FINAL REPORT
12 May 2000

AERIAL SURVEYS OF MOLTING WATERFOWL IN THE BARRIER ISLAND-LAGOON SYSTEMS BETWEEN SPY ISLAND AND BROWNLOW POINT, ALASKA, 1999

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For

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P.O. Box 196612
Anchorage, Alaska 99519-6612

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ABSTRACT

Oldsquaws are the most abundant molting waterfowl in the Beaufort Sea barrier island-lagoon systems. Although there is concern over declines in oldsquaw populations in western North America and Alaska, breeding surveys on Alaska's coastal plain indicate this population is stable. Based on several decades of study, we know that these aggregations of molting/flightless waterfowl are highly susceptible to disturbance and to oil or fuel spills. Our study objective was to determine current distribution and abundance, and compare current and historic numbers and distributions of molting waterfowl in the barrier island-lagoon system between Spy Island and Brownlow Point. Five low-level aerial strip-transect surveys were completed; four during the oldsquaw molt period (29 July to 19 August 1999), and one during the oldsquaw post-molt period (20 August to 30 September 1999). Oldsquaws dominated the avian fauna in the lagoon portion of the study area both in terms of numbers of individuals (84.5%; 84,930 of 100,545) and numbers of sightings (47.4%; 1719 of 3628), as they have since our systematic surveys of the central Alaskan Beaufort Sea lagoon systems began in 1977. Oldsquaws were followed in abundance by eiders (5135 individuals), scoters (3180), geese and swans (2257), gulls (1850), shorebirds (1229), and loons (544). For oldsquaws both sighting and linear densities in the Pole Island to Brownlow Point lagoon system (0.82 sightings/km, 40.53 birds/km) were nearly double the densities in the Spy Island to West Dock lagoon system (0.40 sightings/km, 22.06 birds/km). Between Spy Island and West Dock, oldsquaws were concentrated along the barrier islands and within the lagoon, with few oldsquaws along the mainland shoreline. Between West Dock and Pole Island, oldsquaws were concentrated in the lee of Cross Island and the McClure Islands. Between Pole Island and Brownlow Point, oldsquaws were concentrated along the barrier island shoreline, the mainland shoreline, and throughout the lagoon. Comparisons of 1998 and 1999 oldsquaw distribution maps for the lagoon area near Flaxman Island indicated that more oldsquaw were at mid-lagoon locations than along Flaxman Island in 1999. Comparison of the actual counts of oldsquaw among these transects also indicated that more oldsquaw were counted on the mid-lagoon transect and fewer were counted on the Flaxman Island transect in 1999 versus 1998. During 1999 the USFWS had established a camp and were conducting an oldsquaw capture program in the Flaxman Island area. The total number of oldsquaw within this section of lagoon, however, appeared similar during 1998, when no USFWS activity was occurring, and 1999. Glaucous gull linear density between Spy Island and West Dock (0.76 gulls/km) was double that counted between Pole Island and Brownlow Point (0.34 gulls/km).

Key Words: oldsquaw duck, *Clangula hyemalis,* marine waterbirds, molt period, waterfowl, barrier islands, lagoon, central Alaska Beaufort Sea,

INTRODUCTION

Tens of thousands of molting/flightless ducks and geese are known to aggregate along the mainland and barrier island coastlines and on large inland waterbodies in the vicinity of the Point Thomson Unit Area. Based on several decades of study, we know that these aggregations of molting/flightless waterfowl are highly susceptible to disturbance and to oil or fuel spills (Johnson and Richardson 1981, Johnson 1990, Johnson and Gazey 1992). Specifically, the Simpson Lagoon area and the Stockton-Maguire-Flaxman islands are used extensively by molting oldsquaw (*Clangula hyemalis*) and other waterbirds. Pole Island to Brownlow Point barrier island-lagoon system served as a control area for a larger study to design and test a long-term monitoring program for waterfowl and marine birds (Johnson and Gazey 1992). Thus, there is an extensive 20-year base of data describing the distribution and abundance of waterfowl and marine birds for these areas (Johnson 1990, Johnson and Gazey 1992, Appendix A).

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 expected to occur within the Spy Island to Brownlow Point area: oldsquaw, Pacific eider (*Somateria mollissima v-nigra*), king eider (*Somateria spectabilis*), black scoter (*Melanitta nigra americana*), surf scoter (*Melanitta perspicillata*), and white-winged scoter (*Melanitta fusca deglandi*). In contrast to most inland ducks, whose populations are closely tied to annual production, sea duck populations are controlled more by adult survival than by annual production (Elliot 1997).

Oldsquaws are the most abundant molting waterfowl in the Beaufort Sea barrier island-lagoon systems (Johnson 1990, Johnson and Gazey 1992). Although there is concern over declines in oldsquaw populations in western North America and Alaska (Conant et al. 1997, Hodges et al. 1996), breeding surveys on Alaska's coastal plain indicate this population is probably stable (Elliot 1997, Larned and Balogh 1997, Conant et al. 1997, USFWS 1999). Larned et al. (1999:15) show a slightly increasing trend in the number of oldsquaws recorded during eider nesting surveys on the North Slope of Alaska in 1992 through 1999. Pacific eider spring migrant counts at Point Barrow, Alaska, indicate that the numbers of eiders nesting in northern Alaska and western Canada declined up to 50% between 1976 and 1994 (Suydam et al. 1999). Similarly, spring migration counts of king eiders past Point Barrow indicate a 50% decline between 1976 and 1994 (Suydam et al. 1999). Although breeding and winter surveys do not effectively discriminate between black, surf and white-winged scoters, most indices appear to show populations are declining (Elliot 1997, USFWS 1999). These estimated declines, however, may not adequately incorporate variability inherent in count methodologies and accuracy when comparing historic data to the more accurate methodologies currently employed.

Issues

The issue concerning aggregations of molting/flightless geese and ducks along the Beaufort Sea coast in the barrier island-lagoon systems between Spy Island and Brownlow Point and in large inland lakes in the vicinity of the Point Thomson Unit Area is the potential for petroleum development in the area to cause changes in their normal distribution and abundance that could result in negative population impacts.

Objectives

1. Determine the distribution and abundance of molting waterfowl in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska.

2. Determine the distribution and abundance of molting waterfowl at large lakes along an inland transect in the Point Thomson Unit Area.

3. Compare current and historic numbers and distributions of oldsquaw 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 area, with emphasis on the area between Pole Island and Brownlow Point, Alaska.

METHODS

Four complete and two incomplete low level aerial (fixed-wing) surveys were flown during 30 July to 26 August 1999 in the barrier island-lagoon systems from Spy Island to Brownlow Point, just east of Flaxman Island (Fig. 1). In addition to these lagoon transects, coastal plain transects (500 to 503, Fig. 1) covered many of the large coastal inland lakes within the proposed Point Thomson Unit development area. Aerial surveys were conducted as late in the day as practical (1700 h Alaska Daylight Savings Time) since time of day was determined to be a major factor influencing the distribution and abundance of molting waterfowl (Johnson and Gazey 1992). Surveys were conducted at 1 to 15 day intervals beginning on 30 July 1999. Surveys falling on days with high winds (>20 knots) or heavy ice were delayed until conditions (wave height and chop) were more conducive to sighting birds on the water.

Data Recording

Recording of aerial survey data was standardized according to procedures established during test monitoring surveys conducted by LGL in early August 1989 (Johnson 1990) and were similar to methods used to survey this area over the 15-yr period 1977 to 1991 (Johnson and Gazey 1992). During all surveys, an intervalometer produced a sound audible to all surveyors at 30-sec intervals. This time marker was used to relate (1) the number of birds recorded on- and off-transect along transect segments and transects to (2) information about transect and survey conditions, and prevailing environmental conditions. The intervalometer allowed the distribution and density of birds to be calculated on a more precise scale within each transect, and allowed computation of a variance for on-transect density calculations. Variables recorded at each 30-sec interval included: the exact time (hr-min-sec), amount of ice on- and off-transect, wave height, glare on the water surface, wind speed and direction, habitat type, bird behavior, type and level of human activity on- and off-transect, and any changes in any particular variable noted during the course of the survey.

Information was collected for all species of birds and mammals observed on- and off-transects. Surveys were flown with two observers, one in the right front seat of the Cessna 206 aircraft and the other in the left rear seat. Surveys were flown at an altitude of 45 m and at a ground speed of 180 km/hr. Transect width was 400 m, 200 m on each side of the aircraft; inclinometers were used to calibrate distances from the aircraft. Observers were trained to count large numbers of birds in dense concentrations by practicing with the simulation program "Wildlife Counts", and with poppy seed scatter trials (Johnson 1990).

During aerial surveys, tape recorders were used to record information about the birds, their habitats and environmental conditions during the survey. A notebook computer equipped with a Global Positioning System (GPS) receiver was used to record the flight line at 1-second intervals during surveys. Observers synchronized their watches with the GPS time. Times recorded at the stop/start of the 30-sec time period intervals and at the stop/start of transects were then linked to the GPS aircraft position.

Data Management

Data Entry and Verification

<u>Observational data</u>

Observations for each observer were recorded on audio tape cassettes. At the end of each survey, the tapes were briefly reviewed to ensure that the data was complete. The tapes were reviewed, transcribed, and recorded onto specialized duplicate data coding forms at the end of the field season. Procedures for coding the aerial survey data were reviewed in advance of the surveys.

After the coding forms were completed, they were reviewed and checked for completeness and accuracy. The duplicate coding forms were then separated and the duplicate copy was checked for legibility. The principal investigator retained the original form and the duplicate was the responsibility of one of the other prime observers. Backups included the original audio tape recordings and transcriptions of the recordings.

Data were key-entered using a double-entry verification procedure. Each line on the data entry form was entered as a fixed length, text record. The data entry procedures use custom data entry screens that ensure records are of uniform length and data fields are the correct data type. Following data entry, the data records were loaded into a normalized, relational data structure in dBase IV format. This loading procedure provided control totals for the number of lines processed and the number of survey transects flown. The data were then validated using a custom validation program. The validation program checks for validity of species, behavior, habitat, and other codes against index code lists; checks for missing observation data, time periods and survey transects; checks the chronological sequence of time period observations; checks that totals of males and females, etc. are less than or equal to the total number of animals observed. The validation program also produces control statistics such as the maximum and minimum numbers for each species or species group, frequency of sighting for each species code, list of habitat codes associated with each transect, list of dates that each transect was surveyed, and list of behavior codes for each species.

Project personnel reviewed the results of the verification program. All inconsistencies were documented and resolved either through discussion with the observer who completed the form or by reviewing the tape recordings for that transect. Adjustments to aerial survey data coding and corrections to the database were reviewed by project personnel. After corrections were made, a new verification report was produced. The new verification report was then reviewed and this iterative process was repeated until data inconsistencies were resolved. During this process, detailed records were kept with the coding forms so that any changes could be tracked and rolled back (in a step-wise manner) if required.

Geo-referenced data

A digital 1:63,360-scale basemap (UTM Zone 6, Alaska, North American Datum 1927) of the study area was provided by the BP Exploration (Alaska) Inc. (BP) Cartography Department. The GPS flight record was used in conjunction with the stop/start times to produce time period and transect line segments. Time period and transect lengths, and aircraft ground speed were calculated after data record times were linked to the recorded flight line positions.

Data Analysis

Custom analysis software was used to calculate linear and areal densities of species or species groups by transect and by time period and to produce tabular summaries of frequencies of animal sightings and group sizes by transect and by habitat type. These programs differentiate between on-transect and off-transect observations and correct for situations such as groups of animals seen by both observers and missing time period observations for one, or both, observers (due to, for example, tape recorder malfunctions or periods of poor visibility). Because the data are stored in a dBase data structure, it is also possible to use common database management, statistics, and spreadsheet software to perform ad hoc analyses.

The analysis programs are integrated with the computer mapping software to allow standard and ad hoc query results to be displayed or printed as maps. This involves plotting of symbols at the mid-point of each time period for the transect with the symbol type and size indicating the density of animals for that time period and appropriate legend and title information to identify the data mapped. Computation of the mid-points for time periods is based on average air speed, length, time period interval and start and stop time for each transect. Routine processing involved batch production of maps (for each survey date, and for species and species groups of interest).

RESULTS

Four complete and two incomplete aerial strip-transect surveys were flown (Table 1); three complete and two incomplete surveys during the oldsquaw molt period (29 July to 19 August 1998), and one complete survey during the oldsquaw post-molt period (20 August to 30 September)(Johnson and Richardson 1981). Total survey effort was 3217 km (1286 km^2, Table 2). Results are presented by taxonomic groupings (loons, seabirds, eiders, scoters, etc.) with a general overview followed by a more detailed treatment of species or species groups. 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 per km^2 of on-transect individuals plotted at the mid-point of each 30-sec time period for each transect. All survey data are presented on a series of three maps covering the survey area. Individual survey maps for oldsquaw are presented in Appendix A and composite maps for other selected species are presented in Appendix B. Habitat and behavior analyses were based on the number of sightings of each species. Because individuals within a flock behave similarly and respond to others within the flock, they were considered to be a part of a single unit, and were therefore not considered independent. Flocks were considered independent from one another.

Survey Conditions

Weather conditions in the study area were recorded during each survey and as broadcast from the radio operators at Deadhorse or at the Badami Development. Wind speed and direction were generally assessed by water surface conditions and pilot observations. Temperatures were either recorded at altitude from the aircraft or from Badami weather broadcast. Wind speed and direction greatly influence sightability and behavior of molting waterfowl (Johnson and Richardson 1981, Johnson 1990, Johnson and Gazey 1992) and we attempted to limit survey days to those with acceptable conditions (Table 1). Supplemental coastal weather information was acquired from the Prudhoe Bay NOAA station located at West Dock, approximately 32 miles west of the western end of the survey area (Appendix C). Wind speed and direction did not appear to be well correlated between the NOAA station and observer estimates during the surveys in the study area. Sighting records for vessel traffic recorded during surveys are presented in Appendix A, Table A1.

Overview

Oldsquaw dominated the avian fauna in the lagoon portion of the study area both in terms of numbers of individuals and numbers of sightings (Table 3), which is consistent with results of similar surveys of Beaufort Sea barrier island-lagoon systems, initiated in 1977 (Fig. 2, Johnson and Gazey 1992). As numbers of individuals, oldsquaw were followed in abundance by eiders, scoters, geese and swans, gulls, shorebirds, and loons (Table 3). Shorebirds were not consistently observed and recorded, so density calculations are not presented for this group. Oldsquaw predominated in both the western lagoon system, Spy Island to West Dock, (Table 4) and in the eastern lagoon system, Pole Island (Stockton Islands) to Brownlow Point (Table 5). Total number of birds was larger in the eastern lagoon system despite an extra survey in the western lagoon system (Tables 2, 4, and 5). Dominance among both avian groups and species were also different between these lagoon systems. In the western lagoon system oldsquaw were followed in abundance by scoters, geese, and swans, and then gulls (Table 4). In the eastern lagoon oldsquaw were followed by eiders, gulls and then shorebirds (Table 5). Gulls were a larger proportion of all birds sighted in the western lagoon (2.8%) versus the eastern lagoon (0.8%, Tables 4 and 5). Individual species also differed in relative abundance with species groups between the lagoon systems (Tables 4 and 5).

Loons

The number of loons sighted within the western and eastern lagoon systems ranged from over 120 on 11 August to less than 10 on 26 Aug 1999 (Fig. 3). For the entire survey area density of Pacific loon was nearly triple that of red throated loons (Table 6). For loons classified to species in the western lagoon, pacific (*Gavia pacifica)* (58%) loons and red-throated (*Gavia stellata*) (37%) predominated (Table 4). In the eastern lagoon, Pacific loons predominated (83%, Table 5). Loons were scattered throughout the survey area in low numbers including the tundra transects and the West Dock to Pole Island transects (Figures 4-6). Pacific (*Gavia pacifica)* and red-throated loon sightings were divided between mid-lagoon, mainland shoreline, and all other habitats (Table 7). Yellow-billed loons (*Gavia adamsii)* were sighted primarily along the barrier island and mainland shorelines (Table 7).

Seabirds

Jaegers

Jaegers were not common within the study area (Figures 7-10). They occurred both in the lagoons and mainland shoreline transects (Figures 8-10).

Arctic Tern

Few Arctic tern (*Sterna paradisaea)* were recorded within the survey area (Tables 4 and 5). Many sightings (58%) were adjacent to the barrier islands (Figures B10-B12, Table 8). Arctic terns were recorded nesting on Spy, Bodfish, Long, Narwhal and Jeanette islands during July 1999 (Noel and Johnson 2000).

Gulls

Gull numbers peaked in the western lagoon on 11 August and in the eastern lagoon on 5 August (Fig. 7); no survey was flown in the eastern lagoon on 11 August (Table 1). Gulls were scattered throughout the western lagoon, off Spy Island, near Pingok and Bertoucinni islands, on Long Island, Egg Island, and at Milne Point and West Dock (Fig. 11). Between West Dock and Pole Island gulls were concentrated at Heald Poing and south of Cross Island (Fig. 12). In the eastern lagoon gulls were concentrated at Pole Island (Stockton Islands) and in the Canning River delta (Fig. 13). Glaucous gulls *(Larus hyperboreus)* were recorded nesting on Spy, Long, Egg, Reindeer, and the McClure islands during July 1999 (Noel and Johnson 2000). Nesting was most concentrated on Egg, Reindeer and Spy islands (Noel and Johnson 2000), which corresponds to the concentrations observed near these islands (Figures 11-13). Glaucous gull linear density in the western lagoon (0.76 gulls/km) was double that of the eastern lagoon (0.34 gulls/km, Tables 4 and 5).

Ducks

Eiders

Eider numbers peaked in the eastern lagoon on 1 August (Fig. 14). Common (Pacific) eiders were the most abundant species in this group, comprising 99% of classified eiders (Table 3). The heaviest concentration of eiders appears to be in the eastern lagoon south of the Stockton Islands, although eiders were distributed throughout the survey area (Figures 14-17). Many common eider sightings (46% were on or near the barrier islands, Table 9). Common eiders were second in abundance after oldsquaw (Tables 3 and 6) and eiders were 10 times more abundant in the eastern lagoon (3.44 eiders/km) than in the western lagoon (0.30 eiders/km, Figures 14-17, Tables 4 and 5). Pacific eiders were recorded nesting on Thetis, Spy, Cottle, Long, Egg, Reindeer islands, and the McClure Islands during July 1999 (Noel and Johnson 2000).

Scoters

Scoters were primarily observed in the open lagoon and opposite of eiders were more abundant in the western lagoon (Figures 18-21, Table 10). Scoters were 10 times more abundant in the western lagoon (2.06 scoters/km) than in the eastern lagoon (0.20 scoters/km, Tables 4 and 5), and surf scoters were the third most abundant species in the lagoon systems (Table 6). The largest concentrations of scoters were in Simpson Lagoon (Figures 19-21).

Oldsquaw

Oldsquaws were by far the most abundant birds in the barrier island-lagoon systems between Spy Island and Brownlow Point during 1999. Both sighting and linear densities in the eastern lagoon (0.82 sightings/km, 40.53 birds/km) were nearly double the densities in the western lagoon (0.40 sightings/km, 22.06 birds/km; Fig. 22, Tables 4 and 5). Within the western lagoon system, oldsquaws were concentrated along the barrier islands and within the lagoon with few oldsquaws along the mainland shoreline (Fig. 23, Table 11). Between West Dock and Pole Island, oldsquaws were concentrated in the lea of Cross Island and the McClure Islands (Fig. 24, Table 12). In the eastern lagoon, oldsquaws were concentrated along the barrier island shoreline, the mainland shoreline, and throughout the lagoon (Fig. 25, Table 13). Distribution maps for each survey area by survey day showing oldsquaw density by 30-second time period and vessel traffic are presented in Appendix A, along with the database records of human activity and vessel traffic (Table A1).

For the western lagoon, during the molt period, oldsquaw density was greatest on barrier island transects 202 and 31 on 11 August, and mid-lagoon transect 601 on 1 August, with more than 250 oldsquaw/km^2 (Table 11). During the post-molt period in the western lagoon, oldsquaw density was greatest on the mid-lagoon transects (601 and 302 on 26 August) with more than 100 oldsquaw/km^2 (Table 11). Between West Dock and Pole Island during the molt period, oldsquaw density was greatest on transect 131 on August 5; density was also greatest on this transect during the post-molt period (Table 12). Note that island, mid-lagoon, and shoreline transects alternate coverage (Tables 1 and 12). For the eastern lagoon, during the molt period, oldsquaw density was greatest on barrier island transects 134 and 135, and mainland shoreline transect 192 with over 300 oldsquaw/km^2 (Table 13). During the post-molt period in the eastern lagoon, oldsquaw density was greatest in the mid-lagoon transect 605 with more than 100 oldsquaw/km^2 (Table 13). Oldsquaw were observed on the tundra transects between Brownlow Point and the Shaviovik River at three of the four transects on 30 July, and on one of four transects on 1 August (Table 13). Oldsquaws were not observed after 1 August on the tundra transects (Table 13).

For individual surveys, between 38% and 58% of oldsquaw sightings were in the water along the barrier island shoreline with a mean of 46% for all surveys (Table 14). Mid-lagoon sightings ranged from 26% to 38%, with a mean of 32%. And sightings along the mainland shoreline in the water ranged from 4% to 13% by survey with a mean of 10% (Table 14). Most oldsquaws were swimming when sighted, 80% of sightings for all surveys (range 65% to 91%, Table 15). The proportion of sightings with birds flying remained constant at approximately 3% for individual surveys (Table 15). The proportion of sightings with birds hauled out remained near 8%, dropping to 1% or 2% after August 11 (Table 15). The proportion of sightings with birds diving at the approach of the airplane increased steadily from 4% on 30 July to 30% on 11 August, and then declined to 3% on 26 August (Table 15).

Comparisons of oldsquaw distribution maps of the eastern lagoon area during the molt-periods in 1998 and 1999 indicated that more oldsquaws were within the lagoon than along Flaxman Island in 1999 (Figures 25 and 26) compared to 1998 (Noel et al. 1999). Because there was an extra set of mid-lagoon transects in 1999, which has the visual effect of filling between the barrier island and mainland shoreline, we excluded the extra mid-lagoon transects when comparing abundance among years (Fig. 27). This analysis also indicated that fewer birds were along Flaxman Island transect 136 in 1999 than in 1998; and that correspondingly more oldsquaws were counted on the mid-lagoon transect 180 in 1999 compared to 1998 (Fig. 27).

When mean oldsquaw densities from surveys conducted during the period 1989 to 1999 were expanded to numbers of individual oldsquaws in the various habitat strata (e.g., barrier island, mid-lagoon, mainland shoreline; oldsquaw transect density * transect area), it appears that the number of oldsquaws present in the mainland shoreline stratum in the western lagoon, was not a significant proportion of the total number of oldsquaws present in the total lagoon system (Figures 28 and 29). In the eastern lagoon, in contrast, the proportion of oldsquaws in the mainland shoreline stratum was markedly higher (Figures 28 and 29). This is consistent with our 1999 distribution maps (Figures 23, 25, A1-A15). Data used to generate these figures are found in Table A3.

Other Ducks

Aside from oldsquaw, only a few other duck species were recorded regularly. Northern pintail *(Anas acuta)* occurred in 33 flocks with a mean flock size of 9 in the western lagoon between Spy Island and West Dock during 1999. Northern pintails occurred in 11 flocks with a mean flock size of 25 in the eastern lagoon between Pole Island and Brownlow Point. For the entire survey area, density of northern pintails was 0.32 birds/km^2 (Table 6). Three flocks of Greater scaup *(Aythya marila)* were recorded in the western lagoon with a mean flock size of 7. A single red-breasted merganser *(Mergus serrator)* was recorded in the eastern lagoon and one flock of nine red-breasted mergansers was recorded in the western lagoon (Tables 4 and 5).

Geese and Swans

Geese were most abundant before 26 August within the survey areas (Fig. 30). Comparing the lagoon transects only, there were roughly five times as many geese and swans in the western lagoon as the eastern lagoon (Figures 30-33, Table 4 and 5). Inland from the eastern lagoon, however, between Brownlow Point and the Shaviovik River, geese were more abundant (Figures 30 and 33). Very few geese were sighted between West Dock and Pole Island (Figures 30 and 32), noting that the coastline transects in this area were flown only twice (Table 1). Greater white-fronted geese *(Anser albifrons)* were the most numerous geese with a linear density in the study area of 0.77 geese/km (Fig. 30, Table 6). Black brant (*Branta bernicla)* were the next most numerous geese with a linear density of 0.45 geese/km (Fig. 30, Table 6). Black brant occurred in the western lagoon and between West Dock and Pole Island (Figures 30-33). Tundra swans (Cygnus columbianus) occurred primarily on the tundra transects between Brownlow Point and the Shaviovik River (Fig. 30).

Polar Bears

One polar bear *(Ursus maritimus)* was sighted on 26 August on Flaxman Island.

DISCUSSION

In general oldsquaw population sizes are most likely regulated during reproduction by the abundance of food in freshwater lakes and ponds (euphyllopods [fairy shrimp] and Chironomids), spring weather, and predation pressure from arctic foxes (*Alopex lagopus*), glaucous gulls, jaegers, and common ravens (*Corvus corax*) (Pehrsson 1973, 1974, 1985 in Johnson and Herter 1989). This aspect of the biology of oldsquaws appears to be contradictory to other sea ducks, whose populations are believed to be regulated more by adult survival rates than by annual production (Elliot 1997).

Oldsquaws are 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 molt period, male oldsquaws 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, with the highest densities generally occurring immediately south of barrier island shorelines. The 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). Undisturbed molting oldsquaws 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. During mid-day, oldsquaws typically move farther from shore into mid-lagoon habitats to feed (Johnson 1982). During periods of strong southwesterly winds, oldsquaws move toward the mainland coast and/or out through the inter-island passes where they can take shelter in the lee of the mainland coast or north of the barrier islands (Johnson and Richardson 1981).

During periods of disturbance and rough water, Johnson (1982) found that oldsquaws responded by moving to a nearby location that provided protection from wind and waves. This suggests that the recorded changes in distribution were primarily related to weather conditions rather than disturbance, but a decline in overall oldsquaw numbers within their study area over the course of the study indicated that there was also 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 molting oldsquaws. 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).

Unlike any previous year, 1999 was unique in that both the western study area (Simpson Lagoon-Gwydyr Bay area) and the eastern study area (Lions Lagoon-Flaxman Island area) were both occupied throughout the summer oldsquaw molt period by several teams of USFWS biologists who were trying to capture large numbers of molting oldsquaws. These capture programs involved the establishment of summer camps on Bodfish Island (Simpson Lagoon) and on Flaxman Island, and involved near-daily capture efforts using nets and several boats which attempted to herd the molting ducks into capture nets at each location. The disturbance associated with this capture effort in 1999 is unprecedented in the nearly 25 years of biological research that has been conducted in the barrier island-lagoon systems along the Beaufort Sea coast of Alaska. Studies elsewhere (Armstrong 1996) have shown that disturbances associated with intensive biological research activities can affect the productivity of waterfowl. A similar situation may be developing on the North Slope, and concerted efforts by both government and industry should be expended to coordinate biological research activities and reduce overall disturbance to breeding, molting, brood-rearing, and migrating waterfowl.

The presence of the USFWS camp on Flaxman Island and their oldsquaw capture activities, which involved extensive use of small boats and nets (Petersen et al. 1999), apparently displaced oldsquaws from barrier island shoreline habitats to mid-lagoon habitats. The overall total number of oldsquaws present in the eastern lagoon, however, appeared to be similar to 1998, when no USFWS activity occurred in the eastern lagoon (Figures 27 and 28). The USFWS also established a camp with oldsquaw capture activities on Bodfish Island in the western lagoon. However, we do not have comparable data for the western lagoon during 1998. In addition, short-term disturbance which results in changes in distribution during one molting season may have little effect on the numbers of birds returning to these areas in subsequent molting seasons (Ward and Sharp 1974).

There was a high degree of variability in the oldsquaw numbers on transects in Pole Island to Brownlow Point area between 1989 and 1999 (Fig. 28). This variation may be caused by a variety of factors, including wind speed and direction, sea state, and time of day that surveys were conducted. All of these factors are known to significantly effect the numbers of oldsquaws sighted on transects during systematic aerial surveys (Johnson 1990). Before conclusions can be made about overall trends in numbers of oldsquaws in one barrier island-lagoon complex, more information is needed about the fidelity of birds to specific lagoon systems from one year to the next, and more survey effort is needed in the mid-lagoon strata, where a very small change in the density of oldsquaws extrapolated over a very large area results in a very large number of birds. Before conclusions can be reached about trends in oldsquaw numbers, much more emphasis needs to be placed on developing weighting factors to correct for biases in oldquaw sightability due to weather and time of day.

AKNOWLEDGEMENTS

This study was funded by BP Exploration (Alaska) Inc. (BP). We thank Dave Trudgen for his support and suggestions concerning this study. Isaac Helmericks and Tammy Olson served as observers for aerial surveys and transcribed their data tapes. Shelley Schwenn assisted with document preparation. The survey aircraft was expertly piloted by Jim Helmericks, who has piloted these surveys since 1977.

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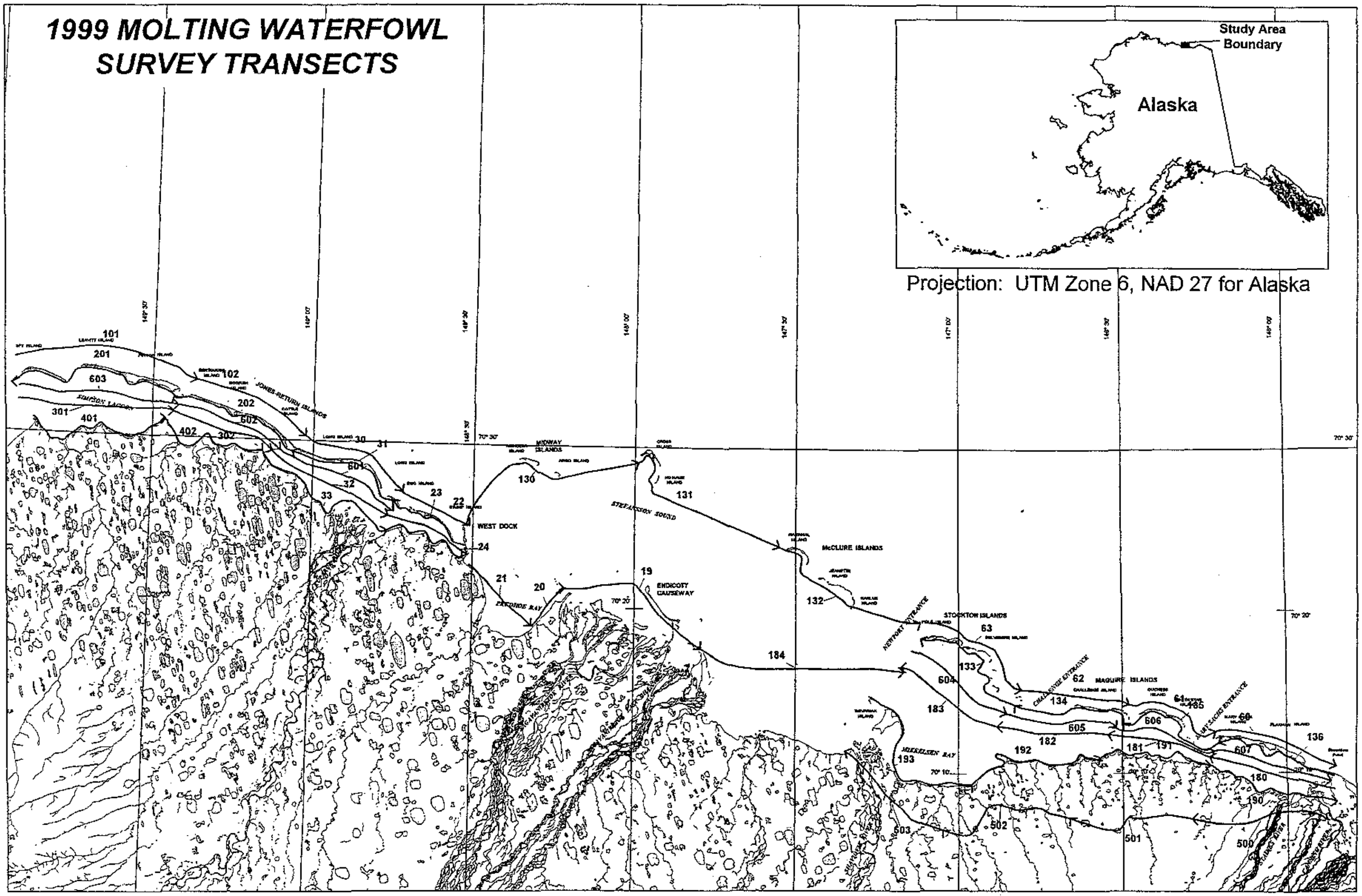

Figure 1. Locations and numbers for aerial survey transects in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska. Transect numbering is consistent with Johnson and Gazey (1992).

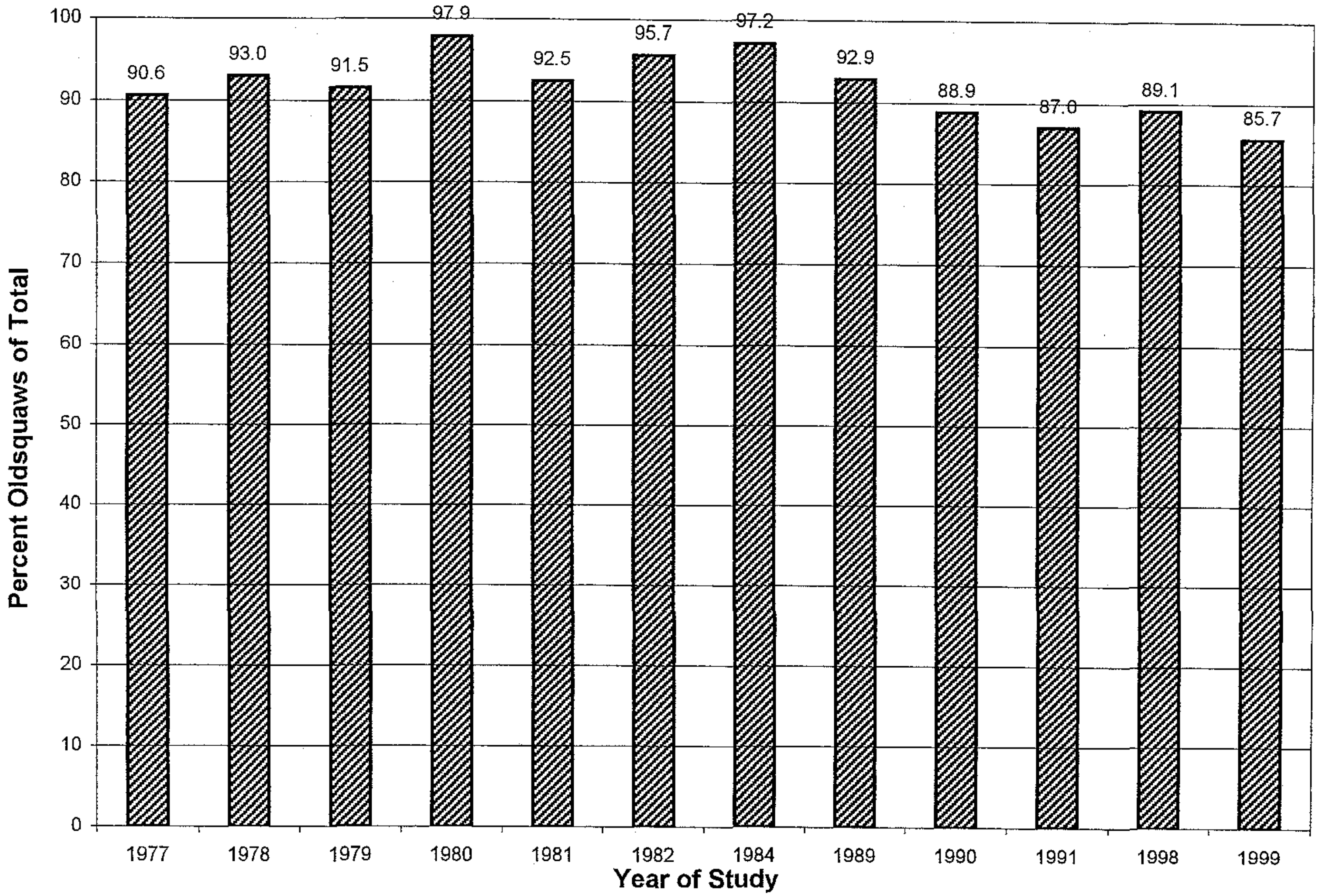

Figure 2. Oldsquaw sightings as percentage of all bird sightings for aerial surveys in nearshore waters of the central Alaska Beaufort Sea, 1977 to 1991 (Table A2, Johnson and Gazey 1992), 1998 (Noel et al. 1999) and 1999.

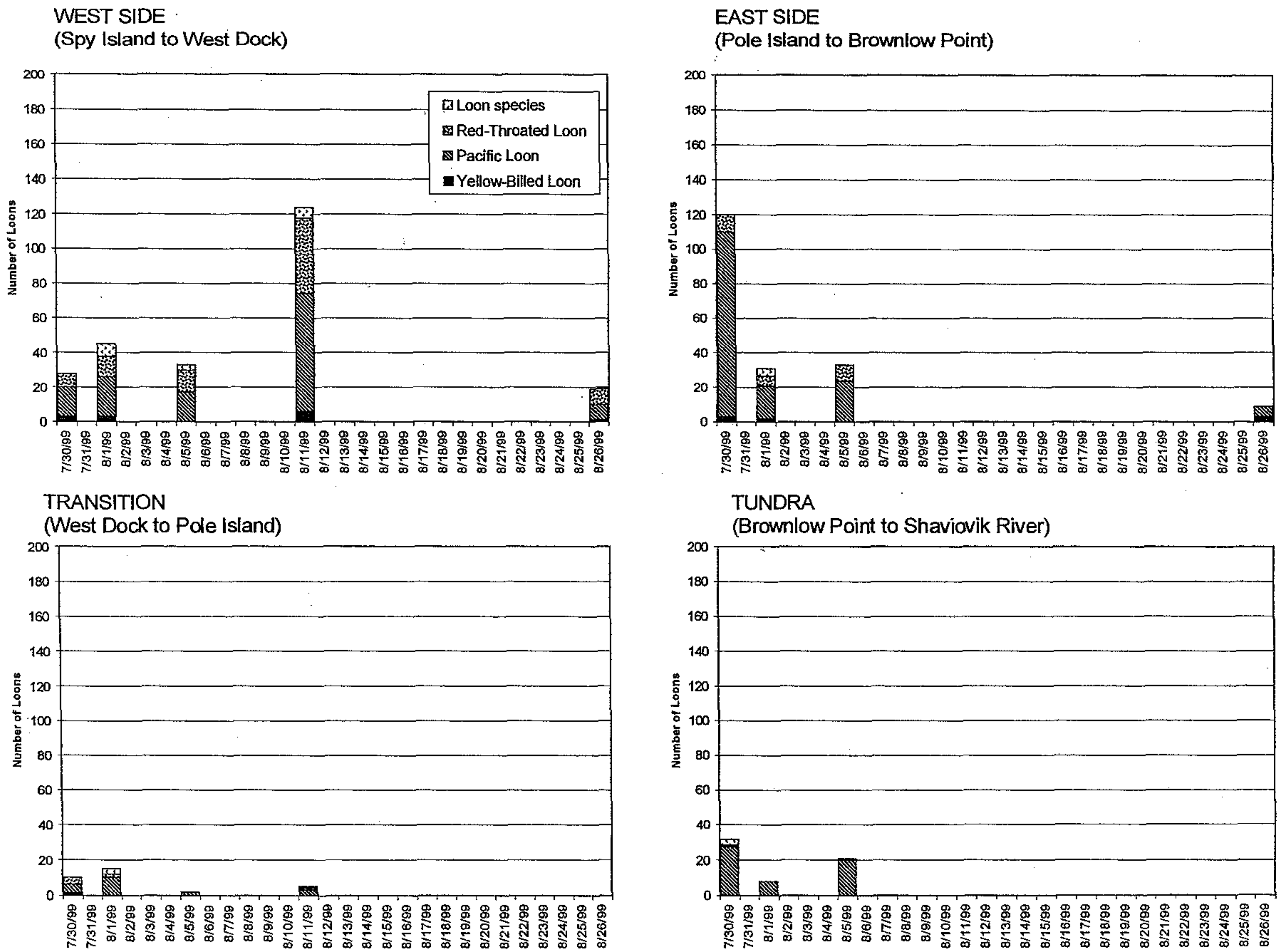

Figure 3. Total number of loons on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. The survey on 4 August covered the Transition area only. The Survey on 11 August 1999 covered the West Side and Transition areas only.

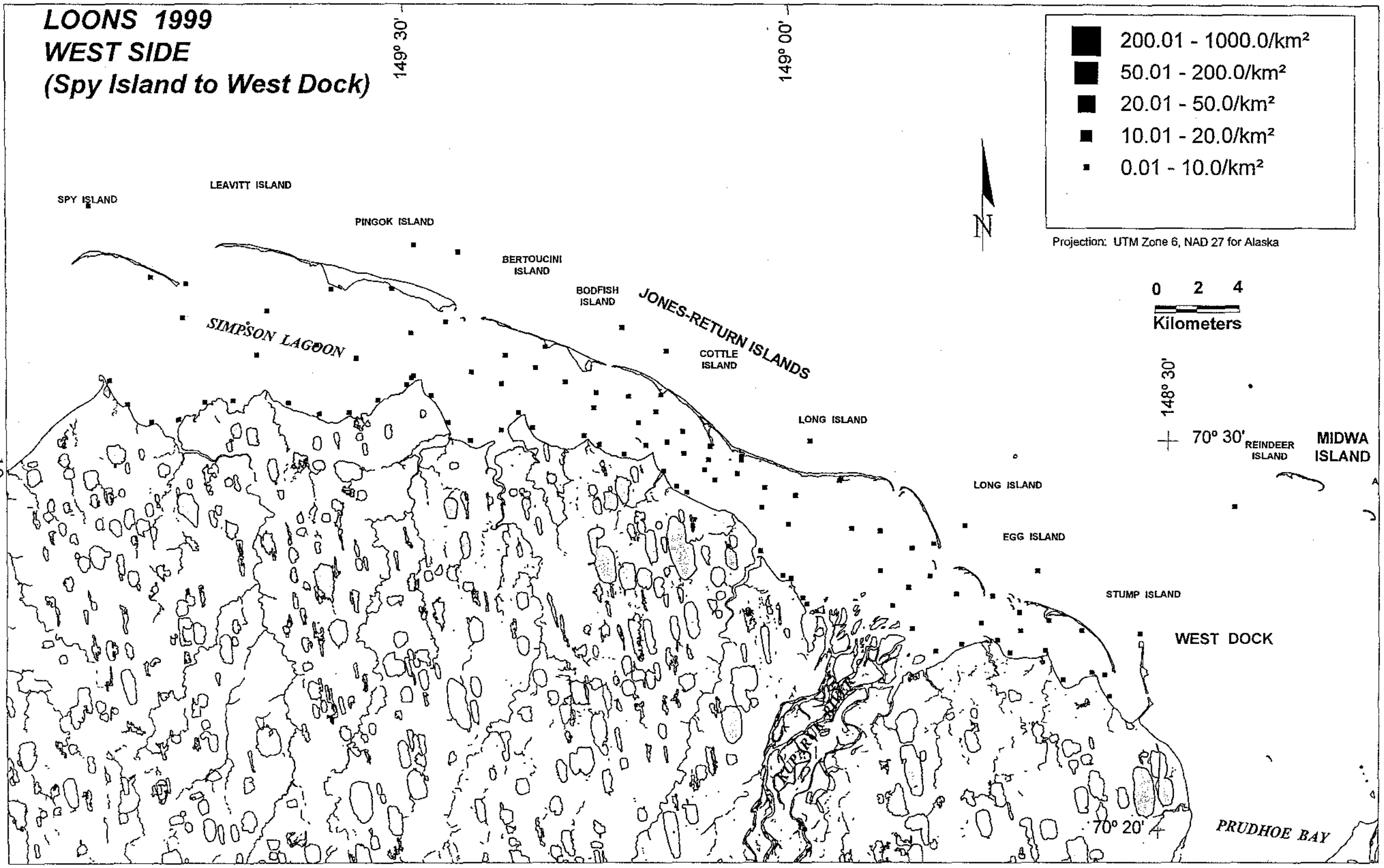

Figure 4. Summary of density for loons by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

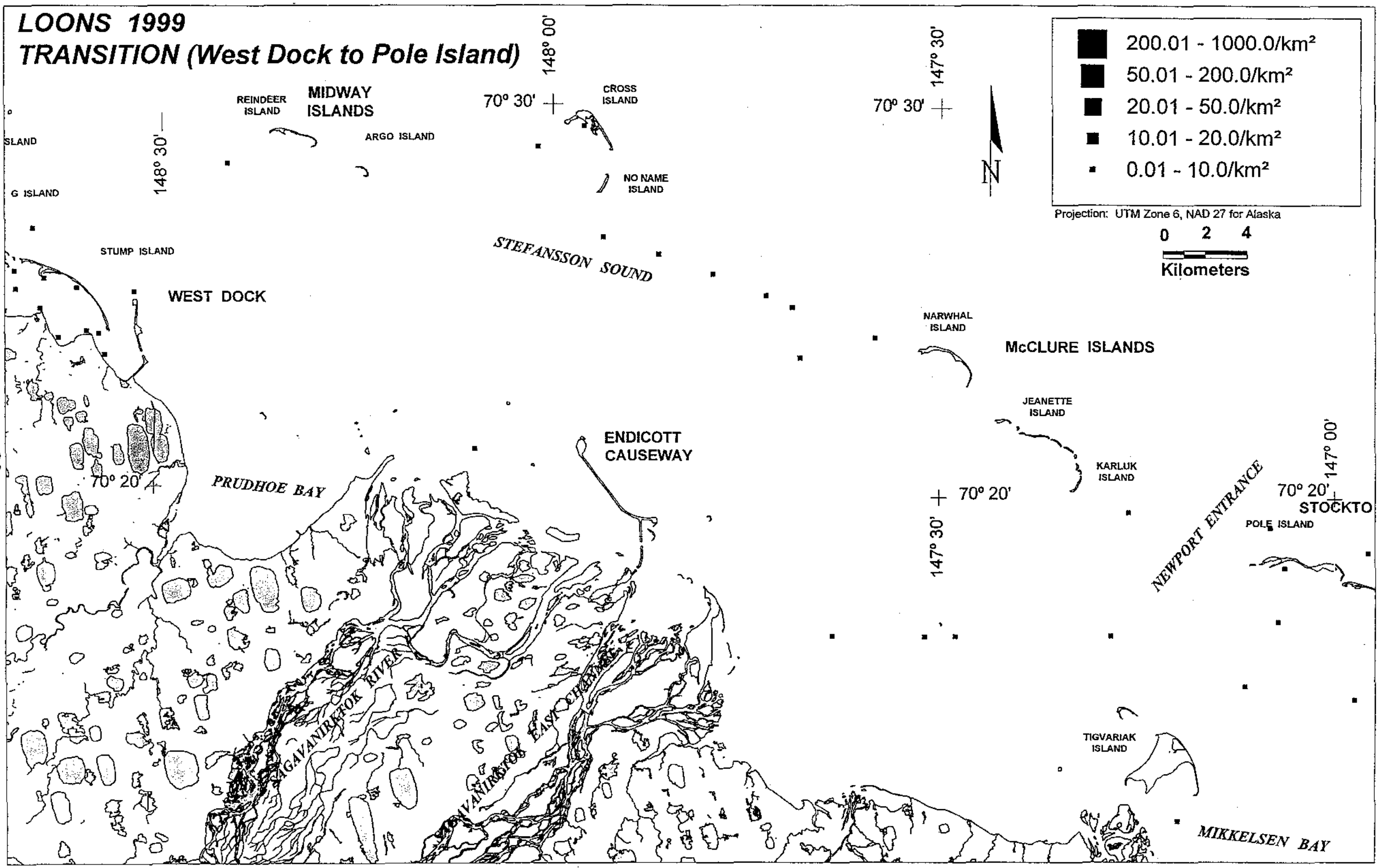

Figure 5. Summary of density for loons by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

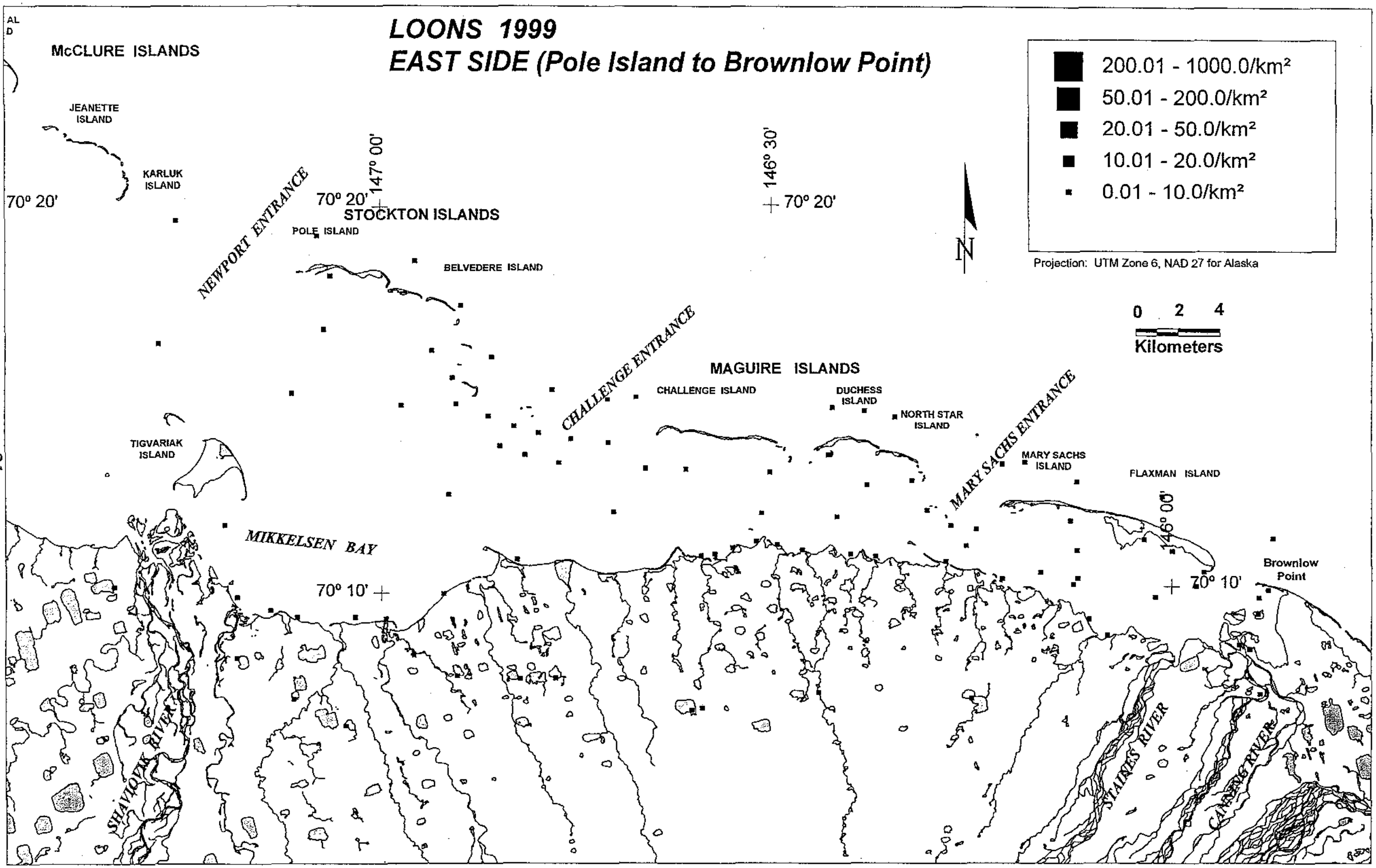

Figure 6. Summary of density for loons by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

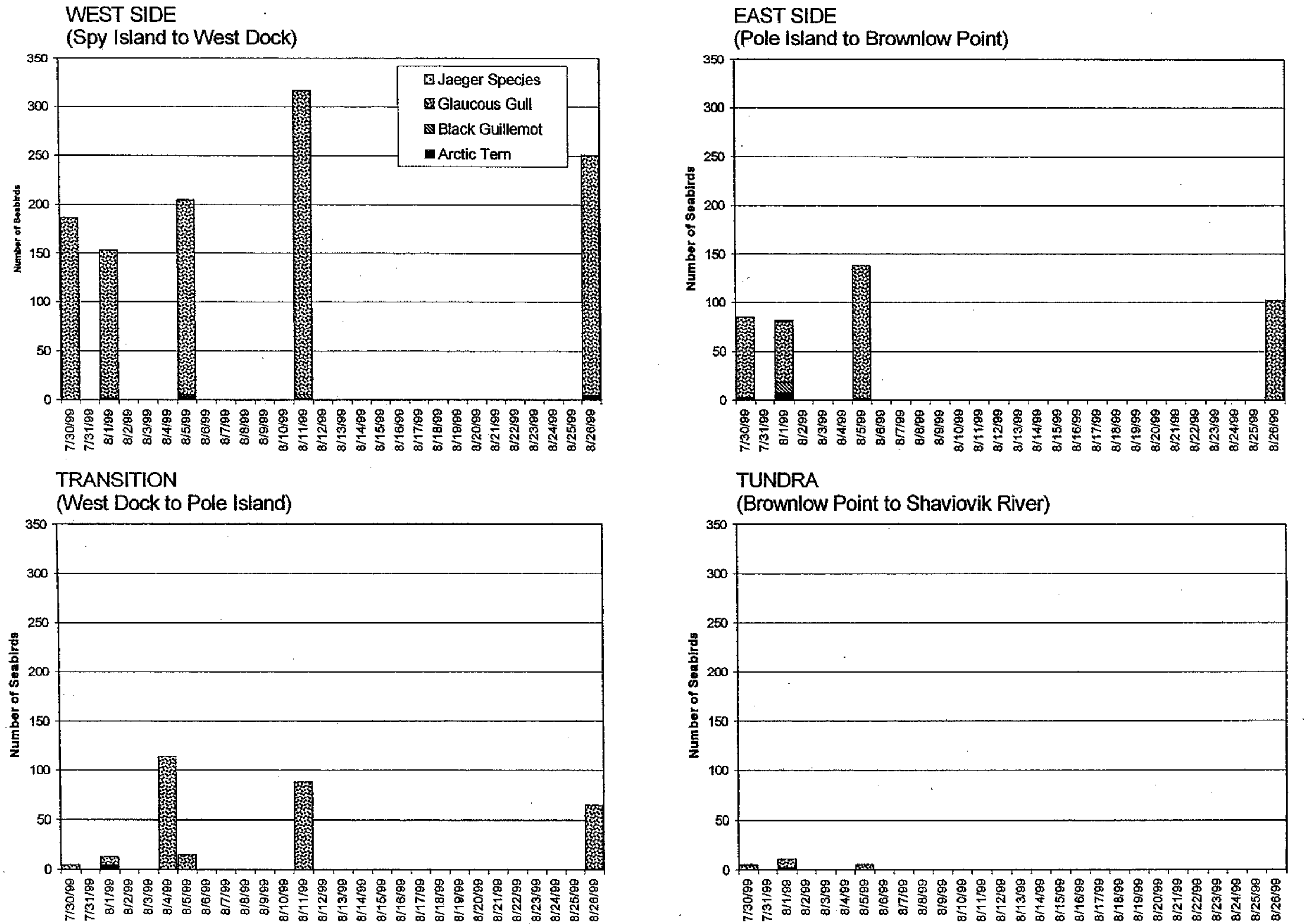

Figure 7. Total number of seabirds on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. The survey on 4 August covered the Transition area only. The Survey on 11 August 1999 covered the West Side and Transition areas only.

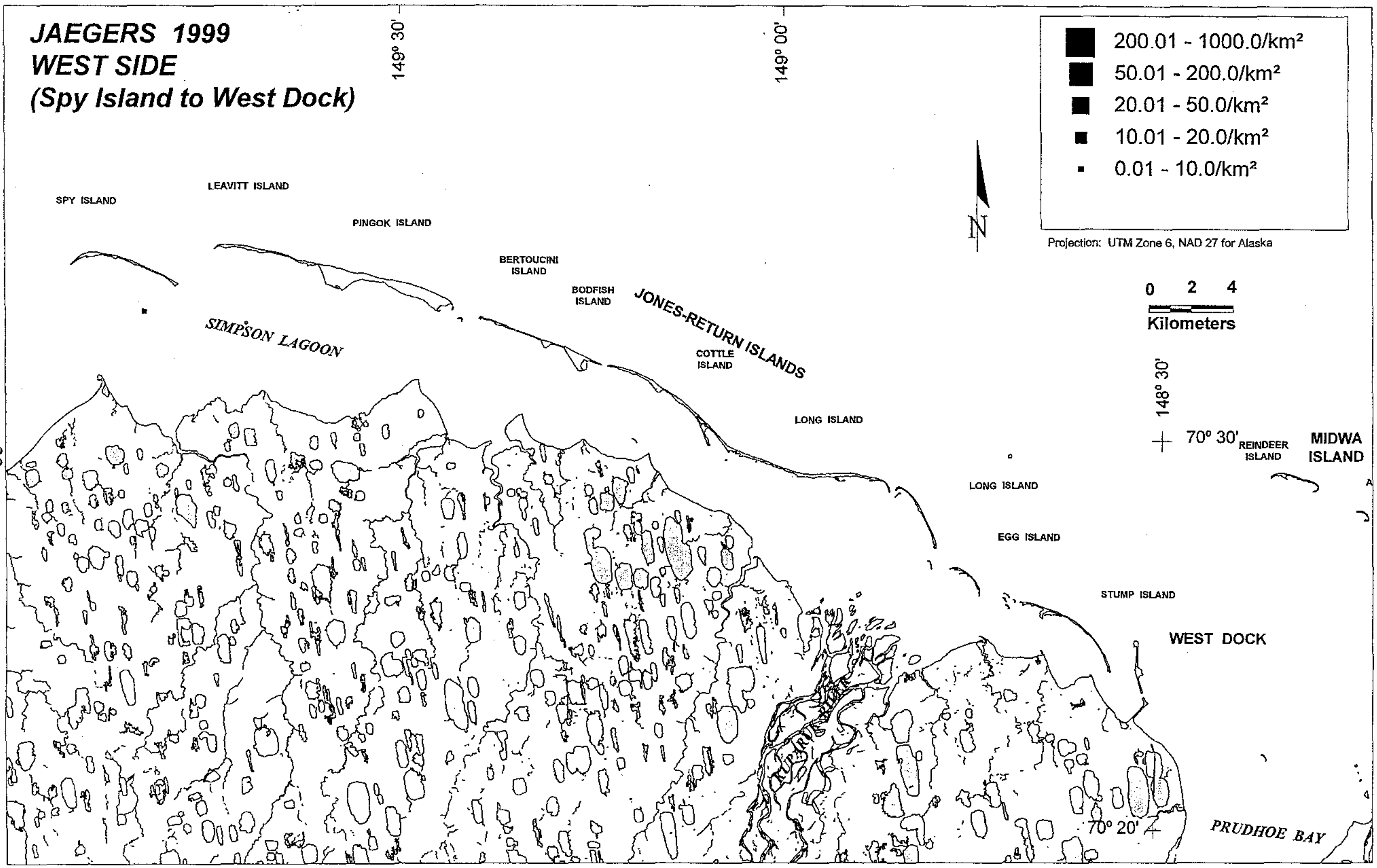

Figure 8. Summary of density for jaegers by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

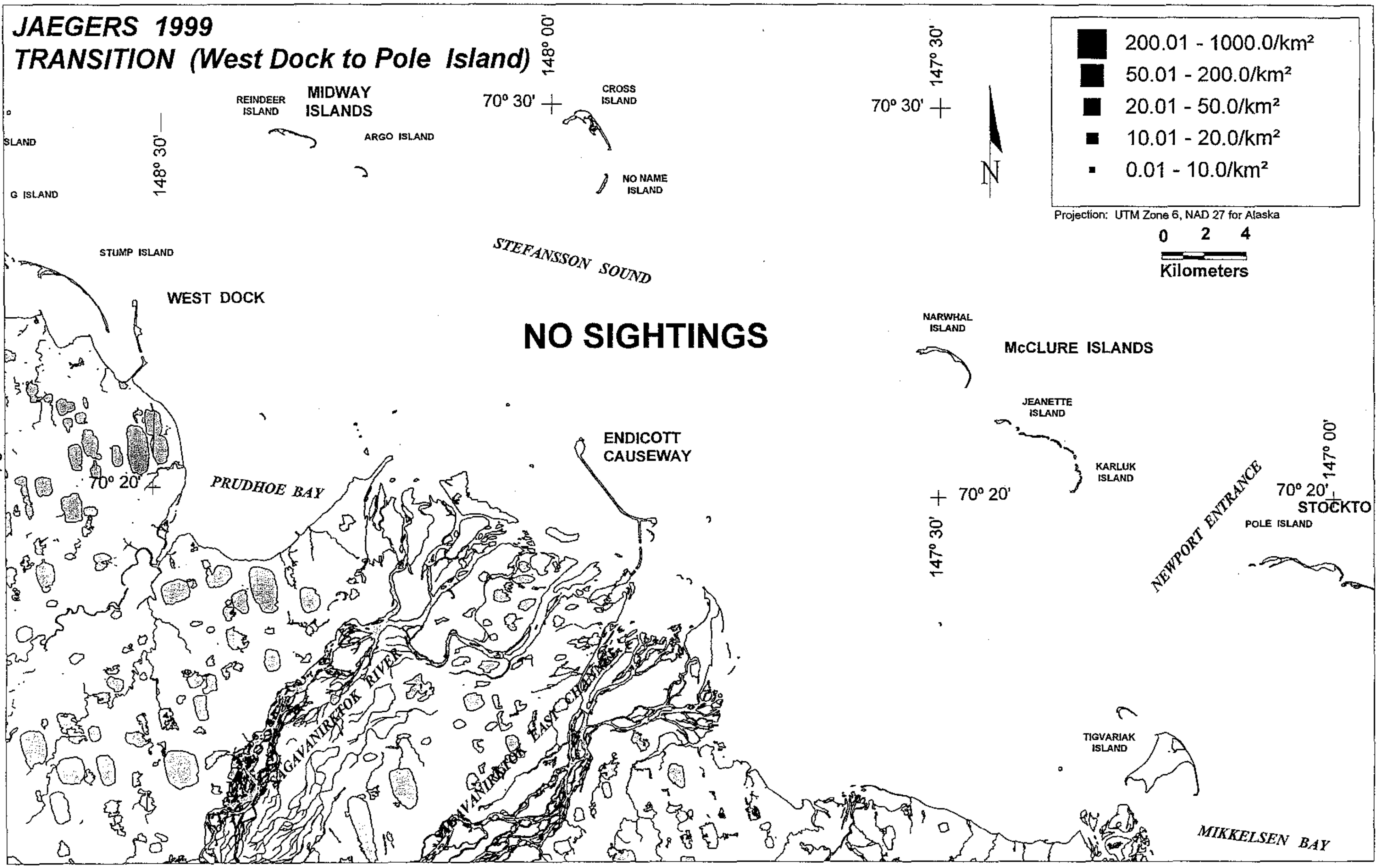

Figure 9. Summary of density for jaegers by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

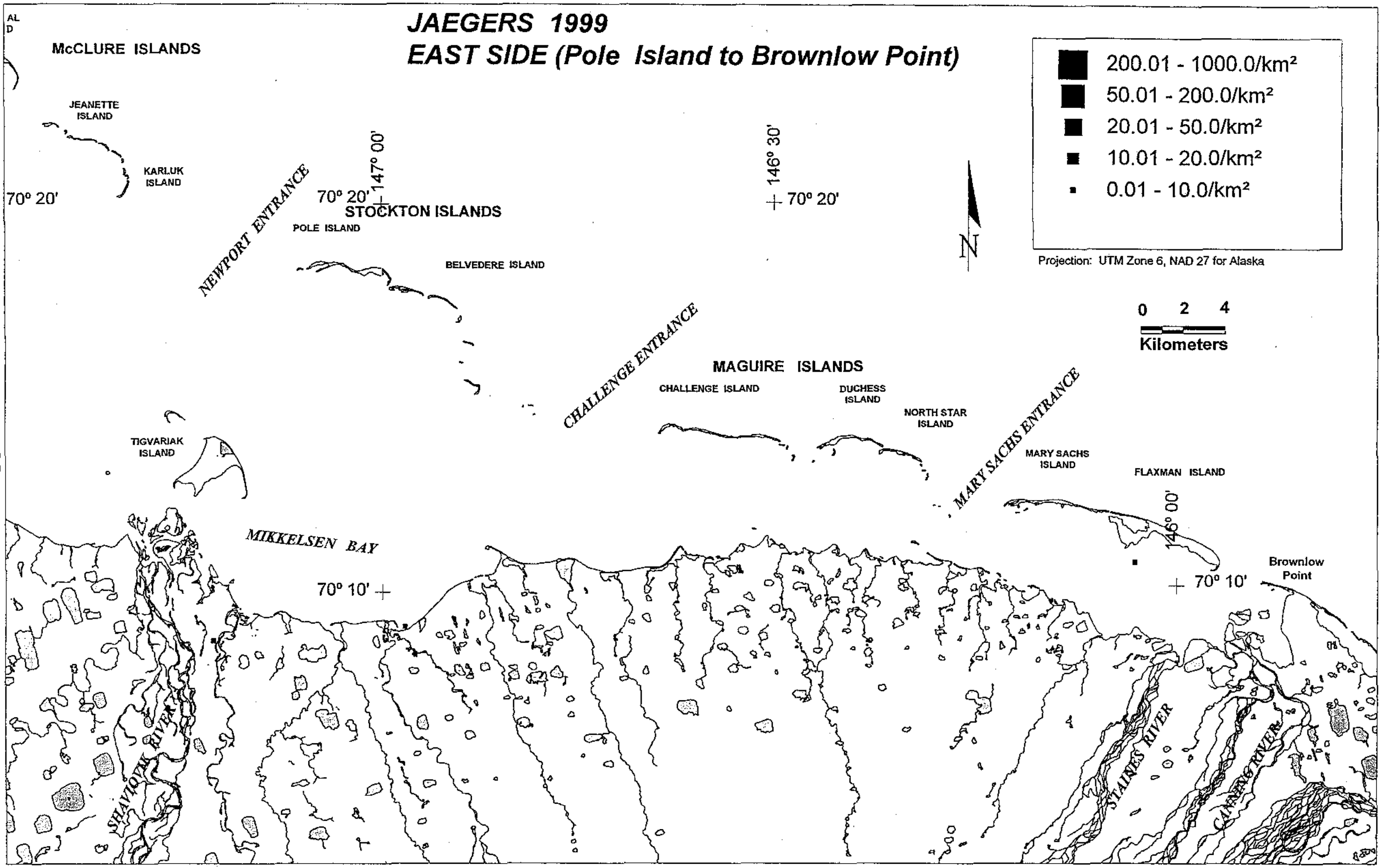

Figure 10. Summary of density for jaegers by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

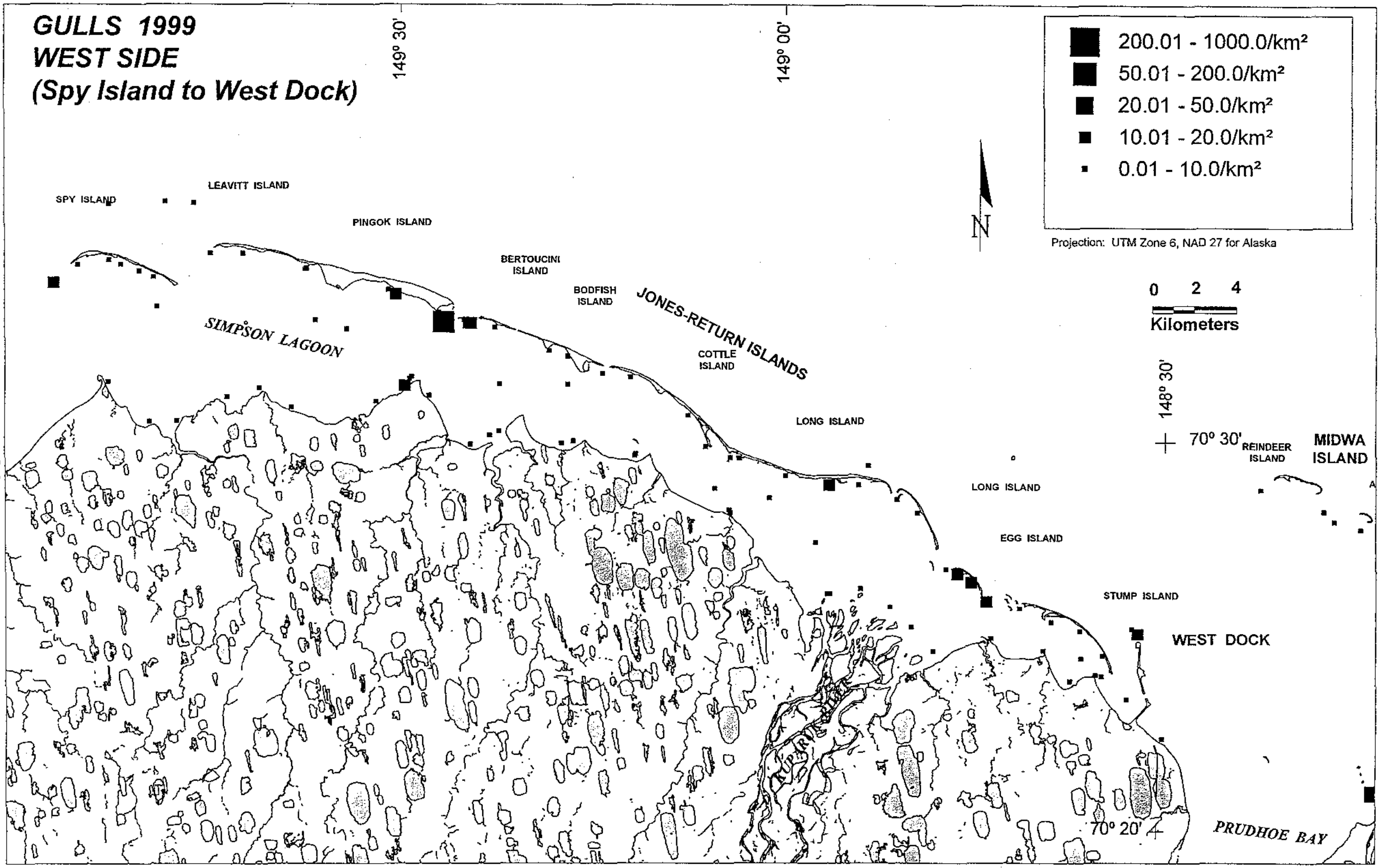

Figure 11. Summary of density for gulls by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

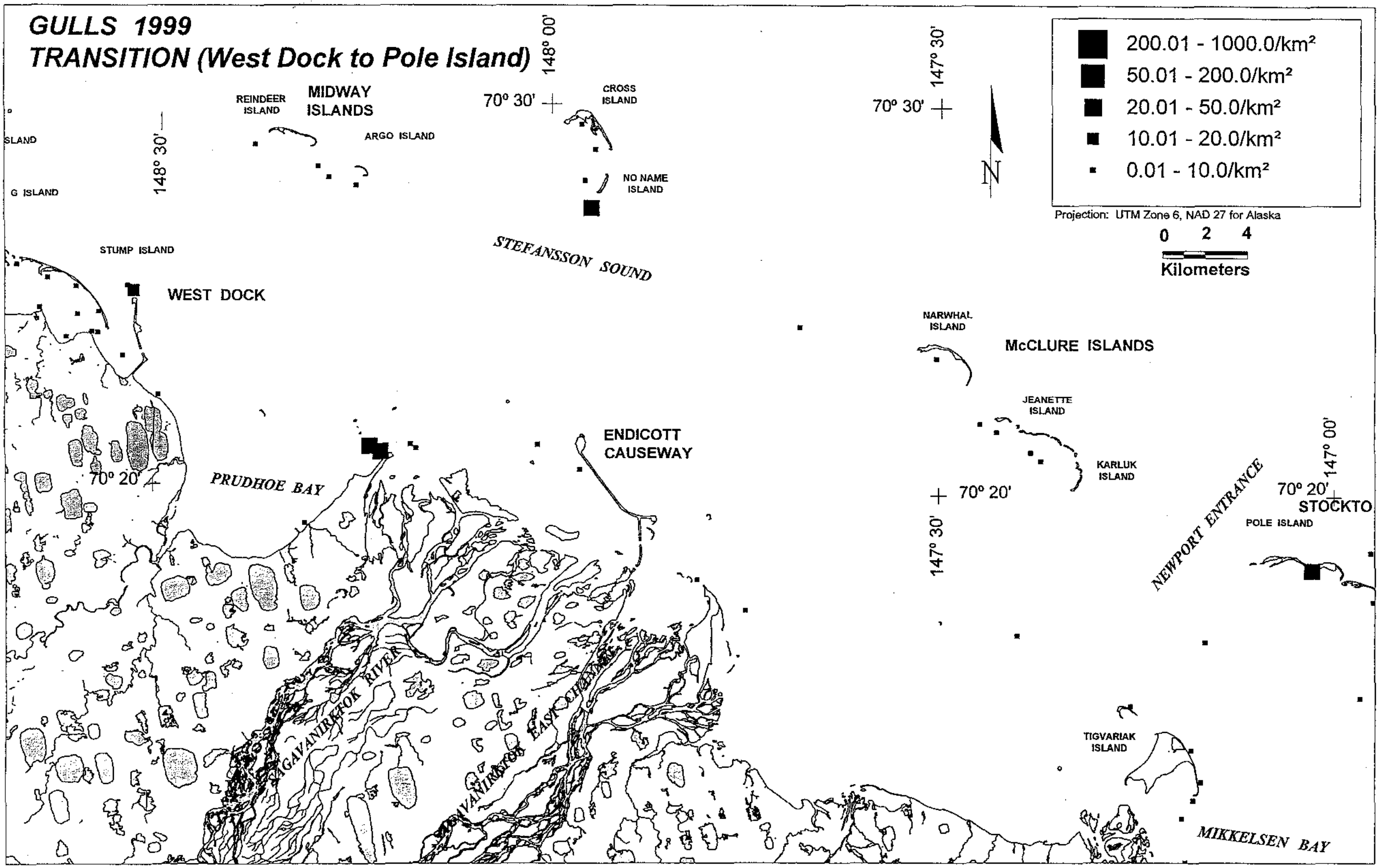

Figure 12. Summary of density for gulls by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

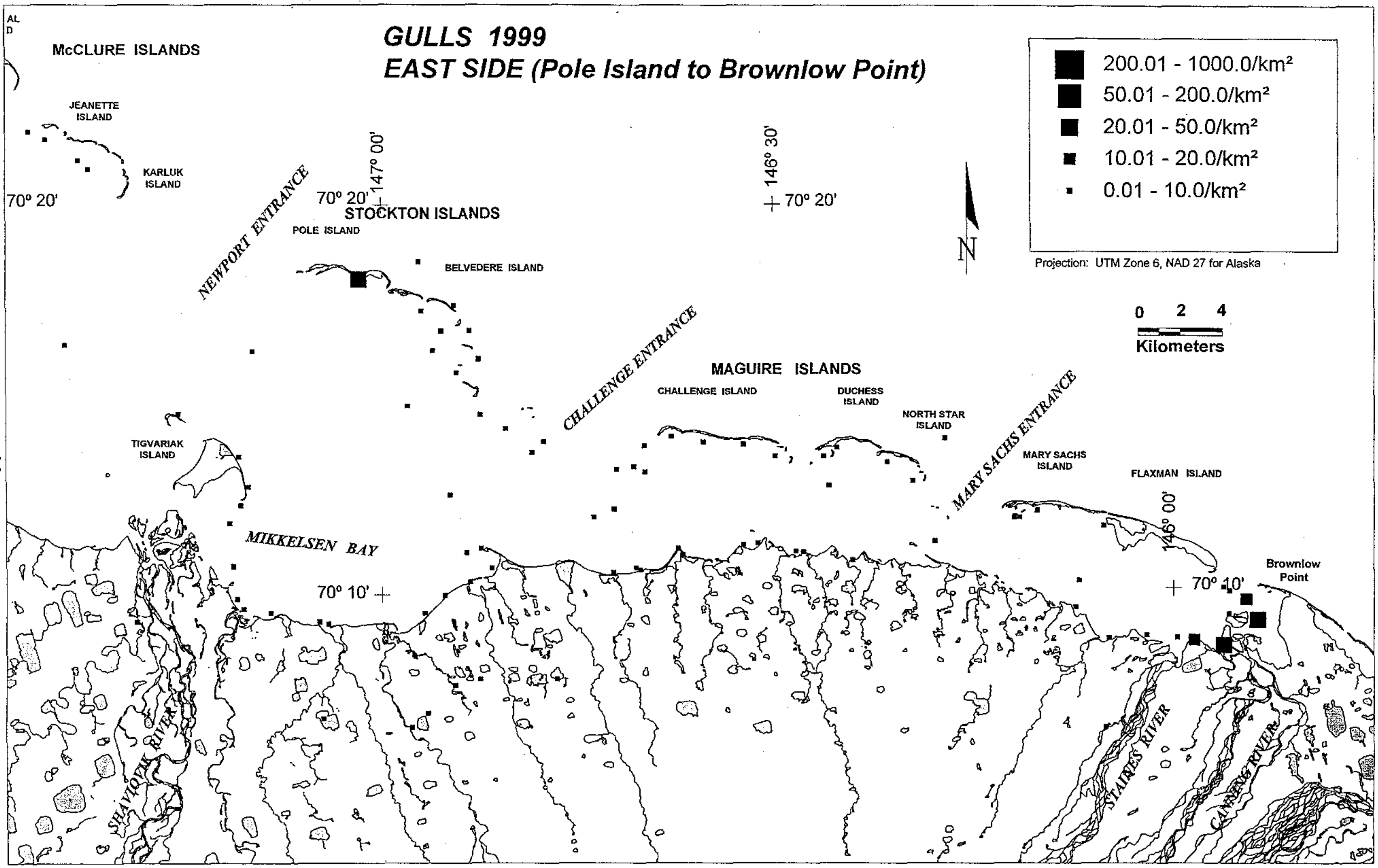

Figure 13. Summary of density for gulls by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

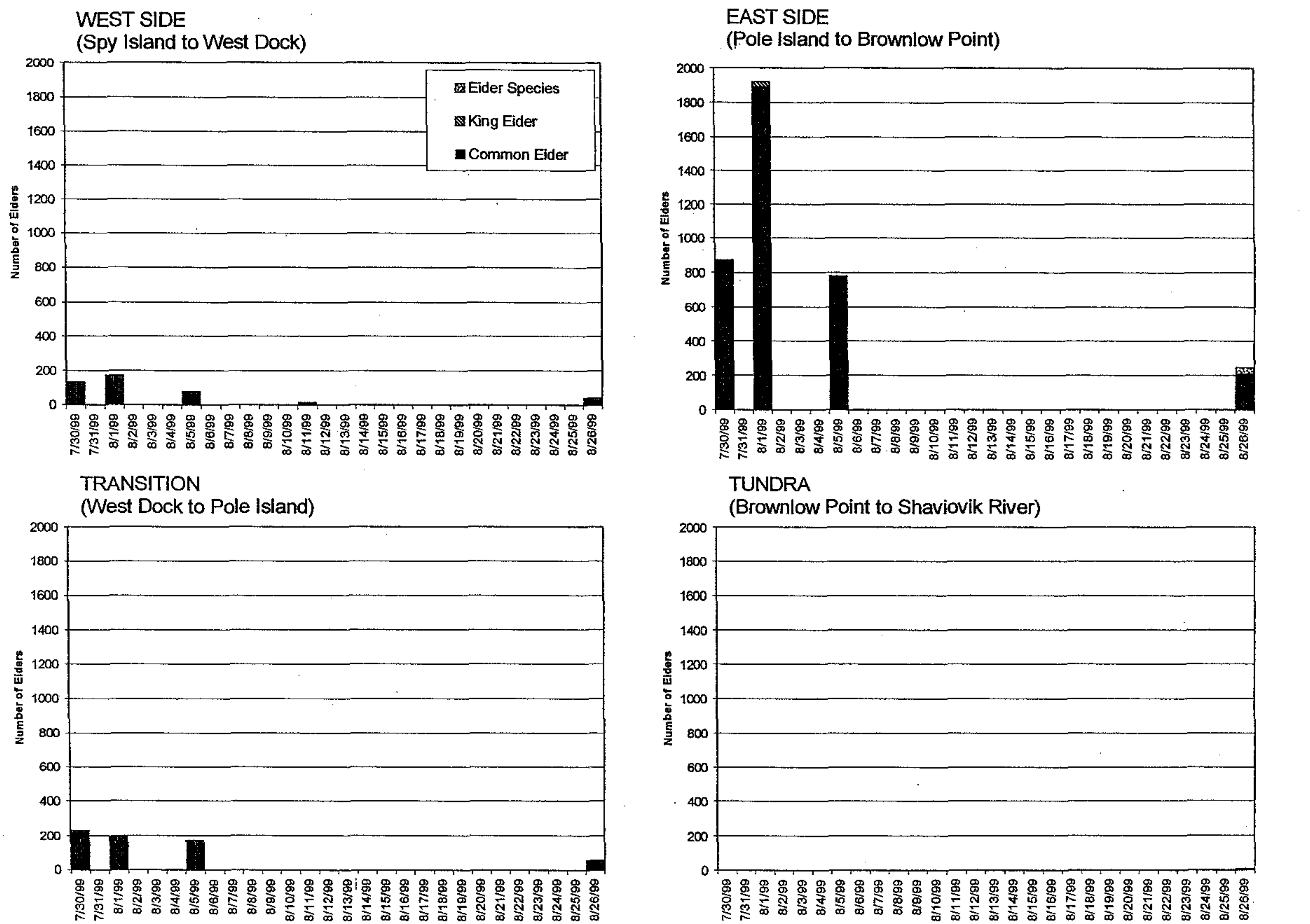

Figure 14. Total number of eiders on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. The survey on 4 August covered the Transition area only. The Survey on 11 August 1999 covered the West Side and Transition areas only.

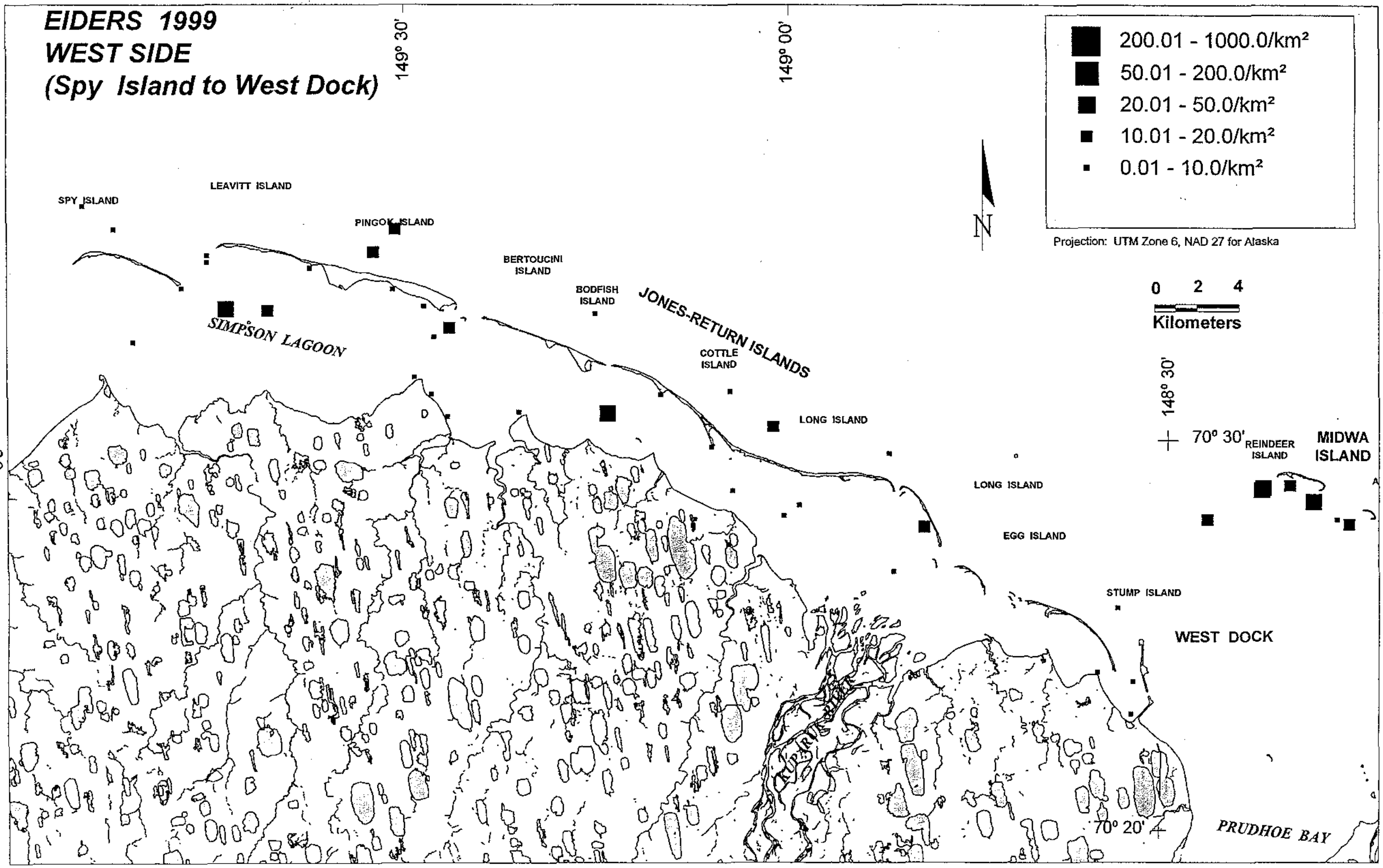

Figure 15. Summary of density for eiders by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

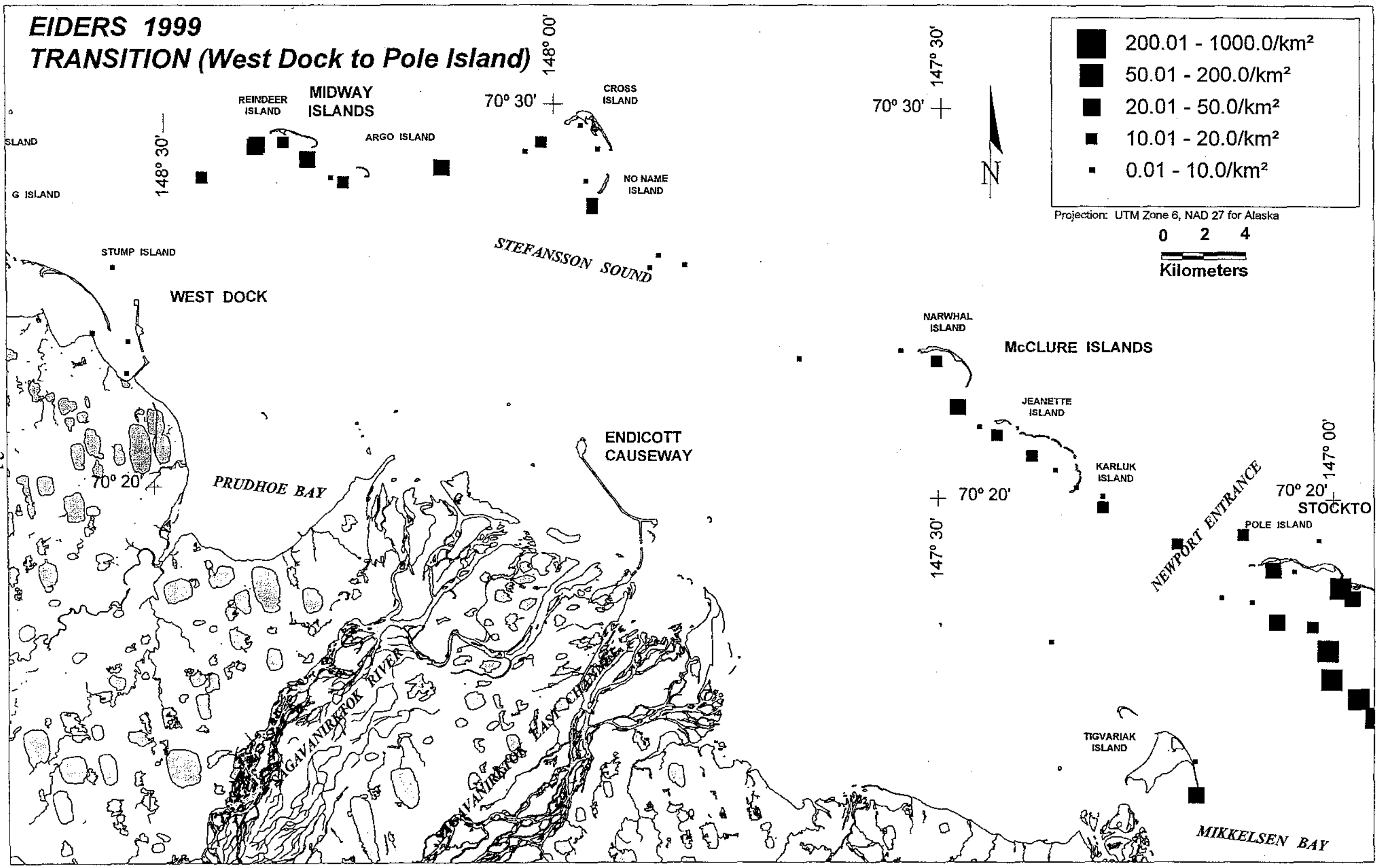

Figure 16. Summary of density for eiders by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

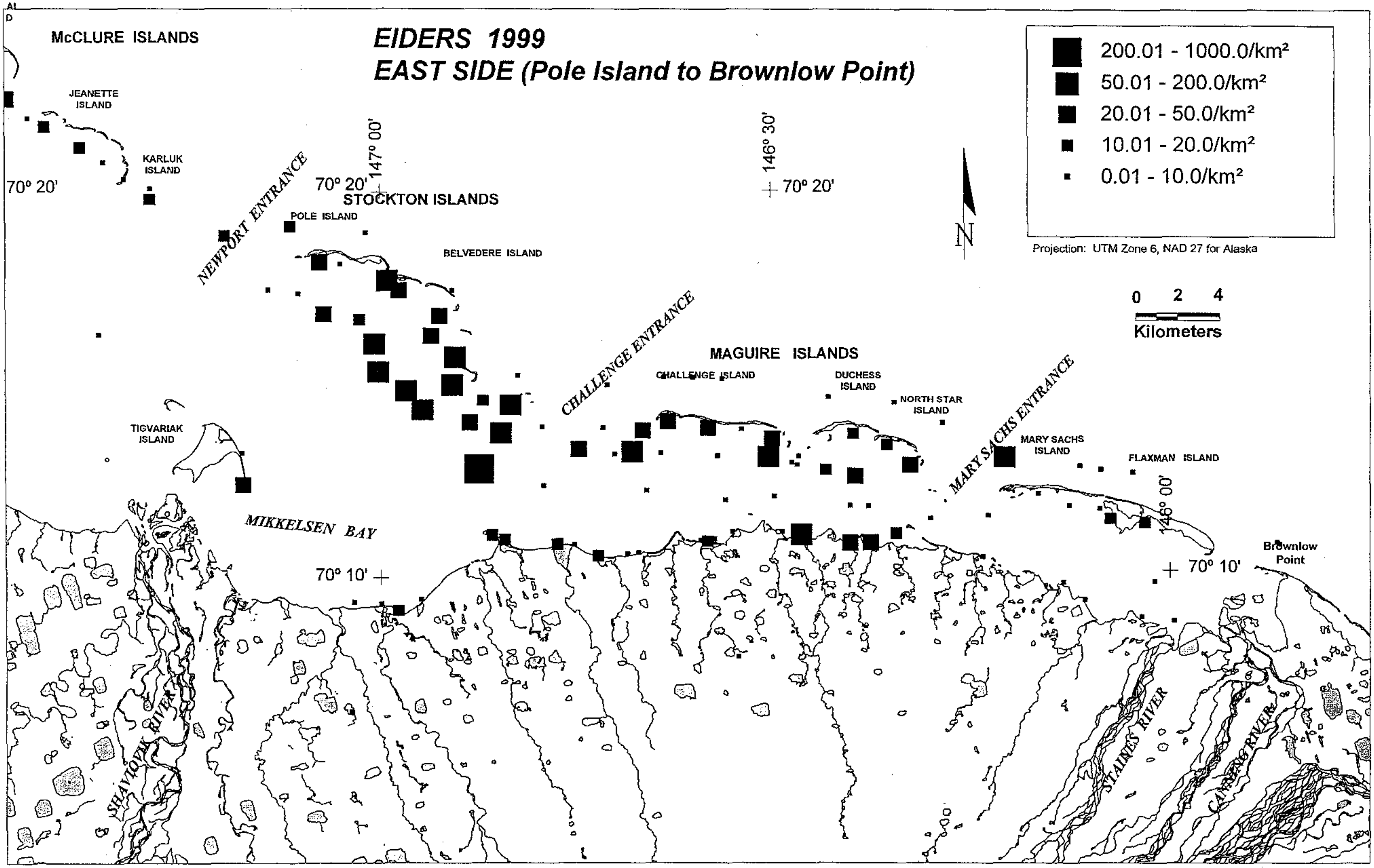

Figure 17. Summary of density for eiders by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

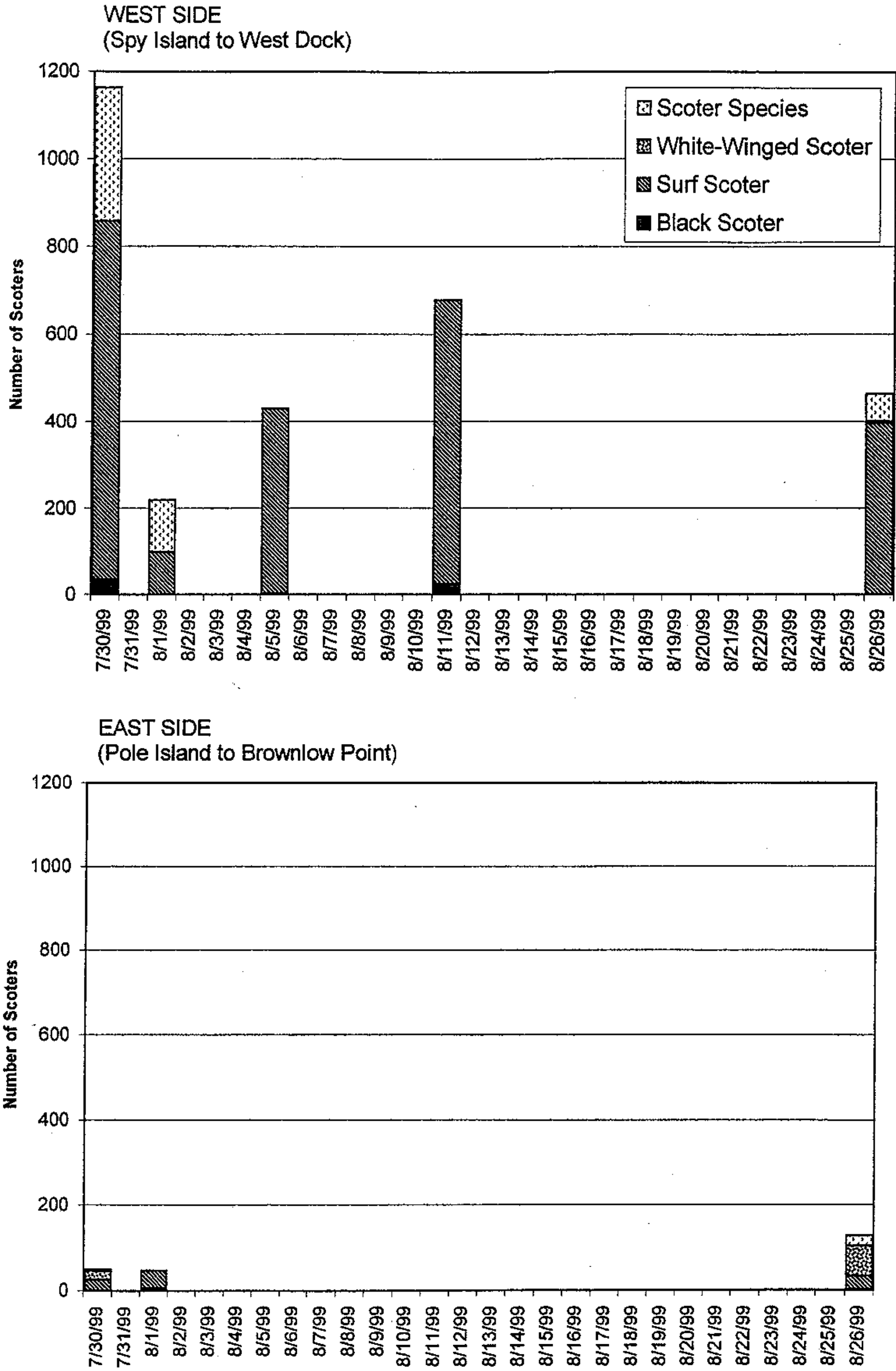

Figure 18. Total number of scoters on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. No scoters were recorded on Transition (West Dock to Stockton Islands) or Tundra (Brownlow Point to Shaviovik River) transects. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. Surveys on 4 and 11 August were incomplete coverage.

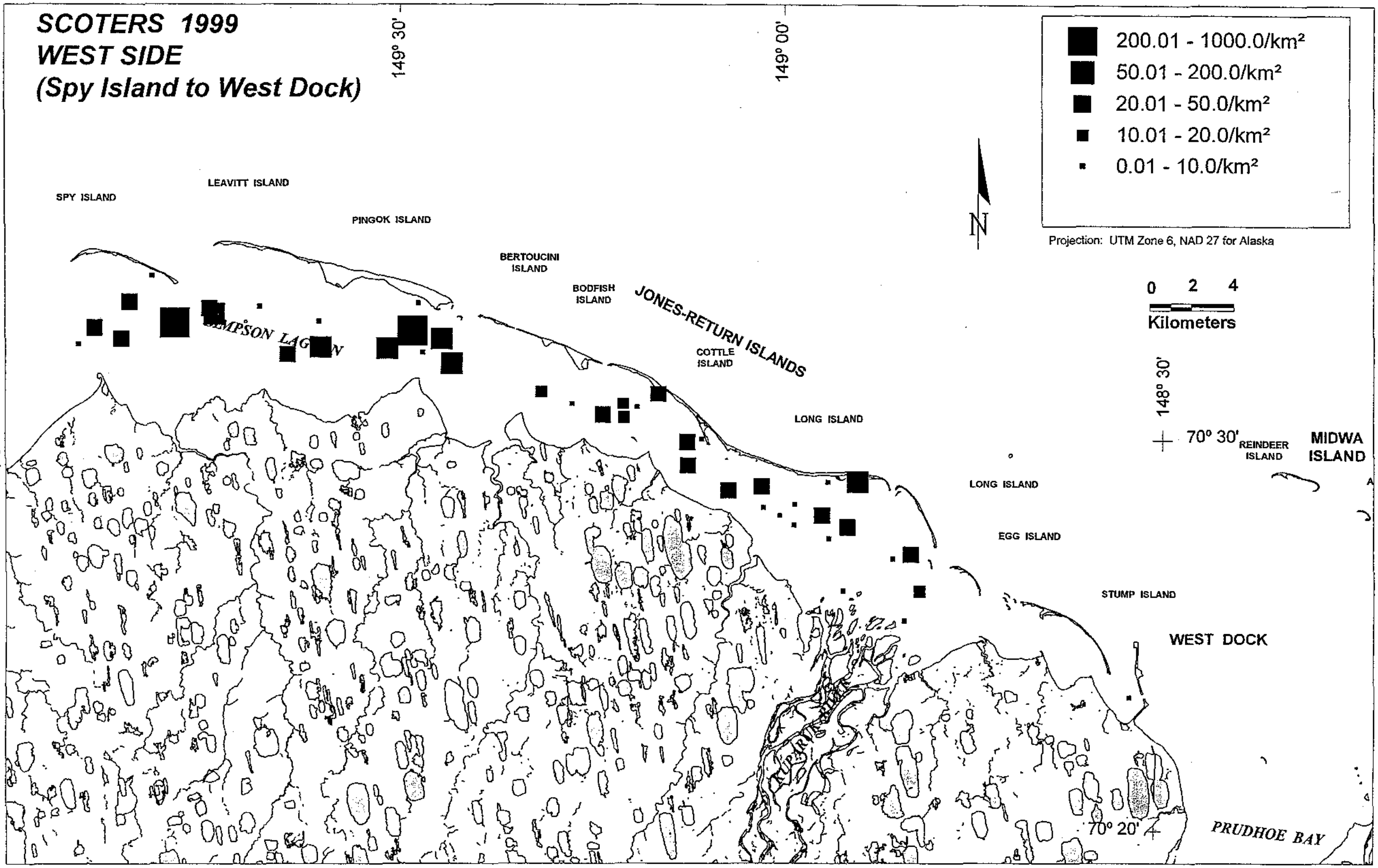

Figure 19. Summary of density for scoters by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

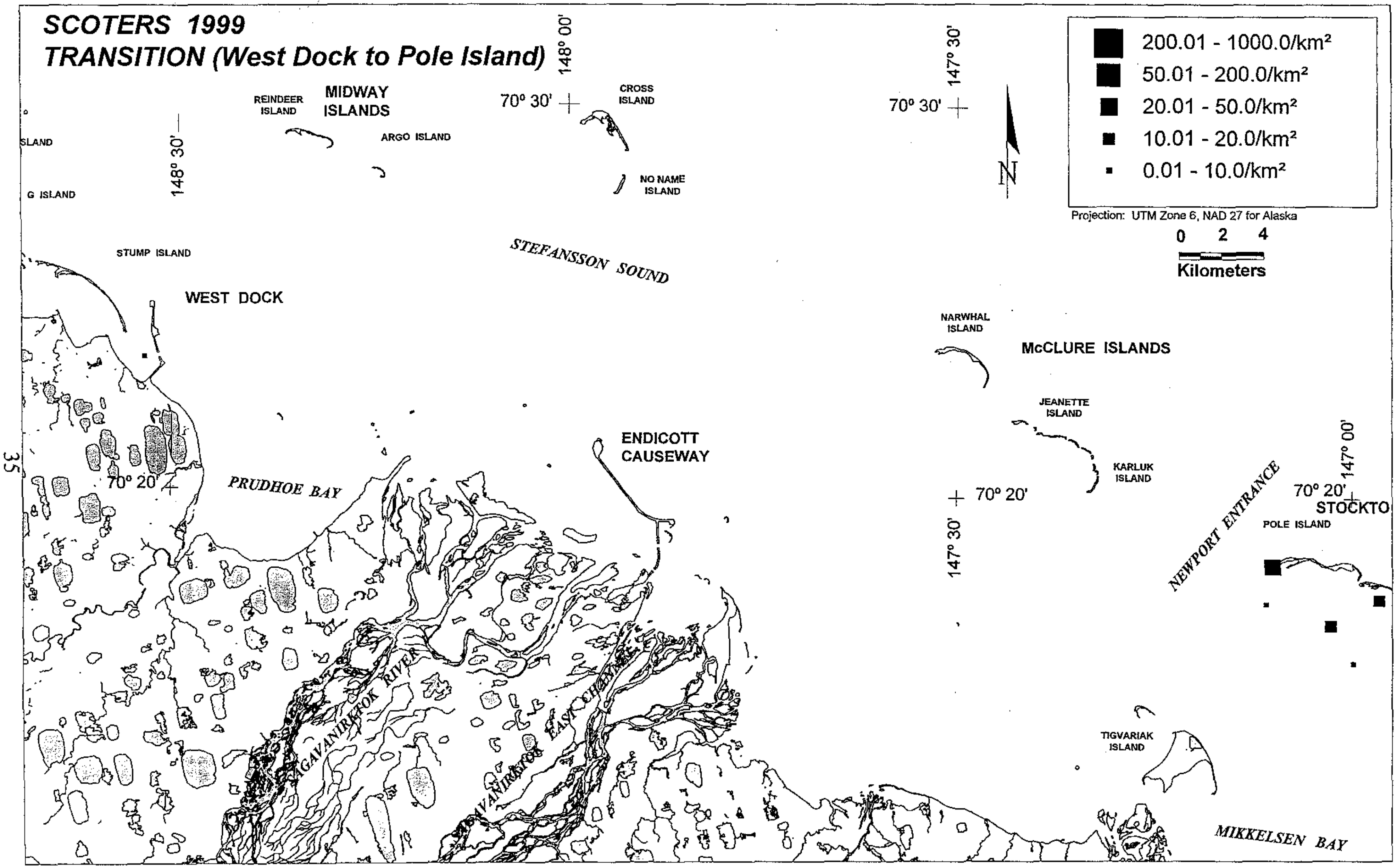

Figure 20. Summary of density for scoters by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

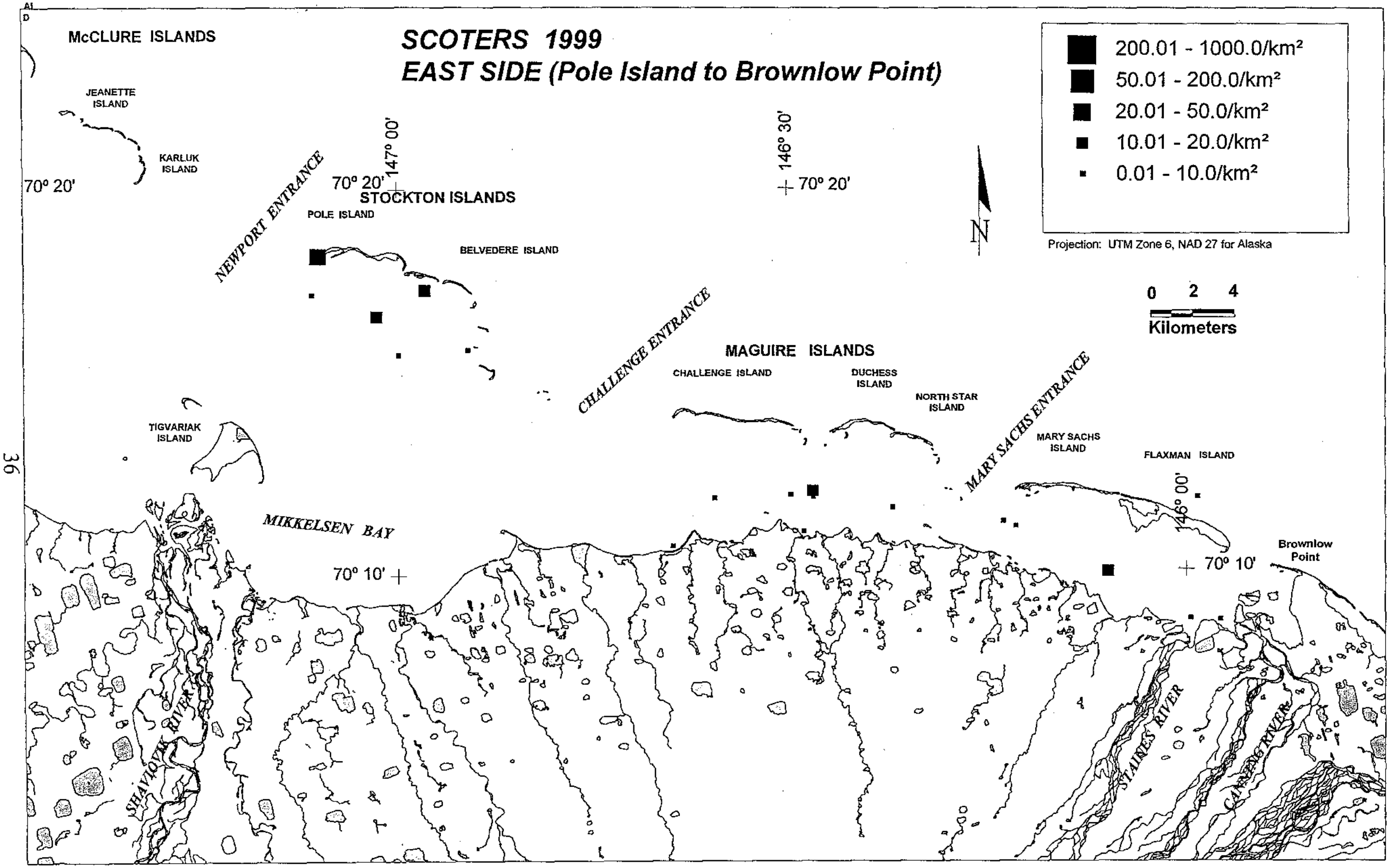

Figure 21. Summary of density for scoters by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

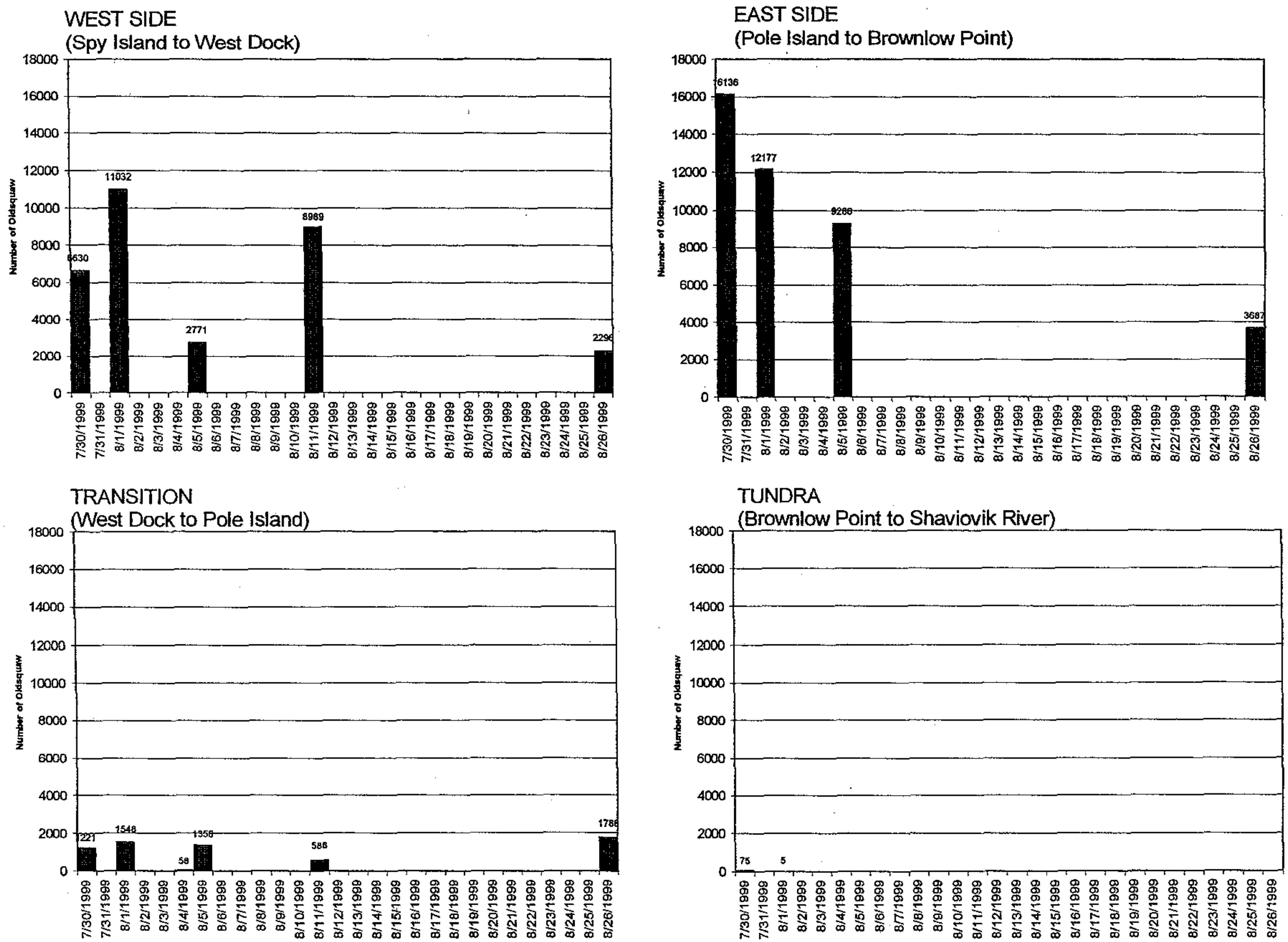

Figure 22. Total number of oldsquaw on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. The survey on 4 August covered the Transition area only. The Survey on 11 August 1999 covered the West Side and Transition areas only.

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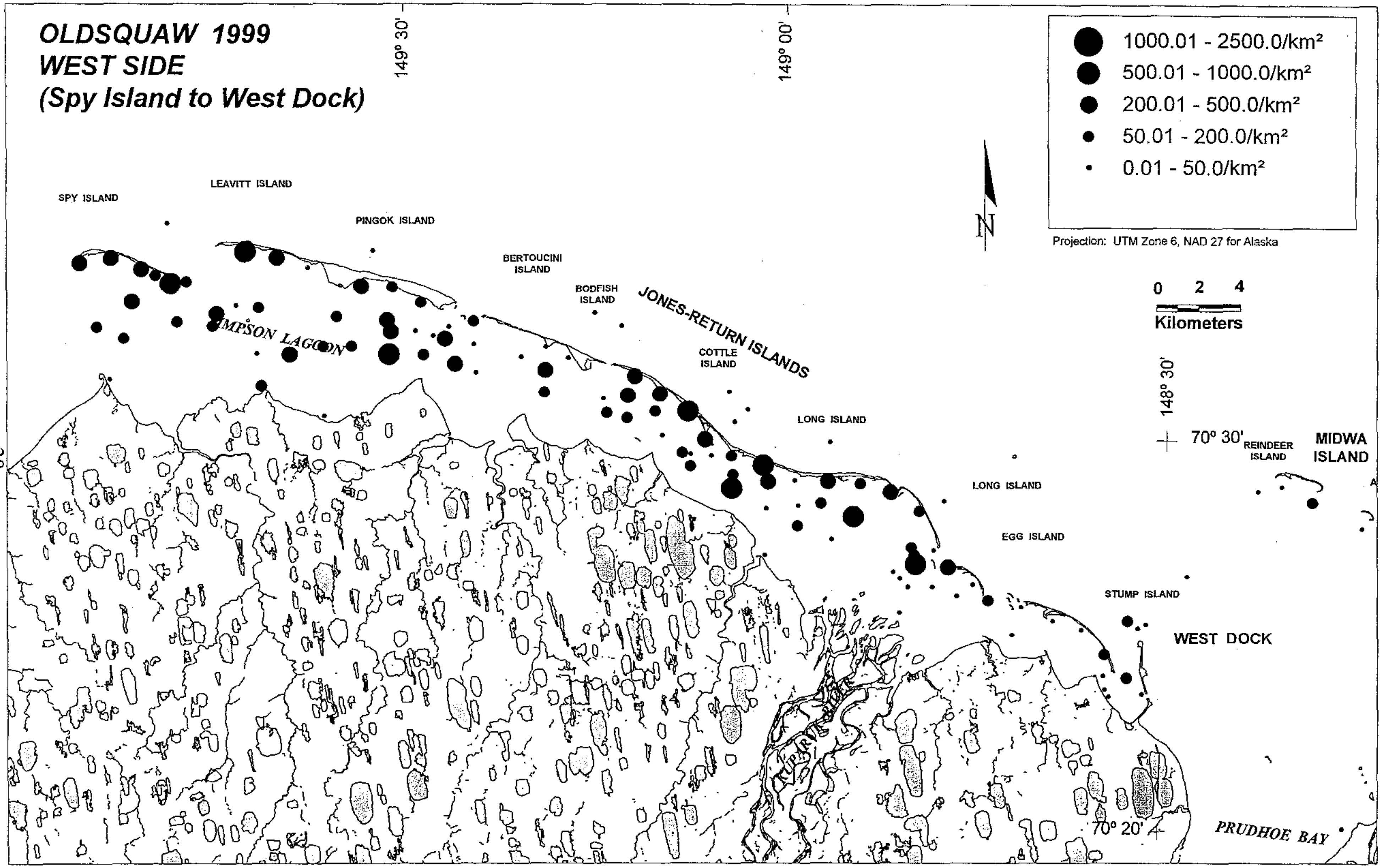


Figure 23. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

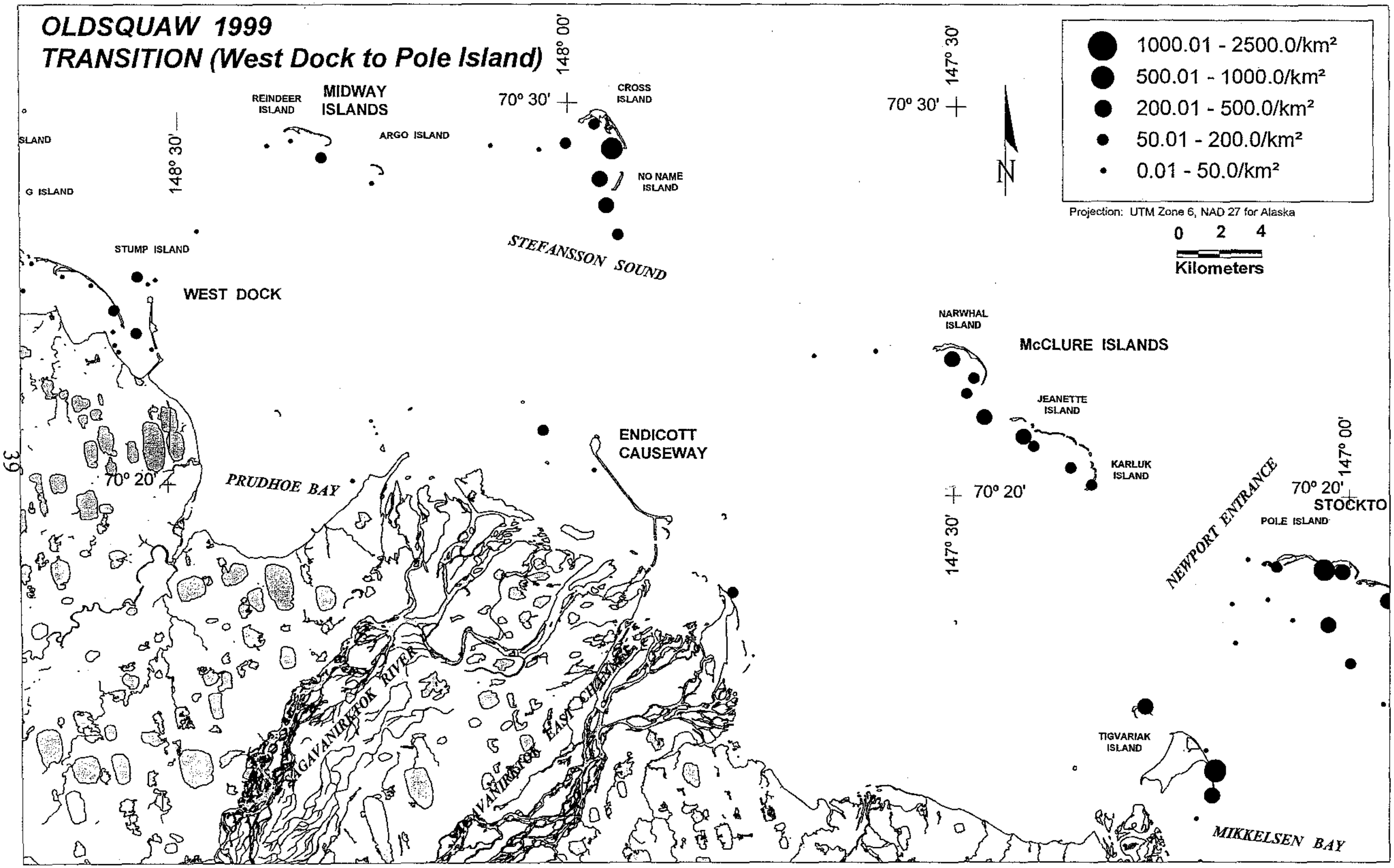


Figure 24. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

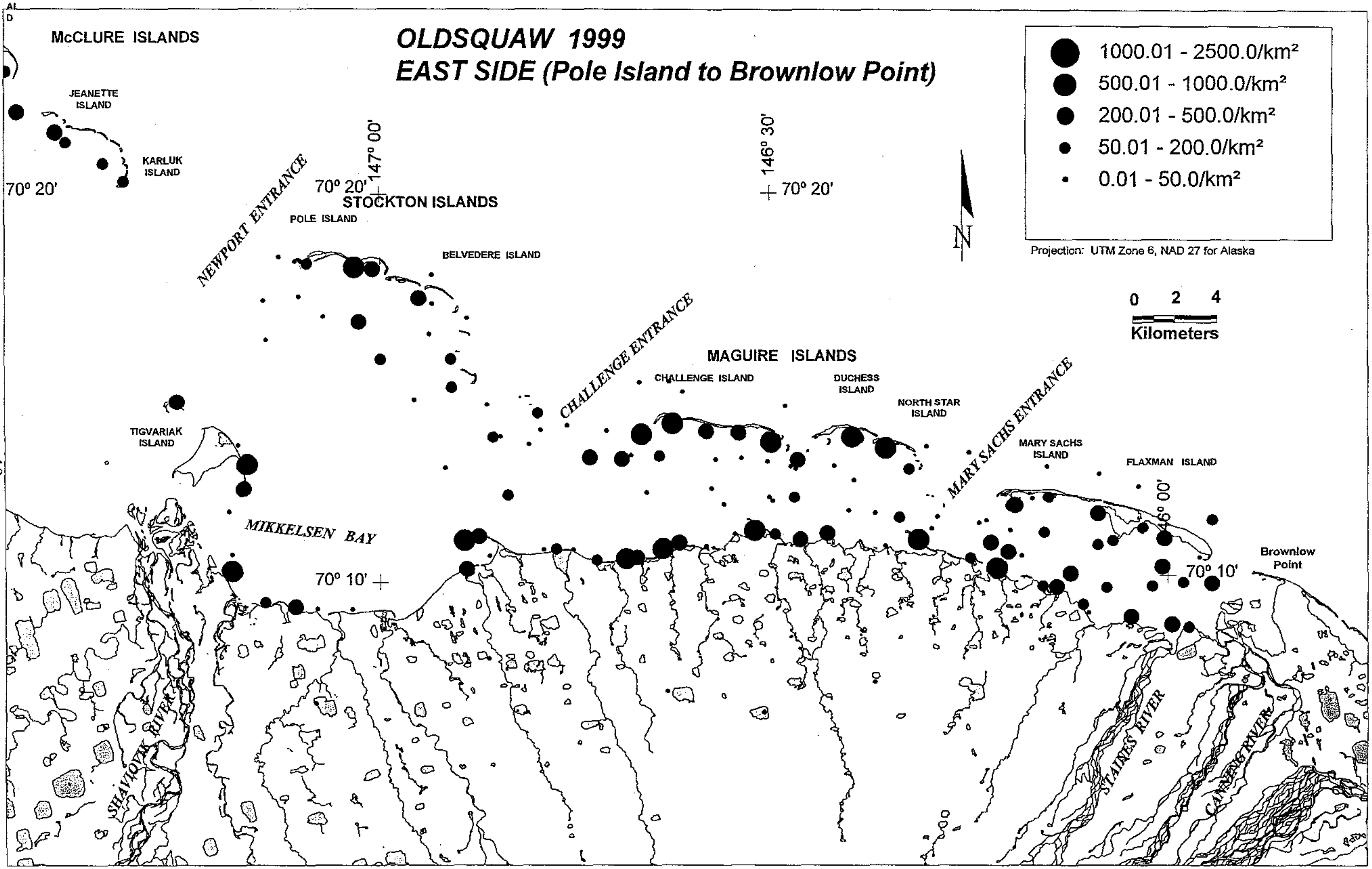


Figure 25. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

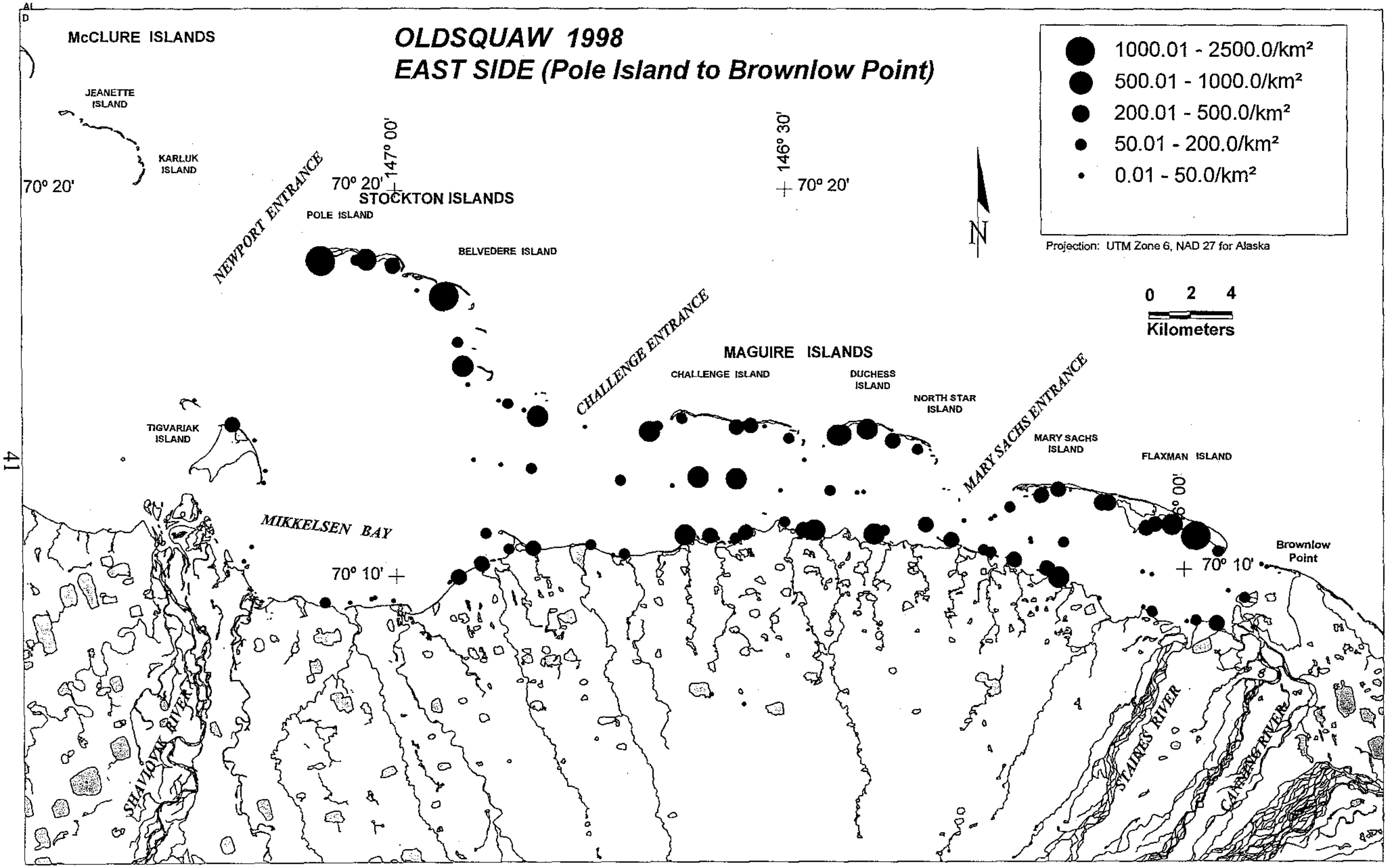


Figure 26. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 5 August to 3 September 1998.

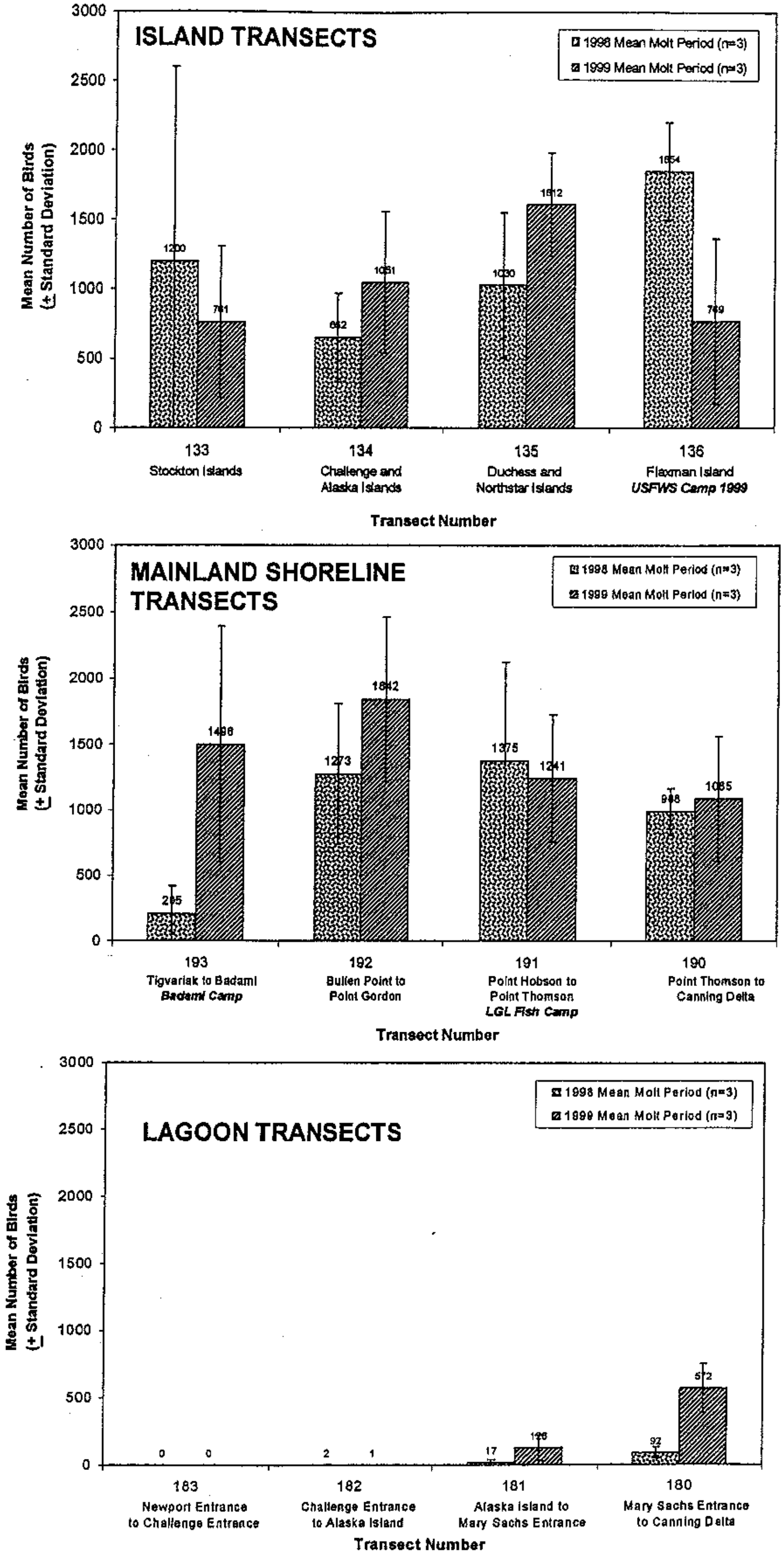


Figure 27. Comparison of the number of oldsquaws by transect for barrier island, mainland shoreline, and lagoon transects in the Pole Island to Brownlow Point area during the male oldsquaw molt period, 28 July to 19 August 1998 and 1999. Based on actual on transect oldsquaw counts.

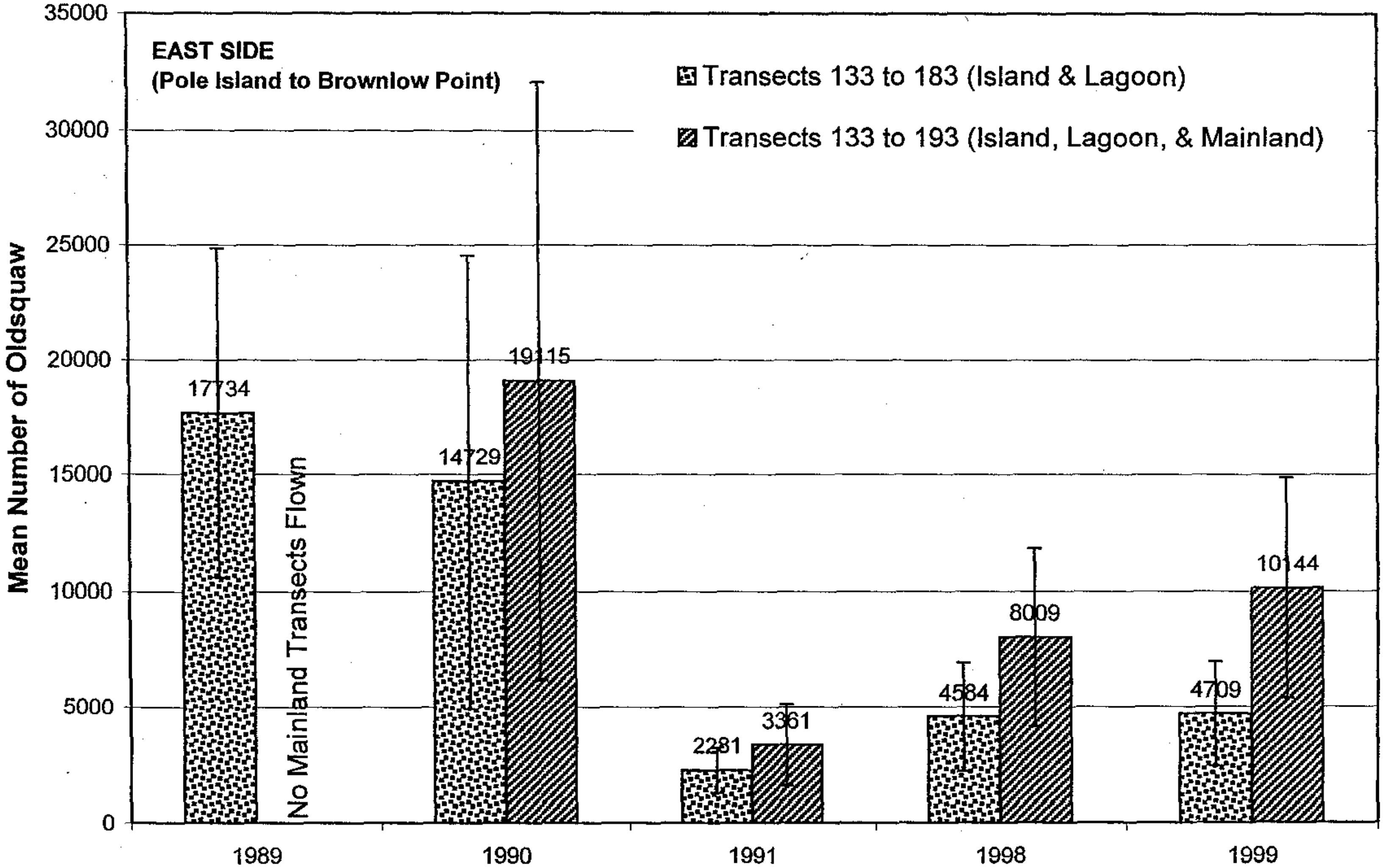


Figure 28. Comparison of the mean number of oldsquaws by year for barrier island, lagoon, and mainland shoreline transects combined in the Pole Island to Brownlow Point area during the male oldsquaw molt period, 28 July to 19 August 1989 to 1999. Mean number of oldsquaws calculated as the mean density times the transect area as reported in Johnson and Gazey (1992).

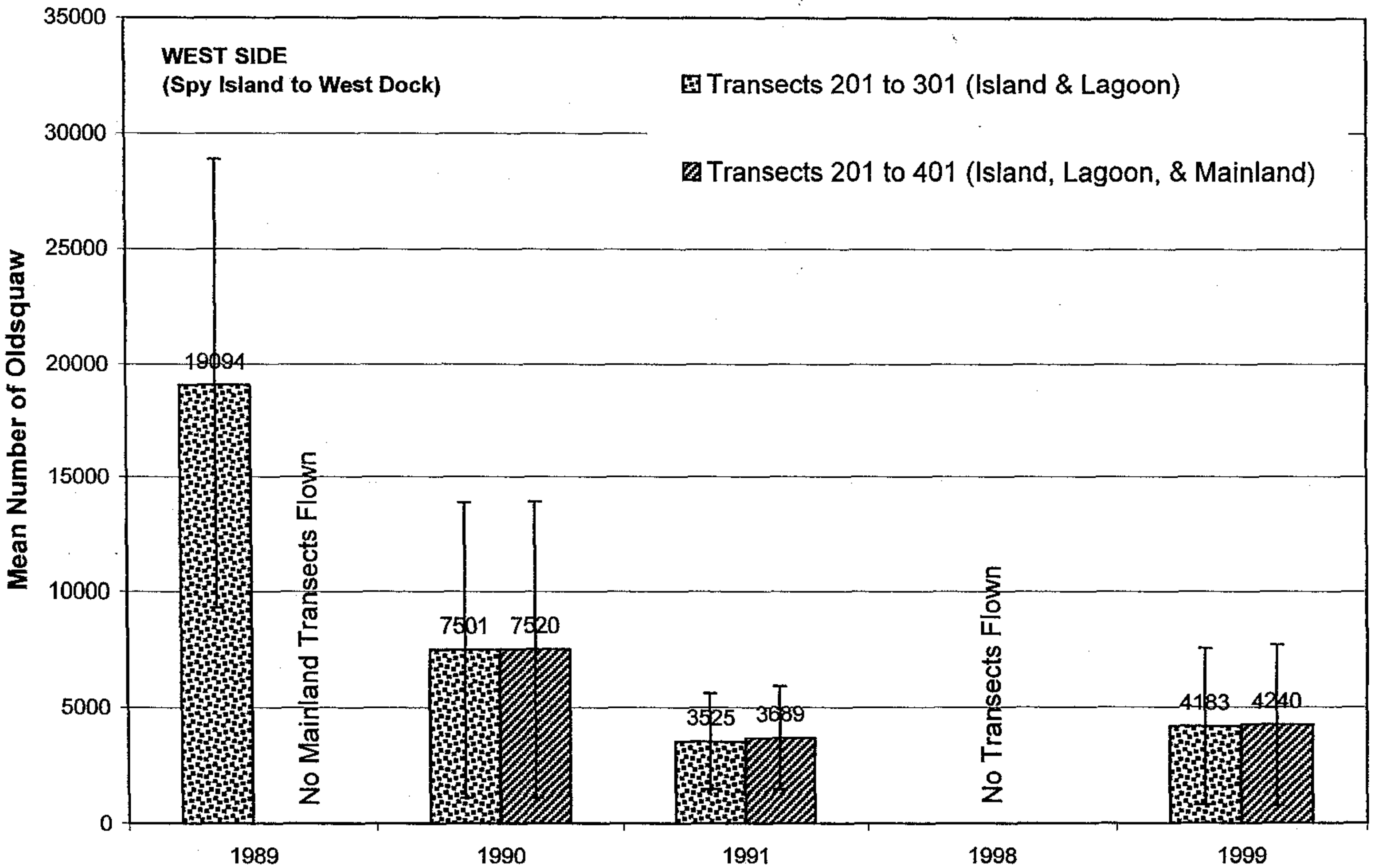


Figure 29. Comparison of the mean number of oldsquaws by year for barrier island, lagoon, and mainland shoreline transects combined in the Spy Island to West Dock area during the male oldsquaw molt period, 28 July to 19 August 1989 to 1999. Mean number of oldsquaws calculated as the mean density times the transect area as reported in Johnson and Gazey (1992).

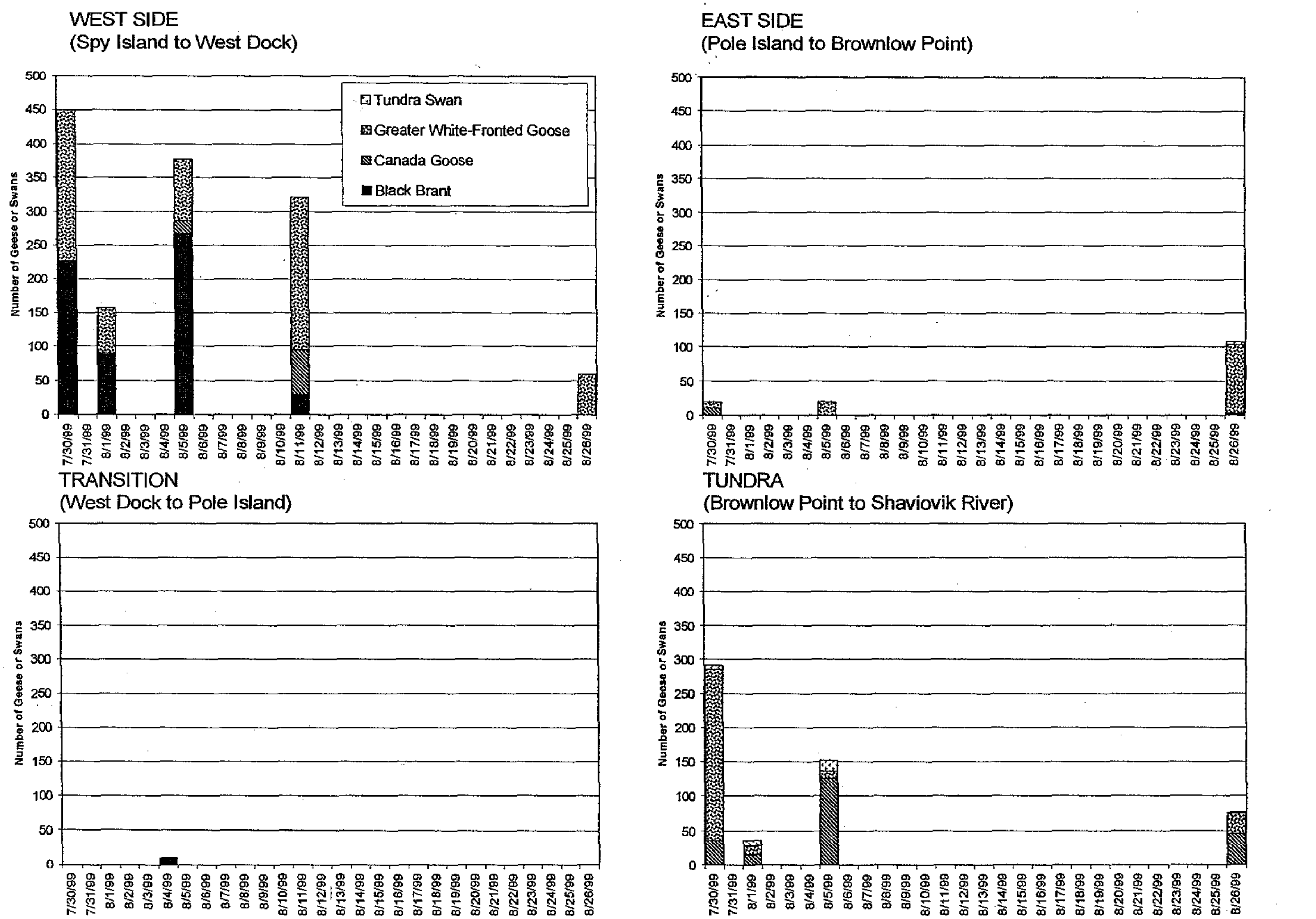


Figure 30. Total number of geese and swans observed both on and off transect during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. Surveys were flown on 30 July; 1, 4, 5, 8, 11, and 26 August 1999. The survey on 4 August covered the Transition area only. The Survey on 11 August 1999 covered the West Side and Transition areas only.

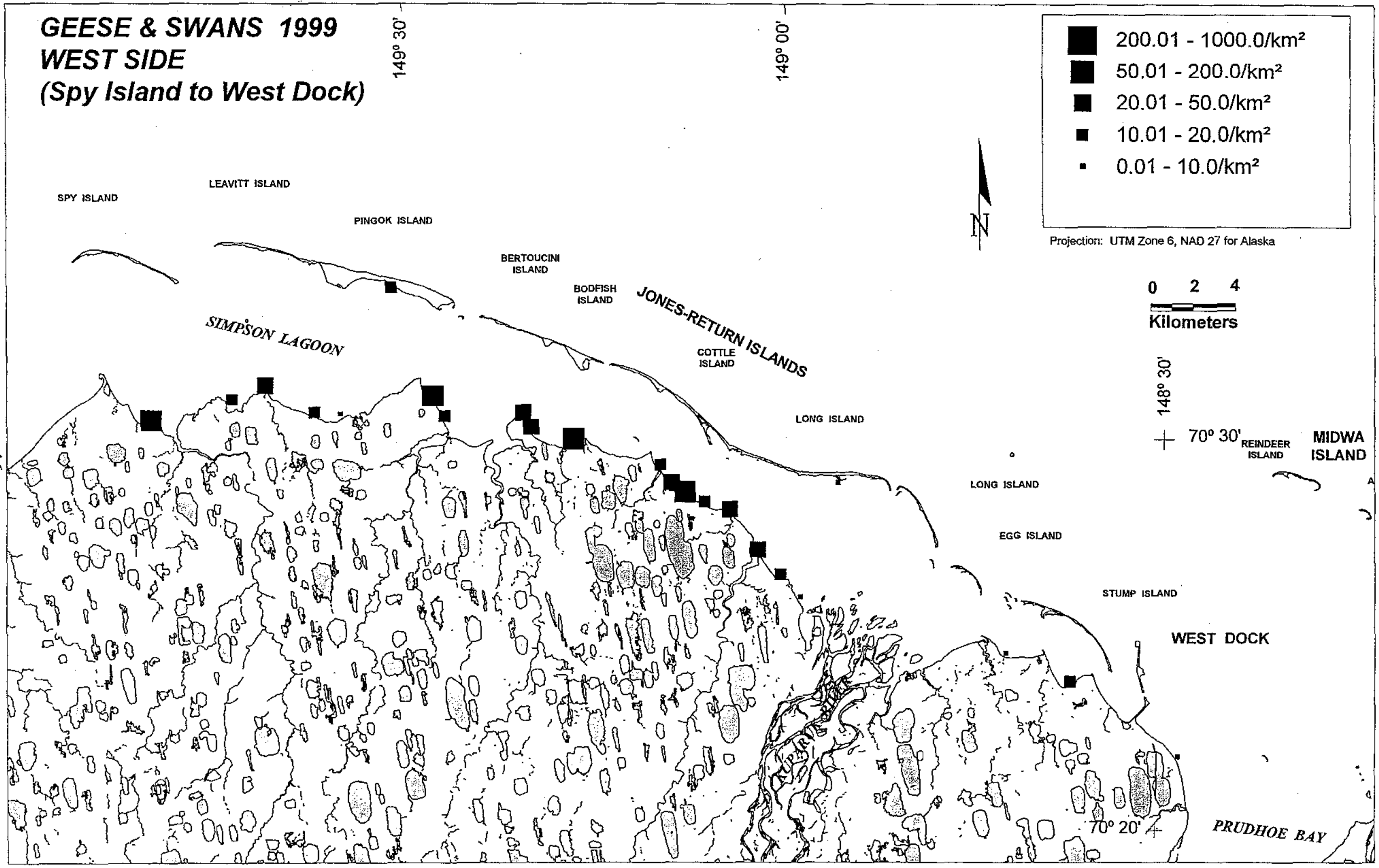


Figure 31. Summary of density for geese and swans by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

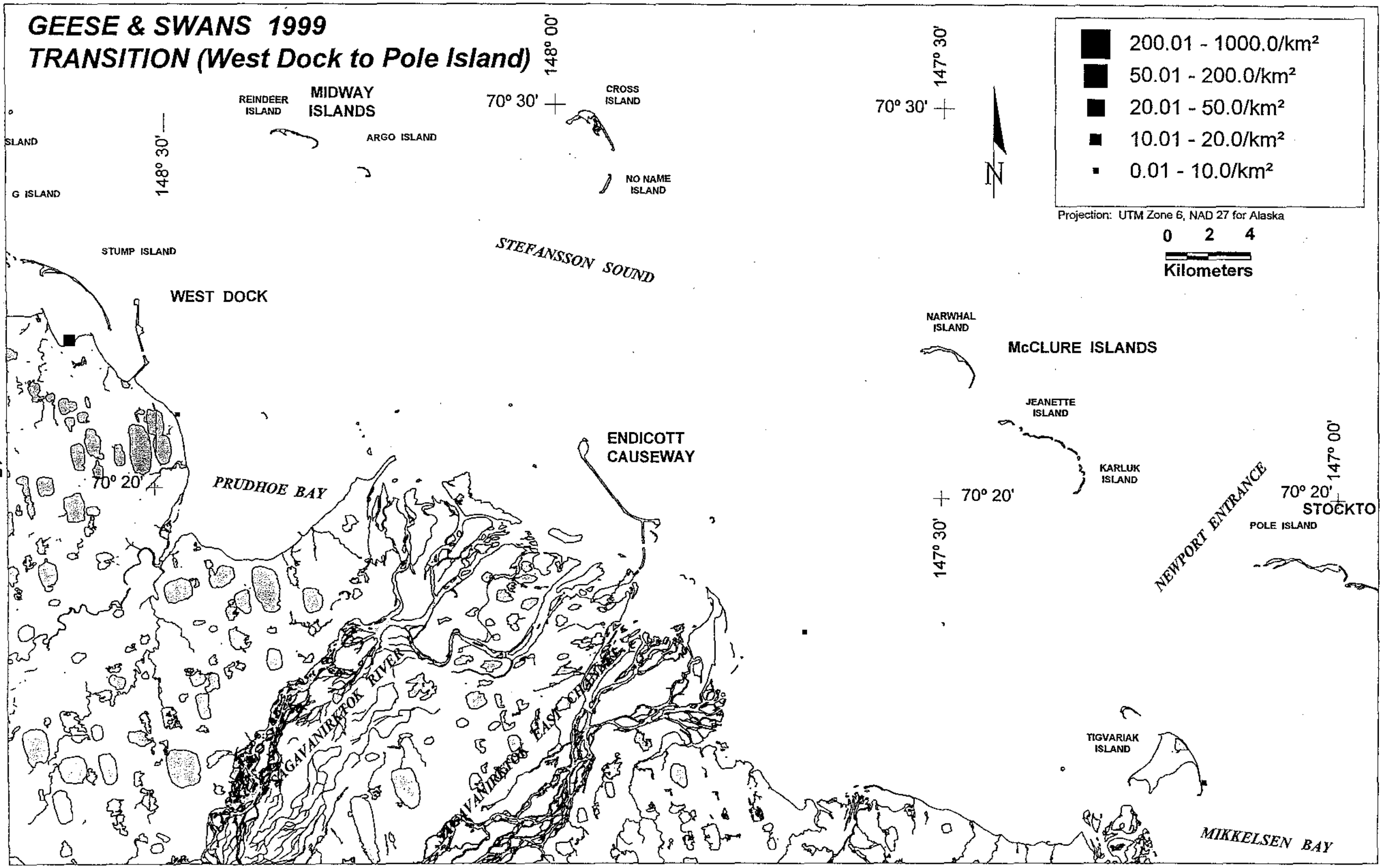


Figure 32. Summary of density for geese and swans by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

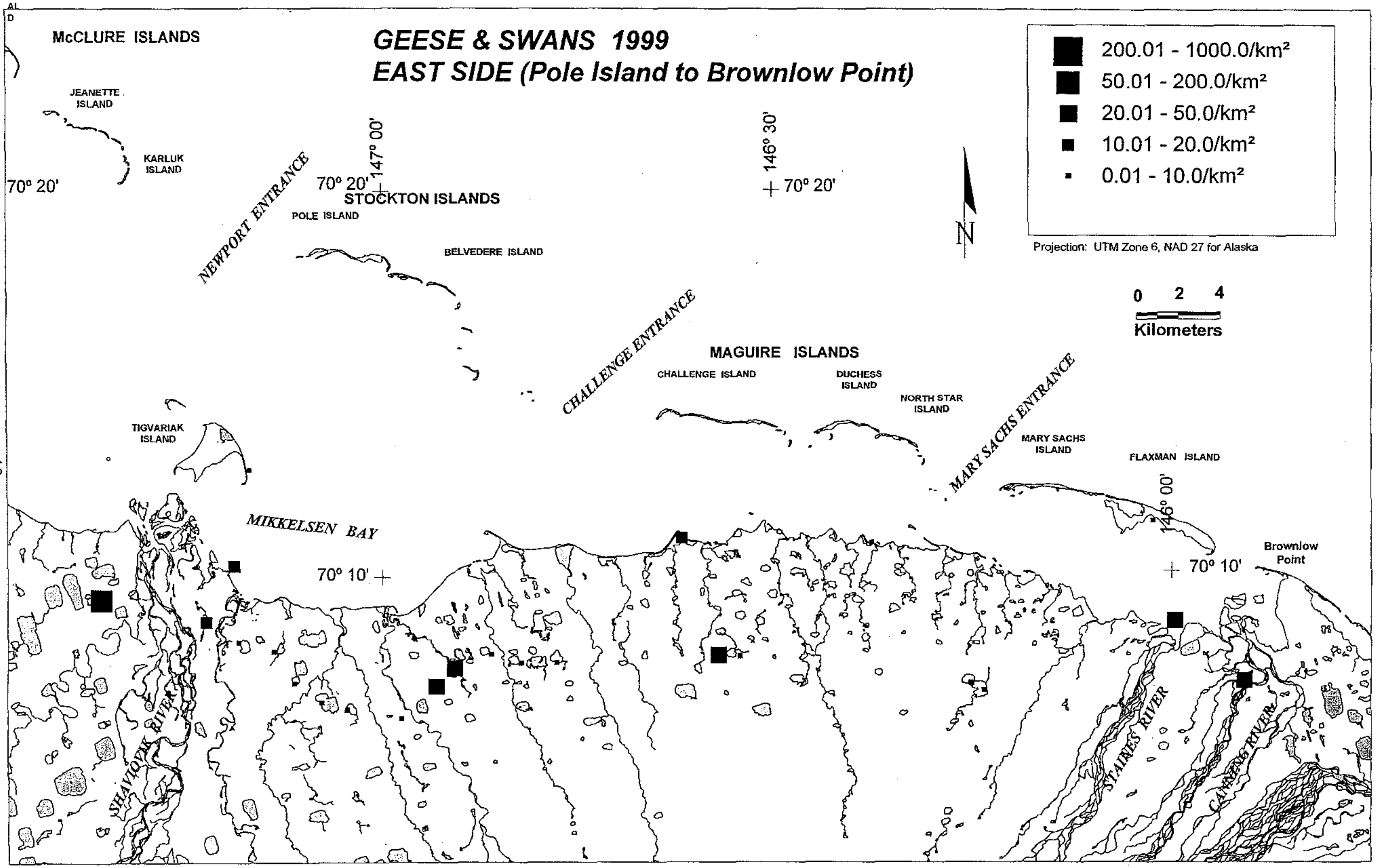


Figure 33. Summary of density for geese and swans by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

Table 1. Summary of weather and lagoon conditions during 5 aerial surveys in the barrier island-lagoon system between the Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. (ADST = Alaska Daylight Savings Time)

Survey	Start Time (ADST)	Survey Duration (minutes)	Air Temperature (°C)	Wind Speed (kph)	Cloud Cover (tenths)	Right Front Observer	Right Rear Observer	Left Rear Observer
WEST SIDE (Spy Island to West Dock)								
30 Jul 99	14:03:10	107.80	8°-10° Lagoon 2° Offshore	16-20	4 Lagoon 8 Offshore	Steve Johnson	Lynn Noel	Isaac Helmericks
01 Aug 99	13:46:15	101.28	13°-14°	11-25	6 to 7	Steve Johnson	Lynn Noel	Isaac Helmericks
04 Aug 99								
05 Aug 99	13:32:32	107.72	8°-17°	11-20	0	Lynn Noel		Isaac Helmericks
11 Aug 99	12:59:03	100.25	13°-14°	0-10	0	Lynn Noel		Isaac Helmericks
26 Aug 99	13:48:35	94.65	6°	16-20	-	Isaac Helmericks		Tammy Olson
TRANSITION (West Dock to Pole Island)								
30 Jul 99	16:47:13	24.32	6°	6-10	9	Steve Johnson	Lynn Noel	Isaac Helmericks
01 Aug 99	16:13:50	24.83	14°	11-15	6	Steve Johnson	Lynn Noel	Isaac Helmericks
04 Aug 99	14:05:22	21.53	7°	31-35	0	Lynn Noel		Isaac Helmericks
05 Aug 99	16:21:28	25.54	8°-18°	6-10	0	Lynn Noel		Isaac Helmericks
11 Aug 99	15:36:18	19.72	14°	6-10	0	Lynn Noel		Isaac Helmericks
26 Aug 99	10:13:10	19.50	4°	26-30	-	Isaac Helmericks		Tammy Olson
EAST SIDE (Pole Island to Brownlow Point)								
30 Jul 99	17:13:34	119.63	6°	0-10	4 to 9	Steve Johnson	Lynn Noel	Isaac Helmericks
01 Aug 99	16:38:40	119.45	12°-14°	6-20	6	Steve Johnson	Lynn Noel	Isaac Helmericks
04 Aug 99								
05 Aug 99	16:47:39	121.88	10°-13°	6-15	0	Lynn Noel		Isaac Helmericks
11 Aug 99								
26 Aug 99	10:33:00	122.93	4°	26-35	-	Isaac Helmericks		Tammy Olson

Table 2. Summary of survey effort in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999. West Side (Spy Island to West Dock), Transition (West Dock to Pole Island), East Side (Pole Island to Flaxman Island), and Tundra (Brownlow Point to Shaviovik River).

Region	Transect Number	Number of Replicates	Total Length (km)	Coverage (km^2)
Thetis Island	0	1	8.1	3.24
West Side	22	5	42.5	17.00
	23	5	51.0	20.05
	24	5	50.2	20.08
	25	5	59.1	23.64
	30	5	67.1	26.84
	31	5	73.0	29.20
	32	5	79.3	31.72
	33	5	84.7	33.88
	101	5	109.8	43.92
	102	5	73.6	29.44
	201	5	110.7	44.28
	202	5	76.5	30.27
	301	5	87.8	35.12
	302	5	61.7	24.68
	401	5	93.3	37.02
	402	5	78.5	31.40
	601	5	80.2	32.08
	602	5	64.7	25.88
	603	5	93.8	37.52
Total Effort			1437.5	574.02
Transition	19	2	36.1	14.44
	20	2	11.7	4.68
	21	2	20.7	8.28
	130	4	100.5	40.20
	131	4	93.2	37.28
	132	4	80.9	32.36
	184	2	44.0	17.60
Effort			387.1	154.84
East Side	60	4	53.8	21.52
	61	4	48.7	19.48
	62	4	49.5	19.80
	63	4	55.0	22.00
	133	4	60.6	24.24
	134	4	51.5	20.60
	135	4	57.6	23.04
	136	4	62.3	24.92
	180	4	58.1	23.24
	181	4	46.6	18.64
	182	4	52.9	21.16
	183	4	49.9	19.96
	190	4	63.7	25.48
	191	4	57.6	23.04
	192	4	78.5	31.40
	193	4	82.7	33.08
	604	4	56.1	22.44
	605	4	51.3	20.52
	606	4	47.7	19.08
	607	4	56.4	22.56
Effort			1140.5	456.20
Tundra	500	4	65.6	26.24
	501	4	54.2	21.68
	502	4	69.1	27.64
	503	4	55.2	22.08
Effort			244.1	97.64
Total Effort	All Transects		3217.3	1285.94

Table 3. Total number of bird sightings and individuals seen on- and off-transect for all aerial survey transects (total length = 3217.3 km) in the barrier island-lagoon system, offshore, and on tundra between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

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*)	256	7.1	375	0.4	72.5
RTLO	Red-throated Loon (*Gavia stellata*)	93	2.6	120	0.1	23.2
YBLO	Yellow-billed Loon (*Gavia adamsii*)	17	0.5	22	0.0	4.3
LOSP	Loon Species (*Gavia* spp.)	18	0.5	27	0.0	
Loons		**384**	**10.6**	**544**	**0.5**	
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	1	0.0	1	0.0	33.3
PAJD	Parasitic Jaeger-Dark Phase (*S. parasiticus*)	2	0.1	2	0.0	66.7
JAEG	Jaeger Species (*Stercorarius* spp.)	1	0.0	1	0.0	
Jaegers		**4**	**0.1**	**4**	**0.0**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	594	16.4	1846	1.8	
SAGU	Sabine's Gull (*Xema sabini*)	2	0.1	2	0.0	
GULL	Gull Species (*Larus* spp.)	1	0.0	2	0.0	
Gulls		**597**	**16.5**	**1850**	**1.8**	
ARTE	Arctic Tern (*Sterna paradisaea*)	20	0.6	33	0.0	
BLGU	Black Guillemot (*Cepphus grylle*)	7	0.2	16	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**628**	**17.3**	**1903**	**1.9**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*)	491	13.5	5007	5.0	98.6
KIEI	King Eider (*Somateria spectabilis*)	17	0.5	73	0.1	1.4
EISP	Eider Species (*Somateria* spp.)	13	0.4	55	0.1	
Eiders		**521**	**14.4**	**5135**	**5.1**	
BLSC	Black Scoter (*Melanitta nigra*)	8	0.2	72	0.1	2.7
SUSC	Surf Scoter (*Melanitta perspicillata*)	84	2.3	2497	2.5	93.8
WWSC	White-winged Scoter (*Melanitta fusca*)	7	0.2	94	0.1	3.5
SCOT	Scoter Species (*Melanitta* spp.)	23	0.6	517	0.5	
Scoters		**122**	**3.4**	**3180**	**3.2**	
GRSC	Greater Scaup (*Aythya marila*)	4	0.1	22	0.0	
NOPI	Northern Pintail (*Anas acuta*)	45	1.2	584	0.6	
OLSQ	Oldsquaw (*Clangula hyemalis*)	1719	47.4	84930	84.5	
RBME	Red-breasted Merganser (*Mergus serrator*)	2	0.1	10	0.0	
DIDU	Diving Duck	7	0.2	587	0.6	
MERGSP	Merganser Species (*Mergus* spp.)	1	0.0	1	0.0	
SCAUP	Scaup Species (*Aythya* spp.)	1	0.0	1	0.0	
DKSP	Duck Species	31	0.9	110	0.1	
DUCKS		**2453**	**67.6**	**94560**	**94.0**	
BRAN	Black Brant (*Branta bernicla*)	21	0.6	626	0.6	30.1
CAGO	Canada Goose (*Branta canadensis*)	11	0.3	315	0.3	15.1
GWFG	Greater White-fronted Goose (*Anser albifrons*)	29	0.8	1102	1.1	53.0
LSGO	Snow Goose (*Chen caerulescens*)	4	0.1	4	0.0	0.2
DAGO	Dark Goose	2	0.1	30	0.0	
GOSP	Goose Species	7	0.2	146	0.1	
TUSW	Tundra Swan (*Cygnus columbianus*)	15	0.4	34	0.0	1.6
Geese & Swans		**89**	**2.5**	**2257**	**2.2**	
WASP	Waterfowl	2	0.1	9	0.0	
WATERFOWL (Ducks, Geese & Swans)		**2544**	**70.1**	**96826**	**96.3**	
LBDW	Long-billed Dowitcher (*Limnodromus scolopaceus*)	1	0.0	5	0.0	
REPH	Red Phalarope (*Phalaropus fulicaria*)	1	0.0	15	0.0	
PHSP	Phalarope Species (*Phalaropus* spp.)	14	0.4	580	0.6	
SMSH	Small Shorebird	18	0.5	354	0.4	
MESH	Medium Shorebird	18	0.5	221	0.2	
SHBD	Shorebird	4	0.1	54	0.1	
SHOREBIRDS		**56**	**1.5**	**1229**	**1.2**	
GYRF	Gyrfalcon (*Falco rusticolus*)	1	0.0	1	0.0	
RLHA	Routh-legged Hawk (*Buteo lagopus*)	2	0.1	2	0.0	
RAPTORS		**3**	**0.1**	**3**	**0.0**	
LSCR	Sandhill Crane (*Grus canadensis*)	1	0.0	20	0.0	
BISP	Bird Species	12	0.3	20	0.0	
BIRDS		**3628**	**100**	**100545**	**100**	

Table 4. Total number of bird sightings and individuals seen on- and off-transect for aerial survey transects (total length = 1437.5 km) in the barrier island-lagoon system and offshore between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

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*)	104	7.3	134	0.3	57.5
RTLO	Red-throated Loon (*Gavia stellata*)	67	4.7	86	0.2	36.9
YBLO	Yellow-billed Loon (*Gavia adamsii*)	11	0.8	13	0.0	5.6
LOSP	Loon Species (*Gavia* spp.)	11	0.8	16	0.0	
Loons		**193**	**13.6**	**249**	**0.6**	
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	0	0.0	0	0.0	0.0
PAJD	Parasitic Jaeger-Dark Phase (*S. parasiticus*)	1	0.1	1	0.0	100.0
JAEG	Jaeger Species (*Stercorarius* spp.)	0	0.0	0	0.0	
Jaegers		**1**	**0.1**	**1**	**0.0**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	346	24.3	1093	2.8	
SAGU	Sabine's Gull (*Xema sabini*)	1	0.1	1	0.0	
GULL	Gull Species (*Larus* spp.)	0	0.0	0	0.0	
Gulls		**347**	**24.4**	**1094**	**2.8**	
ARTE	Arctic Tern (*Sterna paradisaea*)	9	0.6	13	0.0	
BLGU	Black Guillemot (*Cepphus grylle*)	2	0.1	5	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**359**	**25.2**	**1113**	**2.8**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*)	48	3.4	431	1.1	99.8
KIEI	King Eider (*Somateria spectabilis*)	1	0.1	1	0.0	0.2
EISP	Eider Species (*Somateria* spp.)	5	0.4	12	0.0	
Eiders		**54**	**3.8**	**444**	**1.1**	
BLSC	Black Scoter (*Melanitta nigra*)	5	0.4	64	0.2	2.6
SUSC	Surf Scoter (*Melanitta perspicillata*)	75	5.3	2400	6.0	97.2
WWSC	White-winged Scoter (*Melanitta fusca*)	2	0.1	4	0.0	0.2
SCOT	Scoter Species (*Melanitta* spp.)	16	1.1	488	1.2	
Scoters		**98**	**6.9**	**2956**	**7.4**	
GRSC	Greater Scaup (*Aythya marila*)	3	0.2	21	0.1	
NOPI	Northern Pintail (*Anas acuta*)	33	2.3	311	0.8	
OLSQ	Oldsquaw (*Clangula hyemalis*)	573	40.2	31718	79.9	
RBME	Red-breasted Merganser (*Mergus serrator*)	1	0.1	9	0.0	
DIDU	Diving Duck	3	0.2	540	1.4	
MERGSP	Merganser Species (*Mergus* spp.)	0	0.0	0	0.0	
SCAUP	Scaup Species (*Aythya* spp.)	1	0.1	1	0.0	
DKSP	Duck Species	15	1.1	62	0.2	
DUCKS		**781**	**54.8**	**36062**	**90.8**	
BRAN	Black Brant (*Branta bernicla*)	19	1.3	613	1.5	44.7
CAGO	Canada Goose (*Branta canadensis*)	4	0.3	85	0.2	6.2
GWFG	Greater White-fronted Goose (*Anser albifrons*)	18	1.3	668	1.7	48.8
LSGO	Snow Goose (*Chen caerulescens*)	4	0.3	4	0.0	0.3
DAGO	Dark Goose	1	0.1	20	0.1	
GOSP	Goose Species	1	0.1	40	0.1	
TUSW	Tundra Swan (*Cygnus columbianus*)	0	0.0	0	0.0	0.0
Geese & Swans		**47**	**3.3**	**1430**	**3.6**	
WASP	Waterfowl	1	0.1	8	0.0	
WATERFOWL (Ducks, Geese & Swans)		**829**	**58.2**	**37500**	**94.4**	
LBDW	Long-billed Dowitcher (*Limnodromus scolopaceus*)	1	0.1	5	0.0	
REPH	Red Phalarope (*Phalaropus fulicaria*)	0	0.0	0	0.0	
PHSP	Phalarope Species (*Phalaropus* spp.)	13	0.9	540	1.4	
SMSH	Small Shorebird	8	0.6	194	0.5	
MESH	Medium Shorebird	7	0.5	53	0.1	
SHBD	Shorebird	2	0.1	33	0.1	
SHOREBIRDS		**31**	**2.2**	**825**	**2.1**	
GYRF	Gyrfalcon (*Falco rusticolus*)	1	0.1	1	0.0	
RLHA	Routh-legged Hawk (*Buteo lagopus*)	0	0.0	0	0.0	
RAPTORS		**1**	**0.1**	**1**	**0.0**	
LSCR	Sandhill Crane (*Grus canadensis*)	0	0.0	0	0.0	
BISP	Bird Species	11	0.8	19	0.0	
BIRDS		**1424**	**100**	**39707**	**100**	

Table 5. Total number of bird sightings and individuals seen on- and off-transect for aerial survey transects (total length = 1140.5 km) in the barrier island-lagoon system and offshore between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

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*)	108	6.5	165	0.3	83.3
RTLO	Red-throated Loon (*Gavia stellata*)	18	1.1	25	0.0	12.6
YBLO	Yellow-billed Loon (*Gavia adamsii*)	5	0.3	8	0.0	4.0
LOSP	Loon Species (*Gavia* spp.)	3	0.2	4	0.0	
Loons		**134**	**8.0**	**202**	**0.4**	
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	1	0.1	1	0.0	50.0
PAJD	Parasitic Jaeger-Dark Phase (*S. parasiticus*)	1	0.1	1	0.0	50.0
JAEG	Jaeger Species (*Stercorarius* spp.)	0	0.0	0	0.0	
Jaegers		**2**	**0.1**	**2**	**0.0**	
GLGU	Glaucous Gull (*Larus hyperboreus*)	169	10.1	390	0.8	
SAGU	Sabine's Gull (*Xema sabini*)	0	0.0	0	0.0	
GULL	Gull Species (*Larus* spp.)	0	0.0	0	0.0	
Gulls		**169**	**10.1**	**390**	**0.8**	
ARTE	Arctic Tern (*Sterna paradisaea*)	7	0.4	13	0.0	
BLGU	Black Guillemot (*Cepphus grylle*)	5	0.3	11	0.0	
SEABIRDS (Jaegers, Gulls, and Terns)		**183**	**11.0**	**416**	**0.8**	
COEI	Common (Pacific) Eider (*Somateria mollissima v-nigra*)	327	19.6	3928	7.6	98.8
KIEI	King Eider (*Somateria spectabilis*)	11	0.7	47	0.1	1.2
EISP	Eider Species (*Somateria* spp.)	7	0.4	42	0.1	
Eiders		**345**	**20.7**	**4017**	**7.7**	
BLSC	Black Scoter (*Melanitta nigra*)	3	0.2	8	0.0	4.1
SUSC	Surf Scoter (*Melanitta perspicillata*)	9	0.5	97	0.2	49.7
WWSC	White-winged Scoter (*Melanitta fusca*)	5	0.3	90	0.2	46.2
SCOT	Scoter Species (*Melanitta* spp.)	7	0.4	29	0.1	
Scoters		**24**	**1.4**	**224**	**0.4**	
GRSC	Greater Scaup (*Aythya marila*)	0	0.0	0	0.0	
NOPI	Northern Pintail (*Anas acuta*)	11	0.7	270	0.5	
OLSQ	Oldsquaw (*Clangula hyemalis*)	930	55.8	46230	89.0	
RBME	Red-breasted Merganser (*Mergus serrator*)	1	0.1	1	0.0	
DIDU	Diving Duck	2	0.1	17	0.0	
MERGSP	Merganser Species (*Mergus* spp.)	1	0.1	1	0.0	
SCAUP	Scaup Species (*Aythya* spp.)	0	0.0	0	0.0	
DKSP	Duck Species	8	0.5	16	0.0	
DUCKS		**1322**	**79.3**	**50776**	**97.7**	
BRAN	Black Brant (*Branta bernicla*)	1	0.1	3	0.0	2.0
CAGO	Canada Goose (*Branta canadensis*)	1	0.1	10	0.0	6.8
GWFG	Greater White-fronted Goose (*Anser albifrons*)	3	0.2	130	0.3	88.4
LSGO	Snow Goose (*Chen caerulescens*)	0	0.0	0	0.0	0.0
DAGO	Dark Goose	0	0.0	0	0.0	
GOSP	Goose Species	4	0.2	79	0.2	
TUSW	Tundra Swan (*Cygnus columbianus*)	2	0.1	4	0.0	2.7
Geese & Swans		**11**	**0.7**	**226**	**0.4**	
WASP	Waterfowl	0	0.0	0	0.0	
WATERFOWL (Ducks, Geese & Swans)		**1333**	**80.0**	**51002**	**98.1**	
LBDW	Long-billed Dowitcher (*Limnodromus scolopaceus*)	0	0.0		0.0	
REPH	Red Phalarope (*Phalaropus fulicaria*)	1	0.1	15	0.0	
PHSP	Phalarope Species (*Phalaropus* spp.)	1	0.1	40	0.1	
SMSH	Small Shorebird	8	0.5	129	0.2	
MESH	Medium Shorebird	5	0.3	145	0.3	
SHBD	Shorebird	2	0.1	21	0.0	
SHOREBIRDS		**17**	**1.0**	**350**	**0.7**	
GYRF	Gyrfalcon (*Falco rusticolus*)	0	0.0	0	0.0	
RLHA	Routh-legged Hawk (*Buteo lagopus*)	0	0.0	0	0.0	
RAPTORS		**0**	**0.0**	**0**	**0.0**	
LSCR	Sandhill Crane (*Grus canadensis*)	0	0.0	0	0.0	
BISP	Bird Species	0	0.0	0	0.0	
BIRDS		**1667**	**100**	**51970**	**100**	

Table 6. Species densities for all transects (total area = 1285.94 km^2) during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

Species Code	Species Name	Total Number of Birds on Transect	Number of Transects with Sightings	Bird Density (Number/km^2)
LOONS				
PALO	Pacific Loon (*Gavia pacifica*)	353	120	0.275
RTLO	Red-throated Loon (*Gavia stellata*)	119	57	0.093
YBLO	Yellow-billed Loon (*Gavia adamsii*)	22	13	0.017
SEABIRDS (Jaegers, Gulls, and Terns)				
PAJA	Parasitic Jaeger (*Stercorarius parasiticus*)	3	4	0.002
GLGU	Glaucous Gull (*Larus hyperboreus*)	1383	133	1.075
ARTE	Arctic Tern (*Sterna paradisaea*)	31	20	0.024
SAGU	Sabine's Gull (*Xema sabini*)	2	2	0.002
BLGU	Black Guillemot (*Cepphus grylle*)	8	5	0.006
WATERFOWL (Ducks, Geese & Swans)				
COEI	Common Eider (*Somateria mollissima v-nigra*)	4302	105	3.345
KIEI	King Eider (*Somateria spectabilis*)	73	16	0.057
BLSC	Black Scoter (*Melanitta nigra*)	72	8	0.056
SUSC	Surf Scoter (*Melanitta perspicillata*)	2224	36	1.729
WWSC	White-winged Scoter (*Melanitta fusca*)	94	6	0.073
OLSQ	Oldsquaw (*Clangula hyemalis*)	70728	170	55.001
RBME	Red-breasted Merganser (*Mergus serrator*)	10	2	0.008
NOPI	Northern Pintail (*Anas acuta*)	408	23	0.317
BRAN	Black Brant (*Branta bernicla*)	576	14	0.448
CAGO	Canada Goose (*Branta canadensis*)	255	11	0.198
GWGO	Greater White-fronted Goose (*Anser albifrons*)	996	23	0.775
TUSW	Tundra Swan (*Cygnus columbianus*)	32	11	0.025

Table 7. Habitat associations of loons during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

		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)	71	26.7	29	32.2	1	9.1
	Spit (10)	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-
	TideFlat (13)	-	-	1	1.1	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-
	River Delta (16)	8	3.0	1	1.1	-	-
	Man-made Structures (79)	-	-	-	-	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-
	Spit (10)	-	-	-	-	-	-
	Island (11)	1	0.4	-	-	-	-
	Shoal (12)	1	0.4	-	-	-	-
	Shoreline (land side; 14)	-		-	-	-	-
	Shoreline (water side; 15)	30	11.3	7	7.8	6	54.5
	Pond (47)	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-
	Man-made Structures(79)	-	-	-	-	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	22	8.3	8	8.9	-	-
	Lagoon (9)	18	6.8	5	5.6	-	-
	Shoreline (water side: 15)	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-
	Wet Tundra (25)	2	0.8	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-
	Lake Shore (44)	1	0.4	-	-	-	-
	Pond (47)	3	1.1	2	2.2	-	-
	Small Lake (48)	15	5.6	-	-	-	-
	LargeLake (49)	9	3.4	-	-	-	-
	River (54)	-	-	-	-	-	-
	Stream (55)	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	-	-	-	-	-	-
	Island (11)	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	-	-	-
	Shoreline (land side; 14)	1	0.4	-	-	-	-
	Shoreline (water side; 15)	72	27.1	32	35.6	4	36.4
	River Delta (16)	1	0.4	1	1.1	-	-
	Mudflat (41)	-	-	-	-	-	-
	Pond (47)	2	0.8	-	-	-	-
	Small Lake (48)	1	0.4	-	-	-	-
	Onshore Lagoon (61)	5	1.9	1	1.1	-	-
	Man-made Structures (79)	-	-	-	-	-	-
River Delta (92)	Spit (10)	-	-	-	-	-	-
	Tide Flat (13)	3	1.1	3	3.3	-	-
	Mudflat (41)	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-
TOTAL		266	100	90	100	11	100

Table 8. Habitat associations of seabirds during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

		Parasitic Jeager		Arctic Tern		Glaucous Gull		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	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	2	66.7	1	4.3	45	7.9	-	-
	Spit (10)	-	-	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	TideFlat (13)	-	-	-	-	4	0.7	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-	-	-
	River Delta (16)	-	-	-	-	8	1.4	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-	-	-
	Spit (10)	-	-	-	-	19	3.3	-	-
	Island (11)	-	-	1	4.3	95	16.6	-	-
	Shoal (12)	-	-	-	-	2	0.3	-	-
	Shoreline (land side; 14)	-	-	2	8.7	48	8.4	-	-
	Shoreline (water side; 15)	-	-	10	43.5	160	28.0	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures(79)	-	-	-	-	5	0.9	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	-	-	3	13.0	23	4.0	-	-
	Lagoon (9)	-	-	1	4.3	8	1.4	-	-
	Shoreline (water side: 15)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	2	0.3	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-	-	-
	Wet Tundra (25)	-	-	1	4.3	6	1.0	-	-
	Mudflat (41)	-	-	-	-	1	0.2	-	-
	Lake Shore (44)	-	-	-	-	-	-	1	16.7
	Pond (47)	-	-	-	-	1	0.2	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	LargeLake (49)	-	-	-	-	-	-	-	-
	River (54)	-	-	-	-	2	0.3	-	-
	Stream (55)	-	-	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	-	-	-	-	15	2.6	-	-
	Island (11)	-	-	-	-	3	0.5	-	-
	Tide Flat (13)	-	-	1	4.3	2	0.3	-	-
	Shoreline (land side; 14)	-	-	1	4.3	27	4.7	1	16.7
	Shoreline (water side; 15)	1	33.3	2	8.7	72	12.6	3	50.0
	River Delta (16)	-	-	-	-	5	0.9	-	-
	Mudflat (41)	-	-	-	-	3	0.5	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	1	0.2	-	-
River Delta (92)	Spit (10)	-	-	-	-	1	0.2	-	-
	Tide Flat (13)	-	-	-	-	13	2.3	1	16.7
	Mudflat (41)	-	-	-	-	1	0.2	-	-
	Pond (47)	-	-	-	-	-	-	-	-
TOTAL		3	100	23	100	572	100	6	100

Table 9. Habitat associations of eiders during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

		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)	100	25.3	6	33.3	1	25.0	107	25.7
	Spit (10)	-	-	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	TideFlat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	1	0.3	-	-	-	-	1	0.2
	River Delta (16)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-	-	-
	Spit (10)	1	0.3	-	-	-	-	1	0.2
	Island (11)	3	0.8	-	-	-	-	3	0.7
	Shoal (12)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	19	4.8	-	-	-	-	19	4.6
	Shoreline (water side; 15)	157	39.7	3	16.7	-	-	160	38.4
	Pond (47)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures(79)	-	-	-	-	-	-	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	36	9.1	4	22.2	-	-	40	9.6
	Lagoon (9)	34	8.6	2	11.1	1	25.0	37	8.9
	Shoreline (water side: 15)	1	0.3	-	-	-	-	1	0.2
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-	-	-
	Wet Tundra (25)	-	-	-	-	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Lake Shore (44)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	1	5.6	-	-	1	0.2
	Small Lake (48)	-	-	-	-	-	-	-	-
	LargeLake (49)	-	-	-	-	-	-	-	-
	River (54)	-	-	-	-	-	-	-	-
	Stream (55)	-	-	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	3	0.8	-	-	1	25.0	4	1.0
	Island (11)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	2	0.5	-	-	-	-	2	0.5
	Shoreline (water side; 15)	36	9.1	2	11.1	1	25.0	39	9.4
	River Delta (16)	-	-		0.0	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	1	0.3		0.0	-	-	1	0.2
	Man-made Structures (79)	1	0.3	-	-	-	-	1	0.2
River Delta (92)	Spit (10)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-		0.0	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
TOTAL		395	100	18	100	4	100	417	100

Table 10. Habitat associations of scoter during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

		Surf Scoter		White-winged Scoter		Black 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	Number of Sightings	Percent of Total
Lagoon (9)	Lagoon (9)	60	80.0	3	75.0	4	66.7	67	78.8
	Spit (10)	-	-	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	TideFlat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-	-	-
	River Delta (16)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-	-	-
	Spit (10)	-	-	-	-	-	-	-	-
	Island (11)	-	-	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	2	2.7	-	-	-	-	2	2.4
	Shoreline (water side; 15)	10	13.3	1	25.0	1	16.7	12	14.1
	Pond (47)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures(79)	-	-	-	-	-	-	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	-	-	-	-	1	16.7	1	1.2
	Lagoon (9)	1	1.3	-	-	-	-	1	1.2
	Shoreline (water side: 15)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-	-	-
	Wet Tundra (25)	-	-	-	-	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Lake Shore (44)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	LargeLake (49)	-	-	-	-	-	-	-	-
	River (54)	-	-	-	-	-	-	-	-
	Stream (55)	-	-	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	-	-	-	-	-	-	-	-
	Island (11)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-	-	-
	Shoreline (water side; 15)	-	-	-	-	-	-	-	-
	River Delta (16)	2	2.7	-	-	-	-	2	2.4
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
River Delta (92)	Spit (10)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	-	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
TOTAL		75	100	4	100	6	100	85	100

Table 11. Oldsquaw density (number of individuals/km^2) by transect during aerial surveys in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

	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)																			
30 Jul 99	13.79	99.00	39.07	214.27	1.52	40.77	149.29	76.64	57.55	19.51	35.70	0	0	0	0	0.80	0	0	2.52
1 Aug 99	4.81	103.30	113.32	114.68	0.24	217.11	102.47	51.41	277.65	116.21	75.14	0	0.28	3.99	0	10.17	10.26	0	3.47
4 Aug 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 Aug 99	10.58	63.83	96.72	9.11	0	0	43.85	32.26	39.03	30.66	100.54	0	1.85	0	0	0	0	0.23	0.86
11 Aug 99	131.38	267.43	310.88	204.19	1.46	2.61	83.86	0.21	3.92	33.01	109.57	7.48	0	20.65	0	56.82	3.57	0	0
Average Density	40.14	133.39	140.00	135.56	0.81	65.12	94.87	40.13	94.54	49.85	80.24	1.87	0.53	6.16	0	16.95	3.46	0.06	1.71
Post-Molt (20 August -- 30 September)																			
26 Aug 99	0	24.51	5.94	23.42	4.08	29.82	19.07	101.19	103.80	16.60	13.83	1.67	0	9.27	0	0	0	0.36	1.61

Table 12. Oldsquaw density (number of individuals/km^2) by transect during aerial surveys in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

	Transect Numbers						
	Barrier Islands			Mid-Lagoon	Mainland Shore		
Date	130	131	132	184	19	20	21
Molt (28 July -- 19 August)							
30 Jul 99	33.76	43.23	54.15	-	-	-	-
1 Aug 99	3.40	70.58	70.39	-	-	-	-
4 Aug 99	-	-	-	0	2.13	17.80	0
5 Aug 99	15.70	80.71	56.25	-	-	-	-
11 Aug 99	-	-	-	21.33	31.65	0	0
Average Density	17.62	64.84	60.26	10.67	16.89	8.90	0
Post-Molt (20 August -- 30 September)							
26 Aug 99	4.92	87.11	121.59	-	-	-	-

Table 13. Oldsquaw density (number of individuals/km^2) by transect during aerial surveys in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

	Transect Numbers																							
	Barrier Islands				Mid-Lagoon								Mainland Shore				Off Shore				Tundra			
Date	133	134	135	136	180	181	182	183	604	605	606	607	190	191	192	193	60	61	62	63	500	501	502	503
Molt (28 July -- 19 August)																								
30 Jul 99	171.55	300.59	248.79	142.12	79.28	26.39	0.38	0.21	76.96	65.98	21.23	188.73	241.72	291.43	311.13	303.13	0	1.60	0	0	0	5.76	0.76	6.16
1 Aug 99	190.07	106.71	351.03	206.86	82.92	46.22	0.19	0	0	16.60	5.17	151.63	101.88	115.58	145.98	134.51	10.50	10.83	6.20	0	0	0.88	0	0
4 Aug 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5 Aug 99	21.38	214.17	224.50	17.45	136.89	6.25	0	0	0.75	9.23	8.33	31.99	176.11	223.83	242.44	102.86	0.97	0.58	0.21	1.12	0	0	0	0
11 Aug 99	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Average Density	127.67	207.16	274.77	122.14	99.70	26.29	0.19	0.07	25.90	30.60	11.58	124.12	173.24	210.28	233.18	180.17	3.82	4.34	2.14	0.37	0	2.21	0.25	2.05
Post-Molt (20 August -- 30 September)																								
26 Aug 99	97.60	68.25	42.04	57.05	2.67	59.90	34.96	0	47.20	111.07	1.87	31.08	18.79	10.08	24.21	5.88	14.36	0	8.01	0	0	0	0	0

Table14. Habitat associations of oldsquaws during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

General Habitat Type	Specific Habitat Type	Number of Sightings 30 July 99	Number of Sightings 1 Aug 99	Number of Sightings 4 Aug 99	Number of Sightings 5 Aug 99	Number of Sightings 11 Aug 99	Number of Sightings 26-Aug-99	Total All Surveys	Percent of Total
Lagoon (9)	Lagoon (9)	190	127	1	62	42	133	555	32.3
	Spit (10)	1	-	-	-	1	-	2	0.1
	Shoal (12)	-	2	-	-	-	-	2	0.1
	TideFlat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	1	-	-	-	-	-	1	0.1
	River Delta (16)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	1	-	-	-	1	2	0.1
Barrier Island (11)	Lagoon (9)	-	-	-	1	-	-	1	0.1
	Spit (10)	4	3	-	2	-	-	9	0.5
	Island (11)	-	-	-	-	-	-	-	-
	Shoal (12)	-	9	-	1	2	-	12	0.7
	Shoreline (land side; 14)	17	17	-	9	-	5	48	2.8
	Shoreline (water side; 15)	268	127	-	109	89	193	786	45.7
	Pond (47)	-	-	-	-	2	-	2	0.1
	Onshore Lagoon (61)	3	-	-	1	-	-	4	0.2
	Man-made Structures(79)	-	-	1	-	5		6	0.3
Nearshore Sea <3 mi. (13)	Ocean (8)	14	12	-	10	6	9	51	3.0
	Lagoon (9)	10	4	-	4	-	5	23	1.3
	Shoreline (water side: 15)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	-	-	-	-	-	-
	Wet Tundra (25)	-	-	-	-	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Lake Shore (44)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	3	1	-	-	-	-	4	0.2
	LargeLake (49)	1	-	-	-	-	-	1	0.1
	River (54)	-	-	-	-	-	-	-	-
	Stream (55)	-	-	-	-	-	-	-	-
Mainland Coast (27)	Spit (10)	7	4	-	3	-	3	17	1.0
	Island (11)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	1	-	-	-	-	1	0.1
	Shoreline (land side; 14)	2	3	-	3	-	-	8	0.5
	Shoreline (water side; 15)	53	23	3	32	7	48	166	9.7
	River Delta (16)	-	2	-	-	-	-	2	0.1
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	6	-	-	2	-	5	13	0.8
	Man-made Structures (79)	-	1	-	1	-	-	2	0.1
River Delta (92)	Spit (10)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	1	-	-	1	0.1
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	-	-
All Habitats		580	337	5	241	154	402	1719	100

Table15. Oldsquaw behavior during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

Specific Behaviors	Sightings 30 July 99	Sightings 1 Aug 99	Sightings 4 Aug 99	Sightings 5 Aug 99	Sightings 11 Aug 99	Sightings 26 Aug 99	Total All Surveys
Hauled out on ice (01)	4	-	-	3	-	-	7
Hauled out on land (02)	15	1	-	9	-	2	27
Hauled out on ice-swim/dive (04)	-	-	-		-	-	-
Hauled out on land-swim/dive (06)	2	-	-	7	-	5	14
Swimming (07)	488	259	4	161	100	368	1380
Swimming then diving (08)	24	37	1	51	46	13	172
Swimming then flying (09)	-	2	-	1	-	3	6
Flying (11)	18	8	-	6	3	11	46
Flying then landing on water (13)	-	-	-	-	-	-	-
Standing (15)	17	14	-	2	2	-	35
Standing then flushing (18)	-	-	-	-	-	-	-
Standing then swimming (19)	11	16	-	-	-	-	27
Running (21)	-	-	-	-	-	-	-
Walking (22)	-	-	-	-	-	-	-
Feeding (90)	1	-	-	-	-	-	1
Unknown or unrecorded (99)	-	-	-	1	3	-	4
TOTAL	580	337	5	241	154	402	1719

Table 16. Habitat associations of geese during aerial surveys in the barrier island-lagoon system between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

		Black Brant		Canada Goose		Greater White-fronted Goose		Tundra Swan	
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)	1	3.8	-	-	-	-	-	-
	Spit (10)	-	-	-	-	-	-	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	TideFlat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-	-	-
	River Delta (16)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Barrier Island (11)	Lagoon (9)	-	-	-	-	-	-	-	-
	Spit (10)	-	-	-	-	-	-	2	9.5
	Island (11)	-	-	-	-	1	4.0	-	-
	Shoal (12)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	-	-	-	-	-	-	-	-
	Shoreline (water side; 15)	-	-	1	7.7	-	-	1	4.8
	Pond (47)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	-	-	-	-	-	-	-	-
	Man-made Structures(79)	-	-	-	-	-	-	-	-
Nearshore Sea <3 mi. (13)	Ocean (8)	-	-	-	-	-	-	-	-
	Lagoon (9)	-	-	-	-	-	-	-	-
	Shoreline (water side: 15)	-	-	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
Wet Tundra (25)	Dry Tundra (23)	-	-	1	7.7	-	-	-	-
	Wet Tundra (25)	-	-	-	-	1	4.0	1	4.8
	Mudflat (41)	-	-	-	-	-	-	-	-
	Lake Shore (44)	-	-	1	7.7	4	16.0	9	42.9
	Pond (47)	-	-	-	-	2	8.0	-	-
	Small Lake (48)	-	-	1	7.7	1	4.0	5	23.8
	LargeLake (49)	-	-	-	-	1	4.0	1	4.8
	River (54)	-	-	-	-	-	-	-	-
	Stream (55)	-	-	-	-	1	4.0	-	-
Mainland Coast (27)	Spit (10)	1	3.8	-	-	-	-	-	-
	Island (11)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	-	-	-	-	-	-
	Shoreline (land side; 14)	6	23.1	1	7.7	2	8.0	-	-
	Shoreline (water side; 15)	15	57.7	6	46.2	11	44.0	1	4.8
	River Delta (16)	-	-	-	-	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	1	4.0	-	-
	Small Lake (48)	-	-	-	-	-	-	-	-
	Onshore Lagoon (61)	3	11.5	-	-	-	-	-	-
	Man-made Structures (79)	-	-	-	-	-	-	-	-
River Delta (92)	Spit (10)	-	-	-	-	-	-	-	-
	Tide Flat (13)	-	-	2	15.4	-	-	-	-
	Mudflat (41)	-	-	-	-	-	-	-	-
	Pond (47)	-	-	-	-	-	-	1	4.8
TOTAL		26	100	13	100	25	100	21	100

APPENDIX A: 1999 OLDSQUAW DENSITY BY SURVEY AND HISTORIC DATA

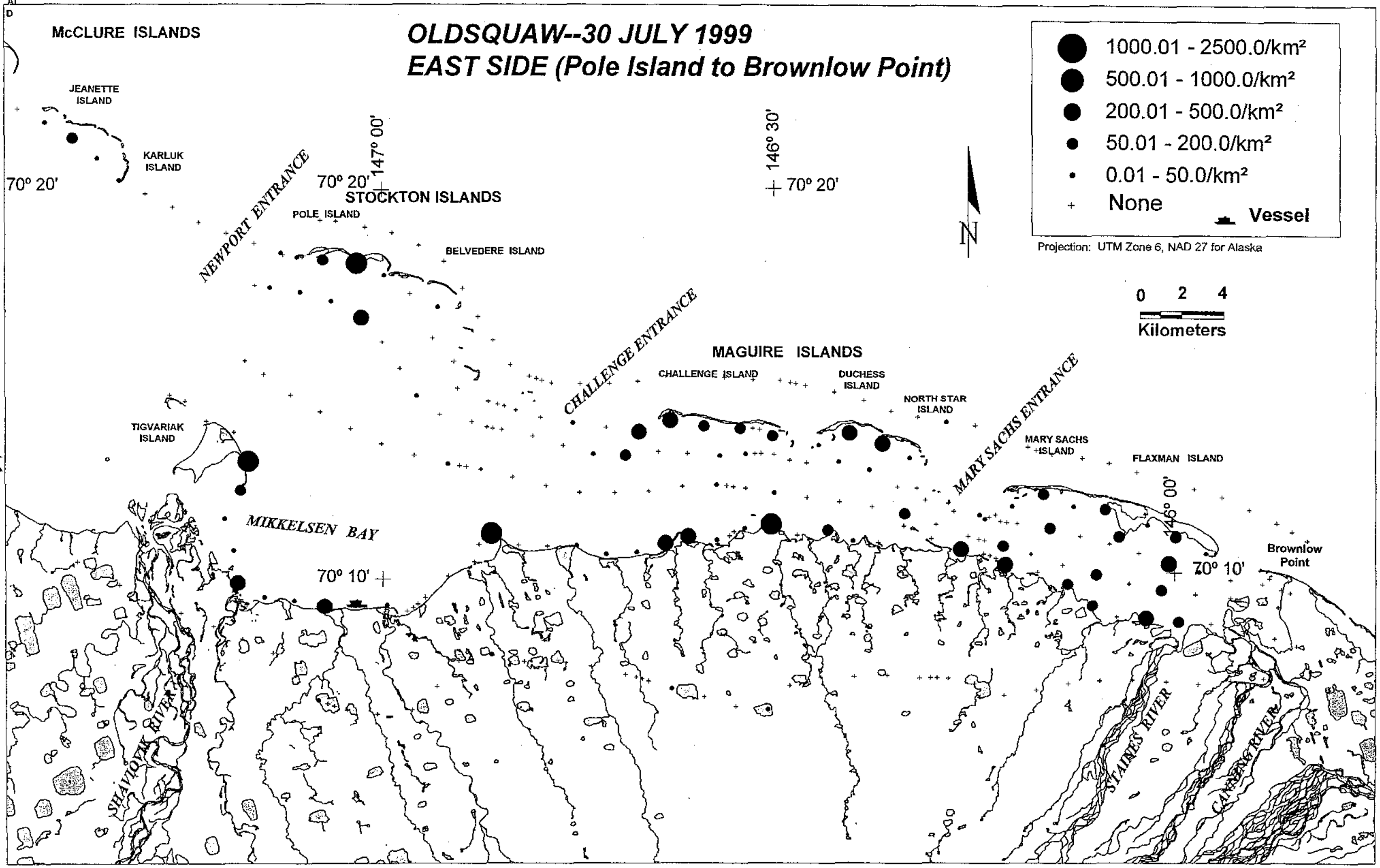


Figure A1. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July 1999.

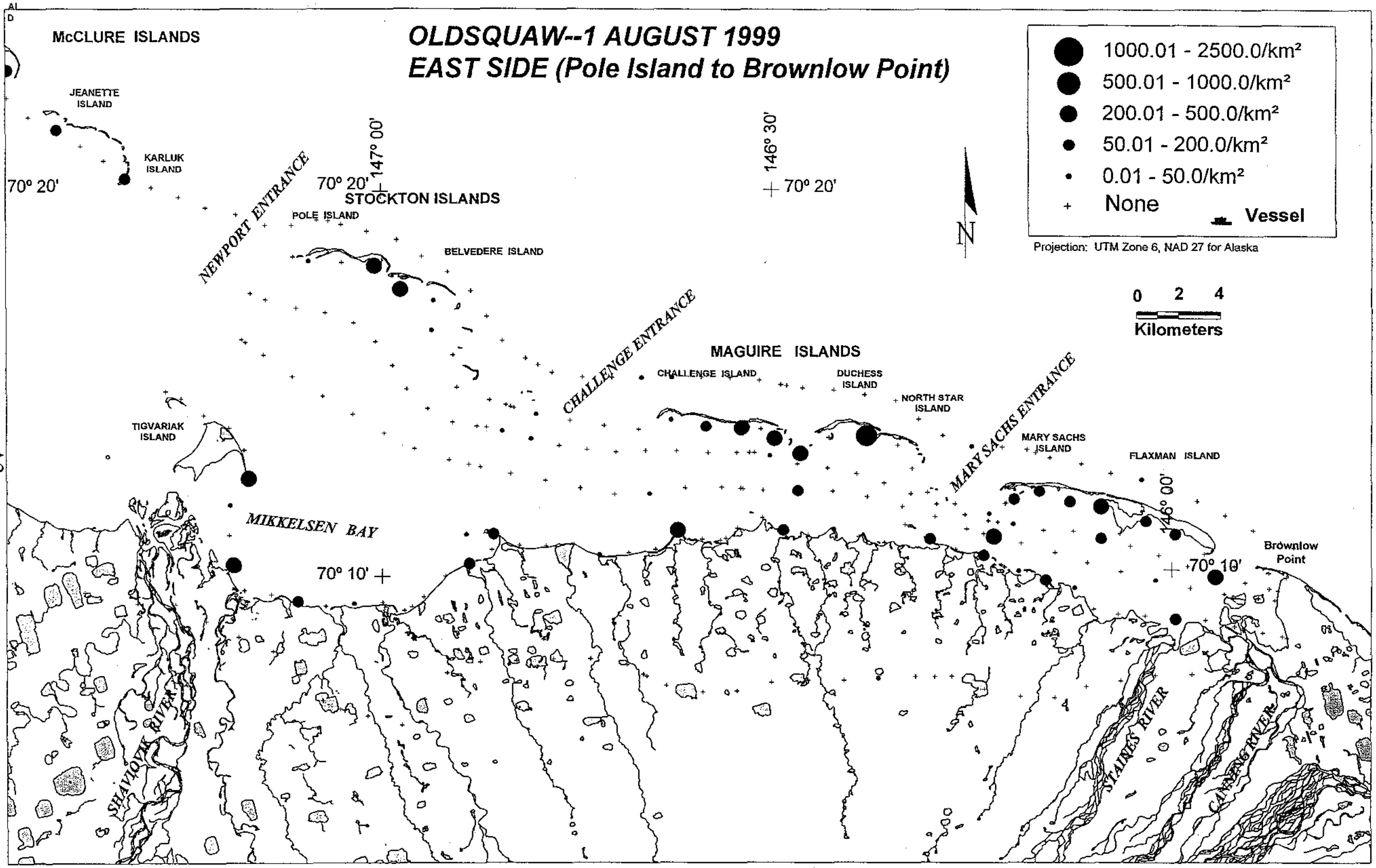


Figure A2. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 1 August 1999.

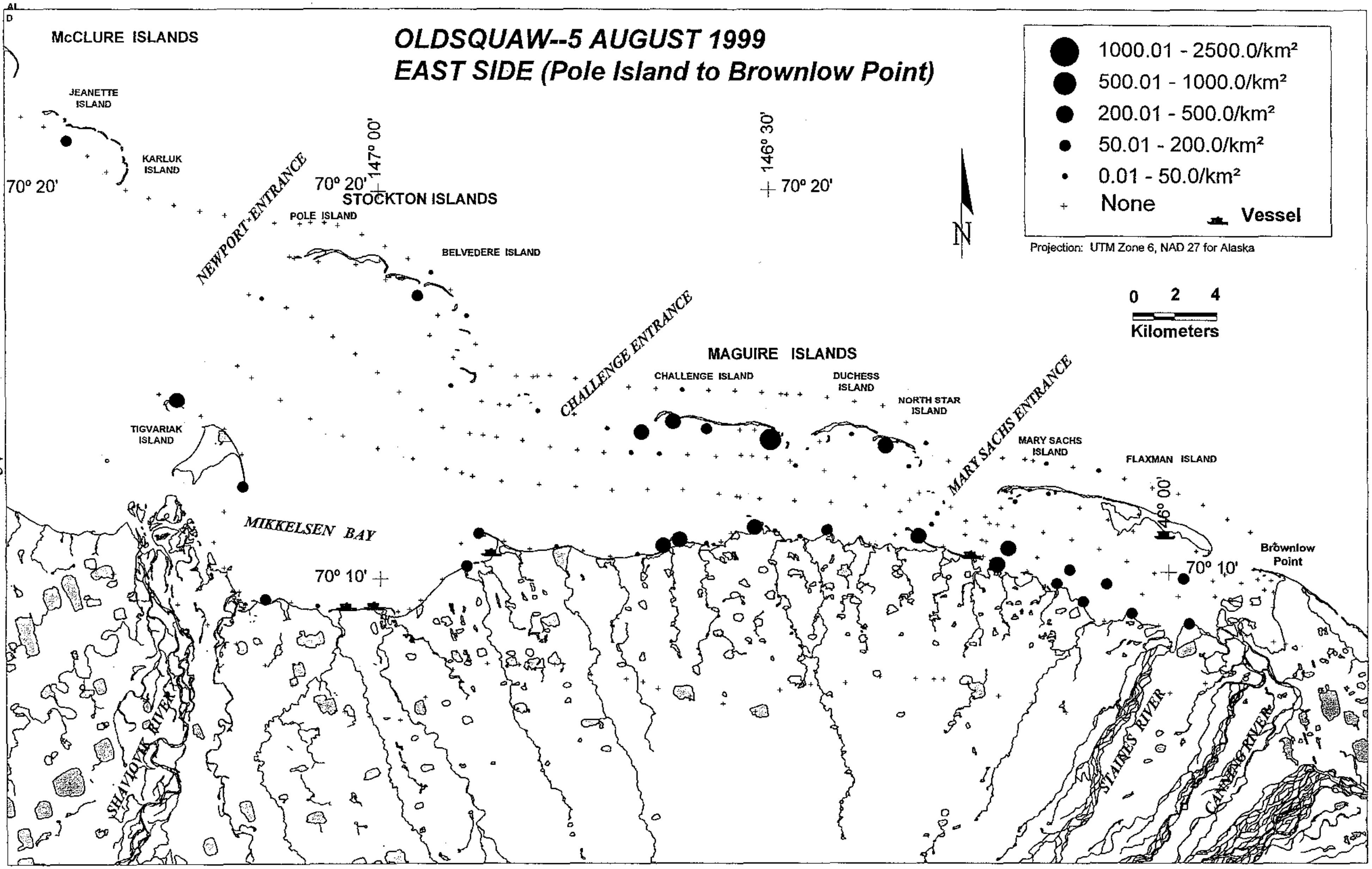
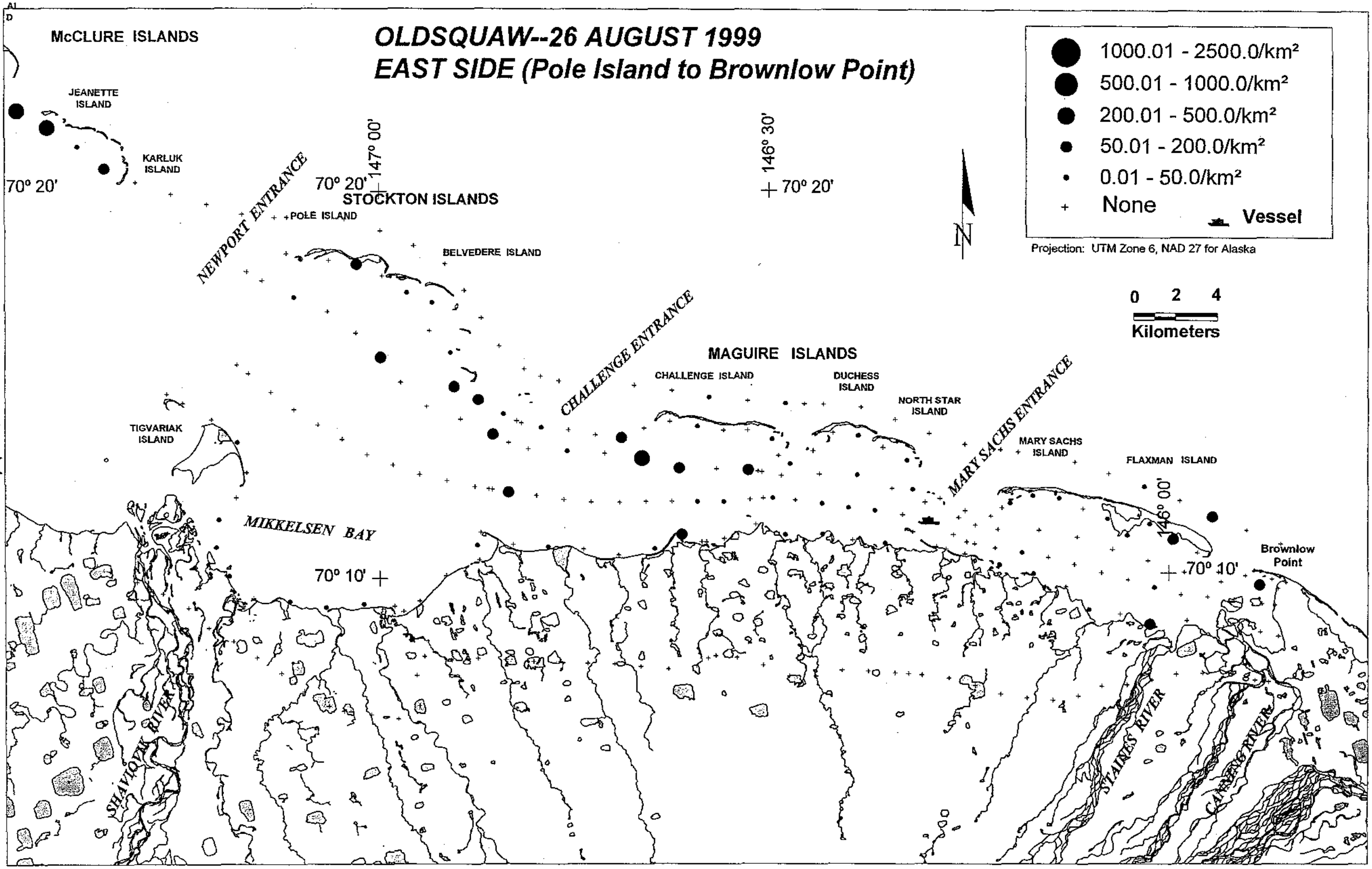


Figure A3. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 5 August 1999.



A4

Figure A4. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 26 August 1999.

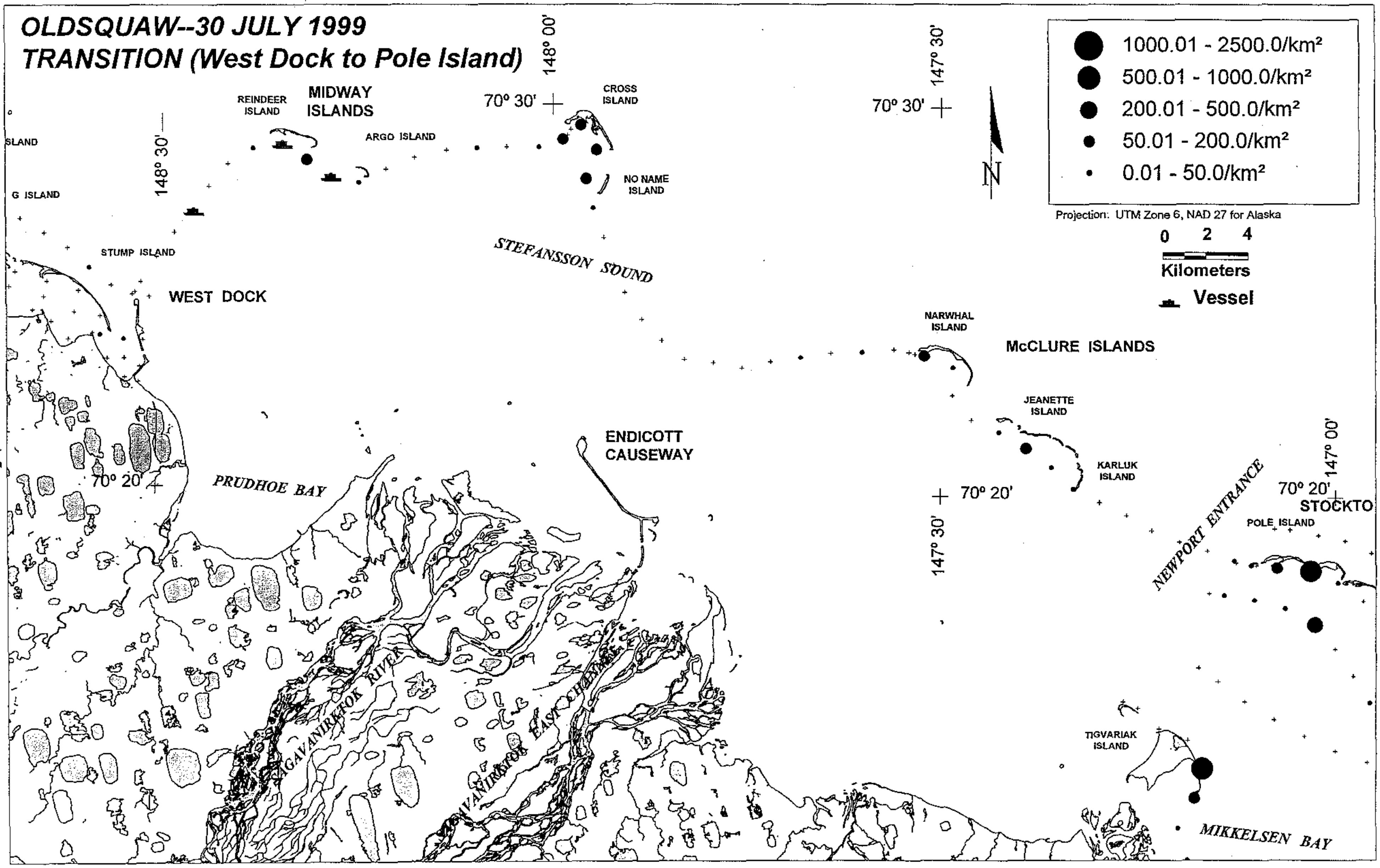


Figure A5. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July 1999.

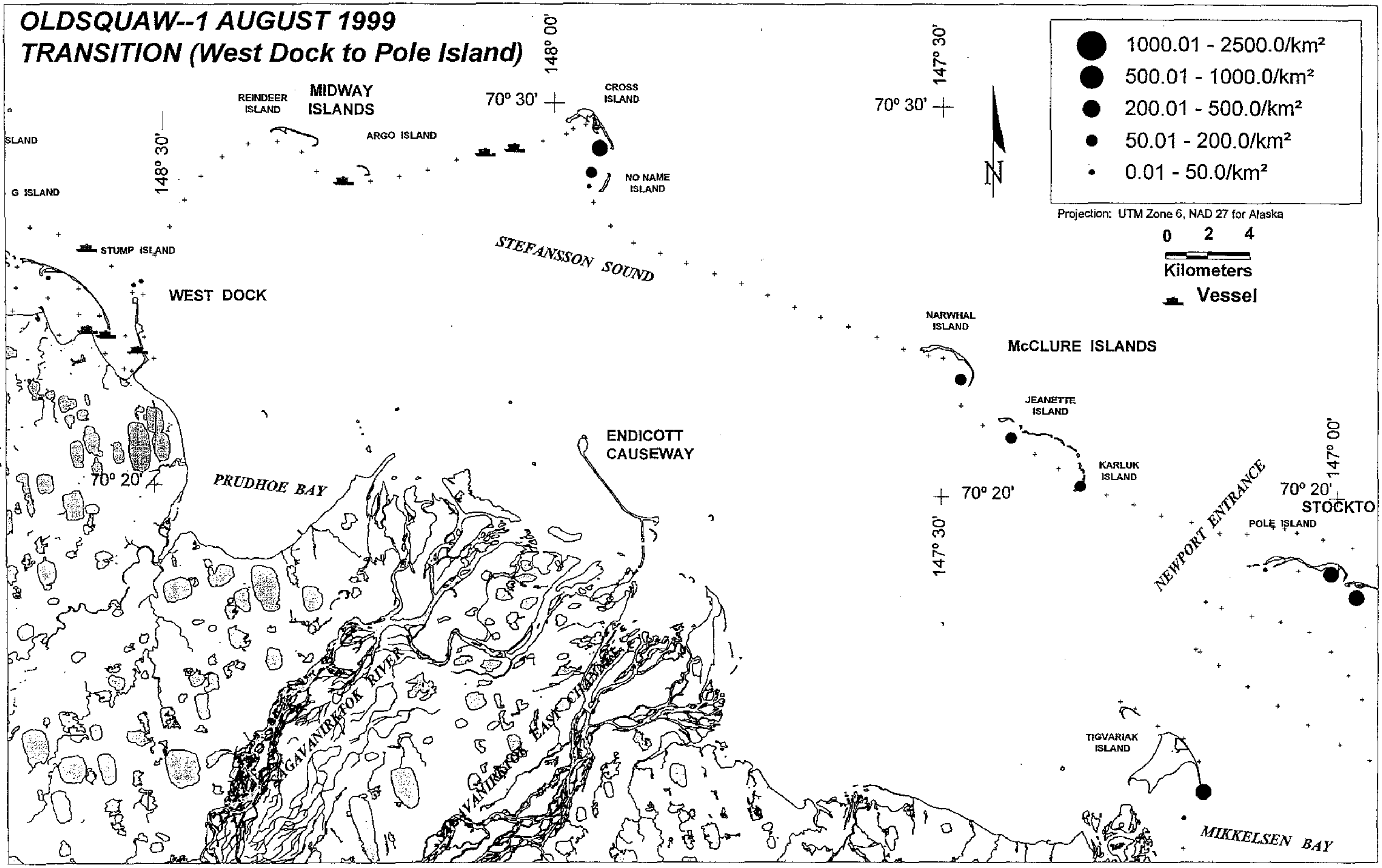


Figure A6. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 1 August 1999.

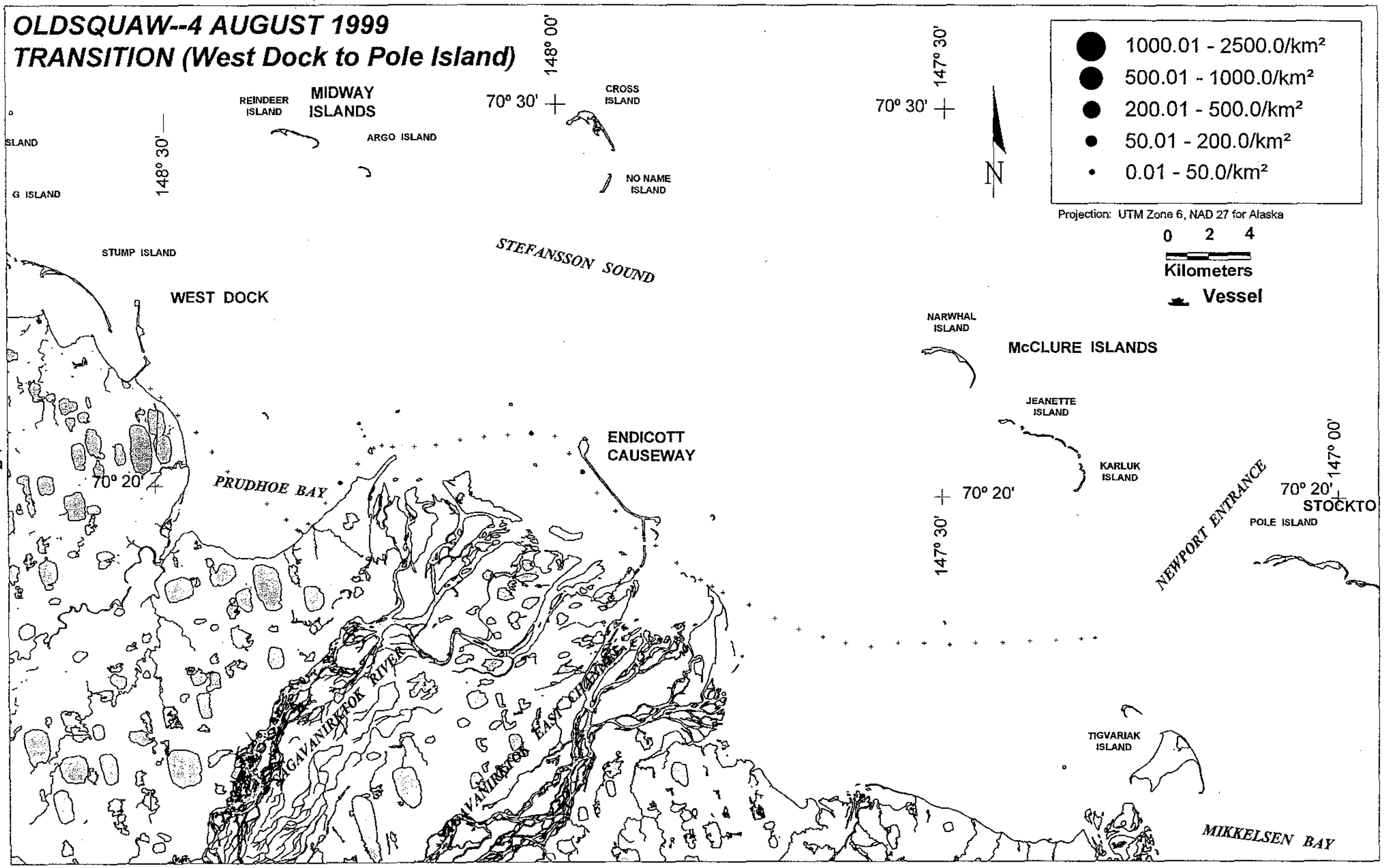


Figure A7. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 4 August 1999.

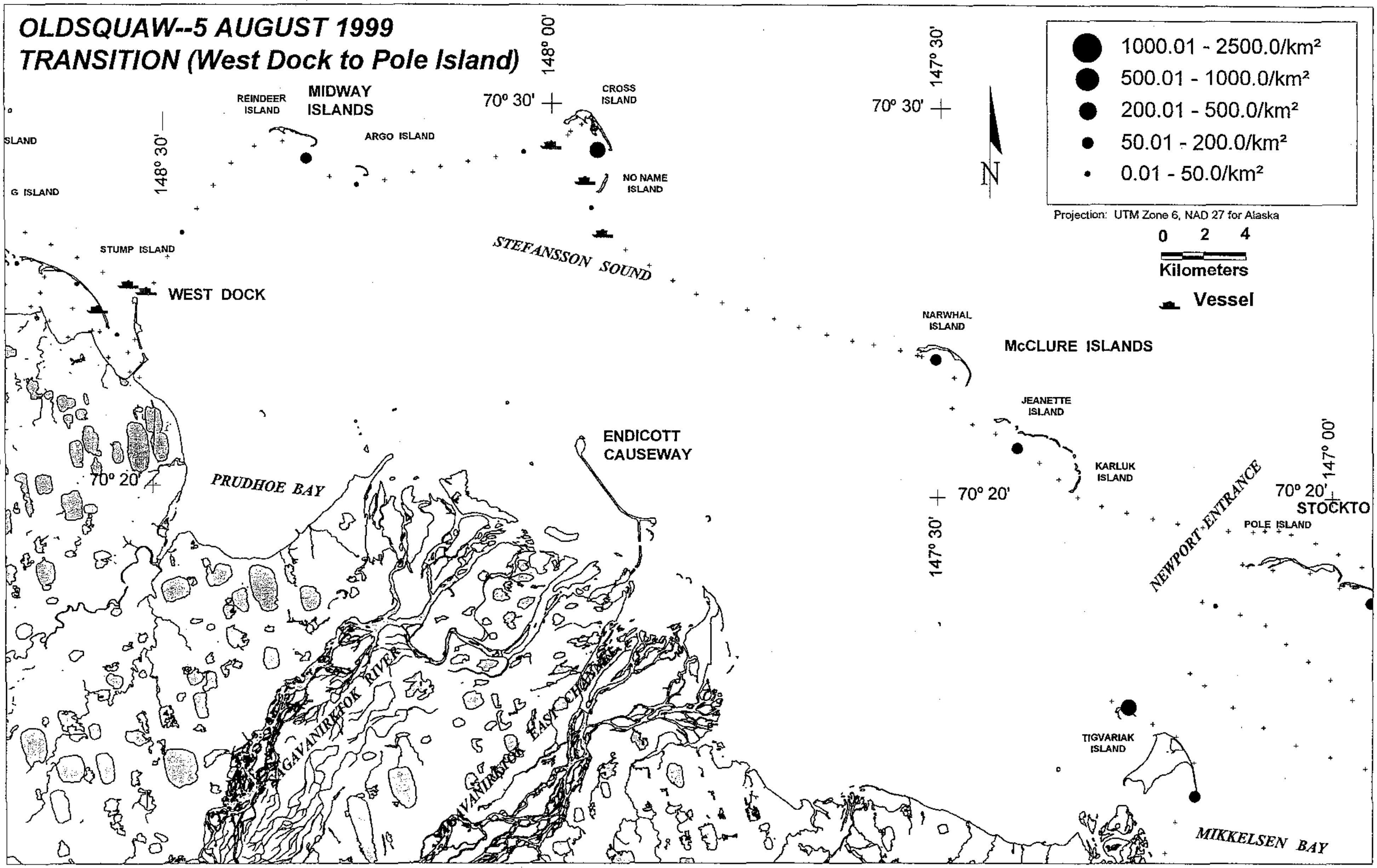


Figure A8. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 5 August 1999.

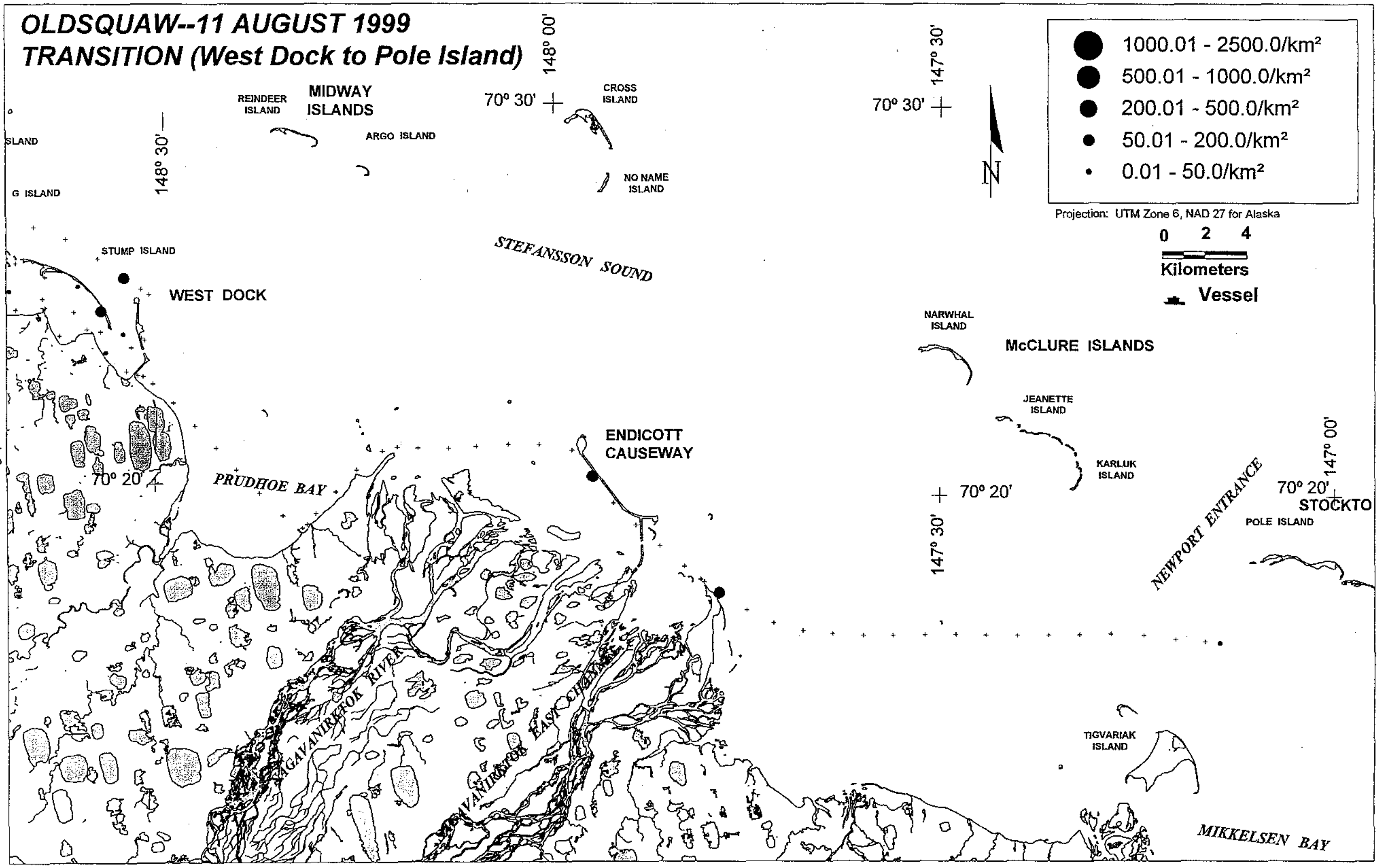


Figure A9. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 11 August 1999.

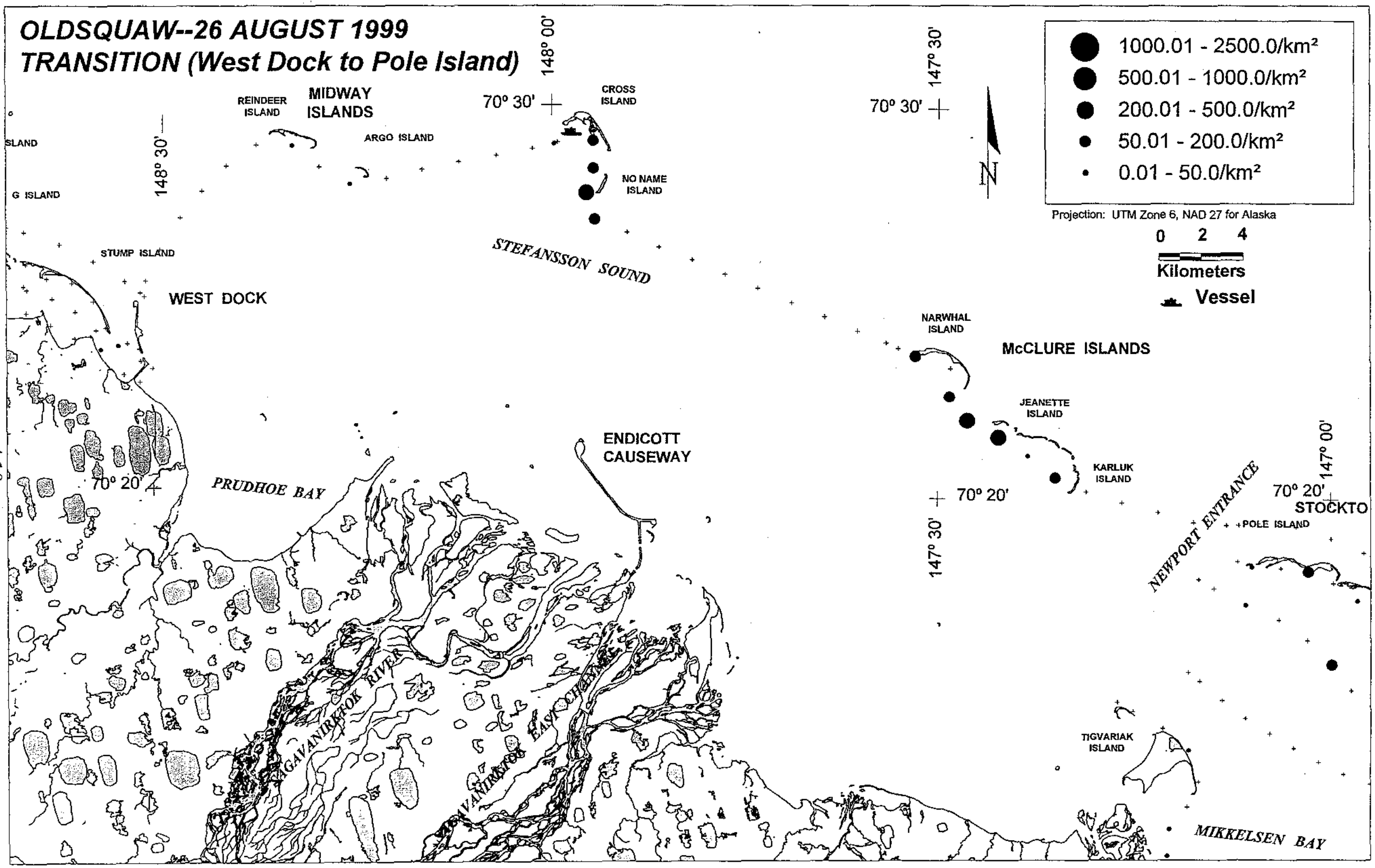
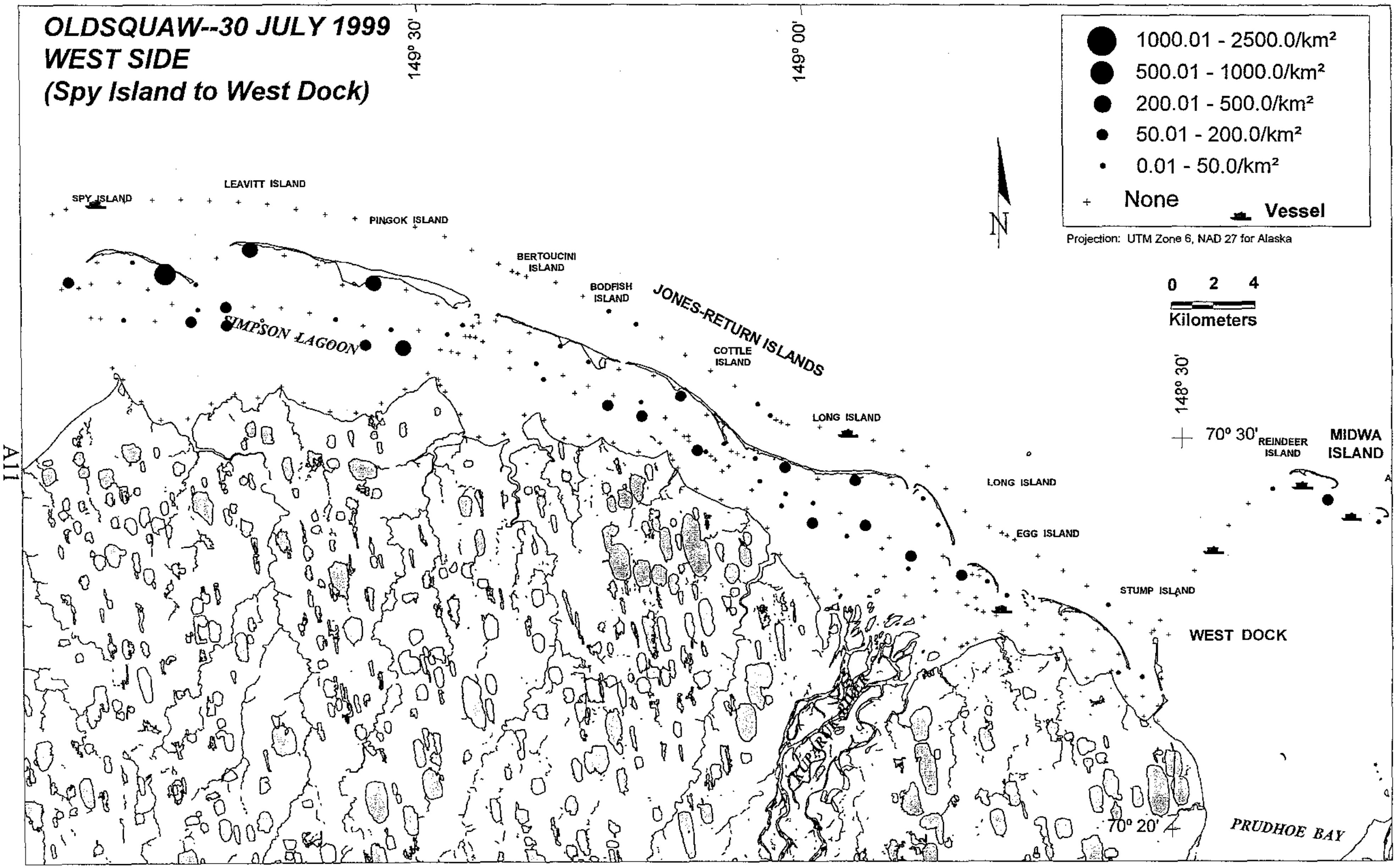
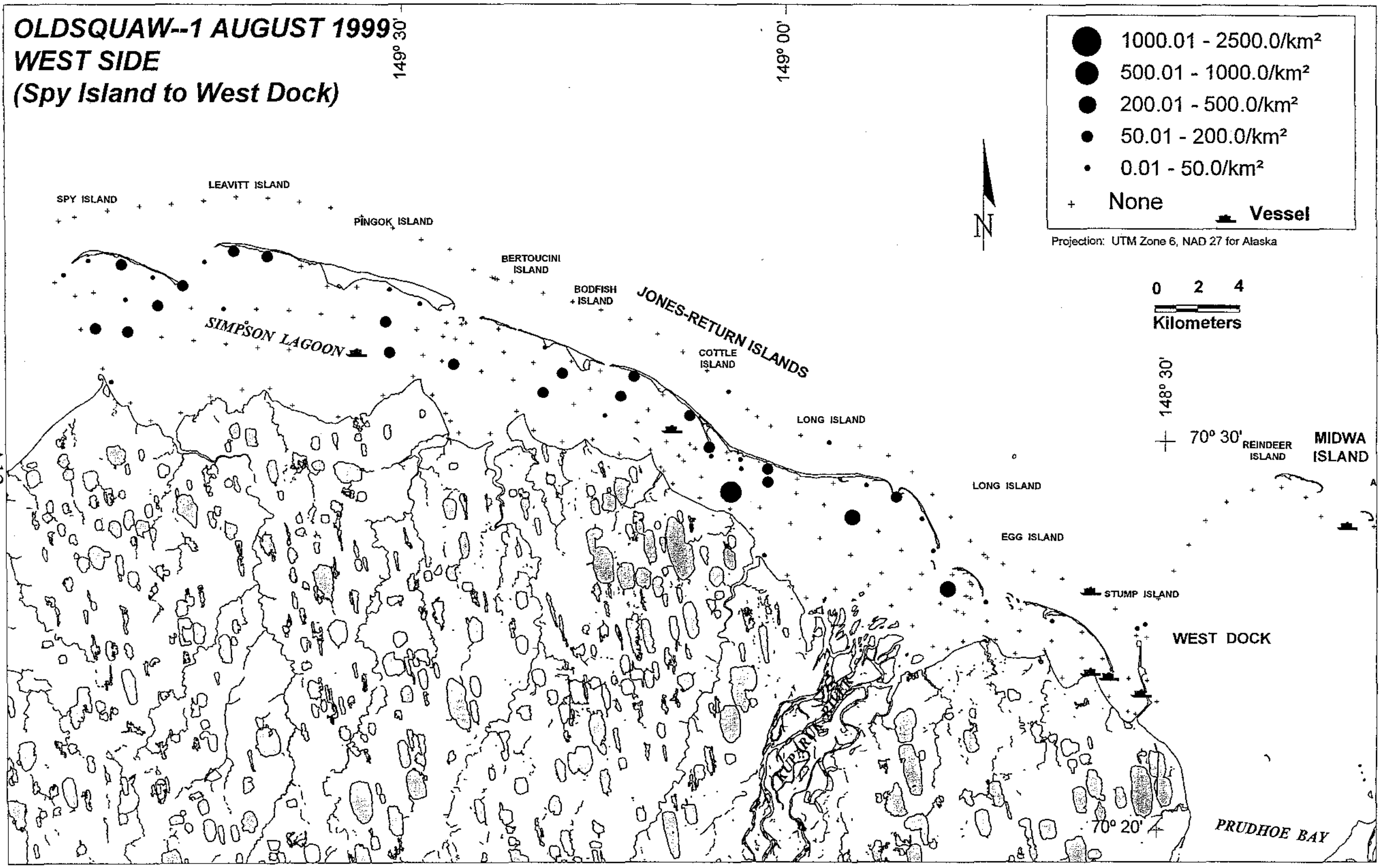


Figure A10. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 26 August 1999.



A11

Figure A11. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July 1999.



A12

Figure A12. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 1 August 1999.

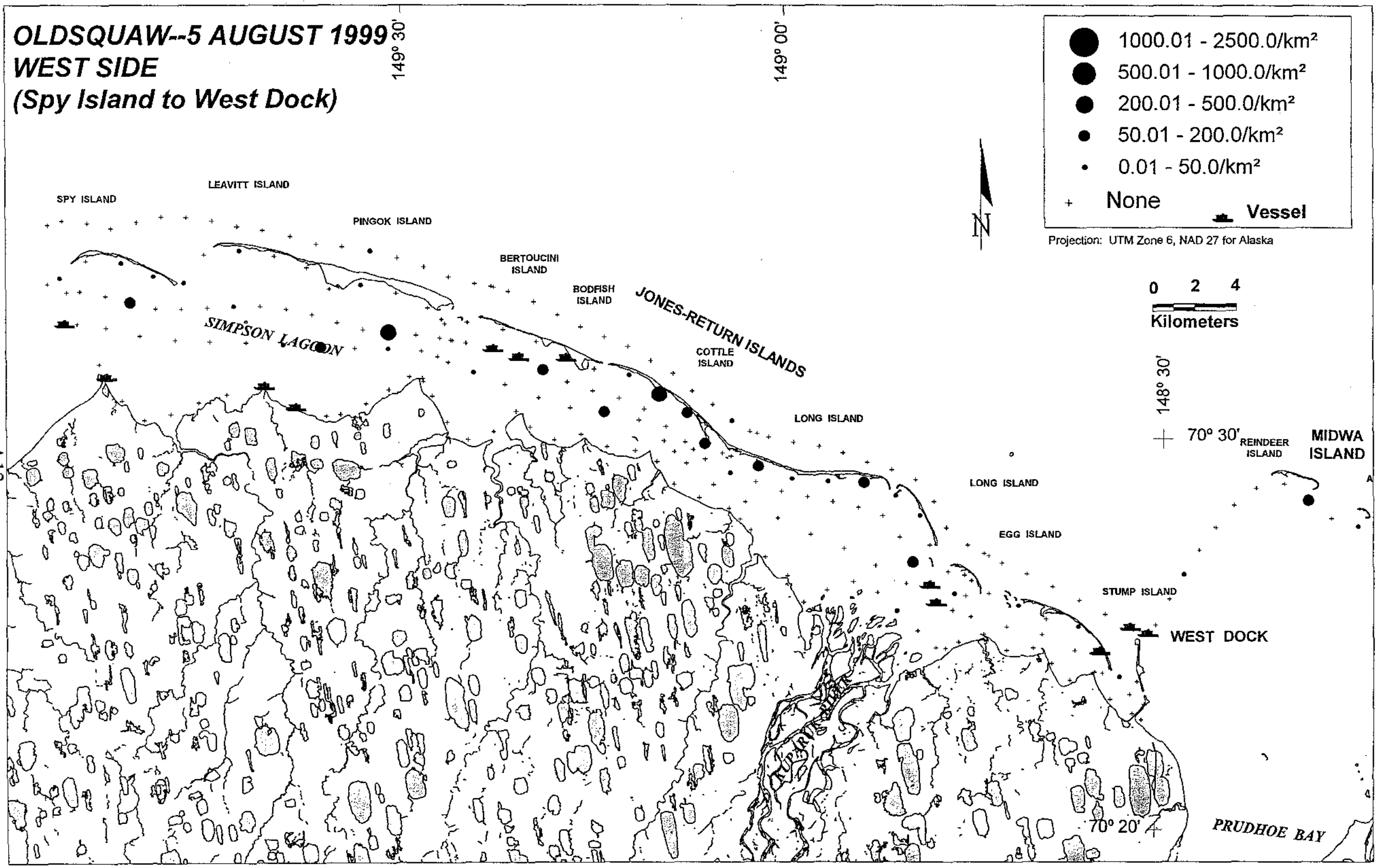


Figure A13. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 5 August 1999.

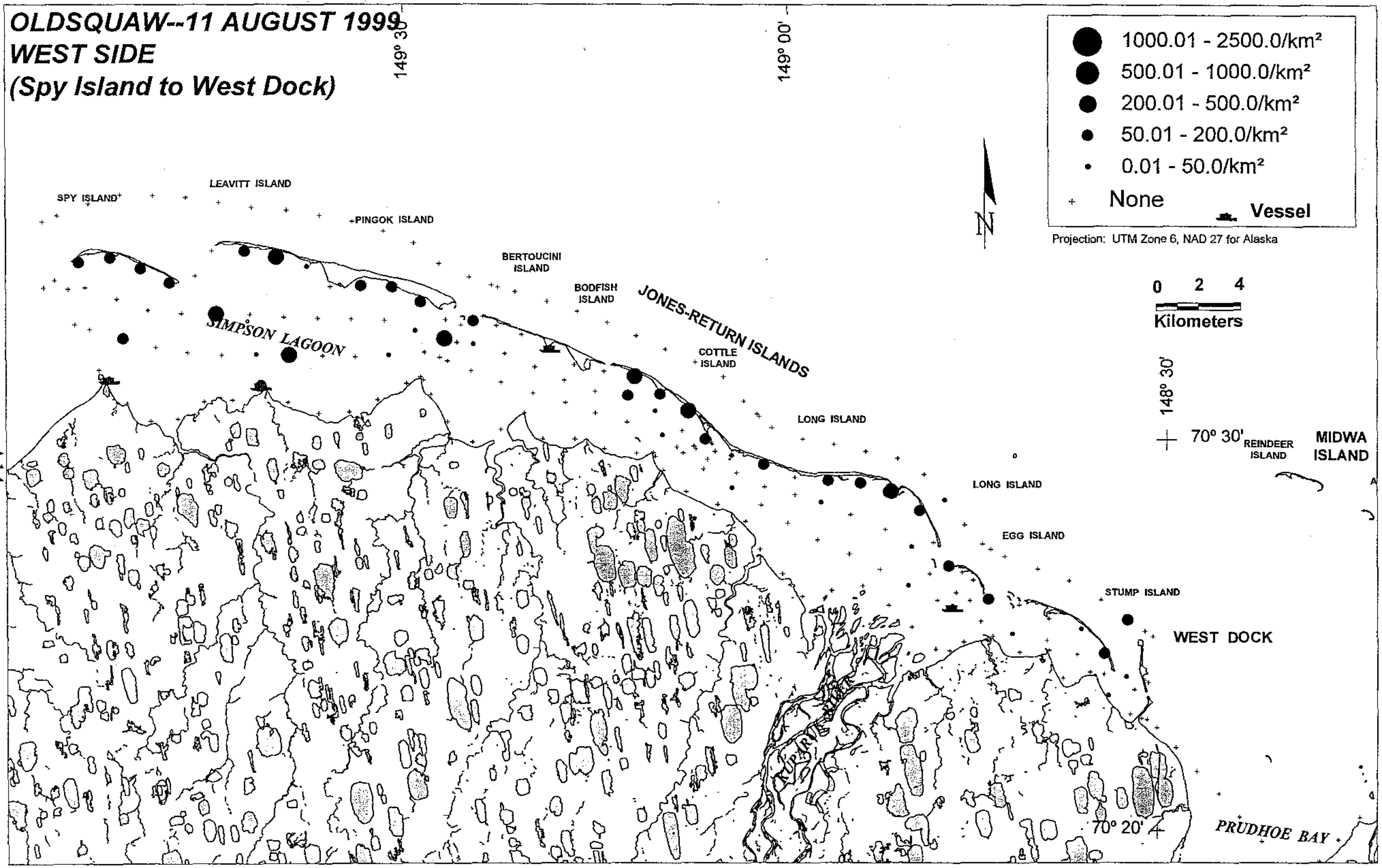


Figure A14. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 11 August 1999.

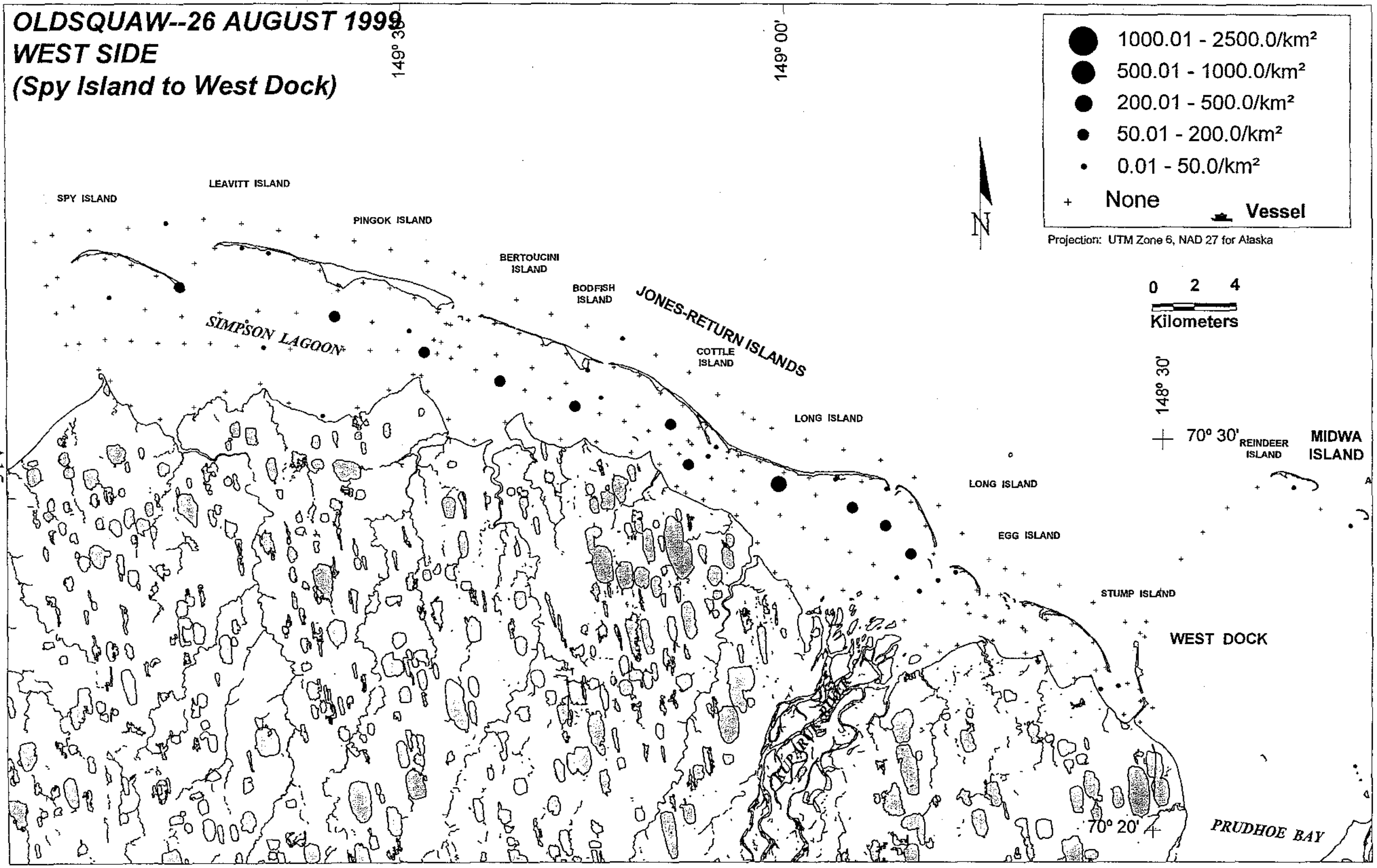


Figure A15. Summary of density for oldsquaw by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 26 August 1999.

Table A1. Database records for sightings of human activity during aerial surveys in the barrier island-lagoon systems between Spy Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

PROJ_CODE	RECORD	TRANS_CD	REGION	TRANS_NO	OBS_NO	ASSOC	SPECIES_C	SPECIES	NO_INDIVD	GR_TYPE	BEHAVIOUR	S_HABITAT	G_HABITAT	ON_OR_OF	SFUNCTION	TIME_PER	ADULTS	SUB_ADULT	YG_OF_YR	MALES	FEMALES	ICE	REPEAT	REMARKS
P458	8843.0	174	3	135	IH		8000.0	HUMAN	1	99	98	15	11	0		2	0000	0000	0000	0000	0000	000		FYKE NET
P458	438.0	11	1	202	LN		8000.0	HUMAN	1	99	98	15	11	0		6	0000	0000	0000	0000	0000	000		NET USFWS
P458	441.0	11	1	202	LN		8000.0	HUMAN	1	99	98	15	11	0		7	0000	0000	0000	0000	0000	000		CAMP USFWS
P458	1552.0	41	1	31	LN		8000.0	HUMAN	1	99	98	15	11	0		7	0000	0000	0000	0000	0000	000		144348 NET CAPTURE
P458	1595.0	42	1	202	LN		8000.0	HUMAN	1	99	98	11	11	1		6	0000	0000	0000	0000	0000	000		USFWS CAMP
P458	2092.0	54	3	60	LN		8000.0	HUMAN	1	99	98	08	13	1		5	0000	0000	0000	0000	0000	000		170449 ACROSS CAMP
P458	2123.0	55	3	136	LN	1	8000.0	HUMAN	1	99	98	15	11	0		4	0000	0000	0000	0000	0000	000		OLDS CAPTURE NET
P458	2155.0	56	3	135	LN		8000.0	HUMAN	1	99	98	15	11	0		1	0000	0000	0000	0000	0000	000		FYKE NET
P458	2577.0	68	3	192	LN	1	8000.0	HUMAN	3	99	98	14	27	0		4	0000	0000	0000	0000	0000	000		PEOPLE AT BULLEN PT
P458	2663.0	69	3	191	LN		8000.0	HUMAN	1	99	98	15	27	0		7	0000	0000	0000	0000	0000	000		182217 FYKE NET
P458	2673.0	69	3	191	LN		8000.0	HUMAN	1	99	98	15	27	0		10	0000	0000	0000	0000	0000	000		FYKE NET
P458	2679.0	69	3	191	LN		8000.0	HUMAN	1	99	98	15	27			11	0000	0000	0000	0000	0000	000		FYKE NET FISH CAMP
P458	2702.0	70	3	190	LN		8000.0	HUMAN	1	99	98	15	27			1	0000	0000	0000	0000	0000	000		FYKE NET
P458	2707.0	70	3	190	LN		8000.0	HUMAN	1	99	98	15	27	0		3	0000	0000	0000	0000	0000	000		182555 FYKE NET
P458	7513.0	147	3	136	LN		8000.0	HUMAN	1	99	98	15	11	1		5	0000	0000	0000	0000	0000	000		173457 USFWS CAMP O
P458	7543.0	147	3	136	LN		8000.0	HUMAN	1	99	98	15	11	0		10	0000	0000	0000	0000	0000	000		173746 FYKE NET
P458	8331.0	161	3	190	LN		8000.0	HUMAN	1	99	98	15	27	0		1	0000	0000	0000	0000	0000	000		184735 FYKE NET
P458	8336.0	161	3	190	LN		8000.0	HUMAN	1	99	98	15	27			3	0000	0000	0000	0000	0000	000		184820 FYKE NET
P458	4540.0	102	3	135	SJ		8000.0	HUMAN	1	99	98	15	11	0		1	0000	0000	0000	0000	0000	000		
P458	5422.0	115	3	191	SJ		8000.0	HUMAN	1	99	98	15	27	0		6	0000	0000	0000	0000	0000	000		
P458	5492.0	116	3	190	SJ		8000.0	HUMAN	1	99	98	15	27	0		2	0000	0000	0000	0000	0000	000		
P458	3263.0	82	1	301	SJ		8001.0	BOAT	1	01	07	09	09	1		3	0000	0000	0000	0000	0000	000		
P458	3397.0	84	1	602	SJ		8001.0	BOAT	2	04	07	09	09	1		8	0000	0000	0000	0000	0000	000		
P458	1812.0	47	1	22	IH		8001.0	BOAT	3	99	98	08	13	0		6	0000	0000	0000	0000	0000	000	1	RUBBER RAFTS
P458	2565.0	67	3	193	IH		8001.0	BOAT	2	99	98	15	27	0		14	0000	0000	0000	0000	0000	000		AT BADAMI ANCHORED
P458	3131.0	78	1	25	IH		8001.0	BOAT	1	99	98	15	27	1		6	0000	0000	0000	0000	0000	000		ZODIAC 3 PEOPLE EAS
P458	3162.0	79	1	24	IH		8001.0	BOAT	3	99	98	09	09	0		2	0000	0000	0000	0000	0000	000		ACS HAULING BOOM
P458	155.0	5	1	401	LN		8001.0	BOAT	1	99	98	15	27	0		7	0000	0000	0000	0000	0000	000		
P458	440.0	11	1	202	LN		8001.0	BOAT	2	99	98	15	11	0		7	0000	0000	0000	0000	0000	000		
P458	691.0	16	1	24	LN		8001.0	BOAT	1	99	98	09	09	1		97	0000	0000	0000	0000	0000	000		ON LAGOON
P458	1110.0	29	1	401	LN		8001.0	BOAT	1	99	98	15	27			7	0000	0000	0000	0000	0000	000		133554 ANCHORED
P458	1112.0	29	1	401	LN		8001.0	BOAT	1	99	98	15	27			8	0000	0000	0000	0000	0000	000		ON BEACH AT F PAD
P458	1281.0	34	1	32	LN		8001.0	BOAT	1	99	98	09	09	1		1	0000	0000	0000	0000	0000	000		800M TO N
P458	1422.0	38	1	602	LN		8001.0	BOAT	1	99	98	09	09	1		2	0000	0000	0000	0000	0000	000		SPEEDING AHEAD KEEL
P458	1424.0	38	1	602	LN		8001.0	BOAT	1	99	98	09	09	1		3	0000	0000	0000	0000	0000	000		2 PEOPLE USFWS
P458	1464.0	39	1	601	LN		8001.0	BOAT	1	99	98	09	09	1		11	0000	0000	0000	0000	0000	000		143219 TO S END TRA
P458	1596.0	42	1	202	LN		8001.0	BOAT	3	99	98	15	11	0		6	0000	0000	0000	0000	0000	000		ANCHORED AT CAMP
P458	1802.0	47	1	22	LN	1	8001.0	BOAT	3	99	98	08	13	0		6	0000	0000	0000	0000	0000	000		151940
P458	1846.0	48	2	130	LN		8001.0	BOAT	1	99	98	09	13	1		18	0000	0000	0000	0000	0000	000		183026 TO SOUTH 1MI
P458	2124.0	55	3	136	LN	1	8001.0	BOAT	2	99	98	15	11	0		4	0000	0000	0000	0000	0000	000		AT CAMP
P458	2578.0	68	3	192	LN	1	8001.0	BOAT	1	99	98	14	27	0		4	0000	0000	0000	0000	0000	000		
P458	2678.0	69	3	191	LN		8001.0	BOAT	2	99	98	15	27	0		11	0000	0000	0000	0000	0000	000		AT CAMP
P458	8169.0	158	3	193	LN		8001.0	BOAT	2	99	98	15	27			12	0000	0000	0000	0000	0000	000		183456 ANCHORED
P458	3931.0	93	1	22	SJ		8001.0	BOAT	2	99	98	08	13			4	0000	0000	0000	0000	0000	000		NEAR STUMP ISLAND
P458	6387.0	131	1	601	SJ		8001.0	BOAT	2	99	98	09	09	1		97	0000	0000	0000	0000	0000	000		AT DOCK HEAD-WEST D
P458	6388.0	131	1	601	SJ		8001.0	BOAT	1	99	98	09	09	1		97	0000	0000	0000	0000	0000	000		NEAR BARGE-WEST DOC
P458	8574.0	167	2	131	TO		8001.0	BOAT	1	99	98	15	11	0		1	0000	0000	0000	0000	0000	000		ANCHORED OFF CROSS
P458	9217.0	182	3	181	TO		8001.0	BOAT	1	99	98	09	09	1		2	0000	0000	0000	0000	0000	000		CROSSING LAGOON TO
P458	6904.0	138	1	30	SJ		8002.0	MBOAT	1	01	07	08	13	1		3	0000	0000	0000	0000	0000	000		
P458	1515.0	40	1	23	IH		8002.0	MBOAT	2	99	98	79	11	0		2	0000	0000	0000	0000	0000	000		ANCHORED AT WEST DO
P458	1813.0	47	1	22	IH		8002.0	MBOAT	1	99	98	08	13	0		6	0000	0000	0000	0000	0000	000	1	ACS BOAT
P458	1097.0	29	1	401	LN	1	8002.0	MBOAT	9	99	98	15	27	0		1	0000	0000	0000	0000	0000	000		4 TUGS 1 BARGE 2 AN
P458	1801.0	47	1	22	LN	1	8002.0	MBOAT	1	99	98	08	13	0		6	0000	0000	0000	0000	0000	000		151940 CIRCLING RAF
P458	3139.0	79	1	24	SJ		8002.0	MBOAT	2	99	98	09	09	0		1	0000	0000	0000	0000	0000	000		
P458	3976.0	94	2	130	SJ		8003.0	SEISMC	1	01		09	13	1		11	0000	0000	0000	0000	0000	000		AT ANCHOR
P458	3982.0	94	2	130	SJ		8003.0	SEISMC	1	01		09	13	1		16	0000	0000	0000	0000	0000	000		AT ANCHOR
P458	6993.0	140	2	130	SJ		8003.0	SEISMC	1	01	07	15	11	1		8	0000	0000	0000	0000	0000	000		SHOOTING E OF REIND.
P458	6998.0	140	2	130	SJ		8003.0	SEISMC	1	01	07	09	13	1		10	0000	0000	0000	0000	0000	000		WSTAR HEAD. EAST
P458	1891.0	49	2	131	LN		8003.0	SEISMC	1	99	98	15	11	0		3	0000	0000	0000	0000	0000	000		163202
P458	3984.0	94	2	130	SJ		8004.0	SHIP	1	01		09	13	1		17	0000	0000	0000	0000	0000	000		8 MILES AWAY
P458	6792.0	136	1	101	SJ		8004.0	SHIP	1	01	07	08	13	1		2	0000	0000	0000	0000	0000	000		
P458	6981.0	140	2	130	SJ		8004.0	SHIP	1	01	07	09	13	1		4	0000	0000	0000	0000	0000	000		E OF REINDEER IS.
P458	1817.0	47	1	22	IH		8004.0	SHIP	1	99	98	08	13	1		7	0000	0000	0000	0000	0000	000		TO NORTH
P458	133.0	5	1	401	LN		8004.0	SHIP	4	99	98	15	27	0		1	0000	0000	0000	0000	0000	000		
P458	1055.0	28	0	0	LN		8004.0	SHIP	2	99	98	15	11	1		99	0000	0000	0000	0000	0000	000		2 BARGES WITH MODUL
P458	1353.0	36	1	301	LN		8004.0	SHIP	2	99	98	09	09	1		97	0000	0000	0000	0000	0000	000		BARGES WITH MODULES
P458	1803.0	47	1	22	LN		8004.0	SHIP	1	99	98	08	13	1		6	0000	0000	0000	0000	0000	000		BARGE AND BOOMS ACS
P458	1895.0	49	2	131	LN		8004.0	SHIP	1	99	98	09	13	1		5	0000	0000	0000	0000	0000	000		163252 BARGE TO SW
P458	2543.0	67	3	193	LN		8004.0	SHIP	1	99	98	15	27	0		13	0000	0000	0000	0000	0000	000		181043 BARGE
P458	3138.0	79	1	24	SJ		8004.0	SHIP	1	99	98	09	09	0		1	0000	0000	0000	0000	0000	000		

Table A2. Numbers and percentages of oldsquaws counted during aerial surveys in nearshore waters of the central Alaska Beaufort Sea, 1977 to 1991 (Johnson and Gazey 1992), 1998 (Noel et al. 1999), and 1999.

Category*	Survey Year													
	1977	1978	1979	1980	1981	1982	1983	1984	1989	1990	1991	1998	1999	All Years
Numbers														
1	20695	111594	28598	22777	30597	31927	-	21998	102968	163915	31316	24455	26478	617318
2	58310	141801	36157	27826	48711	46964	6144	28399	110975	220758	61441	41344	58773	887603
3	94461	215199	49456	37549	65768	66794	-	33987	138729	277327	120397	43639	64393	1207699
4	104318	231307	54049	38364	71104	69775	-	34972	149408	312073	138408	48979	75173	1327930
Percentages														
5	90.55	93.04	91.50	97.88	92.50	95.73	-	97.18	92.85	88.87	86.99	89.10	85.66	91.82
6	55.90	61.30	66.90	72.53	68.51	67.31	-	81.20	74.28	70.74	44.39	84.41	78.18	68.80
7	21.91	51.86	57.83	60.66	46.52	47.80	-	64.72	74.22	59.11	26.01	56.04	41.12	50.65
8	19.84	48.24	52.91	59.37	43.03	45.76	-	62.90	68.92	52.52	22.63	49.93	35.22	46.77
9	61.73	65.89	73.11	74.11	74.06	70.31	-	83.56	79.99	79.60	51.03	94.74	91.27	74.95
10	35.49	78.70	79.09	81.86	62.81	67.98	-	77.46	92.78	74.25	50.97	59.15	45.05	67.13

* 1 = No. of oldsquaws on-transect only on barrier island transects during all surveys
2 = No. of oldsquaws on-transect on all lagoon transects during all surveys
3 = No. of oldsquaws on+off transect on all lagoon transects during all surveys
4 = No. of all birds of all species on+off transect on all lagoon transects during all surveys
5 = Cat. 3/Cat. 4
6 = Cat. 2/Cat. 4
7 = Cat. 1/Cat. 3
8 = Cat.1/Cat.4
9 = Cat.2/Cat.3
10 = Cat.1/Cat.2

Table A3. Individual on-transect densities for transects between Spy Island and Brownlow Point, Beaufort Sea, Alaska, 5 June-23 Spetember 1977-1987; 1989-1991; 1998-1999.

Survey Date	Overall Study Area (Excluding tundra)			Barrier Island Transect Nos. and Areas Sampled (sq. km.)								Non-barrier Island Transect Nos. and Areas Sampled (sq. km.)											
Transect Number	Total Sq. km.	Total # Oldsq.	Overall Dens.	23	31	201	202	133	134	135	136	10	11	12	13	22	24	25	30	32	33	50	51
Transect Area	On-transect	On-transect	Oldsq./sq. km	4.52	5.68	8.48	6.08	6.08	4.84	5.40	6.28	9.48	6.04	5.56	3.48	3.64	4.40	4.80	5.00	5.72	7.52	4.72	4.24
5 Jun.77	54.08	3	0.06			0.00	0.00																
20 Jun.77	54.08	34	0.63			7.55	2.30																
5 Jul.77	54.08	745	13.78			50.00	61.18																
28-29 Jul.77	54.08	35350	653.66			1090.80	545.07																
15 Aug.77	28.32	18001	635.63			1894.34	1496.71																
30 Aug.77	54.08	4287	79.27			443.40	48.68																
22 Sep.77	54.08	14937	276.20			75.71	0.56																
23 Jun.78	74.4	107	1.44	15.93	1.76	2.24	0.00										0.00			1.05			
5 Jul.78	112.08	3305	29.49	8.85	6.87	92.22	264.14	1.81	10.54	2.22	0.80						0.00			11.71			
15 Jul.78	74.4	32771	440.47	86.95	1159.74	1655.90	1148.68										0.45			6.47			
25 Jul.78	111.44	9695	87.00	0.00	465.49	330.07	236.84	23.19	0.00	48.15	165.45						0.00			3.50			
5-6 Aug.78	117.72	12141	103.13	36.50	457.04	375.59	271.55	10.53	3.86	464.81	589.17						0.00			8.04			
15 Aug.78	74.4	18307	246.06	91.81	352.82	1785.97	60.53										45.45			14.86			
25 Aug.78	111.44	19369	173.81	606.19	546.13	578.89	18.91	12.99	294.63	1025.00							2.73			54.37			
5-6 Sep.78	117.72	19951	169.48	23.45	251.94	39.03	313.32	113.98	17.77	244.26	702.55						76.82			38.64			
15 Sep.78	68.68	4393	63.96	34.07	0.35	11.06	99.01										74.32						
23 Sep.78	117.72	21762	184.86	357.52	13.03	11.79	7.73	125.99	1577.69	364.26	129.62						84.55			29.10			
22 Jun.79	74.4	388	5.22	18.81	44.37	3.66	0.99										0.23			2.62			
28 Jul.79	117.72	24539	208.45	0.44	700.18	404.83	702.30	353.95	22.73	382.22	607.32						3.64			4.55			
31 Aug.-1 Sep.79	64.28	5560	86.50	5.97	237.85	76.77	84.87																
22 Sep.79	74.4	5670	76.21	18.36	58.27	280.28	170.23										5.12			21.50			
2 Aug.80	117.72	27826	236.37	63.50	1205.63	812.62	438.65	291.45	20.66	162.04	586.62						0.00			71.68			
18 Jul.81	65.36	1775	27.16	15.49		103.88										1.65	85.23	0.15					
29 Jul.81	71.44	10751	150.49	98.45		247.64	892.93									0.00	0.00	0.62					
2 Aug.81	95.12	15267	160.50	71.02	154.05	335.61	225.00	106.09	263.43	238.15	294.11						74.55			122.03			
12 Aug.81	59.96	1090	18.18	67.92		12.38	91.45									0.00	1.36	0.00					
29 Aug.81	71.44	1432	20.04	2.03		91.51	52.30									34.07	13.86	0.00					
11 Sep.81	71.44	19976	279.62	1596.24		123.00	117.27									137.22	1469.09	510.42					
18 Jul.82	95.36	3817	40.03	44.03	124.47	144.34	102.80									6.32	25.45	0.21	2.40	73.43	2.66		
31 Jul.82	71.44	9214	128.98	126.99		212.97	383.88									104.40	42.73	2.92					
14 Aug.82	77.12	19416	251.76	161.50	1602.46	838.44	1053.62									98.08	10.23	2.08					
28 Aug.82	95.36	5650	59.25	141.81	281.51	142.69	73.68									4.40	42.05	72.92	8.00	7.69	19.95		
23 Sep.82	95.36	8867	92.98	38.27	15.85	157.31	29.63									0.00	4.09	50.21	0.20	47.90	419.68		
29 Jul.83	72.73	6305	86.69	84.96													10.45						
8 Aug.84	133.88	28399	212.12	693.81	263.73	285.73	736.35	347.20	308.26	254.81	872.93					100.00	63.64	0.00	12.00	70.28	0.00		
6 Aug.89	176.96	31304	176.90	84.73	1366.90	92.02	13.65	739.64	321.49	703.70	1131.21	0.00	2.48	0.00	0.00	0.00	0.00		0.00	10.49		3.18	0.00
8 Aug.89	176.96	35060	198.12	230.53	2060.21	817.02	505.43	592.43	23.76	269.07	1005.25	0.21	0.00	0.00	0.00	0.00	0.00		0.00	0.00		0.00	0.00
9 Aug.89	176.96	44611	252.10	467.92	2025.00	628.17	370.23	731.25	450.83	435.19	2000.80	0.00	1.82	0.00	0.00	96.15	7.95		1.41	0.00		0.00	7.08
18 Jul.90	186.36	19400	104.10	97.79	156.87	124.77	55.61	234.54	223.55	244.63	396.83					15.38	3.41	1.25	1.81	24.65	0.00		
20 Jul.90	186.36	19097	102.47	50.88	151.94	110.33	210.20	353.95	155.79	486.67	434.55					12.36	1.14	1.04	9.68	15.56	1.20		
23 Jul.90	186.36	26540	142.41	99.78	394.19	590.38	397.53	281.91	259.30	446.11	599.68					6.87	1.14	0.00	0.00	15.03	0.00		
3 Aug.90	186.36	42596	228.57	33.85	264.08	612.91	872.20	532.07	556.61	1146.48	1416.08					0.00	3.18	1.25	0.00	123.95	1.06		
4 Aug.90	166.28	20614	123.97	17.04	62.68	188.15	247.20	256.09	52.89	139.44	1218.31					0.00	2.73	0.00	0.00	156.99	0.00		
9 Aug.90	143.20	16953	118.39	36.73	91.37	111.74	81.41	888.98	333.47	431.85	348.73						22.73	0.00		54.55	1.20		
16 Aug.90	72.28	6657	92.10	26.11	249.30	671.60	18.09										4.09	0.00		0.17	0.27		
20 Aug.90	186.36	34820	186.84	97.57	230.28	211.74	90.79	953.62	1347.11	1285.19	933.92					0.82	31.59	6.25	3.23	14.16	2.93		
2 Sep.90	186.36	8685	46.60	4.42	3.52	9.15	35.69	451.48	437.81	129.44	262.26					0.00	0.00	0.00	0.00	0.52	14.10		
4 Sep.90	143.20	6728	46.98	0.44	34.15	29.46	17.76	199.51	67.56	165.56	196.18						0.23	2.71		7.52	5.98		
5 Sep.90	143.20	18668	130.36	5.09	19.19	27.58	11.18	727.30	244.21	116.67	1466.40						4.32	3.75		0.00	14.63		
18 Jul.91	73.42	3759	51.20	17.70	104.05	170.75	238.98										2.05	0.00		1.22	0.13		
19 Jul.91	115.60	7153	61.88	75.00	76.06	174.29	162.99	78.13	20.45	92.04	195.22						9.55	0.00		15.03	4.65		
20 Jul.91	115.60	6963	60.23	60.25	105.62	31.26	212.25	29.77	15.91	21.67	108.12						9.55	0.21		25.00	14.36		
22 Jul.91	115.60	9673	83.68	67.04	112.68	252.36	83.72	80.43	36.78	149.81	185.19						3.41	0.00		33.22	0.66		
4 Aug.91	115.60	8670	75.00	90.27	91.73	98.23	136.68	97.37	113.64	115.00	63.54						7.05	2.08		41.96	13.96		
10 Aug.91	115.60	6628	57.34	25.44	28.35	109.91	88.82	131.58	36.16	73.33	39.01						1.36	1.46		144.58	10.24		
14 Aug.91	139.00	6883	49.52	21.90	144.19	166.98	162.83	87.17	46.69	35.19	30.00						9.32	3.13		55.94	0.00		
16 Aug.91	158.76	6464	40.72	6.39	36.33	86.79	25.00	190.30	12.81	49.63	35.51					2.75	2.27	3.75	0.60	36.89	1.33		
21 Aug.91	158.76	5248	33.06	12.83	57.64	35.61	63.82	154.61	30.79	25.56	7.32					5.22	6.36	0.42	17.20	17.48	1.73		
5 Aug. 98	70.92	5302	74.76					14.77	50.36	88.18	299.69												
14 Aug. 98	70.92	9736	137.28					110.58	163.17	253.25	247.65												
16 Aug.98	70.92	12162	171.49					389.61	157.88	181.25	358.55												
31 Aug.98	70.92	4427	62.42					106.63	1.27	34.55	173.84												
3 Sept.98	70.92	14345	202.27					813.70	193.30	271.35	41.56												
30 Jul.99	186.36	18239	97.87	13.79	99.00	214.27	39.07	171.55	300.59	248.79	142.12					0.80	1.52	0.00		40.77			
1 Aug.99	186.36	14051	75.40	4.81	103.30	114.68	113.32	190.07	106.71	351.03	206.86					10.17	0.24		10.26	217.11	0.28		
5 Aug. 99	186.36	10406	55.84	10.58	63.83	9.11	96.72	21.38	214.17	224.50	17.45										1.85		
11 Aug. 99	95.36	6732	70.60	131.38	267.43	204.19	310.88									56.82	1.46	7.48	3.57	2.61			
26 Aug. 99	186.36	3887	20.86		24.51	23.42	5.94	97.60	68.25	42.04	57.05						4.08	1.67		29.82			
n =	68	68	68	55	49	62	61	40	40	40	39	3	3	3	3	26	54	34	18	45	26	3	3
Mean =	109.97	13287.66	128.39	114.56	334.04	300.57	236.05	277.38	214.07	286.08	450.45	0.07	1.43	0.00	0.00	26.67	42.16	19.88	3.91	37.21	20.49	1.06	2.36
s.d. =	46.49	10858.35	123.79	246.27	507.00	416.35	314.57	269.32	324.83	296.80	479.68	0.12	1.28	0.00	0.00	42.48	199.36	87.92	5.22	47.72	81.64	1.84	4.09
c.v. =	0.42	0.82	0.96	2.15	1.52	1.39	1.33	0.97	1.52	1.04	1.06	1.73	0.90	0.00	0.00	1.59	4.73	4.42	1.33	1.28	3.98	1.73	1.73

Table A3. Continued

Survey Date	Non-barrier Island Transect Nos. and Areas Sampled (sq. km.)																				Tundra Transect Nos. and Areas Sampled (sq. km.)			
Transect Number	52	53	60	61	62	63	101	102	301	302	401	402	180	181	182	183	190	191	192	193	500	501	502	503
Transect Area	4.28	5.64	5.76	4.44	4.52	5.36	8.44	6.00	6.92	5.24	7.28	5.64	5.68	4.24	5.16	5.64	6.28	4.48	7.00	9.84	6.56	5.42	6.91	5.52
5 Jun.77							0.00	0.00	0.00	0.00	0.00	2.13												
20 Jun.77							0.00	0.00	0.00	0.00	0.82	2.84												
5 Jul.77							0.12	5.00	4.91	0.38	119.23	44.68												
28-29 Jul.77							0.12	6.67	72.25	1505.73	1550.55	2741.41												
15 Aug.77											1124.73	35.46												
30 Aug.77							5.45	0.17	143.35	244.08	428.57	71.63												
22 Sep.77							5.21	0.83	626.45	1458.78	276.53	1334.04												
23 Jun.78							0.00	0.00	0.00	0.00	0.41	0.00												
5 Jul.78							0.24	0.00	3.90	7.44	3.43	0.53	24.47	107.78	0.00	0.00								
15 Jul.78							2.96	1.67	14.74	72.14	29.69	111.03												
25 Jul.78							18.26	2.17	82.80	62.02	28.43	7.09	4.40	11.79	0.00	0.00								
5-6 Aug.78							0.36	0.53	53.76	75.76	11.40	0.00	183.10	117.62	0.00	0.00								
15 Aug.78							0.00	0.00	4.77	10.88	0.00	0.00												
25 Aug.78							52.37	45.33	24.86	45.42	0.00	1.77	1.07	0.00	0.00	0.00								
5-6 Sep.78							23.70	14.50	11.13	14.12	0.14	0.00	309.15	1354.01	206.59	18.97								
15 Sep.78							163.15	229.50	33.24	25.57	2.06	13.65												
23 Sep.78							2.61	0.00	369.36	56.30	157.69	114.54	438.03	79.01	0.00	152.30								
22 Jun.79							0.00	0.00	0.00	0.00	0.00	0.53												
28 Jul.79							0.00	9.43	131.21	136.45	41.48	17.73	18.84	104.01	23.26	0.00								
31 Aug.-1 Sep.79							6.57	45.83	98.70	640.29	0.00	0.00												
22 Sep.79							19.79	9.50	5.76	0.57	76.10	162.59												
2 Aug.80							0.00	0.00	250.87	61.83	134.71	213.48	0.00	16.98	0.00	0.00								
18 Jul.81							107.94	0.00	53.28	26.39	9.75	8.76												
29 Jul.81							0.00	0.17	129.48	177.67	0.00	0.35												
2 Aug.81							0.00	0.00	51.16	233.59	37.23	27.66	32.22	20.05	0.00	0.00								
12 Aug.81							0.00	0.00	7.37	6.87	0.27	4.79												
29 Aug.81							8.06	0.33	15.32	8.02	0.00	0.00												
11 Sep.81							71.56	18.00	194.87	20.42	0.69	1.24												
18 Jul.82							0.12	0.00	12.86	55.34	5.91	9.04												
31 Jul.82							0.12	0.00	386.99	193.51	22.80	11.70												
14 Aug.82							1.18	0.00	28.12	0.38	0.00	0.00												
28 Aug.82							10.31	1.50	58.09	94.08	0.00	0.00												
23 Sep.82							8.53	0.00	254.77	197.90	17.17	73.58												
29 Jul.83																								
8 Aug.84							7.94	0.00	209.54	387.60	0.00	0.00	101.76	227.19	113.37	7.80								
6 Aug.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	276.01	318.70			0.00	0.00	322.29	0.00								
8 Aug.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	79.48	0.57			4.40	23.58	23.45	0.00								
9 Aug.89	5.79	0.00	0.00	0.00	0.00	0.00	0.00	0.33	14.45	0.57			0.00	0.00	211.24	39.01								
18 Jul.90			36.89	41.52	0.00	0.00	8.29	0.00	227.75	26.72	7.28	0.00	62.68	195.52	34.88	0.00	490.03	372.32	165.29	63.62				
20 Jul.90			0.35	1.56	0.22	0.56	18.84	0.00	147.40	83.21	7.01	0.00	144.72	66.75	34.30	21.28	200.32	242.63	160.14	77.95				
23 Jul.90			0.00	2.23	0.00	0.00	0.59	0.00	59.39	17.75	2.47	0.35	22.18	2.36	0.19	2.66	387.64	452.46	216.57	53.25				
3 Aug.90			0.00	0.00	0.00	0.00	13.63	2.50	130.64	26.72	0.00	4.26	67.61	54.25	4.84	0.00	187.03	802.23	153.00	100.00				
4 Aug.90							0.00	0.00	112.86	34.35	0.96	0.00	13.20	29.25	26.74	2.66	319.3	277.01	150.57	32.01				
9 Aug.90									59.97	56.30	0.14	0.18	31.16	41.04	14.15	0.00	36.23	189.06	56.00	25.91				
16 Aug.90									7.23	4.39	2.61	0.00												
20 Aug.90			0.00	0.00	2.21	0.00	4.27	0.00	19.51	222.14	4.95	1.06	0.35	0.00	27.52	0.00	45.09	406.92	234.43	2.13				
2 Sep.90			0.00	0.22	0.00	0.00	0.00	0.00	15.46	1.34	69.00	0.18	44.54	13.21	0.97	1.95	18.20	40.85	35.00	4.27				
4 Sep.90									19.94	6.11	0.00	0.35	37.32	8.02	237.21	3.72	24.21	71.65	31.00	5.18				
5 Sep.90									1.59	3.24	1.10	0.53	0.00	0.47	62.02	192.73	3.01	140.40	48.86	20.83				
18 Jul.91									12.43	5.73	5.22	2.84												
19 Jul.91									22.40	12.60	7.42	0.18	23.06	7.55	6.78	0.00	45.70	108.04	23.29	4.57				
20 Jul.91									30.35	15.46	11.40	4.96	5.11	7.78	4.84	0.35	11.78	70.76	33.00	8.84				
22 Jul.91									27.89	10.69	19.23	0.18	66.90	63.44	116.67	0.00	67.20	101.34	30.71	50.81				
4 Aug.91									76.59	86.26	16.48	13.48	36.44	34.67	61.24	0.35	49.52	78.13	83.14	44.31				
10 Aug.91									69.94	10.31	13.32	1.77	30.11	16.04	67.44	0.53	39.65	94.64	38.43	17.28				
14 Aug.91				4.50	0.00		0.59	0.00	41.47	16.41	2.34	14.18	0.00	28.30	75.39	0.00	101.43	10.71	65.71	5.89				
16 Aug.91			23.44	65.99	23.23	1.31	0.47	1.67	138.87	147.52	1.92	0.00	35.21	23.35	83.72	0.18	19.90	9.60	9.71	8.94				
21 Aug.91			9.20	4.50	11.06	30.22	0.47	10.33	217.77	9.16	3.57	0.18	10.21	30.66	46.32	0.00	10.19	33.26	2.86	2.44				
5 Aug. 98													8.09	9.11			122.97	87.41	85.03	0.57				
14 Aug. 98													17.36	0.00			173.15	333.93	200.89	20.77				
16 Aug.98													20.50	1.00	1.35		157.93	298.29	211.57	51.53	0.00	0.00		
31 Aug.98													0.68	1.88	30.43		4.69	28.37	35.29	17.03		5.79		
3 Sept.98													8.78	61.67	401.55	1.89	36.88	118.79	87.89	33.67		9.11		
30 Jul.99			0.00	1.60	0.00	0.00	0.00	2.52	149.29	76.64	0.00		79.28	26.39	0.38	0.21	241.72	291.43	311.13	303.13		5.76	0.76	6.16
1 Aug.99			10.50	10.83	6.20	0.00		3.47	102.47	51.41	3.99	0.00	82.92	46.22	0.19		101.88	115.58	145.98	134.51		0.88		
5 Aug. 99			0.97	0.58	0.21	1.12	0.23	0.86	43.85	32.26			136.89	6.25	0.00		176.11	223.83	242.44	102.86				
11 Aug. 99									83.86	0.21	20.65													
26 Aug. 99			14.36		8.01		0.36	1.61	19.07	101.19	9.27		2.67	59.90	34.96		18.79	10.08	24.21	5.88				
n =	3	3	15	15	16	14	49	50	61	61	58	55	40	40	38	33	27	27	27		1.00	5.00	1.00	1.00
Mean =	1.93	0.00	6.38	8.90	3.20	2.37	11.52	8.29	90.85	117.99	73.97	91.94	52.64	72.43	59.85	13.53	114.46	85.43	106.75		0.00	4.31	0.76	0.00
s.d. =	3.34	0.00	11.03	19.01	6.36	8.03	29.57	33.30	115.06	276.86	254.35	406.96	87.47	213.98	94.93	42.10	125.75	179.28	86.63			3.80		0.00
c.v. =	1.73		1.73	2.14	1.99	3.38	2.57	4.02	1.27	2.35	3.44	4.43	1.66	2.95	1.59	3.11	1.10	2.10	0.81			0.88		0.00

APPENDIX B: 1999 DISTRIBUTION MAPS FOR SELECTED SPECIES

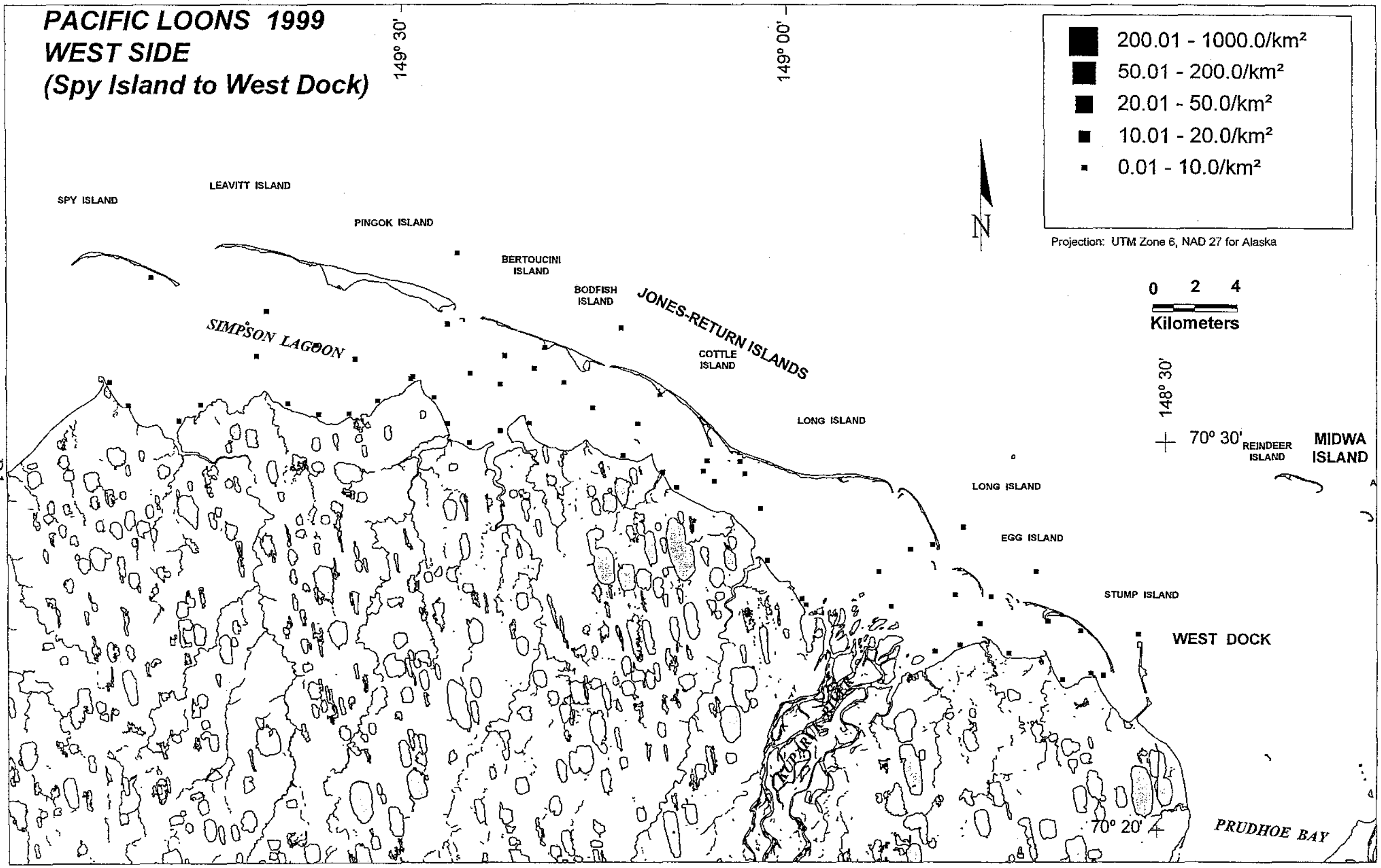


Figure B1. Summary of density for Pacific loons by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

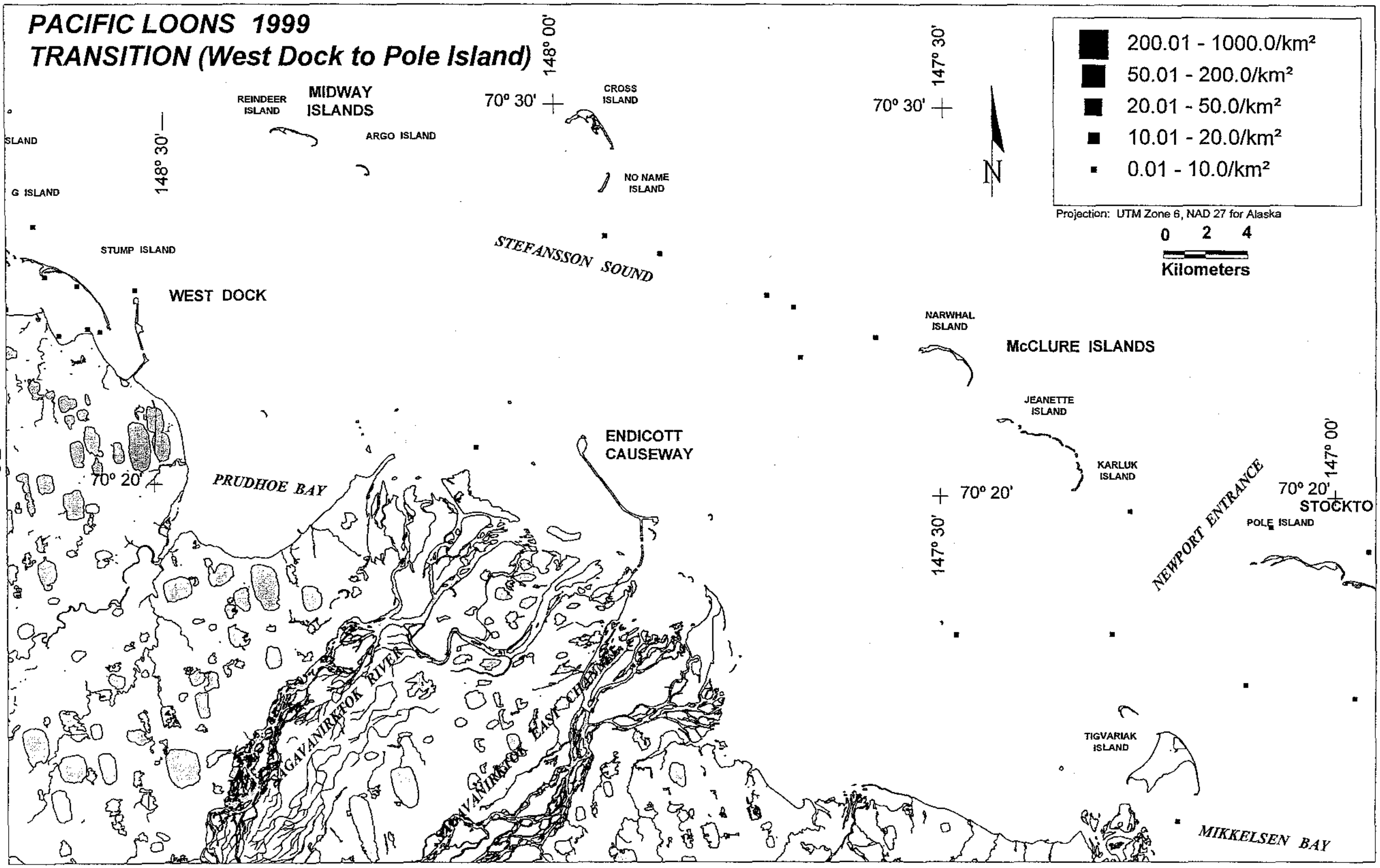


Figure B2. Summary of density for Pacific loons by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

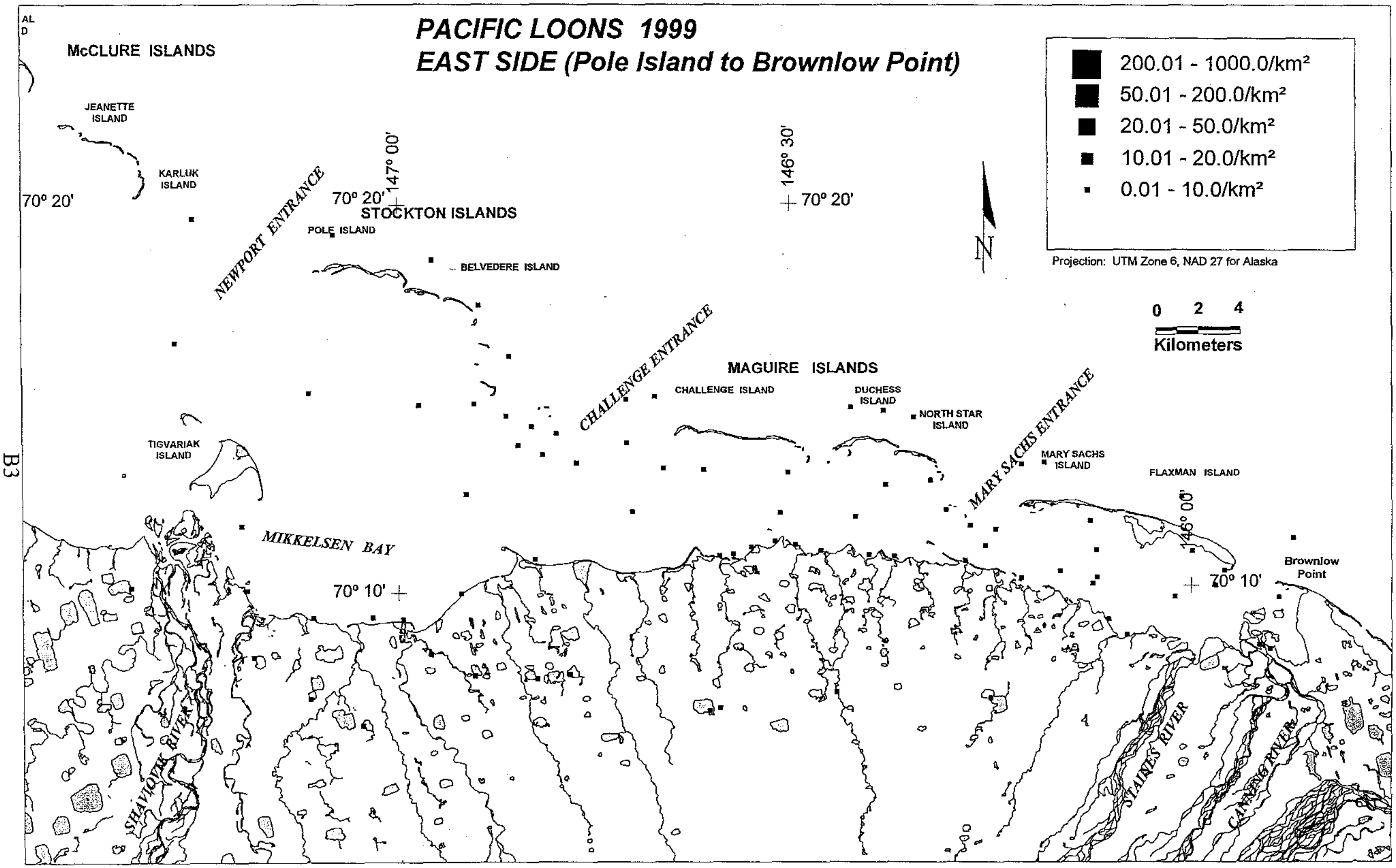


Figure B3. Summary of density for Pacific loons by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

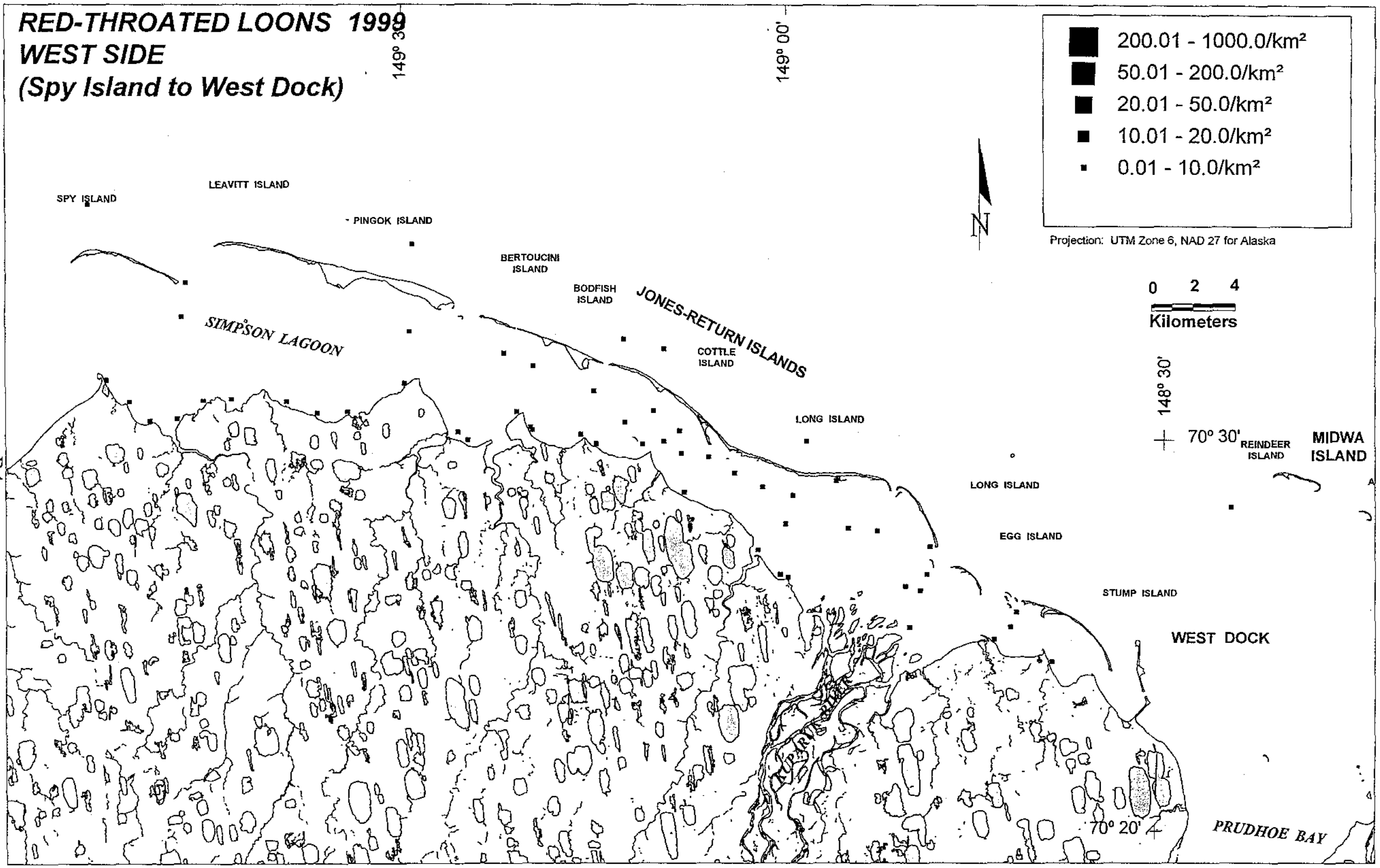


Figure B4. Summary of density for red-throated loons by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

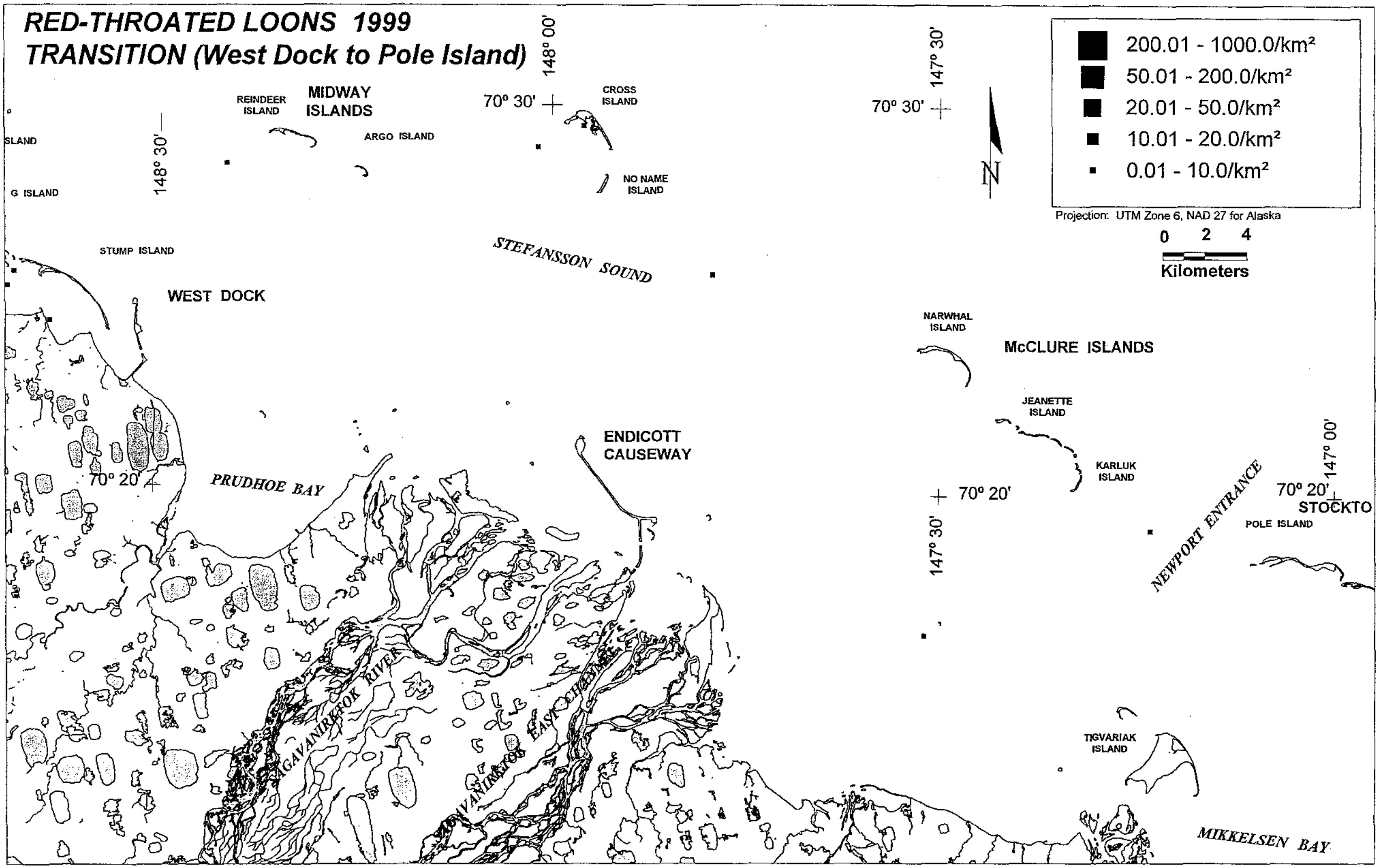


Figure B5. Summary of density for red-throated loons by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

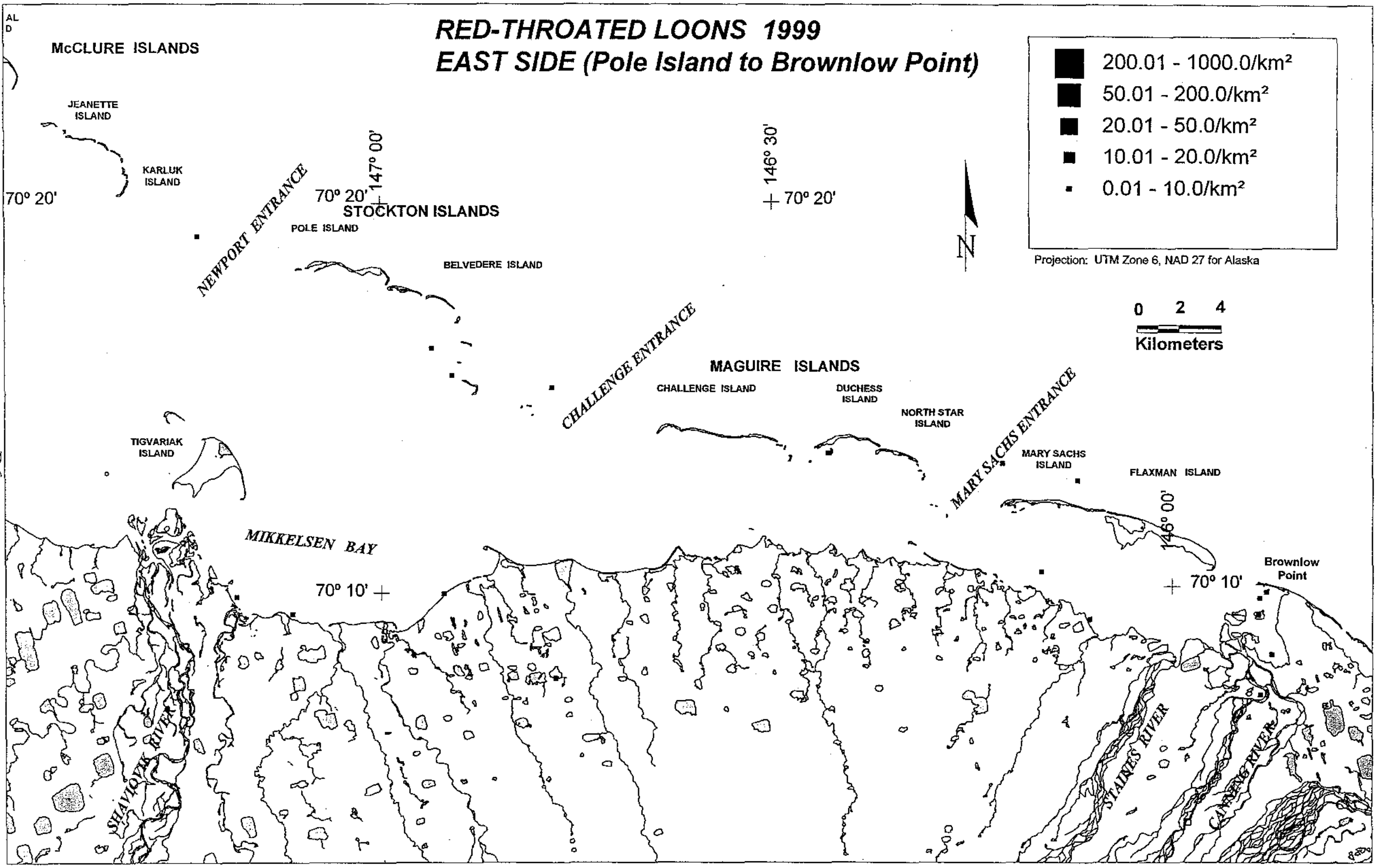


Figure B6. Summary of density for red-throated loons by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

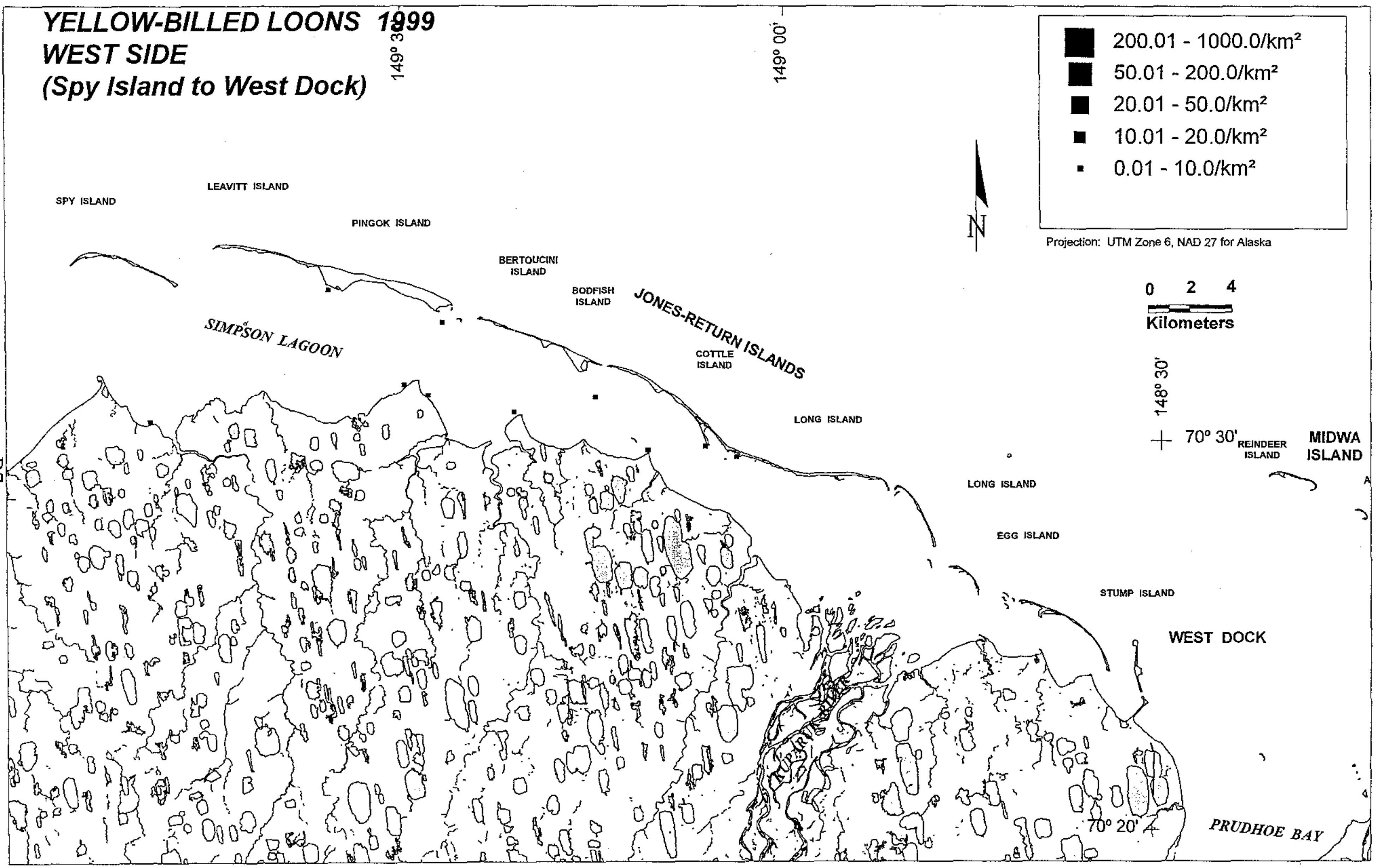


Figure B7. Summary of density for yellow-billed loons by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

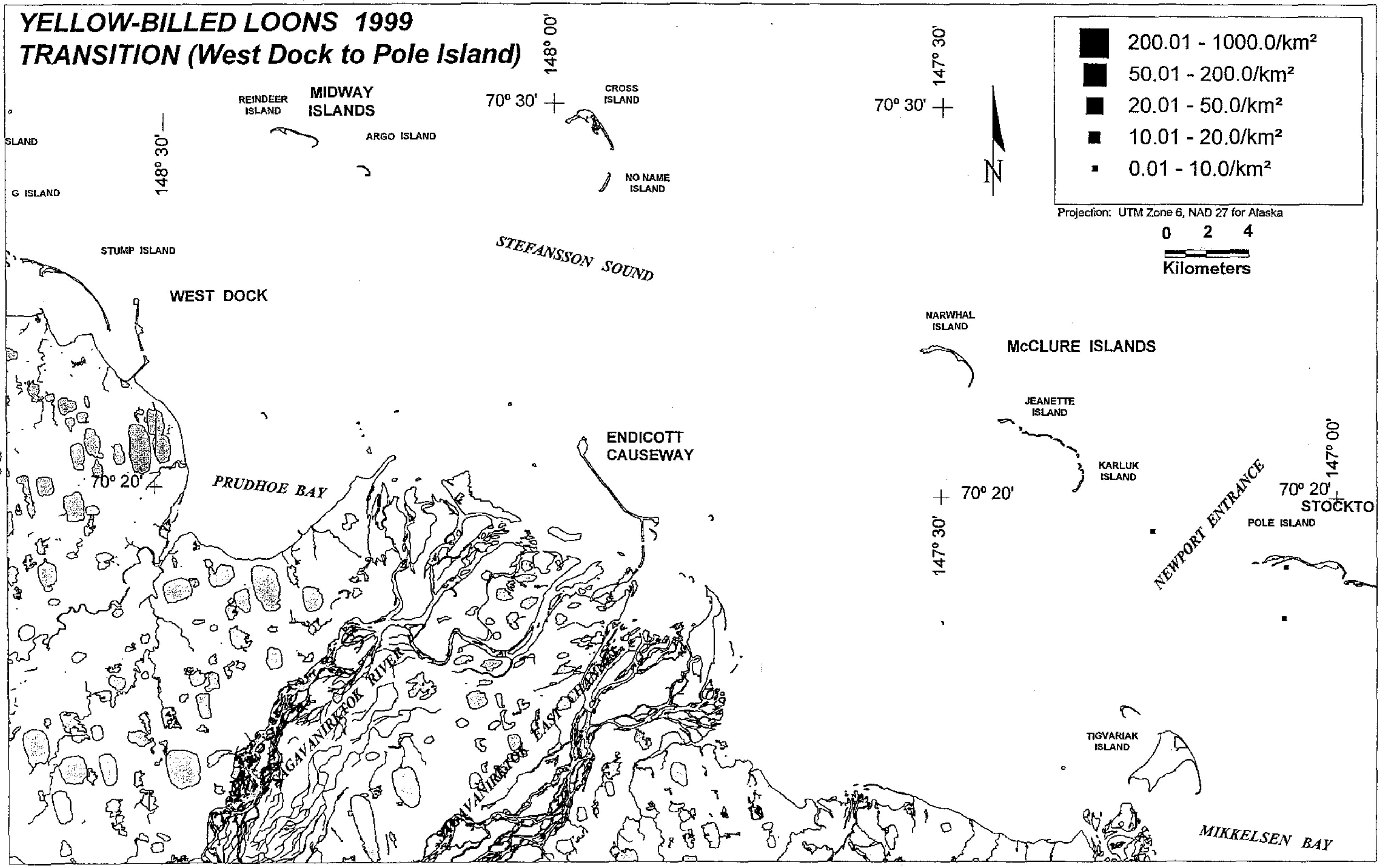


Figure B8. Summary of density for yellow-billed loons by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

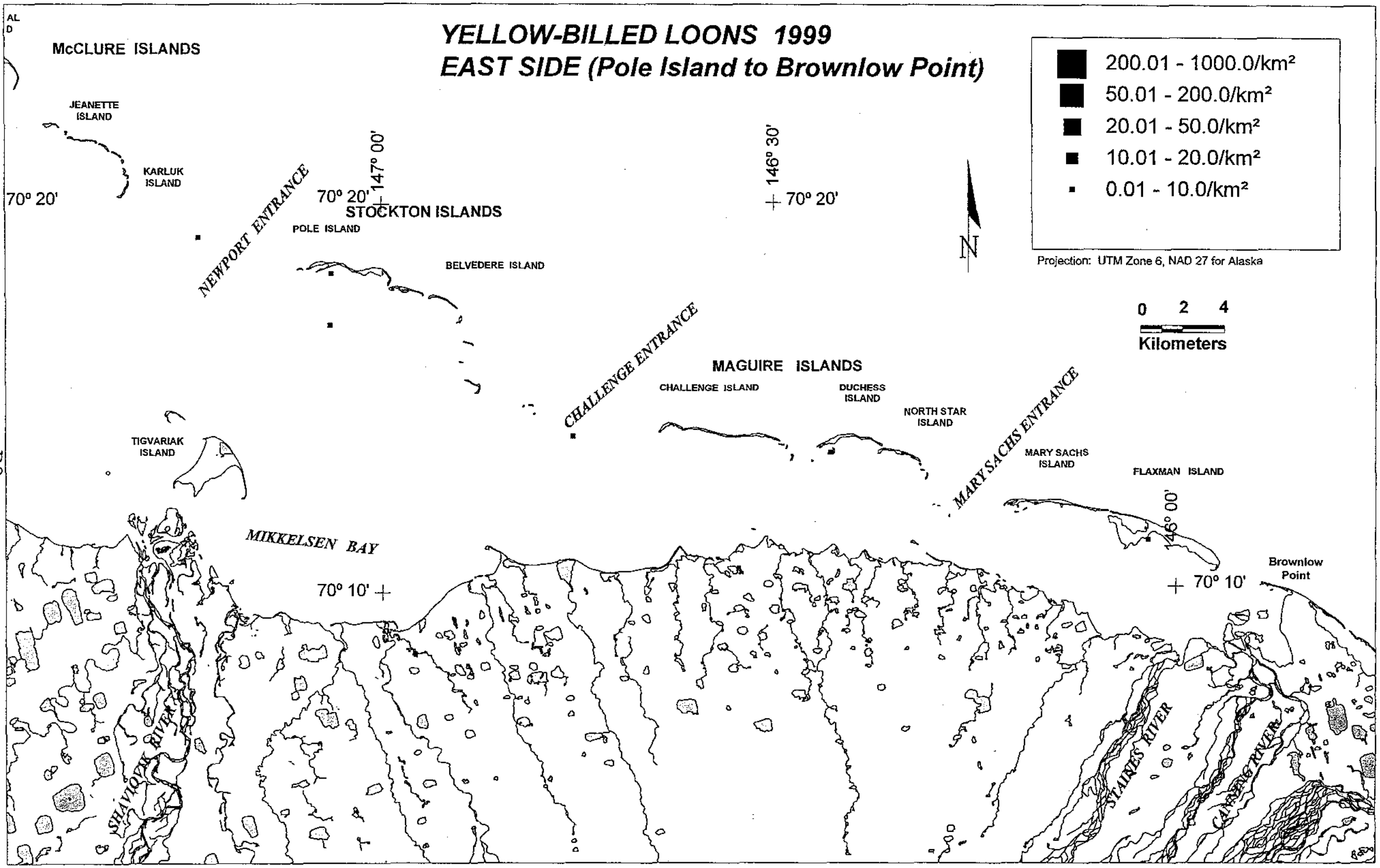


Figure B9. Summary of density for yellow-billed loons by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

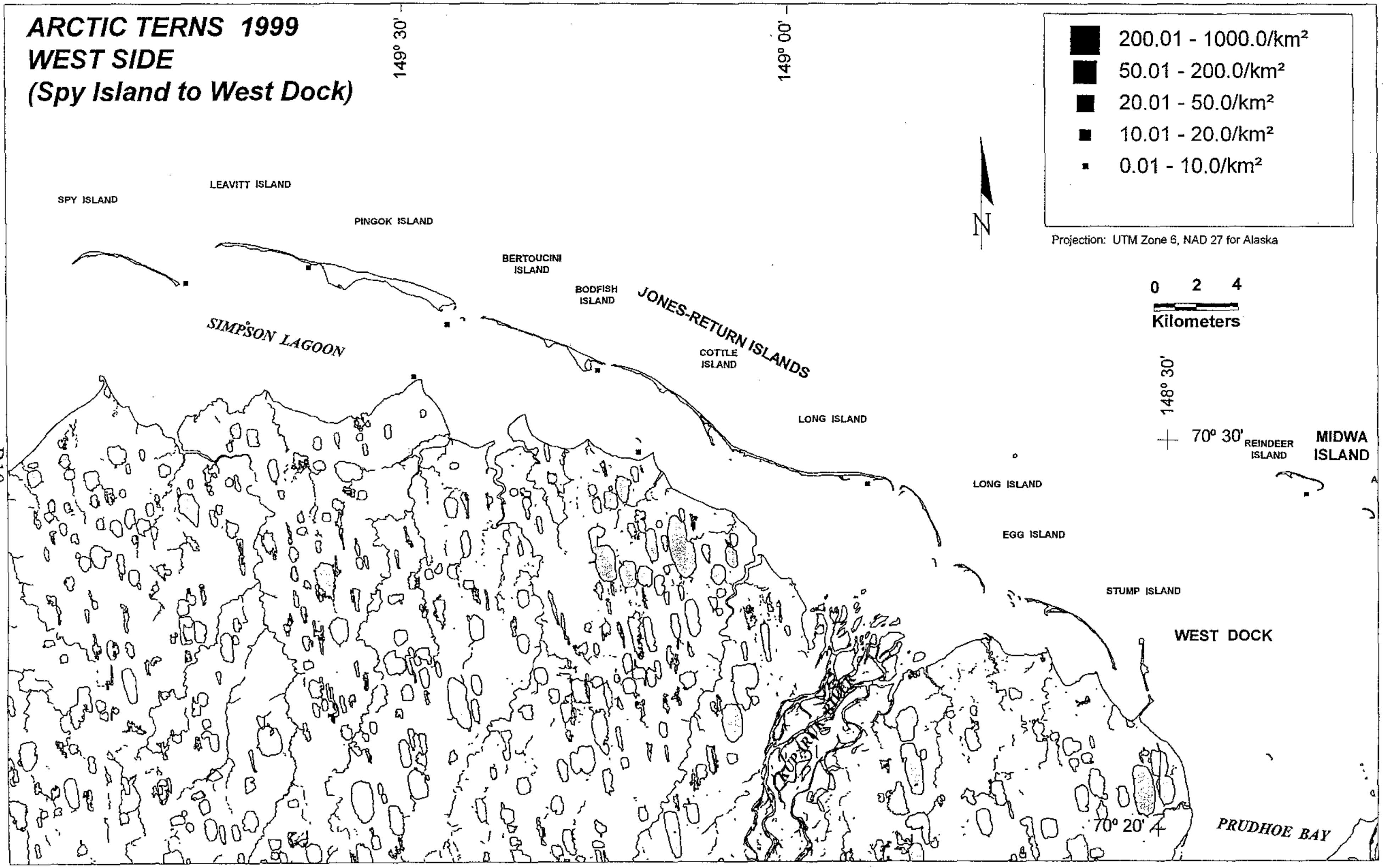


Figure B10. Summary of density for Arctic terns by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

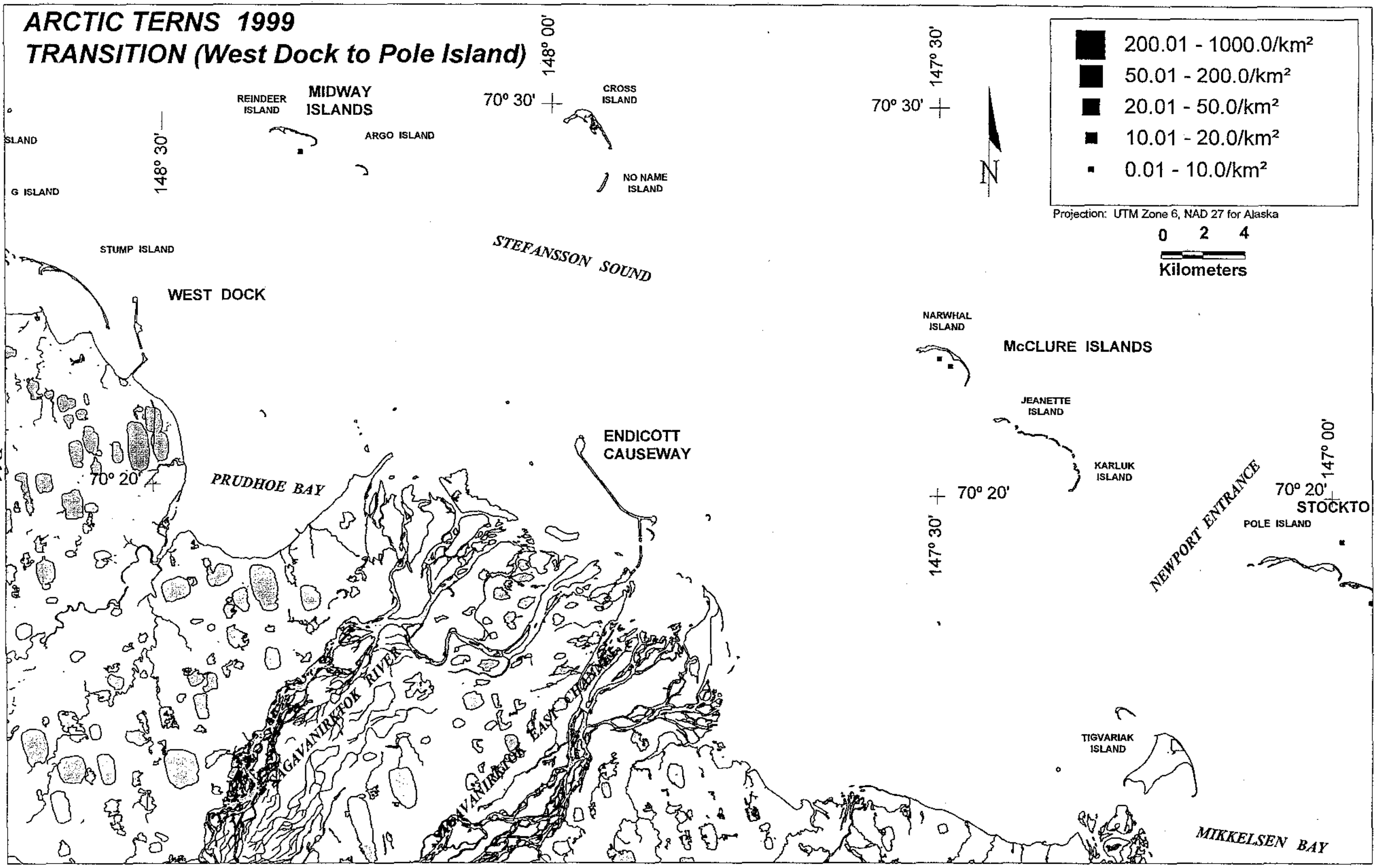


Figure B11. Summary of density for Arctic terns by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

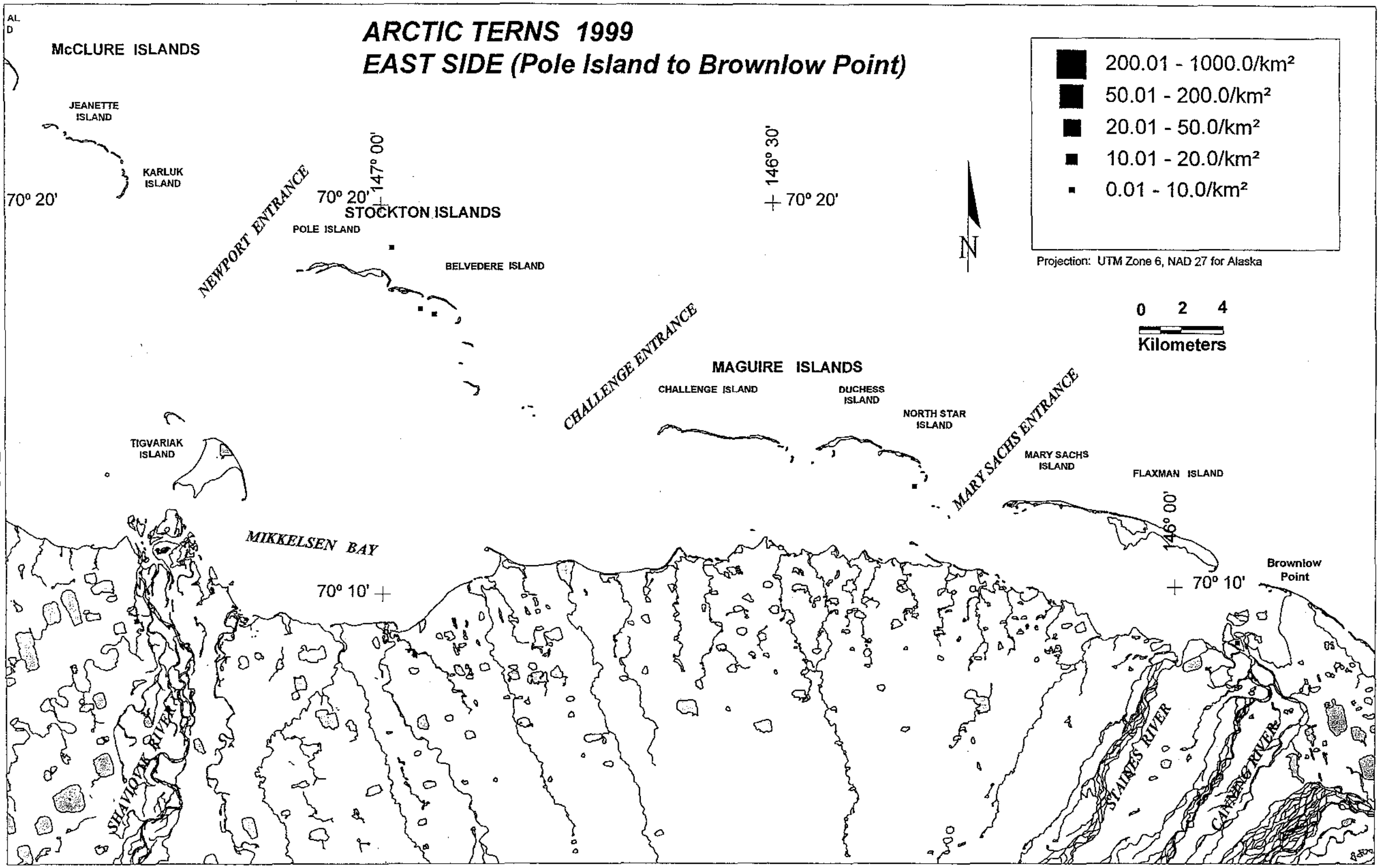


Figure B12. Summary of density for Arctic terns by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

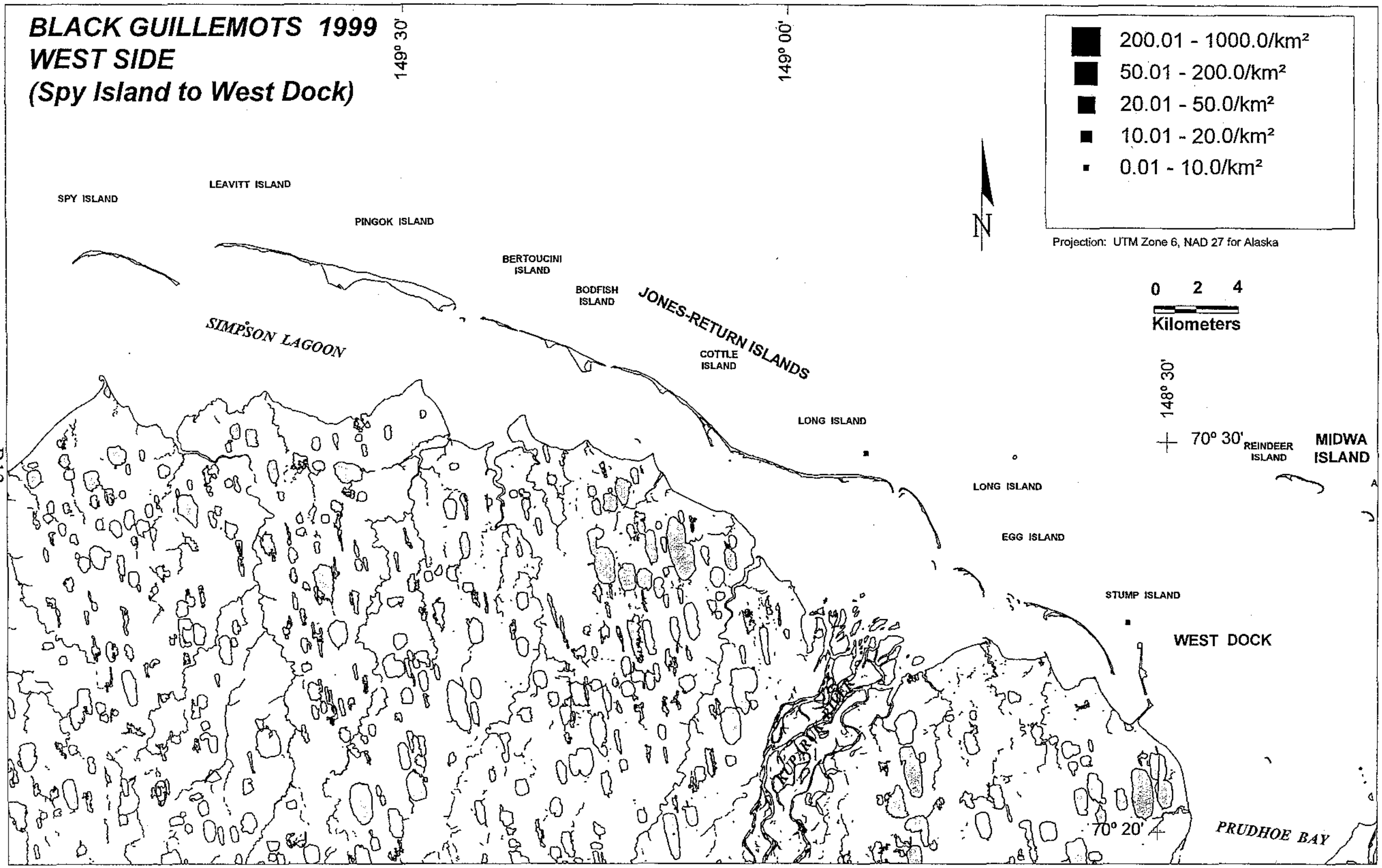


Figure B13. Summary of density for black guillemots by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

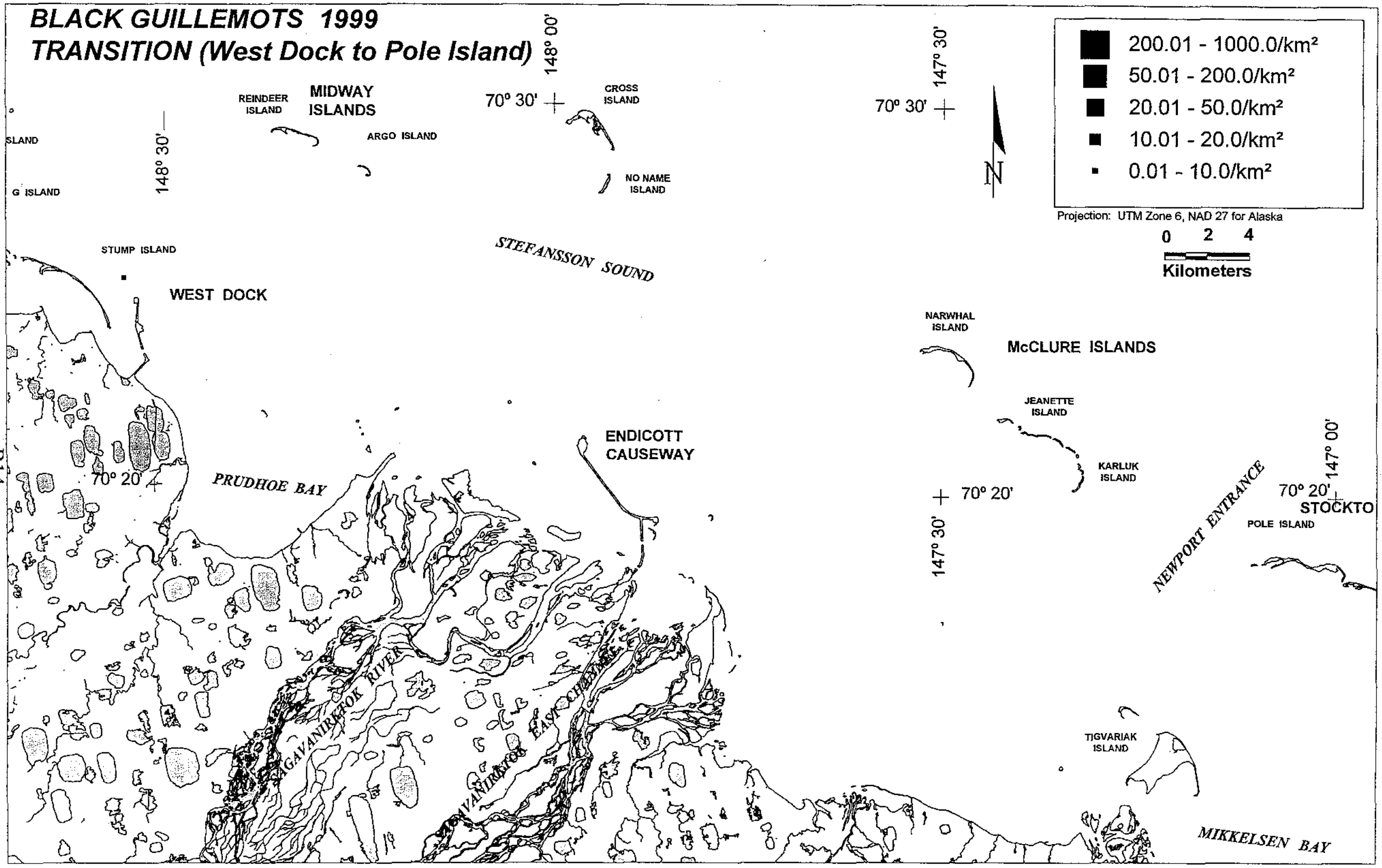


Figure B14. Summary of density for black guillemots by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

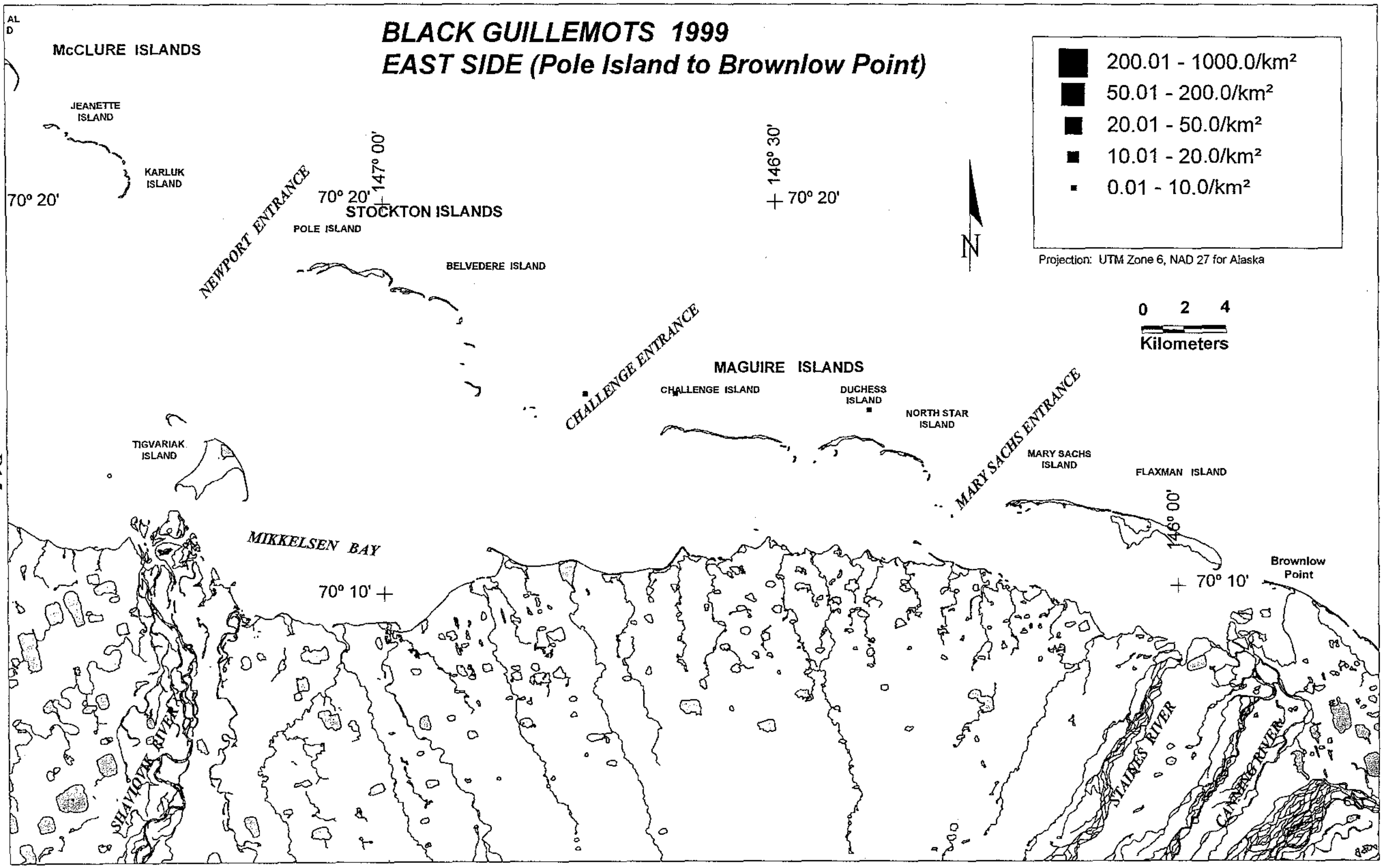


Figure B15. Summary of density for black guillemots by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

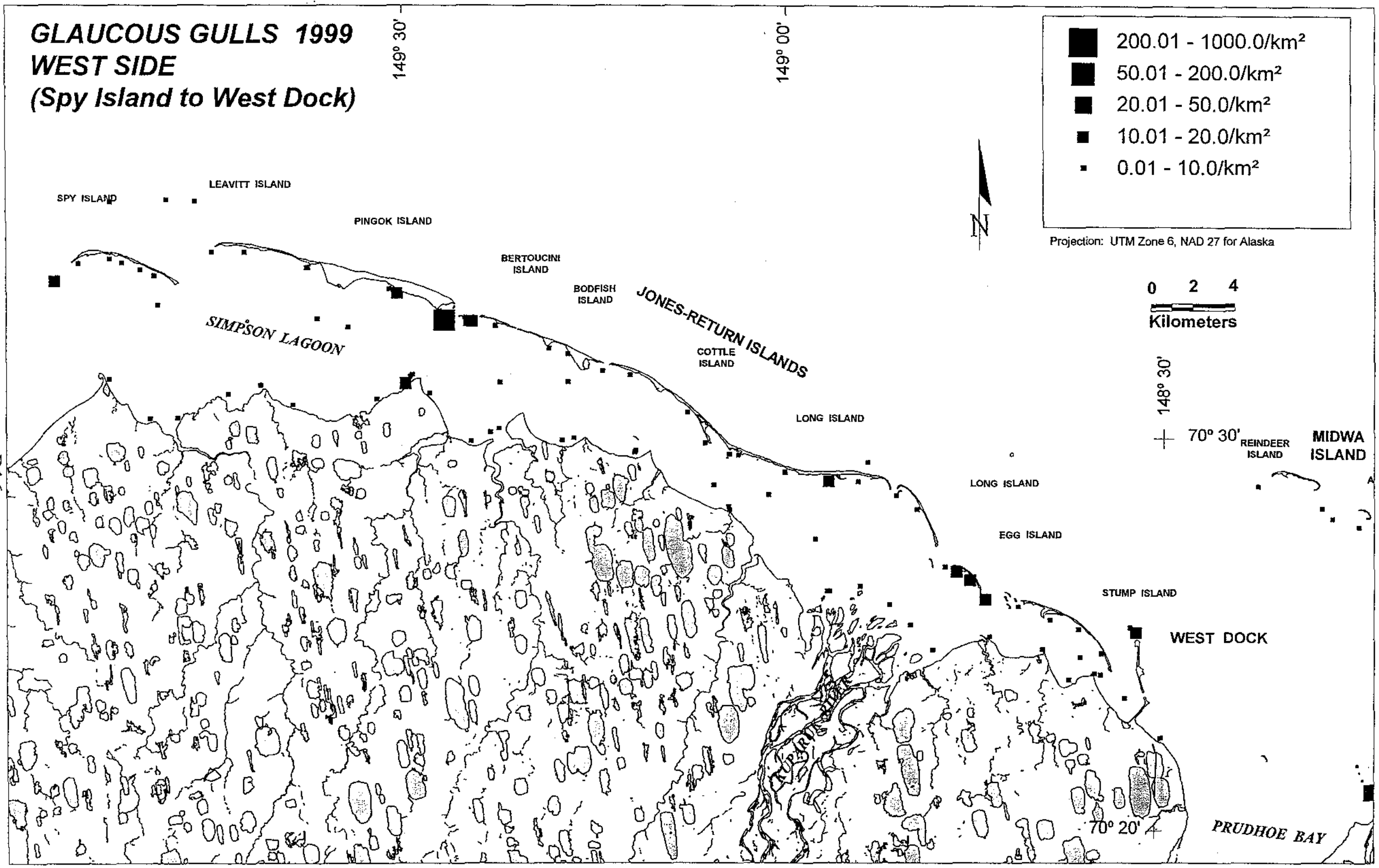


Figure B16. Summary of density for glaucous gulls by 30-second time period segments in the barrier island-lagoon system between Spy Island and West Dock, Alaska, 30 July to 26 August 1999.

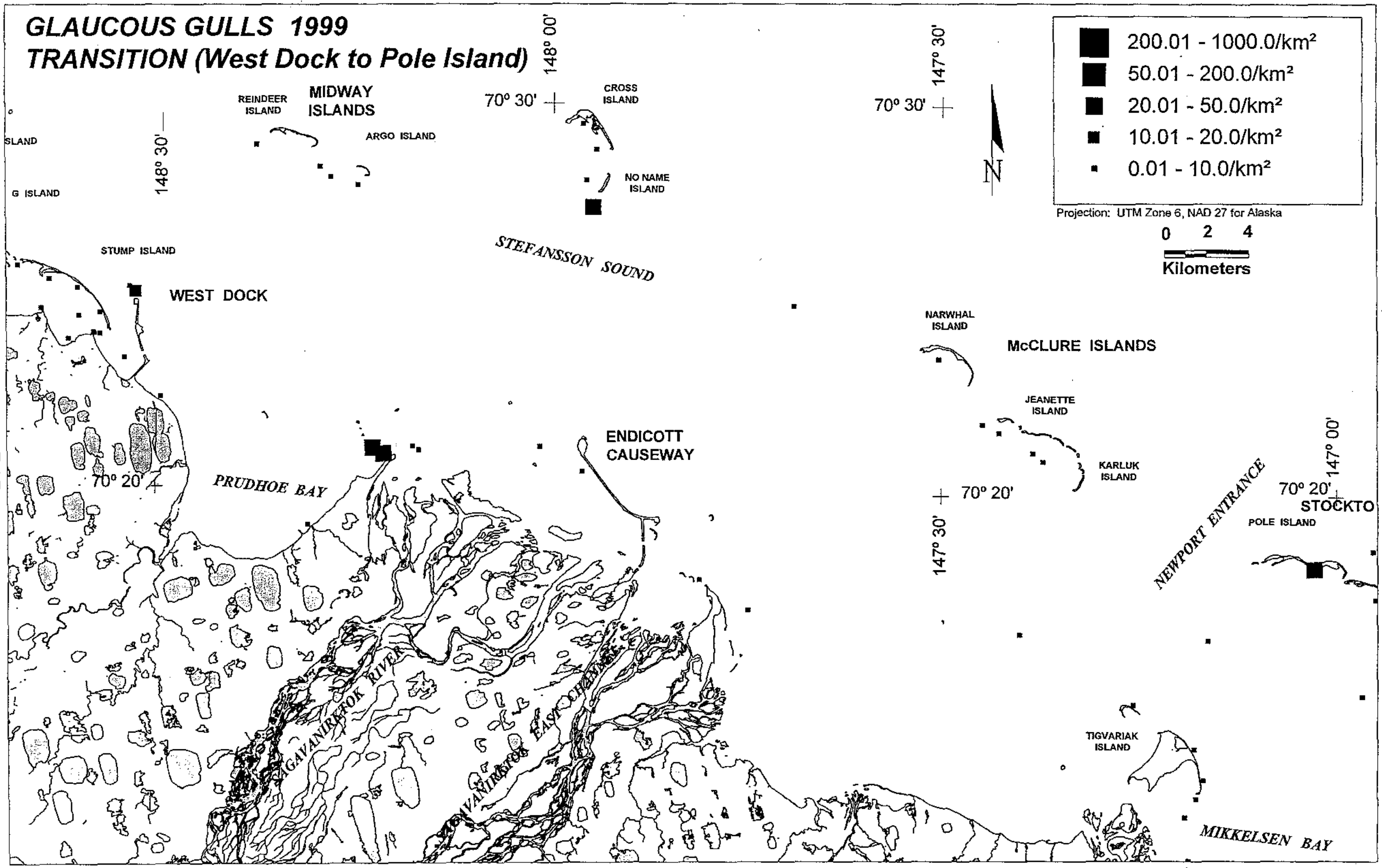


Figure B17. Summary of density for glaucous gulls by 30-second time period segments in the barrier island-lagoon system between West Dock and Pole Island, Alaska, 30 July to 26 August 1999.

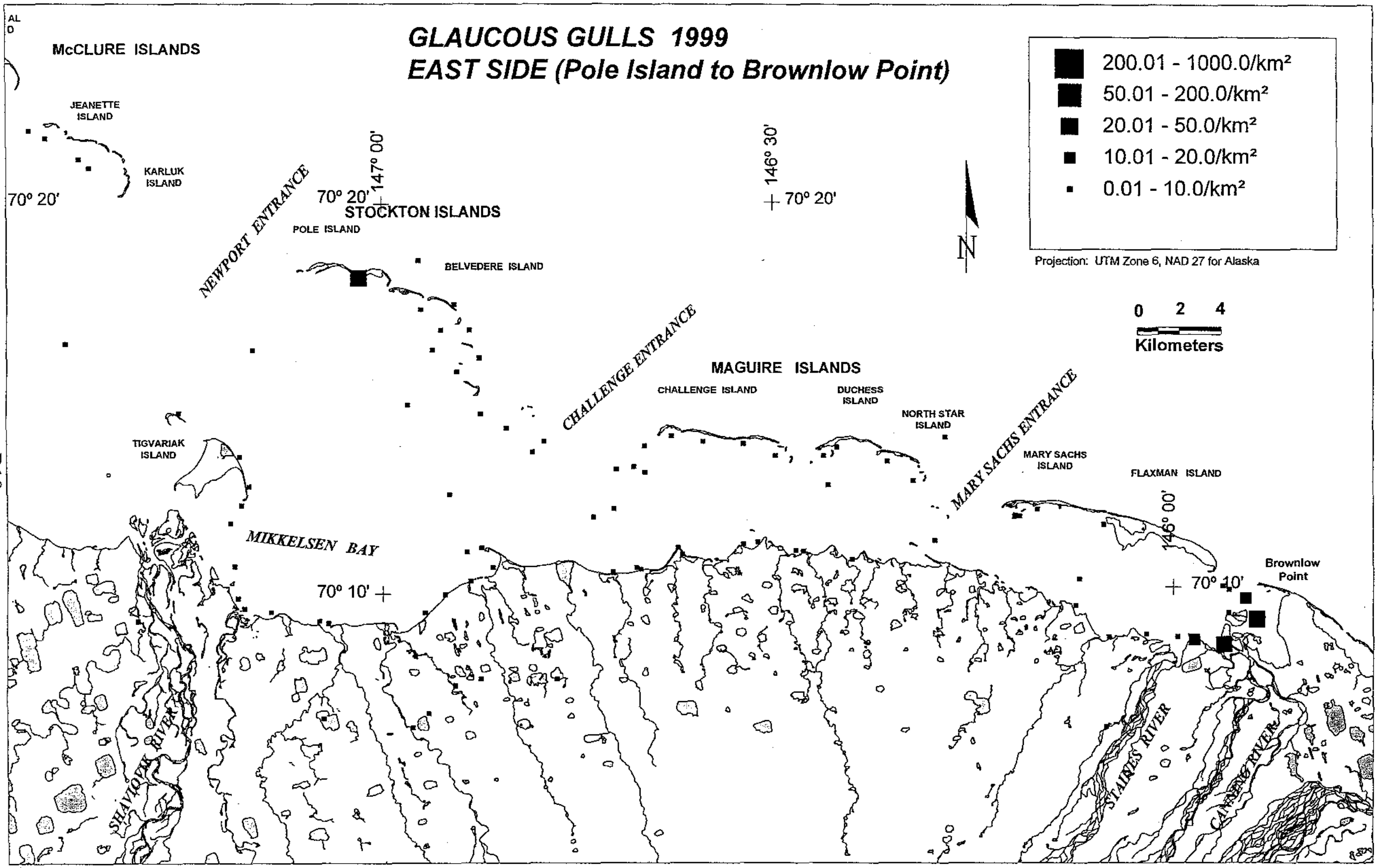


Figure B18. Summary of density for glaucous gulls by 30-second time period segments in the barrier island-lagoon system between Pole Island and Brownlow Point, Alaska, 30 July to 26 August 1999.

APPENDIX C: 1999 WEST DOCK NOAA STATION WEATHER

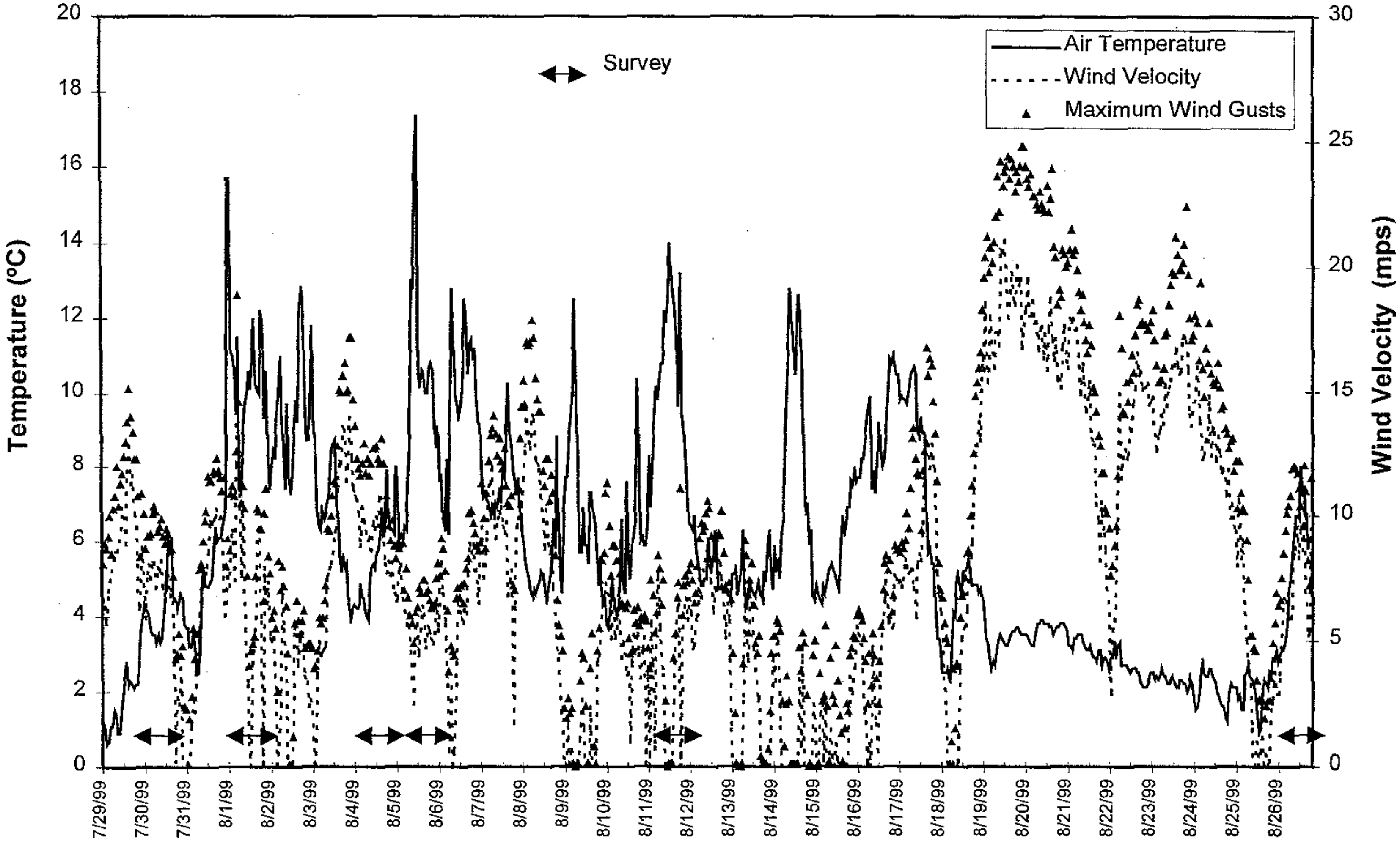


Figure C1. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 29 July to 26 August 1999.

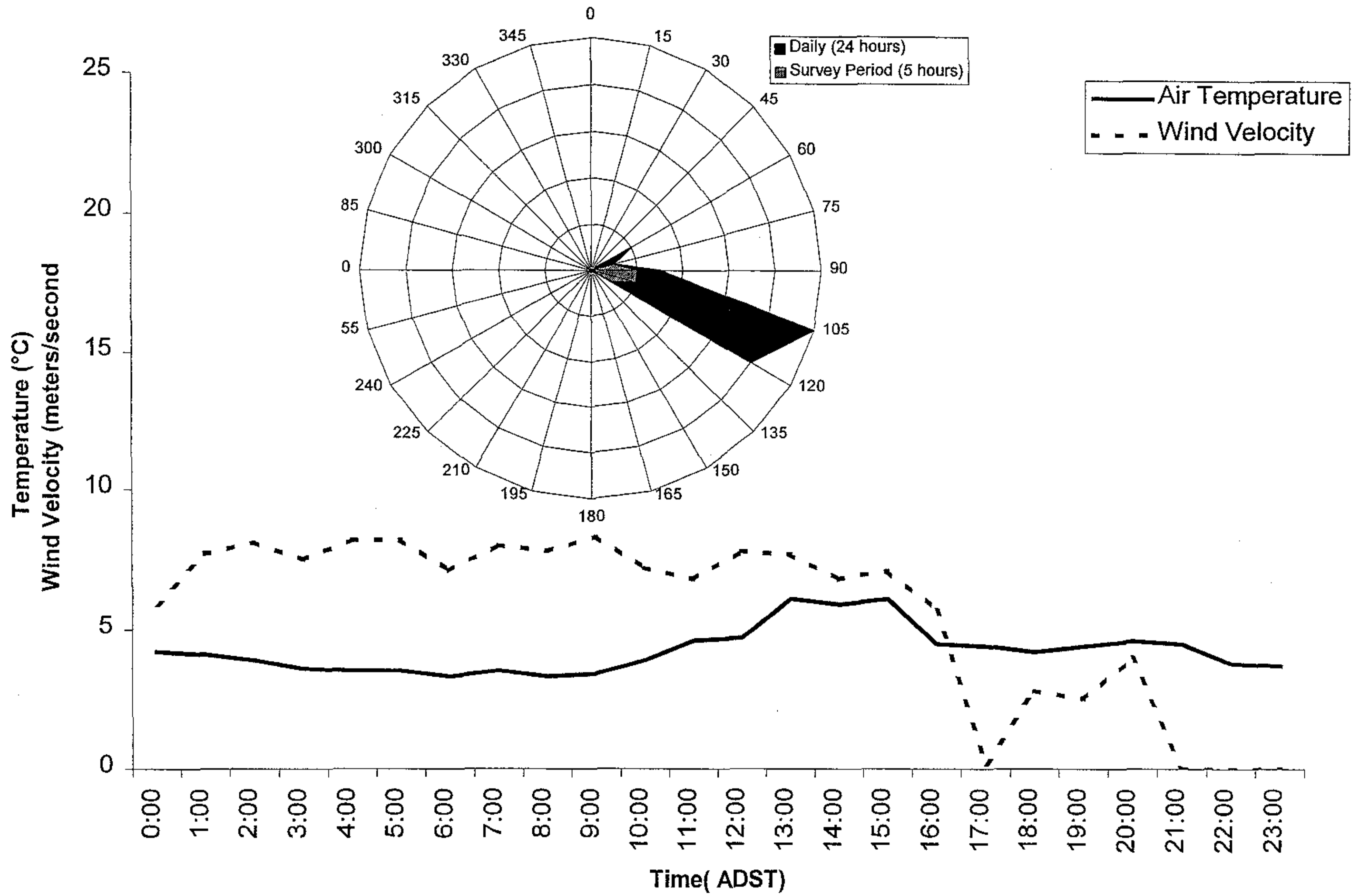


Figure C2. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 30 July 1999.

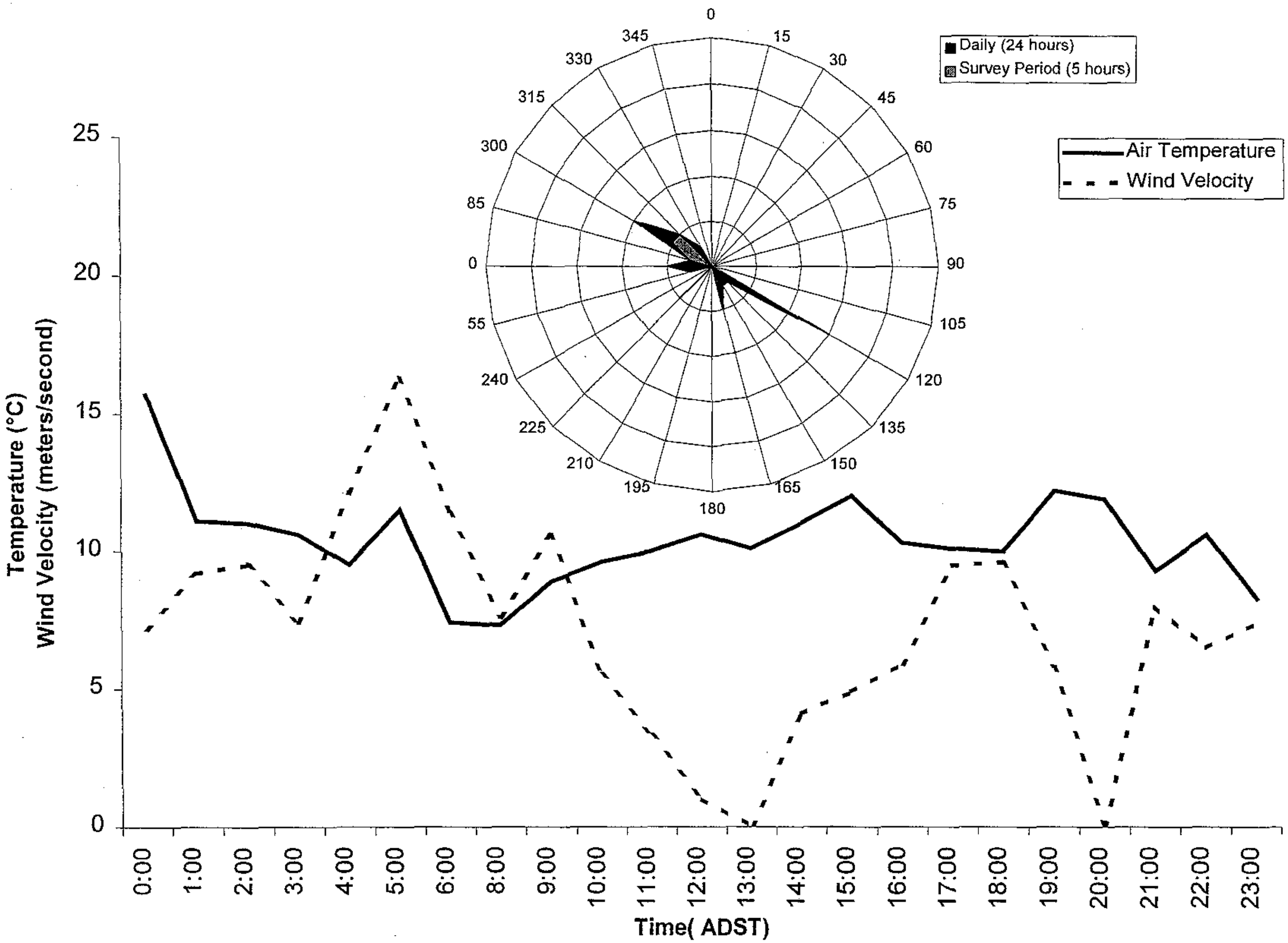


Figure C3. Hourly temperature and wind data recorded at the Prudhoe bay NOAA Station at West Dock, Alaska, 1 August 1999.

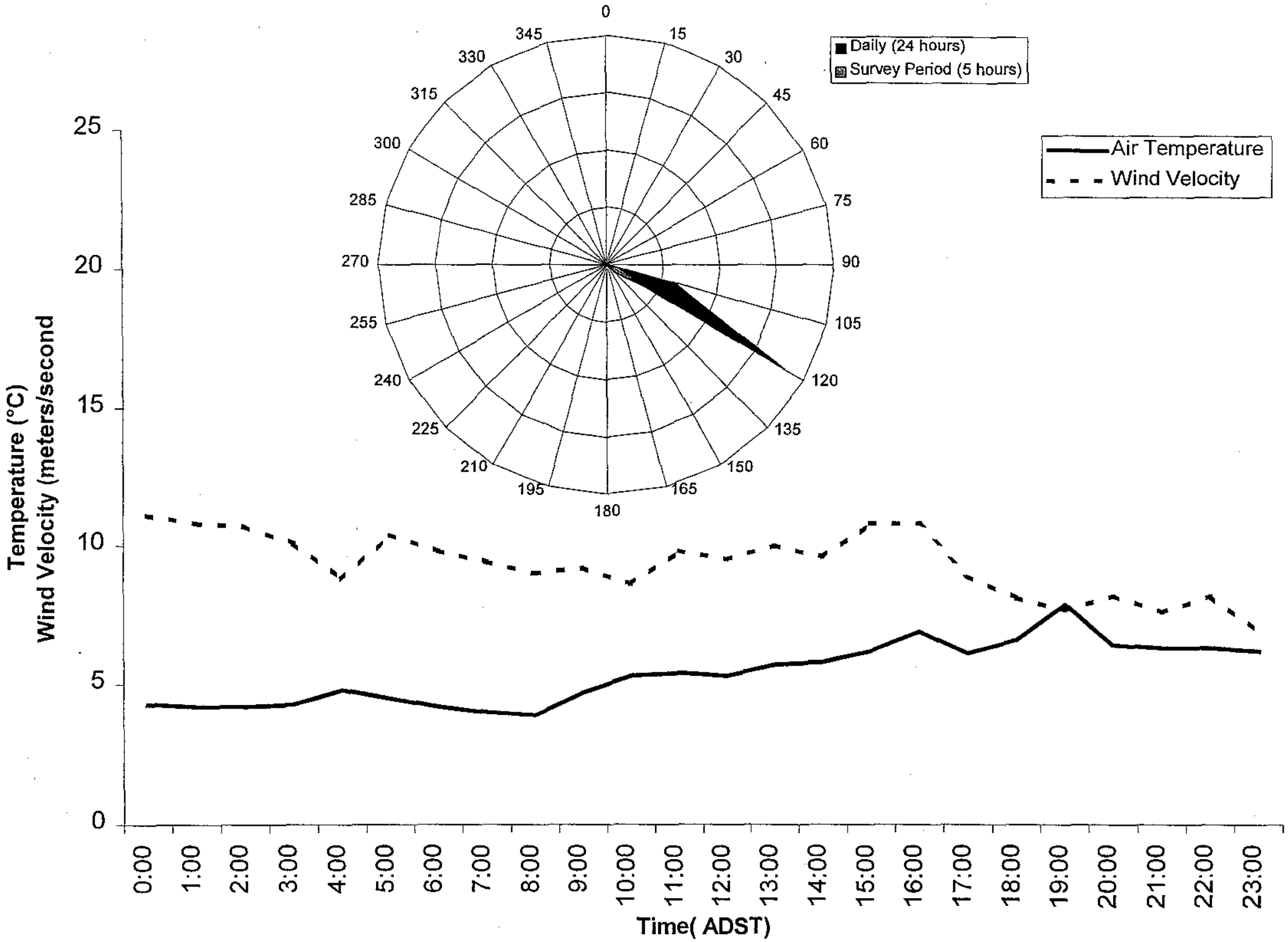


Figure C4. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 4 August 1999.

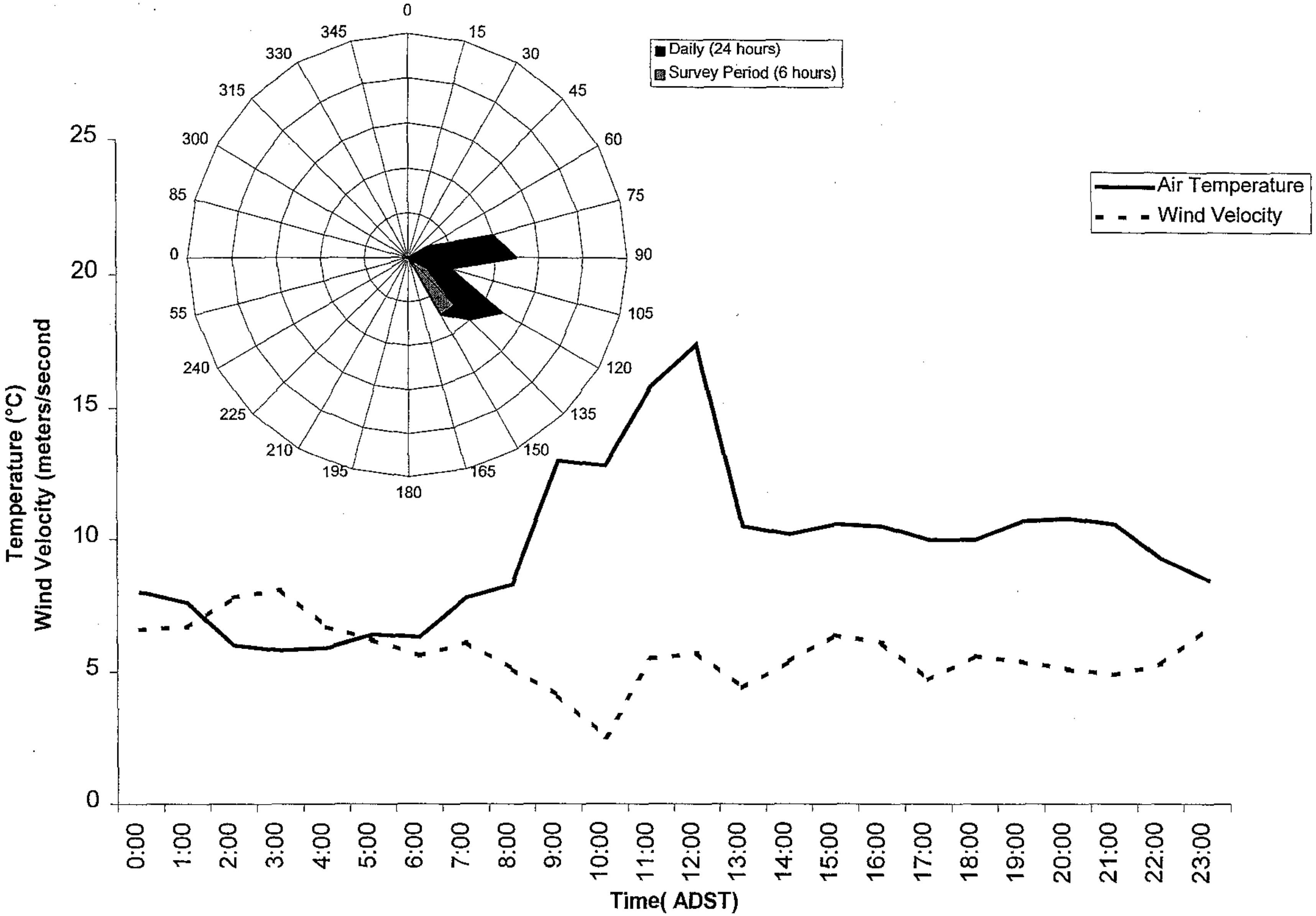


Figure C5. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 5 August 1999.

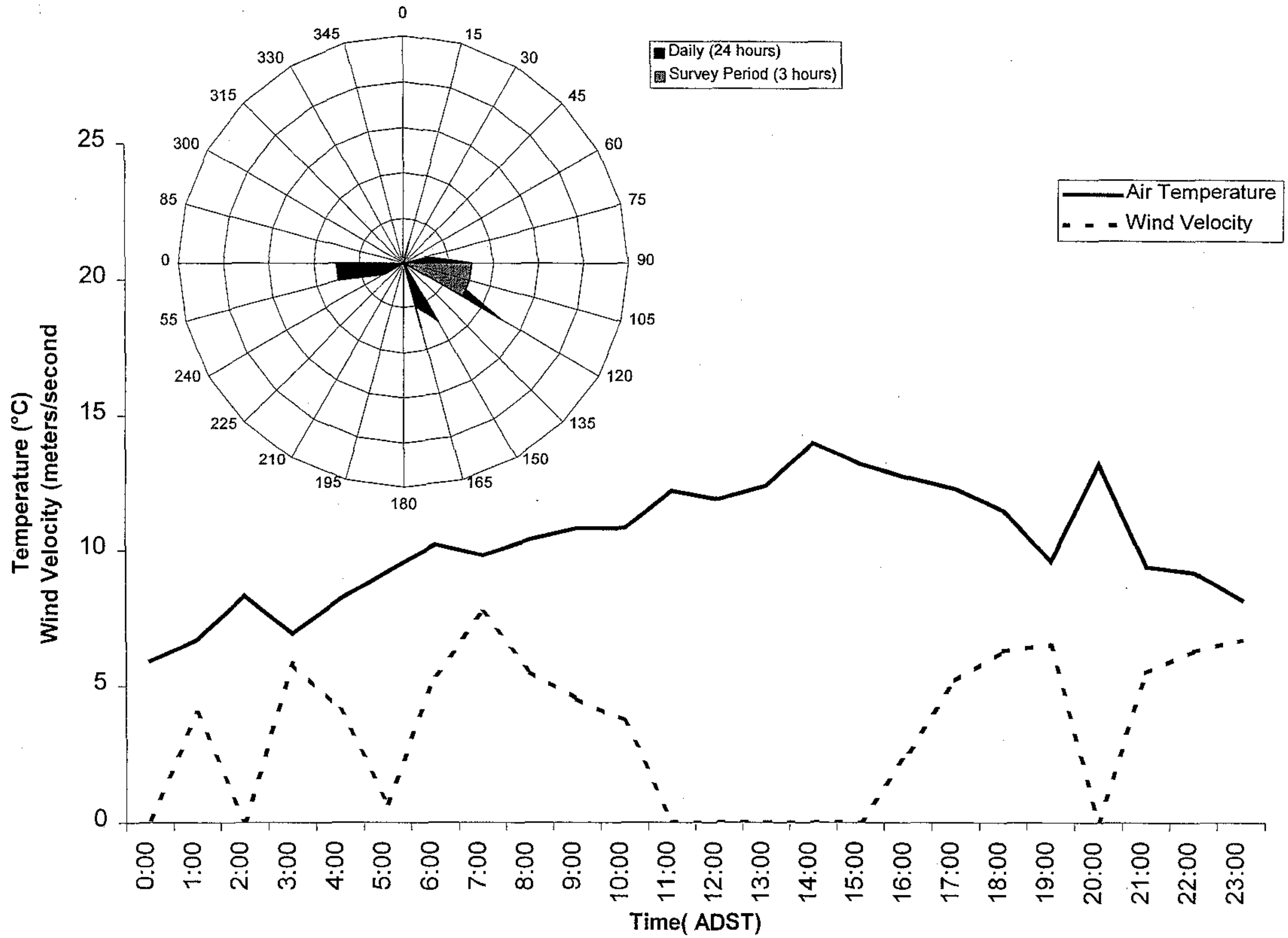


Figure C6. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 11 August 1999.

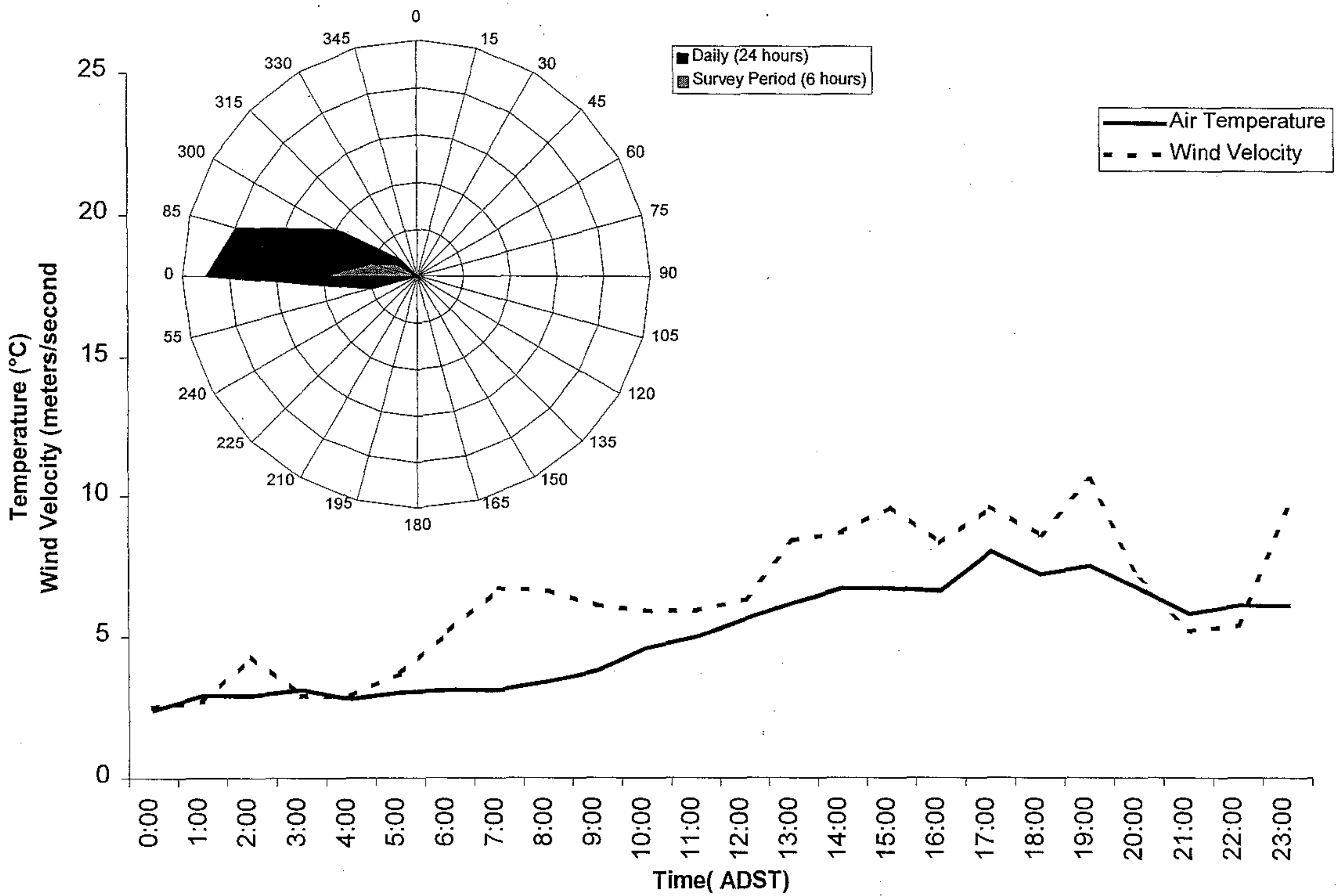


Figure C7. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 26 August 1999.