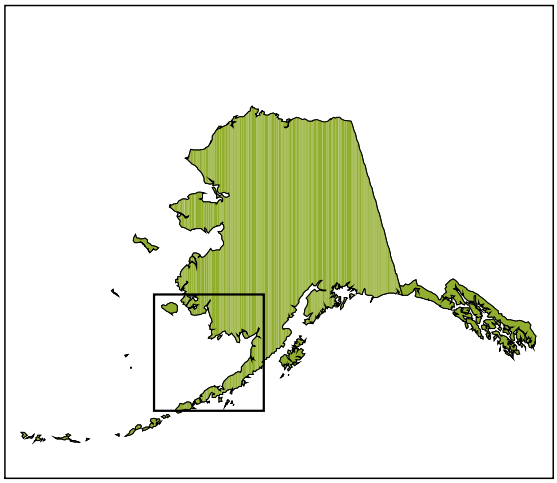
STELLER'S EIDER SPRING MIGRATION SURVEYS
SOUTHWEST ALASKA
2011



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Abstract. Annual spring aerial surveys were conducted most years from 1992 to 2011, to monitor abundance and habitat associations of Steller's eiders (*Polysticta stelleri)* staging for spring migration in southwestern Alaska. We recorded visual estimates of Steller's eiders and all other identifiable water birds and marine mammals along shorelines and within estuaries and shoals where Steller's eiders and other sea ducks were known to congregate during migration. Two to four replicates were conducted per survey year from 1992-1997, with the highest annual count used to target and describe peak numbers of eiders staging within the survey area prior to their departure to arctic nesting grounds. Since 1997, funding cuts precluded replication in all but one year, and timing of the single annual surveys was based on satellite imagery of sea ice, information from local contacts and concurrent telemetry studies. Annual Steller's eider estimates ranged from 54,888 (year 2010) to 137,904 (year 1992), and mean 81,925. The 2011 survey, flown in our new turbine-powered Quest Kodiak amphibious airplane, was completed 13-19 April, under nearly ideal timing and weather conditions. The Steller's eider estimate (74,369) was 9% below the 1992-2010 mean, but 35% above the 2010 all-time low of 54,888. The primary cause of the large difference between 2010 and 2011 may have been poor survey timing in 2010. The long-term trend (1992-2011) indicates an annual decline of 2.3 percent per year (R^2=0.34). We suspect a slight negative trend bias resulted from a higher frequency of optimally-timed counts in early years due to free selection from among survey replicates, compared to the single annual counts in subsequent years. We present maps illustrating the 2010 survey flight path and observed distribution of Steller's eiders and other selected species. A persistent pattern of habitat use by Steller's eiders and most other sea duck species among years provides evidence of relative importance among southwestern Alaskan habitats to staging and migrating waterfowl. To improve precision in monitoring the Pacific Steller's eider population we recommend either returning to the replicated design used prior to 1998, or testing an alternative approach such as a photographic autumn molt survey.

Key Words: Steller's eider, *Polysticta stelleri*, king eider, *Somateria spectabilis*, migration, population, aerial, survey, waterfowl, Bering Sea, Bristol Bay

INTRODUCTION

The majority of the world population of Steller's eiders migrates along the Bristol Bay coast of the Alaska Peninsula in the spring, crosses Bristol Bay toward Cape Pierce, then continues northward along the Bering Sea coast. Most then cross the Bering Strait to their breeding grounds in Siberia, with a smaller number continuing north to the Alaska North Slope to breed (Gill et al. 1978). They linger en route to feed at the mouths of lagoons and other productive habitats. Concern over apparent declines of eiders prompted the U.S. Fish and Wildlife Service to initiate a special survey in 1992 to monitor the population of Steller's eiders that winters in Alaska waters. Since a comprehensive survey of the species is not currently feasible on its extensive and remote winter range, which includes the Aleutian Islands, the Alaska Peninsula, and the western Gulf of Alaska including Kodiak and lower Cook Inlet, we estimate their numbers as they stage during migration in Bristol Bay and Kuskokwim Bay. Objectives of the survey are:

1. Obtain an annual estimate of the pre-breeding population of Steller's eiders that winter in Alaskan waters.

2. Document distribution of and habitats used by Steller's eiders during migration.

3. Describe populations and distributions of other migrating water birds and marine mammals, to the extent that doing so does not compromise the Steller's eider objectives.

This report summarizes results from the 2011 Steller's eider surveys, with comparisons to data from previous surveys.

STUDY AREA AND METHODS

The survey area included estuarine and near shore habitats along the coast of southwestern Alaska, from the Yukon-Kuskokwim Delta (Y-K Delta) to the west end of the Alaska Peninsula. Steller's eiders are normally found feeding and resting in and near lagoons and shoals rich in benthic invertebrate prey and generally less than 10 meters in depth. Our objective for coverage was to search all such areas within the survey area to census all Steller's eiders, as well as to estimate numbers of waterbirds in other important sea duck habitats along the route. In 2011 we flew a Quest Kodiak single-engine turboprop powered amphibious airplane at 90 to 100 knots (166 to 185 km/hr) airspeed and 150 to 250 feet (46 to 76 m) altitude, while in all other years we flew similar flight parameters in a Cessna 206 amphibian. The crew did not detect a difference in behavior of the eiders or discrimination of bird species with change in aircraft. However, the reliability history of the Kodiak's power plant increased the crew's confidence in the safety of the aerial surveys, as the theoretical likelihood of engine failure was much lower than that of the Cessna. Habitats within lagoons and bays were censused using an adaptive contiguous search pattern, varying relative to tides, ice cover, and bird distribution. We surveyed exposed shorelines using a single track parallel to the coast within 1 km of the shoreline, but deviated for flocks sighted at greater distances offshore to the extent consistent with the project safety plan and crew safety in general. Nearly all past surveys were piloted by

pilot/biologist Bill Larned (Table 3). Alternate pilots had served previously as observer on this project, thus were thoroughly familiar with routes and procedures, and were provided with past reports, recorded flight paths, safety plans and all other relevant information. The aerial crew in 2011 consisted of pilot/observer Bill Larned and observer Robert Platte.

For geographic reference, the shoreline was initially divided into 126 numbered segments (Larned et al. 1994), identical to those used for the annual spring emperor goose survey conducted by the U.S. Fish and Wildlife Service, Fairbanks. However, in 1997 we began using a global positioning system (GPS)/laptop computer data collection system which enabled us to electronically record our flight path and the precise location of each observation, so geographic segments were no longer used. The more recent procedure, utilizing a laptop computer for each observer, connected to the onboard GPS receiver, enabled each observer to record observations vocally directly into his/her computer. A custom program developed by John Hodges (U.S. Fish and Wildlife Service, Migratory Bird Management, Juneau, AK) recorded our flight path and automatically linked GPS coordinates to each recorded observation. Recorded observations were later transcribed using an associated program, also created by Hodges, which produced ASCII data files in which each line contained a single observation, including species, numerical count or estimate, geographic coordinates, date, and time. We also recorded auxiliary data, including observers' initials and position in aircraft, tide stage (high, medium, low, and unknown), ice cover in tenths, sea condition (Beaufort scale), wind and sky condition. The latter environmental data have been archived, but thus far used only anecdotally.

The survey was designed to correspond to the specific distribution of Steller's eiders during the spring staging period, and therefore was not necessarily optimal for other species in route or timing. Data for other species are useful primarily to indicate habitat associations persistent among years, and as an "early warning" of major spatial and/or temporal population changes to signal the need for and help direct specific investigations. This document and other annual survey reports contain brief discussions of results for other important sea ducks, while a more detailed interpretation for other selected species is contained in Larned (1998).

The Steller's eider survey total is considered a minimal population estimate because some birds may escape detection by the survey crew by moving northward during the periods between survey flights, while others may be outside the survey area (north or south) during the survey, or simply overlooked. While we strive to minimize such errors, we have not incorporated a method for detecting or measuring bird movements that may occur during the survey, other than comparing contemporaneous satellite telemetry data from small numbers of eiders in a few recent years. No such data from instrumented birds were available for 2011. Since 2000 offshore shoal areas that were too extensive to cover contiguously within budget and safety parameters were surveyed using a "saw tooth" array of sample strips, 500 or 600m wide, depending on survey conditions (Fig. 3). We calculated population estimates for these areas by extrapolating the average density of each species within the samples to the sampled area (Fig. 3). We believe in most cases this procedure produced results more accurate for Steller's eiders and other sea ducks than using unadjusted data, except perhaps king eiders, whose typically highly clustered distribution may have yielded results biased by large sampling error. In 2011 and some other prior years we deviated from the sampling procedure in Kvichak Bay (which contained most of the king eiders in the survey), as calm sea surface and excellent visibility conditions

enabled us to visually detect and estimate most or all flocks. Differences in Steller's eider estimates from shoreline counts prior to 2000 vs. those made later using the "saw tooth" sampling procedure were trivial in the total survey context, as the extrapolated estimates of total observed Steller's eiders recorded within the sampled areas as a percentage of the survey total ranged from 0 percent (2005) to 7.5 percent (2000).

To produce a consistent annual estimate of the target component of the Pacific Steller's eider population, it is critical to conduct the survey when all or most of that population is within the defined survey area between the western end of the Alaska Peninsula and Nunivak Island. The original design strategy (1992) was to bracket the assumed migration period with up to 3 or 4 replicate surveys per year, and use the highest annual count as that year's Steller's eider estimate. This was successfully accomplished to varying degrees prior to 1998. However, due to funding shortages and extended periods of inclement weather, from 1998 to 2011 only one survey per year was flown, with the exception of 2008 when two surveys were conducted. During the latter period optimal timing was estimated using a combination of near-real-time satellite imagery (NASA MODIS Rapid Response System) depicting sea ice coverage of favored staging habitats and migration routes, reconnaissance anecdotes from cooperators located within the survey area, and current forecasts of wind patterns and other weather factors that have long been correlated with timing and synchronization of eider migration (Myres 1958, Woodby and Divoky 1982).

In addition to suboptimal survey timing, another source of error is flock estimation bias. We have attempted to measure and correct for this bias using a representative double sample of oblique aerial photographs of flocks which were also estimated visually. In 1998, visual estimates made by Larned of 17 Steller's eider flocks ranging in size from 94 to 2194 birds, were variable and averaged 35 percent lower than counts made from photographs of the same flocks. The small sample was inadequate for generating a ratio useful for adjusting for observer bias, but suggests that my flock estimates may be low-biased – a tendency common among aerial observers, especially with large dense flocks that are characteristic of wintering and migrating Steller's eiders (Joensen 1974). Unfortunately, attempts to obtain paired photo/visual counts to better understand, and perhaps correct for, estimation bias, have been largely thwarted by the frequent, mostly synchronous diving behavior of Steller's eiders. Our experience suggests that incorporation of this method would require extensive and time-consuming circling maneuvers for each flock, the disturbance of which would often result in dispersal or recombination of other nearby flocks. This would complicate visual flock estimation, and exacerbate fuel reserve issues which are often already critical. In our opinion, if there is potential in this method it lies in use of a second aerial crew dedicated to obtaining comprehensive photo coverage of all eiders in each of a subset of surveyed aggregations, such as those within the lagoons along the Alaska Peninsula.

For all survey years since the survey's inception in 1992, with the exception of 2009, the survey crew has consisted of Bill Larned as pilot and port observer, with various starboard observers (Table 3). We attempted to minimize the effects of inconsistent observer bias by using only experienced aerial observers, and by the pilot/observer intentionally maneuvering the aircraft so that the majority of large eider flocks were on his side for estimation. Observers practiced flock estimation within one week

prior to each survey, using a computer simulation program (Wildlife Counts by John Hodges, USFWS, Juneau, AK), and reviewing aerial photographs of eider and other sea duck flocks of known size.

RESULTS

Habitat and survey conditions

Upon our arrival in Bethel on 13 April we found conditions both on and off shore north of Kuskokwim Bay still locked in ice and snow; the fifth in a string of late springs. Satellite imagery downloaded from the NASA MODIS Rapid Response System website (Fig. 1) showed that most of the Bering Sea pack ice was still present in nearly its maximum winter extent, but Bristol Bay and the Alaska Peninsula lagoons were essentially ice-free. Ice in Kuskokwim Bay appeared to consist primarily of fine thin particles spread evenly southward by northerly winds, with shore fast ice west of the Kuskokwim River mouth typically extensive for this date, and the lagoons (Goodnews, Chagvan and Nanvak Bays) almost completely ice-covered. These conditions, coupled with a synoptic pattern favoring good flying weather with persistent moderate northerly winds suggested an ideal survey window, during which most Steller's eiders would be staging in Bristol Bay lagoons and unlikely to begin to migrate northward out of the survey area soon. We completed the survey from 13-19 April (see itinerary below), with the favorable weather, winds and sea ice conditions persisting throughout, and no eider migration apparent during the survey. Our recorded flight paths for the survey are displayed in Fig 3. Total flight time of 34.3 hrs. includes transit flights (Appendix 1).

Itinerary for 2011:

4/13 2.7-hr flight to ferry survey aircraft Anchorage to Bethel. 3.5-hr survey flight, Nunivak Island south side, abbreviated on west end due to fog. Overnight at FWS bunkhouse.

4/14 Grounded in Bethel due to aircraft mechanical problem.

4/15 Repaired plane in the morning, in afternoon flew 3.8-hr survey flight, Kipnuk to Kuskokwim River mouth.

4/16 8.0-hr. 2 survey flights, Bethel to King Salmon. Overnight at King Salmon, FWS bunkhouse.

4/17 4.3-hr. survey flight, lagoons and shoreline King Salmon to Port Moller, then direct to Cold Bay. Overnight at Cold Bay FWS bunkhouse.

4/18 3.6-hr. survey flight, Port Moller, Herendeen Bay and Nelson Lagoon. Overnight at Cold Bay FWS bunkhouse.

4/19 3.6-hr. survey flight, Izembek NWR and Cold Bay area. 2.6-hr ferry flight Cold Bay to King Salmon, Overnight at King Salmon FWS bunkhouse.

4/20 2.2-hr ferry flight King Salmon to Anchorage – end of survey.

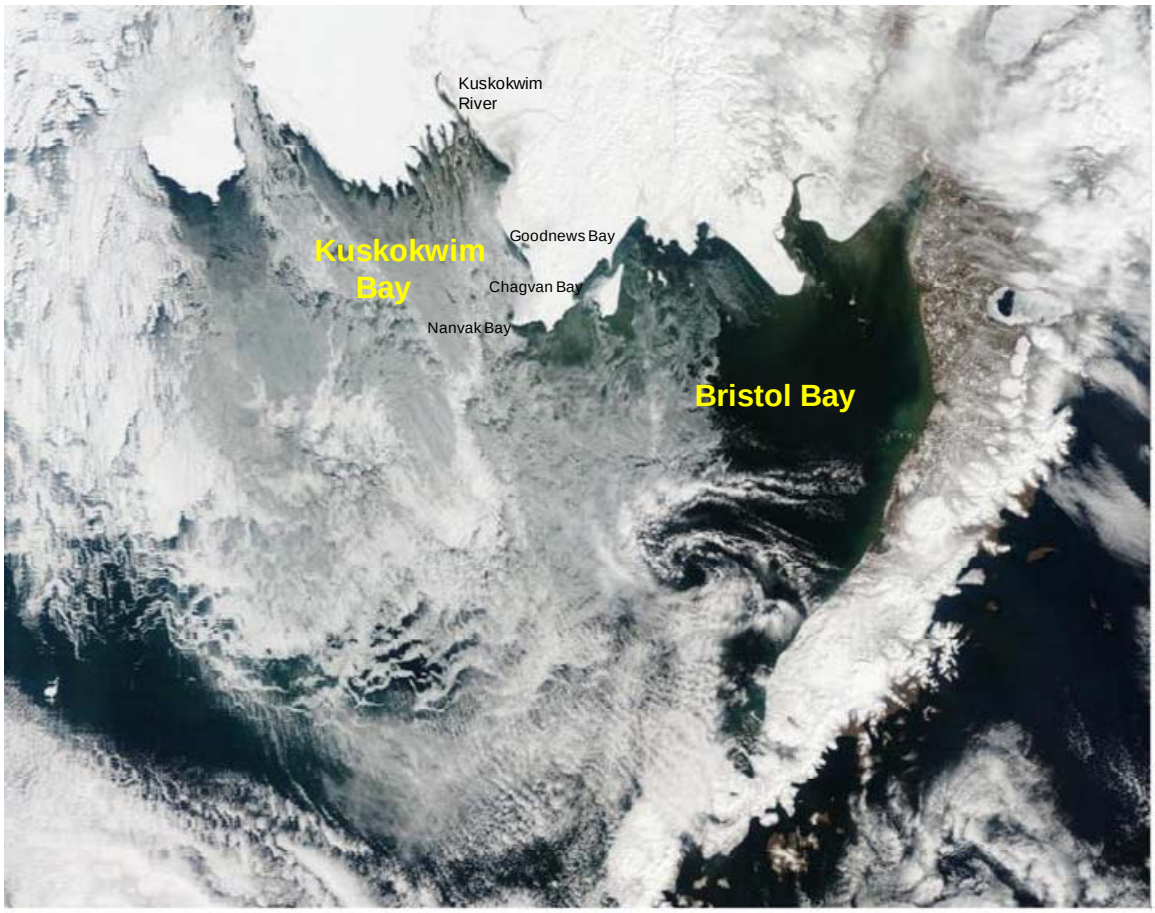

Figure 1. Satellite image of sea ice distribution, southwest Alaska, 14 April 2011. Images from http://rapidfire.sci.gsfc.nasa.gov/realtime/.

Steller's eider results

The 2011 Steller's eider estimate of 74,369 was only 9% below the 1992-2010 average (81,925), and 35% above the 2010 estimate (54,888, Table 2). Calendar timing of the survey was about average, but only 3026 Steller's eiders were north of Bristol Bay, and 4705 were north of the Alaska Peninsula (Table 1, Fig. 3). The mostly ice-free lagoons of the Peninsula held 94% of the total estimate while 51% were in the Cold Bay area, including Izembek Lagoons, cold Bay, and Bechevin Bay (Table 1, Fig. 3). Though we did not survey Sanak Islands or any other habitats south of the Alaska Peninsula lagoons, it was unlikely there were significant numbers of eiders there, due to the early thawing of favored habitats in Bristol Bay. The exponential trend line of our 1992-2011 estimates indicates a 2.3% decline (R2=0.34), while the decline during the 2003 to 2011 period is a slight 0.7% (R2=0.06) (Fig. 2). Though eider numbers have not returned to the level of the earliest years of the survey, they appear to have stabilized since 2002 (Fig. 2).

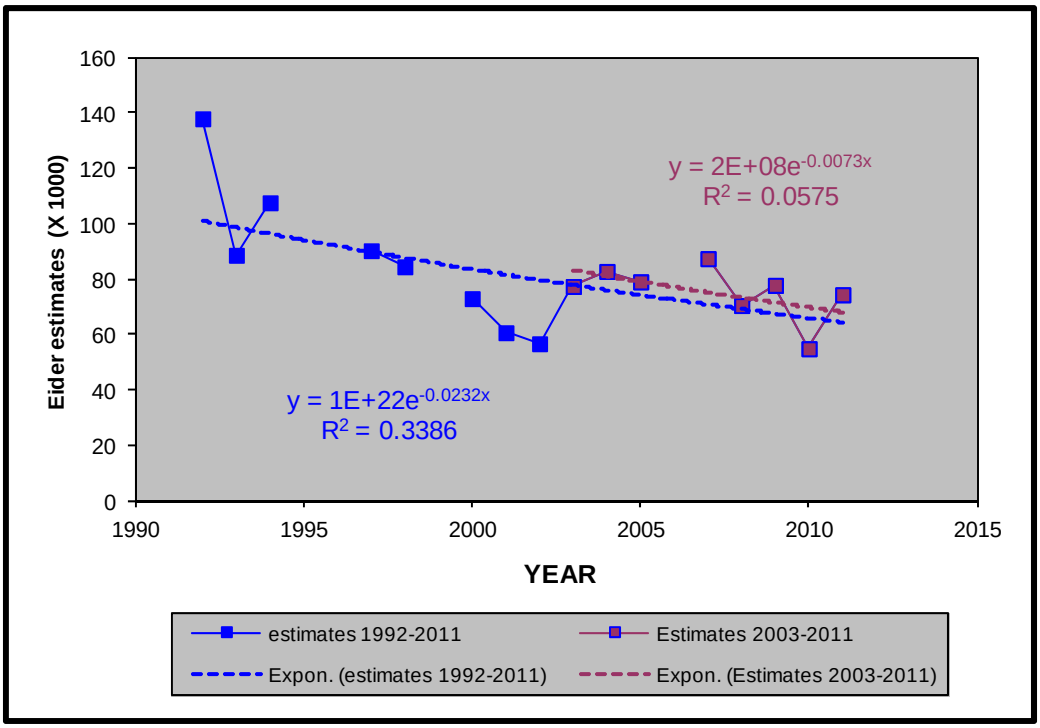

Fig. 2. Trend in Steller's eider estimates from aerial surveys, southwest Alaska, April and May, 1992-2010.

Other Waterfowl

While this survey was not designed to produce high-confidence estimates for species other than Steller's eiders, we have consistently recorded data on non-target sea ducks, geese and other waterbirds to help characterize general staging patterns and relative abundance over the long term, to identify large scale changes, and anticipate problems associated with proposed projects or changes in marine habitats. Both common and king eiders are early migrants and often migrate well offshore, thus we feel we often record a relatively small portion of those that migrate through the survey area. This year the *common eider* estimate was 1,084, most of which were in the northernmost shoals of Kuskokwim Bay and in lower Alaska Peninsula lagoons (Table 1, Fig. 4). The 2011 total estimate of *king eiders* was 82,995, well below the long term average of 166,841 (Table 2). We felt that most of the king eiders were already north of the survey area during our survey. While we recorded the majority of king eiders in their main early spring staging area, smaller numbers were counted in Kuskokwim Bay and along the south shoreline of Nunivak Island (Table 1, Fig. 5). The 2011 l*ong-tailed duck* total of 18,192 was slightly below average for the survey (Table 2), with the largest concentrations among the shoals in northern Kuskokwim Bay and in the Port Moller/Herendeen Bay area (Table 1, Fig. 6). The rest were scattered widely throughout the survey route, typical for this survey. The *Black scoter* survey total (30,894) was also below average (Table 2), with most concentrated along shorelines and in lagoons on the lower Alaska Peninsula, and in Kvichak Bay (Table 1, Fig. 7). We saw no black scoters north of Bristol Bay. *White-winged scoters* totaled 1,648, well below the long-term average of

2,731 (Table 2. The largest concentration was recorded along the shoreline between Port Heiden and Port Moller – 1,421 birds or 86% of the total (Table 1, Fig. 8). Most of those were at Cape Seniavin, an area that often holds many spring staging white-winged scoters, as well as king and sometimes Steller's eiders. Consistent with the five-consecutive-year run of late springs was the complete absence of brant and emperor geese north of the Alaska Peninsula during the mid-April survey (Table 1, Figs. 9, 10). Brant counts were higher this year than the long term average (68,693 compared to 50, 245), while emperor geese were lower than average (15,728 vs. 36,368) (Table 2). Emperor goose populations are addressed specifically during a dedicated annual spring survey, as their distribution is difficult for us to cover thoroughly while conducting the Steller's eider survey.

CONCLUSIONS AND RECOMMENDATIONS

Timing is unquestionably a critical component of this annual survey. Sub-optimal timing will nearly always result in a portion of the population not being counted, thus the estimate is expected to be low-biased. For trend calculation we have used the highest annual estimate, which we assume to be the most optimally timed and therefore most inclusive. The first 4 years of the survey included 2 to 3 replicates, while only one of the subsequent 11 years (2008) included a replicate count (Table 3). In the absence of a high-confidence alternative method of determining optimal timing of the migration, optimal timing of the early subset of survey years was more likely than that of the later, and thus relatively high-biased. I feel it is likely this imbalance in the set of 15 survey-years within a 19-year span negatively biased the calculated trend. If a Steller's eider monitoring program is to be continued with a major objective of Pacific population trend estimation, I recommend either reinstating a replicated design and/or continuing satellite telemetry to help determine the current year's optimal survey timing window.

Alternatively, it may be prudent to test the efficacy of an early autumn monitoring survey of molting Steller's eiders among the well known molting areas in southwest Alaska. During the molt, timing should be more reliable as birds are more spatially stable, and flock behavior is more likely to favor photographic survey techniques, with more precise estimates or counts. I recommend such an experimental survey be conducted as soon as funding can be secured.

ACKNOWLEDGMENTS

Robert Platte (US Fish and Wildlife Service, Waterfowl Management Branch, Anchorage) did an excellent job as observer, and his services are deeply appreciated. We gratefully acknowledge the assistance of the managers and staffs of Alaska Peninsula/Becharof, Izembek, and Yukon Delta National Wildlife Refuges, who provided for the logistic needs of the survey crew. Thanks also to members of the Steller's Eider Recovery Team for their continued support of this project.

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Table 1. Sea duck and goose estimates for geographic aerial survey units, spring Steller's eider survey, southwest Alaska, April 13-19, 2011.

Survey Unit	Date surveyed	Elapsed Time	Expansion Factor	Common eider	King eider	Steller's eider	Harlequin duck	Long-tailed duck	Surf scoter	Black scoter	White-winged scoter	Goldeneyes
Nunivak Island	4/13	0:49	1.00		78	12		30				
Toksook Bay to Kuskokwim R.	4/15	2:02	1.00	354	4	1,330		5,792				
Kuskokwim R. to Chagvan Bay [1]	4/16	1:38	6.88	14	3,880	736		2,635			76	
Goodnews Bay[2]	4/16	0:10	1.00			948						
Chagvan Bay[3]	4/16	0:02	1.00									
Nanvak Bay[4]	4/16	not surveyed	1.00									
Nanvak Bay to Togiak Village	4/16	0:47	1.00	83	8	855		803	5		57	2
Togiak Vilage to Kulukak Bay	4/16	0:36	1.00			749	52	224				83
Kulukak Bay to Cape Constantine	4/16	0:24	1.00			75		31		10	7	54
Cape Constantine	4/16	0:09	1.00		21,404							
Kvichak Bay	4/16	0:52	1.00		57,456			1,642		5,480	2	
Naknek River to Port Heiden	4/17	0:51	1.00		5	384		340		929	31	
Egegik Lagoon	4/17	0:11	1.00					23		17		3
Ugashik Lagoon	4/17	0:12	1.00	4				260		18		
Cinder River Sanctuary	4/17	0:08	1.00			255						
Port Heiden	4/17	0:41	1.00	21		4,887				32		
Port Heiden to Port Moller	4/17	0:47	1.00	150		1,570		99		8,463	1,421	
Seal Islands Lagoon	4/17	0:13	1.00			2,599				30		
Port Moller/Herendeen Bay	4/17-18	0:58	1.00	100		10,861		5,828		6,050		
Nelson Lagoon	4/18	0:43	1.00	358		10,918		5		7		6
Nelson Lagoon to Izembek Lagoon	4/18	0:39	1.00		160	180	6	153		9,331	45	
Izembek Lagoons	4/19	1:54	1.00			37,664		145		276		74
Kinzerof Lagoon	4/19	0:10	1.00			79	47	2		20		15
Morzhovoi Bay Lagoons	4/19	0:11	1.00									170
Bechevin Bay	4/19	0:29	1.00			267	13	180	1	231	9	15
Totals				**1,084**	**82,995**	**74,369**	**118**	**18,192**	**6**	**30,894**	**1,648**	**422**

1. Estimates reported herein for these survey units are expanded using a factor calculated as: area of survey unit/(transect length x transect width). Survey areas extrapolated to are illustrated in figures 2 & 3.
2. Goodnews Bay 90+ percent ice-covered. 3. chagvan Bay 95+ percent ice-covered. 4. Nanvak Bay 100 percent ice-covered.

Table 1. Continued

Survey Unit	Date surveyed	Elapsed Time	Expansion Factor	Bufflehead	Mergansers	Black brant	Emperor goose
Nunivak Island	4/13	0:49	1.00				
Toksook Bay to Kuskokwim R.	4/15	2:02	1.00		1		
Kuskokwim R. to Chagvan Bay [1]	4/16	1:38	6.88		69		
Goodnews Bay[2]	4/16	0:10	1.00				
Chagvan Bay[3]	4/16	0:02	1.00				
Nanvak Bay[4]	4/16	not surveyed	1.00				
Nanvak Bay to Togiak Village	4/16	0:47	1.00		20		
Togiak Vilage to Kulukak Bay	4/16	0:36	1.00		262		
Kulukak Bay to Cape Constantine	4/16	0:24	1.00		77		
Cape Constantine	4/16	0:09	1.00				
Kvichak Bay	4/16	0:52	1.00				
Naknek River to Port Heiden	4/17	0:51	1.00		74		300
Egegik Lagoon	4/17	0:11	1.00		25		300
Ugashik Lagoon	4/17	0:12	1.00		12		
Cinder River Sanctuary	4/17	0:08	1.00		25		1,413
Port Heiden	4/17	0:41	1.00		29		3,191
Port Heiden to Port Moller	4/17	0:47	1.00				67
Seal Islands Lagoon	4/17	0:13	1.00				2,001
Port Moller/Herendeen Bay	4/17-18	0:58	1.00		61		934
Nelson Lagoon	4/18	0:43	1.00		18		5,569
Nelson Lagoon to Izembek Lagoon	4/18	0:39	1.00		69		
Izembek Lagoons	4/19	1:54	1.00	4	73	68,583	1,653
Kinzerof Lagoon	4/19	0:10	1.00	13	23		
Morzhovoi Bay Lagoons	4/19	0:11	1.00	20	16	90	
Bechevin Bay	4/19	0:29	1.00		132	20	300
Totals				**37**	**986**	**68,693**	**15,728**

1. Estimates reported herein for this survey unit are expanded using a factor calculated as: area of survey unit/(transect length x transect width). Survey area extrapolated to is illustrated in figure 2.

2. Goodnews Bay 95+ percent ice-covered. 3. chagvan Bay 95+ percent ice-covered. 4. Nanvak Bay 100 percent ice-covered.

Table 2. Survey totals for all species, Spring Steller's eider surveys, southwest Alaska, 1992-2011. For years with multiple surveys, only results from the survey with the highest Steller's eider count are shown.

SURVEY DATES:	5/2-6/1992	4/10-13/1993	5/6-12/1994	4/15-19/1997	4/22-29/1998	4/17-23/2000	4/22-5/1/2001	4/21-29/2002
Birds:								
Pacific loon	2	30	34	45	23	5	3	0
Red-throated loon	78	51	270	11	97	61	188	64
Common loon	5	13	13	8	0	0	0	5
Yellow-billed loon	2	0	0	0	0	0	0	1
Unident. loon	0	0	85	7	24	3	137	23
Red-necked grebe	32	793	221	178	29	114	316	186
Horned grebe	0	0	3	0	0	2	0	0
Cormorants	979	1,082	1,618	829	653	335	674	483
Tundra swan	2	9	2	24	46	0	7	0
Canada goose	169	28	34	57	210	26	97	2
Brant	5,289	81,743	71,551	80,099	34,045	58,212	74,837	35,610
Gr. white-fronted goose	0	430	30	80	54	0	94	0
Emperor goose	27,876	28,542	25,816	41,279	53,926	32,562	41,800	43,014
Mallard	88	27	39	107	2	97	15	20
Gadwall	5	2	15	0	10	2	0	0
Northern pintail	5,325	1,792	1,760	1,414	893	857	618	1,431
Wigeons	4	0	8	2	79	2	0	0
Northern shoveler	28	2	14	0	3	0	4	0
Am. Green-winged teal	0	0	75	2	1	0	0	35
Canvasback	0	3	57	0	2	0	0	0
Scaups	11,106	5,316	6,598	3,072	2,289	1,864	1,188	1,465
Common eider	5,941	5,069	6,997	21,916	3,862	8,570	5,779	669
King eider	87,954	62,544	69,638	241,992	71,438	219,403	58,128	48,077
Spectacled eider	40	26	35	20	16	0	4	0
Steller's eider	**137,904**	**88,636**	**107,589**	**90,269**	**84,459**	**72,953**	**60,656**	**56,704**
Harlequin duck	757	608	838	328	243	373	946	438
Long-tailed duck	20,512	13,184	22,987	25,548	22,025	48,112	18,948	18,551
Surf scoter	23	347	48	359	8	17	17	114
Black scoter	42,382	37,985	35,672	31,750	45,312	55,538	33,586	29,250
White-winged scoter	1,331	432	484	2,080	2,520	8,484	4,399	2,706
Unident. scoter	361	0	0	1,474	136	0	0	3,962
Goldeneyes	711	177	263	365	136	319	181	222
Bufflehead	36	66	400	0	0	2	0	0
Mergansers	2,103	1,176	2,766	670	1,395	214	211	648
Bald eagle	24	78	29	23	22	17	24	19
Sandhill crane	4	21	10	0	2	0	0	0
Shorebirds	0	0	9,784	40,540	10,012	13,990	456	5,262
Gulls	18,072	49,544	25,038	27,738	25,779	7,991	9,249	15,622
Black-legged kittiwake	68,888	26,579	6,614	41,957	28,333	2,624	479	10,845
Guillemots	0	0	0	0	0	0	0	0
Marine mammals:								
Sea otter	1,736	981	809	1,554	1,068	809	523	442
Pacific walrus	229	315	1,030	143	136	110	1	0
Seal	588	1,976	2,130	1,156	620	438	1,617	4,191
Steller's sea lion	314	902	833	934	1,033	42	8	13
Harbor porpoise	17	9	5	8	1	12	0	6
Belukha whale	80	10	67	100	0	62	0	0
Orca whale	1	0	0	6	0	0	0	0
Humpback whale	0	0	0	0	0	0	0	0
Grey whale	92	114	94	102	57	37	14	30

Table 2. Continued

SURVEY DATES:	3/29-4/11/2003	4/1-11/2004	4/2-4/8/2005	4/11-16/2007	4/24-29/2008	4/15-21/2009	4/18-21/2010	4/13-19-2011	1992-2010 avg
Birds:									
Pacific loon	7	0	0	0	12	0	0	0	11
Red-throated loon	2	0	1	1	4	3	8	2	56
Common loon	1	1	0	1	0	3	43	1	6
Yellow-billed loon	0	0	0	0	0	0	0	0	0
Unident. loon	4	10	8	57	26	9	3	23	26
Red-necked grebe	54	0	4	5	25	7	5	8	131
Horned grebe	0	0	0	3	0	0	0	0	1
Cormorants	217	33	1,110	966	283	252	133	548	643
Tundra swan	2	4	1	4	3	28	0	0	9
Canada goose	15	0	0	0	0	5	0	15	43
Brant	29,293	32,875	28,365	45,047	60,124	75,628	40,964	68,693	50,245
Gr. white-fronted goose	0	0	0	0	64	7	0	0	51
Emperor goose	35,288	53,614	30,681	37,501	37,794	17,394	38,438	15,728	36,368
Mallard	6	225	179	251	130	335	168	106	113
Gadwall	7	8	15	0	3	0	10	0	5
Northern pintail	1,250	1,875	3,528	2,126	4,438	1,963	470	410	1,983
Wigeons	10	85	25	145	15	113	95	0	39
Northern shoveler	0	0	0	0	2	0	0	0	4
Am. Green-winged teal	0	0	3	6	0	0	0	0	8
Canvasback	0	0	0	0	0	0	0	0	4
Scaups	3,557	3,310	5,618	3,832	1,749	1,865	1,750	2,465	3,639
Common eider	3,862	3,841	13,514	3,220	3332	5,934	2,325	1,084	6,536
King eider	109,627	195,841	146,512	575,376	285832	197,302	251,942	82,995	166,841
Spectacled eider	0	0	0	0	0	0	0	0	9
Steller's eider	**77,369**	**82,772**	**79,022**	**87,400**	**70,480**	**77,777**	**54,888**	74,369	81,925
Harlequin duck	176	381	378	1,774	341	1,230	128	118	596
Long-tailed duck	25,883	9,876	32,273	9,244	21,279	7,351	17,134	18,192	20,860
Surf scoter	13	8	0	52	6	25	0	6	69
Black scoter	42,698	16,980	48,040	49,392	41,223	27,910	33,108	30,894	38,055
White-winged scoter	818	102	10,623	995	3,787	1,847	362	1,648	2,731
Unident. scoter	4	32	1,400	0	8,000	15	0	181	1,026
Goldeneyes	610	1,175	1,079	848	255	29	278	422	443
Bufflehead	29	22	8	123	2	119	51	37	57
Mergansers	947	383	1793	2156	962	1022	584	986	1,135
Bald eagle	16	32	53	145	63	67	16	0	42
Sandhill crane	0	0	0	0	0	0	2	0	3
Shorebirds	770	842	2,900	4,842	10,305	10,014	13,827	6,480	8,236
Gulls	16,356	13,927	999	20,701	21,226	10,102	14,926	21,939	18,485
Black-legged kittiwake	710	200	756	168	3,600	1,502	2,606	90	13,057
Guillemots	0	0	0	56	0	7	5	1	5
Marine mammals:									
Sea otter	1,090	1,414	1,917	266	1,629	918	1,573	2,163	1,115
Pacific walrus	1	0	1	1	0	0	14	0	132
Seal	1,076	1,283	978	756	620	203	101	1,042	1,182
Steller's sea lion	1	0	22	9	38	40	30	1	281
Harbor porpoise	0	0	0	0	0	1	0	2	4
Belukha whale	0	2	34	0	0	0	3	0	24
Orca whale	0	0	0	0	0	0	0	0	0
Humpback whale	0	0	0	0	0	11	0	0	1
Gray whale	38	39	20	23	26	8	75	17	51

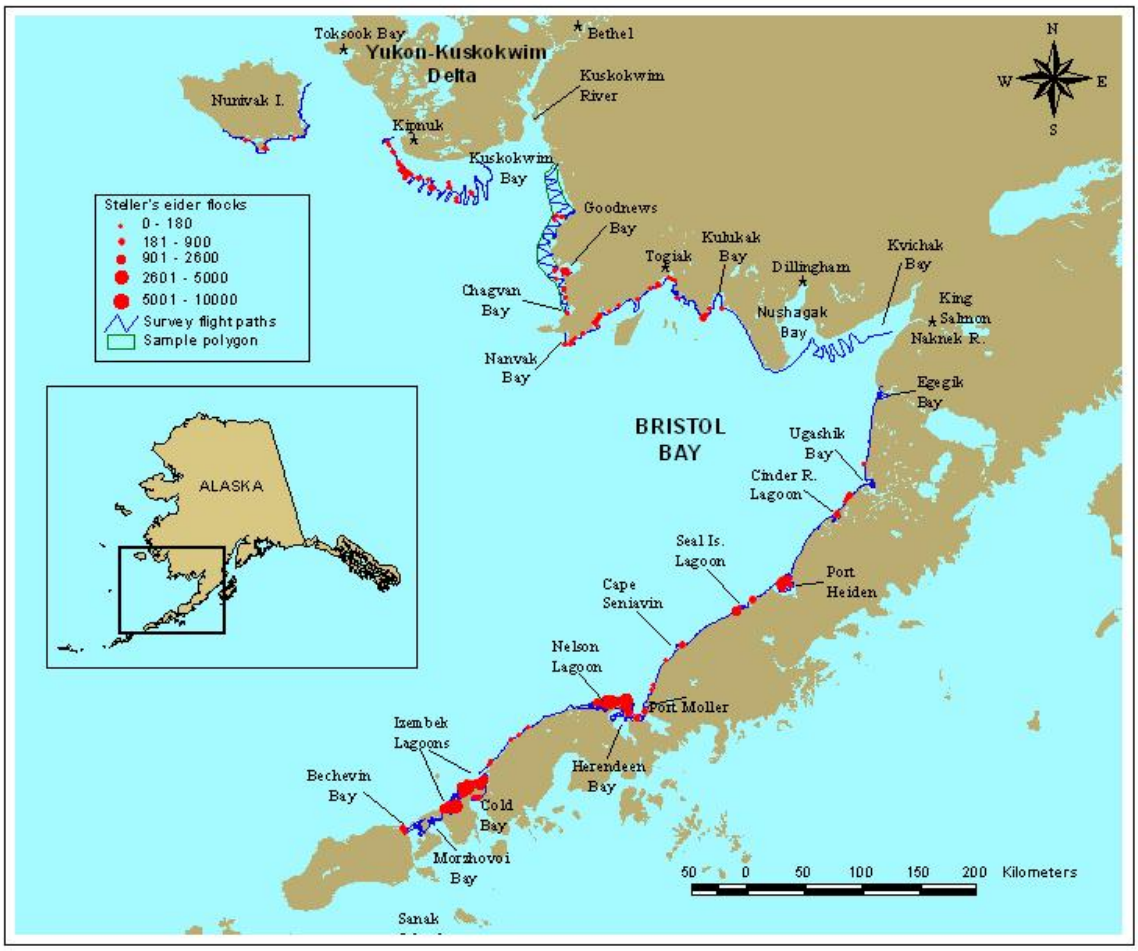

Figure 3. Survey sample areas, flight lines, and Steller's eider flock locations and relative size, Steller's eider spring migration survey, 13-19 April 2011.

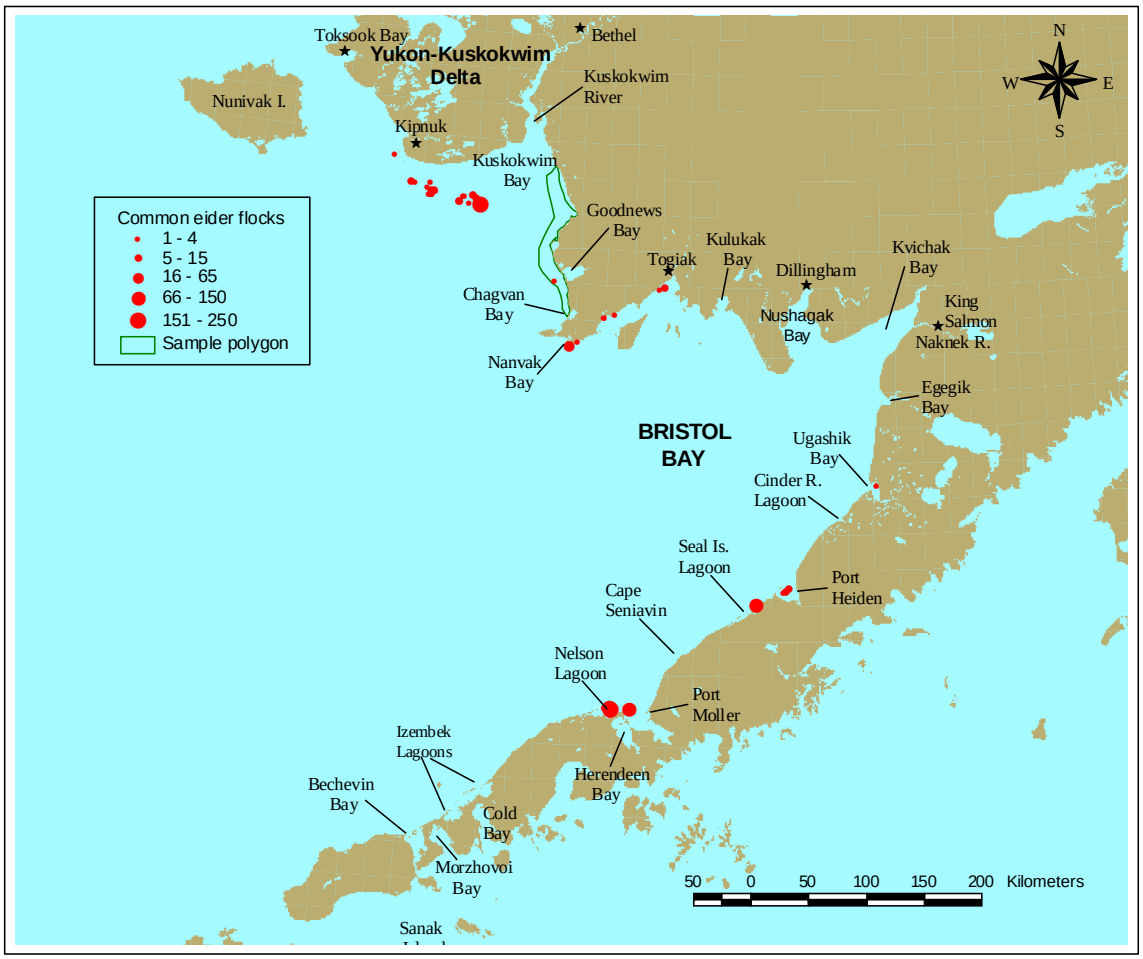

Figure 4. Location and relative size of common eider flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

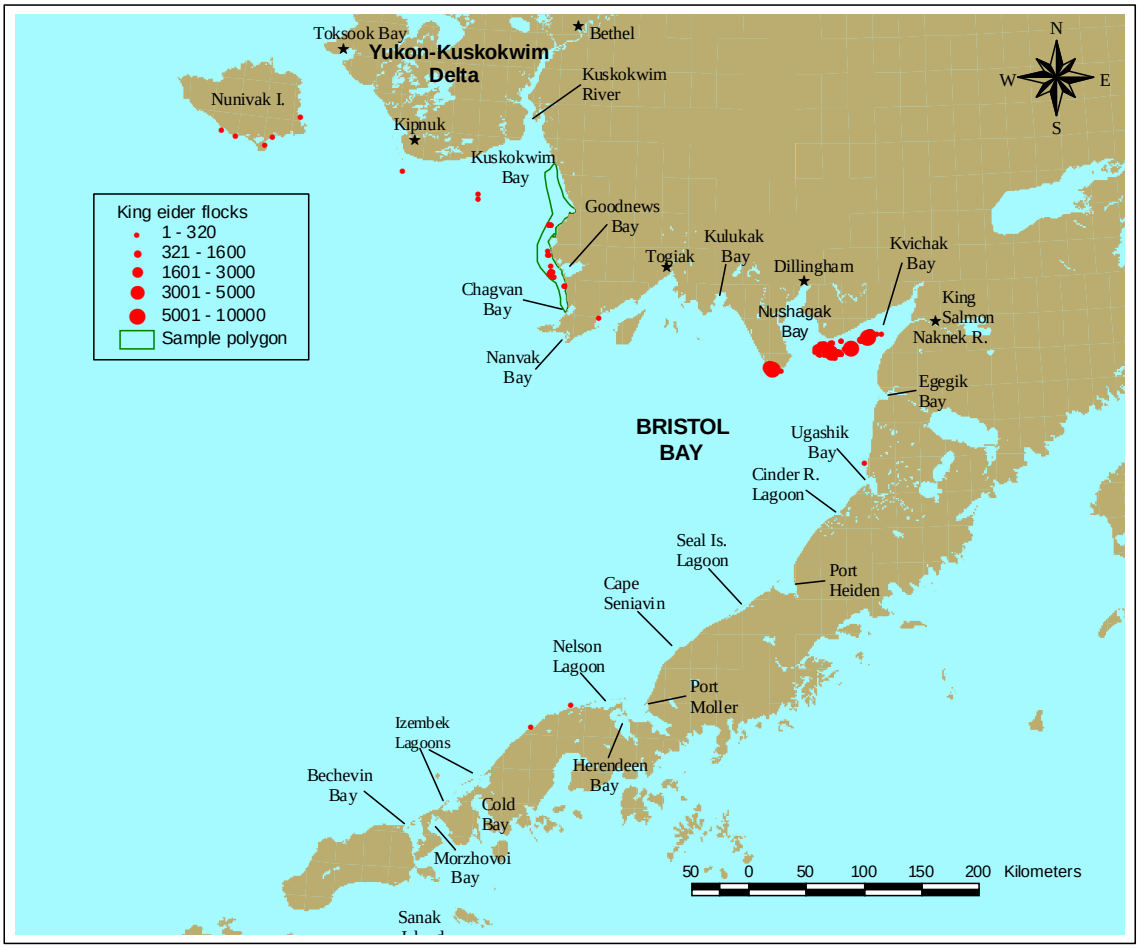

Figure 5. Location and relative size of king eider flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

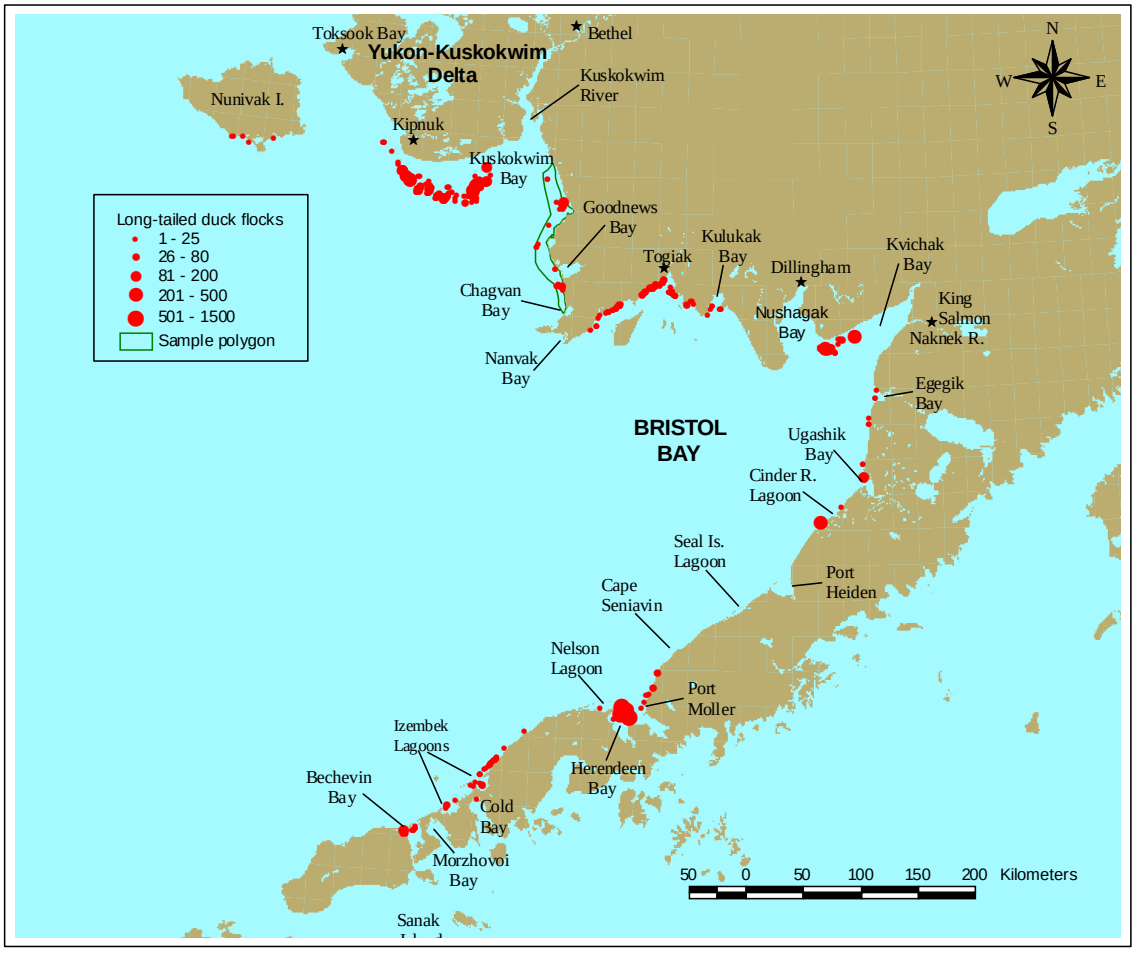

Figure 6. Location and relative size of long-tailed duck flocks recorded during Steller's eiders migration surveys, 13-19 April 2011.

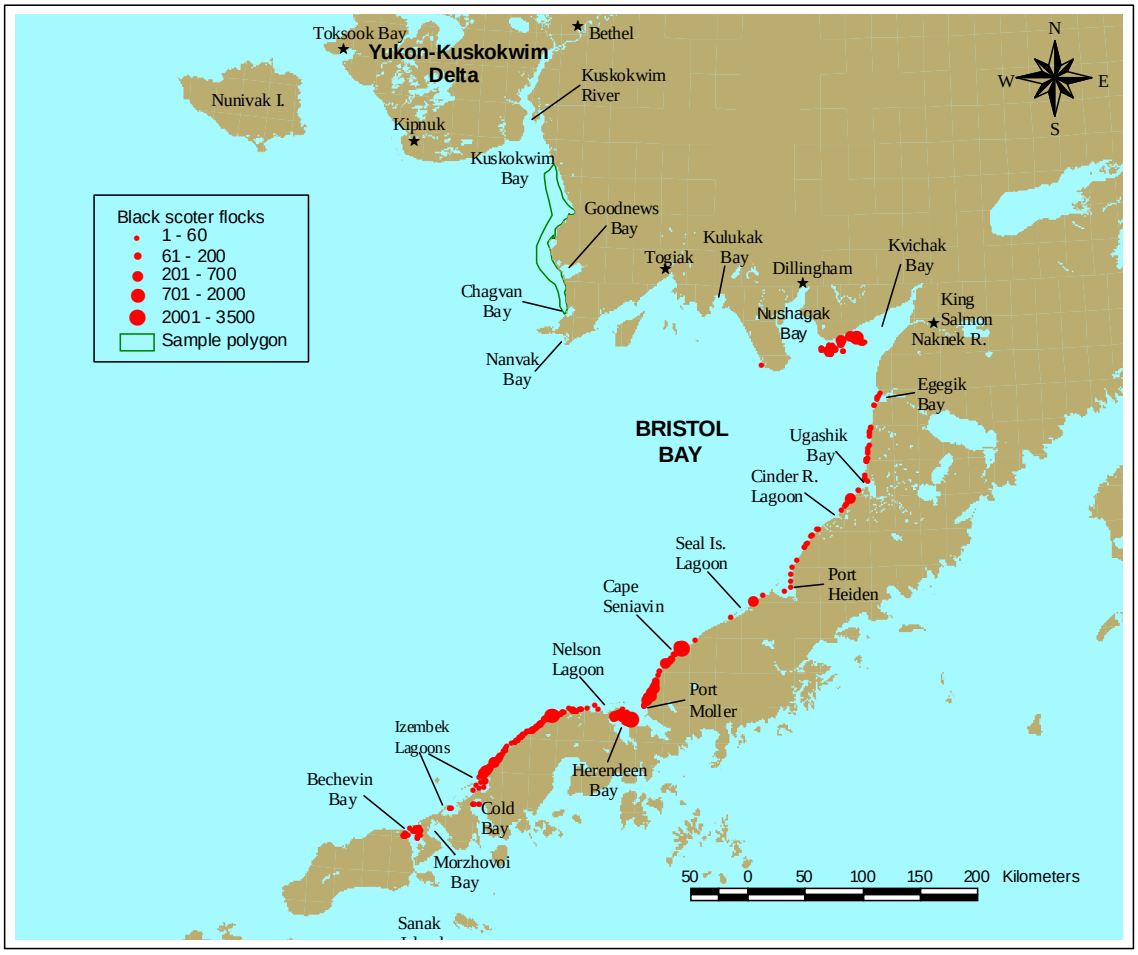

Figure 7. Location and relative size of black scoter flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

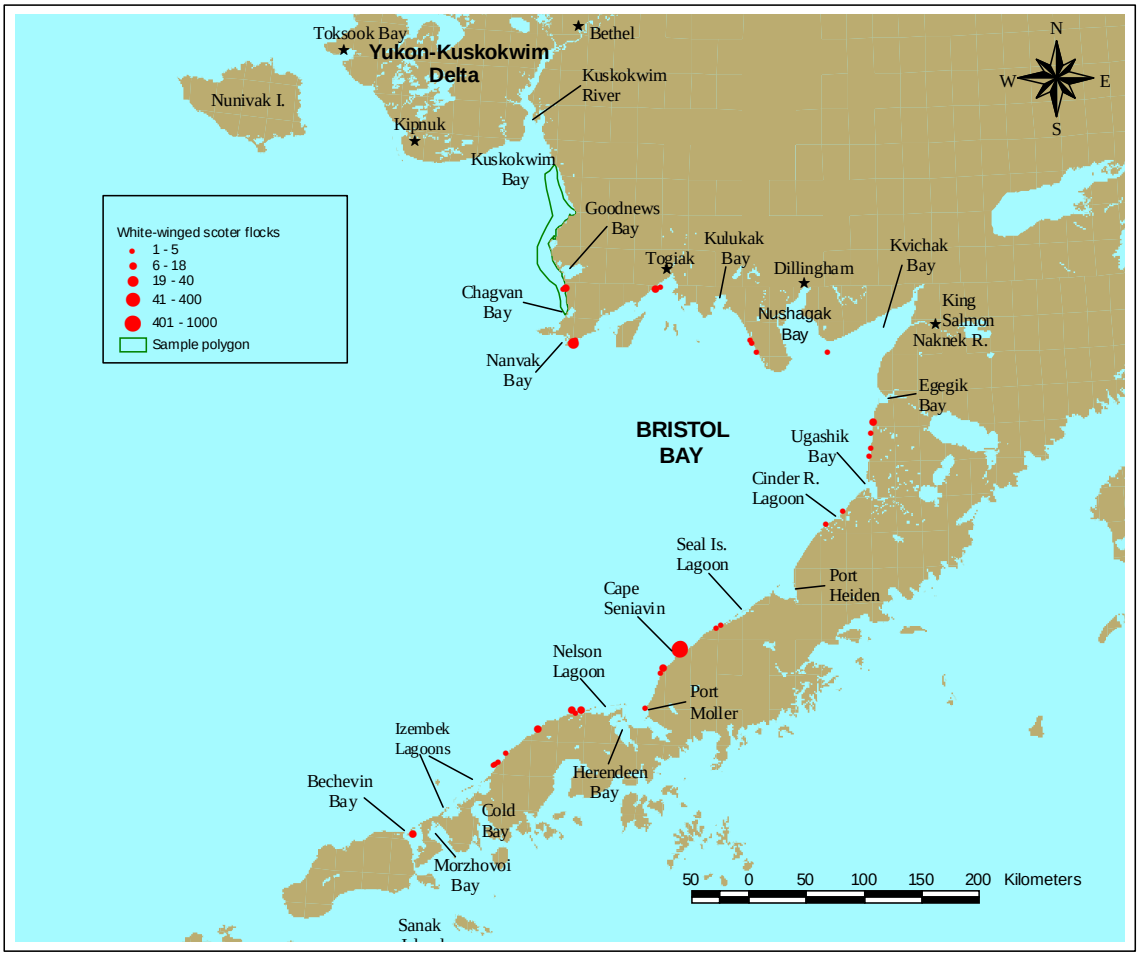

Figure 8. Location and relative size of white-winged scoter flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

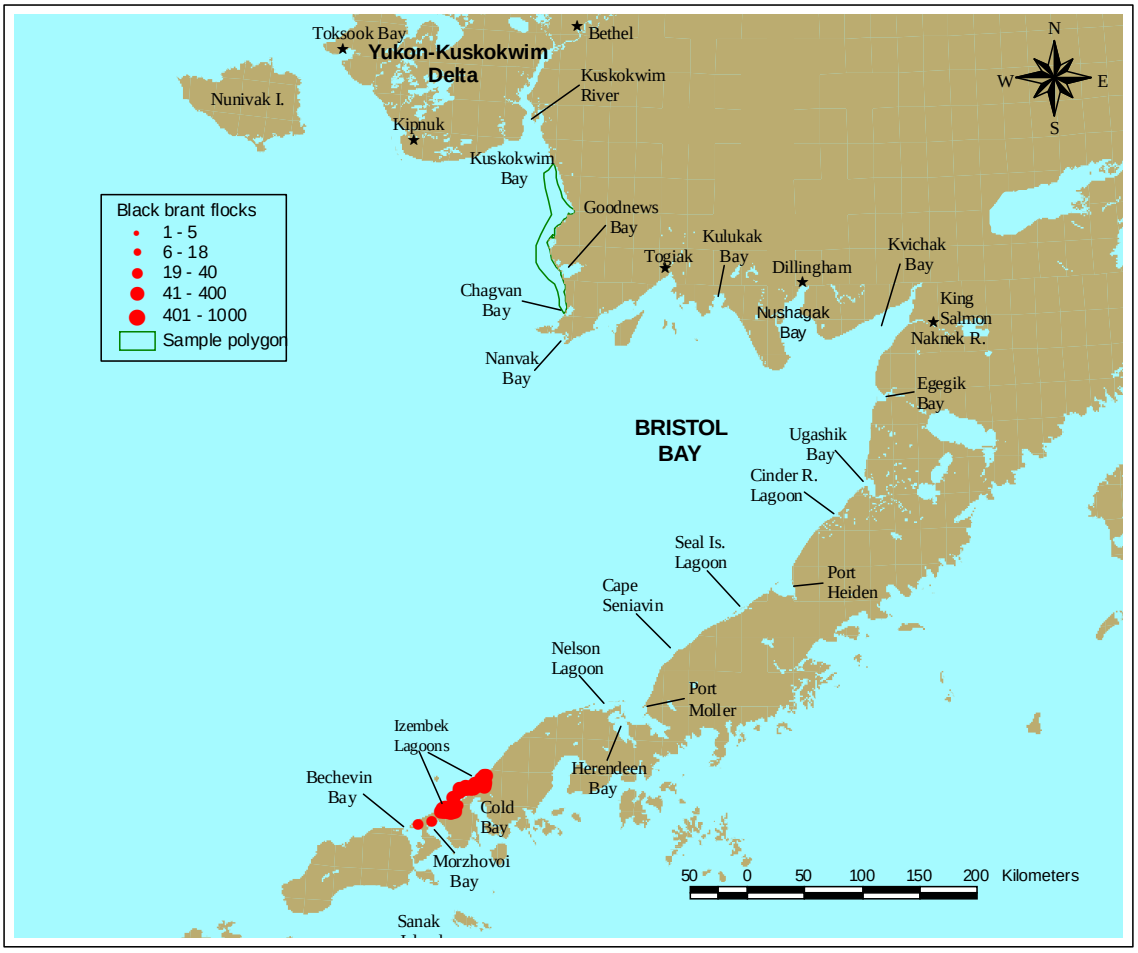

Figure 9. Location and relative size of black brant flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

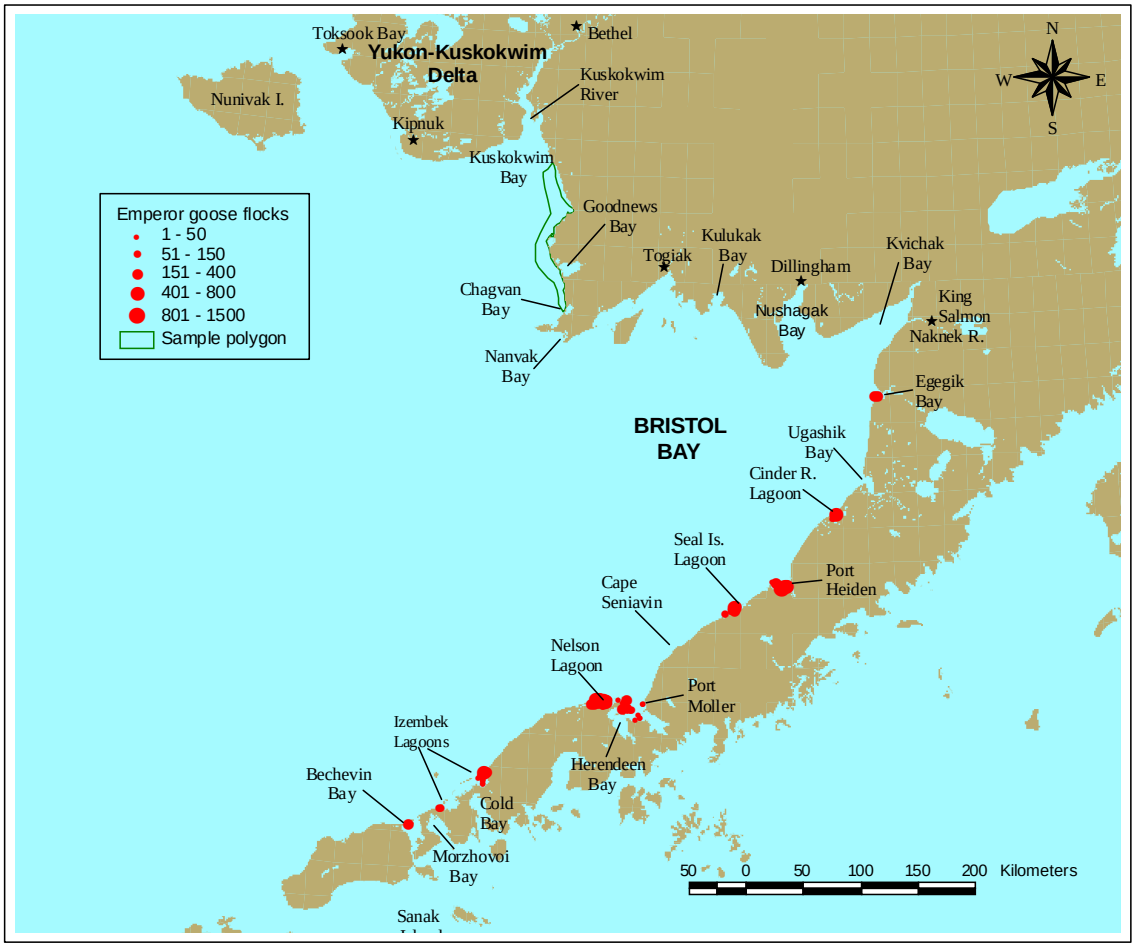

Figure 10. Location and relative size of emperor goose flocks recorded during Steller's eiders migration surveys, southwest Alaska, 13-19 April 2011.

Appendix 1. Inclusive dates, flight hours, and personnel, Steller's eider spring aerial migration surveys, southwest Alaska, 1992-2011. Pilots are in bold font, observers in normal.

	SURVEY 1			SURVEY 2			SURVEY 3		
Year	Dates	Flight hours	Personnel*	Dates	Flight hours	Personnel*	Dates	Flight hours	Personnel*
1992	4/9-13	39.1	**W Larned**, W Eldridge	4/23-27	32.1	**W Larned**, M Petersen, **W Butler**, M Wege B McCaffery	5/2-6	31.3	**W Larned**, J King
1993	4/6-9	35.8	**W Larned**, K Boden **W Butler**, M Wege	4/25-27	40.4	**W Larned**, K Laing **W Butler**, M Wege	5/3-8	34.3	**W Larned**, J King
1994	4/24-5/1	40.2	**W Larned**, J Pearce	5/6-12	25.0	**W Larned**, K Laing			
1997	4/15-19	36.4	**W Larned**, T Bowman	4/26-30	34.4	**W Larned**, T Tiplady			
1998	4/22-29	35.5	**W Larned**, R Platte						
2000	4/17-23	36.9	**W Larned**, T Eskelin						
2001	4/22-5/01	41.8	**W Larned**, P Anderson						
2002	4/21-29	42.6	**W Larned**, P Anderson						
2003	3/29-4/10	38.1	**W Larned**, J Fischer						
2004	4/1-11	35.8	**W Larned**, P Anderson H Wilson						
2005	4/2-8	33.0	**W Larned**, T Bowman						
2007	4/11-16	37.5	**W Larned**, K Bollinger						
2008	4/8-11	29.8	**W Larned**, K Bollinger	4/24-29	25.9	**W Larned**, T Bowman			
2009	4/15-20	44.0	**W Larned, K Bollinger,** S Savage						
2010	4/18-21	30.8	**W Larned**, K Bollinger						
2011	4/13-19	34.3	**W Larned**, R Platte						

APPENDIX 2. Common and scientific names of species mentioned in this report.

Common Name	**Scientific Name**
Loons and grebes: (Families *Gaviidae, Podicipedidae*)	
Pacific loon	*Gavia pacifica*
Red-throated loon	G. *stellata*
Common loon	*G. immer*
Yellow-billed loon	*G. adamsii*
Red-necked grebe	*Podiceps grisegena*
Horned grebe	*P. auritus*
Cormorants: (Family *Phalacrocoracidae*)	
Cormorants	*Phalacrocorax auritus, P. pelagicus, P. urile*
Swans, geese, ducks: (Family *Anatidae*)	
Tundra swan	*Cygnus columbianus*
Canada goose	*Branta canadensis*
Brant	*B. bernicla*
Greater white-fronted goose	*Anser albifrons*
Emperor goose	*Chen canagica*
Mallard	*Anas platyrhynchos*
Gadwall	*A. strepera*
Northern pintail	*A. acuta*
Wigeons	*A. Americana, A. penelope*
Northern shoveler	*A. clypeata*
Am. Green-winged teal	*A. crecca*
Canvasback	*Aythya valisineria*
Scaups	*A. marila, A. affinis*
Common eider	*Somateria mollissima*
King eider	*S. spectabilis*

APPENDIX 2. Continued.

Common Name	Scientific Name
Spectacled eider	*S. fischeri*
Steller's eider	*Polysticta stelleri*
Harlequin duck	*Histrionicus histrionicus*
Long-tailed duck	*Clangula hyemalis*
Surf scoter	*Melanitta perspicillata*
Black scoter	*M. nigra*
White-winged scoter	*M. fusca*
Goldeneyes	*Bucephala clangula, B. islandica*
Bufflehead	*B. albeola*
Common merganser	*Mergus merganser*
Red-breasted merganser	*M. serrator*
Eagles: (Family *Accipitridae*)	
Bald eagle	*Haliaeetus leucocephalus*
Cranes: (*Gruidae*)	
Sandhill crane	*Grus canadensis*
Shorebirds: (Families *Scolopacidae, Charadriidae, Haematopodidae*)	
Gulls: (Family *Laridae*)	
Gulls	*Xema sabini, Larus spp.,*
Black-legged kittiwake	*Rissa tridactyla.*
Alcids: (Family *Alcidae*)	
Guillemots	*Cepphus spp.*
Marine mammals:	
Sea otter	*Enhydra lutris*
Pacific walrus	*Odobenus rosmarus*
Seal	*Phoca spp., esp. Phoca vitulina*
Steller's sea lion	*Eumetopias jubatus*
Harbor porpoise	*Phocoena phocoena*
Belukha whale	*Delphinapterus leucas*
Orca whale	*Orcinus orca*
Gray whale	*Eschrichtius robustus*