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FINAL REPORT
26 May 1999

# AERIAL SURVEYS OF MOLTING WATERFOWL IN THE BARRIER ISLAND-LAGOON SYSTEM BETWEEN THE STOCKTON ISLANDS AND FLAXMAN ISLAND, ALASKA, 1998.

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For

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## ABSTRACT

Oldsquaw 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 the distribution and abundance and compare current and historic numbers and distributions of molting waterfowl in the barrier island-lagoon system between the Stockton Islands and Flaxman Island. Five low level aerial strip-transect surveys were completed; 3 during the oldsquaw molt period (29 July to 19 August 1998), and 2 during the oldsquaw post-molt period (20 August to 30 September). Oldsquaw dominated the avian fauna in the lagoon portion of the study area both in terms of numbers of individuals (43,759 of 50,570) and numbers of sightings (732 of 1322), as they have since systematic surveys of the central Alaskan Beaufort Sea lagoon systems began in 1977. Oldsquaw were followed in abundance by scoters (2,681 individuals), geese and swans (1,415), eiders (1,003), gulls (452), shorebirds (181), loons (105), jaegers (6), and finally raptors (5). Mean areal densities were calculated separately for tundra and lagoon transects. For tundra-transects, geese and swans dominated (7.52 birds/km$^2$), followed by all ducks (1.01 birds/km$^2$), loons (0.34 birds/km$^2$), and then gulls (0.22 birds/km$^2$). In the lagoon system, oldsquaw dominated (110.37 birds/km$^2$), followed by scoters (8.22 birds/km$^2$), eiders (2.47 birds/km$^2$), gulls (1.00 birds/km$^2$), and loons (0.14 birds/km$^2$).



Key Words: marine waterbirds, molt period, waterfowl, Maguire Island group, Stockton Island group, Flaxman Island, central Alaska Beaufort Sea, oldsquaw duck, *Clangula hyemalis,*


## 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 Stockton-Maguire-Flaxman islands are used extensively by molting oldsquaw and other waterbirds. This 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 the area (Johnson 1990, Johnson and Gazey 1992).

Recently concern has been expressed over the apparent decline in 10 of the 15 species of North American sea ducks (Elliot 1997). These include species expected to occur within the Stockton-Maguire-Flaxman islands 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).

Oldsquaw 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 stable (Elliot 1997, Larned and Balogh 1997, Conant et al. 1997). 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 (Elliot 1997). Similarly, spring migration counts of king eiders past Point Barrow indicate a 50% decline between 1976 and 1994 (Elliot 1997). 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). These estimated declines, however, may not adequately incorporate variability inherent in count methodologies and accuracy when comparing historic data to more accurate methodologies currently employed.

## Issues

The issues concerning aggregations of molting/flightless geese and ducks along the coast and in large inland lakes in the vicinity of the Point Thomson Unit Area is the potential for planned 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 system between the Stockton Islands and Flaxman Island, 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 system between the Stockton Islands and Flaxman Island, Alaska.

4. Document the level of human activity during surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska.

## METHODS

Five sets of low level aerial (fixed-wing) surveys were flown from 5 August to 3 September 1998 in the barrier island-lagoon system from the Stockton Islands to Brownlow Point, just east of Flaxman Island (Fig. 1). In addition to the lagoon surveys, coastal plain surveys (sections 500 to 503, Fig. 1) covered many of the large coastal inland lakes within the proposed 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 2 to 15 day intervals beginning on 5 August 1998. 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 to (2) information about the transect and survey conditions and prevailing environmental conditions. The intervalometer also allowed the distribution and density of birds to be calculated on a more precise scale within each transect. 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- the transects. Surveys were flown with two prime 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 during the 5, 14, and 16 August 1998 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

#### Observational data

Observations for each observer were recorded on audio tape cassettes. At the end of each survey the tapes were reviewed to ensure that data were 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.

The results of the verification program were reviewed by project personnel. All inconsistencies were documented and resolved either through discussion with the person who completed the form or by reviewing the tape recordings for that transect. Instructions regarding adjustments to aerial survey data coding and corrections to the database were reviewed by project personnel. Adjustments and corrections were made and a new verification report produced. The new verification report was then reviewed and this iterative process was repeated until the 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. For those surveys conducted without a GPS flight record, generalized transects (i.e., "average" transects") were digitized as a median of the three flight line records generated during surveys when GPS flight records were produced. These generalized transects allowed for computation of the lengths and areas of transects to allow computer-mapping of the survey results.

## 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 (for example due to 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 of 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). The custom software may be operated either in batch or interactive mode and can produce about 100 maps per hour on a laser printer or plotter.

## RESULTS

Five aerial strip-transect surveys were completed; 3 during the oldsquaw molt period (29 July to 19 August 1998), and 2 during the oldsquaw post-molt period (20 August to 30 September)(Johnson and Richardson 1981). 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. Individual survey maps by species and taxonomic groups are presented in Appendix A. Habitat 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 operator at the Badami Development, located just 15 km to the west of the study area. 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 (Fig. 2 to Fig. 6). 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.

Vessel traffic recorded during surveys included: 2 boats and a barge at the Badami dock on 5 August; 1 boat near the Challenge Entrance, 2 boats near the Mary Sachs entrance, and 1 helicopter on Alaska Island on 14 August; and 1 aircraft near the Challenge Entrance on 3 September 1998 (Table 2).

## Overview

Oldsquaw dominated the avian fauna in the lagoon portion of the study area both in terms of numbers of individuals (Table 3 and Fig. 7) and numbers of sightings (Table 3), which is consistent with results of similar surveys of Beaufort Sea barrier island-lagoon systems which were begun in 1977 (Johnson and Gazey 1992). As numbers of individuals, oldsquaw were followed in abundance by scoters, geese and swans, eiders, gulls, shorebirds, loons, jaegers, and finally raptors (Table 3). Shorebirds were not consistently observed and recorded, so density calculations are not presented for this group. Mean areal densities were calculated separately for tundra and lagoon transects. For tundra transects 500 to 503 geese and swans predominated, followed by all ducks (again dominated by oldsquaw), loons, and then gulls (Table 4). In the lagoon system, oldsquaw predominated, followed by scoters, eiders, gulls, and loons (Table 5).

## Loons

The number of loons sighted within the study area increased progressively from 5 on 5 August to 41 on 3 September 1998 (Fig. 8). For loons classified to species, red-throated (*Gavia stellata*) (51%) and pacific (*Gavia pacifica*) (38%) loons predominated (Table 3). Loons were scattered throughout the survey area in low numbers both on the tundra transects and within the lagoon (Fig. 9). Yellow-billed loons (*Gavia adamsii*) were sighted exclusively within the lagoon and occurred only on the barrier island transects (Table 6). Red-throated loons occurred primarily along mid-lagoon transects and along the mainland shoreline (72%), but they also occurred on lakes and ponds (24%). Common (*Gavia immer*) and Pacific (*Gavia pacifica*) loon sightings were equally divided between lagoon and tundra habitats (Table 6).

## Seabirds

### Jaegers

Jaegers were not sighted within the study area until 31 August (Fig. 10); they occurred primarily on the tundra transects (Fig. 11). Parasitic jaegers were observed primarily inland (75%) but they also occurred along the barrier islands (25%, Table 7).

### Arctic Tern

One Arctic tern (*Sterna paradisaea*) was recorded on 16 August on the Stockton Island transect (transect 133) (Fig. 10, Table 7). Arctic terns were recorded nesting on Flaxman, Northstar, and Alaska islands during June 1998 (Noel et al. 1999).

## Gulls

Gull numbers on the 14 and 16 August surveys (125) were notably reduced from the 150 observed on the 5 August, 31 August and 3 September surveys (Fig. 10). Gulls were concentrated along the barrier islands, the Staines River delta and along the mainland shoreline (Fig 12, Table 7). Glaucous gulls *(Larus hyperboreus)* were recorded nesting on Flaxman, Northstar, Duchess, Alaska, and Challenge islands during June 1998 (Noel et al. 1999).

# Ducks

## Eiders

Except for a decline in numbers on the 14 August survey, eider numbers increased steadily from about 150 on 5 August to 300 on 3 September (Fig. 13). Pacific eiders were the most abundant species in this group, comprising 96% of classified eiders. Pacific eiders were recorded nesting on Flaxman, Duchess, Alaska, and Challenge islands during June 1998 (Noel et al. 1999). All eider sightings occurred primarily in lagoon habitats (Table 8), and all eider sightings were on the barrier island transects on 5 August. Eiders were evenly distributed between the barrier island transects and mainland shoreline transects during the 14, 16 and 31 August surveys, with scattered sightings on the mid-lagoon transects. During the 3 September survey, eiders appeared to be concentrated along the mainland shoreline transects, with scattered sightings along the barrier island and mid-lagoon transects. The coastal areas with the highest densities of eiders were between Point Hopson to east of Point Sweeney, and Bullen Point (Fig 14).

## Scoters

The number of scoters sighted during surveys increased from less than 250 on and before 16 August to approximately 1100 on and after 31 August (Fig. 15), and all scoters were primarily in lagoon habitats (Table 9). This increase is primarily due to the presence of 3 groups of approximately 750 surf scoters on a mid-lagoon transect just south of Challenge and Alaska islands (transect 182) on both 31 August and 3 September (Fig. 16). Coastal areas with the highest densities of scoters were Point Sweeney and midway between Badami and Bullen Point (Fig. 16). Surf scoters comprised 85% of the classified scoters (Table 3).

## Oldsquaw

Over the course of the survey period, oldsquaw were evenly distributed along all transects except the tundra transects (500 to 503) and the mid-lagoon transect north of Mikkelsen Bay

(183, Fig. 18); and were overwhelmingly concentrated in lagoon habitats (Table 11). During the molt period (28 July to 19 August, Johnson and Richardson 1981), oldsquaw were evenly distributed between barrier island and mainland shoreline transects (Fig. 17). During the post-molt period (20 August to 30 September), however, more oldsquaw were sighted on the barrier island transects (Fig. 17, Table 10). During the 5 and 14 August surveys, oldsquaw were more abundant in the eastern half of the study area (Fig. 19, 20, Table 10).

During the molt period, density was highest at the barrier island and mainland shoreline transects adjacent to Flaxman Island on 5 August (136, 190; Fig. 19, Table 10). Peak densities shifted west to the Duchess/Northstar transects (transects 191 and 135) on 14 August (Fig. 20, Table 10). By 16 August, oldsquaw density peaked at the western edge at the Stockton Islands transect (transect 133; Fig. 21, Table 10), and at the mainland shore from Point Hopson to Point Thomson (191; Fig. 21, Table 10). Mean density for the 3 molt period transects remained highest at the eastern end of the study area at the Flaxman Island transect (136; Fig. 18, Table 10).

Both the maximum and minimum numbers of oldsquaw occurred during the post-molt period (31 August and 3 September surveys; Figs. 17, 22 and 23, Table 10). Peak density was on the Flaxman Island transect on 31 August (transect 136, Fig. 18, Table 10), and shifted on 3 September to the Stockton Islands and Challenge/Alaska mid-lagoon transects (transects 133 and 182, Fig. 23, Table 10).

When oldsquaw densities from surveys in 1977 to 1991 and 1998 were converted to numbers of individual oldsquaw (transect density * transect area), mean numbers of oldsquaw were generally higher along the barrier islands, especially during the molt and post-molt periods (Figs. 24, 25 and 26). For the mainland shoreline (transects 193 to 190), mean numbers of oldsquaw were highest at the eastern end of the study area from Point Hopson to Brownlow Point (transects 190 and 191, Fig. 24). During the molt period, means of 750 to 1000 oldsquaw occurred from Badami to Brownlow Point, with the highest numbers between Point Hopson and Point Thomson (transect 191), similar to 1998 results (Table 10). For mid-lagoon transects, the eastern half of the study area (transects 180 and 181) had slightly higher use during the pre-molt period, and the middle sections (transects 181 and 182) had slightly higher use during the molt and post-molt periods (Fig. 25). For barrier island transects, the eastern end of the study area (transects 136 and 135), again had slightly higher use during the pre-molt period (Fig. 26). During the molt period, the Flaxman Island transect (transect 136) was the most heavily used, again similar to 1998 results; followed by the Stockton Islands transect (transect 133, Fig. 26). Note that variances are quite high and 95% confidence intervals for these means overlap extensively.

Comparisons of numbers of oldsquaws during the molt period for historical surveys conducted in 1989, 1990, and 1991 versus surveys conducted in 1998, suggests a large amount of variation in numbers on combined lagoon transects 133 through 193, i.e., totals ranging from 17,734 ± 7,130 standard deviation (SD) in 1989 to 2,281 ± 956 SD in 1991 versus 4,584 ± 2,349 SD in 1998. Transects 190 to 193 were not flown in 1989. Numbers of oldsquaw along combined transects 133 through 1993 during the molt period varied from 19,115 ± 12,957 SD in 1990 to 3,361 ± 1,771 SD in 1991 compared to 8,009 ± 3,852 SD in 1998. Again note that standard deviations are high, however, and the differences are likely not statistically significant. In addition, because survey effort is not proportional to lagoon strata (i.e., the mid-lagoon strata encompasses a larger area than either barrier island or mainland shoreline strata yet all three are sampled by 4 transects), and because oldsquaw distribution within strata varies with weather, time of day, and specific habitat type (i.e., oldsquaw distribution may be clustered around points of land or spits along barrier island and mainland shoreline transects late in the day and dispersed and feeding at mid-lagoon locations during mid-day), these factors need to be further investigated before conclusions are reached concerning trends in oldsquaw numbers.

### Other Ducks

By far, oldsquaw dominated all other species in abundance. Aside from oldsquaw, only a few other species were recorded regularly. Northern Pintail (*Anas acuta)*, in singles and flocks of up to 25, were sighted primarily along the tundra and mainland shoreline transects, but one flock of 20 was recorded at Duchess Island on 14 August. Northern pintails were recorded during all survey dates, but were most numerous on 14 August (50 individuals). Red-breasted mergansers (*Mergus serrator)* were seen in flocks ranging in size from 3 to 120 on 31 August along Flaxman Island (transect 136), and on 3 September east of Point Thomson (transect 190) and at Bullen Point (transect 192). A flock of approximately 20 red-breasted mergansers was also recorded in the study area in late June during barrier island nest searches.

## Geese and Swans

Geese were most abundant on 14 and 16 August and greater white-fronted geese *(Anser albifrons)* were the most numerous geese recorded in the study area (Fig. 27). Except for black brant (*Branta bernicla)*, which occurred in coastal and lagoon habitats, geese were most often associated with the tundra lake and pond habitats (Fig. 28, Table 12). Tundra swans were most abundant on 31 August, when 9 individuals were sighted in the study area. A pair with 2 cygnets was sighted in the Canning River delta on 5 August (transect 500); all other sightings were of adult swans.

## Polar Bears

Except for 14 August 1998, when no polar bears *(Ursus maritimus)* were sighted, between 1 and 7 polar bears were sighted on each survey (Figs. 19, 21, 22, and 23). An adult female with 2 cubs was sighted at Brownlow Point on 16 August; sex and age of the other bears was not recorded.

# DISCUSSION

Oldsquaw populations 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 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 oldsquaw 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 oldsquaw 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 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 during 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 by aircraft; swimming, feeding and population levels appeared to be unaffected (Gollop et al. 1974). In addition, 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 the Stockton-Maguire-Flaxman area during 1989, 1990 and 1991 compared to 1998. This variation could have been 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 will result 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 Ray Jakubczak of BP and Dave Trudgen of OASIS, Inc. for their support. Tammy Olson and Isaac Helmericks served as observers for the aerial surveys. Craig Perham transcribed the audio tapes and coded the survey data. The survey aircraft was expertly piloted by Jim Helmericks.

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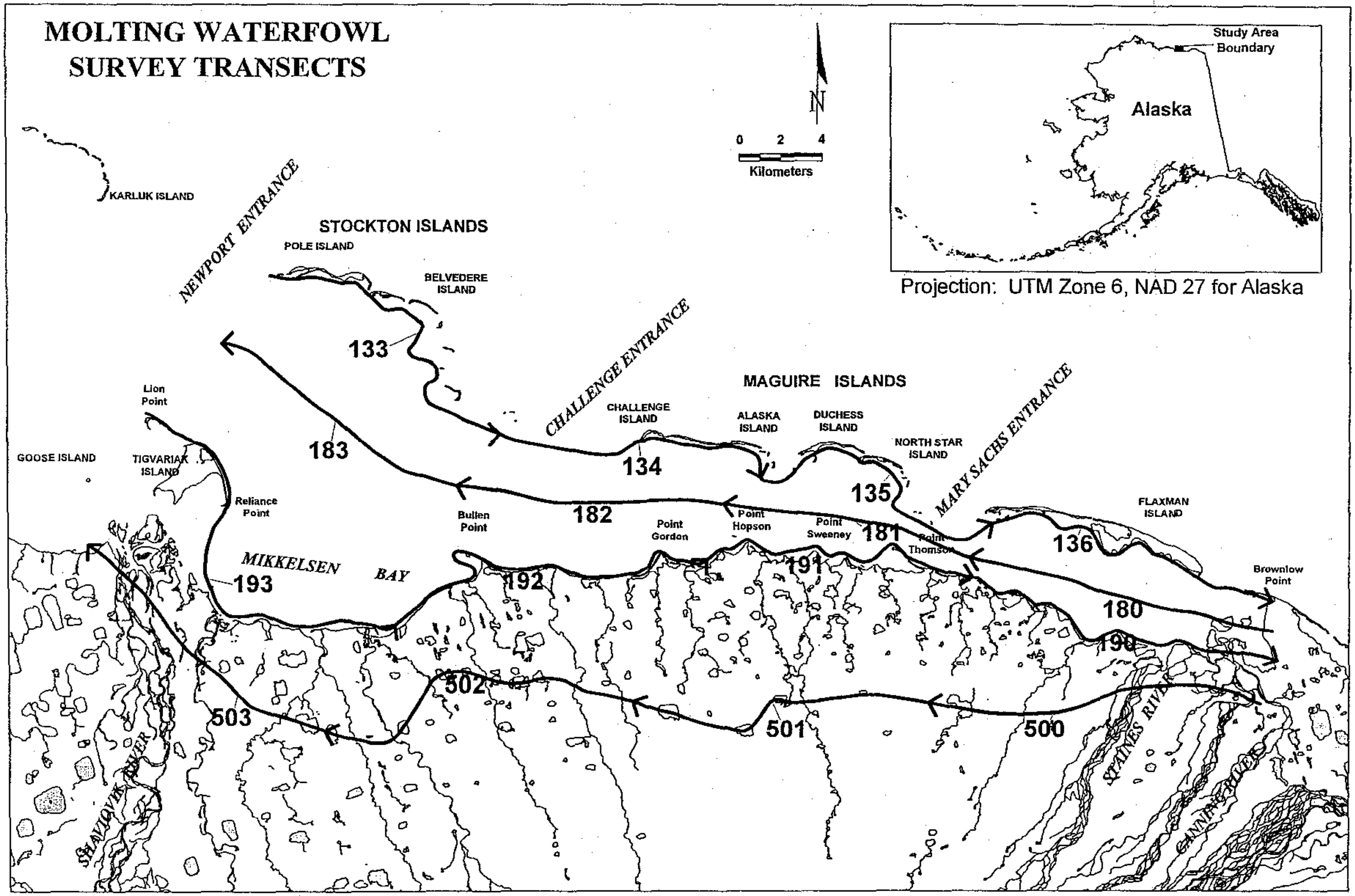


Figure 1. Locations and numbers of aerial survey transect lines in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska.

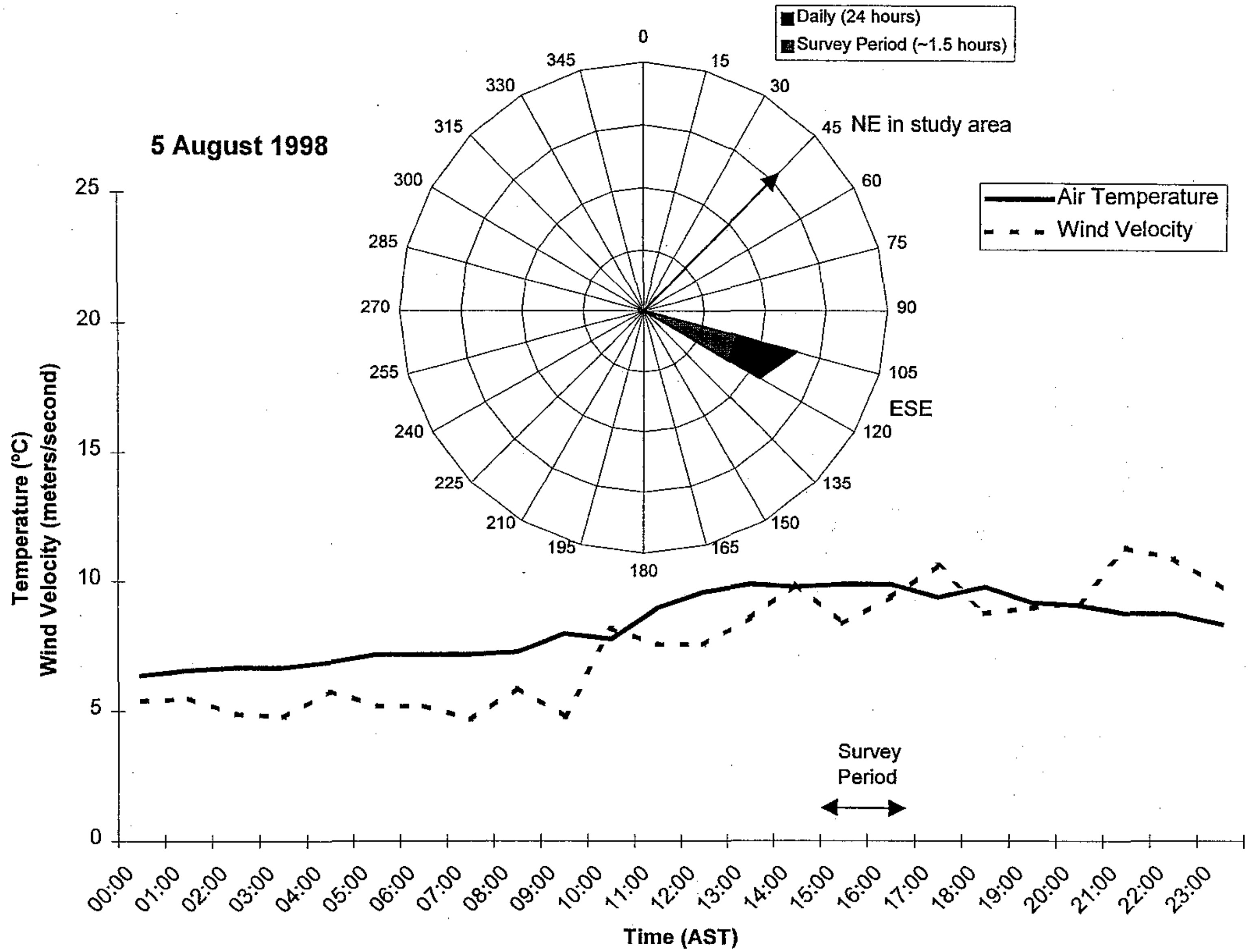


Figure 2. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 5 August 1998.

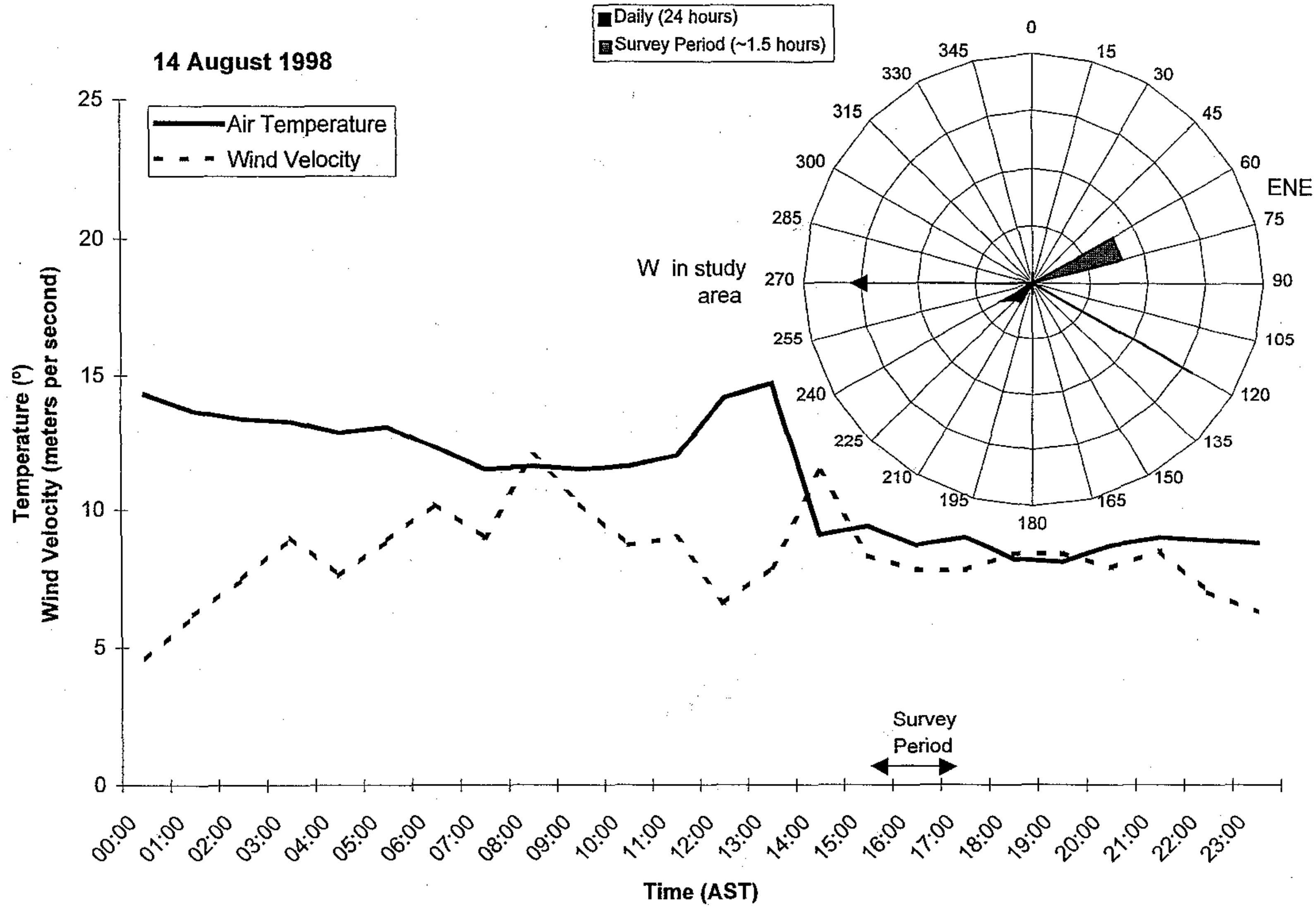


Figure 3. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 14 August 1998.

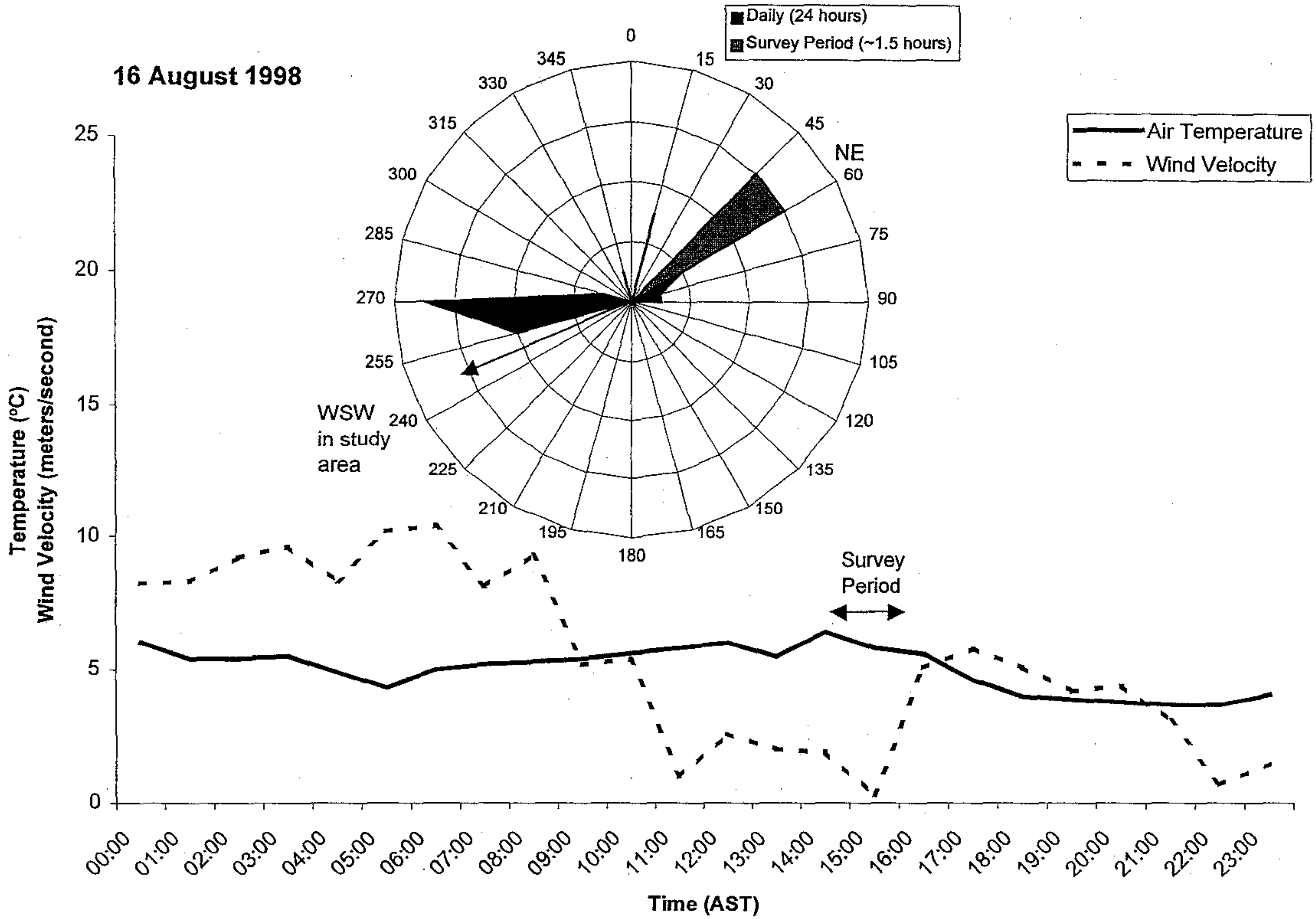


Figure 4. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 16 August 1998.

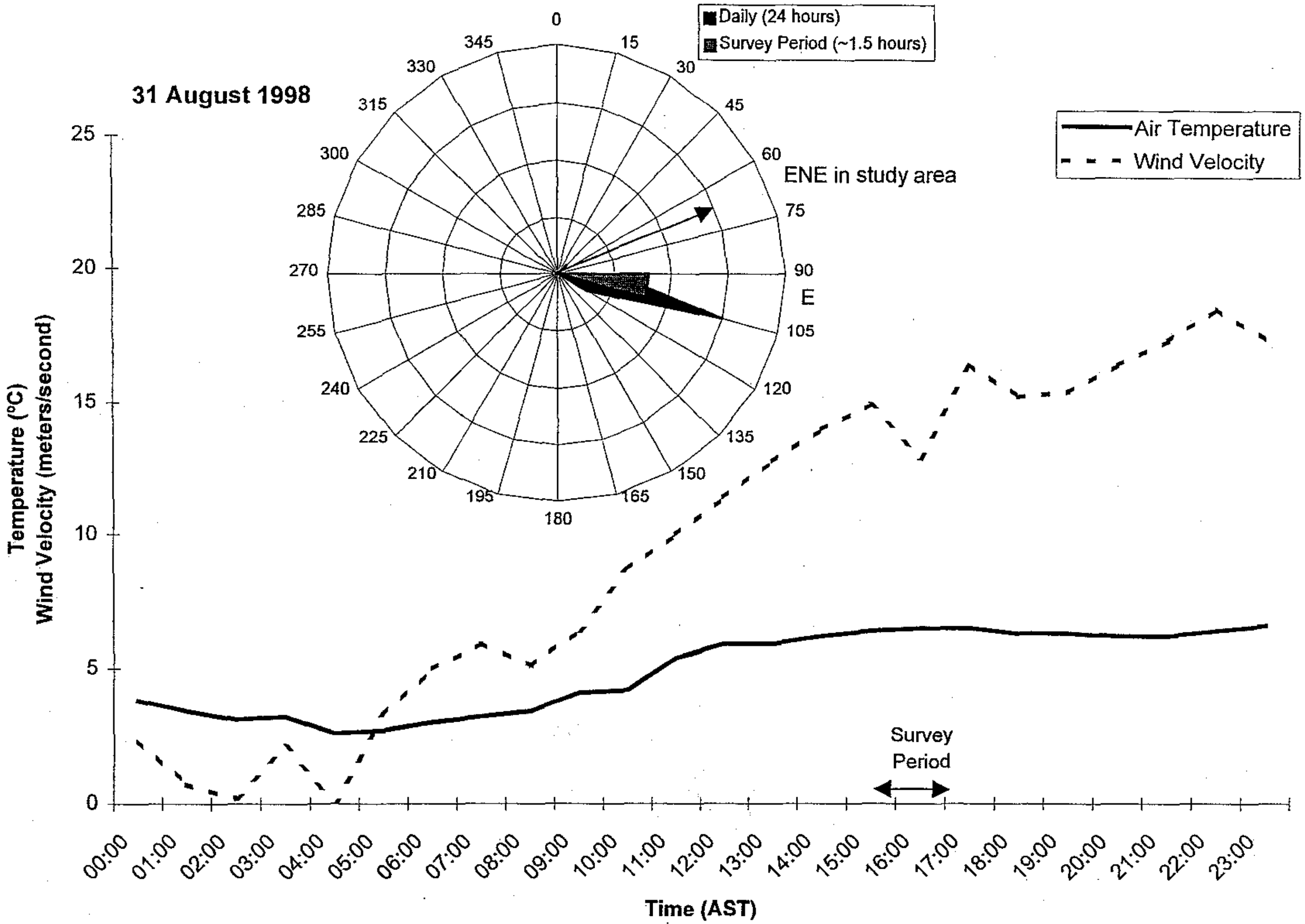


Figure 5. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 31 August 1998.

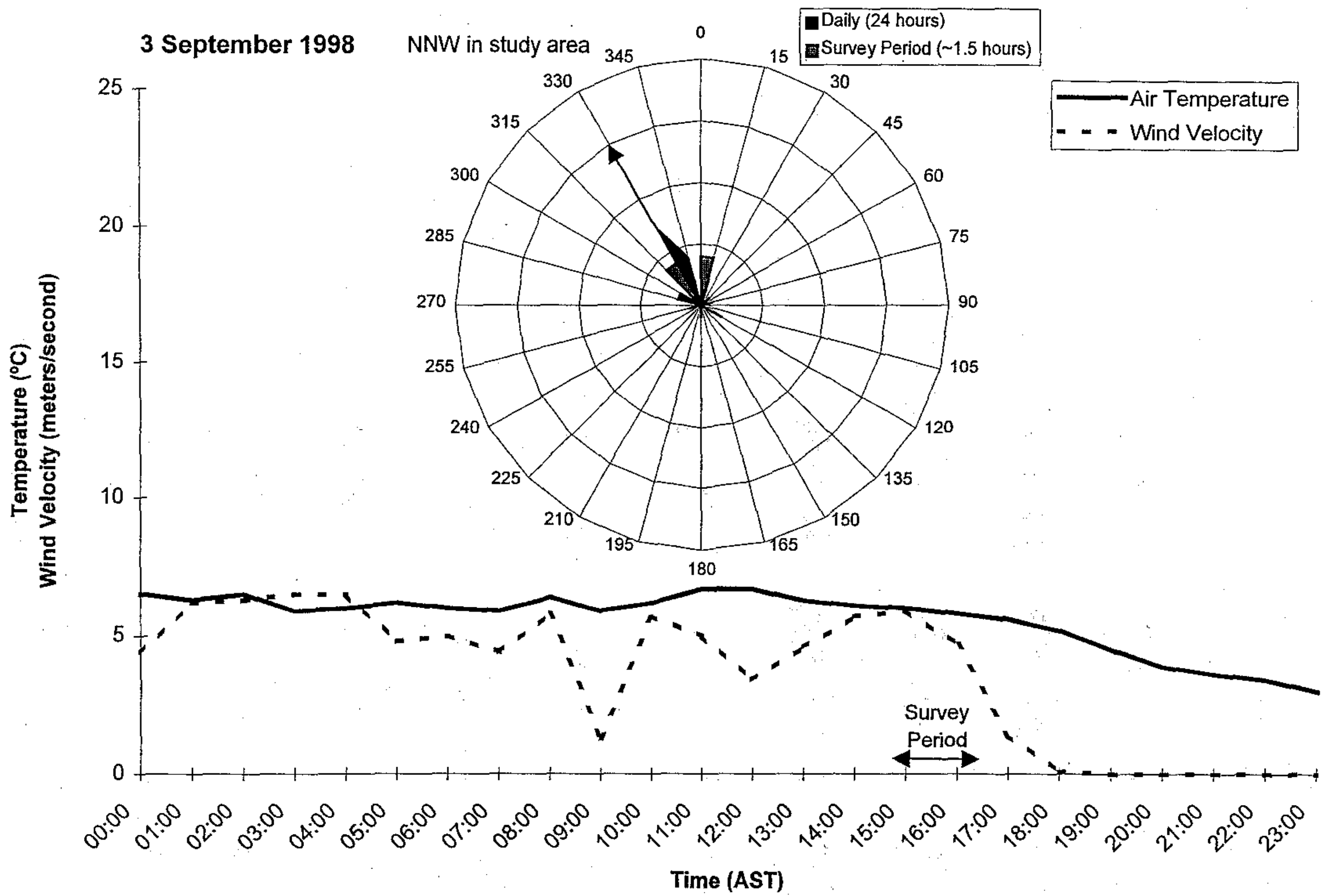


Figure 6. Hourly temperature and wind data recorded at the Prudhoe Bay NOAA Station at West Dock, Alaska, 3 September 1998.


Figure 7. Percentages of oldsquaws counted during aerial surveys in nearshore waters of the central Alaska Beaufort Sea, 1977 to 1991 (Johnson and Gazey 1992) and 1998.

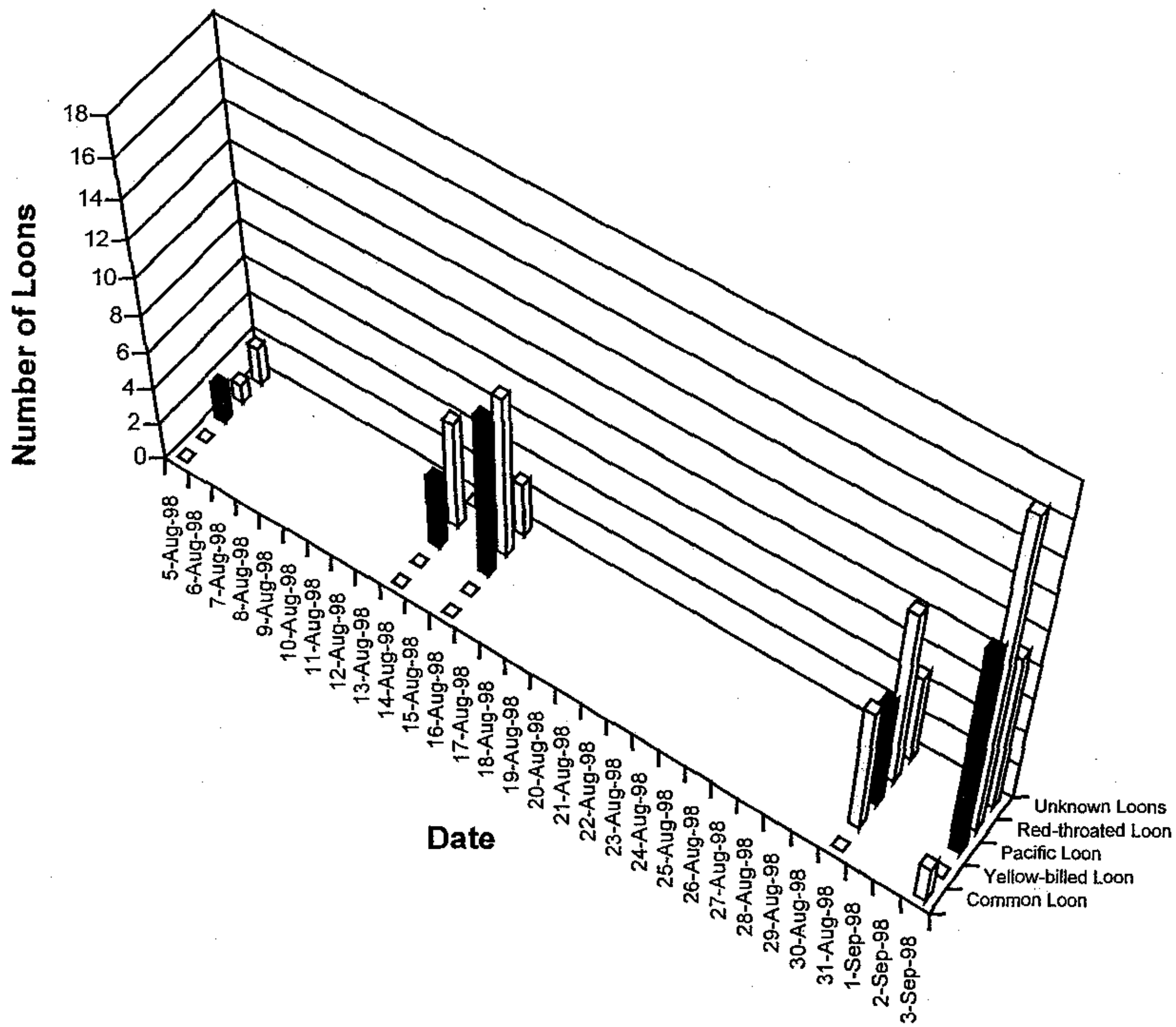




Figure 8. Total number of loons observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

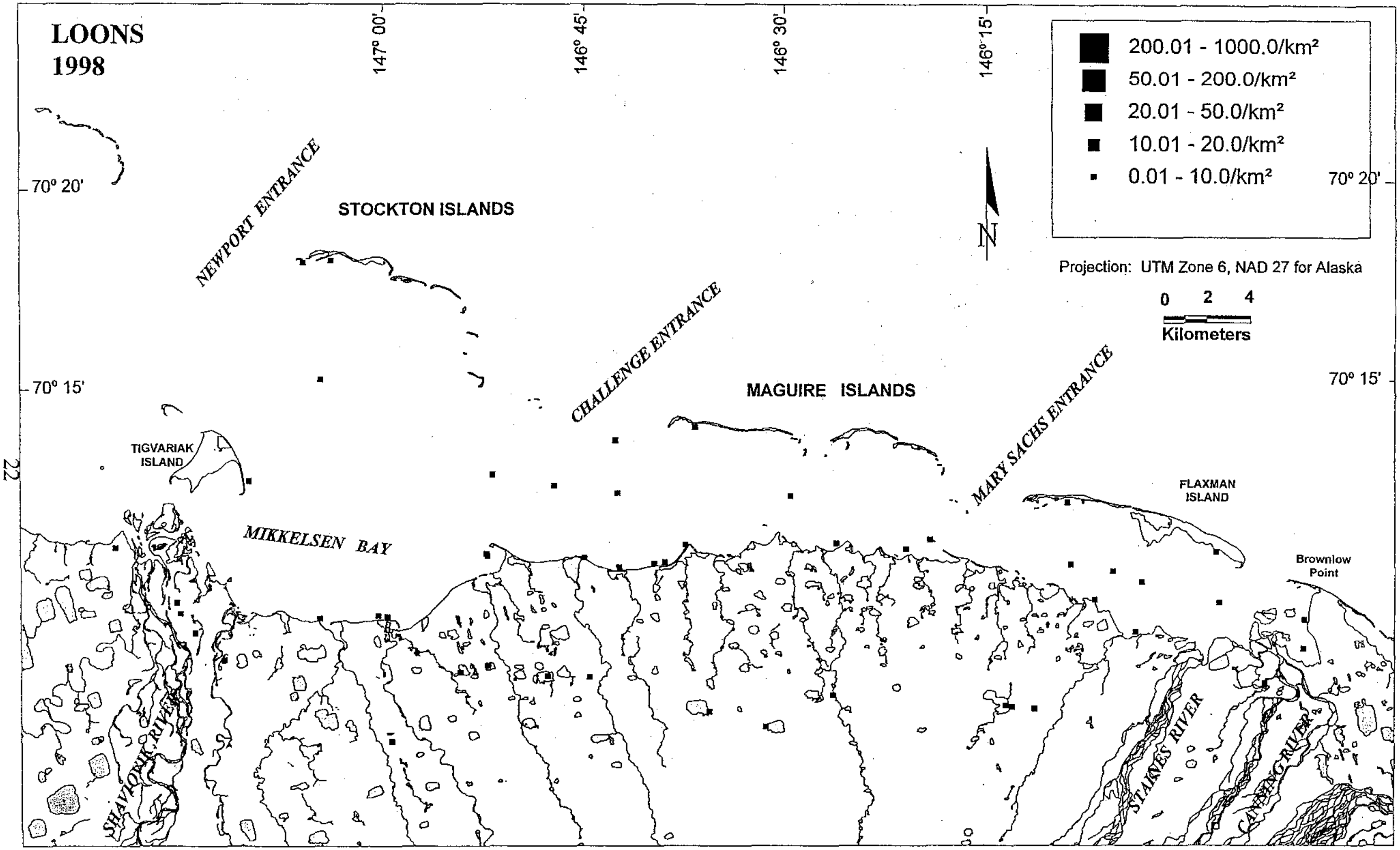


Figure 9. Summary of density of loons for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

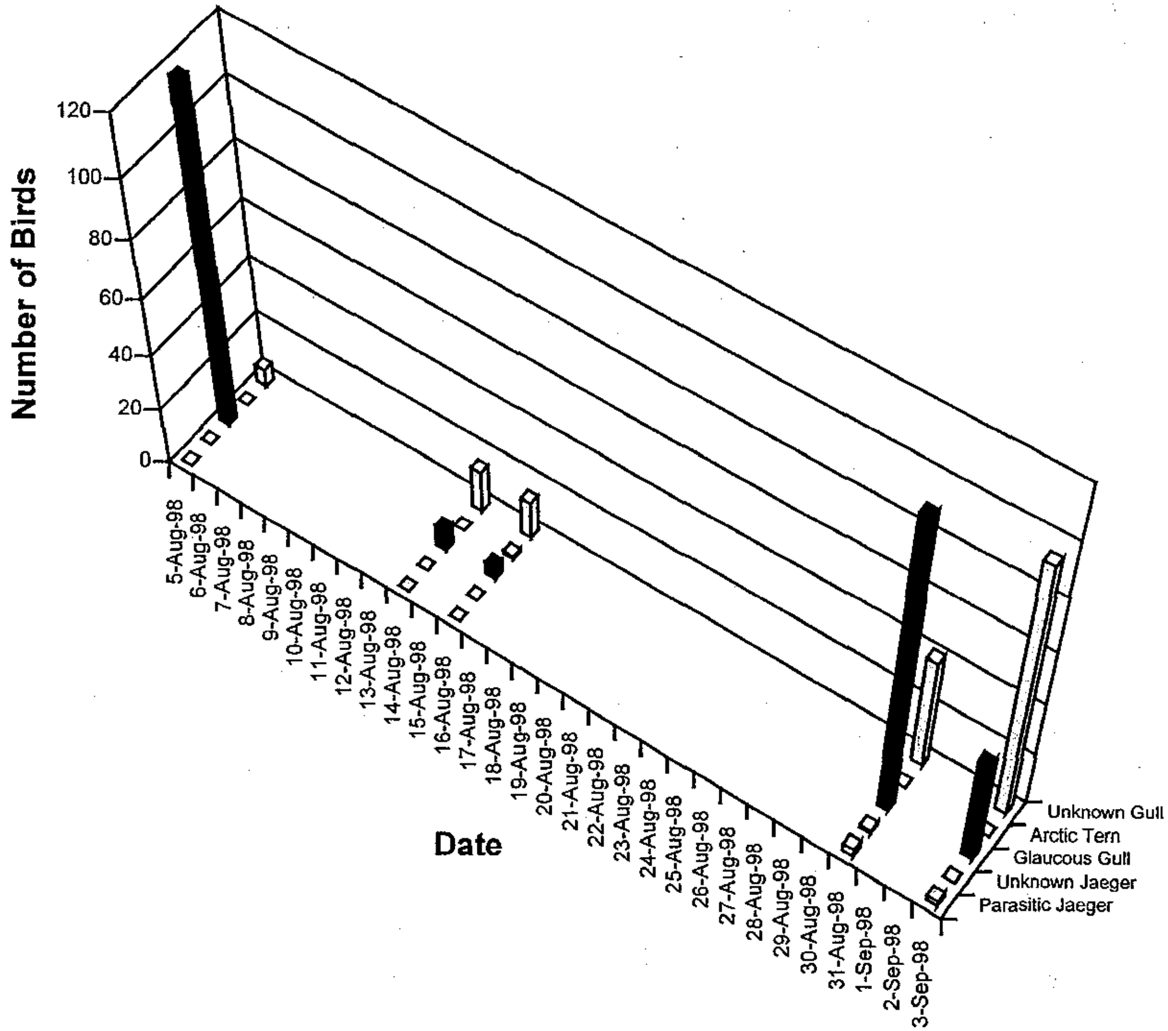


Figure 10. Total number of seabirds observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

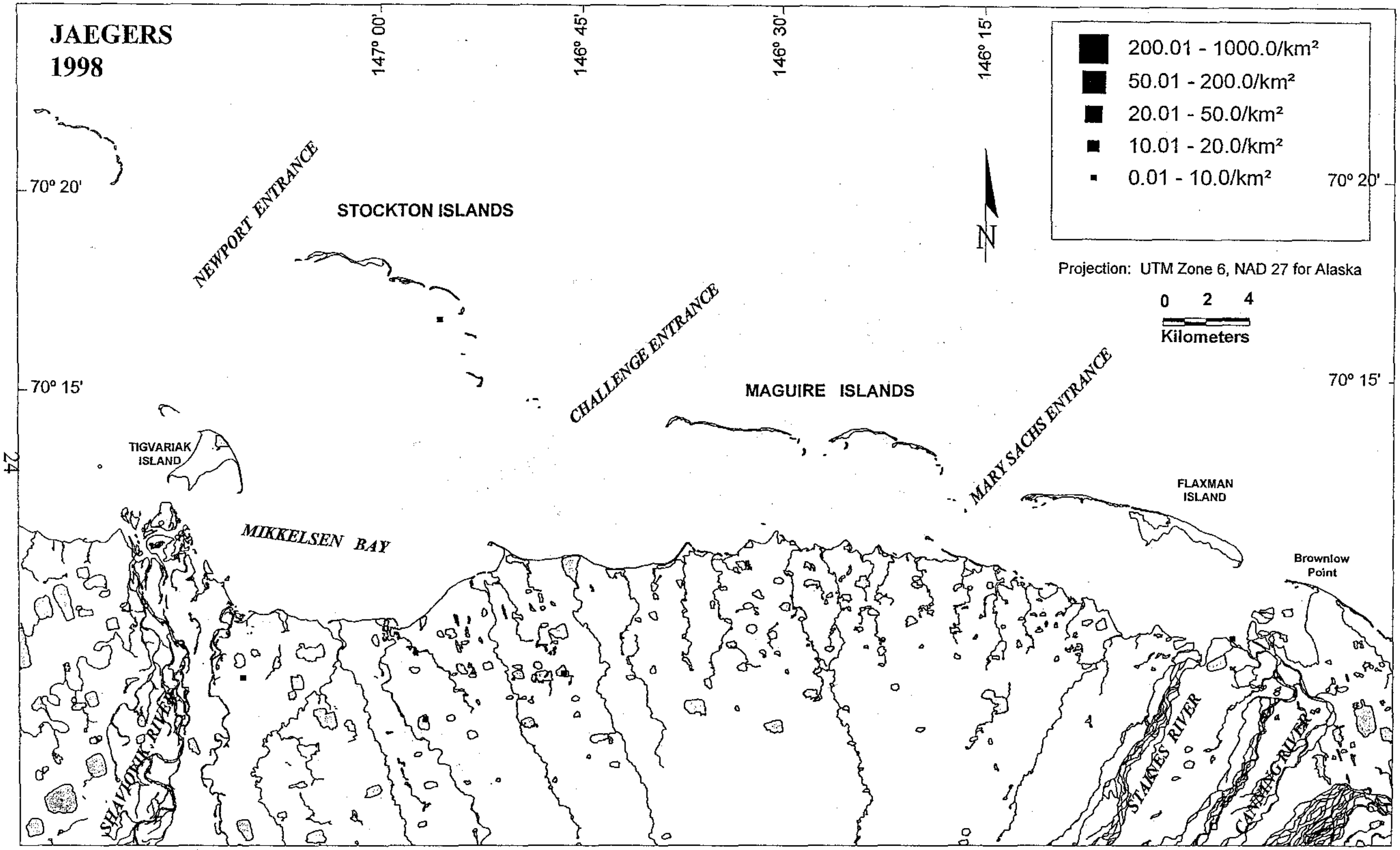


Figure 11. Summary of density of jaegers for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

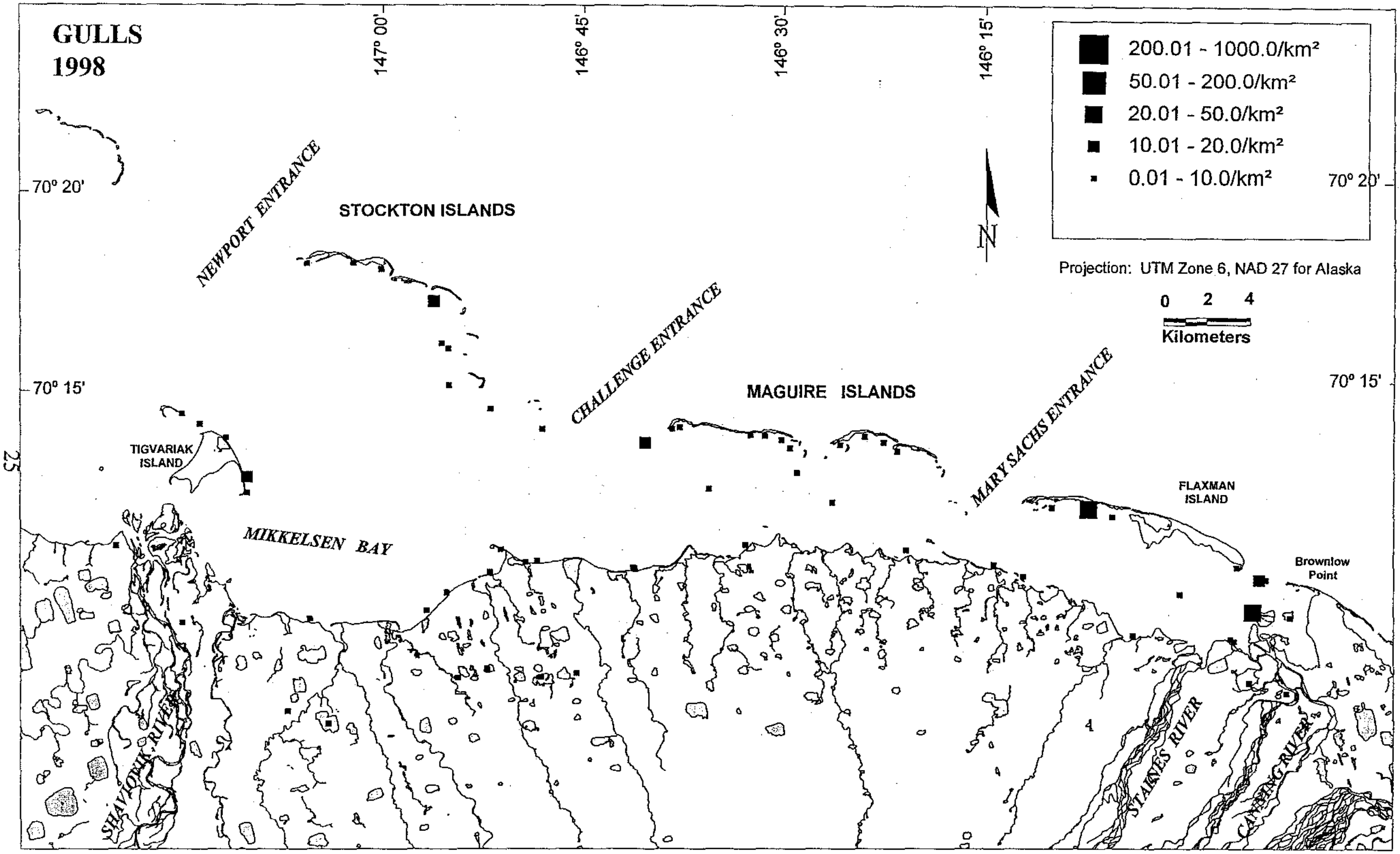


Figure 12. Summary of density of gulls for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

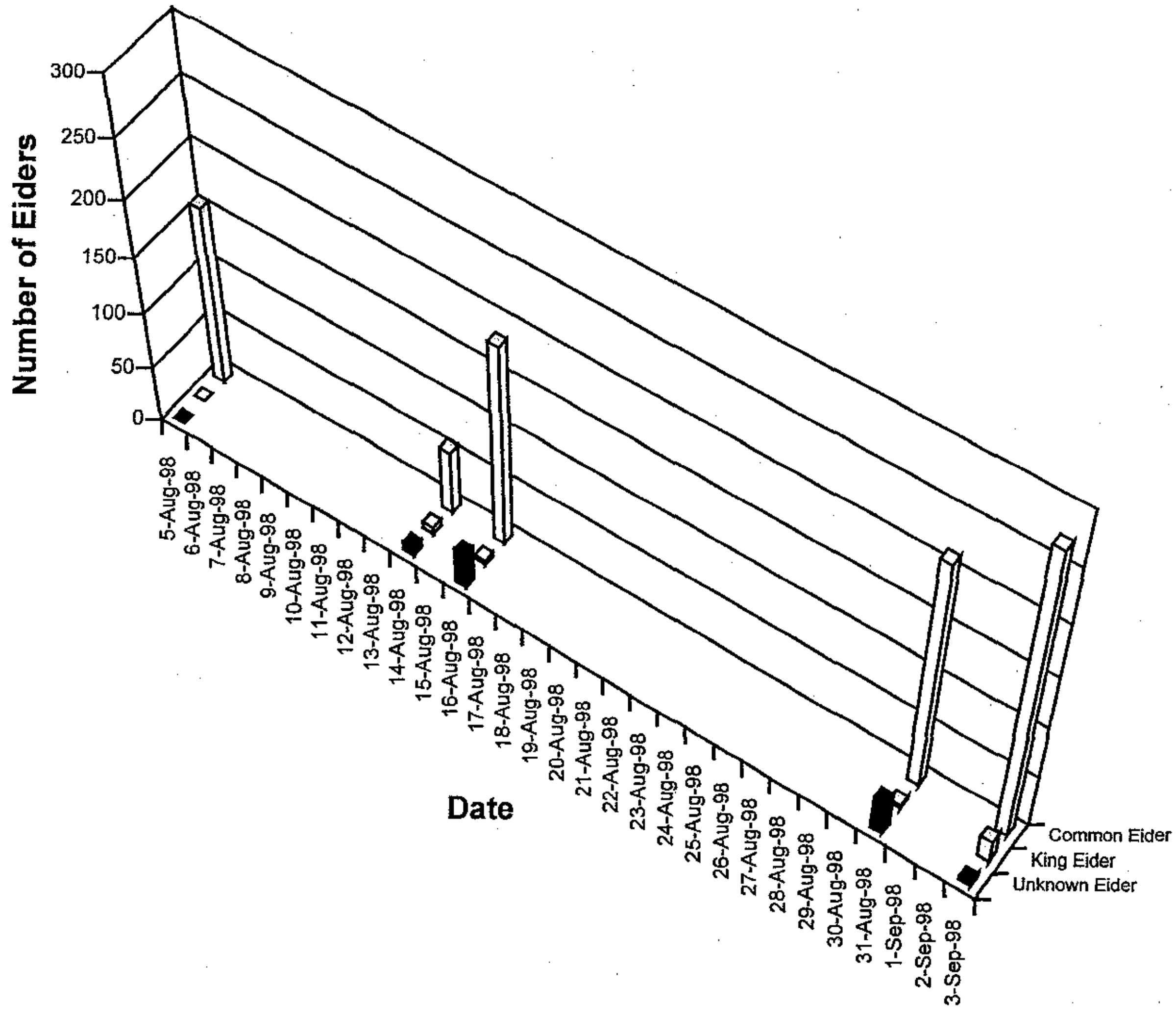


Figure 13. Total number of eiders observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

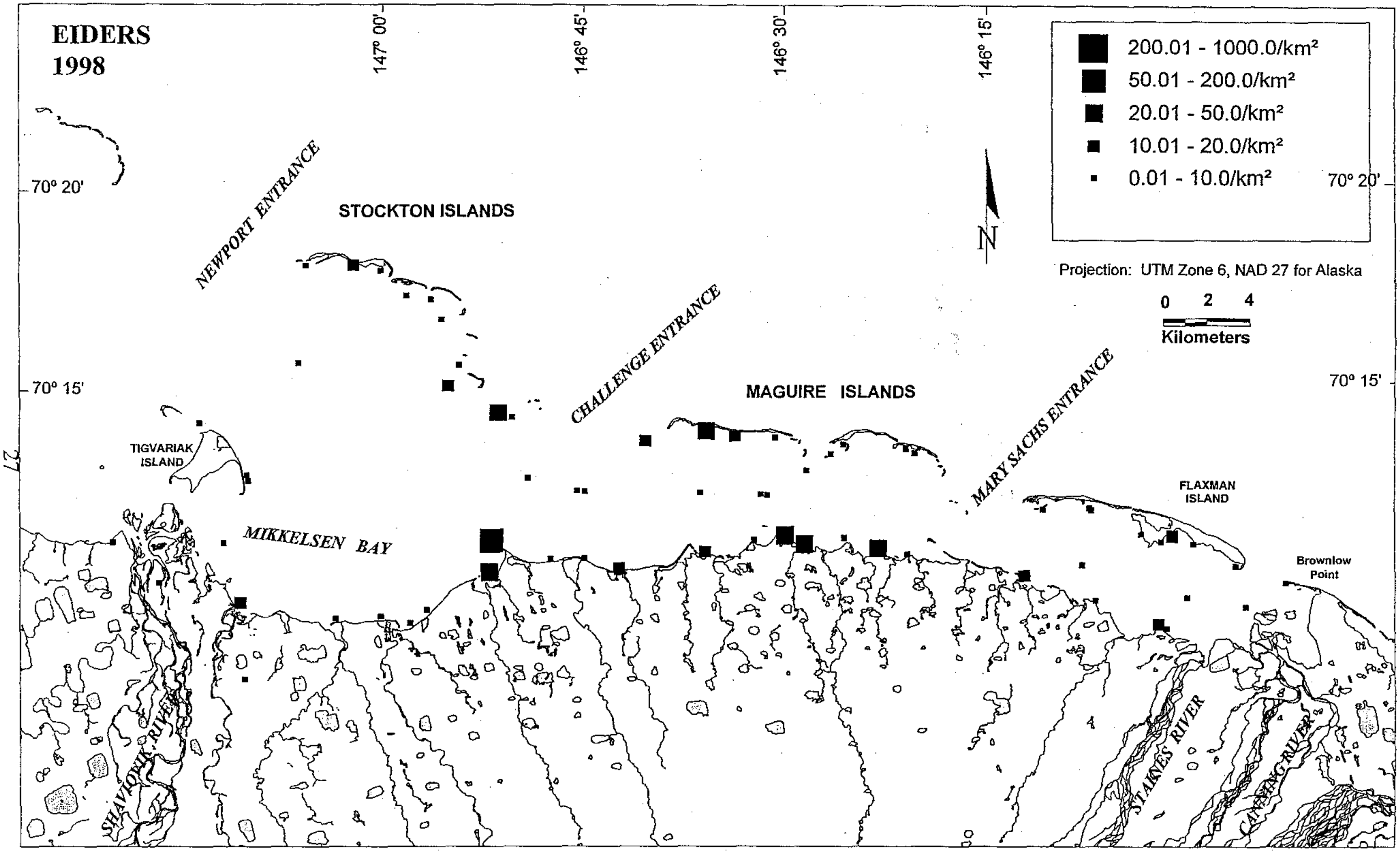


Figure 14. Summary of density of eiders for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

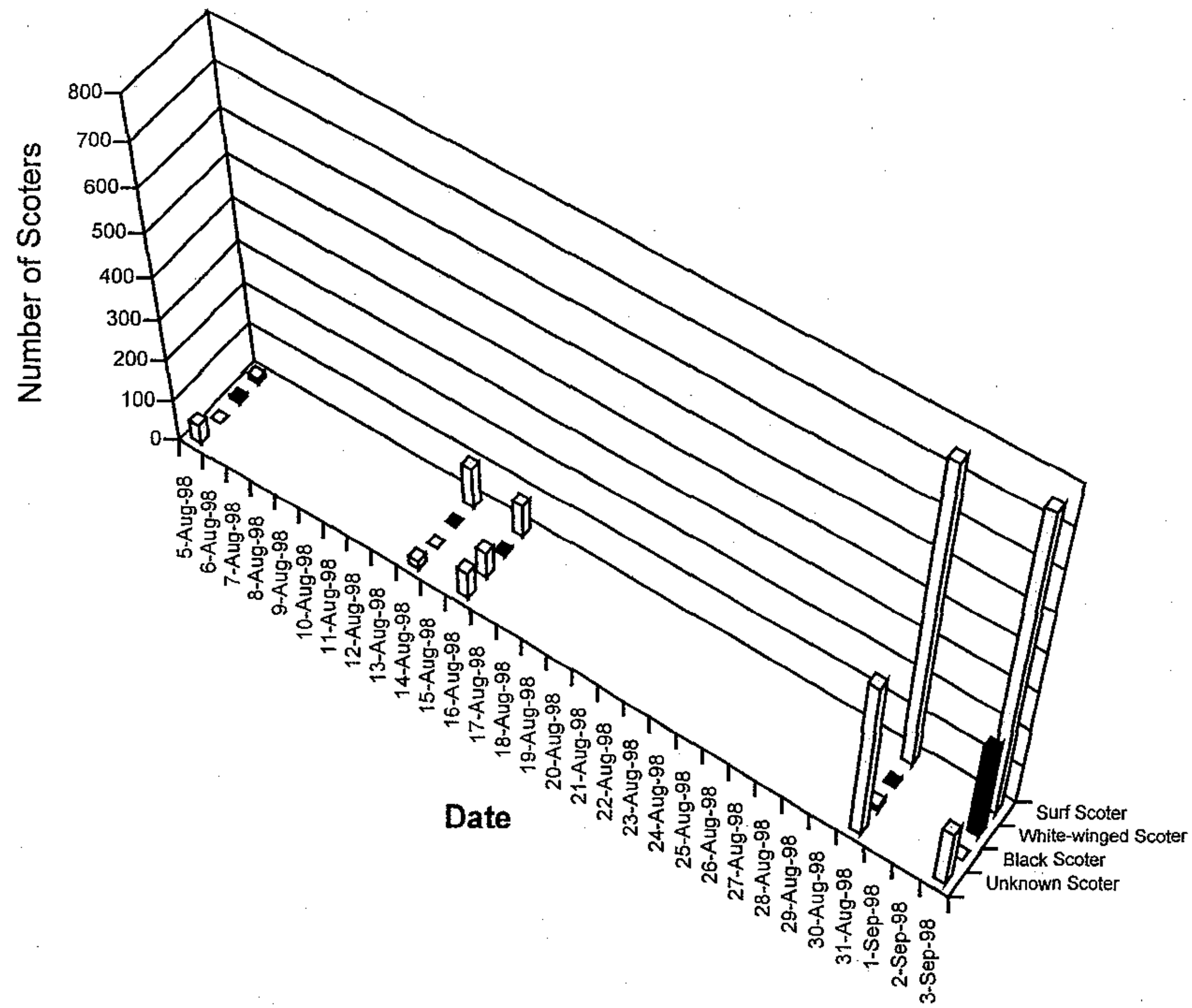


Figure 15. Total number of scoters observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

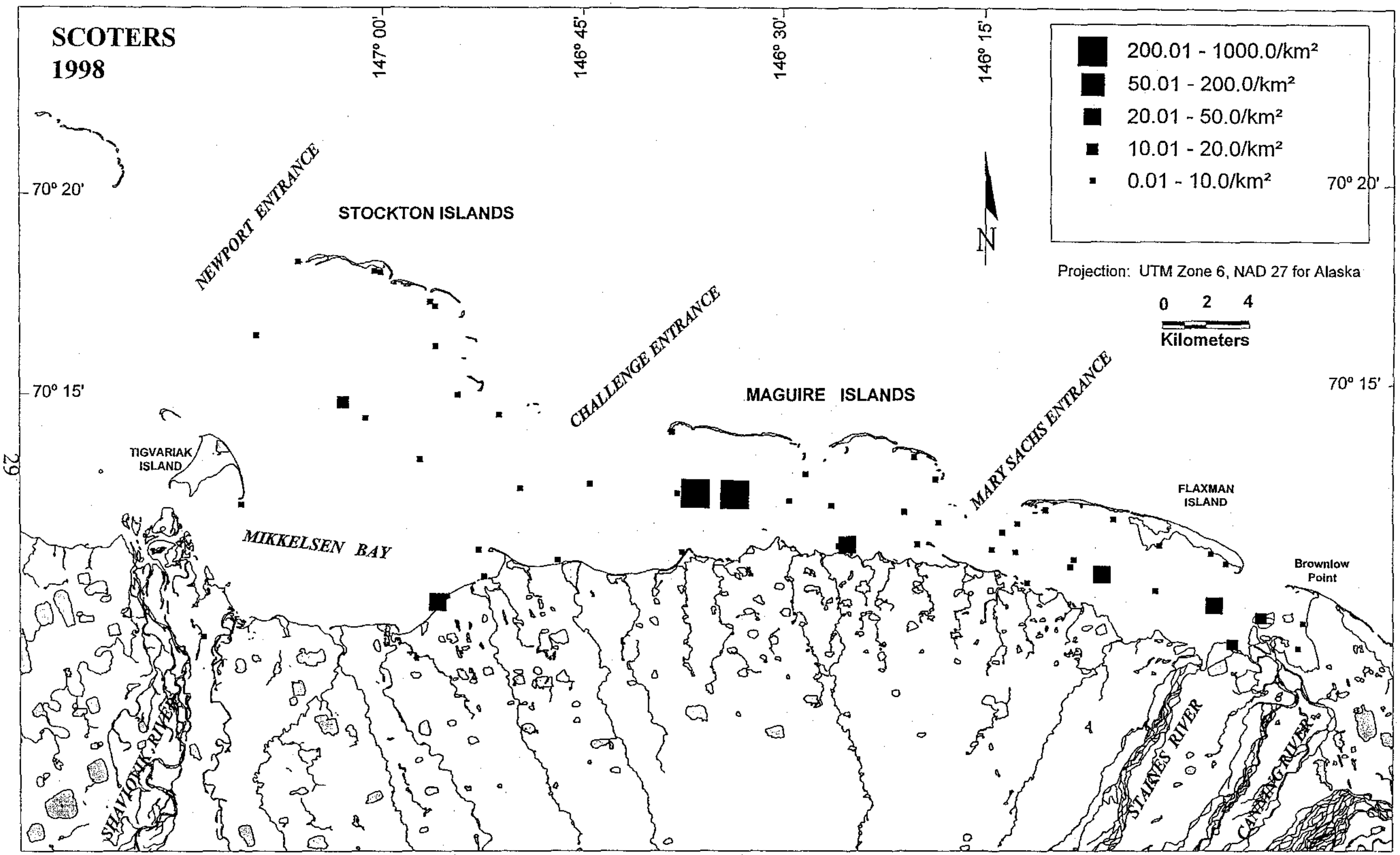


Figure 16. Summary of density of scoters for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

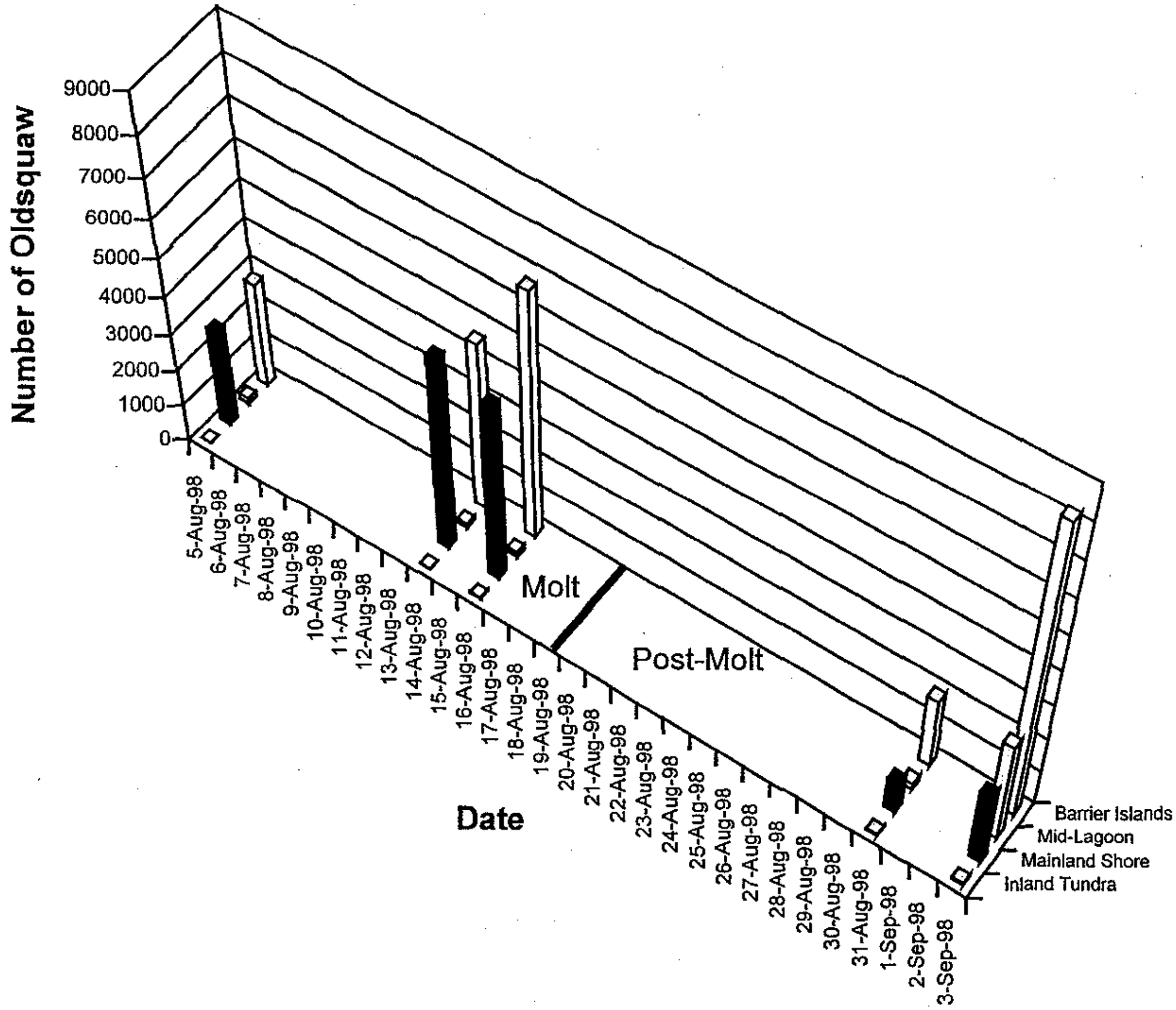


Figure 17. Total number of oldsquaw observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

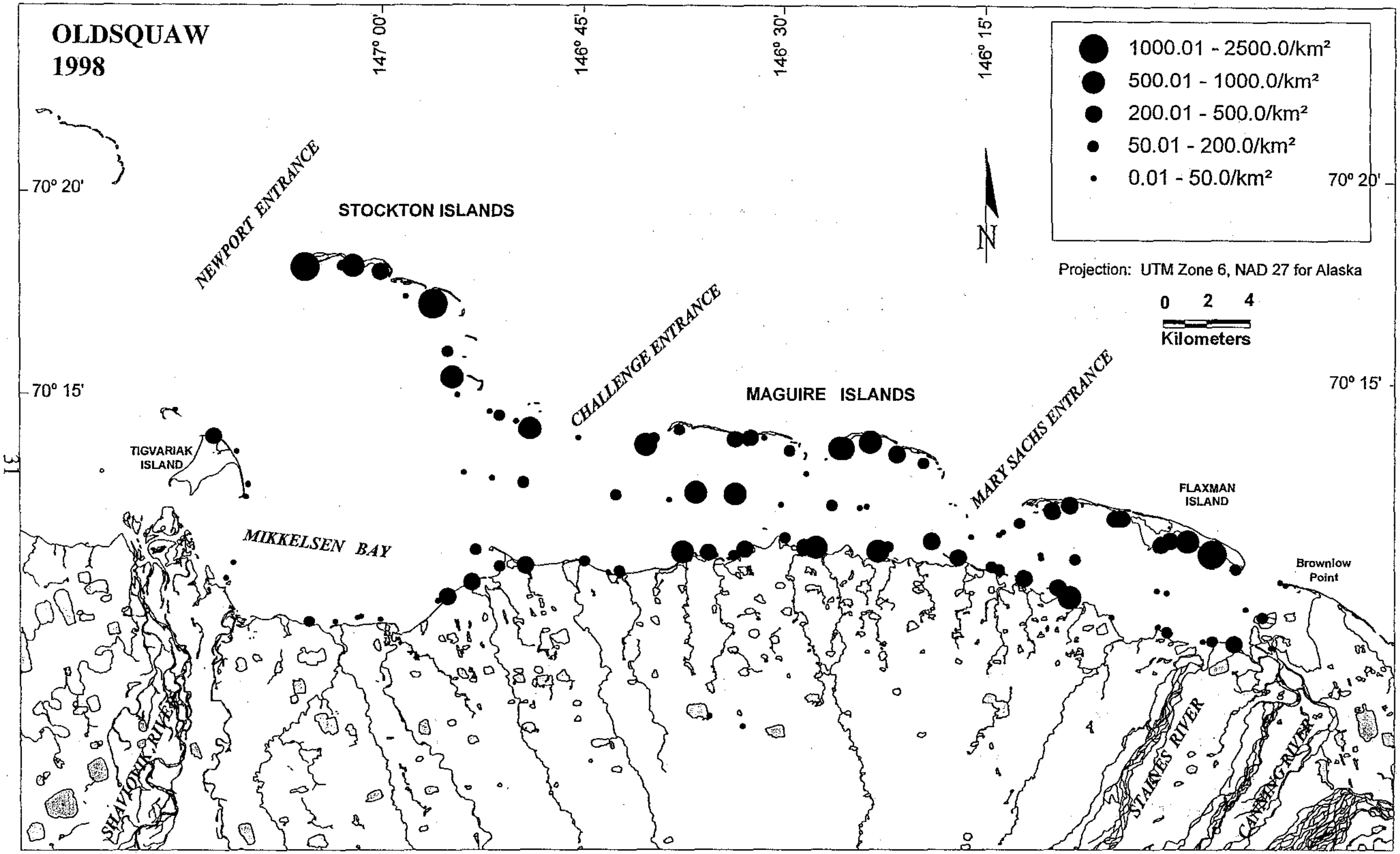


Figure 18. Summary of density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

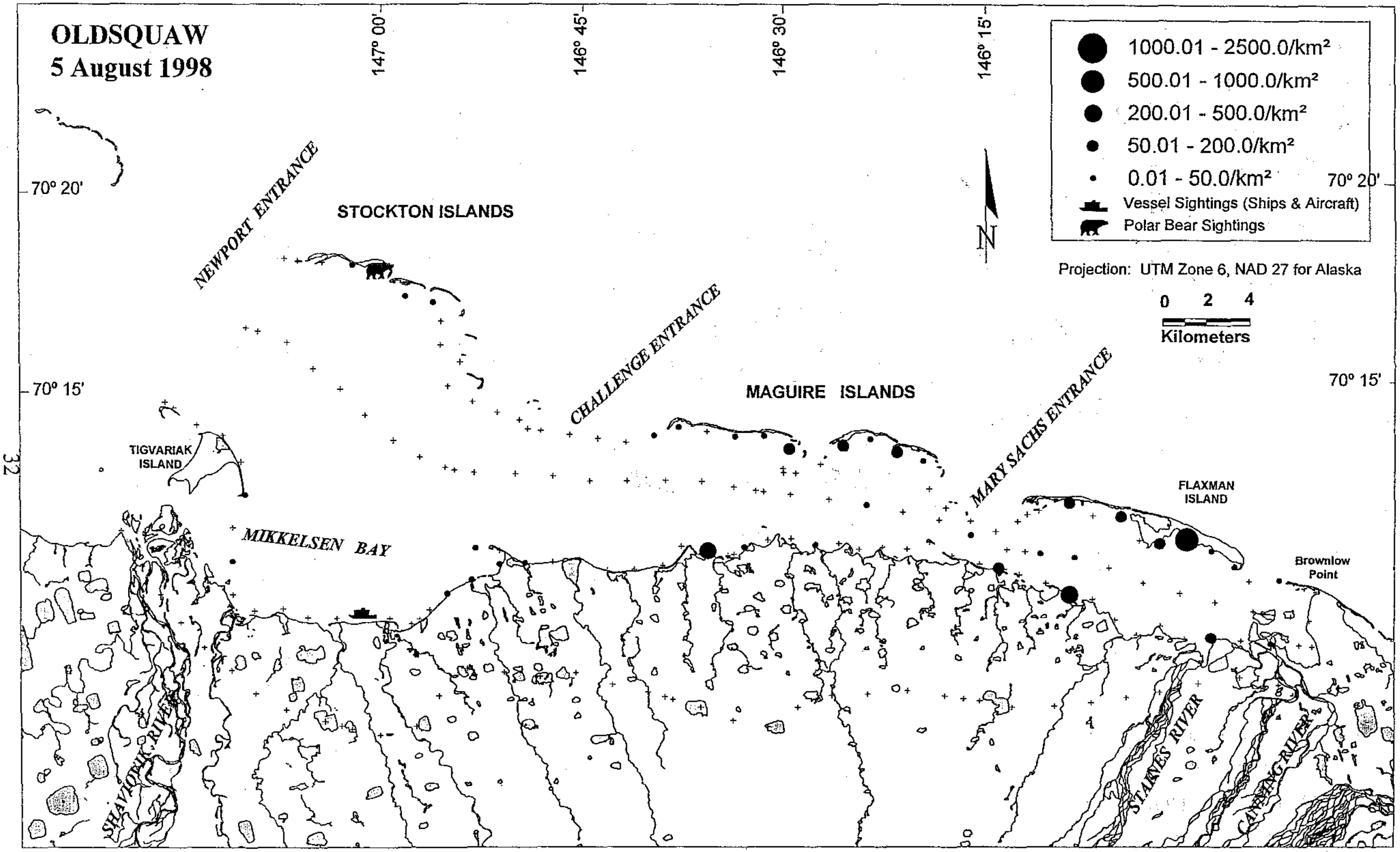


Figure 19. Density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August 1998.

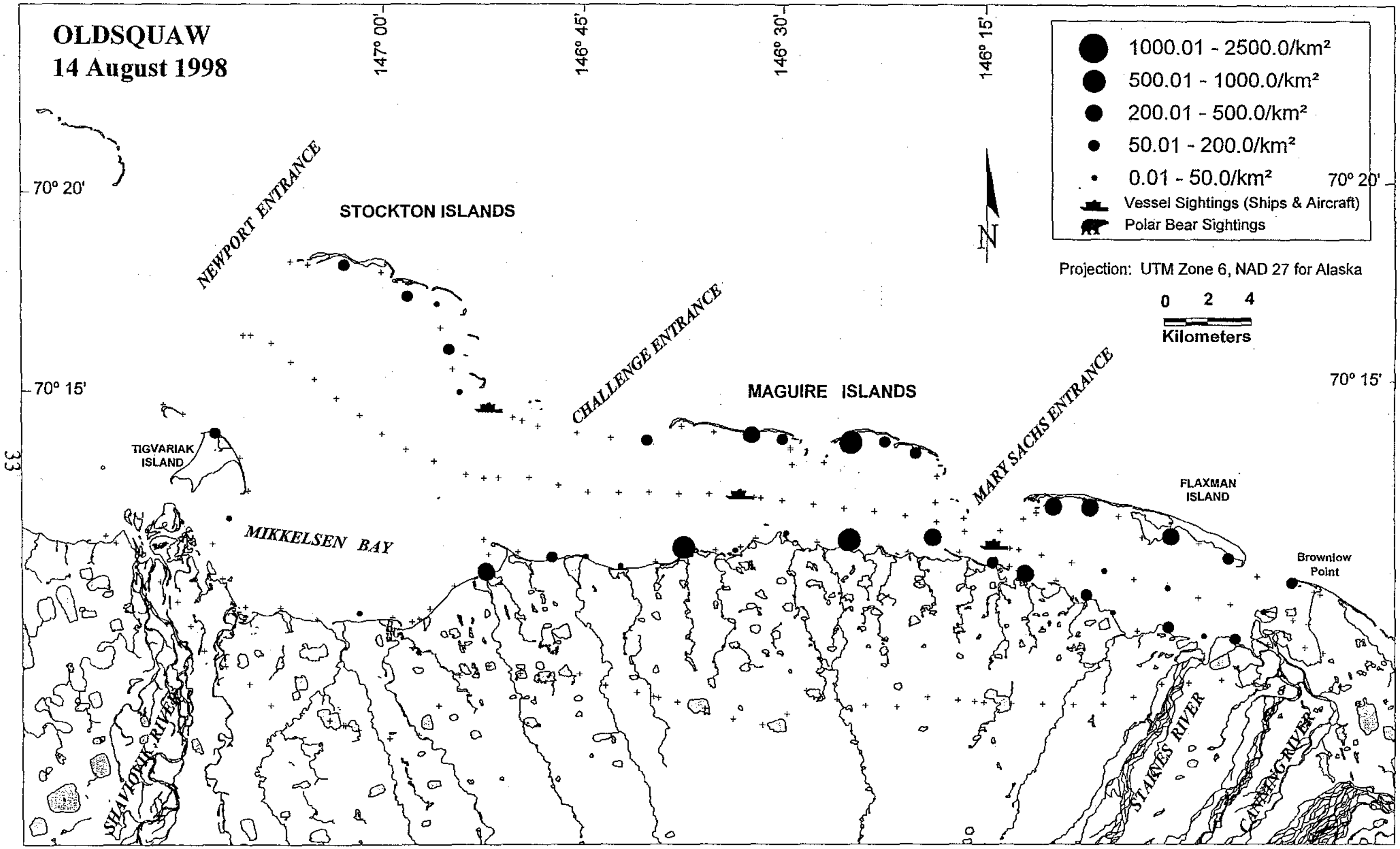


Figure 20. Density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 14 August 1998.

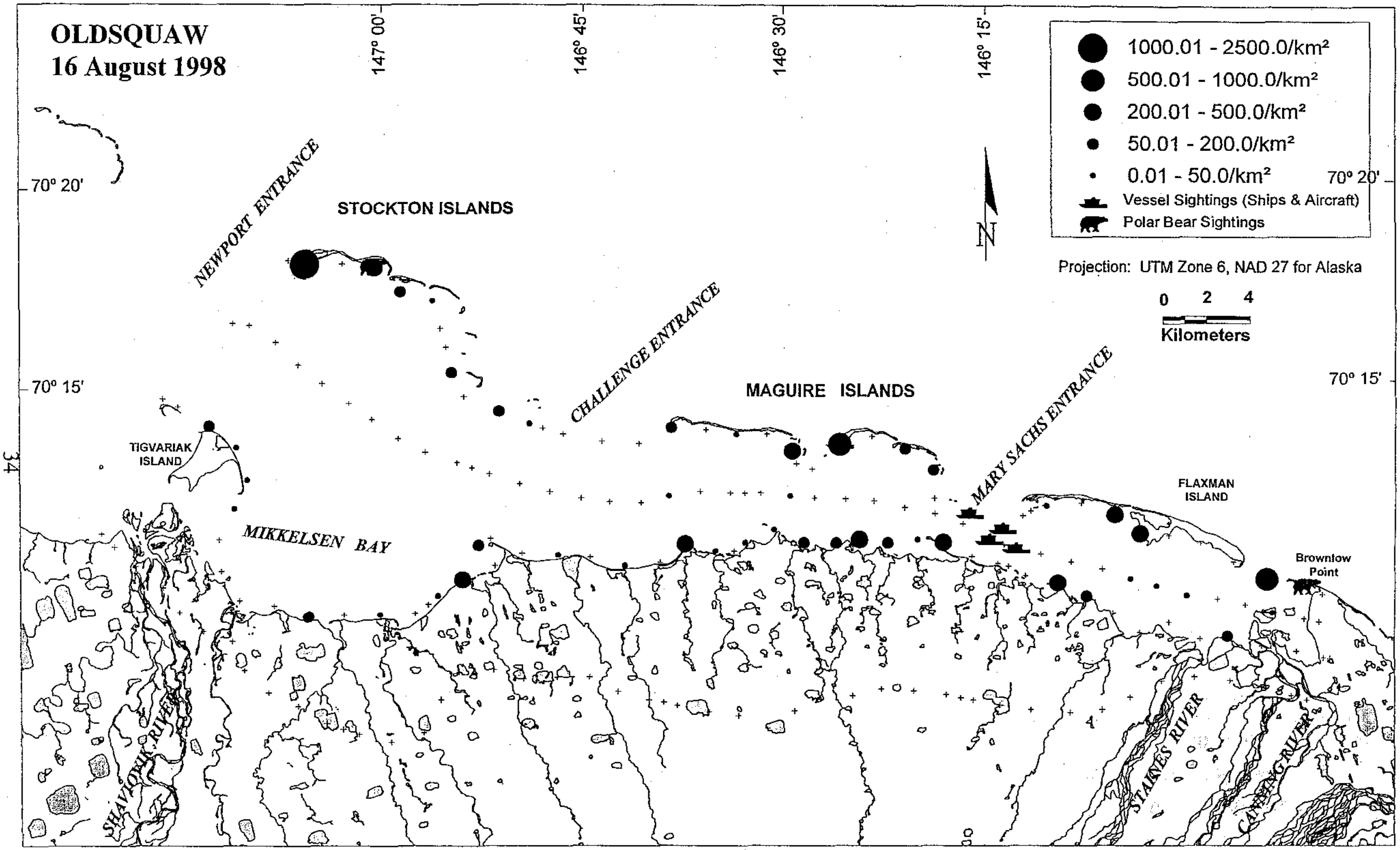


Figure 21. Density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 16 August 1998.

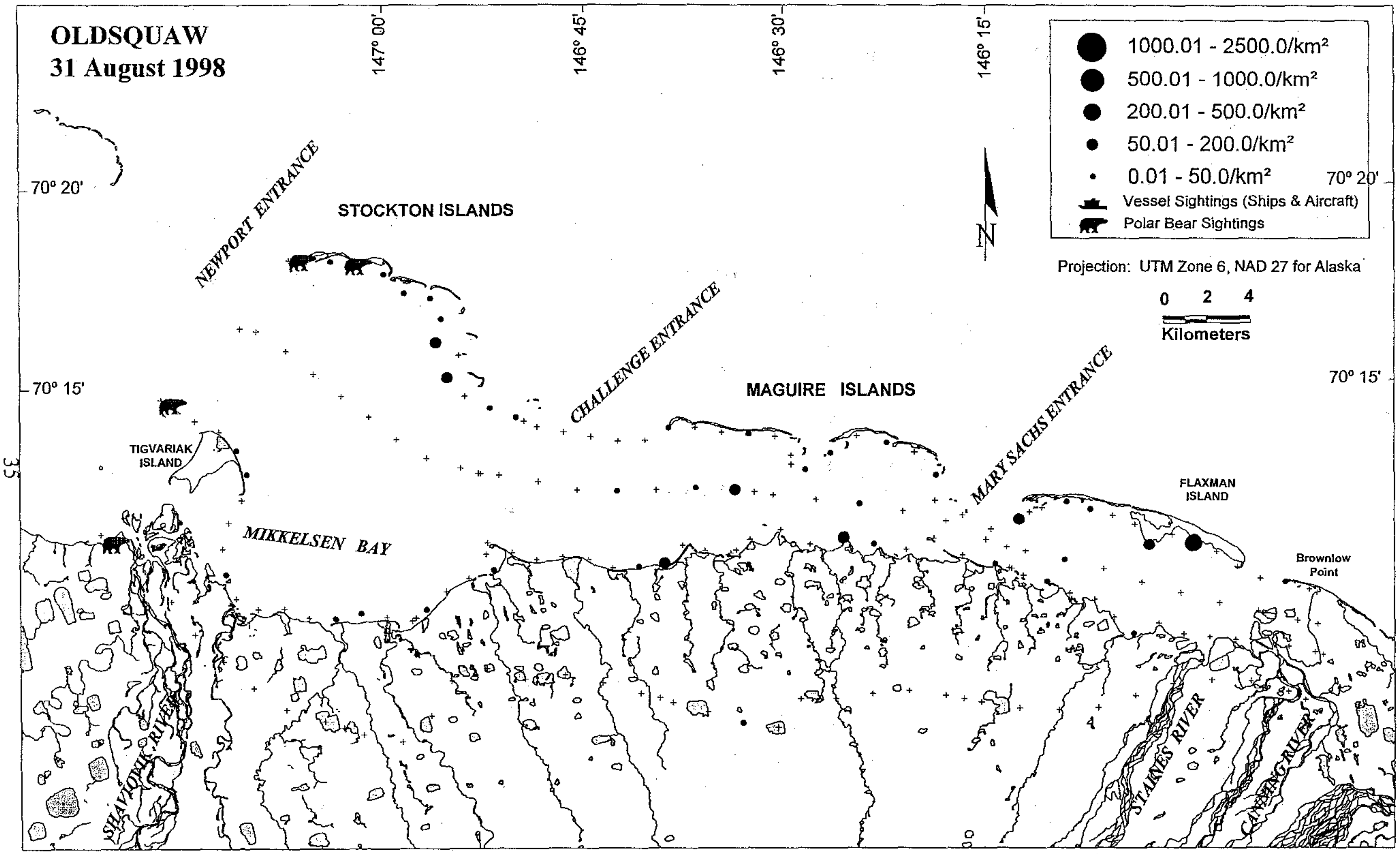


Figure 22. Density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 31 August 1998.

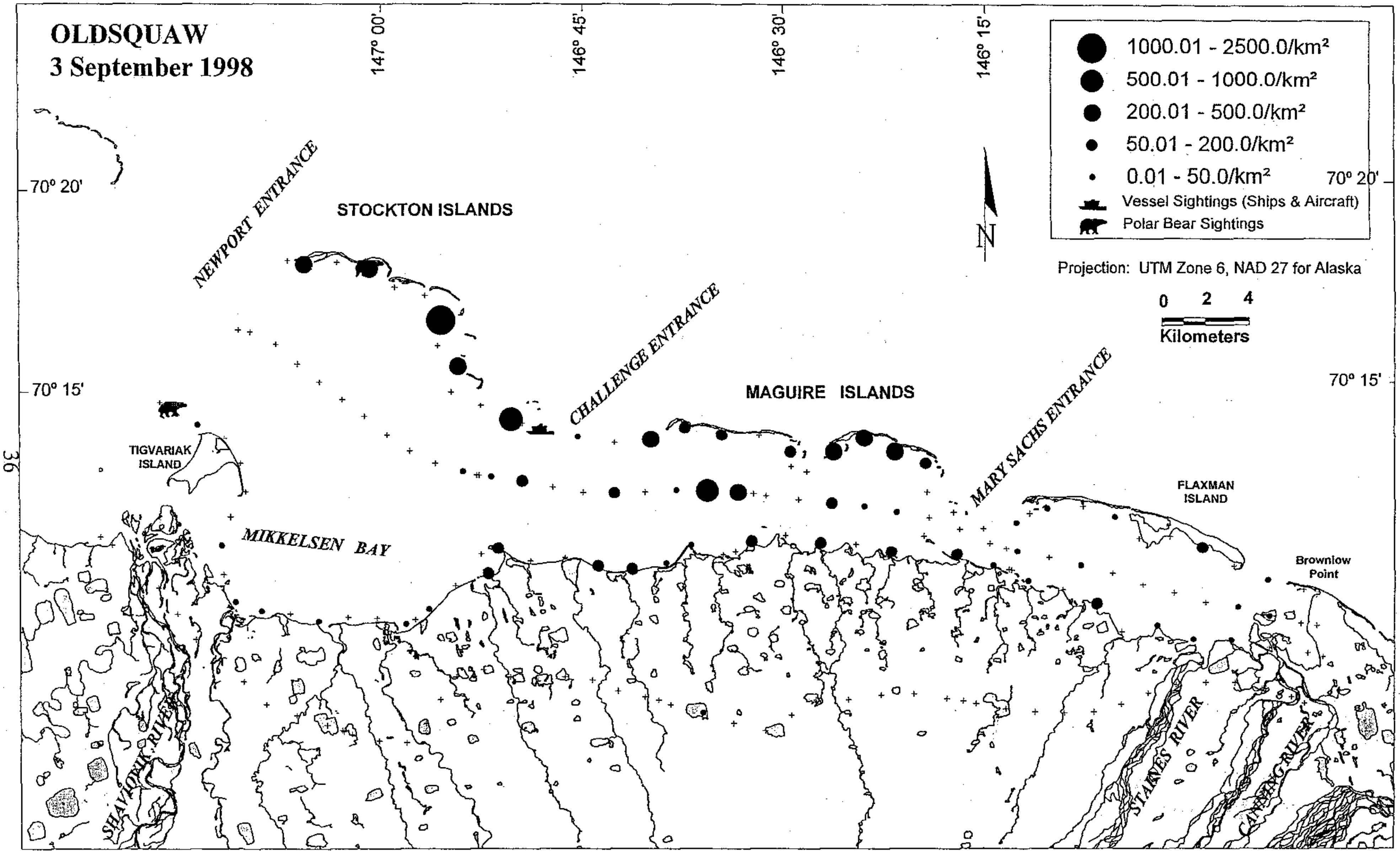


Figure 23. Density of oldsquaw for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 3 September 1998.

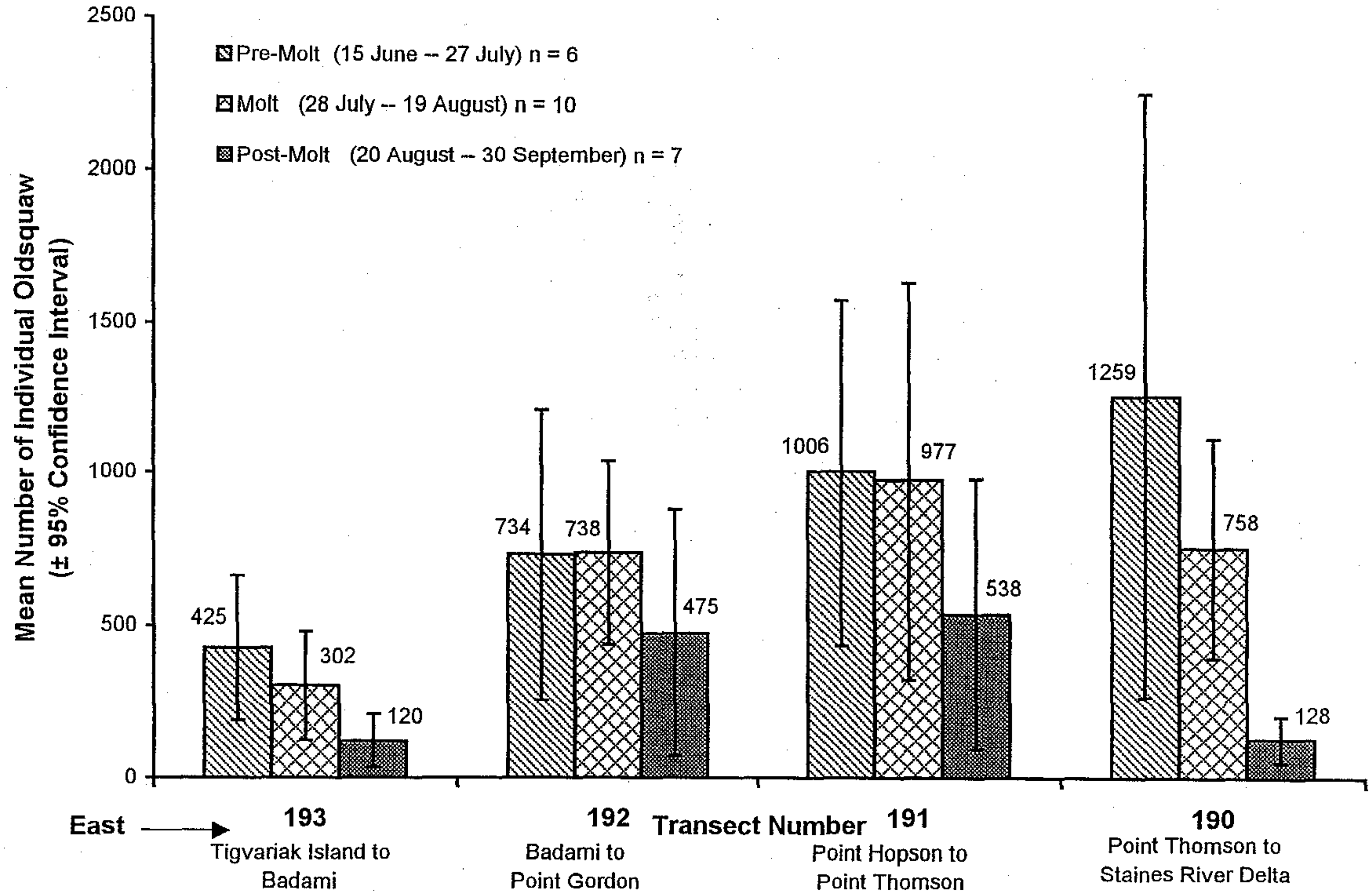


Figure 24. Mean number of oldsquaw for mainland shore transects in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 1977 to 1991 (Johnson and Gazey 1992) and 1998.

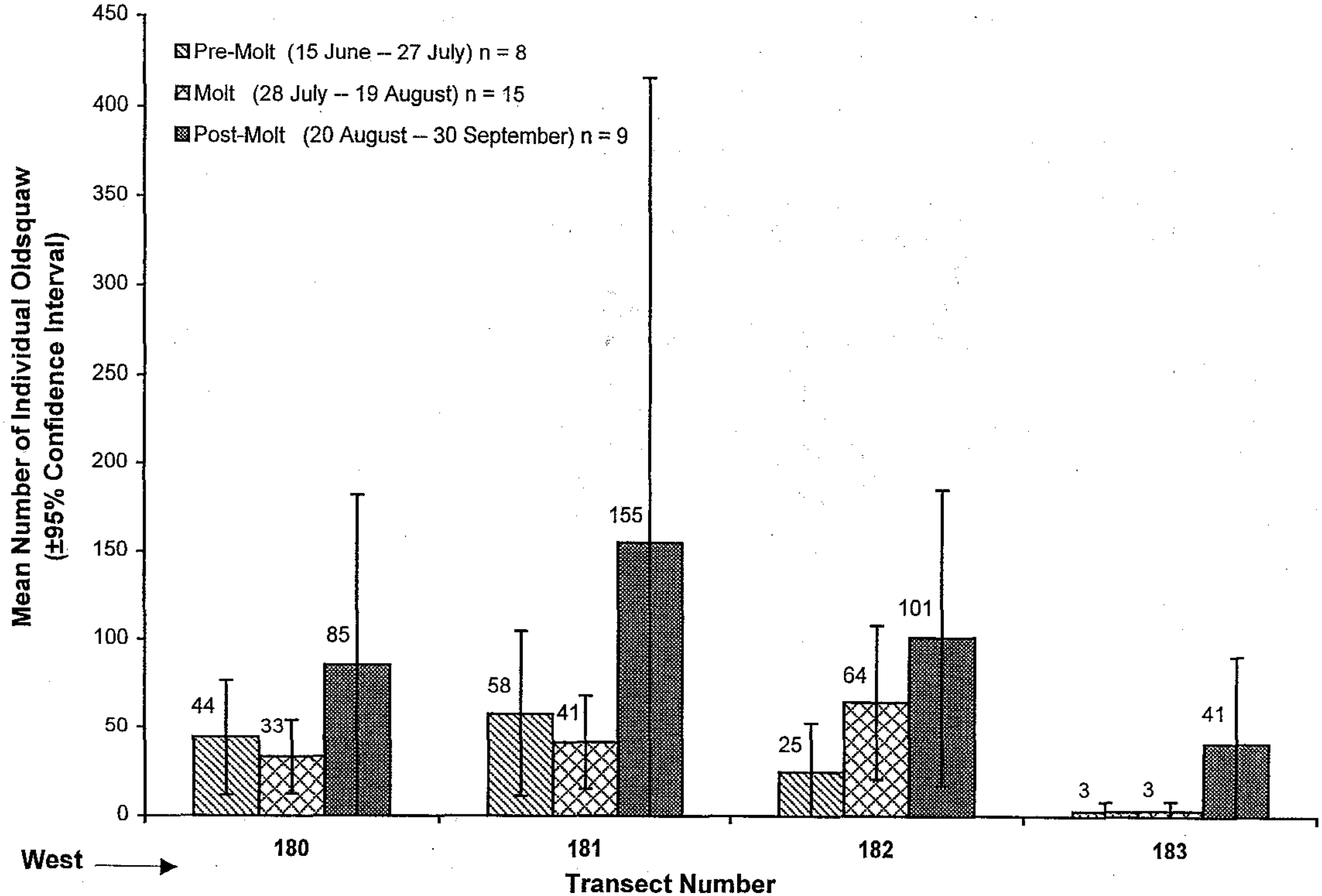


Figure 25. Mean number of oldsquaw for mid-lagoon transects in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 1977 to 1991 (Johnson and Gazey 1992) and 1998.

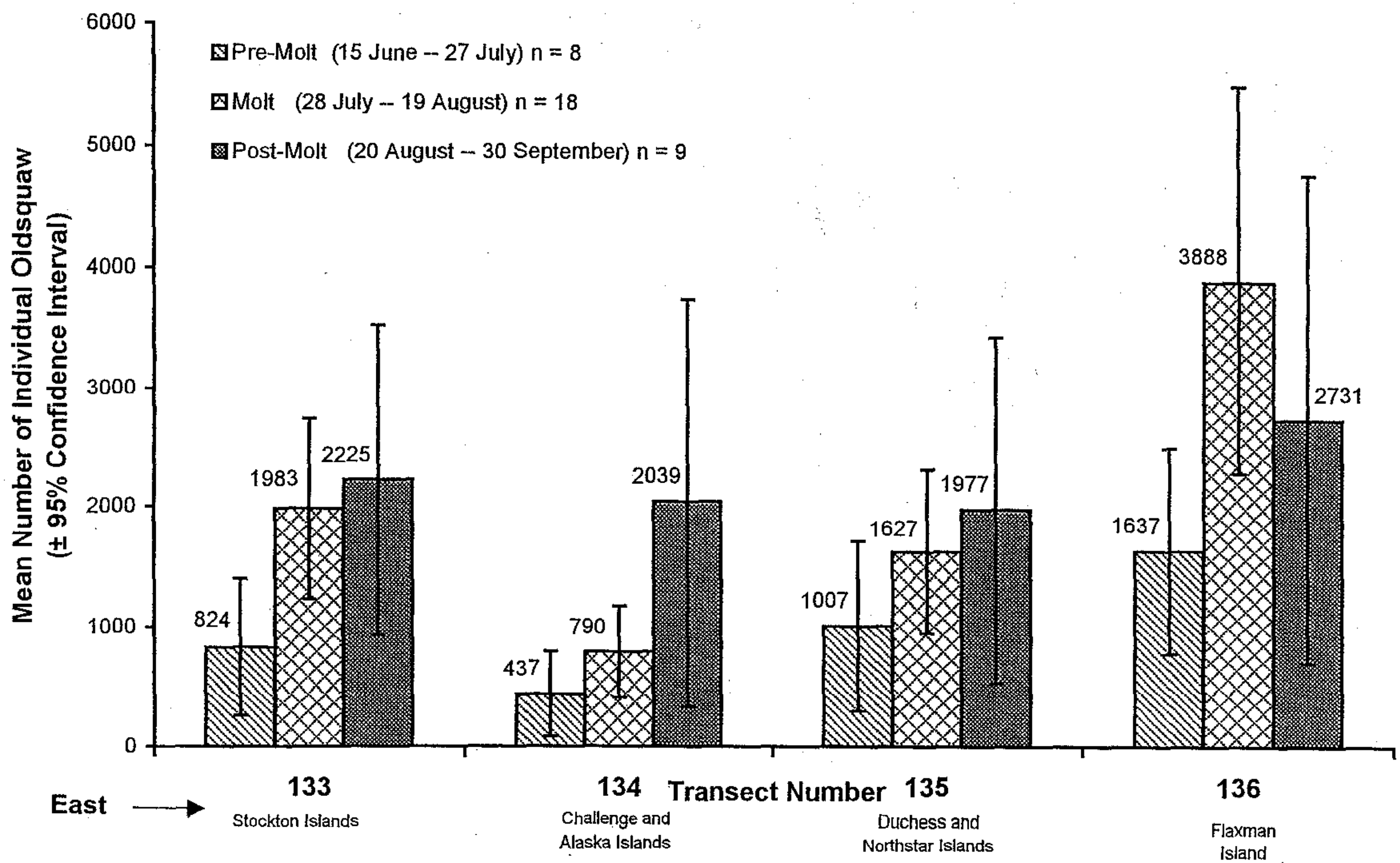


Figure 26. Mean number of oldsquaw for barrier island transects in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 1977 to 1991 (Johnson and Gazey 1992) and 1998.

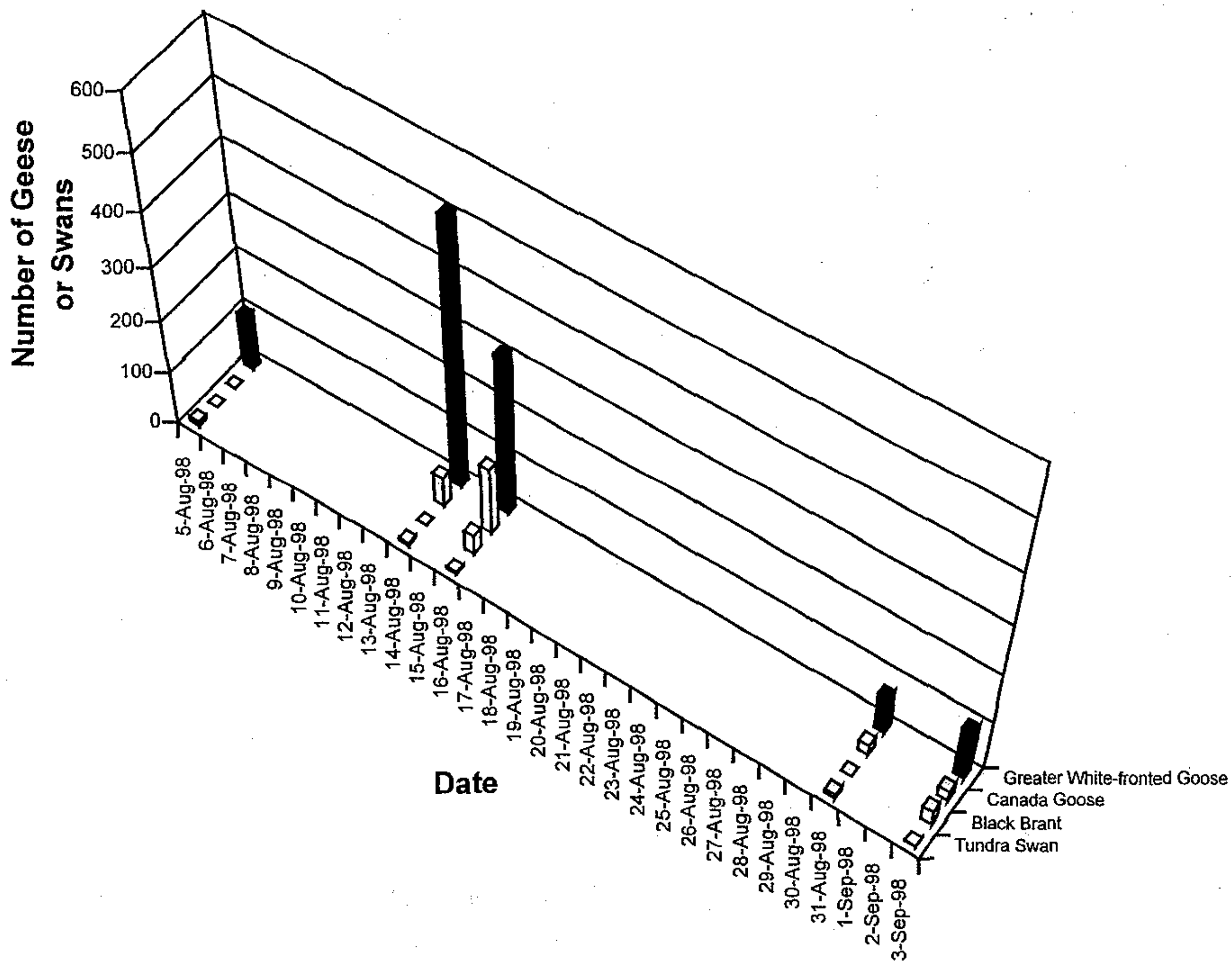


Figure 27. Total number of geese and swans observed both on-transect and off-transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

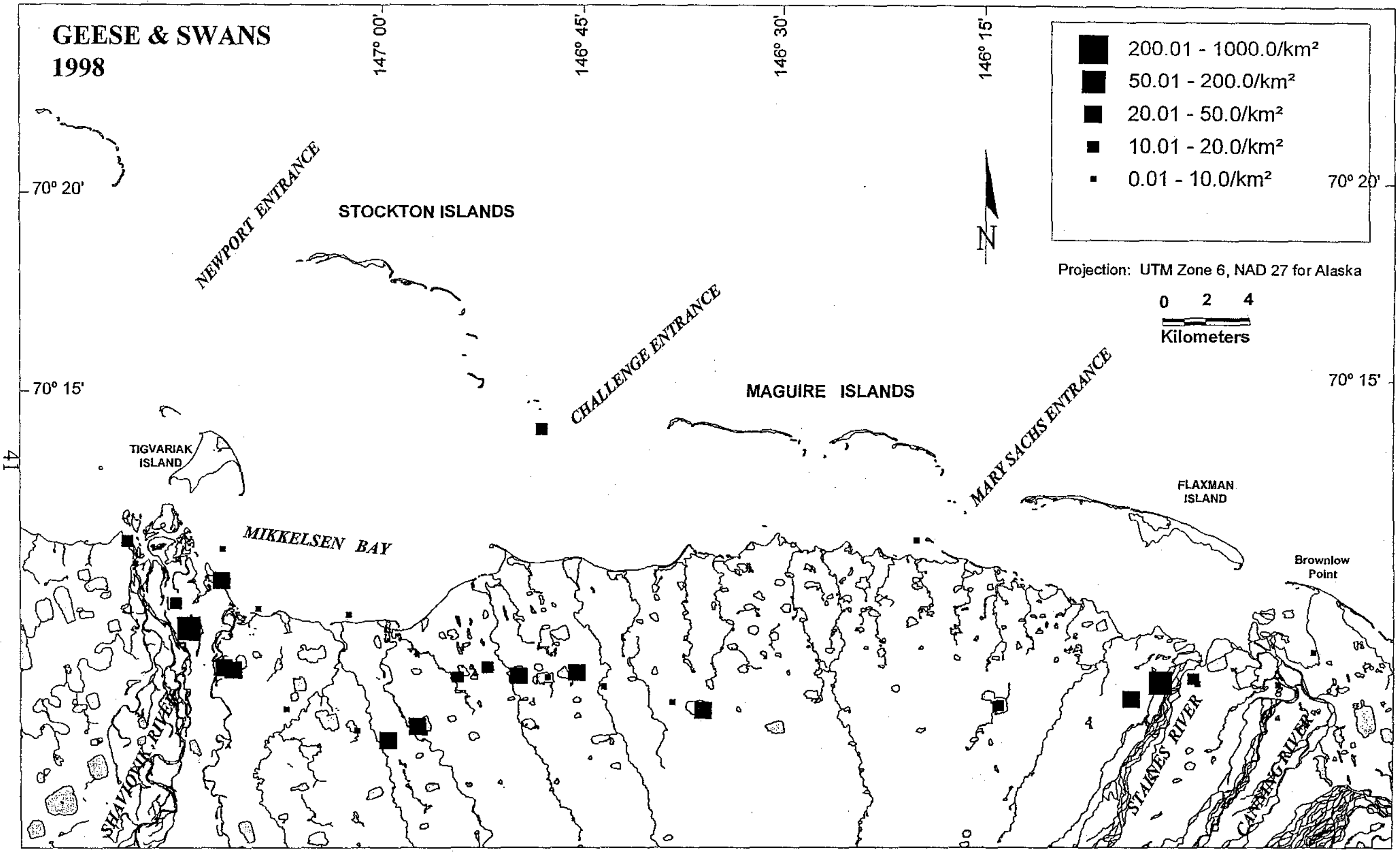


Figure 28. Summary of density of geese and swans for 30-second time period segments in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

Table 1. Summary of weather and lagoon conditions during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| Survey Date | Start Time (ADST) | Survey Duration (minutes) | Air Temperature (°C) | Wind Speed (knots) | Wind Direction | Cloud Cover (tenths) | Wave Height (inches) | Sea State (Beaufort Scale) | Front Right Observer | Rear Left Observer |
|---|---|---|---|---|---|---|---|---|---|---|
| 05-Aug-98 | 14:11:52 | 81.95 | 7 to 9 | 12 to 20 | NE | 7 to 10 | 6 to 18 | 2 to 3 | Tammy Olson | Lynn Noel |
| 14-Aug-98 | 14:47:54 | 80.71 | 15 | 1 to 10 | W | 3 to 6 | 5 to 8 | 1 to 3 | Isaac Helmericks | Tammy Olson |
| 16-Aug-98 | 13:26:20 | 79.84 | 7 | 18 to 22 | WSW | 7 to 9 | 8 to 12 | 1 to 2 | Isaac Helmericks | Tammy Olson |
| 31-Aug-98 | 14:29:23 | 80.50 | 7 | 20 to 25 | NE to ENE | 4 to 10 | | 3 | Isaac Helmericks | Tammy Olson |
| 03-Sep-98 | 14:53:24 | 77.85 | | 6 | NNW | 7 to 10 | | 1 | Isaac Helmericks | Tammy Olson |

Table 2. Observations of vessel traffic during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| Survey Date | Transect Number | Time Period Number | Observer | Time | Numeric Species Code | Species Code | Description | Number of Craft | Repeat? | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| 05-Aug-98 | 193 | 13 | Steve Johnson | 14:59:21 | 8002.0 | MBOAT | Medium Boat 20 to 35 feet | 3 | | Two boats and a barge. |
| 14-Aug-98 | 133 | 10 | Lynn Noel | 14:52:45 | 8001.0 | BOAT | Small Boat <20 feet | 1 | | Across from boat, not seismic. |
| 14-Aug-98 | 181 | 1 | Lynn Noel | 15:12:35 | 8001.0 | BOAT | Small Boat <20 feet | 2 | | Two boats just off barrier islands. |
| 14-Aug-98 | 182 | 1 | Lynn Noel | 15:17:22 | 8005.0 | HELICO | Helicopter | 1 | | Helicopter on barrier island. |
| 16-Aug-98 | 135 | 2 | Lynn Noel | 13:36:10 | 8003.0 | SEISMC | Seismic Ship | 3 | | |
| 16-Aug-98 | 135 | 8 | Lynn Noel | 13:39:29 | 8001.0 | BOAT | Small Boat <20 feet | 1 | Yes | Another boat, green. |
| 16-Aug-98 | 180 | 11 | Lynn Noel | 13:50:38 | 8001.0 | BOAT | Small Boat <20 feet | 1 | Yes | Just south of green boat. |
| 16-Aug-98 | 181 | 1 | Lynn Noel | 13:51:18 | 8003.0 | SEISMC | Seismic Ship | 1 | | Seismic boat? across from us. |
| 16-Aug-98 | 135 | 7 | Tammy Olson | 13:39:07 | 8001.0 | BOAT | Small Boat <20 feet | 1 | Yes | |
| 03-Sep-98 | 134 | 1 | Tammy Olson | 14:59:04 | 8006.0 | PLANE | Airplane | 1 | | Plane flying over open water. |

Table 3. Total number of bird sightings and individuals seen on- and off-transect for both tundra and lagoon transects (total length = 1229.9 km) during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| Species Code | Species Name | Number of Sightings | Percent of Sightings | Number of Individuals | Percent of Individuals | Percent of Classified within Group |
|---|---|---|---|---|---|---|
| COLO | Common Loon (*Gavia immer*) | 2 | 0.2 | 2 | 0.0 | 2.3 |
| PALO | Pacific Loon (*Gavia pacifica*) | 25 | 1.9 | 33 | 0.1 | 38.4 |
| RTLO | Red-throated Loon (*Gavia stellata*) | 25 | 1.9 | 44 | 0.1 | 51.2 |
| YBLO | Yellow-billed Loon (*Gavia adamsii*) | 3 | 0.2 | 7 | 0.0 | 8.1 |
| LOON | Loon Species (*Gavia* spp.) | 13 | 1.0 | 19 | 0.0 | |
| **Loons** | | **68** | **5.1** | **105** | **0.2** | |
| PAJA | Parasitic Jaeger (*Stercorarius parasiticus*) | 2 | 0.2 | 3 | 0.0 | 60 |
| PAJD | Parasitic Jaeger-Dark Phase (*S. parasiticus*) | 2 | 0.2 | 2 | 0.0 | 40 |
| JAEG | Jaeger Species (*Stercorarius* spp.) | 1 | 0.1 | 1 | 0.0 | |
| **Jaegers** | | **5** | **0.4** | **6** | **0.0** | |
| GLGU | Glaucous Gull (*Larus hyperboreus*) | 87 | 6.6 | 281 | 0.6 | |
| GULL | Gull Species (*Larus* spp.) | 51 | 3.9 | 171 | 0.3 | |
| **Gulls** | | **138** | **10.4** | **452** | **0.9** | |
| ARTE | Arctic Tern (*Sterna paradisaea*) | 1 | 0.1 | 1 | 0.0 | |
| **SEABIRDS (Jaegers, Gulls and Terns)** | | **144** | **10.9** | **459** | **0.9** | |
| COEI | Common Eider (*Somateria mollissima v-nigra*) | 111 | 8.4 | 894 | 1.8 | 96.4 |
| KIEI | King Eider (*Somateria spectabilis*) | 9 | 0.7 | 33 | 0.1 | 3.6 |
| EIDE | Eider Species (*Somateria* spp.) | 20 | 1.5 | 76 | 0.2 | |
| **Eiders** | | **140** | **10.6** | **1003** | **2.0** | |
| SUSC | Surf Scoter (*Melanitta perspicillata*) | 37 | 2.8 | 1708 | 3.4 | 84.5 |
| WWSC | White-winged Scoter (*Melanitta fusca*) | 10 | 0.8 | 242 | 0.5 | 12.0 |
| BLSC | Black Scoter (*Melanitta nigra*) | 22 | 1.7 | 72 | 0.1 | 3.6 |
| SCOT | Scoter Species (*Melanitta* spp.) | 32 | 2.4 | 659 | 1.3 | |
| **Scoters** | | **101** | **7.6** | **2681** | **5.3** | |
| OLSQ | Oldsquaw (*Clangula hyemalis*) | 732 | 55.4 | 43759 | 86.5 | |
| RBME | Red-breasted Merganser (*Mergus serrator*) | 8 | 0.6 | 165 | 0.3 | |
| NOPI | Northern Pintail (*Anas acuta*) | 9 | 0.7 | 77 | 0.2 | |
| DUCK | Duck Species (*Anas* spp.) | 1 | 0.1 | 9 | 0.0 | |
| **DUCKS** | | **991** | **75.0** | **47694** | **94.3** | |
| BRAN | Black Brant (*Branta bernicla*) | 2 | 0.2 | 60 | 0.1 | 4.2 |
| CAGO | Canada Goose (*Branta canadensis*) | 9 | 0.7 | 233 | 0.5 | 16.5 |
| GWFG | Greater White-fronted Goose (*Anser albifrons*) | 39 | 3.0 | 1096 | 2.2 | 77.5 |
| TUSW | Tundra Swan (*Cygnus columbianus*) | 9 | 0.7 | 26 | 0.1 | 1.8 |
| **Geese & Swans** | | **59** | **4.5** | **1415** | **2.8** | |
| WATE | Waterfowl | 30 | 2.3 | 666 | 1.3 | |
| **WATERFOWL (Ducks, Geese & Swans)** | | **1080** | **81.7** | **49775** | **98.4** | |
| BBPL | Black-bellied Plover (*Pluvialis squatarola*) | 4 | 0.3 | 7 | 0.0 | |
| SMSH | Small Shorebirds | 2 | 0.2 | 65 | 0.1 | |
| SHOR | Shorebird | 4 | 0.3 | 109 | 0.2 | |
| **SHOREBIRDS** | | **10** | **0.8** | **181** | **0.4** | |
| NOHA | Northern Harrier (*Circus cyaneus*) | 1 | 0.1 | 1 | 0.0 | |
| RLHA | Routh-legged Hawk (*Buteo lagopus*) | 1 | 0.1 | 2 | 0.0 | |
| SEOW | Short-eared Owl (*Asio flammeus*) | 1 | 0.1 | 2 | 0.0 | |
| **RAPTORS** | | **3** | **0.2** | **5** | **0.0** | |
| BIRD | Bird Species | 17 | 1.3 | 45 | 0.1 | |
| **BIRDS** | | **1322** | | **50570** | | |

Table 4. Mean bird densities for 4 tundra transects (total area = 124.65 km$^2$) during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| Species Code | Species Name | Mean Density (Birds/km$^2$) | Number of Records | Standard Deviation |
|---|---|---|---|---|
| COLO | Common Loon (*Gavia immer*) | 0.01 | 20 | 0.03 |
| PALO | Pacific Loon (*Gavia pacifica*) | 0.15 | 20 | 0.23 |
| RTLO | Red-throated Loon (*Gavia stellata*) | 0.10 | 20 | 0.25 |
| YBLO | Yellow-billed Loon (*Gavia adamsii*) | 0.00 | 20 | 0.00 |
| LOON | Loon Species (*Gavia* spp.) | 0.08 | 20 | 0.15 |
| **LOONS** | | **0.34** | **20** | **0.40** |
| PAJA | Parasitic Jaeger (*Stercorarius parasiticus*) | 0.02 | 20 | 0.06 |
| JAEG | Jaeger Species (*Stercorarius* spp.) | 0.00 | 20 | 0.00 |
| **Jeagers** | | **0.02** | **20** | **0.06** |
| GLGU | Glaucous Gull (*Larus hyperboreus*) | 0.17 | 20 | 0.23 |
| GULL | Gull Species (*Larus* spp.) | 0.05 | 20 | 0.15 |
| **Gulls** | | **0.22** | **20** | **0.32** |
| ARTE | Arctic Tern (*Sterna paradisaea*) | 0.00 | 20 | 0.00 |
| **SEABIRDS (Jaegers, Gulls, and Terns)** | | **0.24** | **20** | **0.38** |
| COEI | Common Eider (*Somateria mollissima v-nigra*) | 0.00 | 20 | 0.00 |
| KIEI | King Eider (*Somateria spectabilis*) | 0.08 | 20 | 0.27 |
| EIDE | Eider Species (*Somateria* spp.) | 0.02 | 20 | 0.08 |
| **Eiders** | | **0.10** | **20** | **0.31** |
| SUSC | Surf Scoter (*Melanitta perspicillata*) | 0.00 | 20 | 0.00 |
| WWSC | White-winged Scoter (*Melanitta fusca*) | 0.00 | 20 | 0.00 |
| BLSC | Black Scoter (*Melanitta nigra*) | 0.04 | 20 | 0.19 |
| SCOT | Scoter Species (*Melanitta* spp.) | 0.00 | 20 | 0.00 |
| **Scoters** | | **0.04** | **20** | **0.19** |
| OLSQ | Oldsquaw (*Clangula hyemalis*) | 0.75 | 20 | 2.36 |
| RBME | Red-breasted Merganser (*Mergus serrator*) | 0.06 | 20 | 0.27 |
| NOPI | Northern Pintail (*Anas acuta*) | 0.06 | 20 | 0.16 |
| DUCK | Duck Species (*Anas* spp.) | 0.00 | 20 | 0.00 |
| **DUCKS** | | **1.01** | **20** | **2.30** |
| BRAN | Black Brant (*Branta bernicla*) | 0.00 | 20 | 0.00 |
| CAGO | Canada Goose (*Branta canadensis*) | 1.62 | 20 | 3.39 |
| GWFG | Greater White-fronted Goose (*Anser albifrons*) | 5.79 | 20 | 7.51 |
| TUSW | Tundra Swan (*Cygnus columbianus*) | 0.11 | 20 | 0.22 |
| **Geese & Swans** | | **7.52** | **20** | **8.59** |
| WATE | Waterfowl Species | 0.07 | 20 | 0.20 |
| **WATERFOWL (Ducks, Geese & Swans)** | | **8.60** | 20 | **11.10** |
| **RAPTORS** | | **0.04** | **20** | **0.14** |
| BIRD | Bird Species | 0.00 | 20 | 0.00 |
| **BIRDS** | | **9.32** | **20.0** | **8.62** |

Table 5. Mean bird densities for 12 lagoon transects (total area = 365.82 km$^2$) during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| Species Code | Species Name | Mean Density (Birds/km$^2$) | Number of Records | Standard Deviation |
|---|---|---|---|---|
| COLO | Common Loon (*Gavia immer*) | 0.00 | 60 | 0.02 |
| PALO | Pacific Loon (*Gavia pacifica*) | 0.04 | 60 | 0.10 |
| RTLO | Red-throated Loon (*Gavia stellata*) | 0.08 | 60 | 0.20 |
| YBLO | Yellow-billed Loon (*Gavia adamsii*) | 0.02 | 60 | 0.10 |
| LOON | Loon Species (*Gavia* spp.) | 0.01 | 60 | 0.05 |
| **LOONS** | | **0.14** | **60** | **0.25** |
| PAJA | Parasitic Jaeger (*Stercorarius parasiticus*) | 0.01 | 60 | 0.04 |
| JAEG | Jaeger Species (*Stercorarius* spp.) | 0.00 | 60 | 0.02 |
| **Jeagers** | | **0.01** | **60** | **0.04** |
| GLGU | Glaucous Gull (*Larus hyperboreus*) | 0.60 | 60 | 1.30 |
| GULL | Gull Species (*Larus* spp.) | 0.41 | 60 | 1.49 |
| **Gulls** | | **1.00** | **60** | **1.98** |
| ARTE | Arctic Tern (*Sterna paradisaea*) | 0.00 | 60 | 0.02 |
| **SEABIRDS (Jaegers, Gulls, and Terns)** | | **1.01** | 60 | **2.05** |
| COEI | Common Eider (*Somateria mollissima v-nigra*) | 2.21 | 60 | 3.81 |
| KIEI | King Eider (*Somateria spectabilis*) | 0.06 | 60 | 0.31 |
| EIDE | Eider Species (*Somateria* spp.) | 0.20 | 60 | 0.73 |
| **Eiders** | | **2.47** | **60** | **4.02** |
| SUSC | Surf Scoter (*Melanitta perspicillata*) | 5.39 | 60 | 25.88 |
| WWSC | White-winged Scoter (*Melanitta fusca*) | 0.78 | 60 | 5.63 |
| BLSC | Black Scoter (*Melanitta nigra*) | 0.16 | 60 | 0.63 |
| SCOT | Scoter Species (*Melanitta* spp.) | 1.90 | 60 | 9.65 |
| **Scoters** | | **8.22** | **60** | **37.64** |
| OLSQ | Oldsquaw (*Clangula hyemalis*) | 110.37 | 60 | 145.95 |
| RBME | Red-breasted Merganser (*Mergus serrator*) | 0.42 | 60 | 2.52 |
| NOPI | Northern Pintail (*Anas acuta*) | 0.17 | 60 | 0.69 |
| DUCK | Duck Species (*Anas* spp.) | 0.00 | 60 | 0.00 |
| **DUCKS** | | **121.64** | **60** | **155.09** |
| BRAN | Black Brant (*Branta bernicla*) | 0.14 | 60 | 0.78 |
| CAGO | Canada Goose (*Branta canadensis*) | 0.03 | 60 | 0.24 |
| GWFG | Greater White-fronted Goose (*Anser albifrons*) | 0.03 | 60 | 0.19 |
| TUSW | Tundra Swan (*Cygnus columbianus*) | 0.02 | 60 | 0.11 |
| **GEESE & SWANS** | | **0.23** | **60** | **1.33** |
| WATE | Waterfowl Species | 0.17 | 60 | 0.74 |
| **WATERFOWL (Ducks, Geese & Swans)** | | **122.04** | **60** | **157.16** |
| **RAPTORS** | | **0.00** | **60** | **0.00** |
| BIRD | Bird Species | 0.03 | 60 | 0.16 |
| **BIRDS** | | **123.63** | **60.0** | **154.69** |

Table 6. Habitat associations of loons during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | | Common Loon | | 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 | Number of Sightings | Percent of Total |
| **Nearshore Sea (13)** | Lagoon (09) | 1 | 50.0 | 12 | 48.0 | 18 | 72.0 | 3 | 100 |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Island (11) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | - | - | - | - | - | - | - | - |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Shoreline Land (14) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | - | - | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | - | - | 3 | 12.0 | - | - | - | - |
| | Unclass Tundra (19) | - | - | 1 | 4.0 | - | - | - | - |
| | Coastal Marsh (20) | - | - | - | - | - | - | - | - |
| | Dry Tundra (23) | - | - | - | - | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| | Lake Shore (44) | - | - | - | - | - | - | - | - |
| | Pond (47) | - | - | 1 | 4.0 | 2 | 8.0 | - | - |
| | Small Lake (48) | 1 | 50.0 | 2 | 8.0 | 3 | 12.0 | - | - |
| | Large Lake (49) | - | - | 6 | 24.0 | 1 | 4.0 | - | - |
| | River (54) | - | - | - | - | - | - | - | - |
| | Stream (55) | - | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | - | - | - | - | - | - |
| | Pingo (81) | - | - | - | - | 1 | 4.0 | - | - |
| **All Habitats** | | **2** | **100** | **25** | **100** | **25** | **100** | **3** | **100** |

Table 7. Habitat associations of seabirds during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | | Parasitic Jaeger | | Glaucous Gull | | Gull | | Arctic Tern | |
|---|---|---|---|---|---|---|---|---|---|
| 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 |
| **Nearshore Sea (13)** | Lagoon (09) | 1 | 25.0 | 37 | 50.7 | 31 | 62.0 | 1 | 100.0 |
| | Spit (10) | - | - | 1 | 1.4 | - | - | - | - |
| | Island (11) | - | - | 14 | 19.2 | 9 | 18.0 | - | - |
| | Shoreline Water (15) | - | - | - | - | 4 | 8.0 | - | - |
| | Mudflat (41) | - | - | 4 | 5.5 | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | - | - | - | - | - | - | - | - |
| | Spit (10) | - | - | 3 | 4.1 | - | - | - | - |
| | Shoreline Land (14) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | 1 | 1.4 | - | - | - | - |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | 1 | 1.4 | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | 1 | 25.0 | 4 | 5.5 | 3 | 6.0 | - | - |
| | Unclass Tundra (19) | 2 | 50.0 | - | - | 2 | 4.0 | - | - |
| | Coastal Marsh (20) | - | - | - | - | - | - | - | - |
| | Dry Tundra (23) | - | - | - | - | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | 4 | 5.5 | - | - | - | - |
| | Lake Shore (44) | - | - | 1 | 1.4 | - | - | - | - |
| | Pond (47) | - | - | 1 | 1.4 | 1 | 2.0 | - | - |
| | Small Lake (48) | - | - | - | - | - | - | - | - |
| | Large Lake (49) | - | - | - | - | - | - | - | - |
| | River (54) | - | - | 1 | 1.4 | - | - | - | - |
| | Stream (55) | - | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | 1 | 1.4 | - | - | - | - |
| | Pingo (81) | - | - | - | - | - | - | - | - |
| **All Habitats** | | **4** | **100** | **73** | **100** | **50** | **100** | **1** | **100** |

Table 8. Habitat associations of eiders during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | | 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 |
| **Nearshore Sea (13)** | Lagoon (09) | 96 | 88.9 | 7 | 77.8 | 19 | 95.0 | 122 | 89.1 |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Island (11) | 3 | 2.8 | - | - | - | - | 3 | 2.2 |
| | Shoreline Water (15) | 1 | 0.9 | - | - | - | - | 1 | 0.7 |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | 1 | 0.9 | - | - | - | - | 1 | 0.7 |
| | Spit (10) | 6 | 5.6 | - | - | - | - | 6 | 4.4 |
| | Shoreline Land (14) | 1 | 0.9 | - | - | - | - | 1 | 0.7 |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | 1 | 11.1 | - | - | 1 | 0.7 |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | - | - | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | - | - | - | - | 1 | 5.0 | 1 | 0.7 |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Coastal Marsh (20) | - | - | - | - | - | - | - | - |
| | Dry Tundra (23) | - | - | - | - | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| | Lake Shore (44) | - | - | 1 | 11.1 | - | - | 1 | 0.7 |
| | Pond (47) | - | - | - | - | - | - | - | - |
| | Small Lake (48) | - | - | - | - | - | - | - | - |
| | Large Lake (49) | - | - | - | - | - | - | - | - |
| | River (54) | - | - | - | - | - | - | - | - |
| | Stream (55) | - | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | - | - | - | - | - | - |
| | Pingo (81) | - | - | - | - | - | - | - | - |
| **All Habitats** | | **108** | **100** | **9** | **100** | **20** | **100** | **137** | **100** |

Table 9. Habitat associations of scoters during 5 aerial surveys in the barrier-island lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | | 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 |
| **Nearshore Sea (13)** | Lagoon (09) | 36 | 100.0 | 10 | 100.0 | 21 | 95.5 | 99 | 99.0 |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Island (11) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | - | - | - | - | - | - | - | - |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Shoreline Land (14) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | - | - | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Coastal Marsh (20) | - | - | - | - | - | - | - | - |
| | Dry Tundra (23) | - | - | - | - | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| | Lake Shore (44) | - | - | - | - | - | - | - | - |
| | Pond (47) | - | - | - | - | - | - | - | - |
| | Small Lake (48) | - | - | - | - | - | - | - | - |
| | Large Lake (49) | - | - | - | - | - | - | - | - |
| | River (54) | - | - | - | - | 1 | 4.5 | 1 | 1.0 |
| | Stream (55) | - | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | - | - | - | - | - | - |
| | Pingo (81) | - | - | - | - | - | - | - | - |
| **All Habitats** | | **36** | **100** | **10** | **100** | **22** | **100** | **100** | **100** |

Table 10. Oldsquaw density (number of individuals/km$^2$) by transect during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | Transect Numbers | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Barrier Islands | | | | Mid-Lagoon | | | | Mainland Shore | | | | Tundra | |
| Date | 133 | 134 | 135 | 136 | 180 | 181 | 182 | 183 | 190 | 191 | 192 | 193 | 500 | 501 |
| **Molt** (28 July -- 19 August) | | | | | | | | | | | | | | |
| 05-Aug-98 | 14.8 | 50.4 | 88.2 | 299.7 | 8.1 | 9.1 | 0.0 | 0.0 | 123.0 | 87.4 | 85.0 | 0.6 | 0.0 | 0.0 |
| 14-Aug-98 | 110.6 | 163.2 | 253.3 | 247.7 | 17.4 | 0.0 | 0.0 | 0.0 | 173.2 | 333.9 | 200.9 | 20.8 | 0.0 | 0.0 |
| 16-Aug-98 | 389.6 | 157.9 | 181.3 | 358.6 | 20.5 | 1.0 | 1.4 | 0.0 | 157.9 | 298.3 | 211.6 | 51.5 | 0.0 | 0.0 |
| Average Density | 171.7 | 123.8 | 174.2 | 302.0 | 15.3 | 3.4 | 1.4 | 0.0 | 151.4 | 239.9 | 165.8 | 24.3 | 0.0 | 0.0 |
| **Post-Molt** (20 August -- 30 September) | | | | | | | | | | | | | | |
| 31-Aug-98 | 106.6 | 1.3 | 34.6 | 173.8 | 0.7 | 1.9 | 30.4 | 0.0 | 4.7 | 28.4 | 35.3 | 17.0 | 0.0 | 5.8 |
| 03-Sep-98 | 813.7 | 193.3 | 271.4 | 41.6 | 8.8 | 61.7 | 401.6 | 1.9 | 36.9 | 118.8 | 87.9 | 33.7 | 0.0 | 9.1 |
| Average Density | 460.2 | 97.3 | 153.0 | 107.7 | 4.7 | 31.8 | 216.0 | 1.9 | 20.8 | 73.6 | 61.6 | 25.4 | 0.0 | 7.5 |

Table 11. Habitat associations of oldsquaw during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| General Habitat Type | Specific Habitat Type | Number of Sightings 5-Aug-98 | Number of Sightings 14-Aug-98 | Number of Sightings 16-Aug-98 | Number of Sightings 31-Aug-98 | Number of Sightings 3-Sep-98 | Total All Surveys | Percent of Total |
|---|---|---|---|---|---|---|---|---|
| **Nearshore Sea (13)** | Lagoon (09) | 82 | 111 | 121 | 95 | 271 | 680 | 94.3 |
| | Spit (10) | 1 | - | 7 | - | - | 8 | 1.1 |
| | Island (11) | 1 | - | 2 | 2 | 6 | 11 | 1.5 |
| | Shoreline Water (15) | - | - | - | - | 1 | 1 | 0.1 |
| | Mudflat (41) | - | - | - | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | - | 7 | 5 | - | - | 12 | 1.7 |
| | Spit (10) | - | - | - | 5 | - | 5 | 0.7 |
| | Shoreline Land (14) | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | 1 | - | 1 | 0.1 |
| | Unclass Tundra (19) | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | - | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | - | - | 1 | - | - | 1 | 0.1 |
| | Unclass Tundra (19) | - | - | - | - | - | - | - |
| | Coastal Marsh (20) | - | - | - | - | - | - | - |
| | Dry Tundra (23) | - | - | - | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - |
| | Lake Shore (44) | - | - | - | - | - | - | - |
| | Pond (47) | - | - | - | - | - | - | - |
| | Small Lake (48) | - | - | - | - | - | - | - |
| | Large Lake (49) | - | - | - | 1 | 1 | 2 | 0.3 |
| | River (54) | - | - | - | - | - | - | - |
| | Stream (55) | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | - | - | - | - | - |
| | Pingo (81) | - | - | - | - | - | - | - |
| **All Habitats** | | **84** | **118** | **136** | **104** | **279** | **721** | **100** |

Table 12. Habitat associations of geese and swans during 5 aerial surveys in the barrier island-lagoon system between the Stockton Islands and Flaxman Island, Alaska, 5 August to 3 September 1998.

| | | 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 |
| **Nearshore Sea (13)** | Lagoon (09) | 1 | 50.0 | - | - | 2 | 5.1 | 1 | 11.1 |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Island (11) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Mainland Coast (27)** | Lagoonward Beach along Mainland (61) | 1 | 50.0 | - | - | - | - | 1 | 11.1 |
| | Spit (10) | - | - | - | - | - | - | - | - |
| | Shoreline Land (14) | - | - | - | - | - | - | - | - |
| | Shoreline Water (15) | - | - | - | - | - | - | - | - |
| | Unclass Tundra (19) | - | - | 1 | 11.1 | - | - | - | - |
| | Mudflat (41) | - | - | - | - | - | - | - | - |
| **River Delta (92)** | Mudflat (41) | - | - | - | - | - | - | - | - |
| **Large Lake (49)** | Island (11) | - | - | - | - | - | - | - | - |
| **Wet Tundra (25)** | Pond or Lake (18) | - | - | 6 | 66.7 | 25 | 64.1 | 3 | 33.3 |
| | Unclass Tundra (19) | - | - | - | - | - | - | - | - |
| | Coastal Marsh (20) | - | - | - | - | 1 | 2.6 | - | - |
| | Dry Tundra (23) | - | - | 1 | 11.1 | - | - | - | - |
| | Wet Tundra (25) | - | - | - | - | - | - | 1 | 11.1 |
| | Mudflat (41) | - | - | - | - | 1 | 2.6 | - | - |
| | Lake Shore (44) | - | - | 1 | 11.1 | 1 | 2.6 | 1 | 11.1 |
| | Pond (47) | - | - | - | - | 3 | 7.7 | 1 | 11.1 |
| | Small Lake (48) | - | - | - | - | 1 | 2.6 | 1 | 11.1 |
| | Large Lake (49) | - | - | - | - | 5 | 12.8 | - | - |
| | River (54) | - | - | - | - | - | - | - | - |
| | Stream (55) | - | - | - | - | - | - | - | - |
| | Sandbar (71) | - | - | - | - | - | - | - | - |
| | Pingo (81) | - | - | - | - | - | - | - | - |
| **All Habitats** | | **2** | **100** | **9** | **100** | **39** | **100** | **9** | **100** |