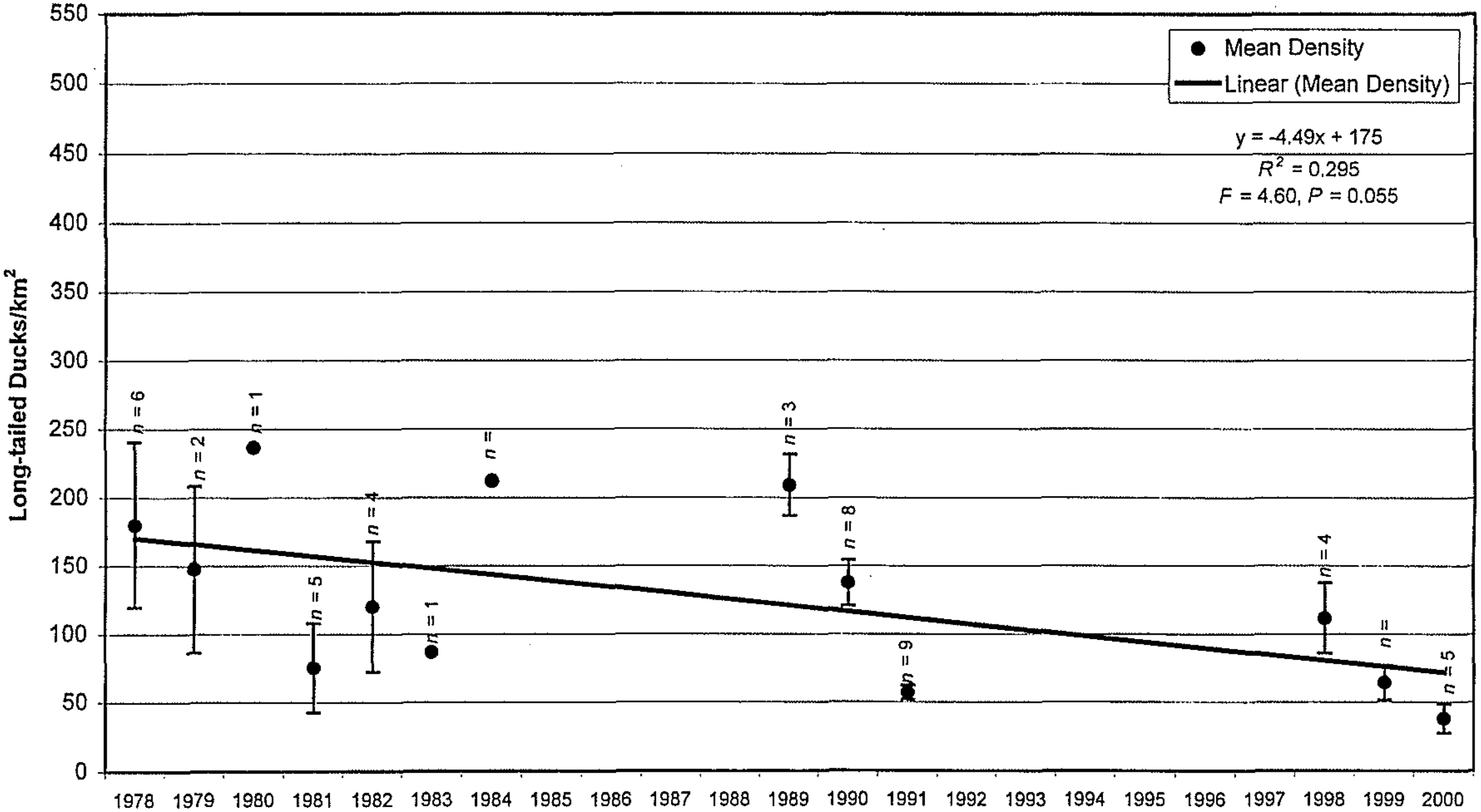


Figure 30. Mean areal long-tailed duck density with standard error by year for aerial surveys in the lagoon systems between Spy Island and Brownlow Point, Alaska, during July and August 1978-2000 (Table A2). Number of surveys is noted above bars. Data includes the western lagoon from Spy Island to West Dock, and the eastern lagoon from Pole Island to Brownlow Point, Alaska. Some surveys did not include all transects.

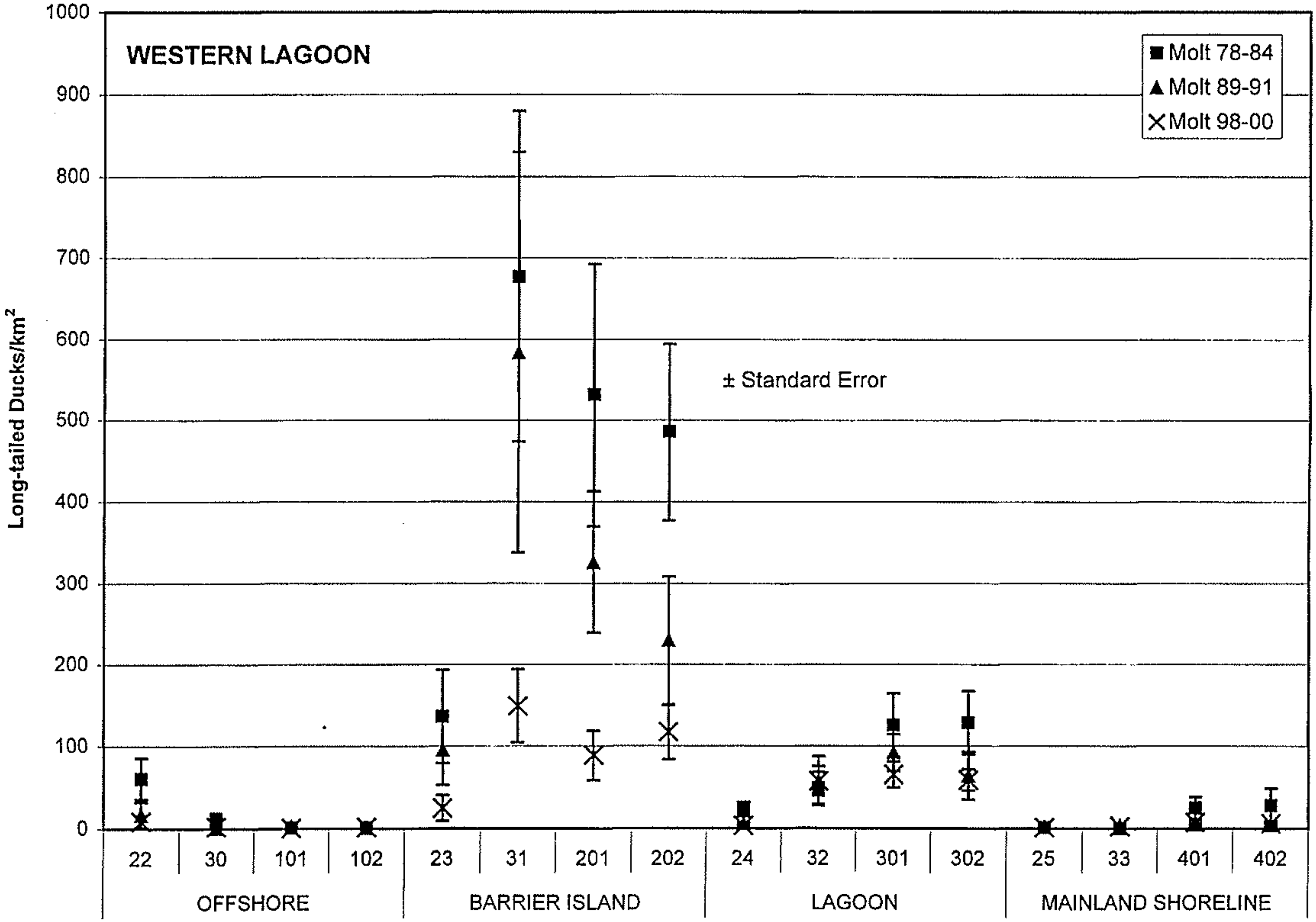


Figure 31. Mean areal long-tailed duck density with standard error by transect for aerial surveys between Spy Island and West Dock, Alaska, during male long-tailed duck molt period from 28 July to 19 August 1978-1984, 1989-1991, and 1998-2000 (Table A2).

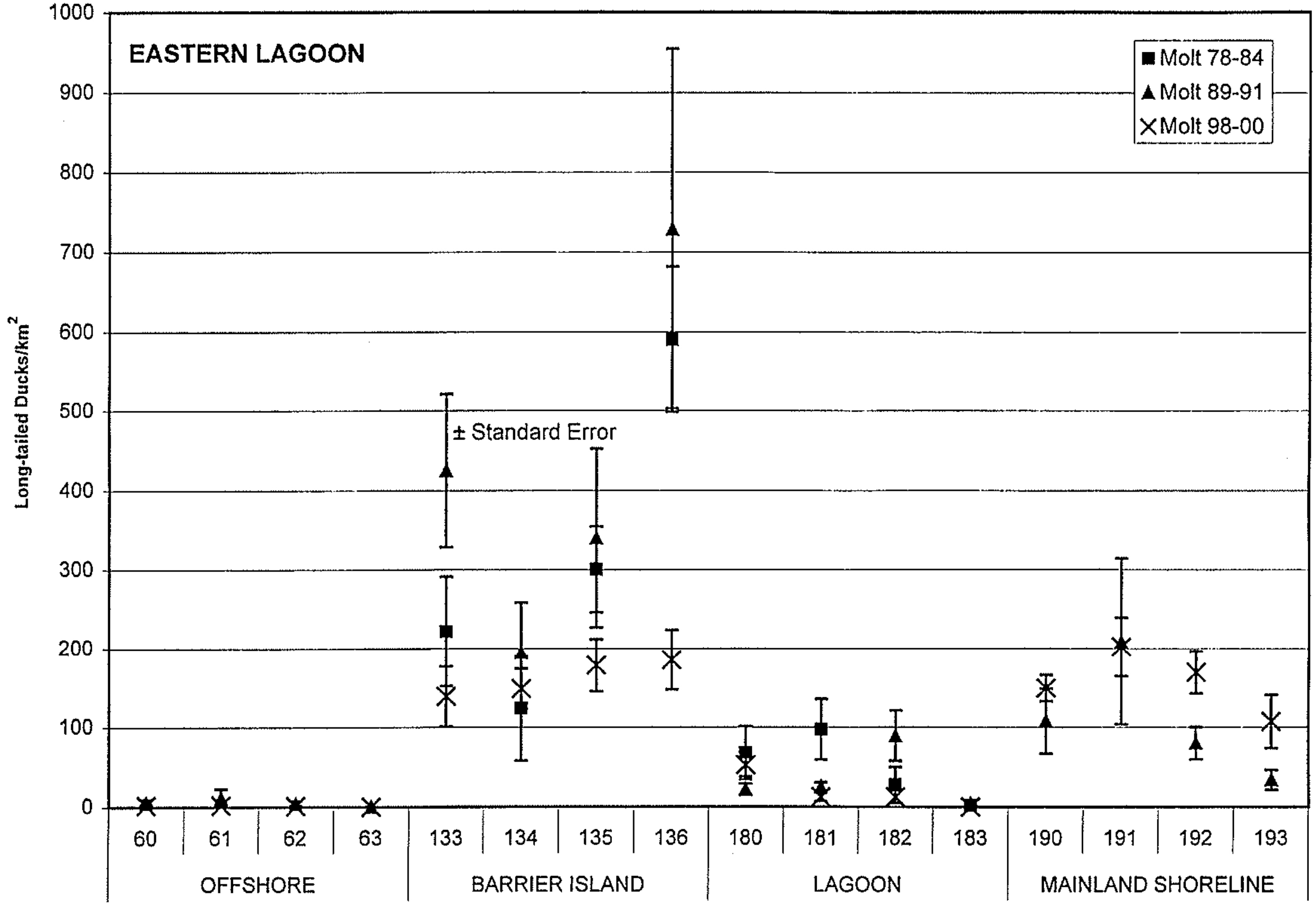


Figure 32. Mean areal long-tailed duck density with standard error by transect for aerial surveys between Pole Island and Brownlow Point, Alaska, during male long-tailed duck molt period from 28 July to 19 August 1978-1984, 1989-1991, and 1998-2000 (Table A2). No offshore or mainland shoreline transects were flown during 1978-1984.

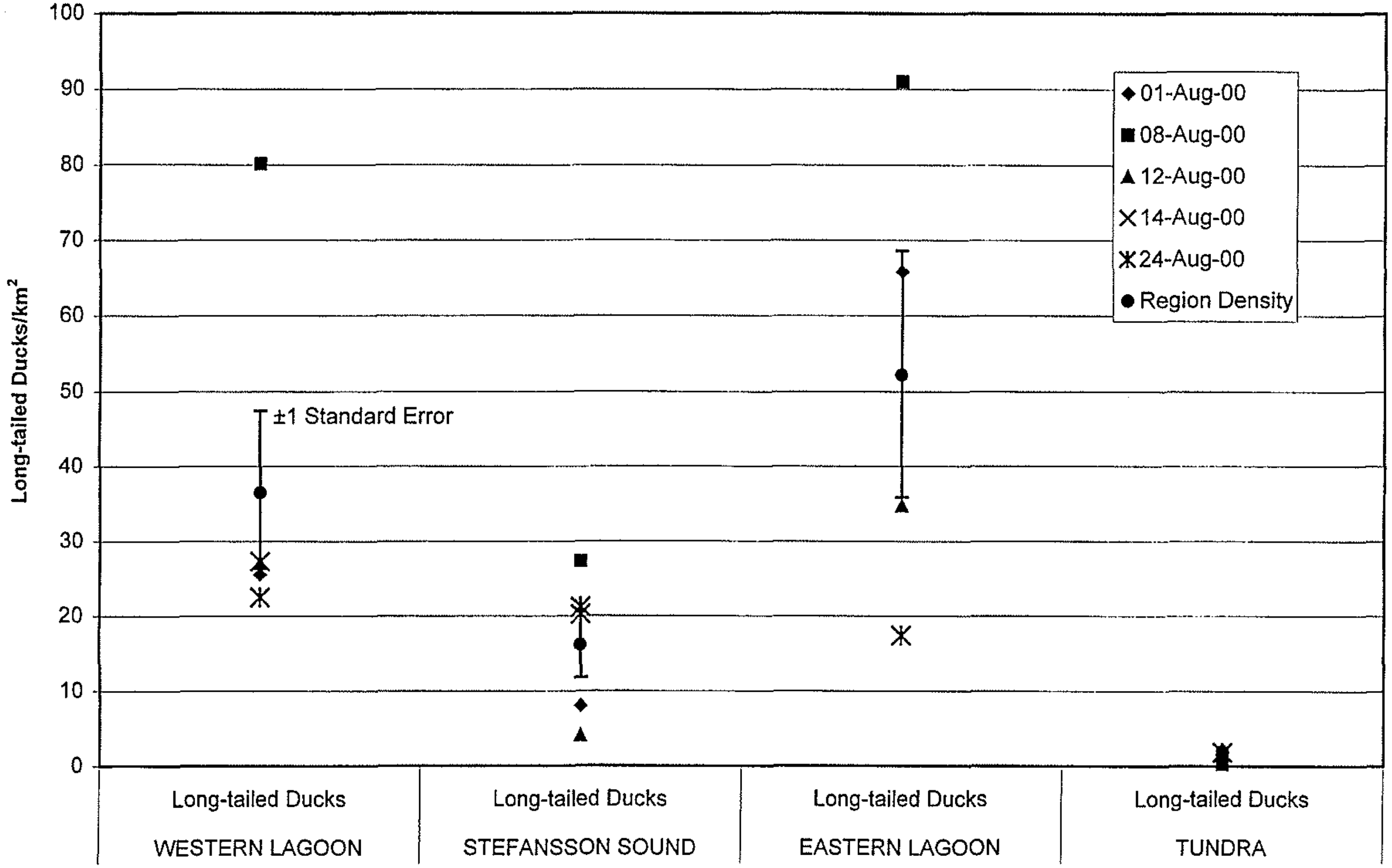


Figure 33. Areal density of long-tailed ducks for 5 aerial surveys during 1-24 August 2000, and mean areal density with standard error for all surveys by region between Spy Island and Brownlow Point, Alaska. On 8 and 12 August 2000 surveys in Stefansson Sound were flown along the mainland shoreline, on 1, 14, and 24 August 2000 surveys in Stefansson Sound were flown along the barrier islands. No survey was flown in the eastern lagoon or tundra on 14 August 2000.

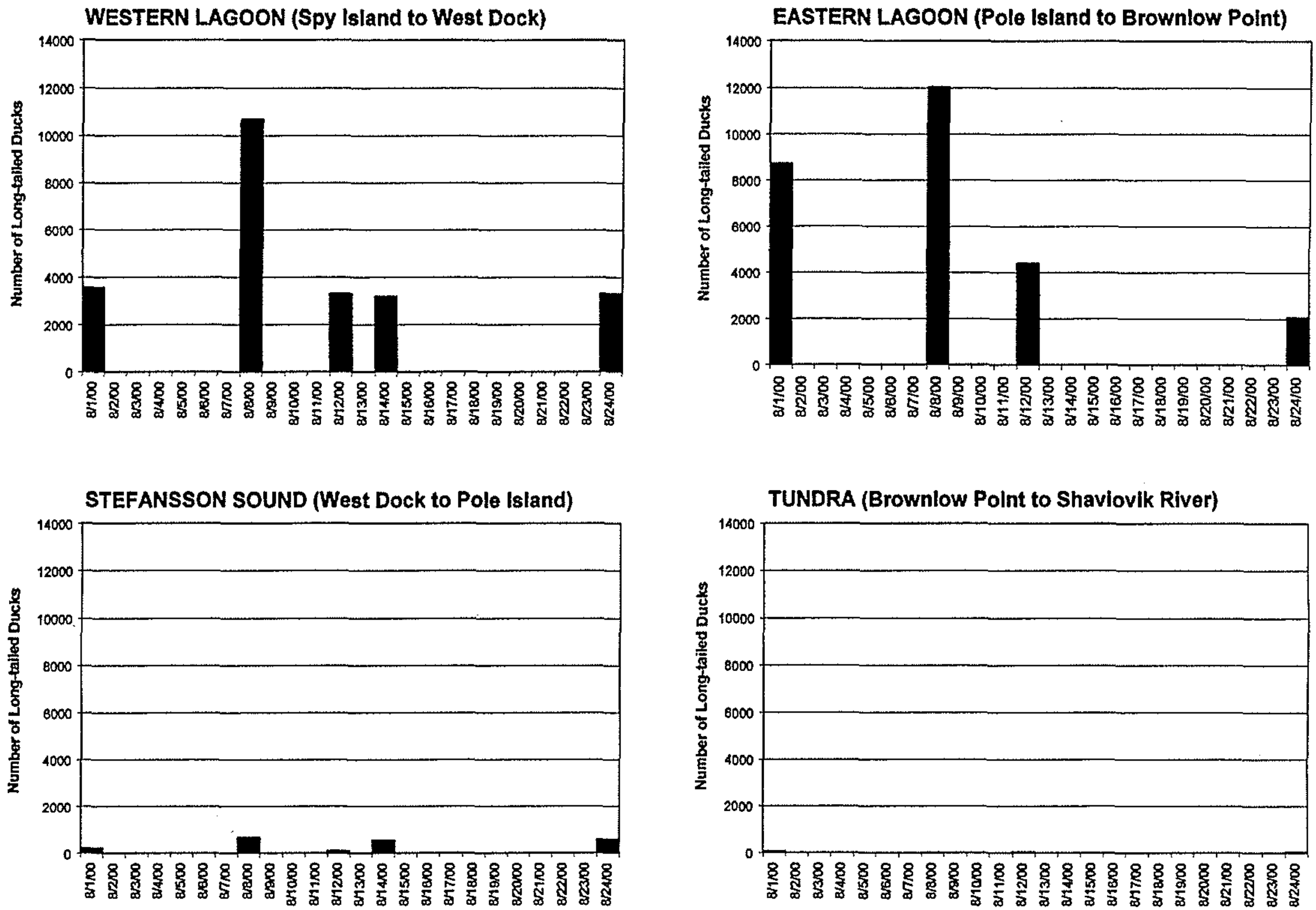


Figure 34. Total number of long-tailed duck on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the western lagoon and Stefansson Sound areas only.

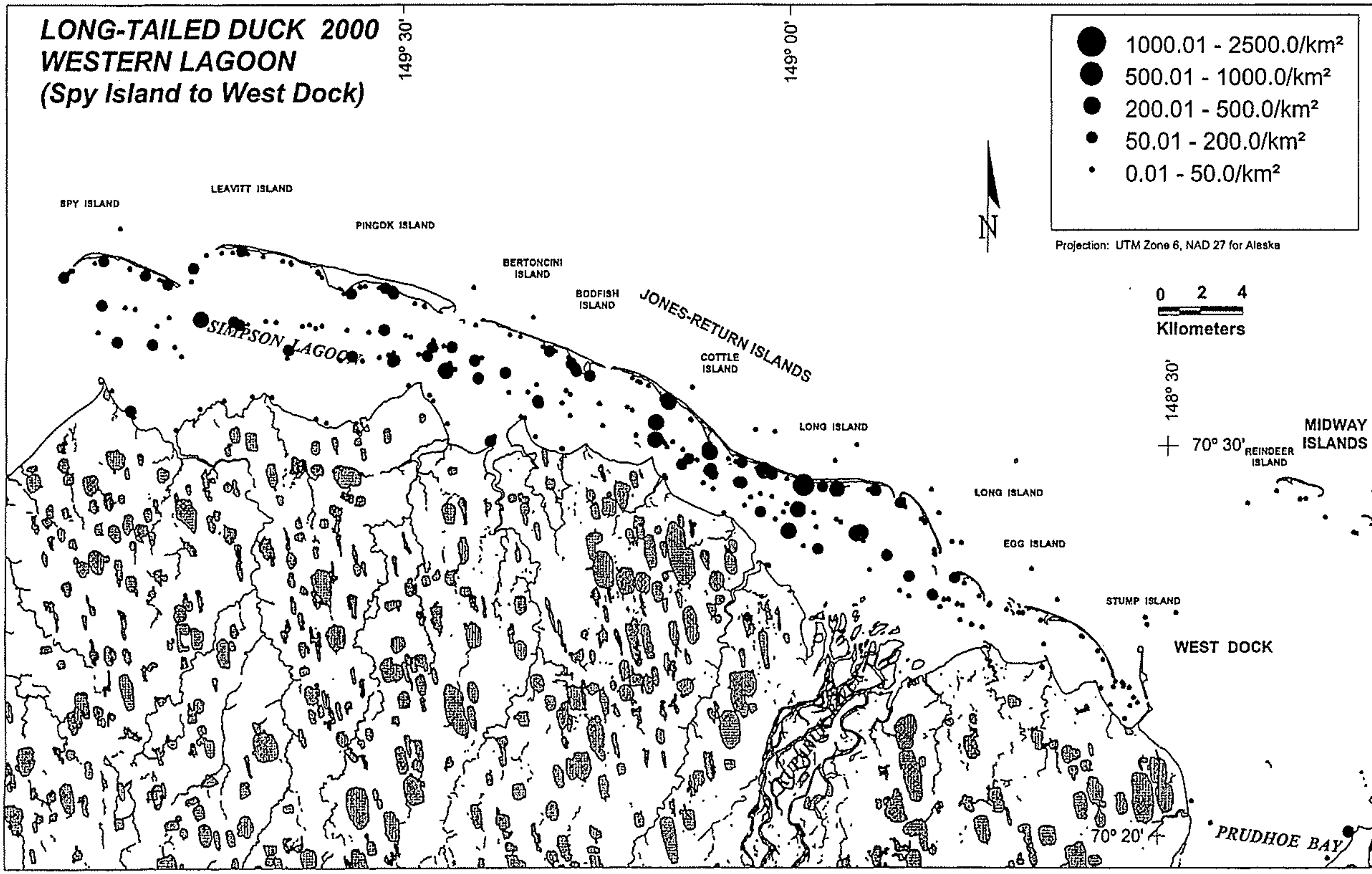


Figure 35. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

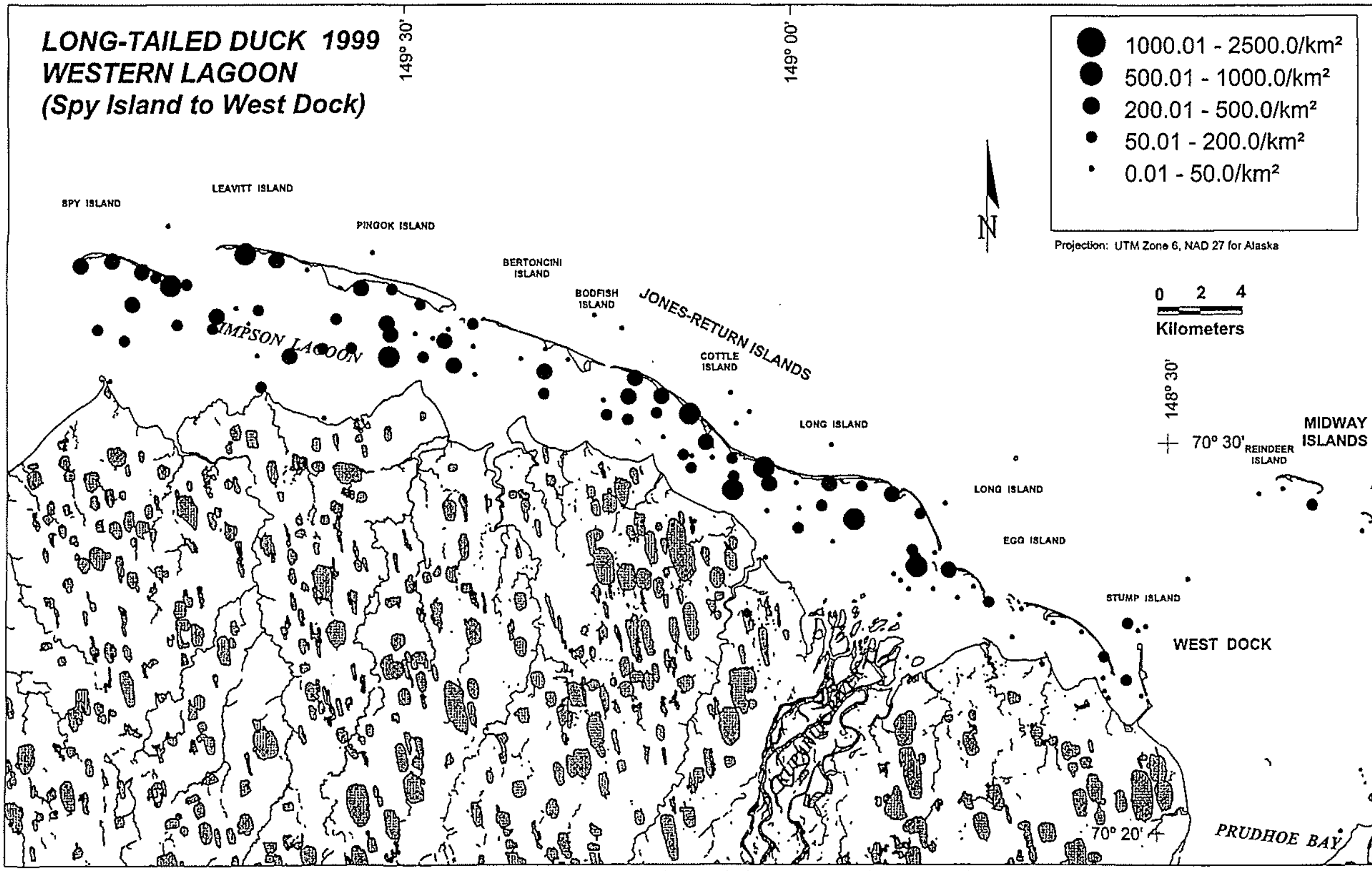


Figure 36. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

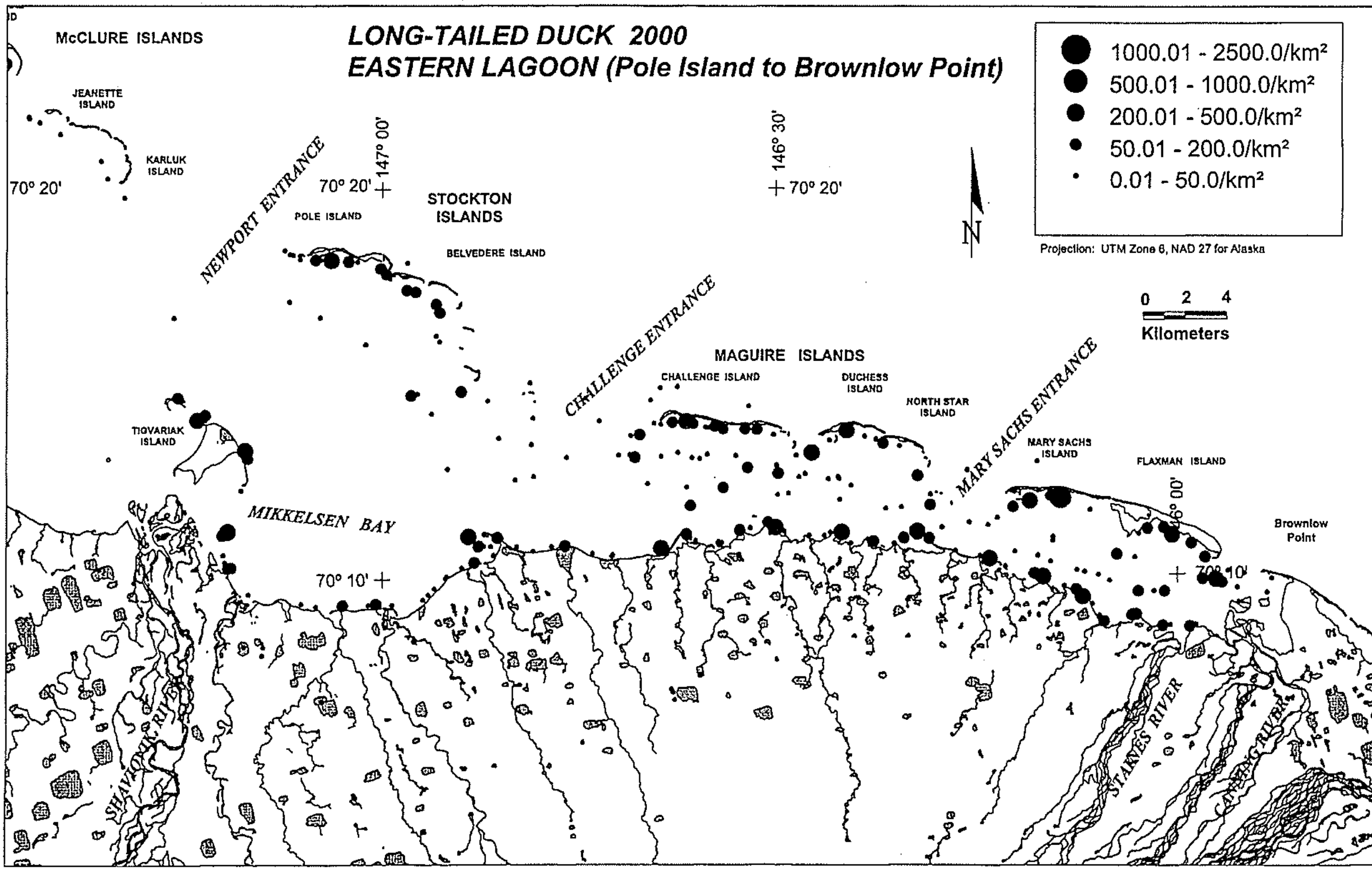


Figure 37. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

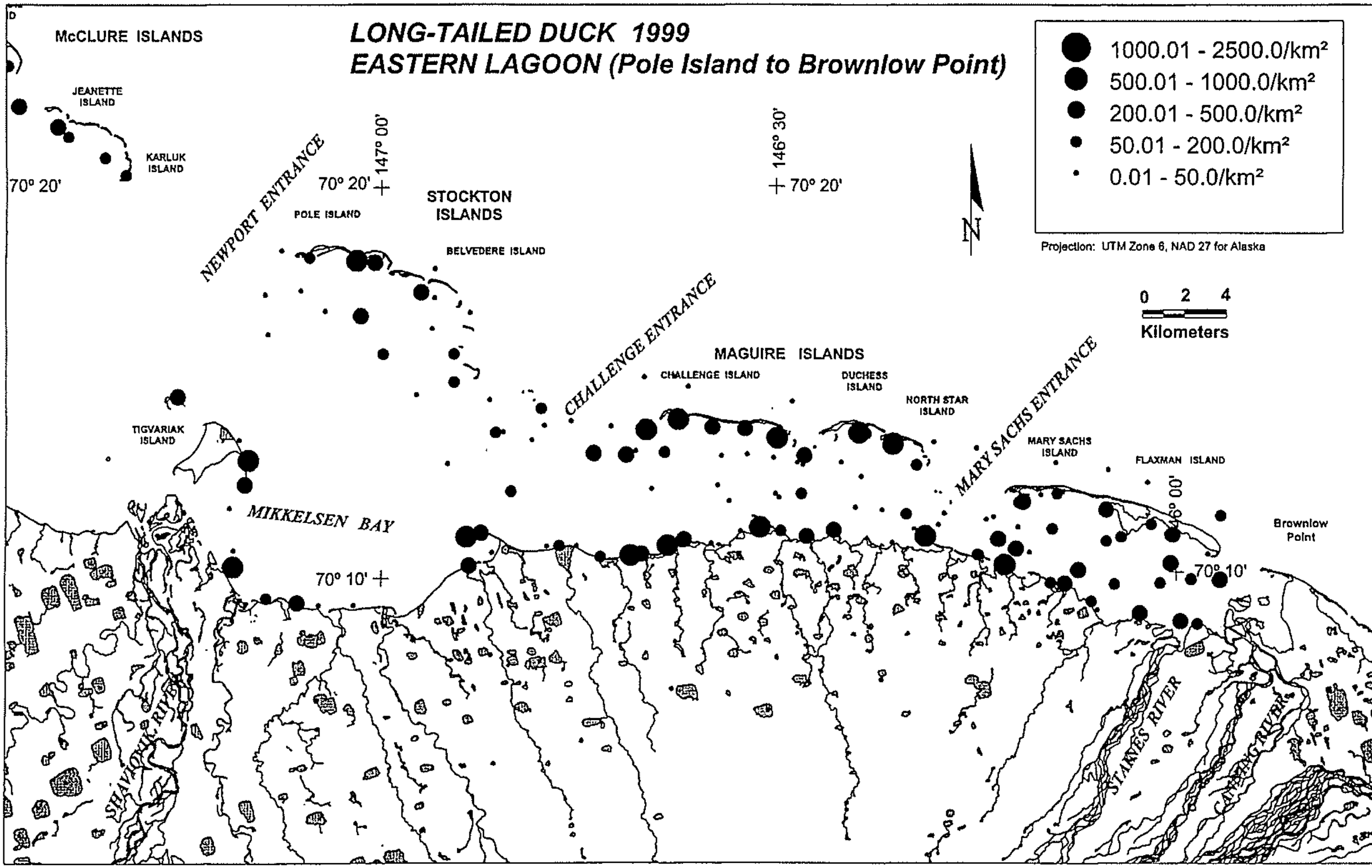


Figure 38. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

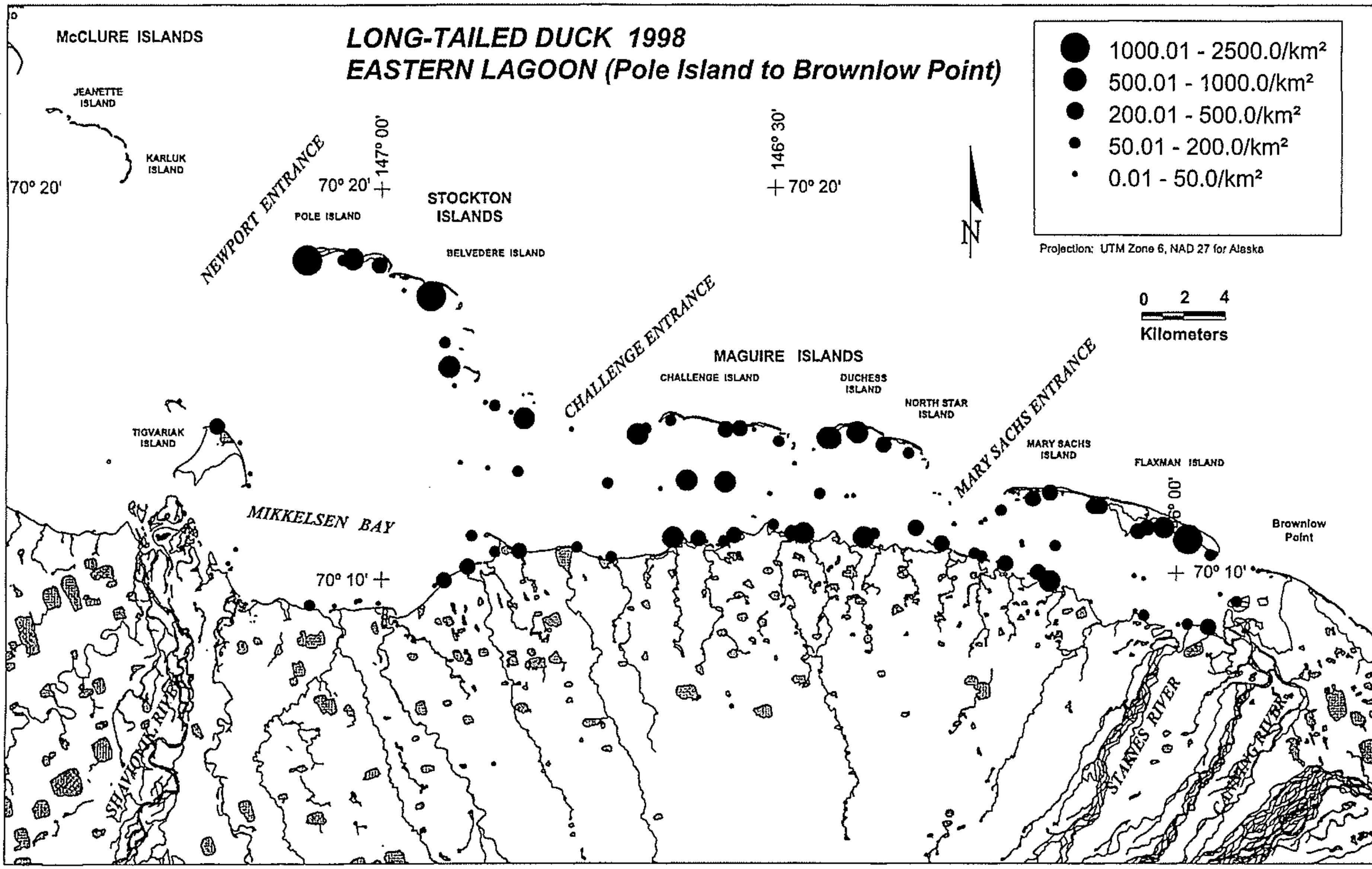


Figure 39. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 5 August to 3 September 1998.

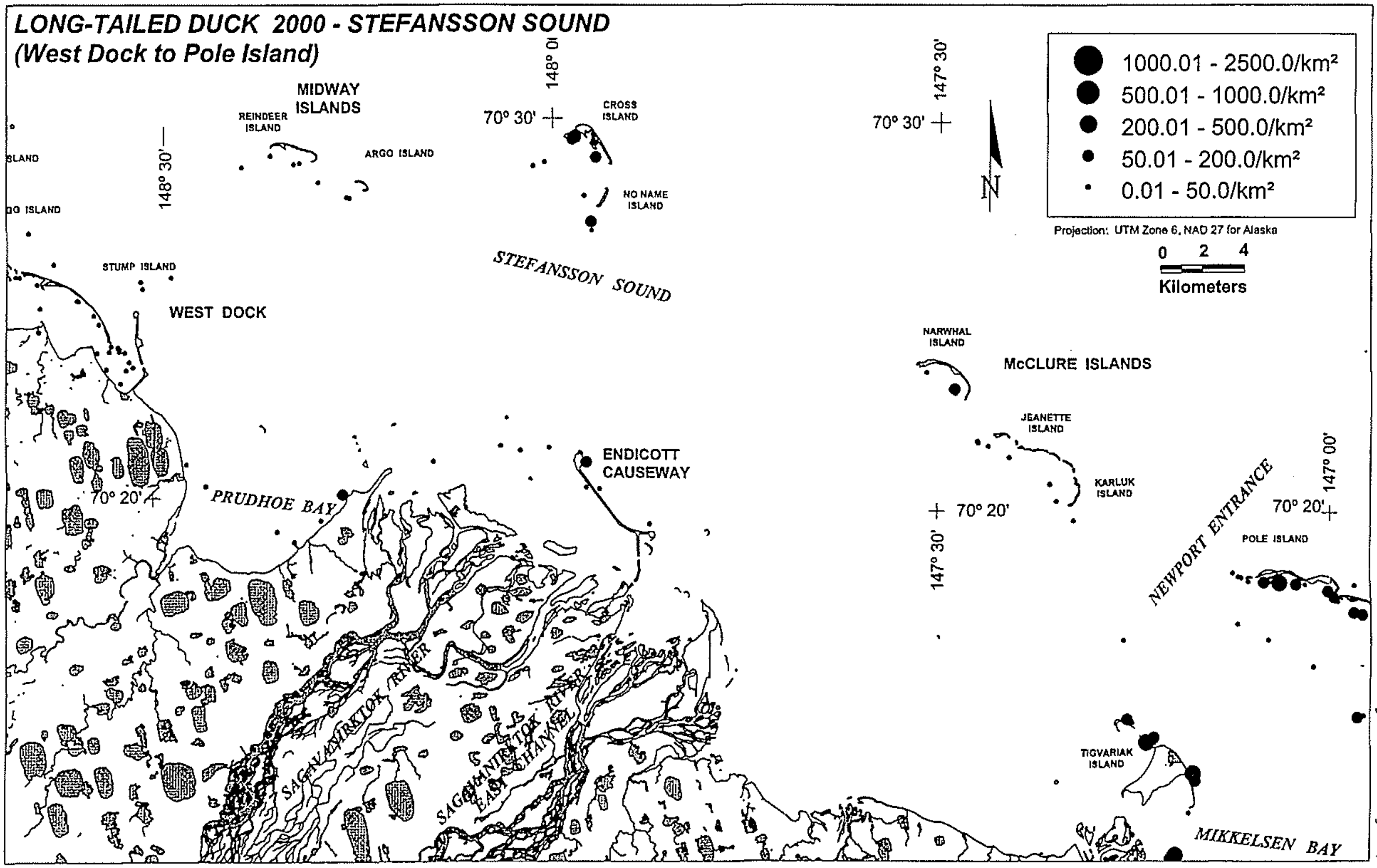


Figure 40. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1-24 August 2000.

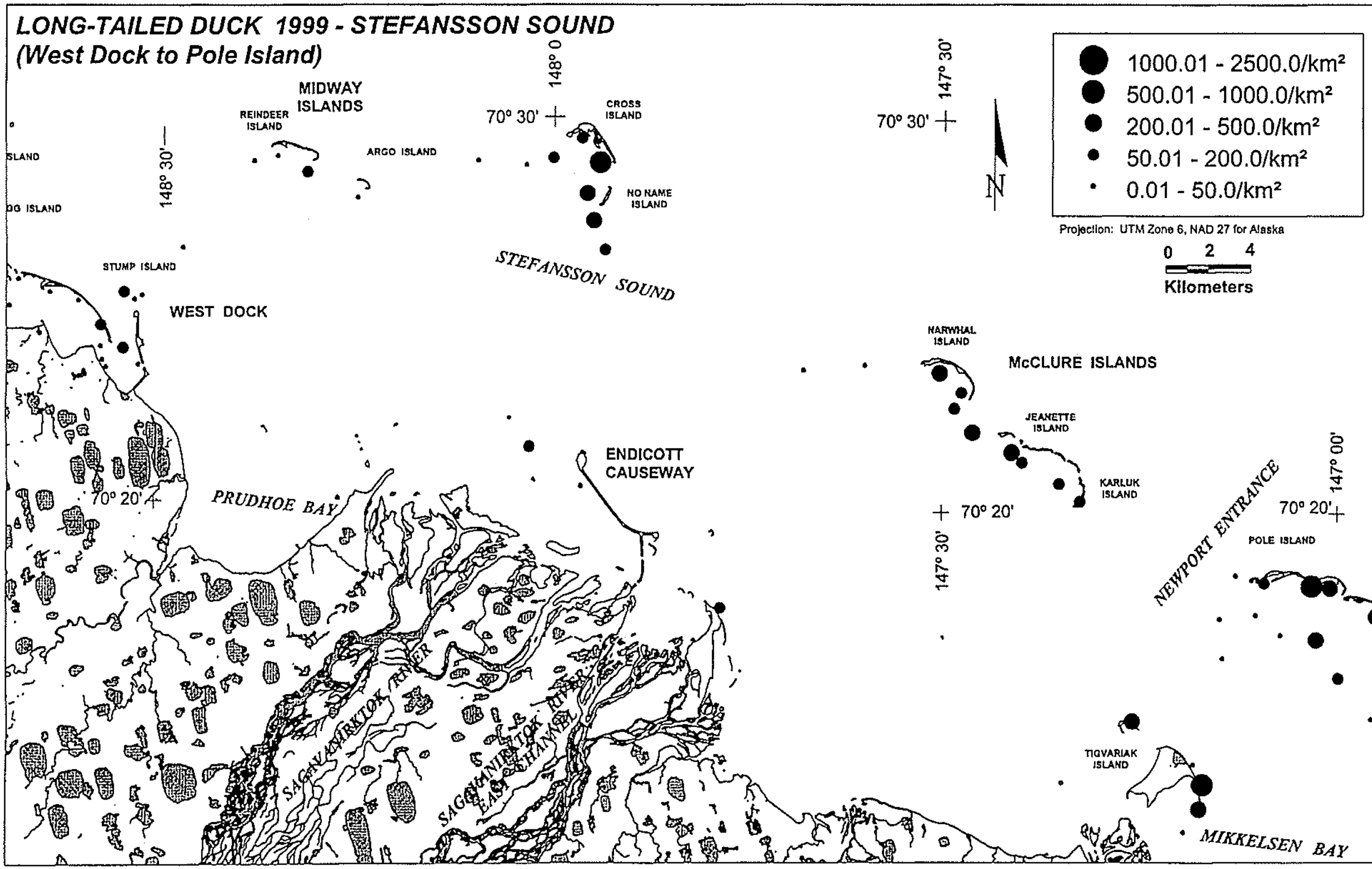


Figure 41. Summary of density for long-tailed ducks by 30-s time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

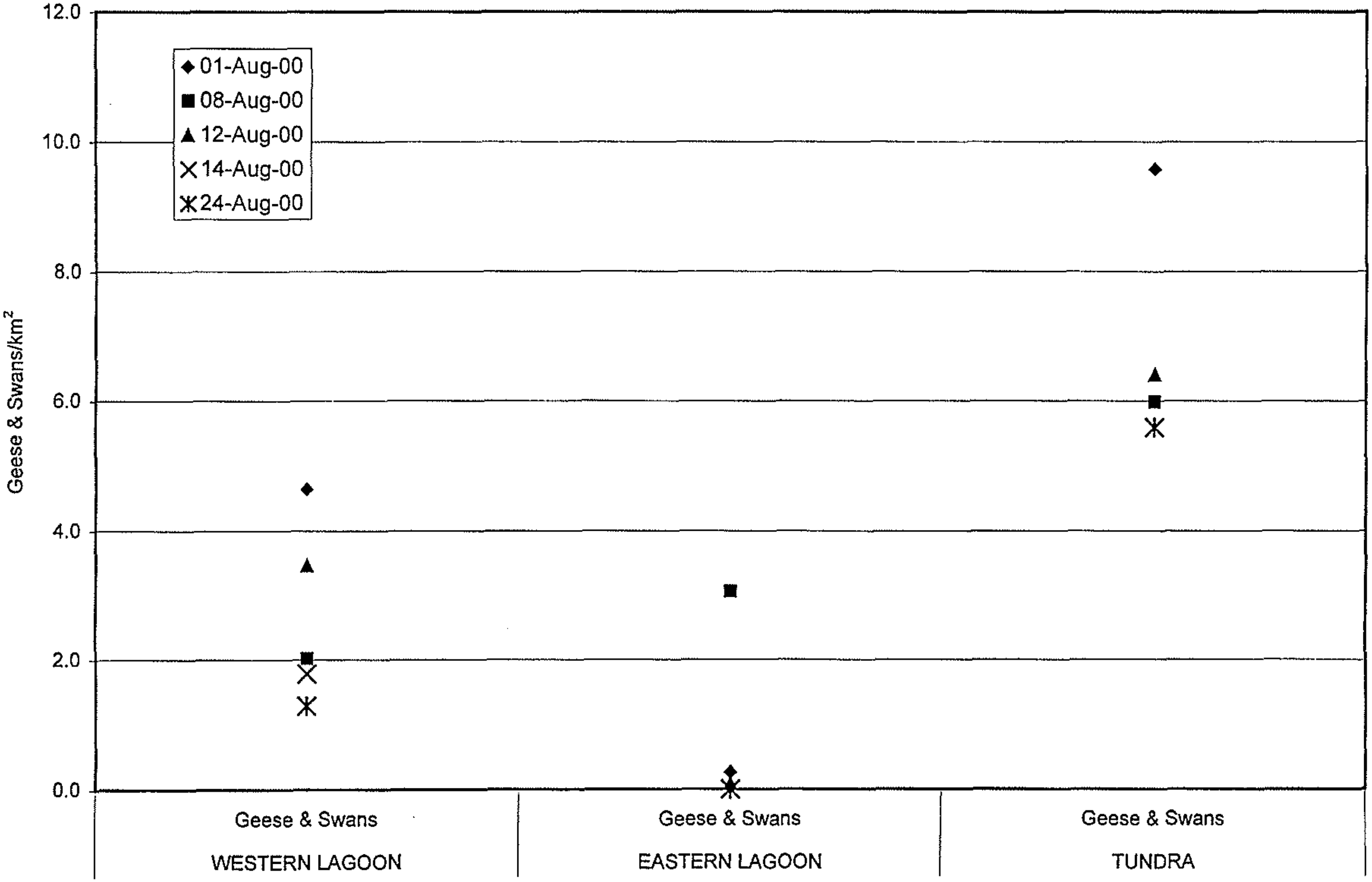


Figure 42. Areal density of geese and swans for 5 aerial surveys by region between Spy Island and Brownlow Point, Alaska, 1-24 August 2000. No survey was flown in the eastern lagoon or tundra on 14 August 2000.

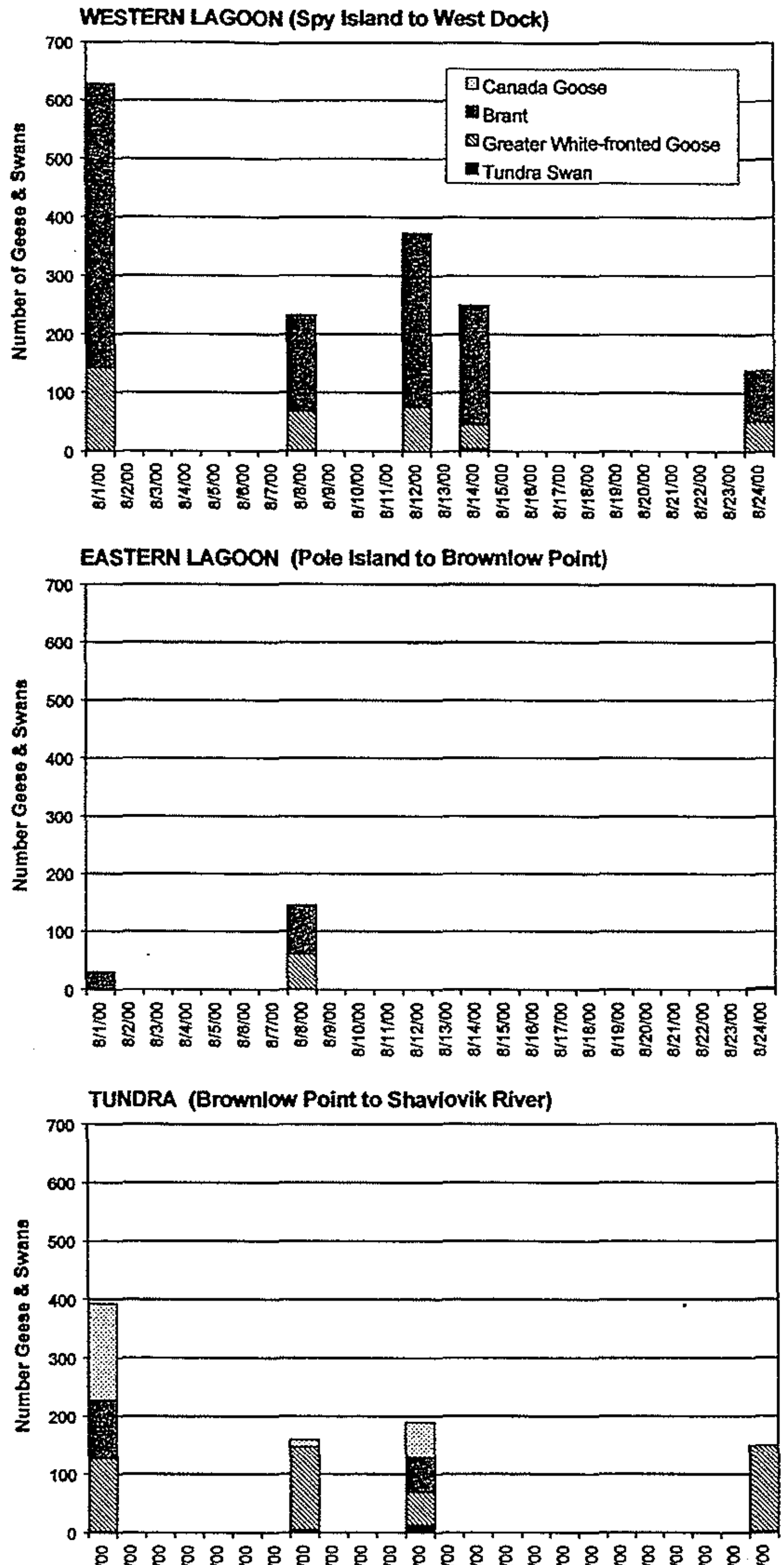


Figure 43. Total number of geese and swans observed both on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August. Surveys were flown on 1, 8, 12, 14, and 24 August 2000. The survey on 14 August covered the Western Lagoon and Stefansson Sound areas only.

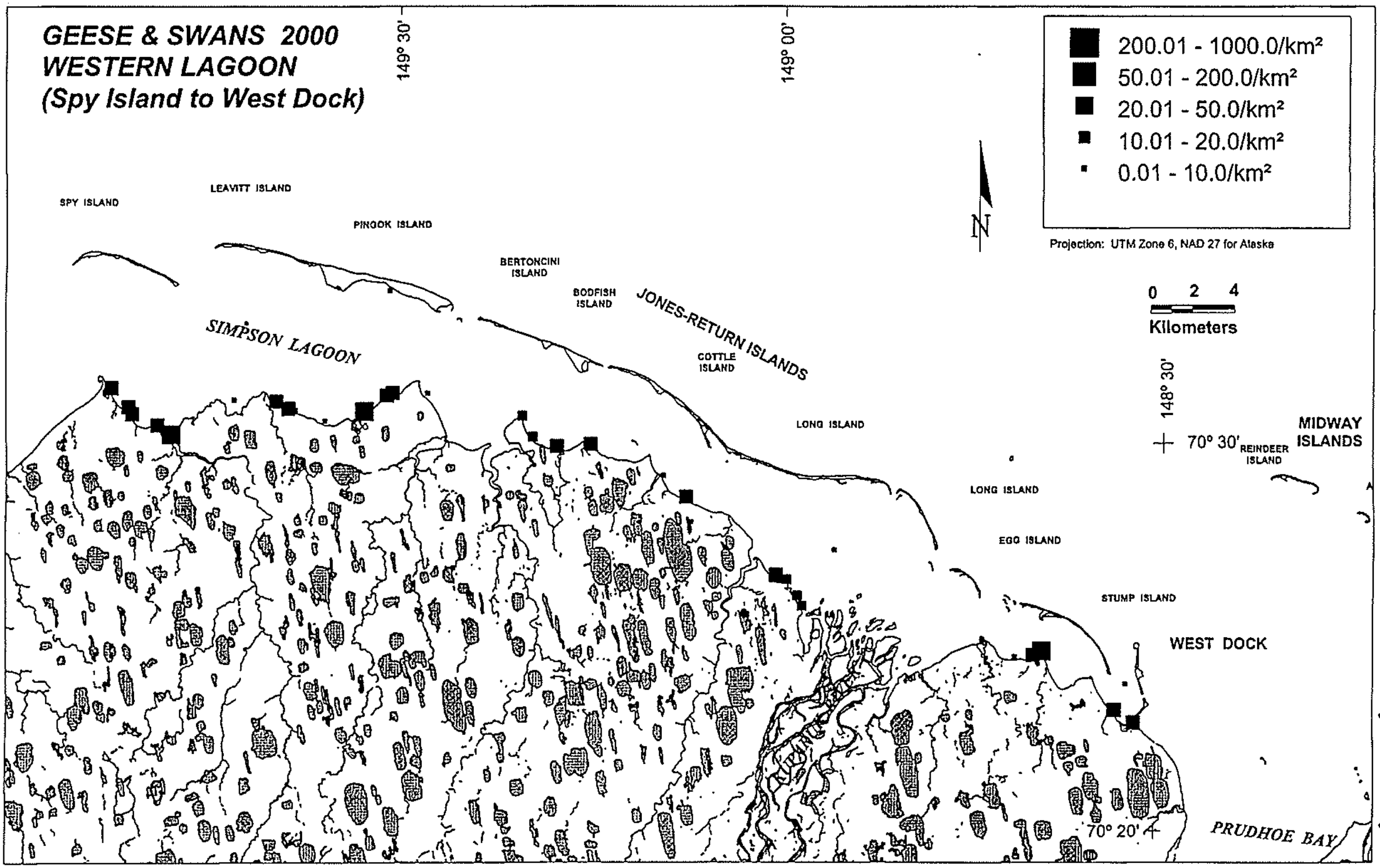


Figure 44. Summary of density for geese and swans by 30-s time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1-24 August 2000.

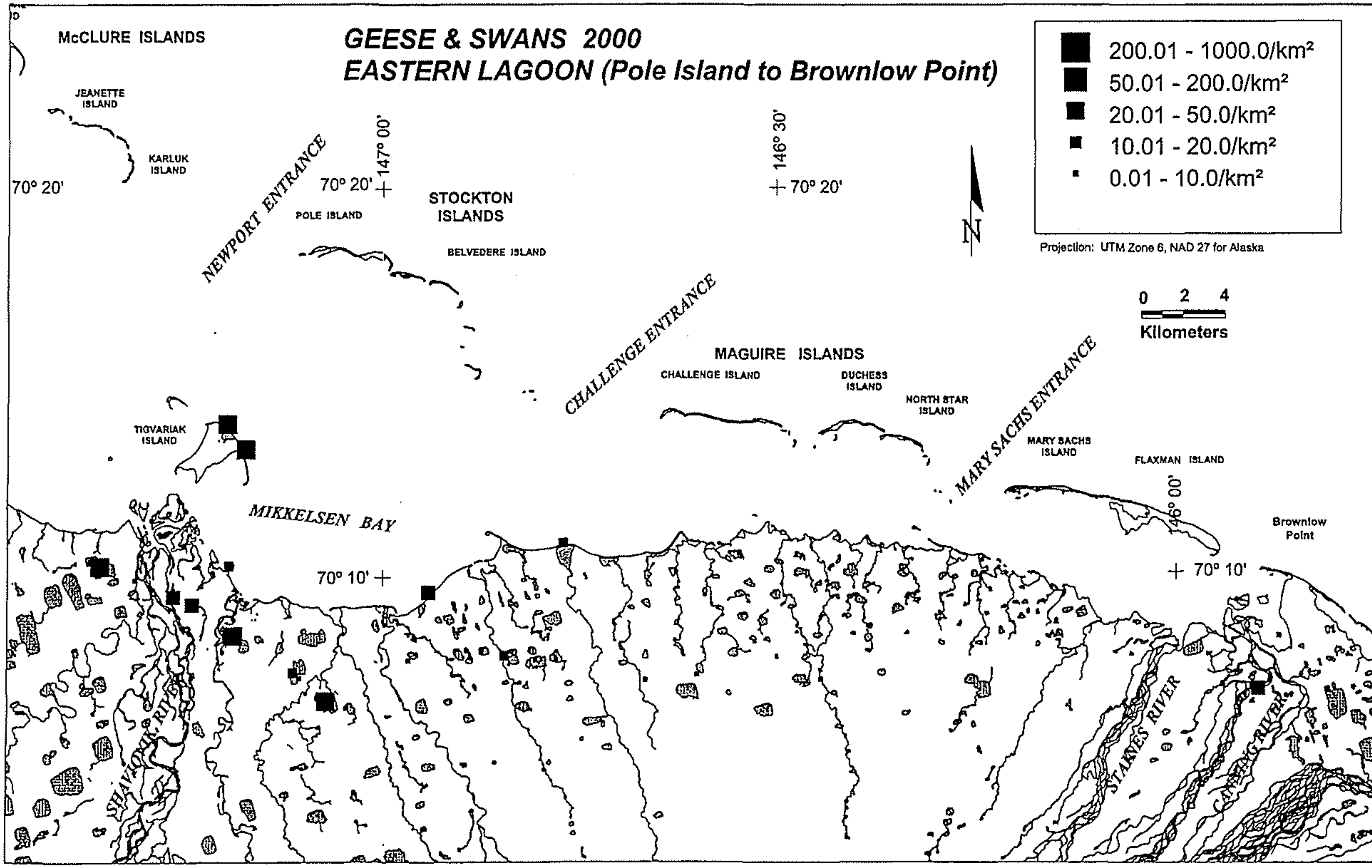


Figure 45. Summary of density for geese and swans by 30-s time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1-24 August 2000.

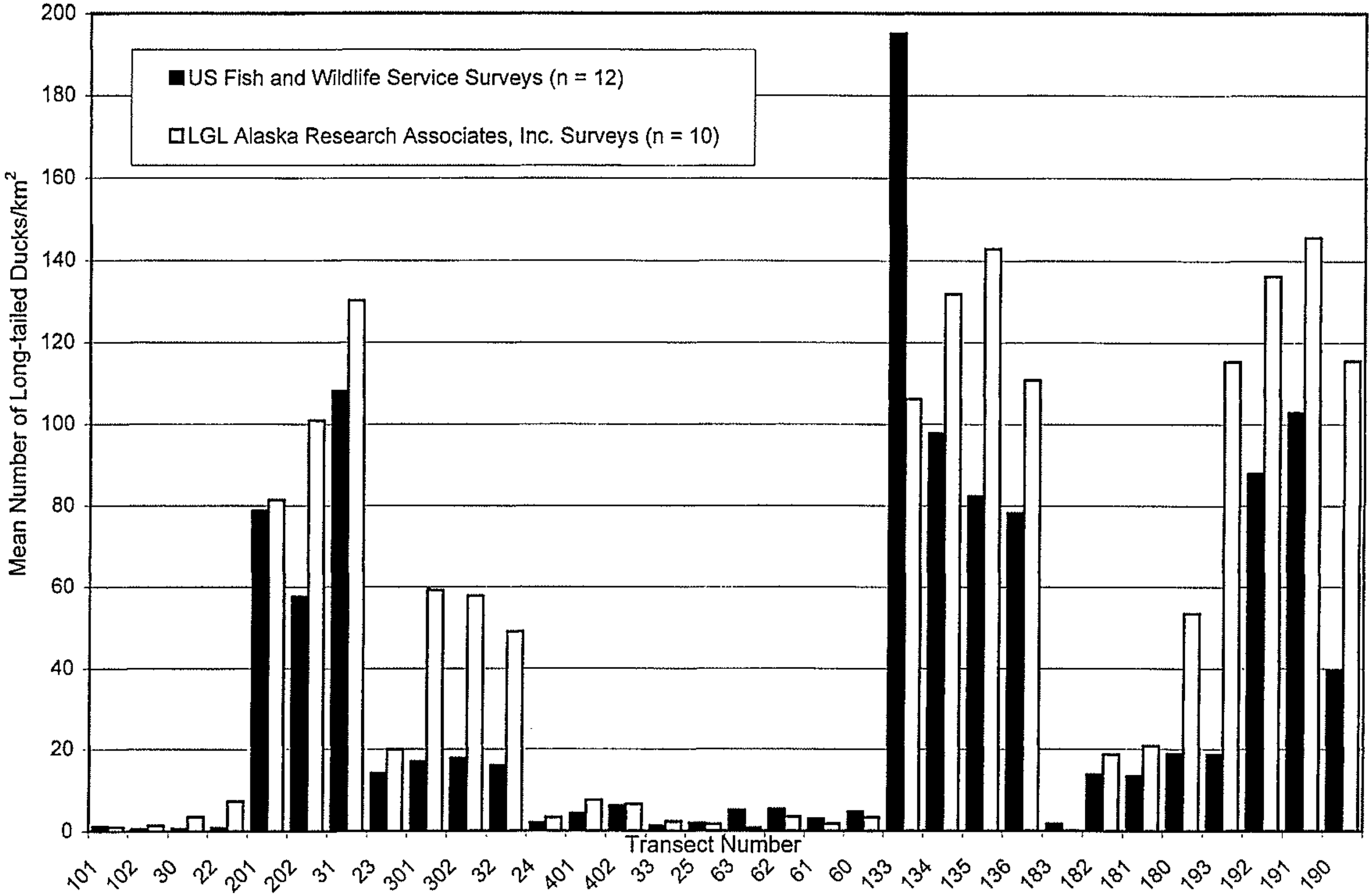


Figure 46. Mean density for long-tailed ducks by survey transect for surveys conducted by the U.S. Fish and Wildlife Service (Flint et al. 2001) and LGL Alaska Research Associates, Inc. (LGL) within the barrier island-lagoon systems from Spy Island to Brownlow Point, Alaska, 22 July to 8 September 1999 and 2000. Mean difference between investigators for all transects was 17 long-tailed ducks/km^2, with LGL generally reporting higher densities for long-tailed ducks. (See Figure 1 for transect locations)

Table 1. Summary of weather and lagoon conditions during 5 aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 1–24 August 2000. (ADST = Alaska Daylight Savings Time)

Survey	Start Time (ADST)	Survey Duration (minutes)	Air Temperature (°C)	Wind Speed (kph)	Cloud Cover (tenths)	Right Front Observer	Left Rear Observer
WESTERN LAGOON (Spy Island to West Dock)							
01 Aug 00	13:30:00	94.62	12°	16	0	Bob Rodrigues	Lynn Noel
08 Aug 00	15:15:36	97.62	0°	0	3	Bob Rodrigues	Lynn Noel
12 Aug 00	14:07:41	102.32	0°	21-25	8	Bob Rodrigues	Lynn Noel
14 Aug 00	13:32:32	97.62	1°	26-30	1	Bob Rodrigues	Lynn Noel
24 Aug 00	15:46:50	97.17	-1°	11-15	10	Bob Rodrigues	Michael Bentley
STEFANSSON SOUND (West Dock to Pole Island)							
01 Aug 00	15:58:50	14.33	12°	15	0	Bob Rodrigues	Lynn Noel
08 Aug 00	16:13:50	15.83	16°	11-15	3	Bob Rodrigues	Lynn Noel
12 Aug 00	16:36:28	20.45	1°	16-20	8	Bob Rodrigues	Lynn Noel
14 Aug 00	17:02:00	15.42	0°	11-15	0	Bob Rodrigues	Lynn Noel
24 Aug 00	12:53:50	28.50	-3°	11-15	1	Bob Rodrigues	Michael Bentley
EASTERN LAGOON (Pole Island to Brownlow Point)							
01 Aug 00	16:19:25	115.70	12°	15	0	Bob Rodrigues	Lynn Noel
08 Aug 00	17:56:24	116.60	16°	11-15	3	Bob Rodrigues	Lynn Noel
12 Aug 00	16:59:44	116.10	1°	16-20	8	Bob Rodrigues	Lynn Noel
14 Aug 00							
24 Aug 00	13:18:05	112.02	-3°	11-15	10	Bob Rodrigues	Michael Bentley

Table 2. Summary of survey effort in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 1–24 August, 2000. Western Lagoon (Spy Island to West Dock), Stefansson Sound (West Dock to Pole Island), Eastern Lagoon (Pole Island to Flaxman Island), and Tundra (Brownlow Point to Shaviovik River).

Region	Transect Number	Number of Replicates	Total Length (km)	Total Areal Coverage (km^2)
Western Lagoon	22	5	41.7	16.68
	23	5	50.7	20.28
	24	5	52.7	21.08
	25	5	59.6	23.84
	30	5	65.2	26.08
	31	5	71.9	28.76
	32	5	76.9	30.76
	33	5	93.6	37.44
	101	5	108.9	43.56
	102	5	71.9	28.76
	201	5	109.9	43.96
	202	5	76.7	30.68
	301	5	88.2	35.28
	302	5	60.1	24.04
	401	5	92.8	37.12
	402	5	73.3	29.32
	601	5	74.6	29.84
	602	5	64.1	25.64
	603	5	88.9	35.56
Total Effort			**1421.7**	**568.68**
Stefansson Sound	19	2	38.0	15.20
	20	2	13.6	5.44
	21	1	11.5	4.60
	130	3	74.2	29.68
	131	3	69.7	27.88
	132	3	61.6	24.64
	184	2	46.7	18.68
Total Effort			**315.3**	**126.12**

Region	Transect Number	Number of Replicates	Total Length (km)	Total Areal Coverage (km^2)
Eastern Lagoon	60	4	51.9	20.76
	61	4	50.8	20.32
	62	4	48.3	19.32
	63	4	53.4	21.36
	133	4	59.6	23.84
	134	4	51.3	20.52
	135	4	57.5	23.00
	136	4	61.1	24.44
	180	4	56.0	22.40
	181	4	49.3	19.72
	182	4	50.1	20.04
	183	4	51.1	20.44
	190	4	64.0	25.60
	191	4	66.8	26.72
	192	4	69.3	27.72
	193	4	82.5	33.00
	604	4	54.9	21.96
	605	4	52.2	20.88
	606	4	49.2	19.68
	607	4	54.4	21.76
Total Effort			**1133.7**	**453.48**
Tundra	500	4	63.9	25.56
	501	4	59.9	23.96
	502	4	68.3	27.32
	503	4	57.4	22.96
Total Effort			**249.5**	**99.80**
Total Effort All Transects			**3120.2**	**1248.08**

Table 3. Total number of bird sightings and individuals seen on- and off-transect for all aerial survey transects (total length = 3120.2 km) in the barrier island-lagoon system, offshore, and on tundra between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

Species Code	Species Name	Number of Sightings	Percent of Sightings	Number of Individuals	Percent of Individuals	Percent of Classified for Group
PALO	Pacific Loon (*Gavia pacifica*)	265	6.7	376	0.5	66.1
RTLO	Red-throated Loon (*Gavia stellata*)	132	3.4	168	0.2	29.5
YBLO	Yellow-billed Loon (*Gavia adamsii*)	23	0.6	25	0.0	4.4
LOSP	Loon Species (*Gavia* spp.)	36	0.9	46	0.1	
Loons		**456**	**11.6**	**615**	**0.9**	
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	1	0.0	1	0.0	25.0
LTJA	Long-tailed Jaeger (*Stercorarius longicaudus*)	3	0.1	3	0.0	75.0
JAEG	Jaeger Species (*Stercorarius* spp.)	1	0.0	1	0.0	
Jaegers		**5**	**0.1**	**5**	**0.0**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	591	15.0	2371	3.4	95.3
SAGU	Sabine's Gull (*Xema sabini*)	15	0.4	115	0.2	4.6
HEGU	Herring Gull (*Larus argentatus*)	1	0.0	1	0.0	0.0
Gulls		**607**	**15.4**	**2487**	**3.6**	
ARTE	Arctic Tern (*Sterna paradisaea*)	28	0.7	88	0.1	
BLGU	Black Guillemot (*Cepphus grylle*)	4	0.1	9	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**644**	**16.4**	**2589**	**3.7**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*	322	8.2	4540	6.5	99.9
KIEI	King Eider (*Somateria spectabilis*)	1	0.0	6	0.0	0.1
EISP	Eider Species (*Somateria* spp.)	40	1.0	349	0.5	
Eiders		**363**	**9.2**	**4895**	**7.1**	
SUSC	Surf Scoter (*Melanitta perspicillata*)	186	4.7	2352	3.4	100.0
WWSC	White-winged Scoter (*Melanitta fusca*)	1	0.0	1	0.0	0.0
SCOT	Scoter Species (*Melanitta* spp.)	29	0.7	512	0.7	
Scoters		**216**	**5.5**	**2865**	**4.1**	
NOPI	Northern Pintail (*Anas acuta*)	11	0.3	46	0.1	0.1
OLDS	Long-tailed Duck (*Clangula hyemalis*)	2002	50.9	53696	77.3	99.9
RBME	Red-breasted Merganser (*Mergus serrator*)	7	0.2	27	0.0	0.1
SCAUP	Scaup Species (*Aythya* spp.)	3	0.1	12	0.0	
DKSP	Duck Species	78	2.0	1235	1.8	
Ducks		**2680**	**68.1**	**62776**	**90.4**	
BRAN	Black Brant (*Branta bernicla*)	43	1.1	1515	2.2	52.2
CAGO	Canada Goose (*Branta canadensis*)	8	0.2	238	0.3	8.2
GWFG	Greater White-fronted Goose (*Anser albifrons*)	32	0.8	904	1.3	31.1
LSGO	Snow Goose (*Chen caerulescens*)	3	0.1	215	0.3	7.4
DAGO	Dark Goose	2	0.1	27	0.0	
GOSP	Goose Species	3	0.1	150	0.2	
TUSW	Tundra Swan (*Cygnus columbianus*)	16	0.4	32	0.0	1.1
Geese & Swans		**107**	**2.7**	**3081**	**4.4**	
WATERFOWL (Ducks, Geese & Swans)		**2787**	**70.8**	**65857**	**94.9**	
PHSP	Phalarope Species (*Phalaropus* spp.)	4	0.1	21	0.0	
SMSH	Small Shorebird	36	0.9	329	0.5	
MESH	Medium Shorebird	5	0.1	11	0.0	
SHOREBIRDS		**45**	**1.1**	**361**	**0.5**	
WIPT	Willow Ptarmigan (*Lagopus lagopus*)	1	0.0	1	0.0	
CORA	Common Raven (*Corvus corax*)	1	0.0	1	0.0	
SNBU	Snow Bunting (*Plectrophenax nivalis*)	1	0.0	1	0.0	
BISP	Bird Species	1	0.0	1	0.0	
ALL BIRDS		**3936**	**100**	**69426**	**100**	

Table 4. Total number of bird sightings and individuals seen on- and off-transect for aerial survey transects (total length = 1421.7 km) in the barrier island-lagoon system and offshore between Spy Island and West Dock, Alaska, 1–24 August 2000.

Species Code	Species Name	Number of Sightings	Percent of Sightings	Number of Individuals	Percent of Individuals	Percent of Classified for Group
PALO	Pacific Loon (*Gavia pacifica*)	149	7.0	186	0.6	58.3
RTLO	Red-throated Loon (*Gavia stellata*)	85	4.0	111	0.4	34.8
YBLO	Yellow-billed Loon (*Gavia adamsii*)	20	0.9	22	0.1	6.9
LOSP	Loon Species (*Gavia* spp.)	20	0.9	25	0.1	
Loons		**274**	**13.0**	**344**	**1.1**	
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	1	0.0	1	0.0	33.3
LTJA	Long-tailed Jaeger	2	0.1	2	0.0	66.7
JAEG	Jaeger Species (*Stercorarius* spp.)	1	0.0	1	0.0	
Jaegers		**4**	**0.2**	**4**	**0.0**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	331	15.7	1233	4.0	91.6
SAGU	Sabine's Gull (*Xema sabini*)	13	0.6	112	0.4	8.3
HEGU	Herring Gull (*Larus argentatus*)	1	0.0	1	0.0	0
Gulls		**345**	**16.3**	**1346**	**4.3**	
ARTE	Arctic Tern (*Sterna paradisaea*)	18	0.9	71	0.2	
BLGU	Black Guillemot (*Cepphus grylle*)	1	0.0	1	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**368**	**17.4**	**1422**	**4.6**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*)	34	1.6	161	0.5	100.0
EISP	Eider Species (*Somateria* spp.)	8	0.4	37	0.1	
Eiders		**42**	**2.0**	**198**	**0.6**	
SUSC	Surf Scoter (*Melanitta perspicillata*)	183	8.7	2329	7.5	100.0
SCOT	Scoter Species (*Melanitta* spp.)	25	1.2	502	1.6	
Scoters		**208**	**9.8**	**2831**	**9.1**	
OLDS	Long-tailed Duck (*Clangula hyemalis*)	1117	52.8	24031	77.2	
RBME	Red-breasted Merganser (*Mergus serrator*)	1	0.0	7	0.0	
SCAUP	Scaup Species (*Aythya* spp.)	3	0.1	12	0.0	
DKSP	Duck Species	22	1.0	478	1.5	
Ducks		**1393**	**65.9**	**27557**	**88.6**	
BRAN	Black Brant (*Branta bernicla*)	37	1.7	1240	4.0	76.5
GWFG	Greater White-fronted Goose (*Anser albifrons*)	14	0.7	373	1.2	23.0
DAGO	Dark Goose	2	0.1	27	0.1	
GOSP	Goose Species	1	0.0	40	0.1	
TUSW	Tundra Swan (*Cygnus columbianus*)	3	0.1	7	0.0	0.4
Geese & Swans		**57**	**2.7**	**1687**	**5.4**	
WATERFOWL (Ducks, Geese & Swans)		**1450**	**68.6**	**29244**	**94.0**	
SMSH	Small Shorebird	11	0.5	90	0.3	
SHOREBIRDS		**11**	**0.5**	**90**	**0.3**	
GYRF	Gyrfalcon (*Falco rusticolus*)	1	0.0	1	0.0	
RAPTORS		**1**	**0.0**	**1**	**0.0**	
BISP	Bird Species	11	0.5	19	0.1	
ALL BIRDS		**2115**	**100**	**31120**	**100**	

Table 5. Total number of bird sightings and individuals seen on- and off-transect for aerial survey transects (total length = 1133.7 km) in the barrier island-lagoon system and offshore between Pole Island and Brownlow Point, Alaska, 1–24 August 2000.

Species Code	Species Name	Number of Sightings	Percent of Sightings	Number of Individuals	Percent of Individuals	Percent of Classified for Group
PALO	Pacific Loon (*Gavia pacifica*)	62	4.6	105	0.3	73.4
RTLO	Red-throated Loon (*Gavia stellata*)	30	2.2	36	0.1	25.2
YBLO	Yellow-billed Loon (*Gavia adamsii*)	2	0.1	2	0.0	1.4
LOSP	Loon Species (*Gavia* spp.)	9	0.7	10	0.0	
Loons		**103**	**7.6**	**153**	**0.5**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	168	12.4	302	0.9	
SAGU	Sabine's Gull (*Xema sabini*)	1	0.1	2	0.0	
Gulls		**169**	**12.5**	**304**	**0.9**	
ARTE	Arctic Tern (*Sterna paradisaea*)	1	0.1	1	0.0	
BLGU	Black Guillemot (*Cepphus grylle*)	1	0.1	5	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**171**	**12.6**	**310**	**0.9**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*	219	16.2	3699	11.2	100.0
EISP	Eider Species (*Somateria* spp.)	21	1.6	160	0.5	
Eiders		**240**	**17.7**	**3859**	**11.7**	
SUSC	Surf Scoter (*Melanitta perspicillata*)	2	0.1	22	0.1	95.7
WWSC	White-winged Scoter (*Melanitta fusca*)	1	0.1	1	0.0	4.3
SCOT	Scoter Species (*Melanitta* spp.)	4	0.3	10	0.0	
Scoters		**7**	**0.5**	**33**	**0.1**	
OLDS	Long-tailed Duck (*Clangula hyemalis*)	773	57.1	27394	83.3	
RBME	Red-breasted Merganser (*Mergus serrator*)	4	0.3	9	0.0	
DKSP	Duck Species	34	2.5	564	1.7	
Ducks		**1058**	**78.1**	**31859**	**96.8**	
BRAN	Black Brant (*Branta bernicla*)	3	0.2	115	0.3	30.3
GWFG	Greater White-fronted Goose (*Anser albifrons*)	1	0.1	60	0.2	15.8
LSGO	Snow Goose (*Chen caerulescens*)	2	0.1	200	0.6	52.8
DAGO	Dark Goose	0	0.0	0	0.0	
GOSP	Goose Species	1	0.1	10	0.0	
TUSW	Tundra Swan (*Cygnus columbianus*)	2	0.1	4	0.0	1.1
Geese & Swans		**9**	**0.7**	**389**	**1.2**	
WASP	Waterfowl	0	0.0	0	0.0	
WATERFOWL (Ducks, Geese & Swans)		**1067**	**78.8**	**32248**	**98.0**	
PHSP	Phalarope Species (*Phalaropus* spp.)	3	0.2	19	0.1	
SMSH	Small Shorebird	7	0.5	164	0.5	
MESH	Medium Shorebird	1	0.1	4	0.0	
SHOREBIRDS		**11**	**0.8**	**187**	**0.6**	
CORA	Common Raven (*Corvus corax*)	1		1		
BISP	Bird Species	1	0.1	1	0.0	
ALL BIRDS		**1354**	**100**	**32900**	**100**	

Table 6. Species densities for all aerial survey transects (total area = 1248.1 km^2) in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

Species Code	Species Name	Total Number of Birds on Transect	Number of Sightings on Transect	Bird Density (Number/km^2)
LOONS				
PALO	Pacific Loon (*Gavia pacifica*)	350	247	0.280
RTLO	Red-throated Loon (*Gavia stellata*)	159	127	0.127
YBLO	Yellow-billed Loon (*Gavia adamsii*)	25	23	0.020
SEABIRDS (Jaegers, Gulls, and Terns)				
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	1	1	0.001
LTJA	Long-tailed Jaeger (*Stercorarius longicaudus*)	3	3	0.002
GLGU	Glaucous Gull (*Larus hyperboreus*)	1885	488	1.510
HEGU	Herring Gull (*Larus argentatus*)	1	1	0.001
SAGU	Sabine's Gull (*Xema sabini*)	114	14	0.091
ARTE	Arctic Tern (*Sterna paradisaea*)	84	27	0.067
BLGU	Black Guillemot (*Cepphus grylle*)	9	4	0.007
WATERFOWL (Ducks, Geese & Swans)				
COEI	Common Eider (*Somateria mollissima v-nigra*)	3765	289	3.017
KIEI	King Eider (*Somateria spectabilis*)	6	1	0.005
SUSC	Surf Scoter (*Melanitta perspicillata*)	2196	175	1.760
WWSC	White-winged Scoter (*Melanitta fusca*)	1	1	0.001
OLDS	Long-tailed Duck (*Clangula hyemalis*)	46806	1871	37.502
RBME	Red-breasted Merganser (*Mergus serrator*)	27	7	0.022
NOPI	Northern Pintail (*Anas acuta*)	46	11	0.037
BRAN	Black Brant (*Branta bernicla*)	1415	42	1.134
CAGO	Canada Goose (*Branta canadensis*)	58	6	0.046
GWGO	Greater White-fronted Goose (*Anser albifrons*)	842	28	0.675
LSGO	Lesser Snow Goose (*Chen caerulescens*)	200	2	0.160
TUSW	Tundra Swan (*Cygnus columbianus*)	21	11	0.017

Table 7. Habitat associations of loons during aerial surveys in the barrier island-lagoon system and tundra transects between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

		Pacific Loon		Red-throated Loon		Yellow-billed Loon	
General Habitat Type	Specific Habitat Type	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	95	35.8	33	25.0	4	17.4
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-
	Shoreline (land side; 14)	-	-	-	-	1	4.3
	Shoreline (water side; 15)	24	9.1	24	18.2	7	30.4
	Mainland Coast (27)	1	0.4	-	-	-	-
	Man-made Structures (79)	2	0.8	4	3.0	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	37	14.0	16	12.1	1	4.3
	Lagoon (9)	5	1.9	1	0.8	1	4.3
Unclassified Tundra (19)	Pond or Lake (18)	11	4.2	2	1.5	-	-
	Unclassified Tundra (19)	2	0.8	-	-	-	-
	Lake w/o Emergents (43)	2	0.8	-	-	-	-
	Pond with Emergents (45)	9	3.4	-	-	-	-
	Large Lake (49)	1	0.4	-	-	-	-
	Stream (55)	-	-	1	0.8	-	-
Wet Tundra (25)	Pond or Lake (18)	6	2.3	-	-	-	-
	Lake with Emergents (42)	1	0.4	-	-	-	-
	Lake w/o Emergents (43)	3	1.1	-	-	-	-
	Pond with Emergents (45)	2	0.8	2	1.5	-	-
Mainland Coast (27)	Spit (10)	-	-	-	-	-	-
	Shoreline (water side; 15)	60	22.6	47	35.6	9	39.1
	River Delta (16)	1	0.4	2	1.5	-	-
	Onshore Lagoon (61)	1	0.4	-	-	-	-
River Delta (92)	Spit (10)	-	-	-	-	-	-
	Tide Flat (13)	2	0.8	-	-	-	-
TOTAL		265	100	132	100	23	100

Table 8. Habitat associations of seabirds during aerial surveys in the barrier island-lagoon system and tundra transects between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

		Arctic Tern		Glaucous Gull		Sabine's Gull	
General Habitat Type	Specific Habitat Type	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	1	3.6	54	9.1	-	-
	Shoal (12)	-	-	1	0.2	-	-
	Mudflat (41)	-	-	1	0.2	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-
	Spit (10)	-	-	1	0.2	-	-
	Island (11)	-	-	62	10.5	1	6.7
	Shoal (12)	-	-	3	0.5	-	-
	Shoreline (land side; 14)	5	17.9	79	13.4	2	13.3
	Shoreline (water side; 15)	15	53.6	191	32.3	11	73.3
	Mainland Coast (27)	-	-	2	0.3	-	-
	Man-made Structures (79)	-	-	8	1.4	-	-
Nearshore Sea	Ocean (8)	2	7.1	16	2.7	-	-
<3 mi. (13)	Lagoon (9)	4	14.3	10	1.7	-	-
Unclassified Tundra (19)	Unclassified Tundra (19)	-	-	3	0.5	-	-
	Stream (55)	-	-	1	0.2	-	-
Wet Tundra (25)	Pond or Lake (18)	-	-	1	0.2	1	6.7
	Unclassified Tundra (19)	1	3.6	1	0.2	-	-
	Wet Tundra (25)	-	-	4	0.7	-	-
	Mudflat (41)	-	-	1	0.2	-	-
Mainland Coast (27)	Spit (10)	-	-	1	0.2	-	-
	Island (11)	-	-	4	0.7	-	-
	Shoal (12)	-	-	2	0.3	-	-
	Shoreline (land side; 14)	-	-	7	1.2	-	-
	Shoreline (water side; 15)	-	-	100	16.9	-	-
	River Delta (16)	-	-	7	1.2	-	-
	Mudflat (41)	-	-	13	2.2	-	-
	Onshore Lagoon (61)	-	-	1	0.2	-	-
	High-centered Polygon (95)	-	-	1	0.2	-	-
	Low-centered Polygon (96)	-	-	1	0.2	-	-
Large Lake (49)	Large Lake (49)	-	-	1	0.2	-	-
River Delta (92)	Spit (10)	-	-	-	-	-	-
	Island (11)	-	-	2	0.3	-	-
	Tide Flat (13)	-	-	10	1.7	-	-
	Mudflat (41)	-	-	2	0.3	-	-
TOTAL		28	100	591	100	15	100

Table 9. Habitat associations of eiders during aerial surveys in the barrier island-lagoon system and tundra transects between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

		Common Eider		King Eider		Eider Species		All Eiders	
General Habitat Type	Specific Habitat Type	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	61	18.9	1	100.0	14	35.0	76	20.9
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-	-	-
	Island (11)	1	0.3	-	-	-	-	1	0.3
	Shoreline (land side; 14)	8	2.5	-	-	-	-	8	2.2
	Shoreline (water side; 15)	161	50.0	-	-	13	32.5	174	47.9
	Onshore Lagoon (61)	1	0.3	-	-	-	-	1	0.3
	Man-made Structures (79)	1	0.3	-	-	-	-	1	0.3
Nearshore Sea <3 mi. (13)	Ocean (8)	19	5.9	-	-	3	7.5	22	6.1
	Lagoon (9)	10	3.1	-	-	3	7.5	13	3.6
Unclassified Tundra (19)	Pond or Lake (18)	-	-	-	-	2	5.0	2	0.6
	Large Lake (49)	-	-	-	-	1	2.5	1	0.3
Wet Tundra (25)	Pond or Lake (18)	-	-	-	-	2	5.0	2	0.6
Mainland Coast (27)	Spit (10)	-	-	-	-	-	-	-	-
	Shoreline (water side; 15)	47	14.6	-	-	2	5.0	49	13.5
	Pond or Lake (18)	1	0.3	-	-			1	0.3
	Mudflat (41)	1	0.3	-	-	-	-	1	0.3
	Onshore Lagoon (61)	11	3.4	-	-	-	-	11	3.0
River Delta (92)	Spit (10)	-	-	-	-	-	-	-	-
TOTAL		322	100	1	100	40	100	363	100

Table 10. Habitat associations of scoters during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

		Surf Scoter		White-winged Scoter		All Scoters	
General Habitat Type	Specific Habitat Type	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	153	82.3	-	-	175	81.0
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-
	Shoreline (water side; 15)	24	12.9	-	-	29	13.4
	Pond (47)	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	5	2.7	1	100.0	6	2.8
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	-	-	-	-	-	-
	Shoreline (water side; 15)	4	2.2	-	-	6	2.8
River Delta (92)	Spit (10)	-	-	-	-	-	-
TOTAL		186	100	1	100	216	100

Table 11. Long-tailed duck density (number of individuals/km^2) by aerial survey transect in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1–24 August 2000.

	Transect Numbers																		
	Barrier Islands				Mid-Lagoon							Mainland Shore				Off Shore			
Date	23	31	202	201	24	32	301	302	601	602	603	25	33	401	402	22	30	101	102
Molt (28 July--19 August)																			
1 Aug 00	5.28	67.02	69.50	20.20	5.00	4.11	28.57	106.91	119.97	8.54	53.16	0.00	0.00	0.70	0.00	0.00	0.00	0.00	0.00
8 Aug 00	8.33	416.73	205.96	102.86	0.00	163.40	58.76	35.83	248.32	75.99	122.22	0.00	0.00	14.48	17.24	0.60	0.00	0.00	0.00
12 Aug 00	16.24	66.72	27.32	11.02	12.98	18.35	33.33	97.90	137.25	41.86	26.12	1.94	9.71	3.46	10.99	0.62	7.22	3.54	4.90
14 Aug 00	7.43	109.09	73.33	30.36	6.37	10.62	20.28	67.36	73.32	60.63	9.19	1.60	10.11	17.57	20.89	1.49	0.00	0.00	0.00
Average Density	9.32	164.89	94.03	41.11	6.09	49.12	35.24	77.00	144.72	46.76	52.67	0.89	4.96	9.05	12.28	0.68	1.81	0.89	1.23
Post-Molt (20 August–30 September)																			
24 Aug 00	1.02	84.46	67.00	83.27	0.48	3.27	32.40	7.20	5.00	0.19	50.29	3.26	0.00	4.01	0.00	1.52	13.08	5.20	0.00

Table 12. Long-tailed duck density (number of individuals/km^2) by aerial survey transect in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1–24 August 2000.

	Transect Numbers						
	Barrier Islands			Mid-Lagoon	Mainland Shore		
Date	130	131	132	184	19	20	21
Molt (28 July–19 August)							
1 Aug 00	8.33	10.53	5.23	-	-	-	-
8 Aug 00	-	-	-	0.00	35.95	98.08	0.00
12 Aug 00	-	-	-	1.82	3.77	0.00	11.52
14 Aug 00	1.71	37.55	23.49	-	-	-	-
Average Density	5.02	24.04	14.36	0.91	19.86	49.04	5.76
Post-Molt (20 August–30 September)							
24 Aug 00	5.71	42.60	15.10	-	-	-	-

Table 13. Long-tailed duck density (number of individuals/km^2) by aerial survey transect in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1–24 August 2000.

	Transect Numbers																					
	Barrier Islands				Mid-Lagoon								Mainland Shore				Off Shore				Tundra	
Date	133	134	135	136	181	181	182	183	604	605	606	607	190	191	192	193	60	61	62	63	500	501
Molt (28 July–19 August)																						
1 Aug 00	151.67	128.88	105.34	38.78	70.36	0.60	58.14	0.00	38.67	39.42	25.41	34.12	147.78	133.63	164.47	68.75	0.00	0.00	0.00	0.00	0.00	6.41
8 Aug 00	152.00	149.81	117.32	228.08	40.11	0.62	0.48	0.00	14.66	31.35	5.28	96.08	160.69	304.03	95.24	235.75	10.50	0.00	0.80	0.36	0.00	0.00
12 Aug 00	50.96	70.47	39.63	131.46	11.52	20.90	49.62	0.21	3.70	17.42	41.60	21.17	65.15	31.72	69.16	45.13	0.00	0.39	0.68	0.00	0.00	4.17
14 Aug 00	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average Density	118.21	116.39	87.43	132.77	40.66	7.37	36.08	0.07	19.01	29.40	24.10	50.46	124.54	156.46	109.62	116.54	3.50	0.13	0.49	0.12	0.00	3.53
Post-Molt (20 August–30 September)																						
24 Aug 00	13.85	15.87	13.99	65.17	3.21	5.40	5.88	0.00	0.00	5.58	19.01	29.41	12.12	54.40	37.63	27.05	0.00	0.20	11.59	4.01	0.00	3.40

Table 14. Habitat associations of long-tailed ducks during aerial surveys in the barrier island-lagoon system and tundra transects between Spy Island and Brownlow Point, Alaska, 1–24 August 2000.

General Habitat Type	Specific Habitat Type	Number of Sightings 1 Aug 00	Number of Sightings 8 Aug 00	Number of Sightings 12 Aug 00	Number of Sightings 14 Aug 00	Number of Sightings 24 Aug 00	Total All Surveys	Percent of Total
Lagoon (9)	Lagoon (9)	80	111	337	232	69	829	41.4
	Man-made Structures (79)	1	-	-	-	-	1	0.0
Barrier Island (11)	Lagoon (9)	1	-	2	-	-	3	0.1
	Spit (10)	-	-	-	-	-	-	-
	Island (11)	1	-	-	-	-	1	0.0
	Shoal (12)	1	-	-	-	-	1	0.0
	Shoreline (land side; 14)	1	-	-	16	5	22	1.1
	Shoreline (water side; 15)	86	199	199	99	144	727	36.3
	Mainland Coast (27)	-	2	-	-	-	2	0.1
	Onshore Lagoon (61)	-	1	-	-	1	2	0.1
	Man-made Structures(79)	-	3	3	-	-	6	0.3
Nearshore Sea <3 mi. (13)	Sea Ice with Surface Water (7)	-	-	-	-	1	1	0.0
	Ocean (8)	-	6	15	1	15	37	1.8
	Lagoon (9)	2	-	-	2	4	8	0.4
	Man-made Structures (79)	-	-	-	-	-	-	-
Unclassified Tundra (19)	Pond or Lake (18)	-	-	4	-	-	4	0.2
	Large Lake (49)	-	1	1	-	-	2	0.1
	River (54)	-	-	1	-	-	1	0.0
Wet Tundra (25)	Pond or Lake (18)	-	-	-	-	1	1	0.0
	Large Lake (49)	3	-	-	-	1	4	0.2
Mainland Coast (27)	Lagoon (9)	9	-	-	-	-	9	0.4
	Spit (10)	1	-	-	-	-	1	0.0
	Island (11)	5	-	-	-	-	5	0.2
	Shoreline (land side; 14)	-	-	-	-	2	2	0.1
	Shoreline (water side; 15)	48	61	111	31	58	309	15.4
	River Delta (16)	-	-	1	-	-	1	0.0
	Onshore Lagoon (61)	2	5	13	-	3	23	1.1
River Delta (92)	Spit (10)	-	-	-	-	-	-	-
ALL HABITATS		241	389	687	381	304	2002	100