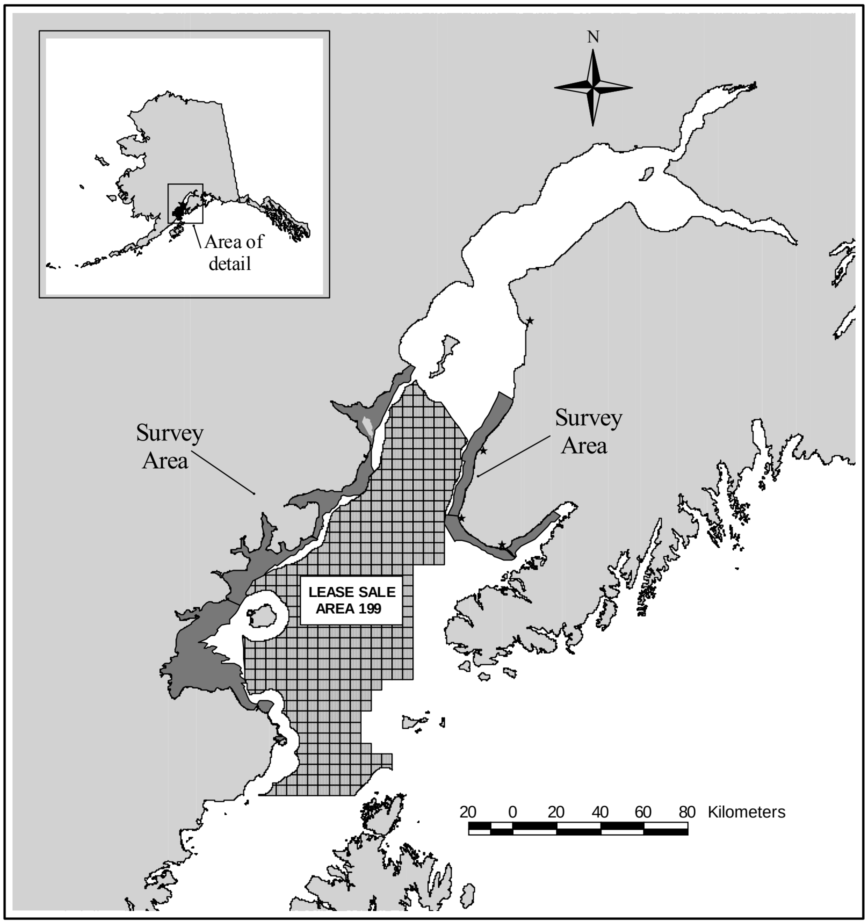
OCS Study
MMS 2006-066

Winter distribution and abundance of Steller's eiders (*Polysticta stelleri*) in Cook Inlet, Alaska 2004-2005



Prepared for
U.S. Department of Interior
Minerals Management Service
Alaska Outer Continental Shelf Region
Environmental Studies Section
3801 Centerpoint Drive, Suite 500
Anchorage, AK 99503-5823

OCS Study MMS 2006-066

FINAL REPORT

December 2006

Winter distribution and abundance of Steller's eiders (*Polysticta stelleri*) in Cook Inlet, Alaska 2004-2005

By
William W. Larned

U. S. Fish and Wildlife Service
1011 E. Tudor Road
Anchorage, AK 99503

Prepared for
U.S. Department of Interior
Minerals Management Service
Alaska Outer Continental Shelf Region
Environmental Studies Section
3801 Centerpoint Drive, Suite 500
Anchorage, AK 99503-5823

This study was funded, in part, by the US Department of the Interior, Minerals Management Service Alaska Outer Continental Shelf Region, Anchorage, Alaska Under Contract No. 0104RU34160, as part of the MMS Alaska Environmental Studies Program

PROJECT ORGANIZATION

William W. Larned, *USFWS, Soldotna, Alaska:*
Principal Investigator, lead pilot and aerial observer, data analyst, report compiler

Paul Anderson, *USFWS, Anchorage, Alaska :*
Pilot and aerial observer, logistics assistant

Christian Dau, Heather Wilson, Robert Platte, William Eldridge, Dennis Marks, *USFWS, Anchorage, Alaska: aerial observers*

Ed Mallek, *USFWS, Fairbanks, Alaska:*
Pilot and aerial observer

Julian Fischer, *USFWS, Anchorage, Alaska:*
Financial Data analyst and assistance with statistical analysis

Charles Monnett, PhD, *MMS, Anchorage, Alaska:*
Contracting Officer's Technical Representative and project Administrator (through summer 2004).

Jeffrey S. Gleason, PhD, *MMS, Anchorage, AK:*
Contracting Officer's Technical Representative and project Administrator (Summer 2004 through project's conclusion).

REPORT AVAILABILITY

U.S. Fish and Wildlife Service
Waterfowl Management Branch
1011 E. Tudor Rd.
Anchorage, AK 99503
Telephone: (907) 786-3443

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone (800) 553-6847

SUGGESTED CITATION

Larned, W. W. 2006. Winter distribution and abundance of Steller's eiders (*Polysticta stelleri*) in Cook Inlet, Alaska, 2004-2005. U.S. Fish and Wildlife Service, Waterfowl Management Branch, Anchorage, Alaska. OCS Study, MMS 2006-066. 37 pp.

ABSTRACT

The U.S. Department of Interior documented the spatial distribution and abundance estimates of Steller's eiders (*Polysticta stelleri*) wintering in Lower Cook Inlet, Alaska, 2004-05. The Alaska breeding population of Steller's eiders is listed as threatened under the Endangered Species Act (ESA). Objectives of this study were to document spatial and temporal patterns of use by wintering Steller's eiders in Cook Inlet which would provide the Minerals Management Service with information relative to the National Environmental Policy Act and Section 7 consultation of the ESA for future exploration and development of offshore oil and natural gas resources in the area. Observations were collected along fixed aerial transects, perpendicular to shorelines, extending from the shoreline to the nearest 20m depth contour with a 2km lateral spacing. Steller's eiders in flocks containing <20 birds were recorded within strips 600m in width. Densities were extrapolated from surveys to the entire survey area. Steller's eiders in flocks of ≥20 birds within the sampled area inside and outside the 600m strips were also recorded. Observations were assigned geographic coordinates via laptop computers equipped with a GPS-linked voice recording program. Replicate same-day surveys using a second aircraft were sometimes conducted. Surveys were accomplished monthly in March, April, and December, 2004, and from January – April, 2005. Largest monthly Steller's eider estimates were 1,247 and 4,200, in eastern and western survey areas, respectively, in January 2005. December estimates typically accounted for <50% of monthly peaks, and by April most birds had departed for Arctic breeding grounds. A pattern of use at wintering sites that was relatively consistent among months and years is described. Temporary departure from this pattern during mid-winter 2005 appeared related primarily to displacement of birds by sea ice. A preliminary conceptual model of Steller's eider distributional dynamics in Cook Inlet is described, based on historical data and results from this study.

KEY WORDS: Aerial survey, Alaska, Cook Inlet, distribution, *Polysticta stelleri*, sea duck, sea ice, Steller's eider

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The Pacific population of the Steller's eider (*Polysticta stelleri*) breeds in arctic Russia, arctic and sub arctic Alaska, and winters primarily in coastal waters of southwest Alaska (Fig. 1). Smaller numbers winter in Kamchatka and other areas in southeastern Russia. The Russian breeding population currently, and probably historically, represented $\geq$95% of the world population (Fredrickson 2001). The Alaska breeding population historically nested in the coastal fringe of the Yukon-Kuskokwim Delta and the western portion of the Arctic Coastal Plain (Kertell 1991, Fredrickson 2001, Quakenbush et al. 2002, USFWS 2002). The Alaska breeding Steller's eider population has shown recent declines in both abundance and geographical extent in both breeding areas recently, and therefore that population was listed as threatened in 1997 under the authority of the Endangered Species Act (ESA) (USFWS 2002).

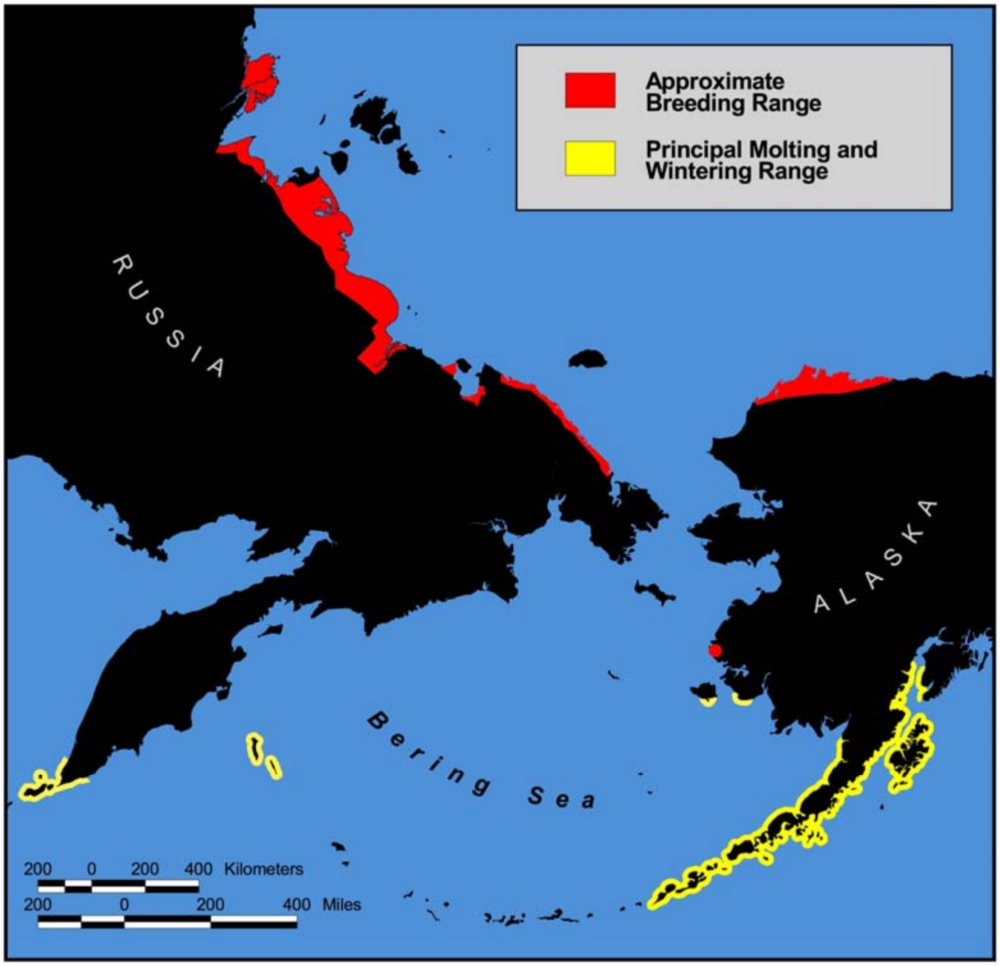


Figure 1. Distribution of the Pacific population of the Steller's eider (U. S. Fish and Wildlife Service 2002).

Any proposed federal action that may affect individuals or modify critical habitat of a listed species, and thus reduce the likelihood of survival of that species, must undergo interagency consultation (50 CFR 402.14). The winter range of the listed Alaska breeding population is poorly known, as is the temporal and geographic extent to which it intermixes with the unlisted Russian breeding population. Hence, all Steller's eiders in Alaska are treated as belonging to the listed population. Cook Inlet (CI) in south central Alaska is known to provide winter habitat for substantial numbers of Steller's eiders (Agler et al. 1995, USFWS 2002, Larned unpubl. data), so federal actions potentially affecting them or their habitat must undergo formal ESA consultation procedures.

The Minerals Management Service (MMS) has offered oil and gas leases in offshore waters (approximately 5-48km seaward of the state of Alaska submerged lands) of CI, so far with only limited interest in the offshore zone by the petroleum industry through May of 2006 (MMS 2003). Lease sale 199 (Fig. 2) is to be offered again in May of 2007, pending sufficient interest by industry. This study was designed by the U.S. Fish and Wildlife Service (FWS) to address MMS's obligation to evaluate potential effects of their action upon Steller's eiders, as required in the implementing regulations for Section 7(a)(2) of the ESA (50 CFR 402.14(i)(3)). Furthermore, this study partially fulfills MMS's obligations under section 7(a)(1) of the ESA and provides preliminary information useful for long-term monitoring.

Historical data

Few avian surveys were conducted in Lower CI before 1976. Since then, four major surveys have been completed in an effort to monitor seabird and sea duck (including Steller’s eiders) distribution and abundance in marine habitats in Lower CI. Arneson (1980) conducted comprehensive pelagic and shoreline aerial surveys in 1976-77 (once each season) in marine waters of southwestern Alaska including CI. Primary objectives were to describe seasonal distribution, abundance and habitat associations of 134 species of marine and coastal birds, to evaluate their vulnerability to potential oil spills associated with Outer Continental Shelf (OCS) oil and gas development. Most of these surveys did not provide detailed data on Steller’s eiders, but did identify habitats seasonally important to “sea ducks”, including major shoals and estuaries in Kachemak Bay, and along the west side of CI from Cape Douglas to Redoubt Bay (Erikson 1977). During these surveys only eight Steller’s eiders were specifically identified and recorded along the shoreline of Lower CI in spring 1976, and no Steller’s eiders were recorded during the other three seasons. No Steller’s eiders were reported from four seasonal pelagic surveys flown across CI during this project, or they were simply included as “sea ducks”, and no Steller's eiders or "unidentified eiders" were reported from within a large area covered in northwestern Kachemak Bay. However, during a survey flight recording marine mammals and marine birds in Kamishak Bay, 1 April, 1976, Erikson (1977) observed a density of 0.1 Steller’s eiders/km^2 , along with 2.7 unidentified eiders/km^2 and 6.1 unidentified sea ducks/km^2, which were "most likely eiders”.

Preparatory to anticipated OCS oil and gas leasing, Agler et al. (1995) conducted both aerial and boat surveys of coastal and pelagic habitats in Lower CI 9-16 February 1994, in which Steller’s eiders and other sea ducks were included. These surveys followed the study design used by Erikson (1977). During the aerial surveys, 442 Steller’s eiders were observed along the southwest and northwest shorelines of Kachemak Bay. In western CI, 1,363 Steller’s eiders were observed from McNeil Cove to Iniskin Bay. Eiders were also observed during pelagic boat surveys, but were not identified to species.

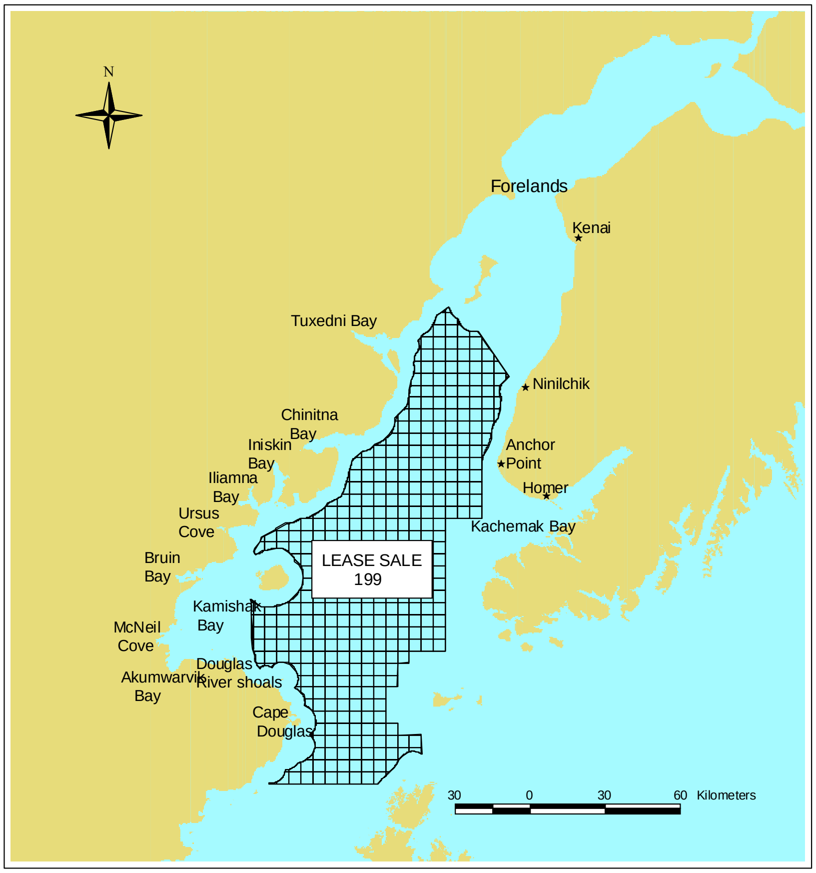


Figure 2. Cook Inlet, Alaska, showing MMS Lease Sale Area 199.

Aerial surveys were flown from 1994-96 by the National Park Service along the Lake Clark National Park shoreline, including Tuxedni and Chinitna Bays (Bennett 1996), to characterize seasonal use of coastal habitats by waterfowl. The surveys were conducted weekly from 15 April - 20 May and from 15 August - 15 October each year, as well as single monthly surveys from December through March. The survey revealed heavy use of these habitats by sea ducks (primarily scoters (*Melanitta spp.*) during spring, summer and fall, but few waterfowl were present during winter, presumably because much of the area was covered with sea ice. No Steller's eiders were reported from any of these surveys.

A 5-year study (1999-2003) was conducted by the Alaska Department of Fish and Game (ADFG) to determine abundance and population trends of sea ducks wintering in Kachemak Bay in response to reported declines of some species (Petrula and Rosenberg 2005). Small boat surveys were conducted from late February through early March along shorelines in addition to random offshore aerial transects stratified by 3 water depth ranges. The 5-year mean Steller's eider estimate from shoreline boat surveys was 63 eiders (range 16-161), while the mean from offshore aerial surveys was 649 eiders (range 165-1,459). Ninety-five percent of the Steller's eiders observed were shoreward of the 20m depth contour and most were clustered in two locations; south of Anchor Point at the mouth of Kachemak bay, and south of Homer immediately southwest of Homer Spit.

Four opportunistic shoreline aerial surveys have also been conducted during February and March 1997 – 2002 from the mouth of Kachemak Bay north to Kenai (W. Larned, U.S. Fish and Wildlife Service, unpubl. data). Clusters of flocks of Steller's eiders were observed on each of these occasions, in locations ranging from Anchor Point to 15km north of Ninilchik, most within 2km of shore. Estimates of eiders observed ranged from 252 (2 Feb. 2002) to 2,370 (5 Mar. 2001).

Finally, The U. S. Army Corps of Engineers conducted a series of eight small boat surveys along both sides of Homer Spit from December 2002 through March 2003. Steller's eider totals ranged from 71 to 301 with nearly all sightings occurring in the area immediately adjacent to the southwest shore of Homer Spit (C. Hoffman, U.S. Army Corps of Engineers, unpubl. data).

In summary, historical survey data for CI Steller's eiders are scarce, and the most geographically comprehensive data sets, from surveys which occurred prior to widespread concern about Steller's eider populations, are difficult to interpret because observations and results for eiders and other sea ducks were usually combined as "eiders" or "sea ducks" rather than identified to individual species. However, data from the most recent winter surveys suggested that there were from a few hundred to about 1,000 Steller's eiders in Kachemak Bay, primarily near the southwest side of the Homer Spit and south of Anchor Point. In addition, estimates in the low hundreds to >2,000 Steller's eiders may be found along the shoreline between Anchor River and Kenai, with an additional >1,000 birds inhabiting the nearshore waters of Kamishak Bay between McNeil Cove and Iniskin Bay.

OBJECTIVES

The following objectives of this study were determined by MMS:

1. Identify habitats important to Steller's eiders wintering in Lower CI, as evidenced by persistent use within and among years.
2. Describe temporal variation in Steller's eider winter use of the waters in Lower CI during two winters.
3. Estimate total numbers of Steller's eiders wintering in the eastern and western portions of Lower CI.

METHODS

Study area

Cook Inlet is a large estuary, approximately 320km in length and varying from 20 - 90km in width (Fig. 3). It is bordered by the volcanic Alaska Range to the west and northwest, the Aleutian Range to the southwest, and the Kenai/Chugach mountains to the east. For convenience, the main body of CI is often divided into north and south regions, called "Upper" and "Lower" CI, by a geographic constriction called the "Forelands", which lies just north of the city of Kenai. The subject study is limited to "Lower" CI.

Cook Inlet is a dynamic, high energy marine system dominated by powerful tides and associated currents (Alaska Inst. of Marine Sci. 1999, Okkonen 2004). The twice-daily tide cycle can exceed 10m from low to high, and generates currents that can range from 8-12kts. at the Forelands (MMS 1984). These currents often amplify storm and wind-generated surface waves, especially when winds are along the long axis (northeast/southwest) of CI (Alaska Inst. of Marine Sci. 1999, MMS 2003).

Cook Inlet has extensive ice cover for several months during the winter in most years. Ice typically begins to form in November, particularly in shallow bays with salinities diluted by fresh water from rivers. Peak ice extent is in February and early March, and most ice is gone by mid-April (Mulherin et al. 2001). The dynamic tidal environment normally keeps ice broken into small pans, collectively known as "brash", which disperse southward due to net effect of currents, and generally melt before they leave CI. As a result the ice rarely gets very thick, and changes in pattern and extent can occur relatively quickly. Mean ice cover for the period 16-28 February 1986-99 incorporated all of the estuaries in western Lower CI, and extended over most of the shoals at least to Augustine Island (Fig. 4). Mean ice during this period extended north and west of a line roughly from Cape Douglas to 20km north of Ninilchik with a >25 percent probability (Fig. 5).

Figure 3. True color image of Cook Inlet acquired 2 September 2002 (Jacques Descloitres, MODIS Rapid Response Team, NASA/GSFC).

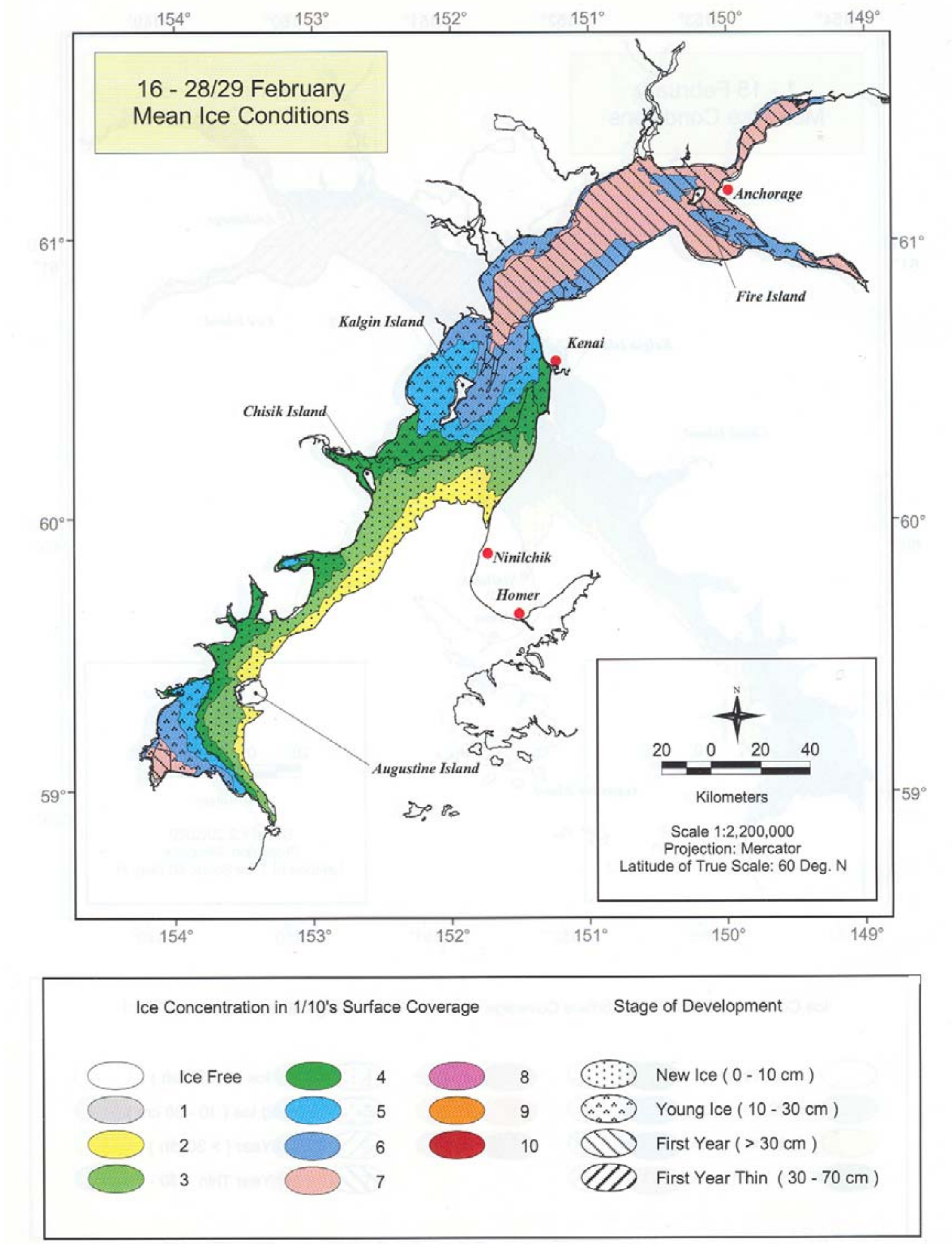


Figure 4. Mean ice conditions, Cook Inlet, Alaska, for the period 16-28 February 1986-99 (Mulherin et al. 2001).

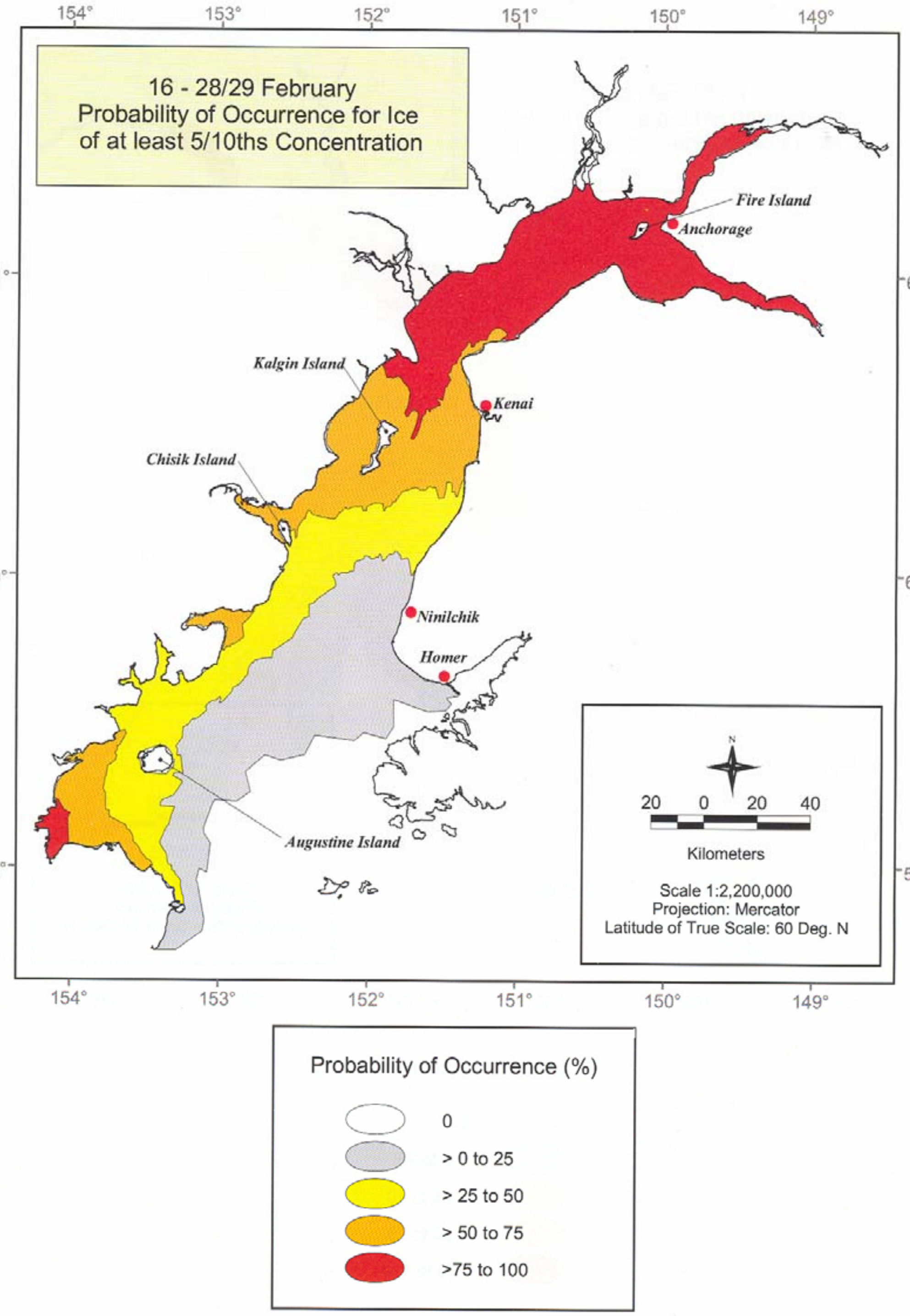


Figure 5. Probability of occurrence for ice of at least 5/10ths concentration, Cook Inlet, Alaska, for the period 16-28 February 1986-99 (Mulherin et al., 2001).

Equipment, transect layout and data recording

We used two Cessna 206 aircraft, equipped with amphibious floats and long range fuel tanks (>6.5 hour fuel duration at survey power settings). The survey was flown at 61m (200ft) altitude and approximately 185km/hr. The crew in each plane consisted of a FWS pilot/biologist who flew the plane and observed and recorded birds on the left (port) side of the aircraft, and a FWS biologist who observed and recorded on the right (starboard) side of the aircraft. Systematic parallel survey transects (flight lines on which survey data were recorded) at 2km intervals were oriented perpendicular to the shoreline to the nearest 20m depth contour (Fig. 6). Steller's eiders are typically associated with the nearshore environment, in protected waters generally <10m in depth (Cottam 1939, Hogstrom 1977, Petersen 1981, U. S. Fish and Wildl. Serv. 2002, Zydelis 2002). We selected the maximum survey depth of 20m as a practical buffer to ensure the inclusion of most eiders, including those that might be displaced seaward by shorefast ice. The perpendicular orientation of the transects was selected to minimize sampling error by crossing the average Steller's eider density gradient (Eberhardt 1978) which, through our survey experience we believed to be related primarily to water depth and distance from shore. This design also minimized transit time between adjacent transects, which reduced the possibility of counting errors resulting from birds moving among transects during the survey (compared with multiple transects parallel to shorelines). The survey area was split into eight alphanumeric-coded polygons ("survey units"); numbers 1E-3E on the east side of CI, and numbers 1W-5W on

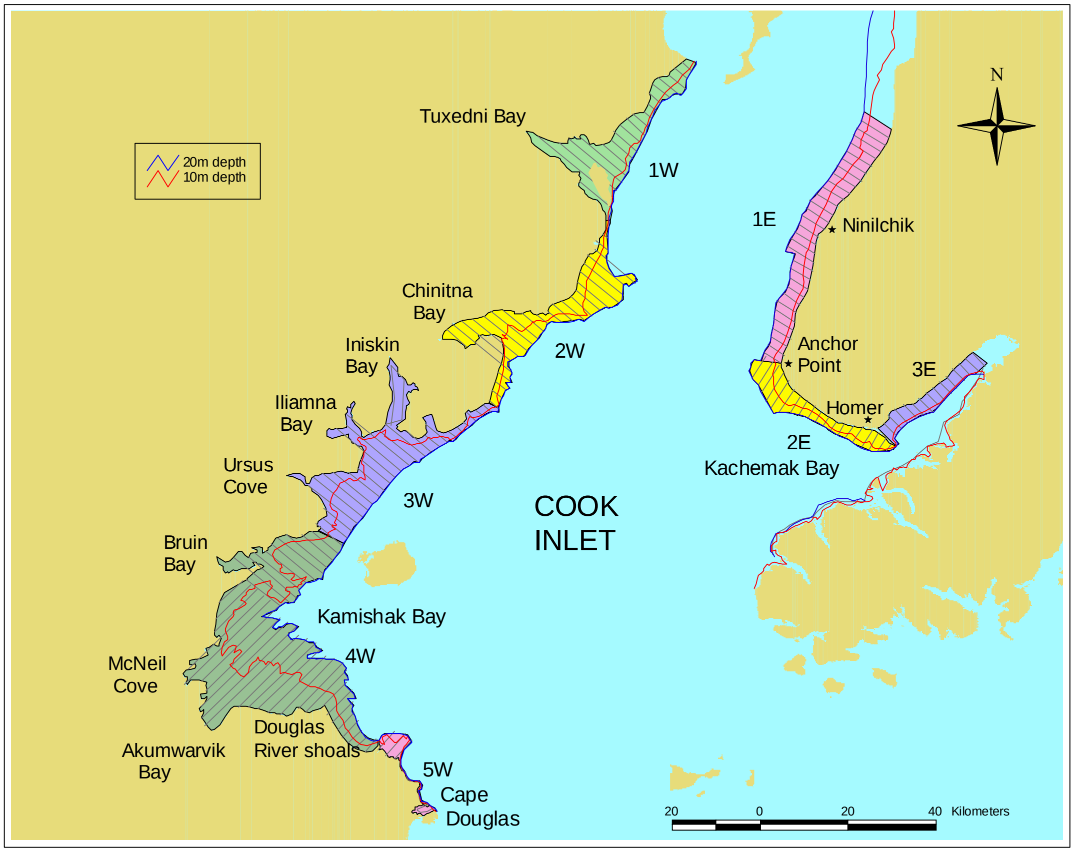


Figure 6. Study area showing survey units, aerial transects, bathymetry, and prominent shoreline features, Cook Inlet, Alaska, 2004-05.

the west side, which facilitated field operations and data summary. Borders between survey units were shoreline features we judged likely to cause natural breaks in wintering eider distribution. Aircraft were navigated along transects, which were displayed in a “moving map” on a laptop computer linked to an instrument-panel-mounted Global Positioning System (GPS), a survey aid developed by John Hodges (U. S. Fish and Wildlife Service, Juneau, Alaska). The recording program consisted of two modules. The first automatically recorded the aircraft GPS coordinates and current time (seconds past midnight) at 5-second intervals, and wrote each position as a line in a computer file in ASCII format. In the second module, each bird observation was recorded into the computer vocally via a microphone, and the program time-linked the current GPS coordinate to the voice recording (.wav file). Each observer used a separate computer for data input. The recorded observations were later transcribed using another custom program, resulting in an ASCII format output file in which each text line contained GPS coordinates, time, species and group size for one observation, plus "header" and auxiliary data (date, observer position in the aircraft, observer initials, survey unit, tide state, Beaufort-scale sea state (http://www.hpc.ncep.noaa.gov/html/beaufort.shtml), tenths of sea-ice cover, wind direction, wind speed, air temperature, visibility and cloud cover.)

Steller’s eiders in flocks containing <20 birds ("small" flocks) were counted within 300m of the aircraft’s flight path. The 600m wide area along a transect we called a "sample strip". The outer limits of a sample strip were determined using calibrated marks on the wing struts. Flocks containing ≥20 birds ("large" flocks) observed within or outside sample strips, to ≤1km, were also counted. Since transects were 2km apart this was considered a complete census of large flocks. Aircraft departed transects as necessary to ensure species identification and increase precision of estimates of flock size.

Recorded flight tracks (excluding the off-transect deviations) were displayed and converted to line shapefiles using ARCVIEW GIS (ESRI 2001), buffered to 300m, and the resulting polygons intersected with the displayed survey units. Areas were calculated for the survey units and sample strips using ARCVIEW script "ViewCalculateFeatureGeometry", and the point estimates for all sampled eiders calculated as simple extrapolations:

$$\sum O * A_{SU} \div A_S$$

Where:

O = Total birds recorded
A_{su} = Total area of survey unit
A_s = Total area of sample strips

The population estimate for each survey unit was calculated as the expanded sample ("small" flock) estimate plus the sum of all birds in "large" flocks.

We used this two-tiered procedure because past survey experience with this species indicated that distribution of birds would consist of clusters of large dense flocks and, in some areas, scattered individuals and small flocks (Larned 2001, Larned 2005, W. Larned, U.S. Fish and Wildlife Service, unpubl. data). Ideal transect spacing would be about 500-600m for all birds to be seen. However, our experience suggests that such spacing would likely have caused birds to flush from adjacent transects ahead of the plane, resulting in under-counting or distributional errors. Also, funding constraints and narrow windows of opportunity due to weather would have precluded inclusion of additional flight hours required for increased sampling intensity. Our experience suggested that dense flocks of approximately ≥20 birds could be readily seen at 1km under anticipated survey conditions, particularly since such flocks tend to occur as clusters. We further reasoned that any flocks missed with the present sampling strategy would be small, and birds that weren't detected would not detract significantly from the utility of the results for their intended purposes. In our opinion the alternative random or systematic partial samples for all flock sizes would have had high sampling errors due to the clumped distribution, requiring replication within each month, and such replication was not feasible due to weather and funding constraints. In summary we reasoned that, if a seasonal pattern of distribution existed that was consistent among years, our design should have been able to characterize it to provide adequate guidance to help MMS avoid conflict between Steller's eiders and industrial activities, infrastructure, and for contingency (e.g., spills of crude oil or fuel) planning.

<u>Accuracy of observational data,</u>

Aerial surveys have been used extensively for many years for gathering abundance, trend, and distribution data needed for management of waterfowl and many other wildlife taxa. However, this technique is fraught with problems and concerns over sampling and detection bias (Anderson 2001). Detection bias is an especially challenging problem in the marine environment due mainly to spatial and temporal variation in the viewing environment, i.e., the color, wave action, and illumination of the sea surface itself (Stott and Olsen 1972). Other variables we have found to affect detection of birds at sea among and within survey replicates include characteristics of the birds themselves (e.g., size, color, flock size and density, types and frequency of escape behaviors like flushing or diving), observer distractions (e.g., non-target animals, sea ice, whitecaps, flotsam), experience level of individual observers, and to a lesser extent, temporal variation in bias among observers (e.g., "learning curve", fatigue and other physiological effects). Ideally, net influence of all these variables (net bias) may be quantified using some form of double sampling technique, wherein a precise (unbiased) count of individuals is obtained from a representative subset of the survey sample, the result compared with the estimate from the corresponding (biased) operational subset, and the resulting ratio applied to adjust the entire operational data set (Stott and Olson 1972, Eberhardt and Simmons 1987, Estes and Jameson 1987, Bart and Earnst 2002, Thompson 1992). However, though we considered this approach for our study, it was clearly not a viable option for three reasons. First, we could not envision a sampling strategy that would produce a relatively precise estimate from a survey subsample that would be affordable, representative, and would not create its own bias by disturbing sampled birds. Observation platforms that came to mind for the precise subsample were vessels, shoreline promontories, and helicopters. Safety, cost, and challenges involving logistics and coordination, eliminated the shipboard option. We knew of only one or two locations where eider aggregations might be occasionally visible from the shoreline, potentially yielding only partial counts, and again logistics and coordination would be extremely challenging. The helicopter option was dismissed due to the great distances involved, with associated issues of safety, coordination, logistics, and increased cost.

The second reason we did not choose a double sample technique was that we anticipated an eider distribution composed primarily of a few widely scattered clusters of large flocks. We settled on a systematically designed total census of these large flocks to avoid the large sampling error usually associated with sampling clumped distributions. Lastly, in consideration of the ultimate management objective of avoiding or reducing conflicts between commercial resource development activities and Steller's eiders, we were less concerned with precision of estimates or total counts than with spatial distribution of flocks and persistence of habitat associations through time and space.

The above rejection of double-sampling notwithstanding, we were still interested in reducing detection and estimation bias as much as practicable. We addressed the above listed known sources of detection bias using the following procedures:

One of the most important variables is wave action, especially the presence or absence of whitecaps. We therefore stipulated in our protocol that we would avoid surveying when whitecaps were prevalent, or when sea state >3 on the Beaufort scale (wind 13-18kph, sea with large wavelets, crests beginning to break, and scattered whitecaps). We tried to minimize the effects of surface glare by favoring days with high overcast conditions, but found that we rarely had the luxury of choosing such conditions during the mid-winter months given the short daylight intervals and generally persistent inclement weather. Mitigation of the effects of bird characteristics on detection and identification came primarily from training and experience of observers both prior to and during the survey, and deviation as needed from transects (see above). Steller's eiders are small as sea ducks go, but strikingly marked and gregarious, thus relatively easy to detect and identify compared to most other water birds. Observer distractions including the presence of ‘other’ species may have influenced, at least to some extent, our ability to detect Steller’s eiders, but only if (and when) Steller’s eiders presence overlapped that of other species. We attempted to minimize the distractive effects of ice chunks or ice sheets and other flotsam by selecting intervals to survey when wind and tides distributed these objects against the shore or ice edge versus dispersing them seaward. Again, opportunities for such selectivity were, in reality, limited by the scarcity and brevity of weather windows.

Our organization avoids changes in crew composition (particularly observers) whenever possible, to help minimize observer bias both among and within survey replications. This was our intent with this project as well, but due to unpredictable weather conditions and windows of opportunity to conduct surveys, logistical challenges, conflicting schedules of survey personnel, and an injury to one crewmember; some changes were made in both pilots and observers Tables 2, 3). Although aerial survey experience varied considerably among observers, each observer had previous experience participating in Steller's eider aerial surveys. The principal investigator had flown previously with each observer or had spent some time in the air during this study to ensure competency at identifying Steller’s eiders. During the surveys, observers worked closely to resolve any identification uncertainties and the protocol used allowed for aircraft to depart transects for positive identification and to allow sufficient time for flock estimation.

We used an indirect method to evaluate comparability of observers post-survey. Given the arrangement of transects perpendicular to the anticipated average density gradient of sea ducks (and sea otters, *Enhydra lutris*), and the roughly equal average among-observer viewing conditions, we reasoned that each observer should have had equal opportunity to detect animals, provided the animals had a widely dispersed rather than clumped distribution. Steller's eiders clearly did not fit this description. However, following standard USFWS survey protocol we recorded all identifiable birds and other taxa of interest to the agency (i.e., USFWS) in addition to Steller's eiders. Among these we selected three taxa (long-tailed ducks *Clangula hyemalis*, combined scoters *Melanitta spp.*, and sea otters *Enhydra lutris*) that were recorded by all observers within the 600m sample strips, and were relatively abundant and well-dispersed throughout much of the survey area. We compared total observations of non-target species (numbers of separate groups or flocks observed, rather than total individuals) made by each observer during all surveys in which observers were paired. These taxa were not considered valid surrogates for Steller's eiders, particularly relative to flock configuration and distribution. In addition, among-observer variation is assumed to be lower on average for target than non-target species because survey protocol calls for higher priority to be given to target species whenever workload precludes careful recording of all birds present. However, among-observer comparisons using the three non-target species groups should provide some measure of among-observer variation in detection rates of animals of size roughly comparable to that of Steller's eiders under similar environmental conditions (admittedly a stretch for sea otters, but frequently only the head is visible). We did not complete a detailed statistical treatment of the data, but qualitative assessment revealed some patterns among pairs of observers for which we had sufficient data (Table 1). Observer number 3 generally had similar or slightly higher numbers of detections compared to observers 1, 5, 6, and 9, but was consistently higher than observer 4.

Table 1. Comparison of bird and sea otter observations among left and right paired observers during aerial waterfowl surveys in lower Cook Inlet, Alaska, during year 1 (January-April 2004) and year 2 (December 2004-April 2005). Numbers are total observations for each taxon during all surveys in which the listed observers were paired, and, in parentheses, the percentage of total observations made by the respective observer. LTDU = long-tailed duck (*Clangula hyemalis*), SCOT = combined scoter species (*Melanitta spp.*), SEOT = sea otter (*Enhydra lutris*)

		Year 1			Year 2	
Observers	LTDU	SCOT	SEOT	LTDU	SCOT	SEOT
3	113 (62)	306 (52)	232 (52)	120 (66)	68 (53)	117 (45)
1	70 (38)	280 (48)	216 (48)	63 (34)	60 (47)	145 (55)
3	155 (67)	282 (76)	188 (66)	94 (62)	325 (81)	89 (64)
4	78 (33)	90 (24)	97 (34)	57 (38)	77 (19)	51 (36)
3				50 (49)	90 (48)	98 (53)
5				52 (51)	97 (52)	87 (47)
3				108 (63)	37 (49)	248 (55)
6				64 (37)	38 (51)	203 (45)
3				56 (55)	191 (48)	197 (48)
9				46 (45)	208 (52)	214 (52)
4	32 (40)	60 (27)	NS	113 (43)	117 (24)	292 (34)
1	49 (60)	163 (73)	NS	150 (57)	377 (76)	555 (66)
4				18 (44)	13 (22)	100 (30)
7				23 (56)	46 (78)	228 (70)
2	170 (47)	444 (53)	315 (55)	111 (45)	48 (45)	88 (34)
9	191 (53)	395 (47)	262 (45)	133 (55)	58 (55)	174 (66)

Observers 1 and 7 were also consistently higher than observer 4, while observers 2 and 9 were reasonably similar to one another. Among-observer differences in ability to detect Steller's eiders and differences in their counts may not have been important in the overall estimates and assessment of distribution given the objectives of the survey and because precise population estimates were not a high priority for this study. The primary reason for presenting this comparison is to point out the importance of implementing a more rigorous evaluation of observers prior to any future surveys, such that any discrepancies among observers can be dealt with through remedial training, a numerical correction factor for paired observers, or replacement of observers who cannot meet standards (see below).

Each observer practiced flock estimation using a computer wildlife counting simulation training program (Hodges 1993) prior to and periodically during the study. We initially considered using oblique 35mm photography of as many eider flocks as possible, counting birds in photographs to increase precision for the flocks successfully photographed, and to use the results to compensate for observer estimation bias for unphotographed flocks through double sampling statistical techniques (Eberhardt and Simmons 1987, Lock 1986). However, in prior Steller's eider surveys, including a pilot study in CI (Larned 2005, U. S. Fish and Wildlife Service, unpubl. data) we found that behavior of Steller's eiders rendered this technique unreliable. Specifically, eiders in flocks dove frequently and sequentially as we passed over them in the aircraft, thus resulting in images of partial flocks which were consequently biased low. Also, during aircraft maneuvers required for photographs clustered flocks disturbed by the survey aircraft tended to split and/or be joined by other flocks making it extremely difficult to obtain a single set of images containing all birds. Perhaps more importantly, such maneuvers often caused observers to become disoriented, losing track of focal flocks which almost certainly reduced the precision of our estimates. We therefore rejected the use of aerial photographs in assessing observer bias during this study.

RESULTS AND DISCUSSION

Environmental conditions

Our observations during this study indicated that sea ice extent throughout the two winters covered by this survey was considerably less than average conditions from 1986-1999 (Mulherin et al. 2001). Ice cover in mid-February 2004 within the survey area consisted of limited brash ice in the McNeil Cove/Akumwarvik Bay area, heavier brash ice from Tuxedni Bay northward, and extensive shorefast ice in the more protected west CI bays (Fig. 7). The month of February represented the maximum ice extent during the winter of 2003-04. The winter of 2004-05 was mild in early January and sea ice extent was minimal south of the forelands (Fig. 8). A cold snap in February, however, covered most of the shoals in Kamishak Bay and all west shore estuaries with brash and continuous ice. Continuous ice also covered most of the east shoreline north of Anchor Point (Fig. 9). Sea ice in Lower CI is presumably a major factor influencing use of winter habitats by Steller's eiders and other marine birds, and may account for some of the apparent changes in bird distribution observed among months and years in this survey and previous studies.

Weather during the surveys was mostly within the acceptable parameters we set, and we found viewing conditions generally favorable. However, the area offshore south of Anchor Point (Fig.

6) often had stronger winds than the rest of the eastern survey units. Often when the rest of the survey area was Beaufort 2 or less with no whitecaps, the area south of Anchor Point had Beaufort 3 conditions with some whitecaps present. It became readily apparent that we would have to occasionally fly surveys under these conditions in order to complete the surveys per the survey schedule to meet objectives of the study. We believe this may have resulted in slightly poorer eider detection rates in this area compared to adjacent areas, hence the estimates for that area may be biased low. The same was occasionally true for the more exposed shorelines in survey units 3W and 4W between Bruin and Illiamna Bays. We do not consider the magnitude of this problem to have been great enough to have significantly affected our conclusions regarding the overall distribution pattern. However, in future studies we recommend reducing widths of transect strips, either throughout the survey or only for those areas where detection probabilities are likely poor or lessened due to ice and sea state conditions. We felt that detection probabilities of birds were also lower during the period of winter when sun angles are at the lowest, especially when coupled with choppy sea surface conditions.

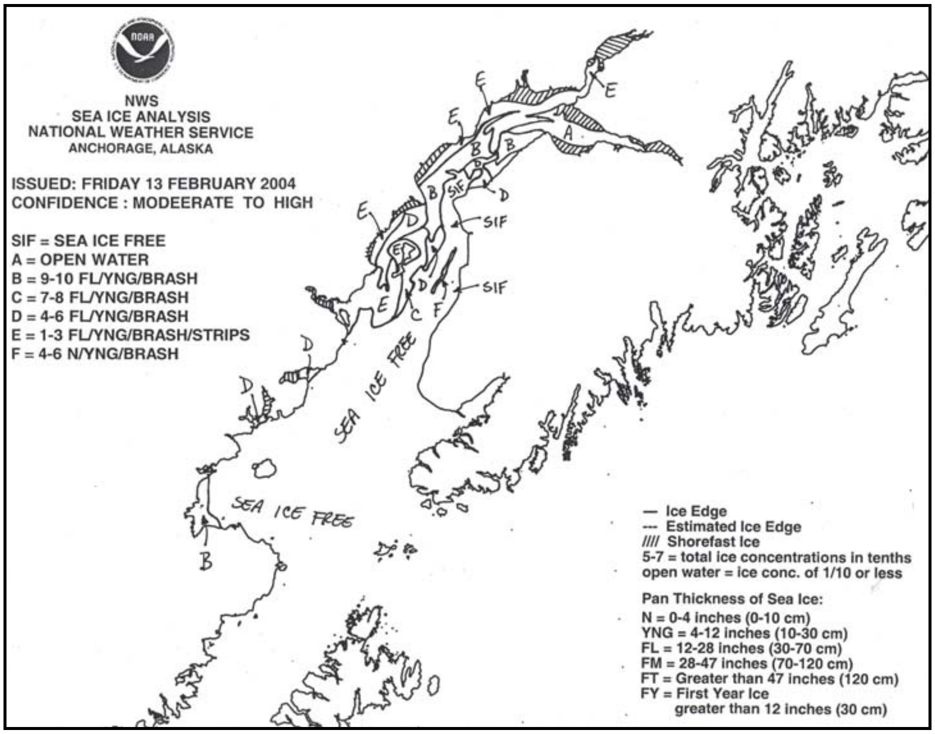


Figure 7. Sea ice cover in Cook Inlet, Alaska, 13 February 2004. Graphic developed by Sea Ice Desk, National Weather Service, Anchorage, Alaska.

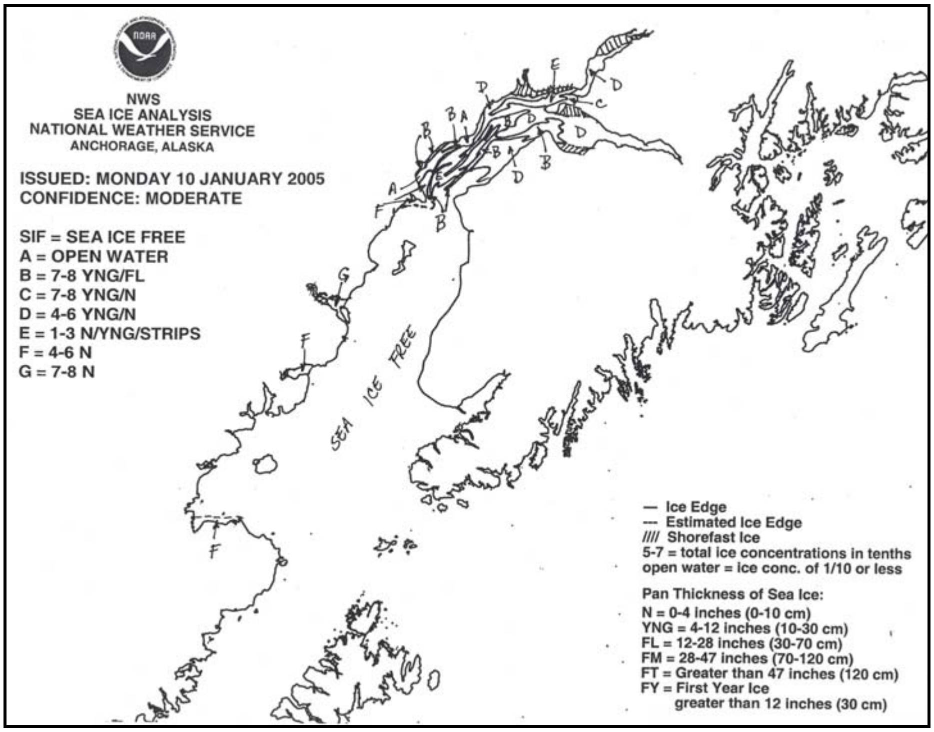


Figure 8. Sea ice cover in Cook Inlet, Alaska, 10 January 2005. Graphic developed by Sea Ice Desk, National Weather Service, Anchorage, Alaska.

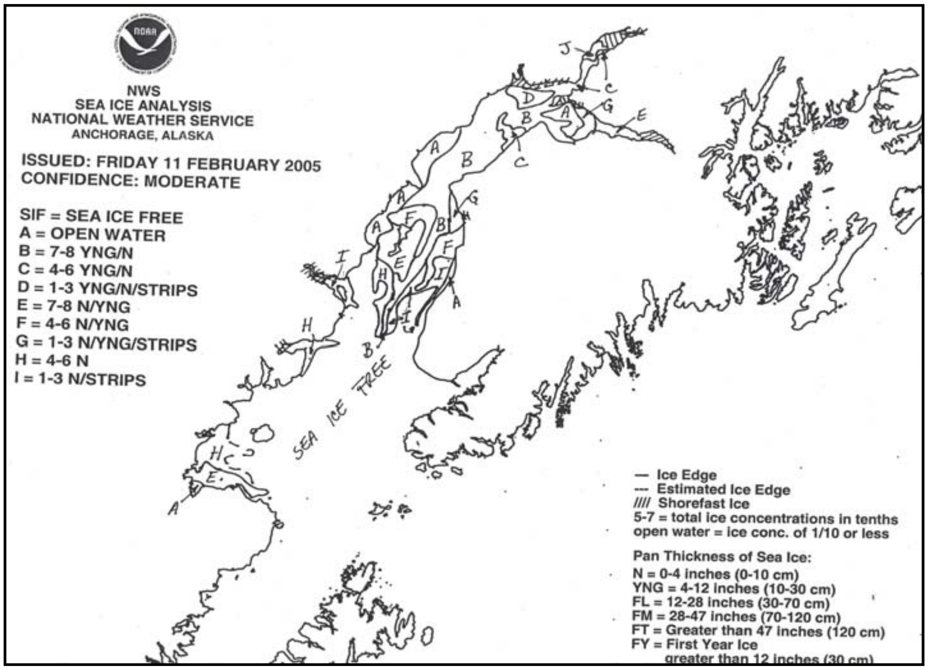


Figure 9. Sea ice cover in Cook Inlet, Alaska, 11 February 2005. Graphic developed by Sea Ice Desk, National Weather Service, Anchorage, Alaska.

Abundance and distribution of Steller's eiders

We present Steller's eider estimates as crew totals for each survey unit by month with primary crew data highlighted and summarized by eastern and western Inlet areas (Tables 2 and 3). Monthly Steller's eider totals are compared by survey unit (Figure 10), and locations of individual observations are graphically depicted (Figs. 11-19), graduated symbols representing flock size ranges. Data for both aerial crews are displayed simultaneously in each map, so that all locations of recorded eiders are represented. Therefore, flocks observed by both survey crews are displayed twice, while those flocks observed by one crew only are displayed once. Though this procedure gives an inaccurate representation of the density of eider flocks, it depicts habitats used as inclusively as possible, in light of our knowledge that neither aerial crew detected all Steller's eiders present, and in the interest of leaving no habitats used by eiders unidentified.

Eiders were frequently associated with certain habitats within specific areas surveyed during this study. Survey unit 4W included the bulk (n = 1713) of Steller's eiders observed during this survey, followed by 1E (n = 463), 2E (n = 134), and 3W (n = 125) (Table 4). Very few eiders were recorded among the remaining four survey units: 3E, 5W, 1W and 2W. An important index to use was the relative proportion of CI wintering eider population found along the eastern vs. western shoreline. While the survey was initiated too late during the winter of 2003-2004 for such a determination, during the second year of the survey on average we observed 25% of the Steller's eiders in eastern vs. 75% in western CI (Table 4). The highest monthly estimate among both years (n = 1499) for the eastern survey units occurred in February 2004 (Table 1) with the highest monthly estimate (n = 4284) for the western units occurring in January 2005 (Table 3).

Peak estimates of Steller's eiders varied considerably among years in both number and timing for individual survey units (Fig. 10). Pooled estimates for the eastern units peaked in February 2004 (n = 1499, Table 2) and January 2005 (n = 1247, Table 3). Numbers of Steller's eiders observed during a series of small boat surveys along the Homer Spit during the winter of 2002-03 peaked in mid-January, though numbers observed varied only slightly through the survey period from mid-December to early March (C. Hoffman, U. S. Army Corps of Engineers, pers. comm.). The Western CI units were not surveyed completely in 2004 until March. In 2005, a peak in the pooled estimate occurred in January followed by a dramatic decline in February and a large increase in March (Fig. 10). Most of January 2005 was mild with little sea ice in Kamishak Bay, then a cold snap occurred from late January through most of February which generated extensive sea ice cover that apparently displaced Steller's eiders from that area. A coincidental decline in Steller's eider estimates in the eastern survey units (Fig. 10) indicated a low probability that Kamishak Bay birds relocated eastward across CI. We speculate that these eiders dispersed outside the survey area south along the Alaska Peninsula coast or possibly to open water areas near the Kodiak archipelago.

Locations of Steller's eiders implanted with satellite transmitters showed a pattern of movement between Chiniak Bay (Kodiak) and Kamishak Bay, suggesting that some birds used the Douglas River Shoals area in Kamishak Bay during the August - September post-nuptial molt (D. Rosenberg, Alaska Department of Fish and Game, pers. comm.). The use of this area by substantial numbers of molting eiders was confirmed during two independent aerial surveys in 2005. The first survey was conducted on 29 August in the Douglas River Shoals area only and counted 2,225 Steller's eiders (D. Rosenberg, Alaska Department of Fish and Game, unpubl. data). The second was a shoreline survey conducted on 14 September from the Douglas River to Tuxedni Bay. A total of 2,190 Steller's eiders were recorded, all within the reefs, shoals, and islands of the Douglas River area (W. Larned, U.S. Fish and Wildlife Service, unpubl. data). It is not known how many of these birds remained in the area until winter. Data from four eiders instrumented with satellite transmitters in Chiniak Bay, Kodiak, in March 2005, indicated that they spent the breeding season in the Russian Arctic, returned to molt in the Douglas River area and remained in the latter area from late August or early September until mid-November or later (D. Rosenberg, Alaska Department of Fish and Game, pers. comm.).

Data obtained from this aerial survey suggest that Steller's eiders use certain key winter habitats in CI within and among years (Figs. 11-19). Very few Steller's eiders were observed in upper Kachemak Bay, northeastward of the Homer Spit. However, flocks of various sizes were consistently observed from the west shore of Homer Spit to Clam Gulch. Variables that may have influenced observed distribution and movements include sea ice extent, sea surface conditions, tides, and local prey distribution and abundance. In Kachemak Bay, the two sites most consistently occupied were adjacent to the Homer Spit and an extensive shoal south of Anchor Point. In eastern CI, the largest flocks, and during most surveys the majority of Steller's eiders observed were north of Anchor Point.

Steller's eiders in western CI were consistently distributed and most abundant in the extensive shoals surrounding the mouth of the Douglas River (Figs. 12-19). The only exception was during the February 2005 survey when these shoals were almost completely ice covered (Fig. 17). The site with the next highest abundance within the western survey area was in the general vicinity of Bruin Bay. Distribution within the latter area was more variable (compared to Douglas River Shoals), possibly due in part to greater variability in factors such as sea ice cover and surface conditions. Within the vicinity of Bruin Bay, the two most consistently used sites were an extensive shoal centered about 8km southeast of Bruin Bay and an area very close to the shoreline between Bruin Bay and Ursus Cove (Figs. 12-19). A third area in which we consistently observed eiders during the second year of the survey was at the mouth of Iniskin Bay (range 160 - 435 eiders; Figs. 15-18). In 2004, we had only one observation of 28 eiders in Iniskin Bay (April; Fig. 14), but the area was only surveyed in March and April. The only Steller's eiders recorded north of Iniskin Bay were two very small flocks (*n* = 8, *n* = 5) in Chinitna Bay (Figs. 15 and 17) and a single bird observed in Tuxedni Bay (Fig. 19).

Table 2. Estimates of Steller's eiders observed during aerial surveys, Cook Inlet, AK, January to April 2004. Data from Primary crew used to calculate monthly totals are in bold typeface.

Date of Survey	Survey Unit[1]	Crew[2]	Flocks <20 N	Flocks <20 birds observed	expansion factor[3]	Flocks <20 Estimate	Flocks ≥ 20 N	Flocks ≥ 20 birds observed	Steller's eider Total
Jan. 2004									
1/23/2004	**1E**	**PA/HW**	**11**	**74**	**3.22**	**238**	**10**	**440**	**678**
1/23/2004	**2E**	**PA/HW**	**12**	**54**	**3.16**	**171**	**1**	**48**	**219**
1/23/2004	**3E**	**PA/HW**	**0**	**0**	**3.29**	**0**	**0**	**0**	**0**
January Total for East Units									**897**
January Total for West Units									**not surveyed**
Feb. 2004									
2/11/2004	**1E**	**WL/PA**	**5**	**47**	**4.07**	**191**	**6**	**930**	**1121**
2/11/2004	**2E**	**WL/PA**	**24**	**105**	**3.22**	**338**	**0**	**0**	**338**
2/11/2004	**3E**	**WL/PA**	**1**	**3**	**3.34**	**10**	**1**	**30**	**40**
2/16/2004	3E	EM/CD	1	5	3.33	17	0	0	17
2/14/2004	**1W**	**EM/CD**	**0**	**0**	**3.74**	**0**	**0**	**0**	**0**
2/14/2004	**2W**	**WL/HW**	**0**	**0**	**3.39**	**0**	**0**	**0**	**0**
	3W		Not completed						
	4W		Not completed						
	5W		Not completed						
February Total for East Units									**1499**
February Total for West Units									**not completed**
Mar. 2004									
3/11/2004	**1E**	**WL/PA**	**15**	**54**	**2.98**	**161**	**3**	**180**	**341**
3/23/2004	1E	EM/CD	17	42	3.01	126	0	0	126
3/11/2004	**2E**	**WL/PA**	**6**	**24**	**2.95**	**71**	**1**	**30**	**101**
3/23/2004	2E	EM/CD	18	39	3.00	117	0	0	117
3/11/2004	**3E**	**WL/PA**	**1**	**6**	**2.97**	**18**	**0**	**0**	**18**
3/23/2004	3E	EM/CD	2	16	3.11	50	0	0	50
3/17/2004	**1W**	**WL/PA**	**0**	**0**	**3.33**	**0**	**0**	**0**	**0**
3/16/2004	**2W**	**WL/PA**	**0**	**0**	**3.16**	**0**	**0**	**0**	**0**
3/16/2004	**3W**	**WL/PA**	**1**	**7**	**3.02**	**21**	**0**	**0**	**21**
3/15-16/04	**4W**	**WL/PA**	**7**	**49**	**3.11**	**152**	**14**	**2093**	**2245**
3/16/2004	4W	EM/CD	32	146	3.04	444	19	1860	2304
3/15/2004	**5W**	**WL/PA**	**0**	**0**	**2.47**	**0**	**0**	**0**	**0**
3/16/2004	5W	EM/CD	0	0	3.06	0	0	0	0
March Total for East Units									**460**
March Total for West Units									**2266**
Apr. 2004									
4/12/2004	**1E**	**WL/HW**	**1**	**3**	**3.34**	**10**	**0**	**0**	**10**
4/12/2004	1E	EM/CD	14	30	3.26	98	0	0	98
4/13/2004	**2E**	**WL/HW**	**11**	**38**	**3.32**	**126**	**0**	**0**	**126**
4/12/2004	2E	EM/CD	7	18	3.37	61	0	0	61
4/13/2004	**3E**	**WL/HW**	**3**	**8**	**3.32**	**27**	**0**	**0**	**27**
4/13/2004	**1W**	**WL/HW**	**0**	**0**	**4.28**	**0**	**0**	**0**	**0**
4/13/2004	**2W**	**WL/HW**	**0**	**0**	**3.50**	**0**	**0**	**0**	**0**
4/13/2004	**3W**	**WL/HW**	**1**	**8**	**3.47**	**28**	**0**	**0**	**28**
4/12/2004	**4W**	**WL/HW**	**14**	**123**	**3.42**	**421**	**9**	**885**	**1306**
4/13/2004	4W	EM/CD	49	211	3.37	711	4	195	906
4/12/2004	**5W**	**WL/HW**	**1**	**1**	**2.73**	**3**	**0**	**0**	**3**
4/13/2004	5W	EM/CD	0	0	4.01	0	0	0	0
April Total for East Units									**163**
April Total for West Units									**1337**

1. Data are listed for completed units only. 2. Crew: CD=Christian Dau, EM=Edward Mallek, HW=Heather Wilson, PA=Paul Anderson, WL=William Larned 3. Expansion factor = survey unit area/sampled area. Sampled area is calculated from km flown while actually surveying.

Table 3. Estimates of Steller's eiders observed during aerial surveys, Cook Inlet, Alaska, December 2004 to April 2005. Data from primary crew used to calculate monthly totals is in bold typeface.

Date of Survey	Survey Unit[1]	Crew[2]	Flocks <20 N	Flocks <20 birds observed	expansion factor[3]	Flocks <20 Estimate	Flocks ≥ 20 N	Flocks ≥ 20 birds observed	Steller's eider Total
Dec. 2004									
12/8/2004	**1E**	**WL/CD**	**0**	**0**	**3.27**	**0**	**6**	**825**	**825**
12/8/2004	1E	PA/TB	5	22	3.21	71	5	570	641
12/8/2004	**2E**	**WL/CD**	**1**	**4**	**3.20**	**13**	**1**	**30**	**43**
12/8/2004	2E	PA/TB	3	7	3.20	22	0	0	22
12/8/2004	**3E**	**WL/CD**	**0**	**0**	**3.31**	**0**	**0**	**0**	**0**
12/5/2004	**2W**	**WL/CD**	**0**	**0**	**3.44**	**0**	**0**	**0**	**0**
12/5/2004	**3W**	**WL/CD**	**0**	**0**	**3.43**	**0**	**1**	**160**	**160**
12/5/2004	3W	PA/HW	0	0	3.52	0	1	250	250
12/4-5/2004	**4W**	**WL/CD**	**2**	**13**	**3.43**	**45**	**6**	**930**	**975**
12/4-5/2004	4W	PA/HW	5	26	3.31	86	5	1981	2067
12/4/2004	**5W**	**WL/CD**	**0**	**0**	**2.56**	**0**	**0**	**0**	**0**
12/5/2004	5W	PA/HW	0	0	3.71	0	0	0	0
December Total for East Units									**868**
December Total for West Units									**1135**
Jan. 2005									
1/6/2005	**1E**	**WL/RP**	**2**	**14**	**3.26**	**46**	**11**	**1095**	**1141**
1/6/2005	1E	PA/HW	3	15	3.22	48	6	1245	1293
1/6/2005	**2E**	**WL/RP**	**5**	**25**	**3.26**	**82**	**1**	**25**	**107**
1/6/2005	2E	PA/HW	5	17	3.28	56	0	0	56
1/6/2005	**3E**	**WL/RP**	**0**	**0**	**3.41**	**0**	**0**	**0**	**0**
1/6/2005	3E	PA/HW	0	0	3.31	0	0	0	0
1/7/2006	**2W**	**WL/RP**	**0**	**0**	**3.88**	**0**	**0**	**0**	**0**
1/7/2006	**3W**	**WL/RP**	**1**	**10**	**3.32**	**33**	**2**	**330**	**363**
1/7/2006	3W	PA/HW	2	8	3.44	28	1	220	248
1/11/2005	**4W**	**WL/WE**	**4**	**15**	**3.37**	**51**	**9**	**3870**	**3921**
1/11/2005	4W	PA/HW	5	21	3.47	73	0	0	73
1/11/2005	**5W**	**WL/WE**	**0**	**0**	**2.39**	**0**	**0**	**0**	**0**
1/11/2005	5W	PA/HW	0	0	3.47	0	0	0	0
January Total for East Units									**1248**
January Total for West Units									**4284**
Feb. 2005									
2/3/2005	**1E**	**WL/HW**	**4**	**4**	**3.25**	**13**	**9**	**635**	**648**
2/3/2005	1E	EM/CD	1	5	3.26	16	3	128	144
2/3/2005	**2E**	**WL/HW**	**11**	**26**	**3.24**	**84**	**1**	**20**	**104**
2/3/2005	2E	EM/CD	5	12	3.40	41	0	0	41
2/3/2005	**3E**	**WL/HW**	**1**	**2**	**3.34**	**7**	**0**	**0**	**7**
2/3/2005	3E	EM/CD	0	0	3.39	0	0	0	0
2/4/2005	**1W**	**WL/HW**	**0**	**0**	**4.84**	**0**	**0**	**0**	**0**
2/4/2005	1W	EM/CD	0	0	3.83	0	0	0	0
2/4/2005	**2W**	**WL/HW**	**0**	**0**	**3.65**	**0**	**0**	**0**	**0**
2/4/2005	2W	EM/CD	1	5	3.73	19	0	0	19
2/4/2005	**3W**	**WL/HW**	**0**	**0**	**3.36**	**0**	**0**	**0**	**0**
2/4/2005	3W	EM/CD	0	0	3.47	0	3	435	435
2/4,12/2005	**4W**	**VL/HW/D**	**2**	**5**	**3.46**	**17**	**3**	**206**	**223**
2/4,12/2005	4W	EM/CD	0	0	3.46	0	5	290	290
2/12/2005	**5W**	**WL/DM**	**0**	**0**	**2.32**	**0**	**0**	**0**	**0**
2/12/2005	5W	EM/CD	0	0	3.44	0	0	0	0
February Totals for East Units									**759**
February Totals for West Units									**223**

Table 3. (Continued).

Date of Survey	Survey Unit[1]	Crew[2]	Flocks <20 N	Flocks <20 birds observed	expansion factor[3]	Flocks <20 Estimate	Flocks ≥ 20 N	Flocks ≥ 20 birds observed	Steller's eider Total
Mar. 2005									
3/4/2005	**1E**	**PA/WL**	**12**	**66**	**3.23**	**213**	**1**	**40**	**253**
3/7/2005	1E	WL/PA	3	34	3.27	111	2	175	286
3/4/2005	**2E**	**PA/WL**	**37**	**118**	**3.22**	**380**	**1**	**45**	**425**
3/7/2005	2E	WL/PA	6	28	3.29	92	3	86	178
3/4/2005	**3E**	**PA/WL**	**0**	**0**	**3.30**	**0**	**0**	**0**	**0**
3/7/2005	3E	WL/PA	1	3	3.22	10	1	29	39
3/2/2005	**1W**	**WL/DM**	**0**	**0**	**3.78**	**0**	**0**	**0**	**0**
3/2/2005	1W	PA/RP	0	0	3.94	0	0	0	0
3/2/2005	**2W**	**WL/DM**	**0**	**0**	**3.49**	**0**	**0**	**0**	**0**
3/2/2005	2W	PA/RP	0	0	3.34	0	0	0	0
3/2/2005	**3W**	**WL/DM**	**0**	**0**	**3.33**	**0**	**1**	**300**	**300**
3/2/2005	3W	PA/RP	0	0	3.36	0	1	520	520
3/1-2/2005	**4W**	**WL/DM**	**4**	**33**	**3.39**	**112**	**18**	**2540**	**2652**
3/1-2/2005	4W	PA/RP	31	101	3.39	342	20	2176	2518
3/1/2005	**5W**	**WL/DM**	**0**	**0**	**2.42**	**0**	**0**	**0**	**0**
3/1/2005	5W	PA/RP	0	0	3.26	0	0	0	0
March Totals for East Units									**678**
March Totals for West Units									**2952**
Apr. 2005									
4/12/2005	**1E**	**WL/PA**	**2**	**5**	**3.20**	**16**	**1**	**21**	**37**
4/12/2005	**2E**	**WL/PA**	**3**	**3**	**3.27**	**10**	**1**	**25**	**35**
4/12/2005	**3E**	**WL/PA**	**0**	**0**	**3.30**	**0**	**0**	**0**	**0**
4/14/2005	**1W**	**WL/CD**	**0**	**0**	**3.96**	**0**	**0**	**0**	**0**
4/14/2005	1W	PA/HW	1	4	4.01	16	0	0	16
4/14/2005	**2W**	**WL/CD**	**0**	**0**	**3.45**	**0**	**0**	**0**	**0**
4/14/2005	2W	PA/HW	1	2	3.30	7	0	0	7
4/13-14/2006	**3W**	**WL/CD**	**0**	**0**	**3.36**	**0**	**0**	**0**	**0**
4/13-14/2006	3W	PA/HW	1	3	3.28	10	0	0	10
4/13/2005	**4W**	**WL/CD**	**13**	**75**	**3.43**	**257**	**10**	**410**	**667**
4/13/2005	4W	PA/HW	7	35	3.41	119	2	115	234
4/13/2005	**5W**	**WL/CD**	**0**	**0**	**2.42**	**0**	**0**	**0**	**0**
4/13/2005	5W	PA/HW			3.47	0			0
April Totals for East Units									**72**
April Totals for West Units									**667**

1. Data are listed for completed areas only. 2. Crew: CD=Christian Dau, DM=Dennis Marks, EM=Edward Mallek, HW=Heather Wilson, PA=Paul Anderson, RP=Robert Platte, TB=Timothy Bowman, WE=William Eldridge, WL=William Larned.

3. Expansion factor = survey unit area/sampled area. Sampled area is calculated from km actually flown while surveying.

Table 4. Monthly Steller's eider estimates averaged over all months in which surveys were completed (March, April, and December, 2004, and January – April, 2005), aerial Steller's eider surveys, Cook Inlet, Alaska.

Survey Unit	Average Monthly Means	Rank
1E	462.7	2
2E	134.4	3
3E	7.4	5
East Total	**604.5**	
1W	0	7
2W	0	7
3W	124.6	4
4W	1712.7	1
5W	0.4	6
West Total	**1837.7**	

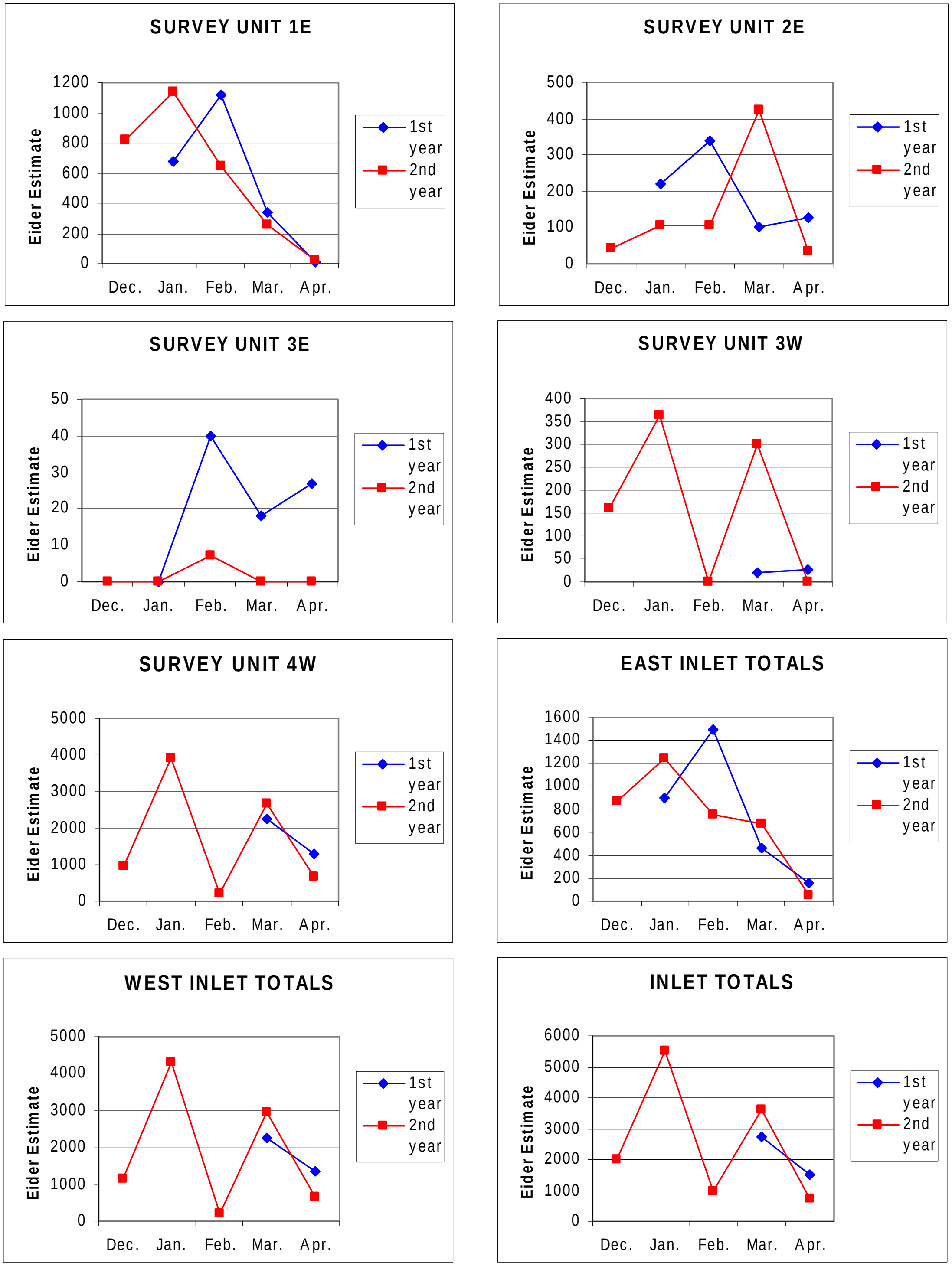


Figure 10. Steller's eider estimates from survey units completed by the primary survey crew during monthly aerial surveys in Cook Inlet, Alaska, January – April 2004 and December 2004 – April 2005. Note that no data are included from survey units and area totals not completely surveyed.

Figure 11. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 23 January 2004. Flock symbol sizes are proportional to ranges of numbers of eiders as noted in the legend.

Figure 12. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 11-16 February 2004. Flock symbol sizes are proportional to ranges of numbers of eiders as noted in the legend.

Figure 13. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 11-17 March 2004. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 14. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 12-13 April 2004. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 15. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 4-8 December 2004. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 16. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 6-11 January 2005. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 17. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 3-12 February 2005. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 18. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 2-4 March 2005. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

Figure 19. Transects flown and locations of Steller's eider groups recorded during an aerial survey, Cook Inlet, Alaska, 12-14 April 2005. Flock symbols are proportional to ranges of numbers of eiders as noted in the legend.

SUMMARY AND CONCLUSIONS

The general goal of this study was to provide information that would enable MMS to avoid or mitigate potential impacts to threatened Steller's eiders during oil and gas development activities in CI. Based on prior survey experience in CI (U.S. Fish and Wildlife Service, unpubl. data; Petrula and Rosenberg 2005) and other portions of this species' winter range (Larned 2001, Larned 2005) we considered it unlikely that proposed Federal Lease Sale 199 would include habitats used frequently by Steller's eiders. Steller's eiders are normally associated with the near shore environment, in protected waters generally <10m in depth (Cottam 1939, Hogstrom 1977, Petersen 1981, U. S. Fish and Wildl. Serv. 2002, Zydelis 2002). In CI all such habitats are well shoreward of the lease sale area. However, many related activities (e.g., seismic exploration, transportation vessels in support of drilling, production, product and waste removal, and mishaps like crude oil and fuel spills) have considerable potential to damage important eider habitat, force the birds to relocate to alternate habitats of lower quality, or cause the loss of eiders directly. Such effects may be prevented or at least reduced by awareness and avoidance of Steller's eider concentration areas and at times when the birds tend to congregate in these areas.

Our strategy was to conduct a series of monthly aerial surveys and use the resulting periodic "snapshots" to help depict and describe, in as much detail as possible, the seasonal distribution of the eiders and location of habitats apparently important to their overwinter survival while in CI. Steller's eiders exhibit strong fidelity to wintering (Murie and Scheffer 1959, Jones 1965, Kistchinski 1973) and molting (Jones 1965, Petersen 1981, Dau et al. 1985, Flint et al. 2000) areas. We thought it reasonable to assume that eider distribution in future years would be similar to that observed during this study under similar environmental conditions in the future, particularly if we did not see any major inconsistencies between our data and those from earlier surveys. Our original study design called for two years of monthly surveys, December – April. However, coverage of all survey units during the first year was completed only for March-April, due to inclement weather and delays in funding approval. This was unfortunate, as two full years of surveys covering all months would have been very beneficial in documenting the patterns we observed, particularly since weather and sea ice conditions varied considerably among the two years.

As noted earlier, we anticipated conducting a consistent series of aerial marine wildlife surveys during an Alaskan winter to be challenging, and precision of results to be less than desired. The difficulties we encountered resulted in an unmeasured and variable bias, presumably low, for monthly estimates based on discrepancies among data from two crews on comparable surveys (e.g., each crew occasionally recorded flocks that were apparently not recorded by the other crew, Tables 2, 3). However, given these limitations, our data, in conjunction with other survey and telemetry data reviewed in this report, provide the basis for a preliminary conceptual model of seasonal distribution that should enable industry and regulatory agencies to make management decisions that provide a large measure of protection for Steller's eiders wintering in CI.

The conceptual model of arrival and dispersal for Steller's eiders in Cook Inlet during winter we propose is described as follows:

Following nesting in high Arctic Russia and Alaska, most Steller's eiders migrate to southwest Alaska, including lower CI. In Nelson Lagoon on the Alaska Peninsula, arrival of non-breeding subadults begins in mid-July and peaks in early August (Petersen 1980). In 1980 Steller's eiders arrived in Izembek Lagoon beginning 18-24 August (Laubhan and Metzner 1999). Birds molting in Izembek Lagoon are mostly adults, and they continue to arrive through the fall (Jones 1965) with peak numbers occurring in mid-September (Laubhan and Metzner 1999). Independent observations of approximately 2,000 molting eiders in the Douglas River shoals area in late August and September (see p. 16 above) suggest a similar timing in CI. Additional surveys and/or satellite telemetry data are needed to further evaluate the timing and extent of eider presence in CI from mid-summer through the early winter period.

Steller's eider numbers continue to build in CI habitats through early winter, peak in January and February, then decline as they depart on spring migration to nesting grounds from early March through mid to late April. The chronology described likely varies somewhat among and within years depending on weather and sea ice dynamics, and perhaps also as a function of physiological condition of the birds.

The highest wintering population estimates from this study were 1,247 and 4,284 eiders in eastern and western CI, respectively, in January 2005. We believe most of the estimates made during this study are biased slightly low because data were uncorrected, i.e., for eiders not detected during surveys. A higher estimate (2,370) for eastern CI was recorded during an aerial survey in early March, 2001 (W. Larned, U.S. Fish and Wildlife Service, unpubl. data). Nearly all of the birds seen on the latter survey were in one cluster of flocks near Ninilchik, and the survey area did not include Kachemak Bay, where more eiders were likely present.

Areas frequented by substantial numbers of Steller's eiders in winter during these surveys (with maximum estimates recorded) included, in eastern CI, the nearshore area from Anchor Point to 25km north of Ninilchik (1,141 in January 2005, Table 3, Fig. 16, and 2,370 in March 2001, W. Larned, U.S. Fish and Wildlife Service, unpubl. data), and the nearshore area from Homer Spit to Anchor Point (338 in February 2004, Table 2, Fig. 12). Important areas included in western CI, were southern Kamishak Bay from Douglas River to Bruin Bay, including the shoreline between Bruin Bay and Ursus Cove, and a shoal 12km southeast of Bruin Bay (3,921 in January 2005, Table 3, Fig. 16), and the mouth of Iniskin Bay (363 in January 2005, Table 3, Fig. 16).

During the winter, limited satellite telemetry data (D. Rosenberg, Alaska Department of Fish and Game, unpubl. data) indicated that birds in at least one location (southern Kamishak Bay) may have moved to Kodiak and other portions of the species winter range outside the study area, apparently in response to displacement from favored feeding areas by sea ice and possibly inclement weather.

RECOMMENDATIONS

The model we propose based on results of this study and other local and more general survey and research data, is incomplete and will hopefully be refined and validated, and any errors corrected, in the near future. Major questions inadequately addressed during this study that should be addressed in the future include:

1. What is the sequence of arrival and departure of eiders in the populous and consistently used habitats?

2. In the interest of safety and to maximize detection of birds, we surveyed only during mild weather conditions. In addition to those habitats occupied extensively by Steller's eiders during

this study, are there other more sheltered sites, perhaps less productive but nonetheless important as alternates, used primarily during inclement weather?

3. During the winter, is there any exchange of individuals between eastern and western CI, or other areas? If so, in the event of a major natural or anthropogenic disaster or disturbance could we expect eiders to readily move to these sites on their own, or after being intentionally hazed from an oil spill or other hazard?

4. What are the breeding, molting and staging area affinities of eiders that winter in CI?

Probably the best initial approach to answering these questions is through the use of satellite telemetry, supplemented with additional aerial surveys, to determine numbers of birds occupying sites initially identified by telemetry.

Future winter aerial surveys should be redesigned to delete intensive coverage of that portion of the west shoreline north of Iniskin Bay that is apparently underutilized by Steller's eiders (this survey, see also Bennett 1996). A single shoreline transect would suffice to document birds that unexpectedly appeared in this area. The resulting substantial savings of flight time could then be applied to reducing transect spacing, which should improve detection of birds and thus enhance precision of estimates. Another recommendation is to reduce the small-flock sampling strip width to 200m or possibly less, to better match the effective detection distance under the worst detection conditions likely to be encountered during winter surveys. Additionally or alternatively, further analysis of data from this study and habitat covariate data from other sources might provide the basis for a more efficient model-based stratified survey design. Finally, we recommend more rigorous testing of observer proficiency against negotiated standards in future surveys, and providing remedial training or substitute observers when deficiencies are identified.

ACKNOWLEDGEMENTS

I would like to thank the Minerals Management Service for providing most of the financial support. Charles Monnett and Jeffrey Gleason, Minerals Management Service provided valuable technical guidance and encouragement during the study. U.S. Fish and Wildlife Service employees listed under "project organization" who acted as aerial observers and pilots devoted a great deal of time, energy, and patience under often trying circumstances, and maintained their standby status through many "weather holds". My thanks also to U.S. Fish and Wildlife Service Waterfowl Management Branch project leader Russ Oates, for his support and patience. Finally, Dan Rosenberg, Alaska Department of Fish and Game coordinated with me on several complementary sea duck projects. Jeffrey Gleason and 2 anonymous reviewers provided comments that greatly improved this report.

LITERATURE CITED

Agler, B. A., S. J. Kendall, P. E. Seiser, and D. B. Irons. 1995. Monitoring seabird populations in areas of oil and gas development on the Alaskan Continental Shelf: Estimates of marine bird and sea otter abundance in Lower Cook Inlet, Alaska during summer 1993 and winter 1994. Final report. OCS Study MMS 94-0063. U. S. Fish and Wildlife Service, Anchorage AK. 124 pp.

Alaska Institute of Marine Science. 1999. Cook Inlet oceanography workshop, 9 November 1999, Kenai, Alaska, proceedings. (M.A. Johnson et al., eds.) University of Alaska, Fairbanks, Institute of Marine Science et al. 1999. AK. OCS Study, MMS 2000-043U.S. DOI. 118 p.

Anderson, D. R. 2001. The need to get the basics right in wildlife field studies. Wildl. Soc. Bull. 29(4):1294-1297.

Arneson, P. D. 1980. Identification, documentation and delineation of coastal migratory bird habitat in Alaska. U. S. Department of Commerce, NOAA, OCSEAP Final Report. 15(1981):1-363.

Bart, J. and S. Earnst. 2002. Double sampling to estimate density and population trends in birds. The Auk 119(1):36-45.

Bennett, A. J. 1996. Physical & biological resource inventory of the Lake Clark National Park – Cook Inlet coastline, 1994-96. Unpublished Report, Lake Clark National Park & Preserve, Kenai Coastal Office, Kenai, AK 137 pp.

Cottam, C. 1939. Food habits of North American diving ducks. U.S. Dep. Agric. Tech. Bull. 643, Washington, D.C.

Dau, C. P., J. E. Sarvis, R. D. Jones, Jr. 1985. Temporal and spatial distribution of band recoveries of Steller's Eiders from Izembek Lagoon, Alaska. *In* Alaska bird conference: program and abstracts (T. C. Roth, ed.). Anchorage, AK.

Eberhardt, L. L. 1978. Transect methods for population studies. J. Wildl. Manage. 42(1):1-31.

Eberhardt, L. L. and M. A. Simmons. 1987. Calibrating population indices by double sampling. J. Wildl. Manage. 51(3):665-675.

Erikson, D. 1977. Distribution, abundance, migration and breeding locations of marine birds – Lower Cook Inlet, Alaska, 1976. Vol. VIII in L. L. Trasky, L. B. Flagg, and D. C. Burbank, eds. Environmental studies of Kachemak Bay and Lower Cook Inlet. Unpublished Report, Alaska Dept. of Fish and Game, Anchorage, AK. XII vols.

Estes, J. A., and R. J. Jameson. 1987. A double-survey estimate for sighting probability of sea otters in California. J. Wildl. Manage. 52(1):70-76.

Flint, P. L., M. R. Petersen, C. P. Dau, J. E. Hines, and J. D. Nichols. 2000. Annual survival and site fidelity of Steller's eiders molting along the Alaska Peninsula. J. Wildl. Manage. 64(1):261-268.

Fredrickson, L. H. 2001. Steller’s eider (*Polysticta stelleri*). *In* The Birds of North America, No. 571 (A. Poole and F. Gill, eds.). The Birds of North America, Inc., Philadelphia, PA.

Hodges, J. I. 1993. COUNT – a simulation for learning to estimate wildlife numbers. Wildl. Soc. Bulletin. 21:96-97.

Hogstrom, S. 1977. Alforradarens (*Polysticta stelleri*) beteende under Vinter. Var Fagelvarld 36: 250–259.

Jones, R. D. 1965. Returns from Steller's eiders banded in Izembek Bay, Alaska. Wildfowl 16:83-85.

Kertell, K. 1991. Disappearance of the Steller’s Eider from the Yukon-Kuskokwim Delta, Alaska. Arctic 44: 177–187.

Kistchinski, A. A. 1973. Waterfowl in north-east Asia. Wildfowl 24:88-102.

Larned, W. W. 2001. Aerial surveys of Steller's eiders (Polysticta stelleri) and other waterbirds and marine mammals in southwest Alaska areas proposed for navigation improvements by the U. S. Army Corps of Engineers, Alaska. Unpubl. Final report. U. S. Fish and Wildlife Service. 66pp.

Larned, W. W. 2005. Steller's eider spring migration surveys, Southwest Alaska 2005. U. S. Fish and Wildlife Service, Unpubl. Rept. 22pp.

Laubhan, M. K. and K. A. Metzner 1999. Distribution and diurnal behavior of Steller’s Eiders wintering on the Alaska Peninsula. Condor 101: 694–698.

Lock, A. R. 1986. A census of common eiders breeding in Labrador and the Maritime Provinces. pp. 30-38 in A. Reed (ed.) Proceedings of Eider ducks in Canada, Canadian Wildlife Service Special Report Series, No. 47.

Minerals Management Service (MMS). 1984. Gulf of Alaska/Cook Inlet Sale 88. Final Environmental Impact Statement. Vol. 1. USDI-ASOCSR, Anchorage, AK. 470 pp.

Minerals Management Service. 2003. Cook Inlet Planning Area oil and gas lease sales 191 and 199, Final Environmental Impact Statement; OCS EIS/EA, MMS 2003-055, 3 vols.

Mulherin, N. D., W. B. Tucker III, O. P. Smith, and W. J. Lee. 2001. Marine Ice Atlas for Cook Inlet, Alaska. U. S. Army Corps of Engineers, Technical Report TR-01-10. 155 pp.

Murie, O. J. and V. B. Scheffer. 1959. Fauna of the Aleutian Islands and Alaska Peninsula. U.S. Fish and Wildl. Serv. N. Am. Fauna Ser. No. 61. Washington, D. C.

Okkonen, S. R. 2004. Observations of hydrography and currents in central Cook Inlet, Alaska during diurnal and semidiurnal tidal cycles. U. of Alaska, Institute of Marine Science, Fairbanks, Alaska. Minerals Management Service OCS Study 2004-058. 32p.

Petersen, M. R. 1980. Observations of wing-feather molt and summer feeding ecology of Steller's Eiders at Nelson Lagoon, Alaska. Wildfowl 31: 99–106.

Petersen, M. R. 1981. Populations, feeding ecology, and molt of Steller's eider. Condor 83:252-256.

Petrula, M. J., and D. H. Rosenberg. 2005. Small boat and aerial survey of waterfowl in Kachemak Bay, Alaska, during winter 1999-2003. Unpublished Draft Report. Alaska Department of Fish and Game, Anchorage, Alaska. 50pp.

Quakenbush, L. T., R. H. Day, B. A. Anderson, F. A. Pitelka, and B. J. McCaffery. 2002. Historical and present breeding season distribution of Steller's eiders in Alaska. Western Birds. 33:99-120.

Stott, R. S., and D. P. Olson. 1972. An evaluation of waterfowl surveys on the New Hampshire Coastline. J. Wildl. Manage. 36(2):468-477.

Thompson, S. K. 1992. Sampling. John Wiley and Sons, Inc., New York.

U.S. Fish and Wildlife Service. 2002. Steller's Eider Recovery Plan. Fairbanks, Alaska. 21 pp.

Zydelis, R. 2002. Habitat selection of waterbirds wintering in Lithuanian coastal zone of the Baltic Sea. Institute of Ecology, Vilnius, Lithuania, Summary of Doctoral Dissertation. 32pp.