Sea Duck Joint Venture
Annual Project Summary
FY23 (October 1, 2022 – September 30, 2023)

Project Title *(including SDJV Project #)*: Improving US Sea Duck Harvest Estimates through Improved Sampling Design and Model Development – SDJV project #163

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Project Description *(issue being addressed, location, general methodology):*

Our proposal directly addresses the following SDJV priority science need: to improve harvest estimates for North American sea ducks by increasing the amount and quality of information from hunters and applying analytical techniques to reliably estimate the size and composition of harvests. The level and composition of the harvest, derivation and distribution of the harvest and an assessment of the values and concerns of stakeholders are all necessary elements of effective harvest strategies and regulatory framework that ensure sustainable harvests.

Project Objectives:

This project involves two primary objectives:

1. Develop Bayesian hierarchical models to estimate species' harvests by integrating data from the Waterfowl Harvest Survey and the PCS.

2. Evaluate model structures to identify critical factors affecting harvest estimation and determine streamlined design elements that capture main sources of uncertainty for performance. Model components to evaluate include: (1) the general model structure, including likelihood and prior distributions, and (2) incorporating underlying trends or auto-regressive structure.

Preliminary Results *(include maps, photos, figures/tables as appropriate):*

We developed two Bayesian hierarchical model structures to integrate data from the Waterfowl Harvest Survey and the PCS. The simplest model is the "Independence Model" where we integrate the Harvest Survey and PCS data for each year-species one at a time. This model requires the fewest assumptions, but does not share any information across time (years). The second model is one where we assume that the change between years in both the total harvest and harvest composition follows a random walk, such that proportional changes in harvest and harvest composition for a focal flyway-year are correlated with the proportional changes in the previous flyway-year. This model allows information about total harvest and harvest composition to be shared across years within each flyway.

We fit these two models to the Waterfowl Harvest Survey and PCS data from 2003-2019 and compared the estimates of species-specific harvest across models. For the independence model, we found that the priors were difficult to set such that the MCMC sampling was adequate without inducing much positive bias for states where species were truly not harvested. As a result, we believe the independence model may overestimate the harvest in flyway-years for species with 0 or very few samples in the PCS sample. In these cases, the time model estimated lower species-specific harvest by pooling information across years within each flyway.

The flyway and species-specific harvest estimates from the time model were generally more precise, particularly for flyway-species with no or very few PCS samples. However, estimates for flyway-species with more abundant PCS samples are also more precise and the point estimates are likely to be more accurate because they consider the temporal correlation in estimates across time. In Figure 1, we show the total harvest estimates for King and Common Eiders in the Atlantic Flyway, the former with low harvest and the latter with a higher harvest. Each figure depicts the respective point and 95% interval estimates for from 2003 to 2019 in the Atlantic Flyway. For the rare King Eider, we see the time model provides consistently lower and more precise estimates than the independence model. For the more abundant Common Eider, we see fewer differences in the point and interval estimates, but the time estimates are more precise on average and more similar to the estimates of neighboring years.

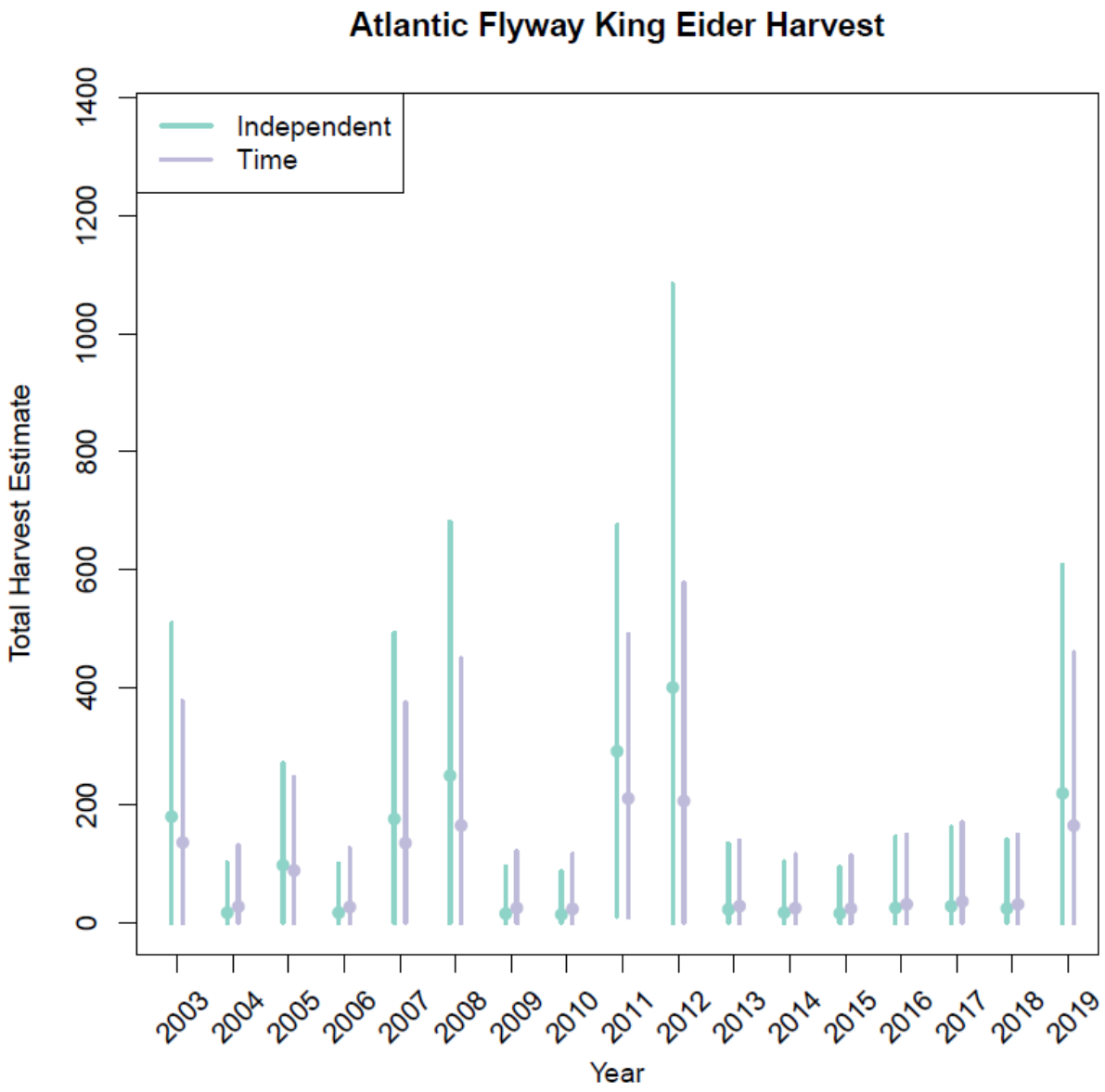

Figure 1. Total harvest point and 95% interval estimates for King Eider in the Atlantic Flyway from the Independence and Time Models.

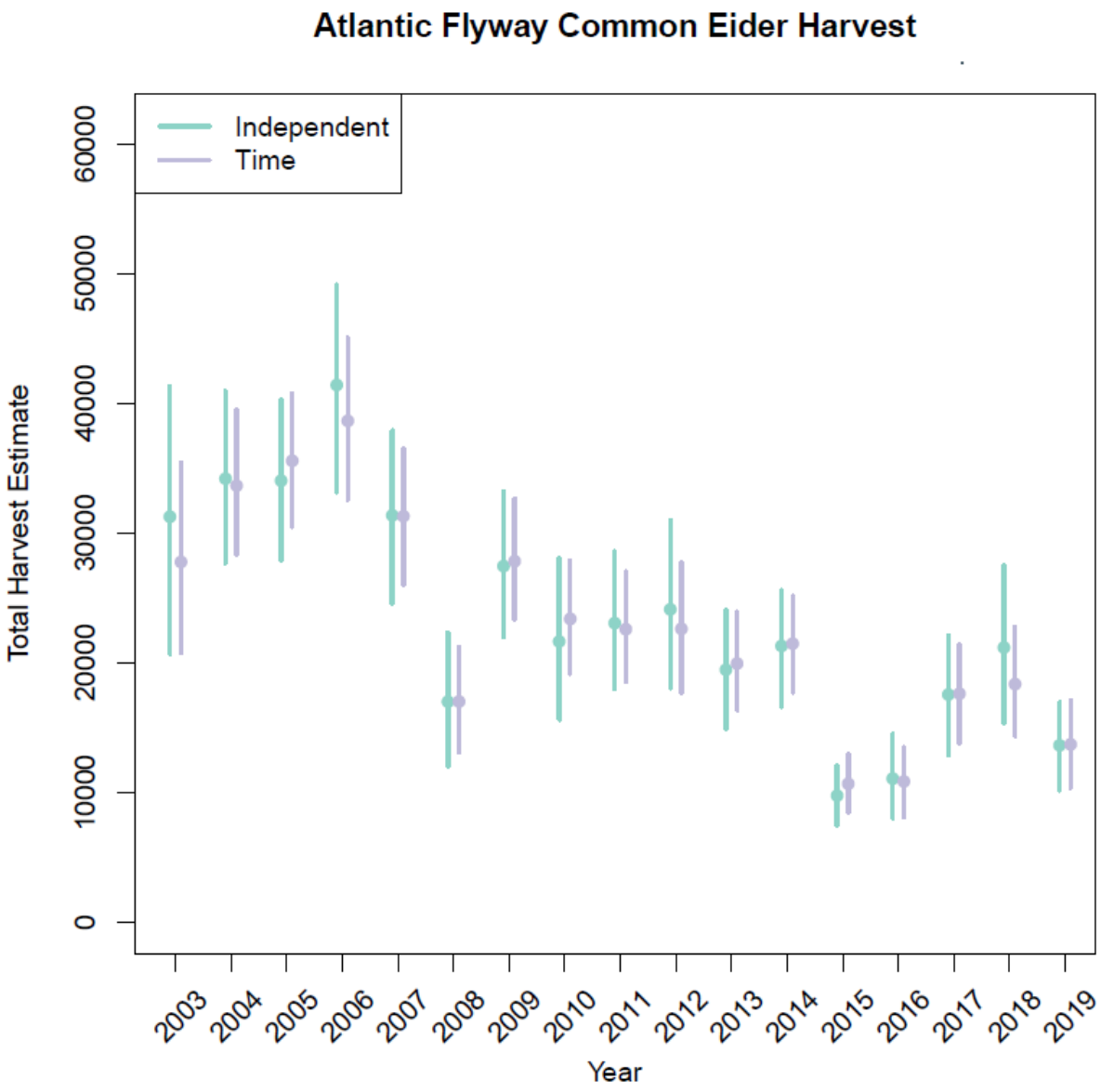

Figure 1. Total harvest point and 95% interval estimates for Common Eider in the Atlantic Flyway from the Independence and Time Models.

Project Status *(e.g., did you accomplish objectives, encounter any obstacles, what are your future plans):*

We have achieved Objectives 1 and 2. We developed models to integrate the Waterfowl Harvest Survey and PCS data to produce appropriate uncertainty intervals for flyway-level species-specific harvest, which can be aggregated to higher spatial orders, such as the entire United

States. All code has been shared with project partners so estimates can be updated through time as new data is available every year. We are working on the final report with a target date for distribution by the end of Nov 2023.

Project Funding Sources (US$). Complete only if funded by SDJV in FY23. This is used to document: 1) how SDJV-appropriated funds are matched, and 2) how much partner resources are going into sea duck work. You may include approximate dollar value of in-kind contributions in costs. Add rows as needed for additional partners.

(NOTE: All funding sources have been reported in previous fiscal years.)

SDJV (USFWS) Contribution	Other U.S. federal contributions	U.S. non-federal contributions	Canadian federal contributions	Canadian non-federal contributions	Source of funding (name of agency or organization)

Total Expenditures by Category (SDJV plus all partner contributions; US$). Complete only if project was funded by SDJV in FY23; total dollar amounts should match those in previous table.

ACTIVITY	BREEDING	MOLTING	MIGRATION	WINTERING	TOTAL
Banding (include only if this was a major element of study)					
Surveys (include only if this was a major element of study)					
Research					