

Environmental Studies Program: Ongoing Study

Title	Atlantic Marine Assessment Program for Protected Species (AMAPPS) - Photogrammetric Aerial Surveys to Improve Detection and Classification of Seabirds, Cetaceans, and Sea Turtles (AT 20-02)
Administered by	Office of Renewable Energy Programs
BOEM Contact(s)	Timothy White (timothy.white@boem.gov)
Conducting Organization(s)	US Fish and Wildlife Service
Total BOEM Cost	\$800,000
Performance Period	FY 2020–2023
Final Report Due	September 2023
Date Revised	October 2, 2020
PICOC Summary	
<i><u>Problem</u></i>	Visual surveys, involving multiple air-crews and observers must include methods to minimize or estimate significant biases, including those known to vary widely among observers such as detection, misclassification, group-size estimation and sample area determination.
<i><u>Intervention</u></i>	Integration of airborne remote sensing (<i>e.g.</i> , high-resolution camera systems fixed to survey aircraft) as a primary data collection tool or as a means of reducing errors in counting and improved species detection.
<i><u>Comparison</u></i>	The study builds on a decade of AMAPSS observer-based aerial surveys conducted by the USFWS. BOEM has identified problematic species on these surveys (<i>e.g.</i> , > 90% of terns unidentified to the species level). We will compare species identification accuracy using high-resolution imagery with previous AMAPPS observer-based data.
<i><u>Outcome</u></i>	This project will conduct aerial surveys to collect georeferenced imagery to advance the accuracy of species detections and counts through the application of computer vision and automated detection and classification algorithms.
<i><u>Context</u></i>	Targeted locations off the Atlantic coast and offshore areas.

BOEM Information Need(s): Frequent misclassification of marine wildlife on agency wildlife aerial surveys likely results from a combination of observer experience, high observer turnover rates, and species with similar morphologies. Advanced remote sensing technologies combined with automation through machine learning and computer vision will improve aerial survey data collections (Edney and Wood, 2020).

Background: Low-level aerial surveys can cover large areas in a relatively short time frame, and serve a critical component in BOEM’s monitoring framework. Aerial operations can mobilize faster than ship-based surveys and can reach locations hazardous to ships, but essential to marine wildlife. From 2010–2019 the USFWS, in coordination with BOEM, conducted

systematic high fixed-wing aerial surveys from Florida to Maine, focused on seabirds, sea turtles, and marine mammals. However, despite the enormous survey effort, bountiful records of low taxonomic classification exist in the Northwest Atlantic Seabird Catalog (NWASC) collected by USFWS for AMAPPS. Many instances of low ranking occur in areas with a high probability of encountering endangered species. For example, aerial observers classified > 90% of Cape Cod terns to the genus level, making it impossible to tease out the distribution of the endangered Roseate Tern from Common Terns. These inaccuracies frequently result in classification of endangered species to lower taxonomic levels than desirable for National Environmental Policy Act analyses.

Visual surveys involving multiple aircrews must include methods to minimize biases that are known to vary widely among observers such as detection (*i.e.*, perception), misclassification, group-size estimation, and sample area determination. Although AMAPPS aerial surveys conducted by the USFWS are spatially and temporally comprehensive and systematic, they suffer from high observer turnover and varying observer experience levels. Collection and integration of high-resolution, spatially-explicit photogrammetry as a primary data collection tool on AMAPPS and on other BOEM projects can maximize survey effort by improving detection and counts of all species encountered on at-sea transects. Automation of computer vision algorithms is currently in development through BOEM/U.S. Geological Survey (USGS) collaboration per study [NT-19-04](#) (*Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery*). Archiving this proposed new collection of imagery will improve confidence in species-specific maps for offshore planning purposes and will provide a permanent and open source imagery archive for when advances occur in the fields of computer vision and unmanned aircraft systems (UAS).

Objectives: The primary aim of this study is to conduct photogrammetric aerial surveys in targeted areas offshore. We will build a database of annotated photos to train deep learning computer vision algorithms (currently in development by study NT-19-04) to count and identify all species of marine mammals, sea turtles, and seabirds encountered on at-sea transects coordinated by BOEM. Once trained, deep learning models will automatically detect and count species in new imagery. A similar approach was successfully applied to automated detection of individual endangered right whales with 87% accuracy (Bogucki *et al.*, 2018); birds (Chapbot and Francis, 2016); and sea turtles (Gray *et al.*, 2019).

Methods:

- USFWS will conduct aerial surveys at least once per season to target breeding, wintering, staging, migrating species, and mixed-species groups during the study period.
- USFWS aircraft will use high-resolution camera systems to collect spatially referenced targeted imagery on marine mammals, sea turtles, and seabirds to increase the taxonomic and seasonal coverage of the imagery and annotation archive.
- USFWS will collect imagery in hotspot areas identified by BOEM using distribution and abundance data collected on AMAPPS I and II.

- BOEM and USFWS will continue to develop and annotate a digital aerial imagery archive with Upper Midwest Environmental Sciences Center-USGS under study NT-19-04 to train deep learning algorithms on imagery of seabirds, marine mammals, and sea turtles. The archive will include a range of pixel ground sample distances (GSDs) and environmental conditions affecting sea state and sun glare as the two principal factors affecting detection and classification at sea.

Specific Research Question(s): How do we integrate results from different observational methodologies?

Current Status: High-resolution multiarray cameras deployed on FWS aircraft and tested. Targeted imagery collection currently underway.

Publications Completed: None.

Affiliated WWW Sites: None.

References:

Bogucki, R., Cygan, M., Khan, C.B., Klimek, M., Milczek, J.K. and Mucha, M., 2018. [Applying deep learning to right whale photo identification](#). *Conservation Biology*.

Chabot, D., and C. M. Francis. 2016. [Computer-automated bird detection and counts in high-resolution aerial images: a review](#). *Journal of Field Ornithology* 87:343–359.

Gray, P.C., Fleishman, A.B., Klein, D.J., McKown, M.W., Bézy, V.S., Lohmann, K.J. and Johnston, D.W., 2019. [A convolutional neural network for detecting sea turtles in drone imagery](#). *Methods in Ecology and Evolution*.