

## **Steller's Eider Reintroduction**

*A Case Study from the Structured Decision Making Workshop*

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Authors: Angela Matz<sup>1</sup>, Ted Swem<sup>2</sup>, Jim Nichols<sup>3</sup>, Bill Kendall<sup>4</sup>, Barry Grand<sup>5</sup>, Tuula Hollmen<sup>6</sup>, Karen Laing<sup>7</sup>, Brian McCaffery<sup>8</sup>, Eve McDonald-Madden<sup>9</sup>, Donna C. Brewer<sup>10</sup>, Michael C. Runge<sup>11</sup>.

### **Decision Problem**

Determine whether reintroduction is a cost-effective way to enhance viability of Alaska-breeding Steller's eiders.

### **Background**

*Legal, regulatory, and political context*

The Alaska-breeding population of Steller's eiders (*Polysticta stelleri*) is listed as threatened under the Endangered Species Act. A primary reason for the listing was the virtual extirpation of breeding Steller's eiders from the Yukon-Kuskokwim Delta (YKD), and the North Slope breeding population is estimated in the low hundreds. To re-establish the bird on the YKD and therefore meet recovery goals, the Steller's eider recovery team has recommended investigating reintroduction.

A captive flock of Alaska-origin Steller's eiders has been established at the Alaska SeaLife Center in Seward, Alaska. A reintroduction effort will require continuing successful development of husbandry and propagation techniques using this captive flock. (And, based on the results of this structured decision making workshop, we believe the maintenance of the captive flock is necessary not only to entertain any reintroduction discussion, but may in fact be crucial to avoiding extinction.)

Relevant constraints to a reintroduction effort include cost, as even current recovery efforts are threatened by budget cuts, and the role or support of Alaska Native communities near reintroduction sites. Also needed are risk analyses of potential

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<sup>1</sup> U.S. Fish and Wildlife Service, 101 12<sup>th</sup> Ave., Room 110, Fairbanks, AK Beech Forest Road 99701  
angela\_matz@fws.gov

<sup>2</sup> U.S. Fish and Wildlife Service, 101 12<sup>th</sup> Ave., Room 110, Fairbanks, AK 99701 ted\_swem@fws.gov

<sup>3</sup> USGS Patuxent Wildlife Research Center, 12100 Beech Forest Road Laurel, MD, 20708 USA

<sup>4</sup> USGS Patuxent Wildlife Research Center, 12100 Beech Forest Road, Laurel, MD, 20708 USA

<sup>5</sup> USGS Alabama Cooperative Fish & Wildlife Unit, 3301 Forestry Wildlife Sciences Building, Auburn University, AL 36849 USA

<sup>6</sup> Alaska SeaLife Center and University of Alaska Fairbanks, P.O. Box 1329, Seward, AK 99664 USA

<sup>7</sup> U.S. Fish and Wildlife Service, 1011 E. Tudor Rd., Anchorage, AK USA

<sup>8</sup> U.S.F.W.S., Yukon Delta NWR, 807 Chief Eddie Hoffman Rd., Bethel, AK, 99559 USA

<sup>9</sup> Centre for Applied Environmental Decision Analysis, University of Queensland, Australia

<sup>10</sup> USFWS National Conservation Training Center, Shepherdstown, WV USA

<sup>11</sup> USGS Patuxent Wildlife Research Center, Laurel, MD, 20708 25443 USA

catastrophic impacts to wild populations from introduced diseases or genetic diminishment. These are currently being created by the reintroduction subcommittee of the Steller's Eider Recovery Team.

### *Ecological context*

The original causes of population decline on the YKD are unclear, but may include predation (particularly of eggs and ducklings), hunting, habitat changes on the breeding grounds, collisions with structures, severe winter weather, food limitation, ingestion of spent lead shot, changes in the marine environment, and exposure to oil or other contaminants. Current recovery efforts on the YKD, which also apply to the sympatric and threatened spectacled eider, have elucidated or addressed many of these, including lead shot, collisions, changes in the marine environment, and hunting.

## **Decision Structure**

### *Objectives*

Our initial objectives included establishing viable populations of Steller's eiders on both the North Slope (where they currently breed, but with very low rates of reproductive success) and the YKD, and minimizing costs. Implementing a structured decision making process during the workshop helped us refine our objectives to only include re-establishing a viable population on YKD, indexed as a target number of naturalized breeding females, and to minimize costs. Thus, a formal objective function would be to minimize reintroduction costs while attaining a threshold number of naturalized breeding females. We would also likely require a constraint on the number of individuals released per year, based on the current or a reasonable future capacity of the breeding colony at the Alaska SeaLife Center.

### *Alternative actions*

As with our objectives, the structured decision making process helped us refine our alternatives. We started with very broad alternatives based on two different funding levels associated with current or expanded capacity (by age; eggs, ducklings, and juveniles) of the captive breeding facility (Table 1). These alternatives were then focused only on the YKD, primarily because no population is extant there, and current recovery efforts such as fox control on the North Slope are thought to be more cost-effective to recover that extant population). Alternatives were also refined by release method; these were selected from a detailed list of potential release methods previously developed by the reintroduction subcommittee.

### *Predictive models*

We used two population models to evaluate our alternatives, a previously developed population viability model for Steller's eiders (Runge 2004), and a population growth model, developed at this workshop, for modeling growth of a naturalized introduced population of Steller's eiders on the YKD.

## Decision Analysis

### *Population Viability Model*

Our initial model was a population viability model incorporating current survival rates based on molting band recovery rates for the Pacific Steller's eider population (which includes individuals from the listed Alaska-breeding population) and other vital rate estimates from Steller's eiders breeding near Barrow (a majority but subset of the Alaska-breeding population) (Runge 2004). All alternatives, which varied by the number and ages of released birds (based on fiscal and captive flock production limits) resulted in a probability of extinction or  $P(\text{extinction}) = 1.00$  (i.e., a 100% probability of extinction), within 30 years (Table 1). Because adult survival and reproductive rates were very low, it didn't matter how many birds were added in any one or even multiple years to the population, they would not survive nor reproduce enough to make the population self-sustaining. The model results indicated that reintroduction efforts would have to be permanent to reestablish and maintain breeding populations. This type of model input would best be reflected as permanent immigration.

The dire projections for extinction in Table 1 were based on the best available estimates of vital rates, but these estimates may be biased low. For example, actual adult survival may be greater because survival estimates were generated from capture-recapture sampling in only a few molting and wintering areas, yet there may be movement between these and other areas. Thus, there may be a component of permanent emigration in the estimates of apparent survival for adult birds, which would result in apparent survival estimates lower than actual survival. Other vital rate data were generated from the breeding population near Barrow on the North Slope, which: 1) does not attempt breeding every year; 2) has very low nest numbers when breeding occurs; and 3) has very low nest success due to predation. The latter may be positively influenced by fox control, which has been undertaken for the last three years near Barrow, in a small subset of the population's range on the North Slope. Therefore, additional model runs using alternative but reasonable (in light of data assumptions and current management) vital rates, such as higher adult survival and higher nest success, appeared to be worth exploring, and is one of our next steps.

Another result of this modeling exercise (and the entire workshop) was to starkly illustrate the potential for extinction of the listed population, perhaps within a short period of time, established by the best available data. Further, we concluded that the established captive population should be maintained for any reintroduction effort, and because it may also be the last reservoir of the listed (Alaska-breeding) population.

### *Population Growth Model*

We developed a model to evaluate alternative approaches to reintroduction on the YKD only (as this is where a population needs to be re-established to meet recovery goals). We adjusted the alternatives in Table 1 to reflect releases only on the YKD, and only at

current captive flock capacity (Table 2). Alternatives, or release strategies, differed in release age and method (i.e. release ducklings with female or without).

We built a stage-based model incorporating the probabilities that individuals released under differing strategies progressed from one age- or stage-class to another (e.g., the probability of survival from year 1 to year 2). Model variables that could be changed among release strategies were the probability of survival to year 1 (which would be expected to increase with release age), and the probability of returning to the YKD to breed (a duckling released with a female to follow on migration may have a higher return probability than one without). Variables that did not differ among release were the probability of survival from years 1-2 post-release, from years 2-3, and the probability of survival once adulthood is reached (year 3 onwards). Initially, these probabilities were the same estimates used in the population viability model, but based on the concerns discussed above (e.g., possibly biased adult survival estimates), and the potential for different anthropogenic and ecological differences between the YKD and the North Slope (e.g., less hunting from informed humans who would be heavily invested in the reintroduction effort), we also ran the model with greater survival probabilities after year 2.

The population growth model objective was to maximize the numbers of breeding adult female Steller's eiders on the YKD, assessed over 20 and 50 years. The model tracked the number of birds in each age class of released birds, and the proportion of those returning to and breeding in the YKD. The resulting total number of birds was the number of adult birds remaining in, plus the number of adult birds produced from, the released population after 20 and 50 years. Initial results showed that with adequate survival and return rates a population with several hundred breeding females could become established from reintroduced Steller's eiders on the YKD.

Although positive, these initial results were derived from estimates of key vital rates for which there was uncertainty. The next is to incorporate uncertainty associated with these parameters.

## **Uncertainty**

While there is a great deal of uncertainty in this entire process, including the availability of funding, and the effects of changing climate on Steller's eiders and their habitats, we evaluated (and continue to evaluate) more specific uncertainties. The first is incorporating uncertainty into analytical models, and the second can best be described as developing monitoring plans. Monitoring is integral to evaluate success, to learn, to refine estimates of vital rates, and to adapt methods, and should specifically include both monitoring of the efficacy of reintroduction protocols and monitoring the establishment and success of a reintroduced population.

### *Model Uncertainty*

Next steps for the population viability and the population growth model include sensitivity analysis, so we are investigating changes in alternative reintroduction strategies to variation in the key vital rates. The analysis will assess the robustness of each alternative, and should also lead to identification of the most influential vital rates. The most influential vital rates can then be prioritized in research and management actions. For example, we know that on the North Slope, reproductive rates are very low because of nest predation, and that predator control may be helping to ameliorate this (Rojek 2008).

### *Monitoring*

The team created a matrix of monitoring methods (Table 3) that would: 1) reduce uncertainty around key parameters such as estimates of survival, breeding propensity, the probability of birds returning to the YKD to breed, and other demographic parameters; 2) evaluate the success of alternative reintroduction methods; and 3) support learning and adaptive management, i.e., help discriminate among alternative hypotheses about the system, such as different survival probability to year 1 associated with different release strategies. Detection, sampling, and cost issues are associated with each method; for example, brightly colored nasal tags might increase predation on normally cryptic females and might only be used to monitor survival and return probability of males. We feel strongly that a monitoring plan must be included in any reintroduction effort.

### *Cost-benefit Analysis*

The alternative actions, for reintroduction itself and for monitoring and evaluation, have different costs and benefits, which would be efficiently evaluated in a formal cost-benefit analysis. This will help to achieve the overall conservation objective, whether it be specifically maximizing the number of breeding female Steller's eiders on the YKD or more generally establishing a YKD self-sustaining population.

## **Discussion**

### *Value of decision structuring*

The Steller's Eider Recovery Team has been evaluating reintroduction as a recovery technique for several years, and a reintroduction subcommittee of the Recovery Team has prepared a draft feasibility analysis of Steller's eider reintroduction (Hollmen et al. 2007). The structured decision making process, particularly in a focused workshop setting, helped define and refine reintroduction objectives and alternatives. In particular, the population viability model results that showed that the Alaska-breeding population of STEI could become extinct within a short time provided clarity and direction to our discussion at the workshop.

The decision analysis process also helped illuminate other decisions that the Recovery Team and the Service may need to address. For example, a key conclusion of workshop participants was that maintaining the current captive flock was essential to any reintroduction program. Further, given that the population viability model results showed

a high probability of extinction over a variety of scenarios, we concluded that maintenance of the captive flock may in fact be essential for maintenance of the threatened population, something that should be considered in Service budget planning.

The decision analysis process also helped clarify the role of reintroduction on the North Slope. Before the group was ready to focus on the alternative actions described above for the Yukon Delta, we discussed whether reintroduction efforts, including protocol development, should first occur on the North Slope. The group consensus was that other recovery actions, such as ongoing predator control and outreach, were likely to be more effective recovering the North Slope population, which is limited by predation, lead exposure, and shooting. Therefore, reintroduction should take place on the North Slope *only if it would facilitate learning* for reintroduction on the YKD. However, the group felt that differences between the two areas, including predators, potential nesting density of other nearby waterfowl, infrastructure, and threat attenuation (managed or otherwise), may make them too different to apply learning from one area to the other. The group then focused specifically on reintroduction efforts for the YKD, where no extant Steller's eider population remains.

#### *Further development*

The ultimate goal of the structured decision process is to provide decision-making tools to assist and support the Recovery Team with their recommendation, and the Service with the decision, whether to pursue reintroduction of Alaska breeding Steller's eiders to help recover the species.

Our next steps are to share the workshop results with the entire Recovery Team; refine the problem statement, objectives, and alternatives; refine the population viability and growth models; incorporate a cost-benefit analysis; and further develop monitoring plans. Given the uncertainty surrounding reintroduction alternatives as well as reasons for the initial species decline, there is a need to learn through monitoring, preferably through a rigorous adaptive learning strategy. Finally, results from the disease and genetic risk analyses currently in progress by the reintroduction subcommittee will be incorporated into the decision-making process, to determine if risks to wild populations are balanced by the benefits of reintroduction.

#### **Literature Cited**

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Rojek, N.A. 2008. Breeding biology of Steller's eiders nesting near Barrow, Alaska, 2007. Technical Report: U.S. Fish and Wildlife Service, Fairbanks Fish and Wildlife Field Office, Fairbanks, AK. 45 pp.

Runge, J. 2004. Population viability analysis for Alaska breeding and Pacific populations of Steller's eiders. Unpubl. report to the Spectacled and Steller's Eider Recovery Team. 27 pp.

### Tables

Table 1: Initial Consequence Table with Alternatives.

Alternatives	Status quo	Release with current capacity:			Release with increased capacity:			
		100 eggs	70 chicks	60 fledglings	500 eggs	350 chicks	300 fledglings	300 adults
Objective:								
P(Ext)	100%	100%	100%	100%	100%	100%	100%	100%
Extinction Time (yrs)	10.2	10.3	10.6	13.8	10.8	11.8	18.8	26.7
Minimize \$ (one-time, K)	0	0	0	0	2100	2350	2600	2850
Minimize \$ (annual, K)	150 <sup>1</sup>	800	850	950	1200	1200	1200	1250

<sup>1</sup> Current Recovery Costs

Table 2. Evolution of alternatives for Steller’s Eider reintroduction.

Three Original Alternatives	Eight Expanded Alternatives (to include number of released birds)	Six Final Alternatives (From original “Current Capacity” alternative)
Status quo (no \$)	Status quo	
Release with current capacity (few \$)	100 eggs 70 chicks 60 fledglings	<ul style="list-style-type: none"> <li>-Eggs added to wild nests</li> <li>- Ducklings added to wild broods</li> <li>- Ducklings released without hens               <ul style="list-style-type: none"> <li>- Juveniles raised on YKD, released on molting areas</li> </ul> </li> <li>- Ducklings fostered to captured wild hens</li> <li>- Ducklings reared and released with captive-reared hens</li> </ul>
Release with increased capacity (most \$)	500 eggs 350 chicks 300 fledglings 300 adults	



Table 3. Potential age-specific monitoring methods for reintroduced Steller's eiders (STEI) on the Yukon-Kuskokwim Delta (YKD). "Check DNA" means compare DNA to established DNA profiles of source flock at the Alaska SeaLife Center.

Monitoring for:				
Reintro Age	Survival	Return to YKD	Reproduction	Migration Patterns
Egg	<ol style="list-style-type: none"> <li>1. Check hatching membrane DNA</li> <li>2. Recapture broods; check brood/chick DNA</li> <li>3. Web tag on young in pipping eggs; search for in broods</li> </ol>	<ol style="list-style-type: none"> <li>1. Capture subadult and adult YKD STEI; check DNA</li> </ol>	<ol style="list-style-type: none"> <li>1. Capture breeding YKD STEI; check DNA</li> <li>2. Check nest bowl feather DNA (for females only)</li> <li>3. Check offspring egg membrane DNA (males only, low prob)</li> </ol>	
Chick (Broods)	<ol style="list-style-type: none"> <li>1. Mark chicks with plasticine - filled metal band; recapture at any age</li> <li>2. Attach hen VHF and relocate during brood-rearing</li> </ol>	<ol style="list-style-type: none"> <li>1. Capture subadult and adult YKD STEI; check DNA, bands</li> </ol>	<ol style="list-style-type: none"> <li>1. Capture breeding YKD STEI; check DNA, bands</li> </ol>	
Fledgling, Adult	<ol style="list-style-type: none"> <li>1. Implant and monitor PTT (satellite) transmitter</li> <li>2. Apply nasal tags (males only)</li> <li>3. Band with color and metal bands</li> <li>4. Attach VHF radio</li> </ol>	<ol style="list-style-type: none"> <li>1. Monitor PTT</li> <li>2. Capture subadult and adult YKD STEI; check DNA, bands</li> <li>3. Observe nasal tags in STEI on YKD</li> <li>4. Monitor VHF</li> </ol>	<ol style="list-style-type: none"> <li>1. Monitor PTT</li> <li>2. Capture breeding YKD STEI; check DNA, bands</li> <li>3. Observe nasal tags in STEI on YKD</li> <li>4. Monitor VHF</li> </ol>	<ol style="list-style-type: none"> <li>1. Monitor PTT</li> <li>2. Monitor VHF</li> </ol>