

# Aerial surveys of eiders and other waterbirds on the eastern Arctic coast of Russia

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*Eiders and other waterbirds were surveyed between 1993-1995 along the eastern Arctic coast of Russia by fixed-wing aircraft to obtain baseline information on size and distribution of breeding populations. Population estimates were obtained for segments of the coast stretching from Kolyunchin Bay to the Lena River delta, a distance of 2,340 kms. The Spectacled Eider was the most abundant waterbird (146,245) with 46,276 (32%) recorded on the Indigirka River delta. Steller's Eiders were the second most abundant waterbird (128,760) with 60% recorded from the Indigirka River delta to the Yana River delta. King Eiders numbered 55,800 and were widely distributed. Common Eiders numbered 15,515 and were restricted to the eastern survey area. Population estimates for all waterbirds observed are presented. Numbers presented are not corrected for visibility bias of birds present but not seen. This survey, the first widespread systematic survey of the region, provided new information on Eider distribution and abundance, and provided baseline population data for future monitoring.*

**Key Words:** Eider, waterbird, Siberia, breeding population distribution and abundance, Arctic.

A dramatic decline in the breeding numbers of Spectacled Eiders *Somateria fischeri* in western Alaska (Stehn *et al.* 1993; Ely *et al.* 1994) prompted listing of the species as threatened in 1993, followed by the North American population of Steller's Eiders *Polysitcta stelleria* in 1997 (U.S. Fish and Wildlife Service 1993, 1997). Steller's Eiders are listed as a "rare" species in Russia due to reports of declining numbers and reduced breeding range (Solomonov 1987). Prior to our survey, the breeding status of Spectacled and Steller's Eiders in Russia was poorly known, and the wintering distribution of Spectacled Eiders had not been determined. Concern over the population declines of these species prompted studies in western Alaska and Russia on nesting ecology (Pear *et al.* 1998a, 1998b; Flint & Grand 1997; Grand & Flint 1997; Flint *et al.* 1997) and winter distribution (Petersen *et al.* 1995, 1998, 1999). In addition, aerial surveys were initiated to estimate the number of breeding Eiders in western and northern Alaska (Larned, pers. comm.; Mallek & King, pers. comm.; Dau & Taylor pers. comm.; Platte & Stehn, pers. comm.).

A concerted effort to survey waterbirds along broad stretches of the north coast of Russia by air had not been conducted prior to this survey. Because current information on eiders was lacking, this survey was proposed to: 1) determine the geographic distribution and minimum population estimates for eiders and other waterbirds from

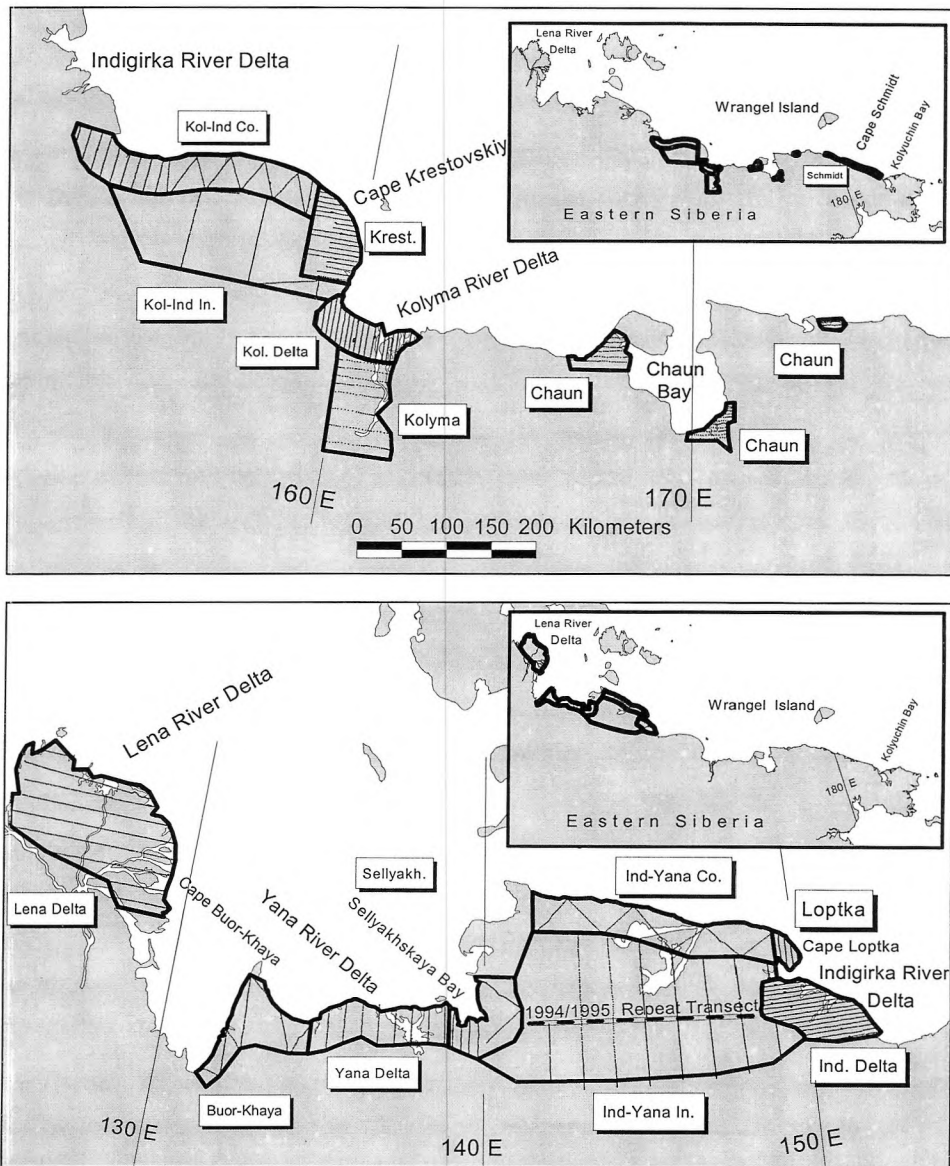
Kolyuchin Bay to the Lena River delta, Russia (**Figure 1**), and 2) conduct a survey that could be repeated for waterbird monitoring. In 1992 permission was obtained to fly an American survey aircraft to Russia. After the feasibility survey of 1992 (Eldridge *et al.* 1993), systematic waterbird surveys of the north coast of Russia continued from 1993-1995.

An aerial survey for eiders on the north coast of Russia provided an opportunity to assess numbers of other avifauna in the study area. Breeding status of other avifauna from the north coast of eastern Russia prior to this effort is described from scattered ground and aerial observations (Gilg *et al.* 2000; Pearce *et al.* 1998 a, b; Kistchinski 1973; Flint *et al.* 1984; Dement'ev & Galdkov 1952).

## Methods

### Study Area

The northern coastal plain between Kolyuchin Bay on the east and the Lena River on the west, a distance of 2,340 km, 62 degrees of longitude, contains four major river deltas: the Kolyma, Indigirka, Yana and Lena (**Figure 1**). The coastal wetland plain extends up to 350 km inland from the Arctic Ocean, but this survey did not extend beyond 200 km inland. The habitat was typical of northern arctic and subarctic tundra and appeared similar to that found on the arctic coasts of Alaska.



**Figure 1.** Map of the 15 areas surveyed in the northern coastal region of eastern Siberia. The Cape Schmidt area is not shown in detail. Transect lines are drawn using the actual GPS positions of the survey aircraft. The map scale is identical for both maps.

The Lena and Indigirka river deltas are extensive systems with a variety of ponds and lakes with varying stages of polygonal development. The Yana River delta consists of wet sedge meadows with intricate pond developments near the coast. The Kolyma River delta consists of lowland sedge meadows and ponds near the coast, many of which appear to experience occasional extensive spring flooding.

Most of the coastal area between the major deltas is more upland in character. The coast between the Kolyma and Indigirka river deltas was typified by low bluffs with sparse wetlands backing a narrow fringe of low-lying coastal wetlands. Further inland the scattered lakes, ponds and wetland complexes were separated by upland habitat and gently rolling hills. West of the Indigirka River, the areas between deltas were drier with smaller ponds and more pronounced streams.

### Survey Design

The nesting habitat to be surveyed was determined by examining 1:300,000 scale Russian topographic maps. The coastal wetland habitats were subdivided into 15 geographic areas (**Figure 1**). Each area was sampled with systematic transects designed to represent habitats within the areas. Different areas received varying percentages of coverage depending on the importance of the area to breeding eiders and distance between fueling points. The survey progressed from east to west in suc-

cessive years, determined by our estimation of potential coverage based on the previous year's effort. The total area, sampled area and median survey date for the 15 areas are presented in **Table 1**. The Indigirka River delta received the most intensive coverage, followed by the Kolyma, Yana and Lena river deltas. Parallel transects were used for the major river deltas and a few other areas (**Figure 1**). Distance between transects on major river deltas ranged from 5-16 km. Zig-zag transects were used where it was necessary to cover long distances between refueling points (**Figure 1**). All transects were 400 m wide.

Survey timing was intended to occur during early to mid incubation, before male eiders departed the breeding grounds for moulting areas. Composite outside limits of survey dates from 1993 to 1995 were 21 June to 4 July.

### Survey

The survey was conducted from a four-person turbine powered DeHaviland Beaver with amphibious floats following standard procedures (U.S Fish and Wildlife Service and Canadian Wildlife Service 1987). The aircraft was flown at approximately 50 m altitude and 150 km/hr<sup>-1</sup>. Primary observers were the pilot and right rear seat observer. A Russian navigator was required in the right front seat and a Russian biologist sat in the left rear seat. A laptop computer was connected to the airplane Global Positioning

**Table 1.** Survey area sizes [see **Figure 1**], sample sizes and survey dates. Areas are in square kilometers.

Area	Shortened Area Name	Area Size (km <sup>2</sup> )	Sample Size (km <sup>2</sup> )	Per cent Sampled	Median Survey Date	Year
Cape Schmidt Coast	[Schmidt]	5,706	200	3.5	6/22	1993
Chaun Bay	[Chaun]	3,018	195	6.5	6/23	1993
Kolyma River	[Kolyma]	7,113	208	2.9	6/25	1993
Kolyma River Delta	[Kol. Delta]	4,051	267	6.6	6/24	1994
Cape Kestovskiy	[Krest.]	4,741	257	5.4	6/25	1994
Kolyma-Indigirka Inland	[Kol-Ind In.]	19,300	86	0.4	6/24	1995
Kolyma-Indigirka Coast	[Kol-Ind Co.]	10,586	235	2.2	6/27	1994
Indigirka River Delta	[Ind. Delta]	6,300	500	7.9	6/28	1994
Cape Loptka	[Loptka]	1,055	32	3.0	6/26	1995
Indigirka-Yana Coast	[Ind-Yana Co.]	10,826	143	1.3	7/04	1994
Indigirka-Yana Inland	[Ind-Yana In.]	45,333	430	0.9	6/26	1994
Sellyakhskaya Bay	[Sellyakh.]	4,640	127	2.7	7/04	1994
Yana River Delta	[Yana Delta]	6,623	149	2.2	6/29	1994
Cape Buor-Khaya	[Buor-Khaya]	6,056	87	1.4	6/30	1994
Lena River Delta	[Lena Delta]	22,263	466	2.1	7/02	1994
Total		157,611	3,382	2.1		

System (GPS) to record the flight path. Tape recorders were used to record all observations. For much of the survey the tapes recorded continuously during transects. Continuous recording permitted point locations to be calculated for each observation based on time along transect for use in mapping (Butler *et al.* 1995a, 1995b). All visible bird species, except shorebirds and passerines, and three species of mammals were counted by the pilot and right rear seat observer within the 200 m on each side of the plane. Gulls, skuas, mergansers, and swans were not identified to species, and sub-

species of White-fronted Geese *Anser albifrons* and *A. erythropus* were combined (**Appendix I**). Waterfowl were counted as singles, pairs or flocks. No visibility correction factors were applied for birds that were present but not seen.

The following assumptions were made: 1) our sample transects, including zig-zag transect legs, were independent and representative of each area, 2) flights along a transect did not influence distribution of birds on adjacent transects and 3) visibility was constant for given species over space and time.

## Data Analysis

Population estimates for ducks, except Greater Scaup *Aythya marila*, were based on the indicated total, which was the number of single drakes doubled, plus paired birds, plus flocked birds. Single observations of geese, swans, drakes of Greater Scaup and non-waterfowl species were not doubled (U.S Fish and Wildlife Service and Canadian Wildlife Service 1987). Density estimates were calculated as indicated total birds per km<sup>2</sup> surveyed. Densities were expanded to areas bounded by transect ends to obtain the population estimate. Coefficients of variation were computed using transects as sample units weighted by length. The variance estimate did not include variability from observers, aircraft type, survey timing, or weather conditions.

Common and scientific names for all species observed on the survey are listed in **Appendix I**. Additional data not presented here include point locations of all observations along most transects, including swan *Cygnus bewickii* and *C. cygnus*, and Siberian White Crane *Grus leucogeranus* nests. These data are stored at the U.S. Fish and Wildlife Service, Division of Migratory Birds, 1011 E. Tudor Rd, Anchorage, Alaska, USA, 99503.

## Results

The survey required 50, 90, and 44 hours to fly in 1993, 1994 and 1995 respectively. The total distance flown

within Russia for the three years combined was approximately 36,000 km.

## Eiders

The Spectacled Eider was the most abundant waterbird species (**Table 2, Appendix II**). High numbers of Spectacled Eiders were first encountered just west of the Kolyma River delta and few were found west of the Yana River. The Indigirka River delta had the highest number followed by the Kolyma-Indigirka coast (**Table 2, Figure 1**). The Indigirka River delta and Cape Lopatka area (**Figure 1**) had the highest mean breeding densities (**Table 2**), respectively. Singles or pairs comprised 80% of 3,464 birds classified there. The coefficient of variation varied widely among areas (**Table 2**).

Steller's Eiders were the second most abundant waterbird (**Table 2, Appendix II**) and were common throughout the survey area but most concentrated from the Indigirka River delta to the Yana River delta (**Table 2, Figure 1**). Of 2,553 Steller's Eiders observed 25% were classified as singles or pairs.

King Eiders *Somateria spectabilis* were scattered across the survey area, except for the most inland regions, but in lower densities than Steller's or Spectacled Eiders. They were most abundant on the Lena River delta but the highest density occurred in the Cape Lopatka area (**Table 2, Figure 1**). Of 1,803 birds classified, 74% were singles or pairs.

**Table 2.** Eider population estimates, coefficients of variation (C.V.) and density [square kilometers] by area. See **Figure 1** for map and **Table 1** for full area names.

Area	Spectacled Eider			Steller's Eider			King Eider			Common Eider		
	Population Estimate (C.V.)	Density	%	Population Estimate (C.V.)	Density	%	Population Estimate (C.V.)	Density	%	Population Estimate (C.V.)	Density	%
Schmidt	179 [.39]	0.0	0	3,913 [.48]	0.7	3	1,330 [.37]	0.2	2	11,152 [.75]	2.0	74
Chaun	1,820 [.31]	0.6	1	285 [.65]	0.1	0	2,272 [.35]	0.8	4	3,660 [.31]	1.2	24
Kolyma	71 [.99]	0.0	0	214 [.70]	0.0	0	748 [.70]	0.1	1	0	0.0	0
Kol. Delta	5,088 [.16]	1.3	3	1,030 [.71]	0.3	1	3,438 [.23]	0.8	6	303 [.32]	0.1	2
Krest.	18,084 [.16]	3.8	12	10,427 [.57]	2.2	8	1,362 [.19]	0.3	2	0	0.0	0
Kol-Ind In.	8,040 [.25]	0.4	5	1,787 [.12]	0.1	1	0	0.0	0	0	0.0	0
Kol-In Co.	37,685 [.13]	3.6	26	14,728 [.49]	1.4	11	6,039 [.35]	0.6	11	0	0.0	0
Ind. Delta	46,276 [.10]	7.3	32	16,713 [.17]	2.7	13	1,811 [.31]	0.3	3	0	0.0	0
Loptka	9,284 [.71]	8.8	6	25,645 [.32]	24.3	20	4,115 [.27]	3.9	7	0	0.0	0
Ind-Yana Co.	2,577 [.55]	0.2	2	32,137 [.29]	3.0	25	6,670 [.48]	0.6	12	0	0.0	0
Ind-Yana In.	13,431 [.27]	0.3	9	9,412 [.43]	0.2	7	1,058 [.54]	0.0	2	0	0.0	0
Sellyakh.	660 [.59]	0.1	0	2,602 [.58]	0.6	2	2,638 [.70]	0.6	5	0	0.0	0
Yana Delta	1,951 [.63]	0.3	1	621 [.71]	0.1	0	4,169 [.30]	0.6	7	0	0.0	0
Buor-Khaya	0	0.0	0	694 [.53]	0.1	1	416 [.66]	0.1	1	0	0.0	0
Lena Delta	1,099 [.32]	0.0	1	8,554 [.34]	0.4	7	19,736 [.15]	0.9	35	0	0.0	0
Total	146,245 [.08]	0.9	100	128,760 [.13]	0.8	100	55,800 [.10]	0.4	100	15,115 [.56]	0.1	100



Common Eiders *S. mollissima v-nigra* were seen in significant numbers only from Chaun Bay eastward. The Cape Schmidt coast area comprised nearly 75% of the Russian population estimate (**Table 2, Figure 1**). Only 22% of 2,470 Common Eiders were recorded as singles or pairs.

#### Other waterfowl

The most commonly observed waterfowl species other than eiders was the Long-tailed Duck *Clangula hyemalis*, which ranked third in abundance of all species, followed by Northern Pintails *Anas acuta* (**Appendix II**). Nearly 95% of Long-tailed Ducks were observed in flocks probably because of molt migration of males, so the high densities in coastal areas may not reflect actual breeding distribution. The dominant swan in the study area was Bewick's Swans *Cygnus bewickii* but Whooper Swans *Cygnus cygnus* may have occurred in the Kolyma River delta region (Flint *et al.* 1984). The Kolyma and Lena river deltas supported the most swans (**Appendix II**) but 78% of observed nests were recorded on the Kolyma River delta.

#### Other species

Population estimates and coefficients of variation for all other birds observed and three species of mammals are listed in **Appendix II**. Our transects in the Indigirka-Yana interior area covered a large and important part of the breeding habitat of the endan-

gered Siberian White Crane. In the southern half of this area 10 individuals were observed on transect, an estimated 1,058 birds for the area, or 57% of our total estimated Siberian White Cranes.

### Discussion

#### Importance of Russian Eider populations to world populations

The minimum total breeding population estimate for Spectacled Eiders on the Russian north coast, 146,200, is 92% of the surveyed world breeding population for the species. Approximately 9,500 (6%) nest on the north slope of Alaska with the remaining 3,000 nesting on the Yukon-Kuskokwim delta in Alaska (Larned pers.comm.; Platte pers. comm.; Petersen *et al.* 2000). The coefficient of variation for the Russian population estimate was comparable to common species on similar surveys in Alaska (Larned pers. comm.; Mallek & King pers. comm.). Several ground studies (Mikhel 1935; Uspenskii 1962; Uspenskii *et al.* 1962; Vorobev 1963; Krechmar *et al.* 1978; Pearce *et al.* 1998a,b) have indicated the predominance of Spectacled Eiders over other eider species along the north coast of Russia. Petersen *et al.* (1999) estimated a minimum Spectacled Eider population of 337,000 from photographic counts on wintering grounds.

Our estimate of breeding Steller's Eiders on the north coast of Russia represents over 99% of the surveyed



breeding population wintering in the Pacific area. An additional 1,000 (0.8%) nest in Alaska (Mallek & King pers. comm; Larned pers. comm.). The coefficient of variation for Steller's Eiders was high as was the percentage of flocked birds, indicating that the survey may have been less reliable than for Spectacled Eiders. The Steller's Eider population estimate is conservative and was complicated by variable results obtained in 1994 and 1995 on the Indigirka-Yana inland area (**Figure 1**). The Russian estimate does not include an apparently distinct population of 30-50,000 Steller's Eiders that winter in Europe and probably breed in Russia east of the Lena River delta (Nygard *et al.* 1995).

King Eiders are a circumpolar species and not all breeding and wintering areas have been surveyed. Helicopter surveys of the western Canadian Arctic population estimated about 200,000-260,000 nesting individuals (Suydam 2000; Dickson *et al.* 1997). The estimate of breeding numbers for Russia was next in abundance followed by 12,000 on the north slope of Alaska (Larned pers. comm.).

The race of the Common Eider surveyed is the only race that pertains to the Pacific Flyway (Palmer 1976). The estimated 20,000 breeding adults in Russia (summarised in Goudie *et al.* 1994) is greater than the 15,000 Common Eiders of all ages that were estimated for the north coast of Russia (**Table 2**), probably because the estimate was not corrected with a visibility

factor for birds present but not seen or some breeding areas were missed.

The coefficient of variation for the total estimate of Common Eiders was high which indicates that this is not a reliable survey for this species.

### Potential bias in the survey

Survey timing in relation to nest incubation can have a dramatic effect on the estimation of eider numbers due to the absence or presence of the more visible male birds on the nesting ground (R. King, pers. comm.). Surveys for eiders should occur before male departure for optimal population estimates. It was felt that the 1993 survey of the eastern portion of the study area was well-timed to count eiders after arrival to breeding grounds and before male departure. However, the high percentage of flock observations of Common and Steller's Eiders caused concern that optimal timing for these species may have been missed, but it was not known what percentage of these birds were non-breeders.

The bulk of our Spectacled, Steller's and King Eider data were collected in 1994 when the primary breeding grounds had been surveyed. The nesting season in Russia was earlier in 1995 (Pearce *et al.* 1998a, Solovieva pers. comm.) and our arrival in Russia was delayed. It was therefore felt that significant male departure, particularly of Spectacled Eiders, may have occurred before our arrival. Because the 1995 survey covered interior and low-density habitat, it is thought that

the effects of male departure on the total population estimates were minimal.

### Population estimates

This survey was designed to cover as much of the breeding range of eiders as possible but did not completely cover the interior regions. The precision of the survey varied by species (**Table 2, Appendix II**). Population estimates should be considered with coefficients of variation and with the understanding that they only apply to the area within the survey boundaries.

Precision of the population estimate, as measured by coefficient of variation, varied considerably among areas for all species. The coefficient of variation for Spectacled Eiders was low for the whole survey, particularly the Indigirka River delta. We are confident that this survey was well designed for Spectacled Eiders and to a lesser extent, King Eiders. The survey is less precise for Steller's and Common Eiders so increased coverage would be required to minimize variability for these species.

The population estimate for Steller's Eiders posed a problem. In 1994 an inland transect was flown, 260 km long, in transit between the Indigirka and Yana river deltas (**Figure 1**). The high numbers of Steller's Eiders counted on this inland area and the high percentage of Steller's Eiders counted as singles or pairs here (100%) were unexpected. This transect represented 4%

of the total area sampled in 1994 but comprised 20% of all paired observations of Steller's Eiders. The same transect was flown again in 1995 for comparison. The dramatic difference in numbers of Steller's Eiders observed (206 in 1994 versus 16 in 1995) on this transect could be attributed to three factors: 1) the late nesting season in 1994 may have forced more breeding birds to inland habitat represented by this transect, which was more open than the colder coastal habitat, 2) male departure to molting grounds occurred prior to the 1995 survey resulting in a low count or, 3) Steller's Eiders simply did not breed normally in the late year of 1994. Solovieva (pers. comm.) noted that major shifts in nesting distribution due to annual variation in habitat conditions appears to be an adaptive technique of Steller's Eiders nesting in Russia. It was also thought that a shift in nesting distribution in 1995 to the coast was the more likely cause for low numbers recorded on the interior transect that year (Solovieva pers. comm.) because male Steller's Eiders should still have been visible on the survey area. Because coastal transects were not flown in 1995, there was no comparison to the 1994 coastal transects to confirm that a shift in nesting distribution had occurred.

To calculate the Indigirka-Yana area Steller's Eider population estimate, the ratio of Steller's Eiders observed on the common 1994/95 transect was determined and applied to the density obtained on the broader Indigirka-Yana

inland area surveyed in 1995 (**Figure 1**). Using this conversion, the Steller's Eider population estimate for this area would increase from the 9,412 reported in **Table 2** to 121,180 and the estimate for the entire study area would increase from 128,760 to 240,528. However, because the shift in nesting distribution could be confirmed between years, a more conservative value from 1995 has been reported (**Table 2**). The only way to satisfy the question of Steller's Eider numbers would be to survey both the inland and coastal areas extensively in the same year and over a series of years.

The low percentages of Steller's and Common Eiders recorded as pairs raise questions about phenology of breeding, population age structure and distribution of these species compared to other species with higher paired to flocked bird ratios. The population estimates for Spectacled and King Eiders may have been underestimated relative to Common and Steller's Eiders because single and pairs are less visible than flocks.

Population estimates for species other than waterfowl, particularly less visible ones, would be relatively lower than target species because it is unreasonable to expect that the human eye gives all species equal attention.

This survey covered all but the most inland, low-density nesting habitat of Spectacled Eiders and provided good results for both Spectacled and King Eiders (low coefficients of variation). The survey was less successful for

Steller's and Common Eiders due to the higher variability in results, the unexplained high ratio of flocked birds to singles or pairs, and uncertainty of nesting population shifts under varying snow conditions. A more accurate survey for Steller's and Common Eiders requires increased coverage within their respective breeding ranges.

This survey provides new information on distribution and numbers of breeding eiders and confirms that Russia is an important breeding area for eiders wintering in the Pacific Rim. These data provide a basis for future surveys emphasizing single species, variability in populations within and among years, and estimation of long term trends for eiders.

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**Appendix 1.** Common (North American) and scientific names for species identified in the text. Species that were grouped for analysis are indicated.

Common Name	Scientific Name	Combined Groups
Red-throated Loon	<i>Gavia stellata</i>	*Arctic Loon
Black-throated Loon <sup>a</sup>	<i>Gavia arctica</i>	
Pacific Loon <sup>a</sup>	<i>Gavia pacifica</i>	
Yellow-billed Loon	<i>Gavia adamsi</i>	
Bewick's Swan <sup>b</sup>	<i>Cygnus bewickii</i>	*Swan sp.
Whooper Swan <sup>b</sup>	<i>Cygnus cygnus</i>	
Greater White-fronted Goose <sup>c</sup>	<i>Anser albifrons</i>	*White-fronted Geese
Lesser White-fronted Goose <sup>c</sup>	<i>Anser erythropus</i>	
Bean Goose <sup>c</sup>	<i>Anser fabalis</i>	
Brent Goose	<i>Branta bernicla</i>	
Green-winged Teal	<i>Anas crecca</i>	
Eurasian Wigeon	<i>Anas penelope</i>	
Northern Pintail	<i>Anas acuta</i>	
Common Eider	<i>Somateria molissima</i>	
King Eider	<i>Somateria spectabilis</i>	
Spectacled Eider	<i>Somateria fischeri</i>	
Steller's Eider	<i>Somateria stelleri</i>	
Eider female	<i>Somateria sp.</i>	
Greater Scaup	<i>Aythya marila</i>	
White-winged Scoter	<i>Melanitta fusca</i>	
Black Scoter	<i>Melanitta nigra</i>	
Long-tailed Duck	<i>Clangula hyemalis</i>	
Ptarmigan	<i>Lagopus sp.</i>	
Sandhill Crane	<i>Grus canadensis</i>	*Jaeger sp.
Siberian White Crane	<i>Grus leucogeranus</i>	
Long-tailed Jaeger <sup>d</sup>	<i>Stercorarius longicaudus</i>	
Pomarine Jaeger <sup>d</sup>	<i>Stercorarius pomarinus</i>	*Gull sp.
Parasitic Jaeger <sup>d</sup>	<i>Stercorarius parasiticus</i>	
Glaucous Gull <sup>e</sup>	<i>Larus hyperboreus</i>	
Herring Gull <sup>e</sup>	<i>Larus argentatus</i>	
Sabine's Gull <sup>e</sup>	<i>Xema sabini</i>	
Ross's Gull <sup>e</sup>	<i>Rhodostethia rosea</i>	
Mew Gull <sup>e</sup>	<i>Larus canus</i>	
Arctic Tern	<i>Sterna paradisea</i>	
Snowy Owl	<i>Nyctea scandiaca</i>	
Short-eared Owl	<i>Asio flammeus</i>	
Rough-legged Hawk	<i>Buteo lagopus</i>	
Caribou	<i>Rangifer tarandus</i>	
Arctic Fox	<i>Alopex lagopus</i>	
Wolf	<i>Canis lupus</i>	

**Appendix 2.** Population estimates of species other than eiders with coefficients of variation (C.V.) and density (square kilometres) by area. See **Figure 1** for map and **Table 1** for full area names.

Species	Total (C.V.)	Schmidt	Chaun	Kolyma	Kol. Delta	Krest.	Kol-Ind In.	Kol-Ind Co.
Red-throated Loon	5,320 [0.22]	108	175	463	0	71	893	292
Arctic Loon	32,840 [0.16]	146	1,083	1,032	1,090	1,068	6,477	1,579
Yellow-billed Loon	674 [0.55]	55	39	0	0	0	223	39
Swan [species]	32,219 [0.14]	138	5,351	2,100	11,313	286	3,573	253
White-fronted Goose	39,596 [0.16]	1,100	712	71	485	1,325	7,147	3,771
Emperor Goose	5,079 [0.50]	2,952	0	0	0	0	223	0
Pacific Brant	16,744 [0.34]	1,386	1,372	0	8,799	0	0	79
Green-winged Teal	2,364 [0.31]	38	36	712	0	29	0	630
Wigeon [species]	6,142 [0.89]	0	0	5,696	0	0	0	0
Northern Pintail	80,729 [0.19]	4,231	7,551	7,476	4,498	171	2,233	1,674
Greater Scaup	15,837 [0.22]	147	1,923	4,308	878	0	1,563	1,730
White-winged Scoter	2,468 [0.50]	0	36	1,887	242	0	0	0
Black Scoter	775 [0.56]	0	161	71	91	29	0	0
Long-tailed Duck	124,387 [0.17]	5,249	5,782	3,382	6,118	2,432	14,294	7,896
Merganser [species]	748 [0.95]	0	0	748	0	0	0	0
Ptarmigan	12,077 [0.16]	0	24	498	167	14	2,010	116
Sandhill Crane	9,470 [0.09]	796	2,042	320	515	1,684	2,457	1,492
Siberian White Crane	1,852 [0.30]	0	0	0	0	43	447	116
Jaeger [species]	54,457 [0.11]	1,028	950	427	697	572	7,817	3,326
Gull [Species]	143,176 [0.10]	9,092	10,432	2,634	5,497	4,623	6,477	11,579
Arctic Tern	82,624 [0.19]	576	436	9,505	3,862	1,161	4,020	9,246
Snowy Owl	4,109 [0.18]	19	78	0	15	143	0	79
Short-eared Owl	402 [0.42]	0	0	0	0	29	0	0
Rough-legged Hawk	1,092 [0.33]	0	0	0	0	0	223	116
Caribou	333,969 [0.32]	0	0	0	30	5,748	150,082	24,526
Arctic Fox	691 [0.29]	0	20	0	0	14	0	118
Wolf	194 [0.69]	0	0	0	0	0	0	0



Appendix 2 continued

Species	Ind. Delta	Loptka	Ind-Yana Co.	Ind-Yana In.	Sellyakh.	Yana Delta	Buor-Khaya	Lena Delta
Red-throated Loon	0	0	303	1,798	220	89	0	908
Arctic Loon	2,038	165	152	14,594	623	843	278	1,673
Yellow-billed Loon	0	0	0	317	0	0	0	0
Swan (species)	228	0	227	740	110	1,596	139	6,164
White-fronted Goose	1,165	0	4,623	5,816	1,539	1,596	1,596	8,649
Emperor Goose	0	0	0	1,904	0	0	0	0
Pacific Brant	2,988	0	531	0	0	1,064	0	526
Green-winged Teal	430	0	0	212	0	0	278	0
Wigeon (species)	139	0	0	212	0	0	0	96
Northern Pintail	4,178	1,251	0	27,179	696	12,506	1,110	5,973
Greater Scaup	0	0	0	5,288	0	0	0	0
White-winged Scoter	25	0	0	0	0	0	278	0
BlackScoter	0	0	0	423	0	0	0	0
Long-tailed Duck	2,785	4,543	21,677	22,737	4,727	7,495	2,845	12,424
Merganser (species)	0	0	0	0	0	0	0	0
Ptarmigan	177	0	0	7,191	73	133	0	1,673
Sandhill Crane	25	0	0	0	0	0	139	0
Siberian White Crane	38	0	0	1,058	37	44	69	0
Jaeger (species)	3,760	1,646	5,988	14,383	770	5,588	2,775	4,731
Gull (Species)	8,356	2,041	12,279	20,305	4,910	12,417	9,644	22,890
Arctic Tern	15,320	1,448	3,714	27,390	1,796	1,596	69	2,485
Snowy Owl	355	0	2,274	635	147	222	0	143
Short-eared Owl	0	0	0	212	73	89	0	0
Rough-legged Hawk	0	0	0	529	110	44	69	0
Caribou	1,266	230	2,274	118,551	25,723	0	139	5,400
Arctic Fox	51	0	76	317	0	0	0	96
Wolf	0	0	0	106	0	89	0	0