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Disappearance of the Steller's Eider from the Yukon-Kuskokwim Delta, Alaska

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ABSTRACT. The Steller's eider (*Polysticta stelleri*) is apparently extinct as a breeding bird on the Yukon-Kuskokwim (Y-K) delta, one of two areas in Alaska where it was a regular breeder. Once considered a common breeding bird on the Y-K delta, it has not been found nesting since 1975, despite recent extensive geographic coverage of waterfowl habitats and ground searches of historically important nesting areas. The Y-K delta was the only known subarctic breeding area in the species' range. Size of the former population and reasons for its disappearance are unclear, but possible factors responsible for the decline include changes in patterns of movement and increased mortality resulting from overharvest, predation, habitat change, weather, and reduction in food. The Steller's eider is now considered a rare species in the Yakutsk Republic, U.S.S.R., the center of the world breeding range. The North American population is now restricted to a small geographical area near Barrow and it has not yet received special consideration or protection comparable to that in the U.S.S.R. Because most of the world population breeds in the U.S.S.R. and winters in Alaska, effective conservation of the species will require cooperation at the international level.

Key words: Steller's eider, *Polysticta stelleri*, Yukon-Kuskokwim delta, declining species, spectacled eider, Alaska

RÉSUMÉ. L'eider de Steller (*Polysticta stelleri*) a apparemment disparu en tant qu'oiseau reproducteur dans le delta du Yukon-Kuskokwim (Y-K), l'une des deux régions de l'Alaska où il nichait régulièrement. Considéré jadis comme un oiseau reproducteur commun dans le delta du Y-K, il n'a plus été aperçu en train de nicher depuis 1975, malgré une étude géographique à grande échelle sur les habitats de la sauvagine et des recherches au sol d'aires de nidification d'importance historique. Le delta du Y-K était la seule aire de nidification subarctique connue dans le territoire de l'espèce. La taille de la population antérieure et les raisons de sa disparition ne sont pas bien connues, mais, parmi les facteurs pouvant être responsables du déclin, on compte des changements dans les schémas de déplacement et un accroissement de la mortalité dû à la surexploitation, la prédation, le changement d'habitat, le climat et la diminution de nourriture. L'eider de Steller est considéré maintenant comme une espèce rare dans la république de Yakutsk en Union soviétique, siège mondial de l'aire de reproduction. La population nord-américaine ne fréquente plus maintenant qu'une petite aire géographique située près de Barrow, et n'a pas encore reçu de statut particulier ou de protection comparable à celle en Union soviétique. Vu que la majorité de la population mondiale se reproduit en Union soviétique et hiverne en Alaska, la conservation efficace de l'espèce va nécessiter une coopération au niveau international.

Mots clés: eider de Steller, *Polysticta stelleri*, delta du Yukon-Kuskokwim, espèce en déclin, eider à lunettes, Alaska

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INTRODUCTION

A common public perception is that ". . . Alaska remains a pristine wilderness and that wildlife populations are still at prehistoric levels" (King and Derksen, 1986:464). Recent dramatic declines in goose populations in western Alaska (Raveling, 1984) on the Yukon-Kuskokwim (Y-K) delta serve to remind us that this is not the case and that vast areas of habitat do not necessarily guarantee wildlife abundance. Hunted populations of wildlife, because of the public interest and financial support they receive, are monitored closely for indications of decline. But even major changes in populations of species not important for hunting may pass unnoticed.

The Steller's eider (*Polysticta stelleri*) is one such species. It winters at northern latitudes in areas remote from hunters and wildlife observers. Because of its inaccessibility it has not received the same financial support for research and management activities as have other waterfowl species, such as geese. Consequently, its life history and habitat requirements are poorly understood and its current status is unclear. In this respect it is like the over 90% of North American migratory nongame birds that, by virtue of not being hunted or endangered, receive almost no attention (Senner, 1986).

Steller's eiders breed above the Arctic Circle along the coasts of the Arctic Ocean in Alaska and the U.S.S.R. (Fig. 1), with the majority breeding in eastern Siberia (Jones, 1965). Uspenski (1972) estimated the world population at 500 000 birds, but Palmer (1976) thought the total was closer to 400 000, possibly fewer.

In the U.S.S.R., the Steller's eider was considered a common breeding bird in the Yakutsk Republic (Fig. 1) at the beginning of the century and was still considered locally common in the 1950s (Solomonov, 1987). Its status is now of concern in the U.S.S.R., where it is presently a rare species (red book, category 3) in the Yakutsk Republic (Solomonov, 1987). This region encompasses most of the current Soviet breeding range (Fig. 1), an area that extends from the New Siberian Islands and Lena Delta east to the Chukotski Peninsula (American Ornithologists' Union, 1983; Bellrose, 1980; Godfrey, 1986) and includes Wrangel Island (I.V. Dorogoi, pers. comm. 1985). Recoveries of banded eiders west of the Lena Delta suggest that they nest westward to at least the Kheta River (Fig. 2). They have not been found breeding in Norway (Frantzen, 1985).

In Alaska, the Steller's eider has been described as a regular breeder at only two locations (Fig. 1) — near Barrow and on the Y-K delta (Myres, 1958; Gabrielson and Lincoln, 1959; Pitelka, 1974; Palmer, 1976). It has not been found nesting on the Y-K delta since 1975, and the Barrow population is believed to be small and declining (Johnson and Herter, 1989). Because the disappearance of the Steller's eider from the Y-K delta represents the loss of the only known subarctic portion of the world breeding range and a large portion of the North American population, special consideration in North America, at least comparable to that given to the Steller's eider in the U.S.S.R., is warranted.

The purpose of this paper is to: 1) summarize historical literature and current records of Steller's eiders breeding on

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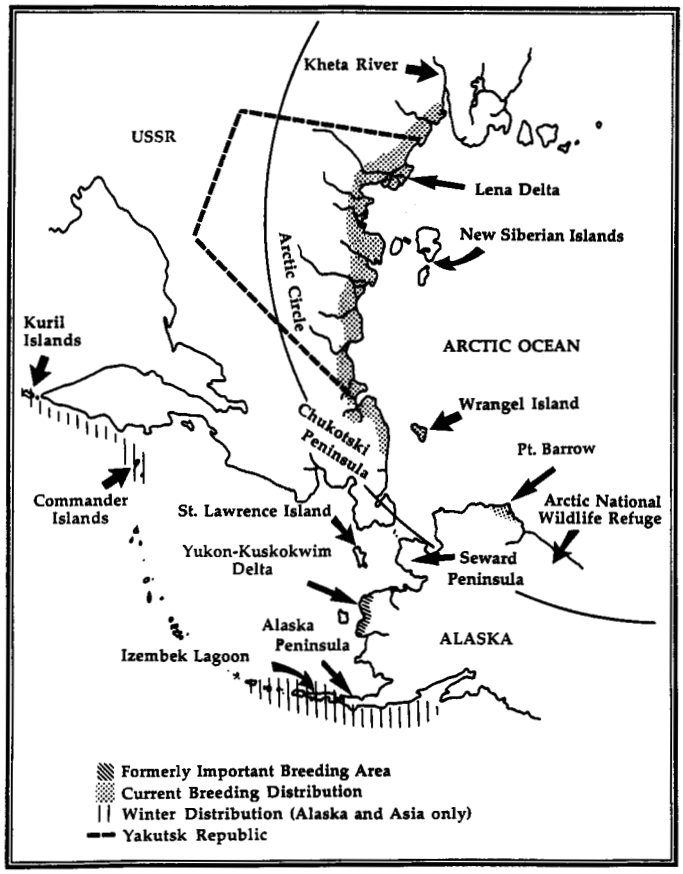

FIG. 1. Current breeding and wintering distributions of the Steller's eider.

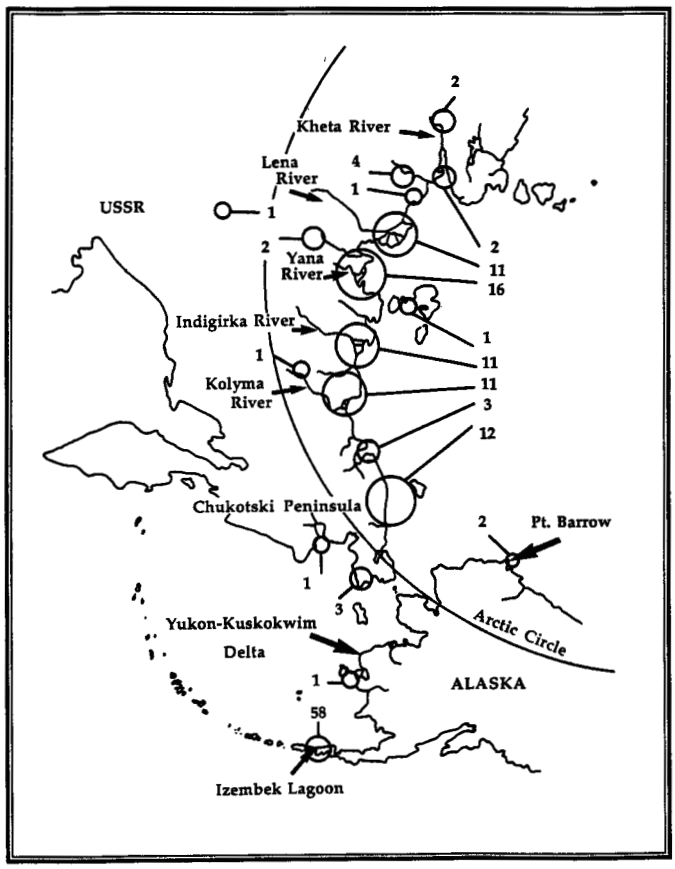

FIG. 2. Recoveries in the U.S.S.R. and Alaska of 143 Steller's eiders banded at Izembek Lagoon, Alaska (through 1986). Courtesy of C. Dau.

the Y-K delta; 2) comment on possible reasons for the disappearance of the Steller's eider from the Y-K delta; and 3) discuss legal mandates and information needed to manage the species.

HISTORY OF BREEDING ON THE Y-K DELTA

Prior to 1950

During a 1924 biological survey of the central Y-K delta (Fig. 3), the Steller's eider was described as a common breeder (Murie, 1924; Conover, 1926; Brandt, 1943). On 27 May "many pairs" were observed on coastal tide pools at Kokechik Bay (Murie, 1924:41). Steller's eiders were found to be "surprisingly common" in the vicinity of Kokechik Bay (Brandt, 1943:344), and in late June, according to Murie (1924), males were observed near ponds where females were nesting or were suspected to be nesting. Nesting birds were observed commonly at Kokechik Bay (Dufresne, 1924; Conover, 1926), along the Kokechik River (Murie, 1924; Conover, 1926), and sparingly near Hooper Bay (Dufresne, 1924). Murie (1959) stated that there was a large nesting population at Nelson Island, apparently based on reports provided to him in 1924 by natives living in that area (Gabrielson and Lincoln, 1959).

The distributional abundance of nests in 1924 is unclear. According to Brandt (1943:344), "The nest of the Steller Eider in the Hooper Bay region must be sought only in the vast morass about Igiak [now Kokechik] Bay," where it was thought by Brandt to be the most common nesting eider. In his narrative, Brandt reports finding five nests at Kokechik Bay on 19 and 20 June. Steller's eiders nested "nearer Kokechik Bay" than either common (*Somateria mollissima*) or spectacled eiders (*S. fischeri*) (Brandt, 1943:267). Murie (1924) stated that they nested near the tide flats along Kokechik Bay, where he described two nests (possibly two of the same nests described by Brandt), and on the flat tundra adjacent to the Kokechik River.

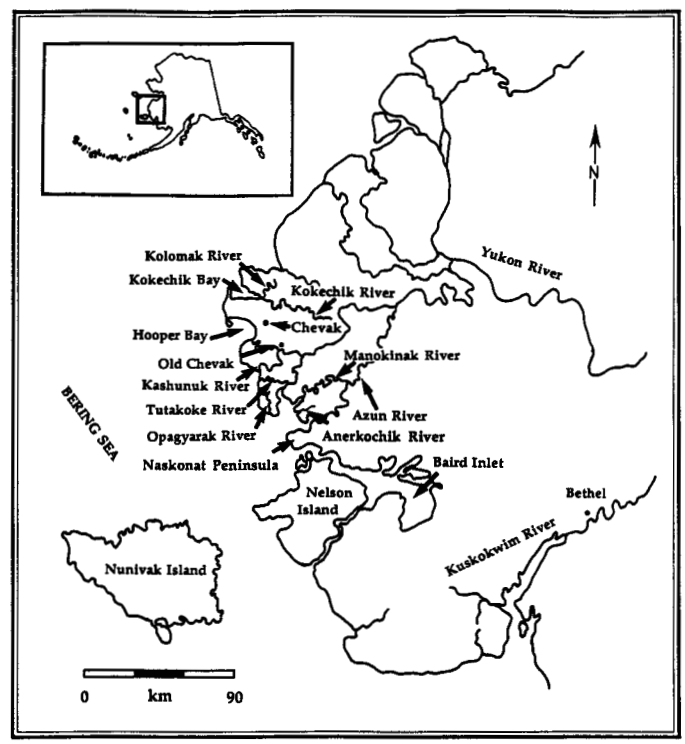

FIG. 3. The Yukon-Kuskokwim delta, Alaska, showing place-names and major geographic features.

During this 1924 survey, downy young were first found on 8 July (Conover, 1926). Large young (large enough to band) were "rather frequently" located after 17 July in the vicinity of Kokechik Bay and adjacent to the Kokechik River, and "a number" were banded (Murie, 1924:44). Of 13 eiders collected at Kokechik Bay and 24 collected at Hooper Bay (Brandt, 1943), 8 were downy young, all collected at Kokechik Bay.

Observations in the 1940s document the continued presence of the Steller's eider as a breeding bird on the Y-K delta. Eiders were seen in "considerable number" in 1941 near the coast on the lower Kashunuk River by Gillham (1941:99), who felt that they were the most common duck in that area. However, most of the birds were subadult females from the previous year, and although a few young were seen, the majority of females (presumably adults in this case) did not have young. According to Gabrielson and Lincoln (1959), Gillham collected a female and downy young at Chevak (lower Kashunuk River) on 2 July 1941. Ten juveniles were reportedly banded in the Old Chevak area in 1949 (Nelson, 1949).

1950–Present

Surveys of important waterfowl nesting areas on the Y-K delta were much more intensive after 1950 than before, particularly beginning in the mid-1980s, when actions were taken by managing agencies to reverse declines in goose populations. The development and implementation of the Hooper Bay Agreement in 1983-84 and the Yukon-Kuskokwim Delta Goose Management Plan in 1985 resulted in increased research and expanded surveys (Pamplin, 1986), primarily for geese, but also for eiders and other waterfowl. Much of this research was conducted in coastal areas historically important to Steller's eiders, such as the lower Kashunuk River and Kokechik Bay. During most years, biologists conducted surveys from permanent camps during the entire breeding season (May-August). In addition to these studies, beginning in 1986 a sampling program was implemented to provide broader coverage of waterfowl nesting areas throughout the central Y-K delta (R. Stehn, USFWS, unpubl. data).

Kashunuk River: Information on densities of Steller's eiders was collected on the lower Kashunuk River in 1951, incidental to a study of brant (*Branta bernicla nigricans*) abundance (Olson, 1951). Olson established three study areas (Fig. 4) with the intention of sampling three distinct vegetation zones located between the seacoast and an area about 13 km inland. Steller's eiders were found nesting in only one of the study areas (#2, about 2 km inland), where they were the second most common of three nesting eider species (Table 1). They also were observed nesting between study areas #2 and #3, but the number of nests was not mentioned.

The lower Kashunuk River (area #2) was resurveyed for eiders in 1961, 1962, and 1963 (Shepherd, 1963). Compared with 1951, Steller's eiders were more common in 1962 but less common in 1961 and 1963 (Table 1; Fig. 5). Too few nests were located, however, to inspire confidence that the data represented trends in abundance. During 1961-63, the mean number of spectacled eider nests increased over threefold compared with 1951 and the number of common eider nests remained consistently low (Table 1).

From 1964 to 1966, Steller's eiders were not found nesting on the lower Kashunuk River in study area #2 (C. Lensink, USFWS, pers. comm. 1985). Common eiders also failed to nest in area #2 during that period, and spectacled eiders were much less common than in the period 1961-63 (Table 1). Area #2 was not censused in its entirety after 1966; however portions of area #2 and several surrounding areas were censused for brant through 1980 (C. Dau, USFWS, pers. comm. 1989). No further sightings of Steller's eiders were made in this area. For the the seven years that area #2 was studied, annual mean nest density for Steller's eiders was 1.53·km^{-2}, compared to 19.10·km^{-2} for spectacled eiders and 0.92·km^{-2} for common eiders.

From 1969 to 1972, biologists censused waterfowl in a 10.4 km^2 study area located about 6 km inland from area #2 (Mickelson, 1975). Although pairs of Steller's eiders were observed during the study (Table 2), no nests were found. In 1973, a plot 1.9 km^2 in size was established within

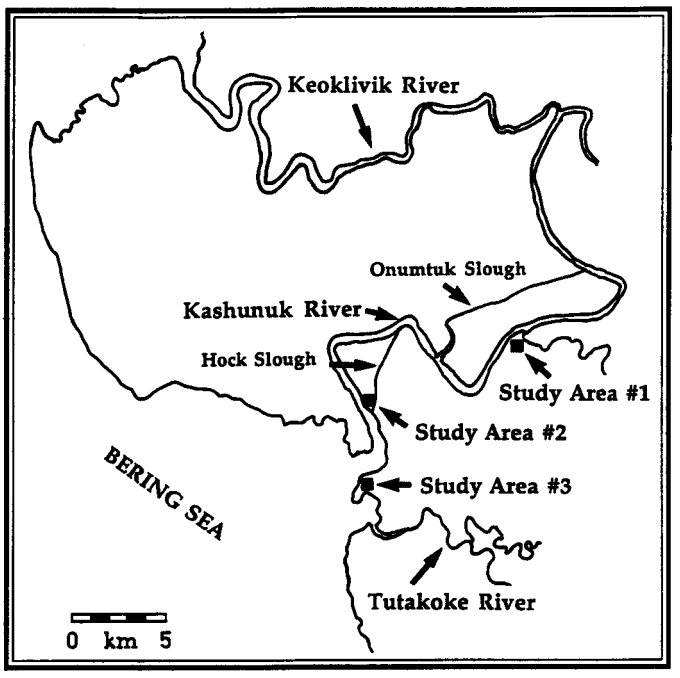

FIG. 4. Study areas established by Olson (1951) along the Kashunuk River, Yukon-Kuskokwim delta.

TABLE 1. Number of nesting eiders at study area #2 (93.5 ha[1]) on the lower Kashunuk River in 1951 and 1961-66

Year	Steller's eider nests	Spectacled eider nests	Common eider nests
1951[2]	3	8	2
1961[3]	1	36	2
1962	5	26	1
1963	1	22	1
1964[4]	0	21	0
1965	0	1	0
1966	0	11	0
Total	10	125	6

[1]Study area #2 was described by Olson (1951) as being 0.5 × 1.0 miles (129.5 ha) in size but later was surveyed and found to be approximately 93.5 ha (C. Lensink, pers. comm. 1990).
[2]Information for 1951 is from Olson (1951).
[3]Information for 1961-63 is from Shepherd (1963).
[4]Information for 1964-66 is from C. Lensink (pers. comm. 1985).

Mickelson's old study area. On 27 and 28 May 1973, a female was seen copulating and constructing a nest scrape within this plot (Table 2), but no completed nest was found (C. Dau, USFWS, unpubl. data). Although this area was surveyed almost yearly from 1973 to 1990 (most recently during 1985-90 by C. Ely [USFWS, pers. comm. 1990]), there has been no further evidence of nesting.

Kokechik Bay: Biologists studying waterfowl in the Kokechik Bay area in the 1960s noted a decline in the number of Steller's eiders from that observed in 1924. Biologists conducting general avian surveys in the vicinity of the Kolomak River (east end of Kokechik Bay) in 1963 (Kessel *et al.*, 1964) and between 1966 and 1969 (Holmes and Black, 1973) and in the vicinity of Kokechik and Hooper bays in 1964 (Johnsgard, 1964) failed to locate any nests. Two nests along the south side of Kokechik Bay in 1969 (Table 2) are the last reported from that area.

FIG. 5. Male Steller's eider along the lower Kashunuk River in June 1963. Photo by J. King.

During the 1970s and 1980s, intensive waterfowl surveys were conducted in the lowlands adjacent to Kokechik Bay. From 1971 to 1973, Eisenhauer failed to find Steller's eider nests on a 4.5 km^2 study area on the south side of Kokechik Bay (Eisenhauer and Kirkpatrick, 1977). In 1985, I also was unsuccessful at finding Steller's eiders in the southern Kokechik Bay area despite intensive searches throughout the breeding season. Similarly, none was observed during waterfowl nest searches on a 1.9 km^2 study area at the southeast end of Kokechik Bay during 1982-86 (Petersen, 1990) or during studies in 1988-90 by Yukon Delta National Wildlife Refuge staff (R. Stehn, USFWS, pers. comm. 1990).

Opagyarak River: The last breeding records for the Steller's eider in the Y-K delta are from the Opagyarak River (Fig. 6). From 1970 to 1980, two to four small plots (4 ha each) located along the Opagyarak River were surveyed annually for nesting brant. In 1975, a single nest was discovered on one of these plots (Fig. 7). A nest and a female with a brood were also found along the Opagyarak River in 1969 (Table 2). There have been no further records. During 1974-80, brant plots located along the Anerkockik River and Naskonat Peninsula were also surveyed, but again no Steller's eider nests were found.

TABLE 2. Observations of Steller's eider on the Yukon-Kuskokwim delta, Alaska, 1967-76 (only observations of nesting birds or pairs are included)

Year	Date(s)	Locations/comments	Source
1967	6 June	Lower Kashunuk River (Hock Slough): 1 pair seen by C. Martell.	YDNWR[1]
1969	21 June	Opagyarak River: Female w/brood of unknown size seen by J. Hout.	YDNWR
	21 June	Opagyarak River: 1 pair and nest w/5 eggs on peninsula in small lake seen by C. Lensink. Onset laying est. 28 May.	YDNWR
	26 June	Kokechik Bay: 2 nests each w/8 eggs seen by C. Lensink. Onset laying est. 13 June.	YDNWR
1970	28 May	Lower Kashunuk River (Onumtuk Slough): 2 pairs seen by P. Mickelson.	C. Dau, pers. comm.
	21 June	Opagyarak River: 1 pair seen by C. Lensink.	C. Dau, pers. comm.
1971	29-31 May	Lower Kashunuk River (Onumtuk Slough): 2 pairs seen each day by P. Mickelson.	C. Dau, pers. comm.
	1 June	Lower Kashunuk River (Onumtuk Slough): 1 pair seen by P. Mickelson.	C. Dau, pers. comm.
1972	9 June	Lower Kashunuk River: 2 males and 1 female seen by C. Dau.	C. Dau, pers. comm.
1973	27 May	Lower Kashunuk River (Onumtuk Slough): 2 pairs; 1 female plucking grass and placing nearby; comfort movements; pair bathings; "rearing" neck compress movements by males; 1 attacked and chased by territorial cackling goose.	C. Dau, pers. comm.
	28 May	Lower Kashunuk River (Onumtuk Slough). Above female made nest scrape, throwing vegetation out behind w/feet; side-to-side body movements to form scrape; male feeding away from nest site; copulation observed lasting 10 sec.	C. Dau, pers. comm.
	2-3 June	Lower Kashunuk River (Onumtuk Slough): 1 pair seen each day by C. Dau.	C. Dau, pers. comm.
	6 June	Lower Kashunuk River (Onumtuk Slough): 1 pair seen by C. Dau.	C. Dau, pers. comm.
1975	20 June	Opagyarak River: Nest w/5 eggs found by C. Dau (same nest w/7 eggs on 3 July). Onset laying est. 22 June. 2 pair in area.	C. Dau, pers. comm.
1976	24 June	Opagyarak River: 1 pair seen by C. Dau.	C. Dau, pers. comm.

[1]Yukon Delta National Wildlife Refuge observation files.

FIG. 6. Vegetated intertidal habitat along the Opagyarak River, Yukon-Kuskokwim delta. Photo by C. Dau.

FIG. 7. Female Steller's eider on nest along the Opagyarak River in 1975, the last confirmed breeding record on the Yukon-Kuskokwim delta. Photo by C. Dau.

Waterfowl monitoring program: During 1986-90, ground searches for nests of geese and eiders were conducted on randomly located plots (0.32 km^2 in size) distributed in over 3900 km^2 of coastal tundra on the central Y-K delta from Kokechik Bay to Nelson Island (R. Stehn, unpubl. data). Each year, between 70 and 100 plots (covering 22.4–32.0 km^2 of coastal tundra) were randomly selected from a total of 447 total plots distributed in a variety of physiographic areas and searched for active and inactive nests during a single visit in early June. Some of the plots were within the geographic area covered by historic ground plots (e.g., Kokechik Bay and Kashunuk River). Despite coverage of formerly important Steller's eider breeding locations and a variety of physiographic areas and an emphasis on locating eider nests, no nests of Steller's eiders were found.

HISTORIC POPULATION SIZE ON THE Y-K DELTA

Prior to the 1950s, surveys of eider abundance were too qualitative to be useful in estimating past population size. Olson's study area #2 was the only area of known size on the Y-K delta that was censused during several years at a time when nests of Steller's eiders were still found regularly. Consequently, it provides the only data useful in estimating population size.

Study area #2 was located in the vegetated intertidal zone (see King and Dau, 1981), the only area in which Steller's eiders have been found nesting on the Y-K delta. There are about 2300 km^2 of vegetated intertidal land on the central Y-K delta from Kokechik Bay to Nelson Island (C. Dau, USFWS, unpubl. data). There are no reports of nests on the Y-K delta north of Kokechik Bay or south of Nelson Island. Using an average annual nest density of 1.53·km^{-2}, I would estimate an upper limit of about 3500 pairs for the population in the 1950s and early 1960s. Considering that Steller's eiders may have been restricted to specific habitats near the coastline at the periphery of the vegetated intertidal zone, the population may have been smaller than predicted by this estimate.

POSSIBLE REASONS FOR DISAPPEARANCE FROM THE Y-K DELTA

The disappearance of the Steller's eider from the Y-K delta may have resulted from a change in patterns of movement, an increase in mortality, or a combination of the two.

Change in Movement Patterns

Movement from the Y-K delta: Eiders from the Y-K delta may have been displaced to breeding areas in northeast Siberia or northern Alaska. The ranges of populations from Siberia and Alaska overlap in lagoons along the north side of the Alaska Peninsula during fall when molting occurs and during winter and early spring (Jones, 1965) when mate selection and pair bonding occur (McKinney, 1965). It is possible that male eiders that formerly bred on the Y-K delta switched breeding areas during pair formation, resulting in a decrease in productivity among females returning to natal areas on the delta. The phenomenon whereby males become displaced in this way is a common feature in duck species (Owen and Black, 1990). When populations are small, changes in the sex ratio can accelerate population decline (Brown and Gibson, 1983).

Although the possibility exists for displacement of birds to other breeding areas, there have been no reports indicating population buildups at Barrow, or elsewhere in Alaska, although coverage has not been as extensive at Barrow or in coastal locations other than the Y-K delta. Despite reports of a considerable decline in Steller's eiders in east Siberia during this century, a population decline does not discount the possibility of Y-K delta eiders moving there. Indeed, if the Y-K delta population was small, it would be very difficult to detect the gradual addition of a few thousand birds into the much larger nesting population in the U.S.S.R.

Contraction of geographic range: The Steller's eider population on the Y-K delta may have been sustained in the past by immigration from breeding areas along the arctic coast of Siberia, the center of the breeding range (Jones, 1965; Uspenski, 1972). Eiders nesting on the Y-K delta formed a peripheral population at the southernmost extreme of this range. For bird populations, abundance is usually greatest in central regions and declines toward the periphery of the species range, suggesting that central areas offer the most favorable habitats (Brown and Gibson, 1983). Because habitats in peripheral areas are often marginal, many peripheral populations (of mobile species such as birds) have

death rates that exceed birth rates and are sustained by a continual influx of immigrants from central populations that produce a net excess of individuals (Brown and Gibson, 1983). This may have been the case with the Steller's eider. As numbers of eiders (and other waterfowl) in east Siberia declined during this century (Kistchinski, 1973; Solomonov, 1987) and a surplus of individuals was no longer produced, immigration to the Y-K delta may have ceased.

Increased Mortality

Subsistence harvest: Geese on the Y-K delta declined from nearly one million birds in the 1950s to less than half that in the 1980s (Raveling, 1984). Populations of cackling Canada geese (*Branta canadensis minima*) declined by over 93% between the mid-1960s and the early 1980s. Overharvest, including hunting at wintering areas outside of Alaska and spring subsistence hunting by natives of coastal Alaskan villages, has been identified as a major reason for waterfowl declines (Raveling, 1984). Increased harvest of geese in Alaska has accompanied a 42% increase between 1960 and 1980 in the Yupik Eskimo population of coastal delta villages and improved mobility of hunters (Raveling, 1984).

Steller's eiders also may have been affected by this combination of more hunters and greater hunter mobility. Excessive hunting prior to 1981 has recently been suggested as the major reason for decline of the Steller's eider in the U.S.S.R., where until recently there was no limit on the number harvested (Solomonov, 1987). (Beginning in 1981, it was declared illegal to hunt Steller's eiders in the Yakutsk Republic.)

In Alaska, Klein (1966) believed that eiders were an important food source to the coastal native population during spring, although king (*S. spectabilis*) and common eiders predominated in the harvest. Steller's eiders made up a small proportion of the spring harvest, apparently because of their small size and low numbers onshore. (They continue to be common in offshore leads during spring migration; C. Dau, USFWS, pers. comm. 1989.) In recent years, only king eiders were taken in any numbers (about 3000 birds per year from 1985 to 1989) by natives on the Y-K delta (J. Copp, unpubl. data; C. Wentworth, unpubl. data). Steller's eiders were not included in the reported take, presumably because too few were taken. Late summer and fall harvest of eiders on the Y-K delta is less than in spring (e.g., about 83 spectacled eiders and 24 king eiders were reported harvested in 1987; J. Copp, unpubl. data).

Egging of eider nests has been considered of little importance to natives on the Y-K delta (Dau, 1974; Klein, 1966; J. Copp, unpubl. data). Considering that Steller's eider nests were well hidden (like the nests of other eiders) and probably uncommon (there is no evidence that Steller's eider nests were clumped [Palmer, 1976], as is sometimes the case with nests of spectacled eiders [Kistchinski and Flint, 1974]), and assuming that discovery of waterfowl nests by eggers is dependent on nest frequency (common nests are more frequently located), it is unlikely that egging would have had a serious impact on the Steller's eider. Only if nests were predictably placed in certain habitats and near nests of more commonly egged species, such as brant, would the loss of a few nests have contributed to the population decline.

Predation: Steller's eider may have succeeded on the Y-K delta by nesting in close association with the formerly extensive coastal goose colonies (J. King, pers. comm. 1990).

Although there are no complete censuses available for goose colonies on the Y-K delta before 1980 (Sedinger, 1987), historically brant were described as nesting on the delta in a near-continuous band extending 160 km from the northern side of Nelson Island to Kokechik Bay (brant apparently were not common nesters at Kokechik Bay in the 1920s but cackling Canada geese may have been; Murie, 1924) and in a smaller colony on the southern side of Nelson Island (Spencer *et al.*, 1951). Such large colonies are thought to have evolved because high densities minimize losses to predators by "swamping" them with overabundant food (Wittenberger and Hunt, 1985). By breeding in association with these colonies, eiders may have been afforded similar protection from predators. Spectacled and common eiders sometimes breed in association with more aggressive colonial species like gulls and terns (Kistchinski and Flint, 1974; Gotmark, 1989).

Brant and cackling Canada geese nesting on the Y-K delta have declined significantly during the past few decades (Raveling, 1984; King and Derksen, 1986). As they disappeared from much of the Y-K delta and colonies were broken up (remaining brant, for example, are largely confined to four remnant colonies: King and Derksen, 1986; Sedinger, 1987), Steller's eiders, because they were much less common than these two goose species, may have declined disproportionately as protection from predators was eliminated. High predation rates in the major brant colonies on the Y-K delta in the mid-1980s demonstrated how predators, especially arctic fox, can decimate numerically small goose colonies (Raveling, 1989) during years when small mammal populations are low. The impact on eiders of gull and jaeger predation is unknown.

Storm tides and nesting habitat: Vegetated intertidal areas on the Y-K delta consist of wet sedge and grass meadows that lie adjacent to extensive unvegetated intertidal flats (King and Dau, 1981). Because of their proximity to the coast and their low relief, these wet meadows are susceptible to flooding from storm tides far beyond the normal range of tidal influence (King and Dau, 1981). Storm tides are most common during fall and winter but occur occasionally in spring (King and Dau, 1981; Thorsteinson *et al.* 1989).

Flooding of coastal habitats on the Y-K delta during the waterfowl nesting season (June and early July) periodically has had a serious impact on productivity of some species (Hansen, 1961; King, 1964). However, severe storm tides (those capable of destroying a large percentage of brant nests on the outer Y-K delta) are relatively rare (estimated recurrence interval of 14.3 years; King, 1964). During the past 30 years, storm tides of this magnitude have had a serious impact on nest success of waterfowl only twice, in 1963 (King, 1964) and 1978 (C. Dau, pers. comm. 1985). Although records of storm tides prior to 1950 are unavailable, natives living on the Y-K delta, when questioned by Olson (1951), could not remember having seen the nesting grounds flooded during May, June, or early July.

Ice scour, sediment deposition, and coastal erosion resulting from storm tides continually affect the distribution of plants, land forms, and the amount of intertidal habitat on the Y-K delta (King and Dau, 1981; Thorsteinson *et al.*, 1989). Storm tides in fall can accelerate normal rates of coastal erosion on west- and southwest-facing shorelines (Reimnitz and Maurer, 1979; Thorsteinson *et al.*, 1989). The degree to which these processes have affected important waterfowl habitats, however, is unknown. There has been no detailed

appraisal of the effects of storm tides on 1) the distribution and characteristics of the permafrost layer, 2) coastal and riverine erosion, 3) lake formation (including thermokarst), and 4) the dynamics of intertidal habitats (King and Dau, 1981).

The distributions of birds on the Y-K delta presumably have always been influenced, to varying degrees, by habitat changes resulting from periodic storm tides (King and Dau, 1981). There is no evidence that such events have occurred with greater frequency in recent years. The fact that eiders probably disappeared at a time when brant were still relatively common (though declining) at coastal locations suggests that habitat changes alone probably cannot explain their disappearance. However, a more thorough evaluation of changes, if any, to coastal nesting habitats on the Y-K delta would be of interest.

Winter mortality: The majority of the world population of the Steller's eider molts along the north side of the Alaska Peninsula (Fig. 1), primarily at Nelson and Izembek lagoons (Petersen, 1981). Following the molt, many eiders move to wintering areas along the south side of the Alaska Peninsula and the easternmost Aleutian Islands (King and Dau, 1981). Smaller populations molt and winter along the Asiatic coastline, primarily from the Commander Islands and Karaginski Inlet south to the Kuril Islands (Fig. 1) and Japan, and along the Kola Peninsula in the U.S.S.R. and the adjacent Varanger Peninsula in Norway (Dement'ev and Gladkov, 1952; Frantzen, 1985; King and Dau, 1981; Palmer, 1976). Because of the inaccessibility of wintering locations, it is unlikely that current levels of winter harvest by people are an important source of mortality in Steller's eider, though annual harvest data are unavailable. Mortality resulting from birds becoming entrapped in gill nets, especially those nets that drift unattended into shallow waters along the Alaska Peninsula, is unknown.

Winter weather conditions on the Alaska Peninsula may be an important source of mortality in some species of waterfowl. For example, large numbers of emperor geese (*Chen canagicus*) are periodically killed after the birds, already weakened by a prolonged blizzard, congregate on spits and shorelines to roost during high tide and are covered by wind-driven spray and freezing rain (R. Gill, USFWS, pers. comm. 1989). Because Steller's eiders winter in similar nearshore habitats and roost on shores, they may also be subject to such weather-related mortality. Indeed, villagers along the north side of the Alaska Peninsula have observed king eiders frozen into the ice or weakened by these conditions. However, there have been no reports of Steller's eiders being affected by the ice, presumably because they move to open nearshore waters of the Bering Sea or fly to areas with more moderate conditions along the south side of the Alaska Peninsula just prior to storms.

A decline in the Alaskan breeding component of Steller's eiders would be virtually impossible to document in their Alaska Peninsula wintering area because the majority of Alaskan wintering birds breed in Siberia. From 1961 to 1984, 6980 Steller's eiders were banded during September at Izembek Lagoon (Fig. 1). Of 143 recoveries through 1986, 82 (57%) were from breeding areas in the U.S.S.R., versus only three (2%) from breeding areas in Alaska (Fig. 2). The remainder were recovered in fall near Izembek (Jones, 1965; Dau, 1985).

Late breakup of sea ice and quick freezes along the arctic coast in spring periodically result in extensive mortality to waterfowl by limiting access to offshore feeding areas. For example, an estimated 100 000 king eiders, about 10% of the average annual estimated population, died from starvation caused by unusually bad ice conditions in the Beaufort Sea in the spring of 1964 (Barry, 1968). These conditions can also cause heavy mortality in birds that have not yet reached flight stage in the fall. Although Steller's eiders nest along the arctic coast, no large die-offs have been reported. This is not surprising considering their low numbers in Alaska and a lack of reports from the Soviet Union.

Food limitation: The pattern of nutrient acquisition in the Steller's eider is unclear. For example, it is not known to what extent energy reserves accumulated during the winter are depleted during migration to the breeding grounds and if Steller's eiders, like common eiders (Parker and Holm, 1990), accumulate significant prelaying reserves by feeding near the breeding grounds before the initiation of nesting. What is known is that foods available at lagoons along the Alaska Peninsula are an important source of energy for maintaining body reserves during times of nutritional stress (eiders at Nelson Lagoon do not lose weight during the molt in late summer [Petersen, 1981]) and for accumulating energy reserves prior to migration (eiders at Izembek Lagoon gained considerable weight at the end of winter [Fredrickson, unpubl. data]). This suggests that, by meeting the energy needs of eiders during a large portion of the year, food resources along the Alaska Peninsula to some extent play an important role in determining breeding success.

A decline in availability of preferred foods at wintering locations is believed by some to have contributed to the extinction of the Labrador duck (*Camptorhynchus labradorius*) (Godfrey, 1986), which, on the basis of its unusual soft-edged bill, was thought to have had a highly specialized diet. Because of similarities in bill structure and body size between the Labrador duck and Steller's eider, it has been suggested that the two are closely related (Portenko, 1972) and that the Steller's eider represents an ecological vicariate of the Labrador duck, occupying a similar marine habitat and consuming the same foods in the North Pacific as did the Labrador duck in the North Atlantic (Johnsgard, 1978). There is no evidence, however, that the diet of the Steller's eider is highly specialized. Studies along the Alaska Peninsula have shown that Steller's eiders feed on a variety of marine invertebrates, including pelecypods, amphipods, and gastropods (Peterson, 1980; Troy and Johnson, 1987; Fredrickson, unpubl. data) and that they are opportunistic and their diet varies according to the availability of prey species at different locations. For example, mussels (*Mytilus edulis*) and amphipods (*Anisogammarus pugettensis*) were the most important foods at Nelson Lagoon during summer (Petersen, 1981), while gastropods, clams (*Macoma* spp.), and amphipods were most commonly taken about 100 km away at Izembek Lagoon during winter (Fredrickson, unpubl. data).

Eider prey species may have declined due to competition from expanding sea otter populations (*Enhydra lutris*). Sea otters now appear to be near or at carrying capacity throughout most of their historical range from the northeastern Gulf of Alaska, westward across the Pacific rim, to the eastern end of the Kuril Islands (Riedman and Estes, 1988). Throughout the north Pacific, sea otters commonly forage on mussels (and other invertebrates) (Kvitek and Oliver, 1988). Considering that extinction of otters in the early 20th

century is believed to have caused population increases in a variety of invertebrates, including pelecypods and gastropods (Estes *et al.*, 1989), it is possible that current predation may now be limiting these invertebrates. Recent studies suggest that sea otters do have significant effects on mussel-dominated communities (VanBlaricom, 1988). At Prince William Sound, Alaska, for example, effects include changes in mussel abundance and size structure and provision of space for invertebrate species that are competitively subordinate to mussels. The degree to which otters have impacted mussels (and other invertebrates) in areas commonly used by Steller's eiders, such as Nelson Lagoon, however, is largely unknown. The potential impact on invertebrates of suspected changes in the ecological importance of fish species in the marine system due to commercial fisheries is also unknown.

CURRENT WORLD POPULATION SIZE

Aerial surveys to count Steller's eiders using the Izembek Lagoon system have been conducted since 1975 by U.S. Fish and Wildlife Service biologists. Monthly counts averaged for the period 1986-90, when compared with the same monthly averages during 1975-85 (Dau, USFWS, unpubl. data) (Table 3), show an overall population decline of more than 50%. Waterfowl surveys conducted in spring and fall from the Alaska Peninsula northward to the Y-K delta also show a large decline since the early 1980s (King and Dau, USFWS, unpubl. data).

There are about 70 000 or fewer eiders currently wintering along the Alaska Peninsula, based on counts during the last five years (King and Dau, USFWS, unpubl. data; Troy and Johnson, 1987). This represents a large decline from the 200 000 once estimated to have wintered there (Jones, 1965) and substantiates reports from the U.S.S.R. of reduced production on the Siberian breeding grounds (Solomonov, 1987). Considering that about 11 000 eiders wintered recently along the Varanger Peninsula in Norway (Frantzen, 1985) and about 15 000-20 000 once wintered in the vicinity of the Commander Islands and Karaginski Inlet in the U.S.S.R. (little is known about the current status of the Soviet segment of the wintering population) (Kistchinski, 1973), the world population now may number fewer than 100 000 birds.

TABLE 3. Average number of Steller's eiders using the Izembek Lagoon system in different months during 1975-85 versus 1986-90

Month	1975-85	1986-90	% decline
January	14 527 (1)[1]	7 741 (3) (2 873–15 350)[2]	-47
March	23 359 (1)	16 196 (2) (9 932–22 460)	-31
April	91 895 (1)	20 265 (1)	-78
May	39 461 (5) (15 518–62 855)	10 748 (5) (7 249–14 324)	-73
August	—	26 942 (3) (7 350–19 592)	—
September	41 174 (4) (14 825–79 970)	17 587 (9) (8 994–25 820)	-57
October	36 736 (6) (14 883–77 735)	16 962 (12) (4 276–27 722)	-54
November	49 098 (1)	19 334 (6) (11 544–23 211)	-61
December	8 323 (1)	6 000 (1)	-28

[1]Number of surveys used to compute average.
[2]Range of survey counts.

DISCUSSION

The Steller's eider possibly was never a common nesting bird on the Y-K delta during historic times, despite claims of its abundance by early observers. Estimating the early population size is difficult because most early reports of abundance were not quantitative and surveys were geographically restricted. Localized surveys may have given erroneous impressions of great overall abundance. Although the magnitude of the historic population is largely speculative, concurrent reductions in populations of Y-K delta geese serve to demonstrate the dramatic speed by which even formerly large Y-K delta waterfowl populations have been reduced.

The Steller's eider is now a regular breeder in Alaska only near Barrow. It is believed to be uncommon east of Point Barrow (see Johnson and Herter, 1989) and has not been recorded breeding in the Arctic National Wildlife Refuge coastal plain (Garner and Reynolds, 1987) or along the Canadian Beaufort Sea coast (see Johnson and Herter, 1989). Recently, it was described as possibly a very rare breeder on the Seward Peninsula (Kessel, 1989). Steller's eiders were reportedly found breeding in small numbers on St. Lawrence Island in the late 1800s (Nelson, 1887) but by the 1950s were rarely found nesting there (Fay and Cade, 1959).

The Steller's eiders near Point Barrow are largely restricted to a small geographic area of the arctic coastal plain (Myres, 1958; Pitelka, 1974), on lands with no special protection. Seventeen nests were found at two study areas near Barrow during the period 1975 to 1980 (Table 4) but no nests have been reported during the last decade. Annual mean nest densities in preferred habitats during 1975-80 ranged from 3.0·km^{-2} (study area #1) to 6.8·km^{-2} (study area #2), higher than those recorded for the Steller's eider on the Y-K delta during the 1950s and 1960s. Furthermore, nest densities near Barrow represent minimum values because the primary goal of the surveys was to map bird terrritories and not to locate nests (B. McCaffery, pers. comm. 1991). There currently is no population estimate available for Steller's eiders nesting along the arctic coast of Alaska.

TABLE 4. Number of Steller's eider nests found at two study areas near Barrow, 1975-80

Year	Study area #1[1] (33 ha)	Study area #2[2] (27 ha)	Source
1975	2	2	Myers and Pitelka, 1975a,b
1976	3	7	Myers *et al.*, 1977a,b
1977	0	0	Myers *et al.*, 1978a,b
1978[3]	0	1	Myers *et al.*, 1979a Myers *et al.*, 1979b
1979[3]	0	0	Myers *et al.*, 1980a Myers *et al.*, 1980b
1980	1	1	Myers *et al.*, 1981a,b
Total	6	11	

[1]Referred to as wet coastal plain tundra (I) by Myers and Pitelka (1975a).
[2]Referred to as wet coastal plain tundra (II) by Myers and Pitelka (1975b).
[3]Territorial males were present on study area #1 in 1978 and on study areas #1 and #2 in 1979; however no nests were found.

Restriction of the North American breeding population of the Steller's eider to one region is significant because the population is now much more susceptible to complete eradication resulting from either natural or human-induced disturbance on the breeding grounds or at nearby offshore molting locations. Equally troublesome is the absence of information concerning its disappearance from the Y-K delta.

Effective surveys or monitoring methods do not exist for many northern bird populations. Disappearance of a geographically significant portion of the North American breeding population of Steller's eider, before it was ever counted, is a recent excellent example of why such surveys are needed.

LEGAL MANDATES AND INFORMATION NEEDS

Effective monitoring of Steller's eider will require international cooperation between the United States and the Soviet Union, in addition to a national effort. A coordinated international effort using standard population monitoring techniques at wintering areas should be instituted to detect further declines. Studies on the breeding biology and nesting chronology of the northern Siberian population are needed to better understand timing of arrival at wintering locations (Petersen, 1981) and to monitor changes in reproductive success. Though the Soviets recognize the need to count and monitor the Siberian population (Solomonov, 1987), the Steller's eider is currently not a high research priority in the U.S.S.R.

Recent amendments to the Fish and Wildlife Conservation Act of 1980 (P.L. 100-653) require that the U.S. Department of the Interior monitor and assess population trends of all species, subspecies, and populations of migratory nongame birds. Although this provision does not explicitly cover Steller's eider (because it is a hunted species), it is significant that Congress recognizes the need for broad-scale monitoring.

There exists a treaty between the United States and the Soviet Union (T.I.A.S. 9073) concerning the conservation of migratory birds and their environment (Senner and Howe, 1984), and the Steller's eider is included in the list of shared species qualifying for consideration. This treaty could in spirit, if not in law, establish a basis and framework for a cooperative monitoring program for Steller's eider and, if warranted, habitat protection for the benefit of eiders and other shared species.

The U.S.-Soviet treaty contains language important in establishing a framework for cooperation. Among other things, the treaty addresses the following: 1) ". . . cooperate to the maximum possible degree in preventing, reducing or eliminating . . . damage to migratory birds and their environment and in providing for the rehabilitation of their habitat" (p. 1157). 2) "Identify areas of breeding, wintering, feeding, and moulting which are of special importance to the conservation of migratory birds within the areas of jurisdiction. Such identification may include areas which require special protection because of their ecological diversity or scientific value" (p. 1157). 3) ". . . promote research related to the conservation of migratory birds and their environment, and agree to coordinate . . . national bird banding programs. In cases where it is desirable, such research may be conducted under agreed upon programs coordinated by the competent authorities of the Contracting Parties" (p. 1158).

In Alaska, studies should be immediately initiated to identify the size and the geographic extent of the arctic population. Additional protection or management may be needed in areas where the species currently nests. Causes of mortality and sources of disturbance should be monitored at breeding, molting, staging, and wintering locations, and hunting at wintering locations should be prohibited (the Steller's eider is legally hunted on the Alaska Peninsula from 1 September to 16 December [Alaska Department of Fish and Game, 1989]). Finally, information should be collected on the size and distribution of food resources along the Alaska Peninsula and a program implemented there to monitor changes in food abundance and quality.

The spectacled eider shares the same general breeding range as the Steller's eider (Alaska and Siberia) and is also declining. In Alaska, spectacled eiders breed on the Y-K delta (Bellrose, 1980), uncommonly on the Seward Peninsula (Kessel, 1989), and along the arctic coast from the vicinity of Point Barrow east to the Colville River delta and Demarcation Point (see Johnson and Herter, 1989). Along the arctic coast of the U.S.S.R., they breed from the Yana delta east to the Chukotski Peninsula, with the center of abundance being Chaunskaya Bay east to the Indigirka and Kolyma rivers (Bellrose, 1980). The center of the world breeding range is believed to be the Yukon-Kuskokwim delta, where between 50 000 and 70 000 pairs are thought to have nested annually (Dau and Kistchinski, 1977).

Recent studies by the U.S. Fish and Wildlife Service suggest that as few as 3000 spectacled eider nests were present on the Y-K delta in 1990 (Stehn, USFWS, unpubl. data), a decline of over 90% when compared with previous estimates of population size. Furthermore, the decline in nest abundance has averaged about 15% per year during the last five years (1986-90). The current status of the spectacled eider in the remainder of its Alaskan and Siberian breeding range is unclear, but the portion of the world population nesting on the arctic coast of Alaska is small compared with numbers nesting in Siberia (Dau and Kistchinski, 1977). Considering recent large declines on the Y-K delta and lack of current information for the remainder of the breeding range, the spectacled eider also merits special consideration or protection.

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