

**Sea Duck Joint Venture  
Annual Project Summary  
FY22 (October 1, 2021 – September 30, 2022)**

**Project Title:** A Bioenergetic Model to Evaluate Winter Food Limitation in Barrow's Goldeneyes and Consequences of Climate Change (SDJV Project #170)

**Principal Investigators:**

Dan Esler and Brian Robinson, Alaska Science Center, US Geological Survey, Anchorage, AK, USA; [desler@usgs.gov](mailto:desler@usgs.gov), [brobinson@usgs.gov](mailto:brobinson@usgs.gov)

**Partners:**

Eric Anderson, British Columbia Institute of Technology, Burnaby, BC, Canada

Heather Coletti, Southwest Alaska Network, National Park Service, Fairbanks, AK, USA

Sean Boyd, Environment and Climate Change Canada, Delta, BC, Canada

**Project Description:**

We are developing a bioenergetic model to quantify Barrow's Goldeneye (BAGO) consumption of their winter prey (Pacific blue mussels) across their Pacific range. Estimates of location-specific consumption by wintering BAGO will be contrasted with estimates of mussel standing stock at those locations to determine if mussel abundance could be a constraint on BAGO performance and population dynamics. This study will provide information on whether BAGO are routinely approaching exhaustion of winter food supplies and whether projected climate change, resulting in more frequent and longer warm periods, may reduce habitat quality at the southern end of their wintering distribution. This will have important management implications for understanding: (1) whether this high priority species is limited by winter food, which could be subject to direct management action, (2) whether climate projections lead to predictions about changing habitat quality and subsequent changes in BAGO fecundity, survival, or distributions, and (3) whether this bioenergetic approach to evaluating carrying capacity and potential effects of climate change might be applicable to other sea ducks with more complex trophic interactions, i.e., a higher diversity of prey species.

**Project Objectives:**

The overarching goal of this project is to evaluate potential for winter food limitation in BAGO at multiple locations through their wintering range. This will be accomplished through 3 objectives:

(1) Create a bioenergetic model to estimate daily energetic needs of a BAGO during winter, through incorporation of existing data and literature on winter BAGO masses and metabolic

rates, size class of mussels in the diet, and energy expenditure and size-specific energy content of mussels.

(2) Estimate site-level consumption of mussels by BAGO and contrast that with mussel standing stock at multiple sites through their winter range, including estimates of mussel standing stock in areas that experienced a climate-induced mass mortality in summer of 2021 that provide a basis for considering changes in food limitation in the face of climate change. This requires data in the same areas on both BAGO and mussel abundance, as well as an estimate of the duration of BAGO winter site occupancy.

(3) Preparation and delivery of final products that present estimates of per capita prey needs of wintering BAGO, evaluate prey needs against current estimates of standing stock, calculate the reduction in carrying capacity of an area that experience climate-related reductions in prey, and interpret potential changes in BAGO habitat quality given projected climate change.

### **Preliminary Results:**

Activities in FY22 involved identifying, gathering, and publishing existing data sets required for populating BAGO bioenergetic models and estimating mussel standing stock. Specific data sets that have been compiled, QA/QC'ed, and published include:

USGS Alaska Science Center, National Park Service Southwest Alaska Inventory and Monitoring Network., 2016, Intertidal mussel (*Mytilus*) data from Prince William Sound, Katmai National Park and Preserve, and Kenai Fjords National Park (ver. 3.0, September 2022): U.S. Geological Survey data release, <https://doi.org/10.5066/F7FN1498>.

Robinson, B. H., Kloecker, K. A. and Esler, D., 2021, Bioenergetics and morphology of mussels (*Mytilus trossulus*) in Kenai Fjords National Park: U.S. Geological Survey data release, <https://doi.org/10.5066/P9N3XS5C>.

USGS Alaska Science Center, National Park Service Southwest Alaska Inventory and Monitoring Network., 2022, Rocky intertidal data from Prince William Sound, Katmai National Park and Preserve, and Kenai Fjords National Park: U.S. Geological Survey data release, <https://doi.org/10.5066/F7513WCB>.

Coletti, H. A. and Kloecker, K. A., 2017, Gulf Watch Alaska Nearshore Component: Marine Bird and Mammal Survey Data from Katmai National Park and Preserve and Kenai Fjords National Park (ver. 2.0, October 2022): U.S. Geological Survey data release, <https://doi.org/10.5066/F7416V6H>.

Additional data sets in the process of being released include Stanley Park BC mussel abundance, Stanley Park BC BAGO abundance, BAGO mass by age and sex, and size class of mussels in BAGO diets.

**Project Status:**

We were successful in accomplishing FY22 tasks, which was primarily gathering necessary data, organizing it, and publishing it in publicly available archives, where appropriate. We also gathered literature to support model-building efforts, including papers with: independent estimates of mussel energy density, descriptions of population bioenergetic modeling, estimated digestive efficiency, and metabolic rates of marine birds. The data and literature assimilation has prepared us for FY23 activities, which will involve building the model to estimate energetic costs in BAGO, estimating standing stock of mussels, and contrasting BAGO energy needs against mussel energy availability.

**Project Funding Sources (US\$).** Complete only if funded by SDJV in FY22. 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.

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)
\$32,044					
	\$20,000				USGS in-kind salary

**Total Expenditures by Category (SDJV plus all partner contributions; US\$).** Complete only if project was funded by SDJV in FY22; total dollar amounts should match those in previous table.

ACTIVITY	BREEDING	MOLTING	MIGRATION	WINTERING	TOTAL
<b>Banding</b> (include only if this was a major element of study)					
<b>Surveys</b> (include only if this was a major element of study)					
<b>Research</b>				<b>\$52,044</b>	