Sea Duck Joint Venture
Annual Project Summary
FY24 (October 1, 2023 – September 30, 2024).

Project Title: Unifying the coast: Advancing image-based surveys to support sea duck conservation along the Pacific Flyway, SDJV Project #173.

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Project Description*:* For most of their annual cycle, North American sea ducks are densely distributed in estuaries and along the coastal nearshore where they are susceptible to oil spills, development, changing ocean conditions, and other potential threats. Observer-based aerial surveys have been an important tool for evaluating coastal distribution and population abundances of sea ducks. However, safety, expense, observer bias and lack of methodological consistency are rising concerns associated with observer-based surveys, making it imperative to transition to more sustainable methods. Digital aerial surveys (DAS) that automate counts from aerial imagery using convolutional neural network (CNN) models are one way to improve survey safety and count accuracy. We are developing a standardized DAS for the lower Pacific Flyway to help maximize safety, while improving data consistency and model accuracy among important regions within the Flyway. To accomplish this goal, we are collecting imagery of Pacific Coast sea ducks using standardized DAS hardware and imagery collection methodology, retraining an existing Pacific Coast seabird CNN model using an iterative reclassification process to create a sea duck-specific model, and conducting DAS at key sea duck sites in the Pacific Flyway to quantify sea duck abundances and species composition. We are focusing our work in two Sea Duck Key Habitat Sites, the Puget Sound and San Francisco Bay (SFB), where we can leverage secured funding for observer-based aerial surveys to help develop robust DAS methods that will be transferrable across the Pacific Flyway.

Project Objectives: The long-term, overarching goal of our project is to develop standardized, imagery-based DAS methodology for the lower Pacific Flyway to help maximize safety, while improving data consistency and model accuracy among important regions within the Flyway (Fig. 1). Specifically, our objectives are:

1. Collect imagery of Pacific Coast sea ducks using standardized DAS hardware and imagery collection methodology

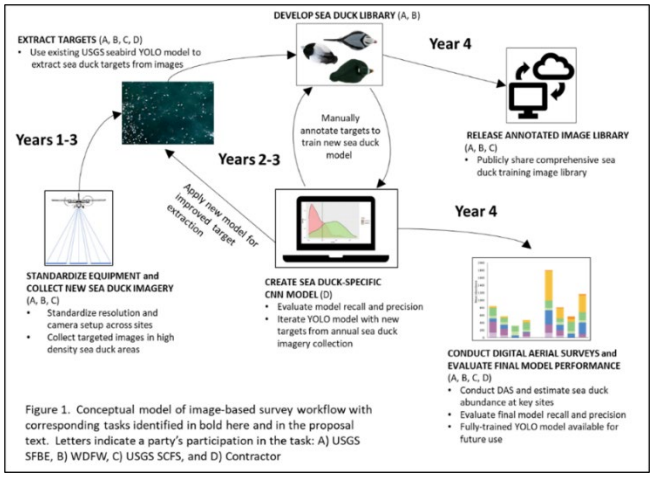

Figure 1. Conceptual model of image-based survey workflow with corresponding tasks identified in bold here and in the proposal text. Letters indicate a party's participation in the task: A) USGS SFBE, B) WDFW, C) USGS SCFS, and D) Contractor

2. Retrain an existing Pacific Coast seabird CNN model using an iterative reclassification process to create a sea duck-specific model
3. Conduct DAS at key sea duck sites in the Pacific Flyway to quantify sea duck abundances and species composition

In FY24, we worked on standardizing hardware and methodology and began image collection under Objective 1 (see Fig. 1).

Preliminary Results: We held several collaborator meetings throughout FY24 to discuss equipment settings, image collection altitudes, and ground sampling distance (GSD) to ensure images collected were comparable among collaborators. Personnel from USGS Santa Cruz Field Station held training flights to transfer knowledge about equipment operation to USGS San Francisco Bay Estuary Field Station staff. Both the USGS and WDFW teams used twin-engine, high-wing aircraft (Partenavia P-68) outfitted with belly ports for each flight. We collected high-resolution RGB still images using two oblique and one nadir downward facing cameras affixed to a custom mount spanning the existing belly port. Camera and lens equipment, flight speed and altitude were adjusted by each group to maintain a consistent image area and an average ground sampling distance (GSD) resolution within the range of 0.83- 0.93 (Table 1). The cameras were triggered simultaneously every one to three seconds. The camera configuration, angle and photo interval produced gaps between adjacent and successive photos, with a resulting nominal total image area of 259×54 m every one to three seconds assuming a level camera mount.

Table 1. Camera and aircraft parameters for flights conducted by each project collaborator (USGS, WDFW) that captured standardized digital aerial images to train CNN models to identify sea ducks and other waterfowl.

	Camera	Resolution (pixels)	Lenses	GSD Nadir	GSD Left & Right	Mean GSD	Speed (kmh)	Altitude (m ASL)	Capture Interval (s)
USGS	Canon EOS 5Ds R (x3)	8688 x 5792	Canon EF 135mm f/2L USM	0.80 - 0.81	0.81 - 0.88	0.83	167	262	3 seconds
WDFW	Canon EOS R5 (x3)	8192 x 5464	Canon RF 135mm f/1.8 L IS USM	0.85 - 0.86	0.86 - 0.93	0.88	194	262	1 second

Image acquisition flights were conducted by WDFW in the Salish Sea during 28-30 Nov 2023 and 18-26 Mar 2024 (Fig. 2A-B). USGS collected training images from Monterey Bay, the coastal embayments of Bodega Bay and Tomales Bay, and northern SFB, CA during 21-23 Feb 2024 (Fig. 3A-

C). Pre-existing permits allowed for images to be collected at 262 m above sea level (ASL) in Bodega, Tomales, SFB in CA, and the Salish Sea in WA, while images in Monterey Bay were collected at 305 m in the Monterey Bay National Marine Sanctuary (MBNMS; Fig. 3A). The CNN model we will use was trained on seabird images collected at 305 m ASL; however, we expect the lower elevation imagery collected in this study will improve the model accuracy and precision going forward. In FY24, we collected more than 189,000 images in total representing a range of background conditions and species occurrences (Fig. 4) along the Pacific Coast.

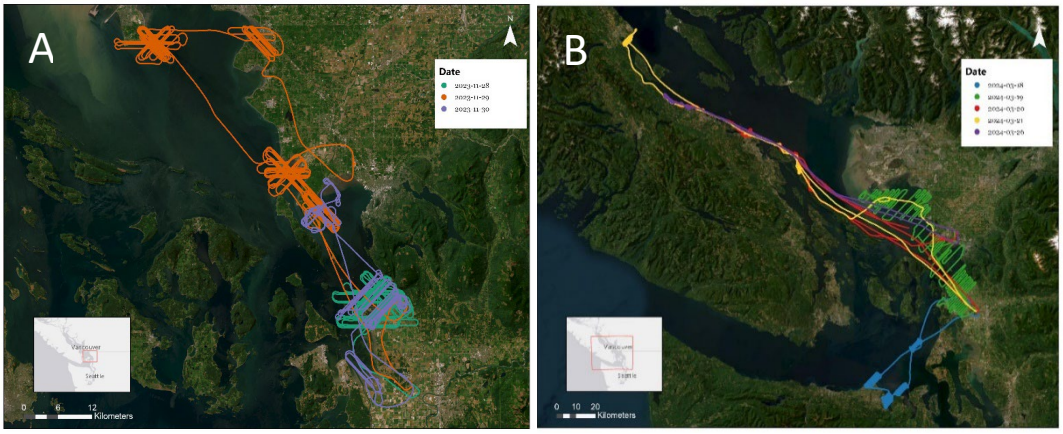

Figure 2. Track lines flown by WDFW in the Salish Sea during A) November 2023 and B) March 2024.

In FY24, USGS successfully contracted with Conservation Metrics, Inc., to re-train their existing Pacific Coast seabird CNN model with sea duck imagery. In Oct 2024, CMI will begin processing camera files through the model to extract likely sea duck images, allowing USGS and WDFW to begin to manual annotation of images.

USGS purchased an additional camera body and 135 mm lens in FY24 and will acquire another set in early FY25. We have also begun work on an additional Partenavia belly port camera mount to be completed in early FY25 in time for our next round of imagery acquisition.

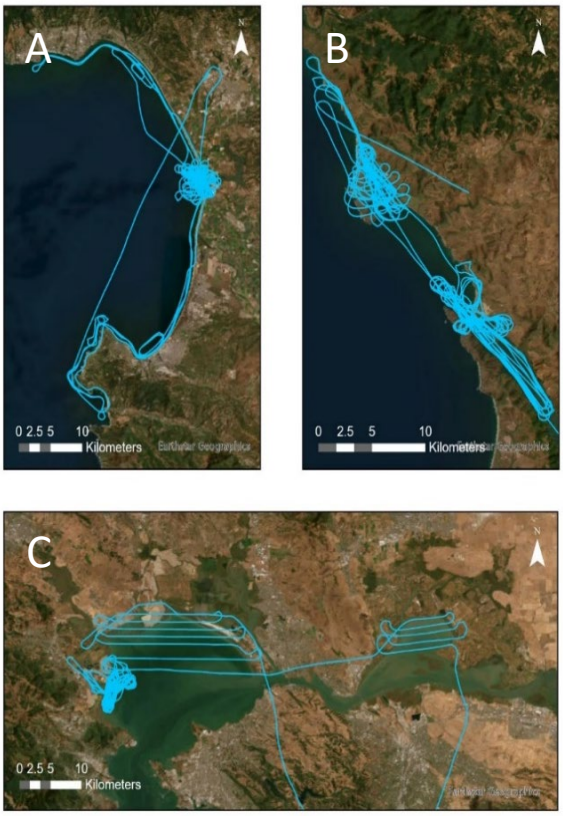

Figure 3. Tracks flown by USGS in A) Monterey Bay, B) Bodega and Tomales Bay, and C) San Pablo and Suisun Bay, CA.

Project Status: Both USGS and WDFW successfully completed planned FY24 image acquisition work under Objective 1 and will continue this work in FY25 and 26 to expand the image library for model training.

In FY25, USGS and WDFW will solidify a workflow with CMI to ensure the CNN model will continue to be iteratively trained with labeled images to improve model accuracy for sea ducks (see conceptual model. Fig 1).

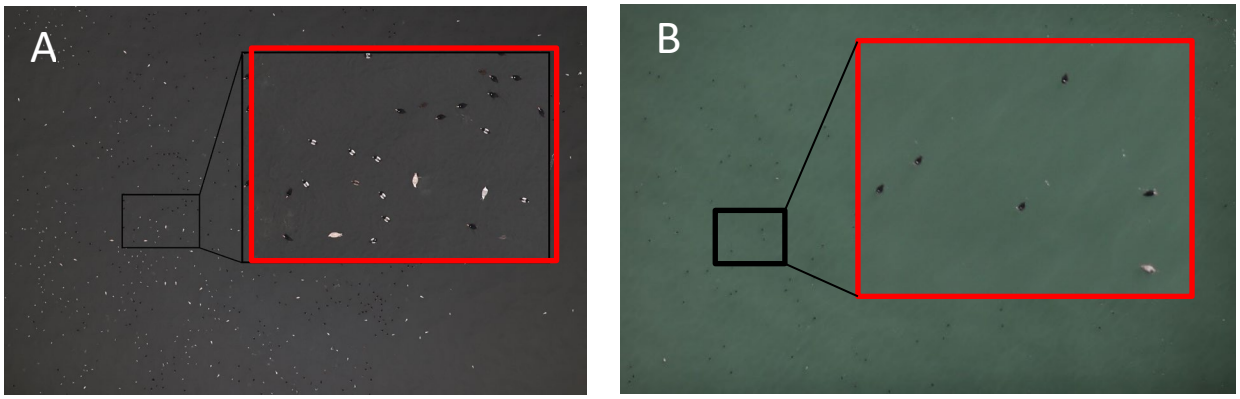

Figure 4. Examples of collected imagery with zoom-in regions showing surf scoters, scaup, and gulls from A) the Salish Sea and B) San Francisco Bay.

In FY24 we were unable to collect images from MBNMS (Fig 3A) at 262 m ASL as the sanctuary has an elevation limit of 305 m in restricted areas without a permit. USGS has since submitted a low-level aviation permit application to the MBNMS, as well as a renewal of our existing permit to fly at low-level in restricted areas of the Greater Farallones National Marine Sanctuary. We anticipate both permits will be approved and in place prior to FY25 image collection, which will allow us to fly at 262 m ASL at all locations.

We also began acquisition of additional camera and lens equipment and work on a second belly-port camera mount in FY24. We expect to have this new equipment in place for the initiation of flights in early FY25. In FY24, a single camera mount and some camera parts were shared between USGS and WDFW, so careful coordination was required to exchange equipment between flights. The additional cameras and mount will reduce the cost and logistical challenges of shipping equipment back and forth between the two groups and enable flights to occur simultaneously if needed. We have also discussed creation of a working group with several interested stakeholders and will hold the first meeting of this group in FY25.

Project Funding Sources (US$).

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)
$84,947					SDJV (USFWS)
		$64,952			California Wildlife Conservation Board
		$99,304			Washington Department of Fish and Wildlife (In-Kind)
	$58,843				US Geological Survey (In-Kind)

Contributions (US$). C

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)				**$308,046**	**$308,046**
Research					