Spectacled Eider
(Somateria fischeri)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Fairbanks Fish and Wildlife Field Office
Fairbanks, Alaska

August 2021

5-YEAR REVIEW
Spectacled Eider/*Somateria fischeri*

GENERAL INFORMATION

Species: Spectacled Eider/*Somateria fischeri*
Date listed: May 10, 1993
FR citation(s): 58 FR 27474
Classification: Threatened Species
Critical Habitat Designation: February 6, 2001: 66 FR 9146

Methodology used to complete the review:
In accordance with section 4(c)(2) of the Endangered Species Act of 1973, as amended (Act), the purpose of a 5-year review is to assess each threatened or endangered species to determine whether its status has changed and it should be classified differently or removed from the Lists of Threatened and Endangered Wildlife and Plants. The U.S. Fish and Wildlife Service (Service) evaluated the status of the spectacled eider through a Species Status Assessment (SSA) to inform this 5-year review. The SSA report was written by biologists in the Fairbanks Field Office who lead the recovery efforts for the species. The SSA report represents our evaluation of the best available scientific information, including the resource needs and current condition of the species. We developed future scenarios of environmental and management conditions to discuss the viability and condition of the species in the future. One independent reviewer, and members of the Spectacled Eider Recovery Team (Team), which includes partner representatives and scientific experts, reviewed the SSA report and provided comments. It was then used as the scientific basis to support our 5-year review decision-making process.

Background and Listing History

The spectacled eider was listed as a threatened species throughout its range in Alaska and Russia on May 10, 1993. This listing was in response to population declines of approximately 96 percent in western Alaska, which, at the time, was thought to be its primary breeding range. The factors that caused the decline were unknown at the time of listing and remain unknown today. Critical habitat was designated on February 6, 2001, to protect molting areas in Norton Sound and Ledyard Bay, nesting areas on the Yukon-Kuskokwim Delta (Y-K Delta), and the wintering area south of St. Lawrence Island (66 FR 9146). A recovery plan finalized on August 12, 1996, included recovery criteria that required each of the three breeding populations (western Alaska, northern Alaska, and Arctic Russia; referred to here as the Y-K Delta, Arctic Coastal Plain [ACP], and Arctic Russia breeding populations, respectively) to meet a threshold for abundance and trend and that threats be ameliorated (USFWS 1996; Figure 1). While the recovery plan has not been revised, the Team and the Service review and update a list of spectacled eider recovery tasks periodically.

FR Notice citation announcing the species is under active review: 85 FR 53840

REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) policy

Spectacled eiders were listed in 1993. We completed a DPS analysis in the last 5-year review (USFWS 2010).

The spectacled eider was listed throughout its range in 1993, largely based on steep declines in the Y-K Delta and Arctic Coastal Plain (ACP) breeding populations; the size of the Arctic Russia breeding population was unknown at the time of listing. Given that males breed in different breeding areas from year to year, and therefore are not permanently attached to any single area, the Service believes that the populations do not meet the criteria of discreteness, and therefore would not qualify to be considered as separate DPSs under this policy. Therefore, because the breeding populations are not designated as DPSs, all three populations must meet the recovery criteria to warrant a change in status under the current Recovery Plan.

Is there relevant new information for this species regarding the application of the DPS policy?

Analysis of more recent genetic samples collected from 2008–2012 showed population differentiation based on mtDNA, but genetic structure was reduced, particularly in comparisons among Y-K Delta and ACP breeding populations (Sonsthagen et al. 2019). These results suggest that female dispersal may have increased with the increase in population size on the Y-K Delta, and lends support to the hypothesis that spectacled eider populations interact as a global metapopulation (Sonsthagen et al. 2019). Dispersal between local populations within one breeding area is also supported by population modeling conducted by Flint et al. (2016) for the Y-K Delta. Thus, dispersal could occur within or between breeding areas.

Recovery Criteria

Recovery Plan: USFWS. 1996. Spectacled Eider Recovery Plan. U.S. Fish and Wildlife Service, Anchorage, Alaska.

A thorough analysis of the recovery criteria was done during the SSA process. See Appendix A. Evaluation of Recovery Criteria in the 1996 Spectacled Eider Recovery Plan.

Updated Information and Current Species Status

The status of spectacled eiders was last reviewed in 2010. Long-term research and monitoring on spectacled eiders was conducted prior to listing, the results of which are summarized in the SSA report. Since listing we have new or updated information on numbers of spectacled eiders, parameter estimates of demographic rates, variability of those estimates, and stressors. This information, and citations are described in detail in the SSA report, and a synopsis is provided below.

Biology and Habitat

Spectacled eiders occupy remote habitats which are largely intact. However, some factors may be currently affecting spectacled eider habitat quality, and these effects may increase in the future (salinization of wetlands, changes to benthic prey communities), or may decrease (fewer years with extreme sea ice conditions). The magnitude of these effects on spectacled eider population resilience is uncertain; therefore, for this SSA, we primarily focused on measures of population abundance and growth rate to evaluate the species status and resilience. These measures reflect the effects of influential factors and habitat changes to date on population resilience.

To characterize population abundance and growth rate, we primarily considered the results of two recently conducted analyses that used the best available data but different methods. First, (Dunham et al. 2021) used a Bayesian state-space model to estimate the abundance and growth rate of the Y-K Delta and ACP populations using count data from 2007–2019. Note the analysis only used data from 2007 forward, as survey methods from 2007-2019 were consistent over time. Second, we (Service) used the available long-term datasets (1988-2019) describing abundance and demographic rates of the Alaska-breeding populations to develop an integrated population model (IPM) linked to a population viability analysis (PVA) for the Y-K Delta and ACP breeding populations (IPM-PVA; Appendix B). The abundance and trend information used in these models is summarized below and a detailed description of the analyses can be found in the SSA report.

Yukon-Kuskokwim Delta Breeding Population
The Y-K Delta breeding population has increased since the species was listed in 1993 (when the population was estimated to number less than 3,000 spectacled eiders; Stehn et al. 1993), and estimates now indicate are more than 12,000 spectacled eiders in the population. The estimated mean population growth rate from 2007–2019 is positive, but the lower 95 percent confidence interval is less than one percent per year, suggesting the population is now stable. The population growth rate has slowed in recent years and appears to have leveled off.

However, while the annual aerial survey did not occur in 2020, the preliminary population estimate from the 2021 survey is 2131 spectacled eiders (95percent CI = 1,625 – 2,638); the lowest count since 1992.

Arctic Coastal Plain Breeding Population
The current abundance in the ACP breeding population is estimated at more than 3,500 individuals. We have limited information on the historical abundance of spectacled eiders in the ACP breeding population; however, available information suggests this breeding population has been stable since listing.

Arctic Russia Breeding Population
When the species was listed in 1993, data were insufficient to estimate population size or trend in Arctic Russia (58 FR 27475). Aerial surveys conducted from 1993 to 1995 produced an index of 146,245 spectacled eiders (coefficient of variation = 0.08, unadjusted for detection rate; Hodges and Eldridge 2001).

In 2019, Russian biologists began conducting aerial waterfowl surveys in the range of spectacled eiders in Arctic Russia. Methods and survey area differed among years, but in 2020 protocol and transects were similar to those used by Hodges and Eldridge (2001). Final results from this survey are not yet available; however, initial comparison of densities observed in key breeding sites indicate substantially lower estimates in 2020 compared to the 1990s. For example, at Indigirka Delta, the 1990s estimate was 46,000 while the 2020 estimate was 3,000 (J. Fischer, Service, *pers. comm.*). While preliminary results suggest a possible decrease in population size, these data cannot be used to produce an estimate of population trend due to timing and survey design differences. Therefore, current Arctic Russia breeding population abundance and trend are unknown, other than what can be inferred from estimates of the global wintering population.

Winter Surveys of the Global Population
Aerial surveys over the wintering area in the Bering Sea were conducted in 1995–1998, 2009, 2010, and 2020 to estimate the size of the global population (Larned et al. 2012, Safine and Bowman 2020). Satellite telemetry and aerial surveys through 2010 suggested that individuals from all three breeding populations winter together in large, tight flocks in an area south of St. Lawrence Island. Due to potential sources of unquantified biases and errors, we consider the results from these surveys as *minimum counts of the global population* of spectacled eiders rather than estimates of population abundance.

Prior to 2020, two surveys were conducted under optimal conditions and considered to be accurate characterizations of the minimum size of the global population. A photographic survey in 1997 resulted in a minimum estimate of 363,030 spectacled eiders (95 percent CI = 333,526 – 392,532; Larned and Tiplady 1997:3 – 4, Larned et al. 2012:7). The survey flown in 2010 under similar conditions and resulted in a minimum estimate of 369,122 spectacled eiders (95 percent CI = 358,163 – 380,081; Larned et al. 2012).

In 2020, another aerial survey was conducted using similar methods (Safine and Bowman 2020) and the resulting minimum estimate of the global population was 76,952 spectacled eiders; 78 percent lower than the previous count. However, the notable differences in flock location, flock size, sea ice dynamics, and sample size of marked birds, indicate the 2020 survey area did not capture the entire population (Safine and Bowman 2020).

In summary, results of all winter surveys of spectacled eiders, including the 2020 count should be considered minimum population counts, as they did not account for detection probability of flocks within or outside of the study area. While a decline in the Arctic Russia breeding population cannot be ruled out as a possible contributor to the lower 2020 count, due to the issues described above it is not appropriate to compare this count with counts in previous years to make inferences about population growth rate.

Minimum size of Arctic Russia Breeding Population
Abundance information on the Arctic Russia breeding population is not available, we subtracted the combined estimates of the Alaska populations (Y-K Delta and ACP) from the count of the global population (Y-K Delta, ACP, and Arctic Russia combined) to calculate the minimum size of the Arctic Russia population. Following the methodology described in the SSA report, the

Arctic Russia population in March 2020 was comprised of *at least* 45,734 spectacled eiders, recognizing this is an underestimate of the true population size.

Demographic changes in Arctic Russia

Solovyeva et al. (2018) documented an annual decline in spectacled eider nest density of eight percent at Chaun from 2009–2016. This study is limited to one site within a widely distributed breeding population but may suggest that nesting effort and/or the spectacled eider population at this local site are decreasing. How this potential decrease at one site relates to the larger Arctic Russia breeding population is not known but warrants further study. We have no information on whether demographic parameters or nesting distribution of spectacled eiders in Arctic Russia have changed since listing.

In summary, information on abundance, distribution, and trend of the Arctic Russia breeding population is extremely limited. At the time of listing, the number of spectacled eiders in this population was unknown; winter surveys in the 1990's and 2010 indicated over 200,000 spectacled eiders in the population. The only information to evaluate current condition of this breeding population is the most recent estimate of the minimum global population size, less the Alaska breeding population estimates, which suggests the Arctic Russia population consists of at least 45,000 spectacled eiders. Beyond this crude estimate, we have no information from which to characterize its current level of resilience.

Summary of Resilience

By comparing the best available information on population abundance and growth rate with the condition categories described in Section 3.3.1 of the SSA, we consider the current resilience of the Y-K Delta breeding population to be moderate-high, and of the ACP breeding population to be low-moderate (Table 1). The estimated minimum size of the Arctic Russia population suggests high resilience, but without concurrent estimates of population growth rate, we do not have sufficient information to adequately characterize its current level of resilience.

Table 1. The current condition of spectacled eider breeding populations based on an integrated population model (Bradley and Osnas 2020) and Bayesian state-space model (Dunham et al. 2021).

Population	Analysis	Abundance (Y-K Delta and ACP) or minimum population count (Arctic Russia)/ Resulting condition category	Population Growth Rate 2007-2019/ Resulting condition category	Overall Level of Resilience
Y-K Delta	IPM-PVA (Bradley and Osnas 2020)	14,027 (95% CRI = 9,781 – 18,257)/ MODERATE	0.006 (95% CRI = -0.025 – 0.030)/ MODERATE	MODERATE-HIGH
	Bayesian state-space model (2007-2019; Dunham et al. 2021)	16,113 (95% CRI = 12,313 – 21,352)/ HIGH	0.016 (95% CRI =-0.065 – 0.091)/ MODERATE	

ACP	IPM-PVA (Bradley and Osnas 2020)	5,408 (95% CRI =3,696 – 7,364)/ LOW	-0.025 (95% CRI -0.055 – 0.004)/ MODERATE	LOW-MODERATE
	Bayesian state-space model (2007-2019; Dunham et al. 2021)	6,401 (95% CRI = 3,766 – 9,750)/ LOW	-0.005 (95% CRI = - 0.092 – 0.082)/ MODERATE	
Arctic Russia	calculation in SSA report	minimum population size: 45,734/ HIGH	N/A	unknown

Summary of Representation
Overall, the current representation of spectacled eiders can be characterized by the following points: 1) spectacled eiders are widely distributed in at least three ecotypes during the breeding season (Y-K Delta, ACP, and Arctic Russia); 2) they use four molting areas with benthic communities that likely differ in composition; 3) they may be able to shift their distribution in response to changing sea ice conditions in the Bering Sea in winter; 4) evidence supports they shift their diet depending on availability of benthic bivalve species; and 5) there is no indication that genetic diversity is limiting their adaptive capacity.

Summary of Redundancy
The global population of spectacled eiders continues to be comprised of three breeding populations that use at least four different molting areas spanning a relatively large and geographically diverse area. However, the high degree of female breeding area fidelity and natal philopatry makes it unlikely spectacled eiders would re-colonize an area should a breeding population become extirpated. In addition, historically, the entire global population used one wintering area in the Bering Sea where birds were concentrated in openings in the sea ice making them susceptible to catastrophic events such as a disease outbreak. However, in the last decade there have been fewer years with extreme sea ice conditions and wintering flocks appear to be more dispersed in milder years (USFWS, unpublished data). While extreme sea ice conditions are predicted to still occur in some years, a wider winter distribution increases the ability of the species to withstand a catastrophic event.

Threats Analysis

The *Factors Affecting Viability* section in the SSA report summarizes the factors hypothesized to affect the current and/or future condition of spectacled eiders throughout some or all the species' range (Table 2). We began our analysis by reviewing threats described in the listing document, the 1993 Recovery Plan, the 2010 5-year review, Biological Opinions developed under Section 7(a)(2) of the Act, and other available scientific information, to determine if they remain important factors affecting viability. For each factor we describe what is known about how it currently affects spectacled eiders, and whether it may affect the species in the future; further detail on each factor can be found in the SSA report.

Table 2. Summary of factors that may affect spectacled eiders at the individual and/or population level.

Act Listing Factor	Factor that may affect population resilience	Currently affecting spectacled eiders?	Predicted to affect spectacled eiders in the future?
A, D	Ingestion of lead ammunition	Yes	Yes, but could decrease with adequate outreach and communication
A, D	Harvest and shooting	Yes	Yes, but could decrease with adequate outreach and communication
A	Contaminants exposure (other than lead)	Unknown	Yes, possible increase in exposure probability from continuing anthropogenic input into the environment and increased oil spill risk from vessel traffic
E	Collisions with structures	Yes	Yes, increasing with more infrastructure/development
E	Collisions with marine vessels	Yes	Yes, increasing with more shipping, research, and fisheries vessel traffic
A	Habitat loss and disturbance	Yes	Yes, increasing with more terrestrial development and vessel traffic
C	Disease, parasites, and bio-toxins	Unknown	Yes, possible increase with changing climate
C	Predation	Yes	Yes, possible increase with more infrastructure/development, and/or changes in ecosystem
A,D, E	Climate change	Yes	Yes, extreme changes to spectacled eider habitat are highly likely; the effect on spectacled eiders, individually and at the population level, are unknown

In summary, several factors may affect individual spectacled eiders, and some may rise to the level that they affect population resilience. For many factors, we have limited information with which to quantify their effects to spectacled eiders, and therefore determine if they are significant population-level threats. However, two factors: exposure to lead and climate change (specifically the effect of both extreme and low sea ice conditions) are of the most concern for spectacled eiders and have been shown to affect demographic rates (Grand et al. 1998, Flint et al. 2016, Christie et al. 2018). All the factors identified in this analysis are expected to continue, at some level, in the future. With adequate management actions, some like harvest and lead exposure, may decrease over time. However, some such as collisions, exposure to contaminants, and salinization of freshwater wetlands, are expected to increase in severity in the future. Climate change has altered, and is expected to continue to alter, both the tundra breeding habitat and the marine non-breeding habitats of spectacled eiders. The northern Bering Sea in particular is expected to undergo drastic changes in the next several decades due to a reduction in sea ice. This may have consequences for spectacled eider food availability and thermoregulation in winter, resulting in reductions in breeding propensity and survival; however, whether spectacled eiders can behaviorally adapt and find adequate foraging conditions is unknown.

Future Condition

To evaluate future condition of spectacled eiders, we developed four future scenarios that incorporated the plausible range of effects from the two major factors previously shown to impact spectacled eider demographic rates: exposure to lead on the breeding grounds (Y-K Delta population only) and sea ice conditions in the 1990s wintering area south of St. Lawrence Island (Y-K Delta and ACP populations). The scenarios were applied to projections of population size of the Y-K Delta and ACP breeding populations in an IPM-PVA (Bradley and Osnas 2020) that produced simulations out to 2060 (40 years, or 5 spectacled eider generations) and 2100 (80 years, or 10 spectacled eider generations). There are not adequate data to conduct an IPM-PVA on the Arctic Russia breeding population; thus, we discuss future condition of that population using qualitative methods below.

In summary, we expect significant changes to the marine and terrestrial habitats used by spectacled eiders in the future due to climate change (SSA, Section 3.1.10). In particular, climate models predict sea ice extent will decrease significantly, and the Bering Sea ecosystem will change due to changes to primary productivity, species distributions, and ocean acidification. However, it is uncertain how spectacled eiders will respond to such changes. We also expect some factors that negatively affect spectacled eiders to increase in the future, such as collision risk, contaminant exposure, and disturbance due to increasing vessel traffic in the Bering and Chukchi seas, and terrestrial habitat loss due to industrial and community development. Others, such as lead exposure and harvest, may decrease with concerted management efforts in Alaska. However, we have no indication that such management efforts are planned or possible in Arctic Russia.

Several factors may influence resilience of spectacled eider populations, including those described in the above paragraph. Given the results of simulations based on plausible scenarios of sea ice conditions and lead exposure rates, factors that have been shown to affect demographic rates and of which we have data for future projections, the probability of quasi extinction remains relatively low through 2060 but increases over time for both Alaska-breeding populations in all scenarios. We do not have data to project future scenarios for the Arctic Russia population but suspect the same factors will act on the resilience of that breeding population. Therefore, we predict the resilience of all three populations will decrease over time, but to an unknown degree. However, because all three populations are likely to persist beyond 2100 based on model results, changes in redundancy are not expected. Both tundra and marine environments are likely to change significantly in the future. We do not have data with which to predict how genetically and/or behaviorally flexible the species will be because of these changes; however, we expect the species to be forced to alter its distribution, diet, and timing of key life history events (nest initiation and migration) in response. Therefore, we predict that the representation of spectacled eiders may be reduced as their habitats shift, particularly past 2060.

Synthesis

The Service determined the global population of spectacled eiders meets the definition of threatened – likely to become an endangered species in the foreseeable future. The current resilience of the Y-K Delta and the ACP breeding populations is moderate-high, and low-moderate, respectively. The resilience of the Russia breeding population is unknown.

The most recent estimate of the global population is 76,952 spectacled eiders; 78 percent lower than the previous count. The preliminary estimate from the 2021 Y-K Delta survey was 2,131 spectacled eiders; the lowest count since 1992. Additionally, Solovyeva et al.(2018) recently documented a decline in spectacled eider nest density of 8 percent per year (2009-2016) at Chaun Delta, Russia.

Spectacled eiders use at least four different molting areas. However, in winter the global population is occasionally restricted to a relatively small area, reducing their level of redundancy during this period. Although we do not have the data to evaluate the genetic adaptive capacity of spectacled eiders, representation of the species can be described by the following factors: distribution in three ecotypes during the breeding season, indications that some individuals shift distribution in response to changing sea ice conditions, and their ability to use different bivalve species depending on availability.

From the IPM-PVA, under all scenarios, we expect declines in the Y-K Delta and ACP breeding populations. We do not have data with which to conduct a similar population viability analysis for the Arctic Russia breeding population, but we also expect decreasing resilience in the Arctic Russia population in the future.

We predict that current stressors will continue and expect significant changes to the marine and terrestrial habitats used by spectacled eiders. Climate models predict that sea ice extent will decrease significantly resulting in changes to primary productivity, species distributions, and ocean acidification. Given the correlation of spectacled eiders with sea ice extent, we predict the species will be negatively impacted. We also expect factors that negatively affect spectacled eiders to increase in the future, such as collision risk, contaminant exposure, and disturbance due to increasing vessel traffic, and terrestrial habitat loss due to industrial and community development.

We acknowledge that several factors may influence resilience of spectacled eider populations, including those described in the above paragraph and predict that the resilience of all three populations will decrease over time. All three populations are likely to persist beyond 2100 based on model results, therefore, changes in redundancy are not expected. Both tundra and marine environments are likely to change significantly in the future. We do not have data with which to predict how genetically and/or behaviorally flexible the species will be; however, we expect the species to be forced to alter its distribution, diet, and timing of key life history events (nest initiation and migration) in response. Therefore, we predict that the representation of spectacled eiders will be reduced as their habitats change and shift.

RESULTS

Recommended Classification

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
____ *Extinction*
____ *Recovery*
____ *Original data for classification in error*
_X___ No change is needed

New Recovery Priority Number: 11

Brief Rationale: The population's recovery priority number (RPN) is currently 5 based on the assessment that the population has a high degree of threat and a low recovery potential. According to policy (48 FR 43104), the high category means extinction is almost certain in the immediate future because of a rapid population decline or habitat destruction. When listed, a rapid population decline was occurring; therefore, the RPN of 5 was warranted at that time. Currently, while we consider the species to be threatened, it does not fall into the "high category," as the population does not appear to be undergoing a rapid decline and extinction is not expected in the immediate future. This assumes that the recent low sample number was an artifact of low sea ice, and thus spectacled eiders were not confined to one area. We believe that assigning the species to a moderate degree of threat and low recovery potential is most appropriate, as numerous identified threats remain and the biological and ecological limiting factors and the threats to the species existence are poorly understood. In addition, the management actions required for recovery remain unknown and have an uncertain probability of success. Therefore, we recommend the RPN be changed to 11: Moderate degree of threat and low recovery potential for the species.

RECOMMENDATIONS FOR FUTURE ACTIONS

1. The Eider Recovery Team updates a prioritized task list every few years based on the Recovery Plan and current information about the species status and threats (Appendix B). We recommend that the actions outlined in the current high priority task list continue to be implemented by the Service and their partners.

2. The Service, with the guidance of the Recovery Team, should assess the current delisting criteria, and possibly modify them, to reflect new data, threats, and model projections.

3. We are unable to assess the potential for future population-level effects of climate change on spectacled eiders at this time. However, we recommend that the Service re-evaluate this conclusion at the next 5-year review to reflect improved understanding and prediction capabilities.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Spectacled Eider (*Somateria fischeri)*

Current Classification: Threatened

Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (Indicate reasons for delisting per 50 CFR 424.11):
____ Extinction
____ Recovery
____ Original data for classification in error
_X_No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: 11

FIELD OFFICE APPROVAL:

Fairbanks Field Office, Field Supervisor, Fish and Wildlife Service

Approve: SARAH CONN Digitally signed by SARAH CONN Date: 2021.09.13 13:59:37 -08'00' Date _________

REGIONAL OFFICE APPROVAL:

Alaska Region, Assistant Regional Director, Fisheries and Ecological Services, Fish and Wildlife Service

Approve PETER FASBENDER Digitally signed by PETER FASBENDER Date: 2021.09.13 17:18:00 -06'00' Date _________

Appendix A. Evaluation of Recovery Criteria in the 1996 Spectacled Eider Recovery Plan

In the 1996 Recovery Plan (Plan), the Recovery Team (Team) identified population abundance and growth rate criteria that, when met, indicate the point at which re-classifications under the Endangered Species Act (Act) should be considered (i.e., endangered, threatened, or not warranted; USFWS 1996). The criteria were based upon the scientific evidence available at the time of Plan development, but also reflect levels of extinction risk and protection deemed acceptable to the Team at that time. Here, we first describe the basis for the recovery criteria developed in the Plan. We then evaluate these criteria in light of the most current information on the species and summarize an analysis of whether the Y-K Delta, ACP, and Arctic Russia populations have met the criteria.

Description of 1996 Recovery Plan Classification Criteria

In the Plan, classification criteria were developed for three breeding populations (Arctic Russia, ACP and Y-K Delta; USFWS 1996). For the *species* to be considered for delisting under the Plan, each breeding population must meet the criteria.

While difficult to decipher from the text in the Plan, it seems the criteria were developed using a step-wise process: first, determine the probability of extinction that corresponded to the definition of threatened and endangered populations using a population viability analysis, and then develop abundance thresholds that corresponded to those probabilities of extinction (Taylor et al. 1996, USFWS 1996).

At the time, little demographic or abundance information was available for spectacled eiders. Therefore, the Team first evaluated extinction risk at varying population growth rates based on data from common eiders (*Somateria mollissima*). Mean growth rate and variance in growth rate were used to project the population size through time using a simple model of exponential population growth (demographic data were not sufficient for a demographic model at the time; USFWS 1996: Appendix 1, 4). Simulations were conducted using uniform prior distributions of growth rate ranging from -0.01 to -0.16 and variation in growth rate ranging from 0.07 to 0.21 standard deviation. Initial population sizes ranged from 1000 to 5000, size was projected for 1000 years, and the time to quasi-extinction (QE) was recorded (USFWS 1996 p. Appendix 1, 11). The QE threshold was set at a population size of less than 250 adult spectacled eiders (equivalent to 125 pairs): the point at which the Team felt only the most radical conservation efforts could result in a full population recovery (e.g., captive breeding; (USFWS 1996). Results demonstrated that a population with a growth rate of -0.05 has a 5 percent probability of reaching QE in 50 years, and the initial population size does not dramatically increase the amount of time to QE until the rate of decrease is more than 5 percent per year. Therefore, the Team selected a population growth rate of ≤ -0.05 as the threshold for classification as endangered.

Table A1. Classification criteria for threatened spectacled eiders from the 1996 Spectacled Eider Recovery Plan (USFWS 1996, p. 36, 38). Note that criteria were developed for breeding populations, and because breeding populations are not designated Distinct Population Segments, all three populations must meet the following criteria to warrant a change in status under this Plan.

Criteria for Delisting from Threatened Status
A population will be considered for delisting from threatened status when the five factors for listing are reviewed for evidence of threats to the population and when:
(1) The population is increasing as judged by the following statistical measures:
The over protection loss exceeds the under protection loss, calculated using population trend data (based on at least 10 years (1 survey/year) of data but not exceeding a 15-year period) and where loss functions are symmetrical around r = 0 with a zero loss for both functions when r = 0; AND The minimum estimated population size[1] is ≥ 6000 breeding pairs (12,000 individuals);
OR
(2) The minimum estimated population size is ≥ 10,000 breeding pairs (20,000 individuals) over ≥ 3 surveys (1 survey/year, with surveys preferably being consecutive);
OR
(3) The minimum estimated population size is ≥ 25,000 breeding pairs (50,000 individuals) in any one survey.
Criteria for Reclassifying from Threatened to Endangered
A population will be considered for reclassification from threatened to endangered when the five factors for listing are reviewed for evidence of threats and when:
(1) The population is declining by ≥ 5%/year, as judged by the following statistical measures:
The under-protection loss exceeds the over-protection loss, calculated using trend data based on at least 5 years but not exceeding 15 year period, and loss functions where the loss when classifying is zero when r < = -0.05 and the loss when not classifying is zero when r >= 0;
AND
The minimum estimated population size is < 3000 breeding pairs for ≥ 1 year;
OR
The minimum estimated population size is < 2000 breeding pairs in any 1 year, unless ≥ 1 survey during the following 2 years produces an estimate of > 2000 breeding pairs.

[1] Minimum estimated population size = the greater of two estimates, as determined by the best available data: (1) the lower limit of the 95% confidence interval (CI) of the population estimate (derived from using any subset of the data that yields the highest lower limit), including a visibility correction factor; or, (2) the actual number of birds counted during population surveys.

Based on available literature regarding minimum viable population size and using a model that did not account for potential density dependence (USFWS 1996 p. Appendix 1, 14), the Team determined that if a population has a less than 5 percent chance of extinction in 500 years (65 spectacled eider generations) it should be considered for delisting. In this case, extinction was defined as less than 1 pair remaining, not the QE threshold of 125 pairs as above (USFWS 1996 p. Appendix 1, 14).

Simulations were then conducted to determine the population size that corresponds with the probabilities of extinction chosen to represent each listing status. Stochastic population growth was simulated 10,000 times using an initial population size ranging from 50 to 25,600 pairs, and a mean population growth rate of r = 0 and standard deviation of 0.21, projected forward until less than 1 pair remain (USFWS 1996 p. Appendix 1, 14). Based on these simulations, if a population of 3000 is declining at greater than or equal to 5 percent per year, on average, then it has less than 50 years until it reaches QE. Therefore, the following alternatives were chosen to represent endangered status: (1) a minimum population size of 3000, a population growth rate of -0.05, and the under protection loss exceeds the overprotection loss; or, (2) a minimum population size of 2000 (USFWS 1996 p. 36).

Simulations indicated that a population size of 10,000 pairs corresponds to a less than 5 percent chance of extinction in 500 years (USFWS 1996); thus, the Team chose this as the abundance threshold for delisting (with the requirement that it be met over greater than or equal to 3 consecutive years). The Team also provided two other alternatives for delisting from threatened status. First, in the case when population abundance data are available, the Team felt that a population abundance of 6,000 breeding pairs was sufficient (corresponding to a less than 6 percent chance of extinction in 500 years (USFWS 1996:Table I-2)), if the probability of overprotection error was greater than the probability of under protection error (defined below). Second, estimated population abundance of greater than or equal to 25,000 breeding pairs in one survey, corresponding to the probability of extinction of 2.5 percent in 500 years, was deemed sufficient to consider delisting (USFWS 1996 p. Table I-2). For all alternatives, the lower 95 percent confidence limit of the estimated abundance, rather than the mean, was used for the threshold to ensure the population abundance was not overestimated (USFWS 1996 p. 36). Note that these abundance thresholds were determined by PVA analysis and were not based on historical size of breeding populations.

In the case of a population that is near the 6,000 breeding pair abundance threshold, the Plan required an additional analysis that ensures the risk of making a classification error is acceptably low. In species listing decisions, two possible classification decision errors could occur: (1) over protection: classifying a species to a protection category that it does not warrant; or (2) under protection: not classifying a species to a low-risk category, when it warrants greater protection (Taylor et al. 1996 p. 1078), Dunham et al. 2021).

A Bayesian decision analysis (BDA) was developed to assess the probability of classification error. BDAs use loss functions that explicitly assign a loss value to decisions (Taylor et al. 1996). For example, not classifying a population declining at 10 percent per year would be a greater loss than not classifying a population declining at 5 percent per year. Similarly, incorrectly classifying a population that was actually increasing by 1 percent per year should be a greater loss than incorrectly classifying a population decreasing by 1 percent per year (Taylor et al. 1996 p. 1079). In the case of spectacled eiders, the risk of making an under protection error is measured as the probability of a breeding population decreasing to under 250 adults in 50 years (i.e., quasi-extinct). This definition of QE was chosen because it left only one management option: captive breeding (USFWS 1996 p. Appendix I, 10). The risk increases in size as the probability of QE nears 1.0. The Team determined that the consequences of under protection and over protection were equal when faced with a delisting decision (Dunham et al. 2021), and the over protection error must exceed under protection error to delist at the 6,000 breeding pair threshold. For decisions to re-classify as endangered, the under protection loss must exceed the overprotection loss (USFWS 1996 p. 36).

Summary of key points:

- The Team selected a population growth rate of ≤ -0.05 as the threshold for classification as endangered
- the Team determined that if a population has a less than 5 percent chance of extinction in 500 years (65 spectacled eider generations) it should be considered for delisting
- the following alternatives were chosen to represent endangered status: (1) a minimum population size of 3000, a population growth rate of -0.05, and the under protection loss exceeds the overprotection loss; or, (2) a minimum population size of 2000
- Simulations indicated that a population size of 10,000 pairs corresponds to a less than 5 percent chance of extinction in 500 years (USFWS 1996); thus, the Team chose this as the abundance threshold for delisting (with the requirement that it be met over greater than or equal to 3 consecutive years)

Applicability of 1996 Recovery Criteria

Choosing decision criteria inherently involves both scientific analysis and value judgements about risk tolerance. As the SSA is intended to be a summary of the best available scientific information, we determined that the criteria were no longer appropriate scientific measures of current or future condition of the species given the current state of knowledge of spectacled eiders. Yet, the evaluation of whether the species has met the 1996 criteria may be useful in the 5-year review. We do caution, however, that the criteria developed in the 1996 plan are problematic as they are difficult to decipher, understand, and explain as written, are based on outdated information, as we explain below.

In 2009, the Team determined that, based on indications that the Y-K Delta breeding population was increasing, the Service should evaluate whether populations have met recovery criteria. Even with the effort of multiple experts (established decision analysts, biometricians and population ecologists), a decade was required to decipher the analysis in the Plan and conduct it based on current data. In addition, the criteria are based on outdated information. Abundance criteria were based on simple models using population growth rate data from a different (but related) species. We now have 25 years of data on demographic rates and population abundance of spectacled eiders that would be more appropriate to use, and could be incorporated into contemporary analyses (e.g., the IPM-PVA; Bradley and Osnas 2020).

Have Alaska breeding populations met the 1996 criteria?

While the criteria have many caveats explained above, decision-makers may find it useful in the 5-year status review discussion to understand if the breeding populations have met the 1996 recovery criteria in the Plan, while acknowledging the caveats and assumptions made during the development of the criteria. Here we summarize Dunham et al.'s (2021) application of the BDA methods described in Taylor et al. (1996) and USFWS (1996) in evaluating if the Alaska breeding populations have met the delisting criteria in the Plan.

First, abundance, population growth rate, and process variation were estimated for both populations by fitting 2007-2019 detection-adjusted aerial survey count data to Bayesian state-space models (Dunham et al. 2021 Table A1). Four alternative models for the Y-K Delta population and two alternative models for the ACP population were developed to account for uncertainties in detection processes. All models indicated that the Y-K Delta population met the 6,000 breeding pair abundance threshold, and the ACP population did not (Table A1).

To determine if the populations met the classification error criterion, Dunham et al. (2021) then generated the under protection loss function by projecting abundance for 50 years over all possible values of population growth to determine the probability of extinction. The probability of committing a classification error is calculated as the sum of the expected loss when population growth rate (r) is less than zero (under protection) or r is greater than or equal to zero (over protection), represented by the area under the loss curve (Figure A1), multiplied by the probability of that value of r from the posterior distribution of mean population growth. The expected loss for each error type is a single value generated after integrating out all possible values of population growth rate (Dunham et al. 2021). The optimal decision minimizes under protection loss in favor of maximizing over protection loss.

For the ACP population, over protection loss is less than under protection loss using both models, indicating that the population has not met the criterion (Table A1, Figure A1). For the Y-K Delta population, the estimated over protection loss is greater than under protection loss using all four models (Table A1); therefore, the population meets the misclassification error criterion in the Plan. Given the preferred model, the risk of committing an over protection error for the Y-K Delta population was 6.18 times that of the risk of committing an under protection error (0.067 and 0.011, respectively; Dunham et al. 2021, Figure A1). However, note that the risk of classification errors in both cases were close to zero, because the mean population growth rate was near zero and estimated with precision as indicated by the narrow posterior distribution, and because the loss curves were chosen to be symmetrical around zero. These factors indicate some uncertainty, and should be considered while making decisions about population resilience and species classification.

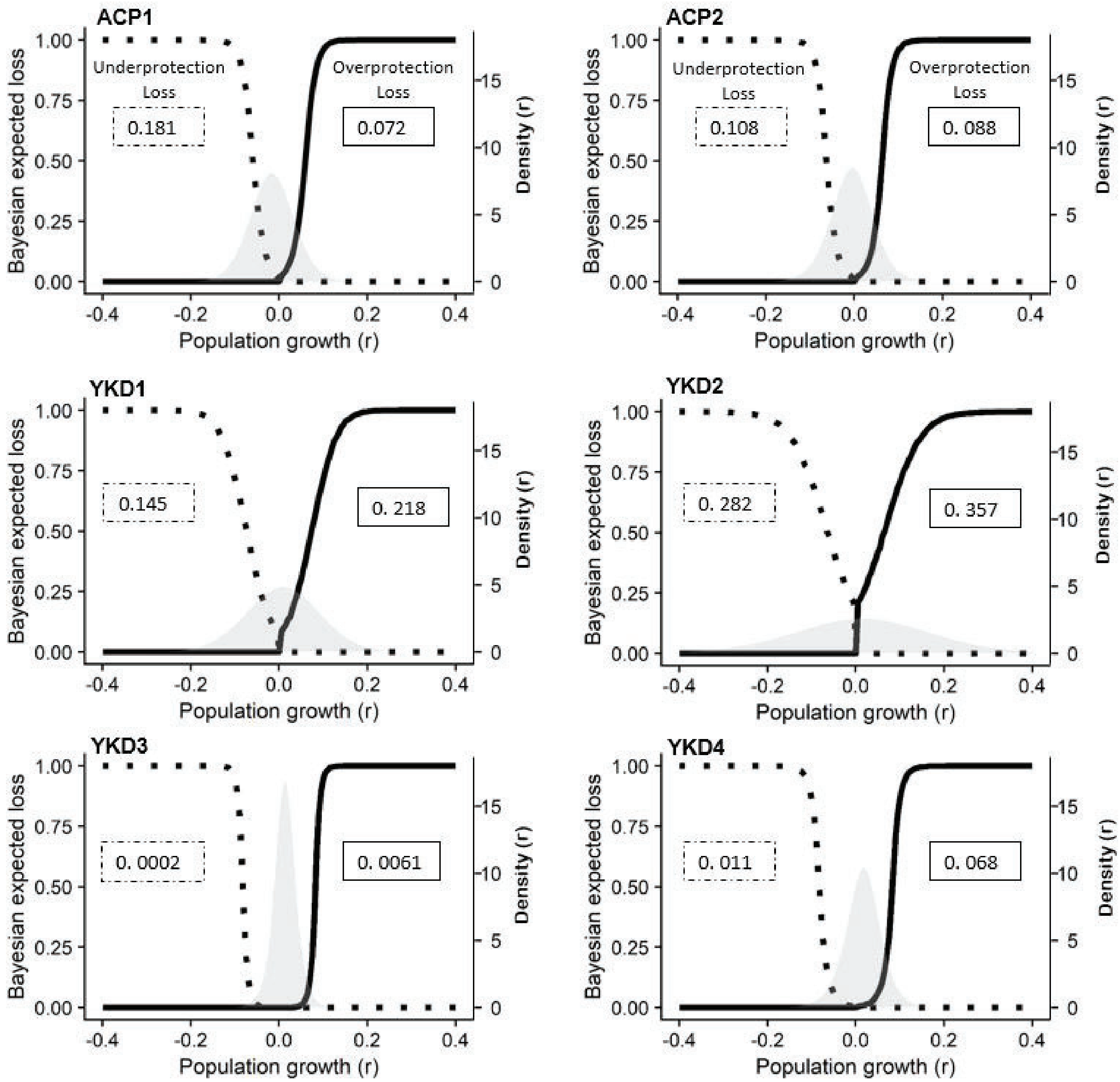

Figure A1. From Dunham et al. (2021): "Loss functions and posterior distributions of population growth rate (r) generated from state-space models of abundance for spectacled eiders breeding on the Arctic Coastal Plain (ACP) and Yukon Kuskokwim Delta (YKD). Loss functions were generated using the probability of QE ($n < 250$) given population size, growth rate, and process variation. The dotted line represents the under-protection loss function (i.e. loss if decision were to delist given negative population growth) and the solid line is the over protection loss function (i.e. loss if the decision were to maintain status given positive population growth). Gray distributions show the posterior density of population growth rate (*r*) estimated by a Bayesian state-space model for the time series from 2007 to 2019. As part of the recovery criteria, spectacled eiders will be considered for delisting if overprotection (value in solid line box) is greater than under protection (value in dashed line box). Greater overprotection error indicates that we are more likely to provide too much protection to the species than we are to provide too little protection to the species. The ACP population has not met this criteria because under protection error is greater than overprotection error. Each alternative model for the YKD population results in overprotection being greater than under protection."

Table A2. From Dunham et al. (2021): "Posterior estimates of population metrics and misclassification error for both Alaskan breeding populations of spectacled eiders (*Somateria fischeri*). Consideration for reclassification from threatened to recovered requires that both populations must reach or exceed the abundance threshold (N ≥ 12,000 breeding birds), and overprotection loss must be greater than under protection loss. Abundance estimates and misclassification error rates for the ACP population do not support the decision to delist. Alternatively, all four models for the YKD population support delisting based on population metrics meeting the reclassification criteria in the species recovery plan."

	ACP1[a]	ACP2[a]	YKD1[b]	YKD2[b]	YKD3[b]	YKD4[b]
Abundance						
Posterior mean	5355	6401	15054	15047	15388	16113
Posterior SD	629	1510	1104	1118	908	2249
95% CRI	4106 - 6589	3766 - 9750	12903 - 17212	12863 - 17253	13595 - 17175	12313 - 21352
Pop. growth 'r'						
Posterior mean	-0.016	-0.005	0.009	0.013	0.013	0.016
Posterior SD	0.043	0.043	0.068	0.137	0.023	0.037
95% CRI	-0.103 – 0.072	-0.092 – 0.082	-0.124 – 0.0143	-0.263 – 0.287	-0.035 – 0.062	-0.065 – 0.091
Process variation						
Posterior mean	0.158	0.142	0.323	0.479	0.073	0.123
Posterior SD	0.061	0.064	0.064	0.137	0.038	0.073
95% CRI	0.057 – 0.293	0.039 – 0.288	0.219 – 0.468	0.284 – 0.814	0.017 – 0.161	0.026 – 0.305
Loss						
Underprotection	0.181	0.108	0.145	0.282	0.0002	0.011
Overprotection	0.072	0.088	0.218	0.357	0.0061	0.068

[a] ACP metrics refer to the Arctic Coastal Plain breeding population.
[b] YKD metrics refer to the Yukon-Kuskokwim Delta breeding population.

Has the Arctic Russia breeding populations met the 1996 criteria?

Information on abundance, distribution, and trend of the Arctic Russia breeding population is extremely limited. At the time of listing, the number of spectacled eiders in this population was unknown; winter surveys in the 1990's and 2010 indicated over 200,000 spectacled eiders in the population. The only information to evaluate current condition of this breeding population is the most recent estimate of the minimum global population size, less the Alaska breeding population estimates, which suggests the Arctic Russia population consists of at least 45,000 spectacled eiders. This crude estimate does not meet the only applicable criterion: The minimum estimated population size is ≥ 25,000 breeding pairs (50,000 individuals) in any one survey (Table A1).

Appendix B. Spectacled Eider High Priority Recovery Tasks – January 2021

Priority	Recovery Task
1	Continue the survey of the wintering area to estimate global population abundance and trend.
1	Continue the survey to estimate the Arctic Russia breeding population abundance and trend.
1	Explore hypothesis that sub-adults winter separately from adults.
1	Continue the Yukon-Kuskokwim Delta Nest Plot Survey and Aerial Breeding Pair Survey.
1	Continue the Arctic Coastal Plain Survey.
1	Characterize locations and use of marine habitats, especially in the Bering and Chukchi Seas.
1	Monitor benthic prey in the wintering area either directly through benthic sampling or indirectly using biochemical indicators of diet in spectacled eider tissue samples.
1	Evaluate and predict effects of climate change in marine habitats on spectacled eiders.
1	Evaluate and predict effects of climate change in breeding areas on spectacled eiders.
1	Capture and mark adult female spectacled eiders nesting on Kigigak Island and potentially other sites on the Yukon Delta NWR to estimate annual survival.
1	Monitor recruitment and productivity of spectacled eiders on Kigigak Island and potentially other sites on the Yukon Delta NWR.
1	Conduct recruitment, productivity, and annual survival study of spectacled eiders in Arctic Russia comparable to the study conducted at Kigigak Island, Yukon-Kuskokwim Delta.
1	Revisit Russian Arctic nest plot sites/surveys to compare information to the 1990s estimates and evaluate potential declines in the Arctic Russian breeding population.
1	Support Duck Management in Russia - Investigate developing cooperative efforts with eastern Chukotkan Native groups to conduct education efforts regarding duck management relative to hunting, use of lead shot, and harvest surveys.
1	Continue monitoring spectacled eider blood lead levels throughout their range.
1	Conduct a winter energetics study
1	Develop a subsistence harvest monitoring program with the appropriate evaluation instrument to reliably quantify the take of spectacled eiders throughout their range.
1	Improve education efforts across the range of the spectacled eider to eliminate shooting and the use of lead shot.
1	Evaluate and reduce impacts of commercial fishing and research vessels on spectacled eiders in the Bering and Chukchi Seas.
1	Evaluate and reduce impacts from oil and gas activities on spectacled eiders in the Bering and Chukchi Seas.
1	Develop and distribute education materials to educate researchers working in spectacled eider breeding areas as to their obligations under the ESA and identify the

Priority	Recovery Task
	actions they should take to minimize the impacts of their studies on spectacled eiders. Evaluate researcher impact at intensive study sites like Kigigak Island.
1	Evaluate factors affecting duckling growth and survival.
1	Determine cause and population effects of egg inviability.
1*	Evaluate the feasibility and efficacy of gull control on the Alaska breeding grounds where gulls may be affecting spectacled eiders.
1	In concert with education efforts, improve law enforcement across the range of the spectacled eider to eliminate take and the use of lead shot.
1*	Investigate competition with walrus in the eastern Chukchi Sea.
1*	Determine whether Ledyard Bay is a staging and molting area for North Slope or Arctic Russia breeding populations.
1	Continue studies to increase understanding of the incidence and impact of diseases on eiders.
1*	Repeat Norton Sound molting survey
1	Monitor for annual survival on the North Slope.
1	Continue education program involving villages, barge companies, and others of eider concentrations in an effort to prevent the chronic and acute oiling of spectacled eiders.
1	Develop technique and identify information needs for evaluating cumulative effects of human development on spectacled eiders.
1	Evaluate the feasibility and efficacy of fox control on the Yukon Kuskokwim Delta where foxes may be affecting spectacled eiders.

Most of these actions are underway or in the planning stages, unless designated by an *. Those projects have not been started.