Environmental Studies Program: Ongoing Study

Title	Automated Detection and Classification of Wildlife Targets in Digital Aerial Imagery
Administered by	Headquarters
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Conducting Organization(s)	*USGS Upper Midwest Environmental Sciences Center*; Berkeley Institute for Data Science
Total BOEM Cost	$0. Funding supported by the USGS OCS Program in support of BOEM's mission.
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PICOC Summary	
Problem	A significant challenge to integrating remote sensing methods for large-scale population surveys is the tremendous volume of data collected during image-based surveys and the lack of efficient tools for automated and rapid detection, classification, and counting of wildlife targets. Automation of wildlife detection and classification from imagery is critical if remote sensing solutions are cost-efficient for natural resource management agencies at broad scales.
Intervention	Artificial Intelligence in the form of deep learning models can improve population estimates and species identification and relieve the manual workload of experts by automating the identification and count process.
Comparison	Evaluate the performance of deep learning models within a proposed in-flight workflow to support efficient monitoring of wildlife populations over broad geographic regions using remote sensing technology.
Outcome	Transferrable computer vision algorithms for use in all BOEM regions and across Federal agencies to identify and count marine wildlife captured in high-resolution imagery aerial imagery.
Context	National: This proof of concept applied to digital imagery collected in the Atlantic and other BOEM regions.

BOEM Information Need(s): High-resolution camera systems are now deployed on nearly all aerial surveys to capture transect-level imagery of seabirds, sea turtles, and marine mammals. This method will develop and/or evaluate methods for efficiently automating counts of wildlife in aerial photographs and may reduce costs of long-term monitoring programs through rapid data processing. This approach may also improve species identification, particularly of species difficult to identify by observers on aerial surveys.

Background: Federal, State, and Provincial wildlife management agencies in North America have a long history of using aircraft to monitor population abundance of marine wildlife at sea. Improved sensor, computing, and image processing technologies offer promise in enhancing the safety of marine animal population surveys while improving the quality of data derived and creating a permanent, georeferenced record of observations. A major challenge to integration of remote sensing methods for population surveys is the tremendous volume of data that is collected during image-based surveys and the lack of suitable tools for automated detection, classification, and counting of at-sea wildlife targets. In some cases, individual low-level surveys collect data on dozens of marine species, are regional or continental in scope, and involve the simultaneous operations of up to a dozen aircrews for a month-long time period. Automation of marine animal detections and classification is critical if remote sensing solutions are to be cost-efficient (Groom et al. 2013, Chabot et al. 2016).

Objectives: The goal of this project is to initiate development of automated detection and classification algorithms for marine wildlife (e.g., cetaceans, seabirds, and sea turtles) in digital aerial imagery. Specific objectives are to:

1. Develop and annotate a digital aerial imagery archive to be used to train computer vision and machine learning algorithms.
2. Develop computer vision and machine learning algorithms for detection, taxonomic classification, and counting of the target species in open water environments
3. Provide recommendations and guidance on image and environmental characteristics that maximize detection and classification accuracy.

Methods:

- Acquire currently accessible digital aerial imagery from BOEM funded studies, and partners (e.g., FWS).
- Begin developing and training algorithms using extant imagery
- Develop and apply computer vision and machine learning algorithms to detect and classify target wildlife species across a range of conditions affecting difficulty in classification.

Specific Research Question(s): Can we develop deep learning algorithms with high enough precision and accuracy to classify and count a wide variety marine species in digital imagery collected by offshore aerial surveys?

Current Status: This study successfully developed and trained deep learning algorithms to detect marine birds. The team also created an opensource annotation tool to leverage newly acquired imagery for algorithm expansion on new species. UMESC continues its ongoing work on infrastructure to host a publicly available imagery database and in the initial steps of creating classification algorithms.

Publications Completed: Ke, T.W., Yu, S.T., Koneff, M.D., Froncska, D.L., Fara, L.J., Harrison, T.J., Landolt, K.L., Hlavacek, E.J., Lubinski, B.R., White, T.P. Deep learning workflow to support in-flight processing of digital aerial imagery for wildlife population surveys. 2021 (in review)

Affiliated WWW Sites: Deep Learning for Automated Detection and Classification of Waterfowl, Seabirds, and other Wildlife from Digital Aerial Imagery

References:

Chabot, D. and C. M. Francis. 2016. Computer-automated bird detection and counts in high-resolution aerial images: a review. Journal of Field Ornithology.

Groom, G., M. Stjernholm, R. D. Nielsen, A. Fleetwood, and I.B. Petersen. 2013. Remote sensing image data and automated analysis to describe marine bird distributions and abundances. Ecological Informatics 14:2-8.