Ongoing Project Updates and New Project Summaries by Members of the Atlantic Marine Bird Cooperative - 2023

February 2024

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At-Sea Surveys

Pelagic Seabird Surveys in Atlantic Canada

Contact: Carina Gjerdrum, Canadian Wildlife Service, Environment and Climate Change Canada, carina.gjerdrum@ec.gc.ca

The Canadian Wildlife Service (CWS) continues to coordinate North Atlantic seabird surveys from ships-of-opportunity, and in 2023 added over 20,000 km of survey data to the Eastern Canada Seabirds at Sea (ECSAS) database. Survey effort extends from the eastern Canadian Arctic to the Gulf of Maine and east across the North Atlantic. The data are used to help understand threats to birds at sea, define areas for marine protection, and used for the purposes of emergency response and damage assessments. Data are summarized in an Atlas of Seabirds at Sea in Eastern Canada 2006-2020 found at the Government of Canada's Open Data Portal (https://data-donnees.az.ec.gc.ca). Methods were developed this year to combine abundance estimates from two different survey methods (1965-1992 and 2016-2019) to quantify changes over time, and seasonal-specific species distribution models are now available for a variety of marine spatial planning initiatives, including an emerging offshore wind industry.

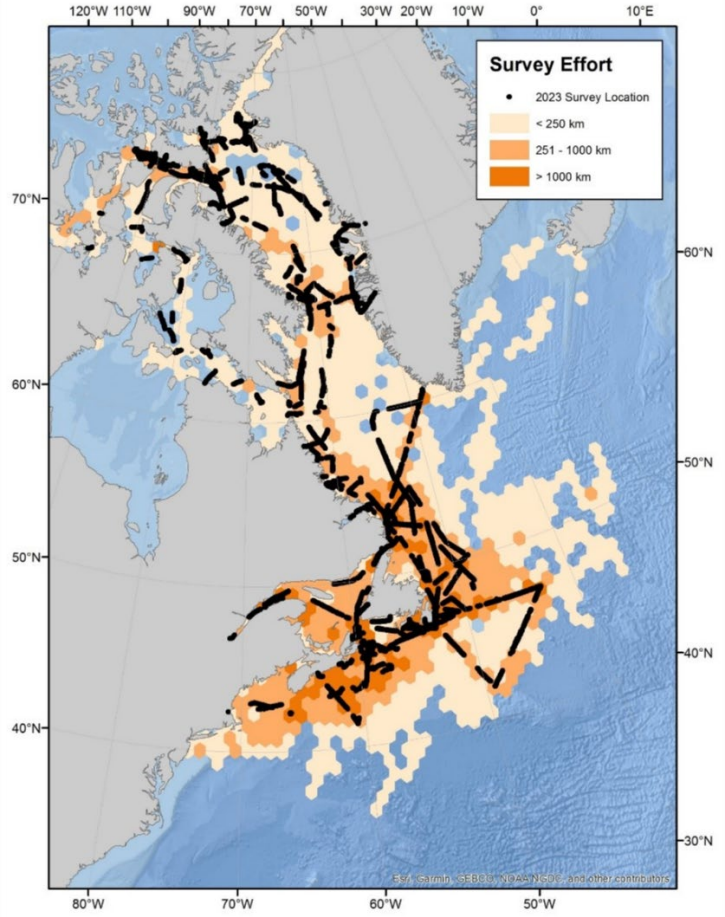

Figure: Pelagic seabird survey effort in eastern Canada since 2006, highlighting survey effort in 2023.

Monitoring and Adaptive Activity Implementation Plan (MAAIP): Vessel Surveys for Abundance and Distribution (VSAD) of Marine Mammals and Seabirds

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Collaborators: Pamela E. Michael, Terra Mar Applied Sciences; Jeffery S. Gleason, U.S. Fish and Wildlife Service, Gulf of Mexico Migratory Bird Coordinator.

The Gulf of Mexico is a critical marine region providing breeding, staging, migration, and wintering habitat for a wide variety of North America's avifauna. Yet information remains sparse about species composition, distribution, and abundance of birds Gulf-wide, particularly given the large footprint of oil and gas infrastructure in the Central and Western Planning Areas and newly anticipated offshore wind energy and aquaculture projects expected in the northern Gulf. Using methods directly comparable to the 2017-2019 Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) study, the 2023-2024 Vessel Survey for Abundance and Distribution (VSAD) of Marine Mammals and Seabirds project will survey along predetermined track lines, with two-person teams conducting visual seabird surveys alongside marine mammal observers.

The VSAD project has completed three survey Legs. Rare or casual species for the northern Gulf of Mexico (nGoM) observed in Leg 1: 22 June - 1 July 2023 include Red-footed Booby (Figure 2), Red-billed Tropicbird, and Black-capped Petrel (white-faced form). Only one sub-adult Masked Booby was detected, but as many as five adult, sub-adult, or juvenile Brown Boobies could be seen at any one time foraging for flying fish off the ship's bow. The Loop Current during this survey had entrained from Mississippi River outflow massive amounts of fresher and more turbid 'green' water southward and away from the areas where we typically encounter this water mass. As in almost all previous surveys, we commonly encountered flocks of Sooty Tern grouped over schooling tuna in the eastern nGoM.

VSAD Leg 2/3: 20 July - 15 August 2023 (Figure 1). Compared to previous nGoM vessel surveys, little *Sargassum* and virtually no patches100 m2 - 1,000 m2 were detected. The total count and number of birds per unit effort were among the lowest for daily seabird abundances observed in nGoM surveys. Nevertheless, the 'evenness' of seabird abundance during VSAD Leg 2/3 was high, with no days with exceedingly low abundances (<10 birds/day) and few with especially high abundances (>100 birds/day; n = 8; 29.6% of survey days).

Efforts merging data from GoMMAPPS, VSAD, and the National Resource Damage Assessment Surveys undertaken during the *Deepwater Horizon* oil spill are underway. Data and updated models will inform long-term conservation and management of seabird populations in the nGoM. This will improve information available to natural resource managers as they try to limit risks to seabird populations from activities such as aquaculture and wind energy development. The study will also help restoration planning ensure that projects are designed to provide maximum benefits to species injured during the *Deepwater Horizon* oil spill.
Analyses characterizing seabird assemblages undertaken during GoMMAPPS while Dr. Michael was at the South Carolina Cooperative Fish and Wildlife Research Unite were also completed

and published this year: Michael, Pamela E., et al. "Migration, breeding location, and seascape shape seabird assemblages in the northern Gulf of Mexico." *Plos one* 18.6 (2023): e0287316. Four distinct assemblages of seabirds were identified (Figure 3), each displaying patterns in space and time linked to life history and physical habitats.

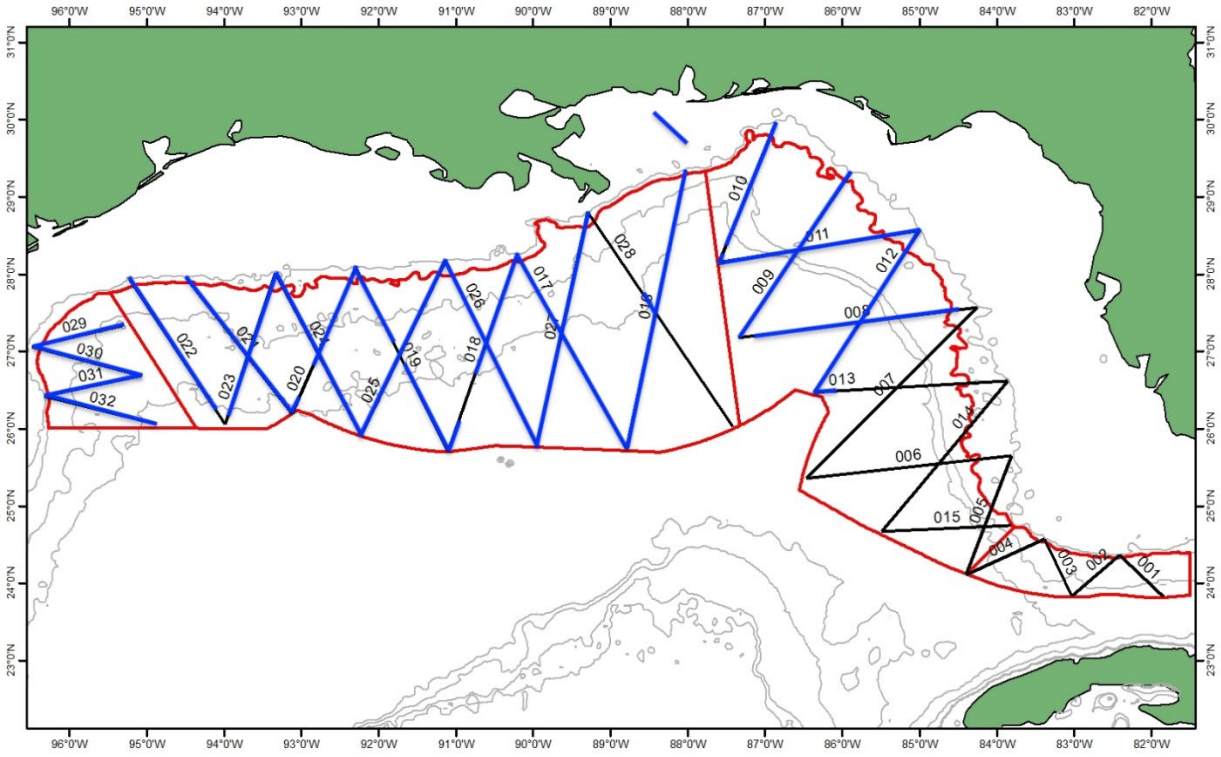


Figure 1. Marine bird and mammal track lines (*blue shading)* on Leg 2/3 of the 2023 VSAD survey aboard the R/V *Gordon Gunter*. Observers conducted strip transect surveys from 20 July to 15 August 2023, including some transit track lines. NOTE: The depiction of survey route is an approximation and does not necessarily precisely represent the survey coverage along the ship's full course. Leg 2/3 departed from and returned to Pascagoula, MS.

Figure 2. Red-footed Boobies *Sula sula* observed during the VSAD Leg 2/3 survey in the northern Gulf of Mexico. The bird on the left is an adult white morph (photo credit: Jonathan M. Andrew). The bird on the right is an immature brown morph (both body and tail)(photo credit: Jonny Reid).

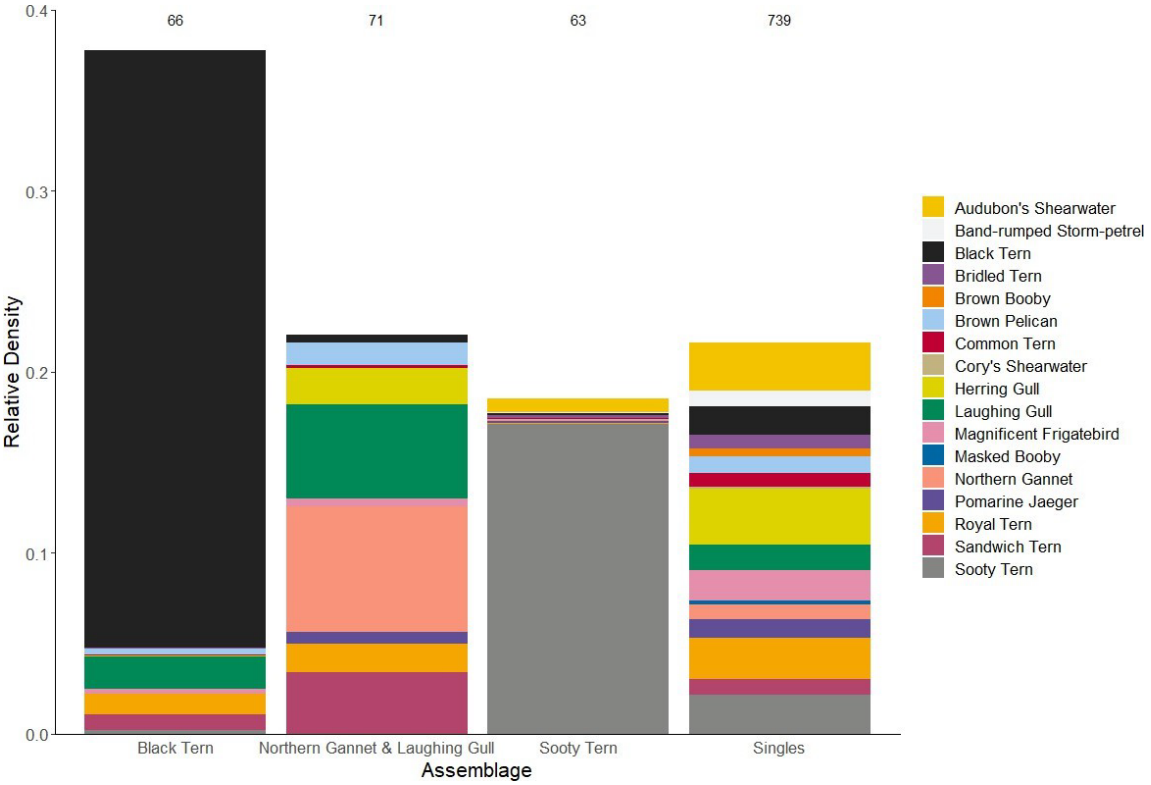


Figure 3: from Michael et al., 2023. The total relative density (seabirds/km2; y-axis) of distinct seabird assemblages (x-axis) in the northern Gulf of Mexico. Each color indicates a different species and is consistent across assemblages. Assemblages were identified as having a unique composition of seabirds: co-occurrence of species and the relative density of each species. The number of cell-days (a 10 x 10 km cell with seabird observations in a given day) in each assemblage is shown at the top of the column. The same species can occur in multiple assemblages.

Gulf of Mexico Marine Assessment Program for Protected Species (GOMMAPPS): Seabird Surveys in the Northern Gulf of Mexico, 2017-2020

Contact: Jeffrey S. Gleason, U.S. Fish and Wildlife Service, R4 Migratory Bird/Science Applications Program, jeffrey_gleason@fws.gov
Collaborators: Allison L. Sussman, James E. Lyons, U.S. Geological Survey, Eastern Ecological Science Center; Kayla L. Davis, Elise F. Zipkin, Department of Integrative Biology, Ecology, Evolution, and Behavior Program, Michigan State University; J. Christopher Haney, Terra Mar Applied Sciences; Kathy M. Hixson, Pamela E. Michael, Yvan G. Satgé, South Carolina Cooperative Fish & Wildlife Research Unit, Department of Forestry and Environmental Conservation, Clemson University; Emily D. Silverman, U.S. Fish and Wildlife Service, Migratory Bird Program, Branch of Monitoring and Data Management; R. Randy Wilson, U.S. Fish and Wildlife Service, R4 Migratory Bird/Science Applications Program; Patrick G. R. Jodice, South Carolina Cooperative Fish & Wildlife Research Unit, Department of Forestry and Environmental Conservation, Clemson University, U.S. Geological Survey, South Carolina Cooperative Fish and Wildlife Research Unit, Clemson University.

Research was conducted in the northern GOM from the coastline out to ~50 nm (for aerial surveys) and from the continental shelf out to the EEZ between roughly 81° and 98° W and 24° and 31° N. We trained seabird observers aboard USFWS Kodiak amphibious aircraft and NOAA Vessels of Opportunity to document distribution and abundance of seabirds across seasons and across the three BOEM planning areas. From the aerial survey platform, we also collected data on wintering waterfowl, marine mammals, and sea turtles, and from the vessel survey platform, we also collected data on non-marine birds, marine mammals, and flying fish. Aerial seabird observers detected and recorded a total of 52 species of birds with representatives from five taxonomic groups: 23 seabird species, 15 waterfowl species, 10 wading bird species, 3 raptor species, and 1 shorebird species. Vessel seabird observers recorded 1,345 detections of 6,980 birds classified as non-marine avifauna representing 77 species. Vessel seabird observers recorded 9,347 detections of 44,029 seabirds representing 44 species; 47 species of seabirds were identified across survey platforms, years, and seasons. Seabird observations accounted for 87.4% of all avifauna detections, 86.3% of all individual birds, and 39.3% of all birds identified to species. Species composition differed among years and between seasons irrespective of survey platform. Predictive models of species distribution and abundance and the relative influence of a suite of environmental covariates varied considerably depending on the survey platform and model used, season, and species or guild. The inclusion of individual environmental covariates within a predictive modeling framework should be evaluated at the species-level within a specific season; ensuring there is spatio-temporal overlap of environmental covariates with seabird observations. Observations of the proposed listed Black-capped Petrel (*Pterodroma hasitata*) collected during this study represents a major advancement in our knowledge of at-sea distribution for this species.

Project Accomplishments:

Davis, K. L., E. D. Silverman, A. L. Sussman, R. R. Wilson, and E. F. Zipkin EF. 2022. Errors in aerial survey count data: identifying pitfalls and solutions. Ecology and Evolution 12(3): https://doi.org/10.1002/ece3.8733
Jodice, P. G. R., P. E. Michael, J. S. Gleason, J. C. Haney, and Y. G. Satgé YG. 2021a. Expanding the marine range of the endangered black-capped petrel *Pterodroma hasitata*:

occurrence in the northern Gulf of Mexico and conservation implications. BioRxiv: https://doi.org/10.1101/2021.01.19.427288
Jodice, P. G. R., P. E. Michael, J. S. Gleason, J. C. Haney, and Y. G. Satgé. 2021b. Revising the marine range of the endangered black-capped petrel *Pterodroma hasitata*: occurrence in the northern Gulf of Mexico and exposure to conservation threats. Endangered Species Research 46:49-65. https://doi.org/10.3354/esr01143
Michael, P. E., K. M. Hixson, J. C. Haney, Y. G. Satgé, J. S. Gleason, and P. G. R. Jodice. 2022. Seabird vulnerability to oil: exposure potential, sensitivity, and uncertainty in the northern Gulf of Mexico. Frontiers in Marine Science: 880750 https://doi.org/10.3389/fmars.2022.880750
Michael, P. E., K. M. Hixson, J. S. Gleason, J. C. Haney, Y. G. Satgé, P. G. R. Jodice. 2023. Migration, breeding location, and seascape shape seabird assemblages in the northern Gulf of Mexico. PLoS ONE 18(6): e0287316 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0287316

Data Releases

Sussman AL, and Eyler MC. 2018. EPA 40km hexagons for conterminous United States. U.S. Geological Survey data release. Washington (DC): U.S. Department of the Interior, U.S. Geological Survey. https://doi.10.5066/P9C56AY1
Aerial survey, NCEI Accession 0247205:
https://www.ncei.noaa.gov/archive/accession/0247205
DOI Minted: https://doi.org/10.25921/vyg0-tv44
Citation: Wilson, R. R., J. S. Gleason, J. E. Lyons, E. D. Silverman, A. L. Sussman, E. F. Zipkin, and K. L. Davis. 2022. Seabird visual surveys using line-transect methods collected from USFWS aircraft in the Gulf of Mexico for the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) project from 2018-01-31 to 2020-02-12 (NCEI Accession 0247205). U.S. Department of the Interior, Bureau of Ocean Energy Management. NOAA National Centers for Environmental Information. Unpublished Dataset. https://doi.org/10.25921/vyg0-tv44 [Date Accessed]

Vessel survey, NCEI Accession 0247206:
https://www.ncei.noaa.gov/archive/accession/0247206
DOI Minted: https://doi.org/10.25921/afrq-h385
Citation: Gleason, J. S., R. R. Wilson, P. G. R. Jodice, Y. G. Satgé, P. E. Michael, K. M. Hixson, A. L. Sussman, and J. C. Haney. 2022. Seabird visual surveys using line-transect methods collected from NOAA vessels in the northern Gulf of Mexico for the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) project from 2017-07-21 to 2019-09-25 (NCEI Accession 0247206). U.S. Department of the Interior, Bureau of Ocean Energy Management. NOAA National Centers for Environmental Information. Unpublished Dataset. https://doi.org/10.25921/afrq-h385 [Date Accessed]

A Synthetic Analysis of Post-construction Displacement and Attraction of Marine Birds at Offshore Wind Energy Installations

Contact: Juliet Lamb, The Nature Conservancy, juliet.lamb@tnc.org
Collaborators: Julia Gulka, Evan Adams, Kathryn Williams, Biodiversity Research Institute; Aonghais Cook, British Trust for Ornithology;

Displacement of marine birds from at-sea foraging, resting, and migratory habitat is frequently observed following construction of offshore wind energy installations. However, the presence and strength of displacement effects have been shown to vary widely among species and locations. The sources of this variation are unclear but likely include a combination of morphological and behavioral differences among species and over time, differences in local ecological conditions and site characteristics at wind farm locations, and choice of monitoring methodology and other study design parameters. An understanding of the underlying factors driving both occurrence and detection of displacement effects is required to inform wind farm design and develop best practices for environmental impact assessment, monitoring, and mitigation. We conducted a meta-analysis of existing literature to assess the state of knowledge on displacement effects of marine birds. Drawing from 39 publications and reports on displacement of marine birds by wind energy infrastructure, we extracted the likelihood of detecting a change in distribution compared to pre-construction and/or reference sites, as well as the proportional change in use of the wind energy areas. These outcomes were assessed as functions of wind farm characteristics, bird characteristics, and the observation process. We found that the presence and strength of displacement effects varied most strongly among taxa and seasons, followed by study design criteria, and were least influenced by wind farm characteristics. Displacement effects were more common during breeding season and in studies

with a larger overall study area footprint and a greater number of survey years. Effects diminished with increasing distance from wind turbines, and were greater at high-latitude sites. Effects were significant and negative for loons, grebes, sea ducks, alcids, and gannets, and were neutral or slightly positive for gulls, waterfowl, and cormorants. Rare taxa such as fulmars and skuas had low frequency of significant displacement effects but large negative effect sizes, suggesting that displacement may be underestimated in these groups, and that improved survey methodology to reduce uncertainty is needed to detect changes in these species. Further, we recommend that future monitoring studies clearly report both means and standard errors of underlying metrics (i.e., abundance and/or density) within defined study areas to allow for robust comparison among sites, species, and survey methodologies.

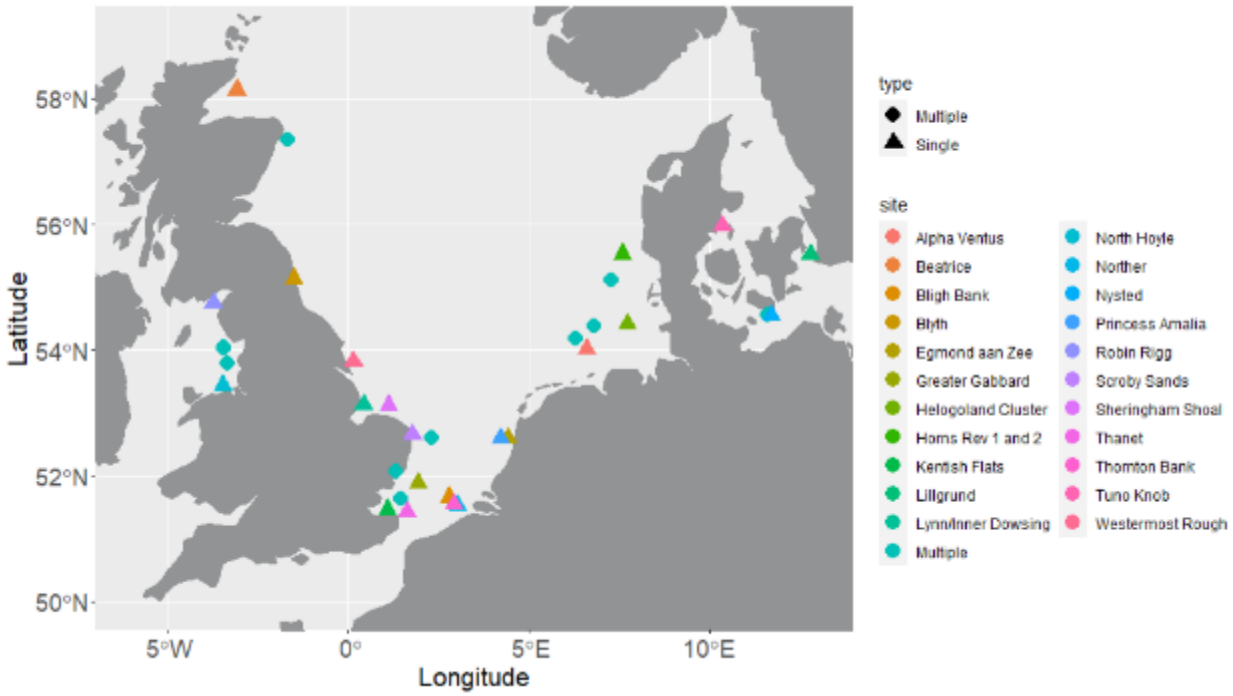


Figure 1: Locations of studies included in the meta-analysis

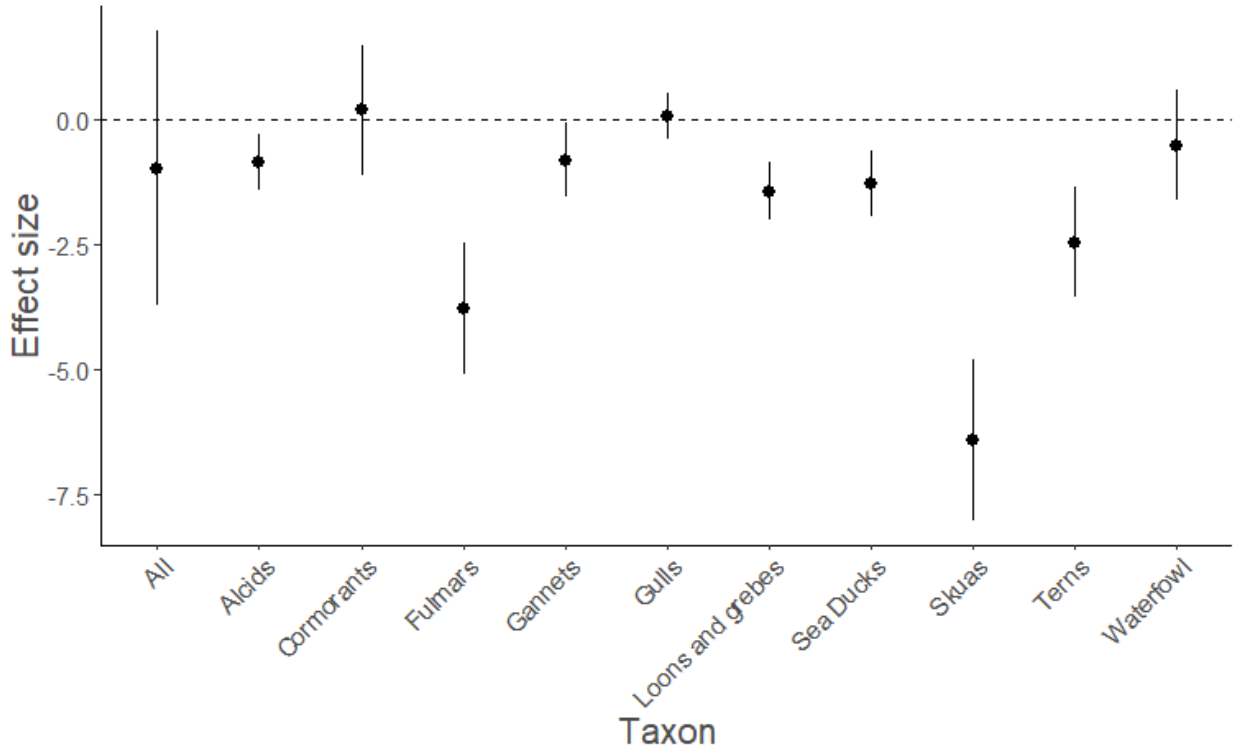


Figure 2: Effect sizes by taxa; more negative values indicate greater displacement.

At-sea Monitoring of the Distributions of Pelagic Seabirds in the Northeast US Shelf Ecosystem

Contacts: Dr. Debra Palka, Acting Conservation Ecology Branch Chief, Protected Species Division, NOAA Northeast Fisheries Science Center, Debra.Palka@noaa.gov; Harvey Walsh, Oceans and Climate Branch, NOAA Northeast Fisheries Science Center, Harvey.Walsh@noaa.gov

Three shipboard surveys were completed in 2023 as part of the NEFSC Atlantic Marine Assessment Program for Protected Species (AMAPPS) during Ecosystem Monitoring (EcoMon) surveys. Cruises sampled regions from Cape Hatteras, North Carolina, to the Gulf of Maine (Figure 1). Over 7000 kilometers of visual transect lines were completed during the three surveys. A total of 22,853 sightings of seabirds, marine mammals, sea turtles, fish, and land birds were recorded. Seabird species composition varied by survey season with the greatest number of sightings during the June survey. Great Shearwaters (*Puffinus gravis*), Sooty Shearwaters (*Ardenna grisea*), and Wilson's Storm-Petrels (*Oceanites oceanicus*) were most frequently sighted seabirds in June. Seabird sightings were lowest during the August survey, and Great Shearwaters, Wilson's Storm-Petrels, and unidentified *Phalaropus* were the most frequently sighted. In the fall (October – November), seabird sightings were greatest for Red Phalarope (*Phalaropus fulicarius*), Great Shearwaters, and unidentified *Phalaropus*.

Table 1. A summary of 2023 NEFSC AMAPPS Shipboard Surveys on which observers sailed with the primary goal of conducting seabird surveys to collect abundance and distribution data and the secondary goal to collect abundance and distribution data for other marine megafauna including marine mammals, sea turtles, sharks, and other large pelagic fishes. Total sightings were inside and outside the 300-m survey zone. Other Taxa includes marine mammals, sea turtles, fish, and land birds.

					Total sightings	
Cruise	Start Date	End Date	Duration (days)	Total Transect Distance (km)	Seabird	Other Taxa
HB2302	9-Jun	27-Jun	19	3590	10,519	1465
HB2303	8-Aug	24-Aug	17	1757	2386	442
PC2305	27-Oct	13-Nov	18	1768	6952	1089

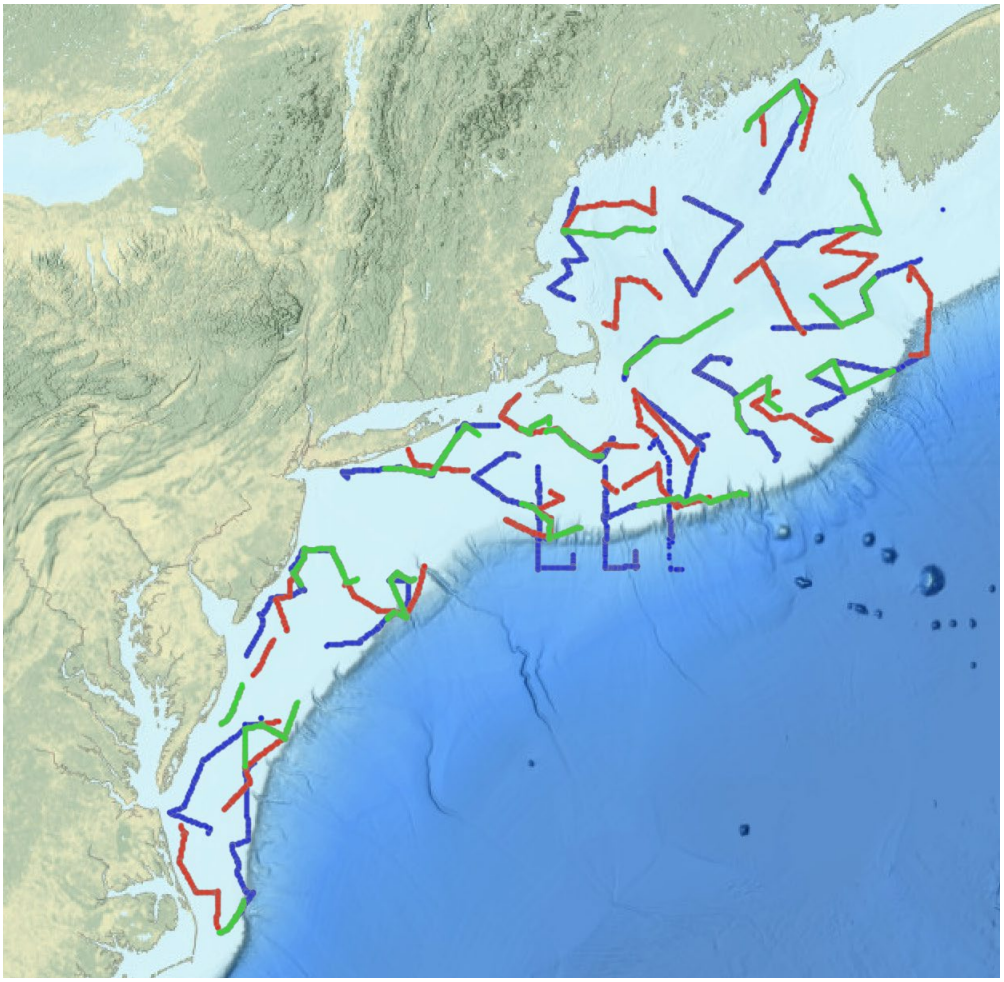


Figure 1. A summary of 2023 NEFSC AMAPPS Shipboard visual survey tracks. Blue tracks were on the June HB2302 survey, red the August HB2303 survey, and green tracks on the fall (Oct-Nov) PC2305 survey.

Metocean Buoy Survey of Marine Wildlife in the New York Offshore Planning Area

Contact: Julia Robinson Willmott, Normandeau Associates, Inc., jwillmott@normandeau.com
Collaborator: Greg Forcey, Normandeau Associates, Inc.

One floating LiDAR (light detection and ranging) buoy remains deployed in the New York Bight in the summer of 2022 and is collecting wind resource data for a period of two years. The buoy is deployed in the vicinity of OCS-A 0537. On behalf of NYSERDA, Normandeau Associates worked with Ocean Tech to add wildlife sensors to the deployed buoy and are analyzing and making wildlife data collected from the buoys available through the ReMOTe (https://remote.normandeau.com) data management system. These data include passive acoustic microphone data of detected vocalizations by birds and bats, hydrophone data of detected vocalizations by marine mammals, and MOTUS and VEMCO receiver data of detected NanoTagged birds and fishes.

Aerial Digital Surveys Off the Coast of Delaware

Contact: Julia Robinson Willmott, Normandeau Associates, Inc., jwillmott@normandeau.com
Collaborator: APEM Inc.

US Wind is planning an offshore wind project in lease area OCS-A0490 off the coast of Delaware. They have implemented two years of aerial digital surveys to study the impacts of traffic separation and vessel traffic on birds and other species. Information on the project can be found at https://remote.normandeau.com/uswind_home.php

2 Years of Buoy-based Acoustic Studies for Birds and Bats in Delaware

Contact: Julia Robinson Willmott, Normandeau Associates, Inc., jwillmott@normandeau.com
Collaborator: Ocean Tech, Inc.

US Wind is planning an offshore wind project in lease area OCS-A0490 off the coast of Delaware. Deployed within the lease area, they have implemented two years of buoy-based bird, bat, and marine mammal acoustic studies and deployed floating MOTUS receivers. Information on the project can be found on https://remote.normandeau.com/uswind_home.php

Acoustic and Thermographic Offshore Monitoring at the Coastal Virginia Offshore Wind Pilot Project, Virginia

Contacts: Greg Forcey, Normandeau Associates, Inc., gforcey@normandeau.com; Julia Robinson Willmott, Normandeau Associates, Inc., jwillmott@normandeau.com
Collaborator: Dominion Energy

Normandeau updated and deployed the latest version of ATOM™ (Acoustic and Thermographic Offshore Monitoring) on 2 turbines at the Dominion Coastal Virginia Offshore

Wind Pilot Project. The ATOM system is a remote bird and bat detection system designed for the harsh offshore environment and can be operated remotely via a satellite modem. The upgraded ATOM system includes 2 bird and bat acoustic detectors, 2 thermographic cameras operating in stereo to permit flight high calculations, a visible light camera, and a dual-band MOTUS receiver and antenna array for detecting birds fitted with Motus tags. The system records birds and bats 24 hours/day while operational and data are downloaded to hard drives bi-monthly. Data from this system are used to assess temporal variation in bird and bat species composition and abundance throughout the year, understand relationships with weather variables, and quantify microavoidance of turbine blades. This information is useful for understanding exposure and collision risks to birds and bats observed at the project. This is a three-year study and is still ongoing at the time of writing.

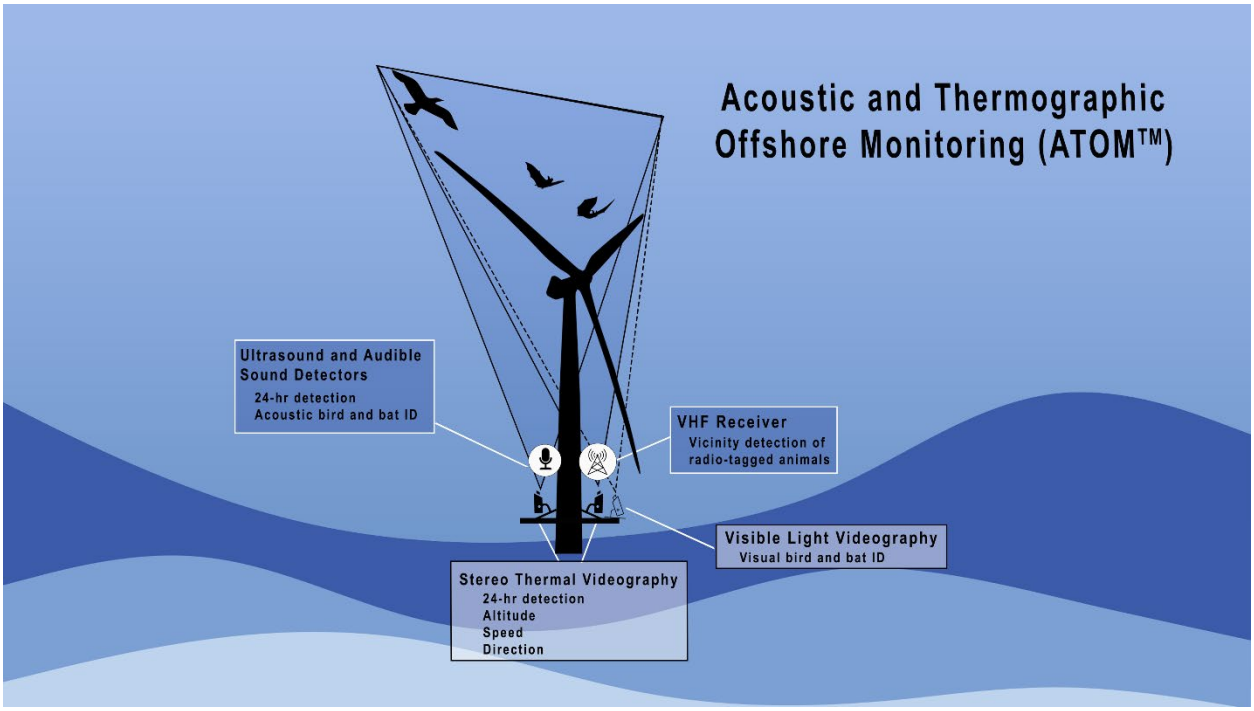
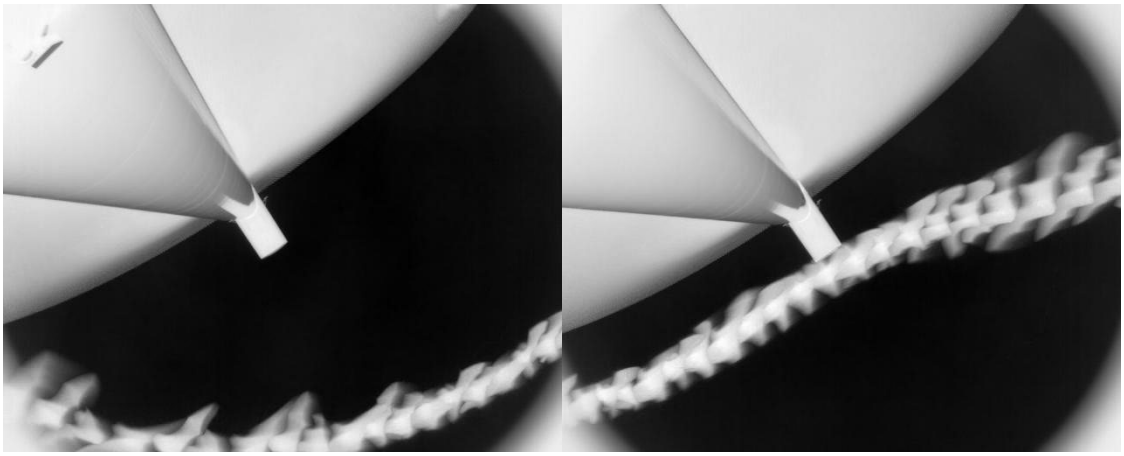


Diagram showing orientation of ATOM sensors on a turbine platform. / Normandeau Associates, Inc.


A bat identified in both thermal cameras. / Normandeau Associates, Inc.

Peregrine falcon observed with visible light cameras. Normandeau Associates, Inc.

History of Marine Wildlife Digital Aerial Surveying

Contact: Martin Scott, HiDef Environmental Consultancy, martin.scott@hidefsurveying.co.uk

Aircraft scale digital aerial surveying of marine fauna has been a commercial entity for 15 years. It developed out of the need to improve on safety and data auditability, from visual aerial and boat surveys, and has since been refined numerous times. A prime driver has been the offshore wind industry which has provided funding (and sites) to push the boundaries of capabilities. Larger survey areas, further offshore, with higher turbine designs have driven forward technologies and methods. New systems and techniques have improved data and our understanding of seabirds – but what next?

High Resolution Digital Aerial Surveys for Seabirds and Other Wildlife in the Gulf of Maine

Contact: Iain Stenhouse, Biodiversity Research Institute, iain.stenhouse@briwildlife.org
Collaborators: David Bigger, BOEM Office of Renewable Energy Programs; Tim White, BOEM Environmental Studies Program; David Cowan, Diamond Offshore Wind; Iain Stenhouse, Kate Williams, Evan Adams, Biodiversity Research Institute; Martin Scott, HiDef Aerial Surveying.

Data on marine wildlife in the offshore environment is critically needed in the Gulf of Maine, and digital aerial surveys will enhance and complement the few existing offshore survey efforts

in the region, including federal programs and state-driven activities. With the goal of informing offshore wind development, the Bureau of Ocean Energy Management (BOEM) is currently supporting seasonal digital aerial surveys across a swath of the Gulf of Maine. BOEM's digital aerial wildlife surveys are conducted by the Biodiversity Research Institute (BRI) and HiDef Aerial Surveying (HiDef), using HiDef's GEN 2.5 survey rig mounted in a fixed-wing aircraft, which is designed specifically for high quality seabird and marine mammal surveys. The rig contains four extremely high-resolution digital video cameras, and surveys are flown at ~400 m altitude at a ground speed of 220 kph (~120 knots), providing imagery at 1.5 cm ground sample distance (GSD). Beginning in the spring of 2023, BRI and HiDef have carried out seasonal surveys in a 6,672 km2 area of the Gulf of Maine, centered on BOEM's Request for Competitive Interest Area (the RFCI). These digital aerial surveys are collecting data on the distribution and abundance of a range of taxonomic groups, including seabirds, marine mammals, and fish, as well as fishing activities. In addition, Diamond Offshore Wind is supporting additional transects to supplement data acquisition specifically across the RFCI. To date, three surveys have been flown and survey imagery is currently under review and analysis. These surveys span the inshore-offshore gradient and provide critical baseline ecological data over a significant area of the Gulf of Maine.

Modeling the Distributions of Marine Birds at Sea to Inform Planning of Energy Development on the US Atlantic Outer Continental Shelf

Contact: Arliss Winship, CSS Inc. under contract to NOAA National Centers for Coastal Ocean Science (NCCOS), arliss.winship@noaa.gov
Collaborators: Jeffery B. Leirness, Michael Coyne, Jacob Howell, CSS Inc. under contract to NOAA NCCOS; Vincent S. Saba, NOAA Northeast Fisheries Science Center and Geophysical Fluid Dynamics Laboratory; John Christensen, NOAA NCCOS; David Bigger, Bureau of Ocean Energy Management (BOEM) Office of Renewable Energy Programs; Timothy P. White, BOEM Environmental Studies Program.

The US Bureau of Ocean Energy Management (BOEM) previously partnered with the National Oceanic and Atmospheric Administration (NOAA) National Centers for Coastal Ocean Science (NCCOS) to apply habitat-based species distribution modeling to at-sea survey data to describe the spatial distributions of marine bird species on the Atlantic Outer Continental Shelf (Winship et al. 2018. OCS Study BOEM 2018-010). The results of that study represented average long-term spatial distributions of marine birds from the late 1970s through the mid-2010s. However, spatial distributions can change over time in response to changes in environmental conditions and prey distributions. Furthermore, BOEM is required to consider potential impacts of future activities in their planning, leasing, and assessments. To address changes in distributions over time, BOEM and NOAA NCCOS continued their partnership in this study (Interagency Agreement M20PG00009) to describe the past, current, and future spatial distributions of marine bird species on the Atlantic OCS. Habitat-based species distribution modeling was again employed to relate at-sea counts of birds to environmental data matched in space and time, and those relationships were used to predict past, current, and future spatial distributions of bird density. At-sea counts of marine birds from surveys during the past 30 years were compiled from the Northwest Atlantic Seabird Catalog and Eastern Canada Seabirds at Sea databases. Environmental data from the same time period were acquired from a global ocean reanalysis

(GLORYS12V1) and a global remotely sensed wind field product (CERSAT). Projected changes in the same environmental variables during the next 30 years were acquired from a simulation experiment that used a high-resolution global climate model (GFDL CM2.6). Study results provide updated estimates of the current distributions of marine bird species in US Atlantic waters as well as potential changes in bird distributions under an idealized climate change scenario. The final report (Winship et al. 2023. OCS Study BOEM 2023-060) will be available in early 2024. Also, model products will be available through the Northeast and Mid-Atlantic ocean data portals in 2024.

Colony Management and Monitoring

Royal Tern, Sandwich Tern and Skimmer Banding

Contact: Lindsay Addison, Audubon North Carolina, laddison@audubon.org
Collaborators: Jon Altman, Chelsey Stephenson, National Park Service, Cape Lookout National Seashore; Kate Goodenough, Louisiana Fish & Wildlife Cooperative Research Unit; Carmen Johnson, NC Wildlife Resources Commission.

Since 2017, Audubon North Carolina has been banding Black Skimmer chicks, in coordination with other states' banding schemes. Over 600 chicks have been banded in the state to date, with over 4,000 resights made. Skimmers from North Carolina have thus far have been resighted in North Carolina (off-colony), New Jersey, Maryland, Virginia, South Carolina, Georgia, and Florida.

From the 1970s to 2020, independent researcher John Weske had banded Royal Terns, Sandwich Terns, and Brown Pelicans in the state. In 2023, Audubon North Carolina began a focused tern banding project on the Cape Fear River. All Royal and Sandwich Tern chicks received a metal federal band and 10-15% of them received a field-readable band on the opposite leg. This project aims to develop information on survival rates for Royal and Sandwich Tern chicks hatched from the Cape Fear River, describe patterns of dispersal and recruitment to breeding colonies, and identify stopover, staging, and winter areas for North Carolina Royal Terns and Sandwich Terns. The Cape Fear River supports >25% of nesting Royal and Sandwich Terns in the state and is a heavily altered estuary due to dredging for shipping traffic to the Port of Wilmington and present and historic industrial and non-point-source contamination.

Coastal Maryland Common Tern Raft

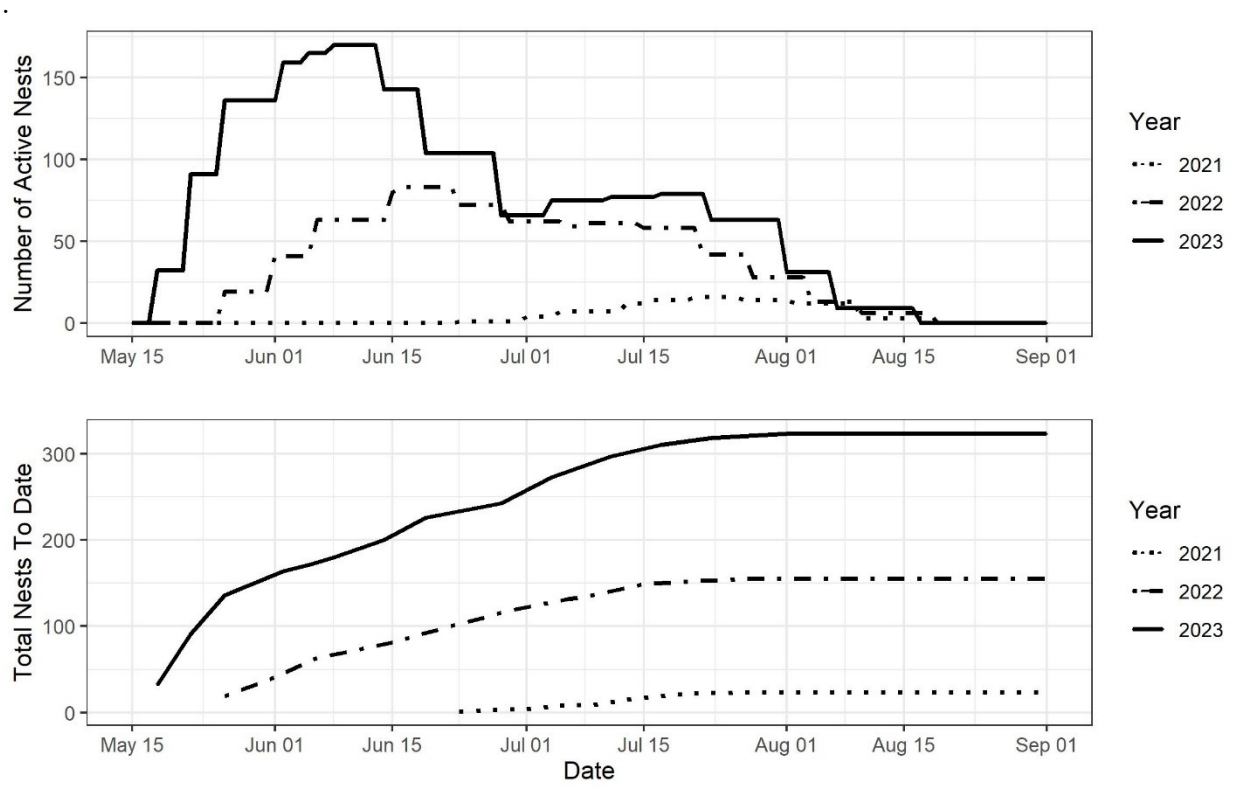
Contact: David F. Brinker, Natural Heritage Program, Maryland Department of Natural Resources, dave.brinker@maryland.gov
Collaborators: Kim Abpalnalp, Roman Jesien, Maryland Coastal Bays Program; David Curson, Audubon Mid-Atlantic.

2023 was the third year that an inter-agency collaboration between the Maryland Department of Natural Resources, Maryland Coastal Bays Program, and Audubon Mid-Atlantic successfully

deployed an artificial nesting island in the Maryland portion of Chincoteague Bay. The raft's objective is to mitigate for some of the loss of critical barren ground nesting habitat that has occurred throughout the state in recent decades. The target species is the Common Tern. The artificial island, 1,024 ft^2 in 2021, expanded to 2,304 ft^2 in 2022, consists of 18 individual 8'x16' wooden platforms fitted with wheeled dock floats and connected together with dock latches. For a more detailed description of the raft, see the 2022 AMBC Project Summary. Thus far, the raft's design has performed well and has not sustained damage from severe weather events, including tropical storms and nor'easters with maximum wind gusts of 45-60 mph. Social attraction is used to encourage colony establishment on the platform, Common Tern decoys are utilized alongside an audio-lure broadcasting Common Tern calls from dawn to dusk. Small wooden shelters are placed throughout the platform to offer shade and protection for hatchlings from weather and predators, along with ledges and overhangs built into the perimeter of the raft itself. Artificial foliage was added in 2022 to provide additional protection from avian predators and to disrupt sight lines on the raft.

In its first year of deployment the platform hosted 23 Common Tern nests. During 2022, earlier installation allowed the colony to grow by over 650% from 23 nests to 155. In 2023, the nesting colony grew again, and it produced 324 nests. Earlier launch dates in mid-April of 2022 and 2023 produced earlier nests by a month in both years. In 2021, 19 adult COTE were banded on the raft during the breeding season; 15 of those individuals were reobserved on the raft in 2022 and 17 in 2023. The combined total for 2021 and 2022 was 111 banded adults. In 2023, 88 of the 111 were documented returning to the raft (79%). Fledging success of chicks hatched on the platform for all three years of raft deployment has been 96%, 93%, and 77% respectively. Reduced fledging success in 2023 was the result of a 3-day nor'easter that seriously impacted adult foraging and chick provisioning. This storm event was responsible for the death of many of the youngest chicks, approximately 45 % of the chicks that had hatched before the storm. More than 700 adult and juvenile Common Terns have been marked with a combination of USGS and field readable bands on the raft over the course of the last three years. The raft has fledged 340 chicks to date.

Maryland Common Tern raft, photo credit Kim Abplanalp 2023



Comparison of Common Tern nesting pair and nest accumulation curves for 2021-2023, graphic credit Maggie Brockart.

Maryland 2023 Colonial Nesting Waterbird Census

Contact: David F. Brinker, Natural Heritage Program, Maryland Department of Natural Resources, dave.brinker@maryland.gov
Collaborators: James M. McCann, Kim Abpalnalp, Maryland Coastal Bays Program.

The Maryland Department of Natural Resources has conducted annual colonial nesting waterbird censuses since 1985. Breeding pair counts of at-risk species—such as Black Skimmers, Royal Terns, and Forster's Terns—are conducted on a yearly basis, while beginning in 1998 other species are fully censused every five years. As part of coordinated Atlantic Flyway monitoring efforts, during 2023 all colonial nesting waterbird species were again censused in Maryland. Comparing the recent data to benchmark census information from 1975-1988, long-term population trends in colonial nesting waterbird species can be generated to establish the general health and biodiversity of Maryland's colonial nesting waterbird populations. While a few species—such as Brown Pelicans, Double-crested Cormorants and White Ibis—have expanded their range throughout the mid-Atlantic since the 1970s, the existence of many waterbirds as viable elements of Maryland's fauna is being jeopardized by critical habitat loss, increased predation, and the effects of global warming on local ecosystems. Maryland has experienced precipitous decline and reproductive failure in colonies of Black Skimmers, Royal Terns, Common Terns, Glossy Ibis, and more. During the reference period ~300 nesting pairs of

Black Skimmer bred in Maryland, no skimmers nesting in Maryland during 2023. Similarly, estimates of the Common Tern breeding population in the reference period were ~2,750 pairs, the Maryland breeding population of Common Terns in now below 500 pairs each summer. The 2023 census work also documented a decline in Herring Gull breeding pair estimates and downward trends are also appearing in several wading bird species. Furthermore, habitat that—even a mere five years ago—acted as viable breeding grounds is now underwater. Extraordinary measures are being undertaken to mitigate breeding habitat losses in Maryland (see the Tern Raft Summary). Chesapeake Bay serves as important breeding habitat along the Atlantic Flyway for over 20 colonial nesting waterbird species, and their future is in great jeopardy as they continue to lose the ability to nest in the mid-Atlantic.

First record of a White Ibis nest in the Maryland Coastal Bays, Chincoteague Bay, July 2023; photo credit Kim Abplanalp 2023.

Evaluating Minimum Buffer Distances and Durations, and Corridor Placement, for Least Tern Nesting Colonies for Cape Hatteras National Seashore

Contact: Ray Danner, UNC-Wilmington, dannerr@uncw.edu
Collaborator: Erin Gallagher, UNC-Wilmington

Ray Danner and students in the Department of Biology and Marine Biology at UNC Wilmington and Cape Hatteras National Seashore are conducting a Cooperative Agreement to study Least Tern productivity and behavior in response to human activities. Research is led by UNCW graduate students Erin Gallagher (PhD expected fall 2024) and Alex Smith (MS spring 2023) and involves close collaboration with NPS staff and USFWS staff. Research takes place on Cape Hatteras National Seashore and Pea Island National Wildlife Refuge. In 2023, the research

involved measuring nest and chick survival, assessing sources of mortality, chick movements, chick banding, behavioral responses to anthropogenic activities, and interactions with stakeholders.

Gulf of Mexico Nesting Waterbird Atlas and Registry

Contact: Kathy Hixson, Clemson University, South Carolina Cooperative Fish and Wildlife Research Unit, kmhixso@clemson.edu
Collaborators: Yvan Satgé, Clemson University, South Carolina Cooperative Fish and Wildlife Research Unit; Jeffrey Gleason, U.S. Fish and Wildlife Service; Patrick Jodice, U.S. Geological Survey South Carolina Cooperative Fish and Wildlife Research Unit, Clemson University.

The coastal zone of the northern Gulf of Mexico supports a diverse array of breeding waterbirds. Because of the dynamic nature of coastal habitats, waterbirds may shift the location of their breeding sites interannually in response to availability, size, and stability of substrates. Such changes can affect local population size or structure, foraging locations, and threat exposure.

Overlaid on this dynamic system is a stakeholder network of three Joint Ventures responsible for management of species and breeding habitats that includes five state agencies, multiple federal agencies, and numerous private organizations. Information and data regarding the location and status of colonies is collected regularly but remains scattered among the stakeholder network and difficult to source.

With the planned expansion of renewable energy development in federal (and state) waters in the northern Gulf of Mexico, a coast-wide spatial inventory of breeding sites is needed to support habitat management, monitoring, and research, as well as marine spatial planning, oil spill response plans, and post-Deepwater Horizon oil spill restoration. Efforts have begun to create an atlas and registry of waterbird breeding sites that integrate existing data from 2010 to 2022. To date, 38 datasets from 8 data providers have been incorporated, representing more than 50,000 surveys of 46 breeding species. This resource will provide critical contemporary information to understand the distribution and status of breeding waterbirds in the northern Gulf of Mexico.

North Carolina Colonial Waterbird Census

Contact: Carmen Johnson, NC Wildlife Resources Commission, carmen.johnson@ncwildlife.org
Collaborators: Lindsay Addison, Audubon North Carolina; Elizabeth Pinnix, Paul Gillikin, North Carolina Coastal Reserve; Jon Altman, Chelsey Stephenson, Will Thompson, Paul Doshkov, Amy Thompson, National Park Service, Cape Lookout National Seashore, Cape Hatteras National Seashore; Brian VanDruten, U.S. Fish and Wildlife Service, Pea Island National Wildlife Refuge; Kip Futch, Jake Vitak, North Carolina State Parks, Fort Fisher State Recreation Area, Hammocks Beach State Park; Hailey Grossman, U.S. Marine Corps Camp Lejune.

Partners across North Carolina conducted the state's tri-annual Colonial Waterbird Survey from April-June 2023. This statewide effort counts nests of all colonial waterbird species on the coast

of North Carolina. Counts are timed to coincide with peak of incubation, are usually conducted on foot with observers walking through sites in transects, and data are collected in an online database maintained by the NCWRC. The Colonial Waterbird Survey has been taking place since the 1970s. At most sites, intensive nest and chick monitoring to estimate productivity is not conducted, with exceptions in some years depending on student projects and staff time available. However, chick and fledgling counts to provide a measure of success are done at NPS, Audubon NC, and USFWS sites. These counts include Least Terns, Black Skimmers, Gull-billed Terns, and Common Terns.

Colonial Waterbird Management and Monitoring in North Carolina

Contact: Carmen Johnson, NC Wildlife Resources Commission, carmen.johnson@ncwildlife.org
Collaborators: Lindsay Addison, Audubon North Carolina; Elizabeth Pinnix, Paul Gillikin, North Carolina Coastal Reserve; Jon Altman, Chelsey Stephenson, Will Thompson, Paul Doshkov, Amy Thompson, National Park Service, Cape Lookout National Seashore, Cape Hatteras National Seashore; Brian VanDruten, U.S. Fish and Wildlife Service, Pea Island National Wildlife Refuge; Kip Futch, Jake Vitak, North Carolina State Parks, Fort Fisher State Recreation Area, Hammocks Beach State Park; Hailey Grossman, U.S. Marine Corps Camp Lejune.

Agencies and NGOs around the state post signs and, where needed, symbolic fencing at colonies across the state annually. The majority of nesting colonial waterbirds are within these protected areas. Level of monitoring varies by site, with Least Terns counted annually statewide and several partners counting pairs or nests of other species annually as well. Predator management takes place at most managed barrier islands, primarily to address coyotes and raccoons. Vegetation management occurs at two dredge-material islands on the Cape Fear River. Two of the sites, south Wrightsville Beach and Emerald Isle, have volunteer bird steward programs that conduct onsite outreach to the public. When possible, site managers coordinate with the USACE for the beneficial placement of dredged material on bird-nesting islands.

Operation Wrack Line

Contact: Alex Kropp, Florida Fish and Wildlife Conservation Commission, Division of Habitat and Species Conservation, Alexander.Kropp@MyFWC.com
Collaborators: Kristin Taylor, Nick Vitale, Mike Sisson, Hailey Garcia, Blair Hayman, Alexis Cardas, Becky Schneider, Ricardo Zambrano, Florida Fish and Wildlife Conservation Commission, Division of Habitat and Species Conservation; Major Jay Russel, Officer Billy Wilkenson, Officer James Suttles, Officer Mario Bertolami, Officer George Hughes, Officer Casey Schroer, Officer Jarred Favrot, Officer Chris Thurkettle, Florida Fish and Wildlife Conservation Commission, Division of Law Enforcement.

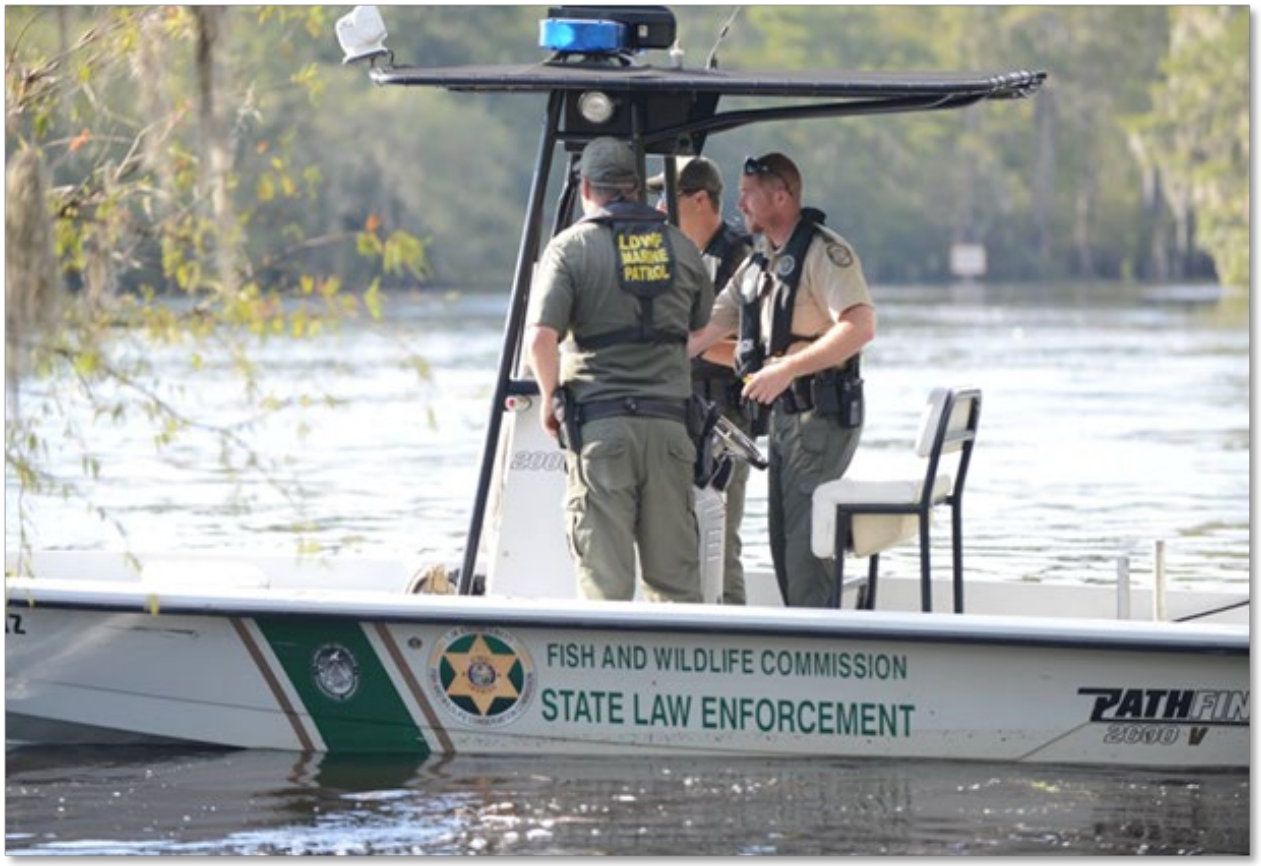
Florida has a growing population of more than 22 million residents. In 2022 alone, Visit Florida Research estimated more than 44 million visitors to the state engaged in “beach and waterfront activities.” The Florida Fish and Wildlife Conservation Commission (FWC) has more than 30 actions in conservation plans stating that reducing human disturbance at waterbird nesting areas

is a high priority. Many of these actions specifically state the necessity of closer coordination between Florida Fish and Wildlife Conservation Commission biologists and law enforcement staff to reduce human disturbance. Much research exists demonstrating human disturbance impacts productivity and chick survival.

Operation Wrack Line is a Division of Habitat and species Conservation and Division of Law Enforcement initiative to shift "FWC culture" so biologists and law enforcement are working together to prevent human disturbance through proactive patrols to priority nesting areas. Law enforcement also responds to reports of human disturbance/impacts to nesting areas from Audubon FL and Florida Shorebird Alliance bird stewards. Operation Wrack Line also aims to shift incentives for DLE from a reactive citation/warning incentive structure to one that also includes incentives for conducting proactive patrols to protect nesting birds from being impacted in the first place (officer presence as a deterrent, officer education/outreach in the areas where nesting occurs). Patrol priorities and patrol "targets" (patrol effort minimums) are tracked and reviewed monthly to incentivize proactive patrols.

This idea was first developed as an initiative in the Northeast Administrative Region starting in 2014. In 2023, FWC completed its first full season of statewide implementation. This project had impressive results in its first year with more than 2,500 patrols conducted.

FWC Law Enforcement conducting a patrol. Photo by FWC.



FWC law enforcement patrols active nesting areas on mainland beaches, spoil islands, barrier islands, oyster rakes and other sites across the state. Photo by FWC.

Seabird Monitoring at Machias Seal Island, New Brunswick

Contact: Heather Major, University of New Brunswick, Saint John, hmajor@unb.ca

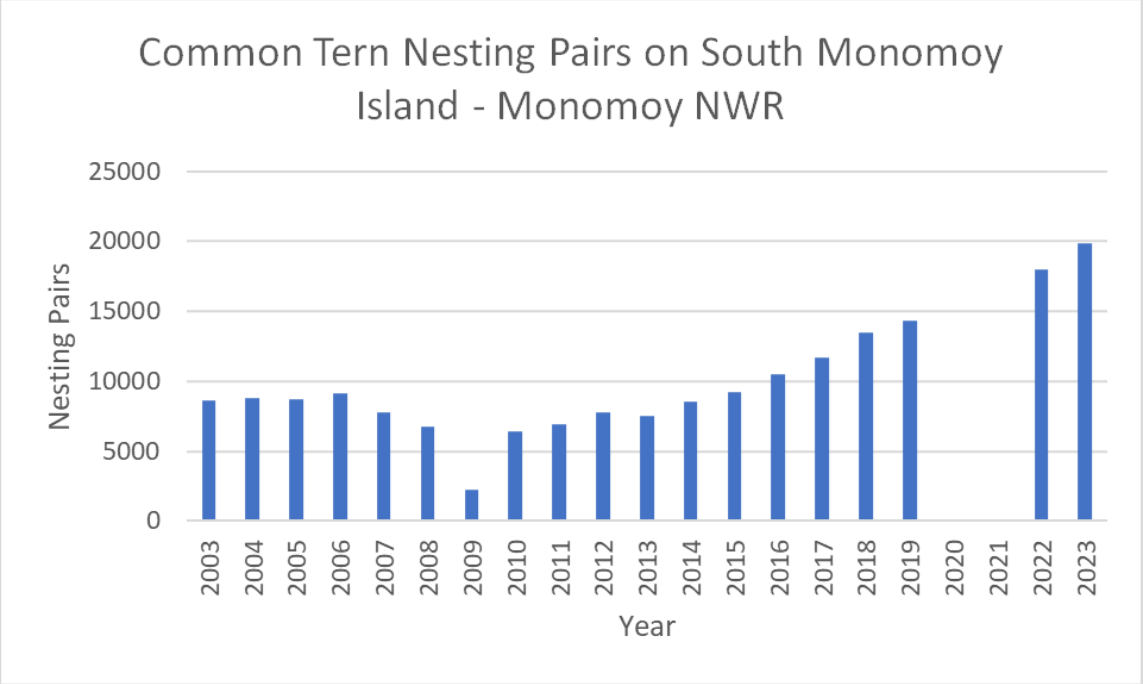
At Machias Seal Island (MSI), 2023 marked the 29th consecutive year of research and monitoring of the seabird community. We had an entirely new crew that included MSc student Tristan Sanford, who's project is focused on foraging ecology of Atlantic Puffins and Common Murres. Breeding success for all species (except Atlantic Puffin) was near our long-term averages; Atlantic Puffin breeding success was lower than average due to slow growth rates of chicks. Arctic Tern fledge success was not as high as 2022, mostly due to one problem gull that depredated many nests early in incubation. Alcid chick diet was mostly composed of sandlance (Razorbill and puffins), and butterfish and herring (Common Murres). There were no confirmed cases of HPAI at Machias Seal Island in 2023. We deployed 20 GLS tags on Razorbill adults in late June to further quantify annual movements, and continued deploying GPS on puffins and Common Murres to assess foraging locations during chick rearing.

Monitoring and Management of Monomoy NWR Tern Colony

Contact: Eileen McGourty, USFWS, Monomoy National Wildlife Refuge, Eileen_McGourty@fws.gov
Collaborators: Lyra Brennan, Jamie Infanti, Carolyn Mostello, MassWidllife; Don Wilda, APHIS.

Monomoy National Wildlife Refuge consists of several barrier islands the stretches for 8 miles off the elbow of Cape Cod including North Monomoy, South Monomoy, Minimoy and Morris Islands. Made up of sand dunes, large expanses of intertidal flats, saltmarsh and freshwater ponds, marshes, and open water, Monomoy supports large numbers of nesting and migrating shorebirds, colonial nesting seabirds, and wintering sea ducks. Due to its importance to migrating shorebirds and species of high conservation concern the refuge has been designated a Western Hemisphere Reserve Network site and an Important Bird Area. In addition, all North Monomoy and most of South Monomoy Islands have been designated as Wilderness and is managed as such. Today, the refuge is home to one of the largest common tern colonies in the world and one of a just a few sites to support roseate terns. Monitoring within the tern colony consists of productivity, chick provisioning, kleptoparasitism, predator presence, disease surveillance, and participation in fecal diet studies of adults and chicks.

In 2023, the refuge supported 19,875 nesting pairs of common terns and 46 pairs of nesting roseate terns with productivity of 1.17 fledglings per nest and 0.70 fledglings per pair respectively. Though we did not have mortality related to high path avian influenza, we did have a significant mortality event that affected common tern fledglings the last two weeks of June and was attributed to starvation. This event coincided with an increase in local sea surface temperatures which may have impacted prey availability for common terns. The main food source for common terns within the colony continues to be sand lance which comprised 77% of prey items provided to chicks this year. Sand lance are also consumed by laughing gulls which will steal prey items being brough into the colony by terns. This year laughing gulls attempted to steal prey items from terns an average of 13 times per hour and were successful in their attempts 57% of the time. Laughing gulls also take up nesting space and predate tern chicks. In 2023 we removed laughing gull nests from areas within the colony with high densities of both species to create more nesting space for terns and reduce impacts to tern productivity. Refuge staff removed all herring gull and greater black-backed gull nests from the tern colony. Predation continues to be a significant threat to tern productivity and in 2023 along with large gulls, black-crowned night herons were found feeding on eggs and chicks with the colony. Coyotes were also documented within the colony and animals were removed throughout the season. Rats were also documented within the colony for the first time and monitoring will continue next year to determine the impact of rats on tern productivity. The refuge plans to continue with habitat management, creating a mosaic of open and vegetated habitat through prescribed burning during the winter of 2024, to manually remove shrubs, and continue to map and control invasive species within the colony.



Number of nesting pairs counted on South Monomoy Island during census.

USFWS Staff-Monomoy NWR - Black-crowned night-heron in tern colony South Monomoy Island

Heather Williams/USFWS Staff-Monomoy NWR -
Roseate terns on South Monomoy Island

Waterbird Research on Poplar Island

Contact: Diann Prosser, USGS Eastern Ecological Science Center, dprosser@usgs.gov
Collaborators: USFWS; USACE; Maryland Environmental Service; Maryland DNR.

Our team continues to conduct a variety of research with colonially nesting waterbird species on Poplar Island, a beneficial dredge use project in the Chesapeake Bay. Our first umbrella of work includes efforts to understand reproductive success and breeding ecology at this site. We are currently working to develop multi-state models aimed at improving nest success estimates relative to more traditionally used proportional hazard models. Similarly, we have ongoing mark-recapture studies exploring fledge success and local movements within the Chesapeake Bay region. Efforts in the past year have identified a new staging location for Common Terns and a manuscript is in preparation. The second major umbrella of our work on focuses on exploring how management activities impact success of focal species. For instance, we compared the ability of overhead line (paired with limited targeted trapping), shooting, and broad scale trapping to reduce competition between nesting common terns and nesting herring gulls. Gulls appeared to adapt quickly to shooting efforts, limiting efficacy and resulting in no significant change in abundance from pre-treatment levels. However, gull use of both the colony and surrounding brush declined significantly following trapping and nest removal. Meanwhile, the number of gulls in the colony area declined from a pre-treatment average of 56 to only six,

following the erection of overhead lines. Although six gull nests were established within the treatment area (overhead lines), they were not replaced once the parents were trapped and nests destroyed. Meanwhile, tern nesting appeared to be unaffected by any of the implemented management activities. Full results from this effort can be found in our manuscript entitled "Managing conflict between nesting common terns and herring gulls" published in Wildlife Research URL: https://doi.org/10.1071/WR23021. We will continue exploring efficacy of management activities as opportunities and challenges arise.

The Re-Tern Project

Contact: Arielle Santos, Conservation Scientist, Seatuck Environmental Association, asantos@seatuck.org
Collaborators: Seatuck Environmental Association, Town of Babylon, and Town of Southold.

Seatuck's Re-Tern Project aims to safeguard and/or establish nesting habitat for least, common, and roseate terns in Long Island New York. Over the last 3 years we have accumulated historical and current Long Island Colonial Waterbird Survey datasets, surveyed tern colonies, and implemented a social attraction pilot study in the Great South Bay. Recently, we expanded our work into the North Fork of Long Island to get a better understanding of the habitat and population numbers of tern species there. We hope to build an island-wide coalition of partners to work to protect current nesting populations, conserve habitat, and in some cases create new suitable sites for the future in the face of increased human disturbance and sea level rise.

Florida Shorebird Alliance

Contact: Daniela Tabilo, Florida Fish and Wildlife Conservation Commission, daniela.tabilo@myfwc.com
Collaborators: Collette Lauzau, Florida Department of Environmental Protection; Megan Hatten, Chris Farrell, Audubon Florida; Andrea Pereyra, Niki Desjardin, Ecological Associates Inc.; Beth Forys, Eckerd College; Jennifer Winters, Jaymie Reneker, Volusia County; Private citizens and many more!

Florida's coastal areas are highly sought after for development and tourism because of their aesthetic and recreational value. Consequently, there is little pristine beach habitat remaining in the state, and even undeveloped areas are often disturbed and degraded to the detriment of beach-dependent birds. Realizing the value of a collaborative approach to statewide conservation, the Florida Shorebird Alliance (FSA) was created to coordinate conservation actions and expand collective knowledge and resources. This partner-driven monitoring and educational outreach program is crucial for progress toward species recovery goals and adaptively managing nesting sites. Partners follow a standardized monitoring protocol and enter data into a centralized data repository, the Florida Shorebird Database. The structure of the FSA facilitates programmatic learning, sharing lessons learned, tracking outcomes in response to actions, and adapting to ever-changing conditions and emerging issues. The success of the FSA highlights the value of standardized, long-term monitoring data collection for identifying research priorities, developing population estimates and recovery goals, and informing restoration strategies. The FSA is a fantastic example of the importance of a multi-pronged approach to conserving shorebird

populations in areas with increased human disturbance, predator abundance, catastrophic events, and even sometimes competing conservation interests.

Florida Fish and Wildlife Research Institute conducting surveys (photo: Karen Parker)

Signs used by FSA partners to protect least tern nesting colonies.

Roseate Tern monitoring and management at Great Gull Island, NY

Contact: Joan Walsh, Mass Audubon, jwalsh@massaudubon.org
Collaborators: Margaret Rubega, University of Connecticut; Peter Paton, University of Rhode Island; American Museum of Natural History; U.S. Fish & Wildlife Service.

Great Gull Island (GGI), a seabird nesting colony in Long Island Sound, has been owned and managed by AMNH since 1949. The program is transitioning leadership as the long-time director, Helen Hays, enters retirement.

Natural History Value: The restoration of the Common and Roseate Tern colony at GGI continues, and in 2023 set a record for the number of nesting federally endangered Roseate Terns. The island is currently the largest concentration of Roseates in the northwest Atlantic, with 2,062 nests, and hosts more than 11,000 Common Tern nests, making it the second largest Common Tern colony in the US.

Tern Conservation Planning: The team was tasked with developing the first conservation plan for GGI. The conservation plan needs to plan for coastal resiliency as sea level rises, and episodes of beach erosion, driven by increasing storm intensity, reducing nesting areas, threatening the long-term viability of GGI. More than 30 ecologists met for two facilitated multi-day planning session to develop the conservation plan, using the Conservation Standards process to set targets, identify threats and theories of change, and develop a plan forward.

Research and Conservation Activities (partial list)

Vegetation: We continued herbicide work to control invasives, spring and fall 2023.

Adult Survivorship Estimation: From 2006 to 2019 over 13,000 Roseate Tern chicks were banded with easy-to-read bands on Great Gull. By searching for these banded birds from blinds, we can determine the current age structure on the island to assess annual survival and recruitment rates. From 13 May to 30 July, we spent 628 observer hours reading bands. We observed 1,570 individual adult banded Roseate Terns in 2023.

Roseate Tern Nest Productivity: We banded 198 Roseate Tern chicks in 2023 to compare fledging rates of chicks from nest boxes to those from nests located in rocky habitats around the perimeter of the islands. We assessed fledging rates by searching for banded chicks capable of flight in areas away from their nest sites.

Common Tern Nest Productivity: To assess productivity of Common Terns, we monitored nesting success on 4 plots. There was considerable variation among the plots in fledging rates ranging from 95% to 50%, primarily due to chick loss from predation events soon after hatching.

Chick Provisioning Project: We monitor the frequency of feeding, and the type and size of prey at focal nests. During 2023 the diets of both Common and Roseate Tern chicks were restricted in breadth primarily to *Ammodytes sp.* This pattern shifted after July 6, and feeding rates were reduced, and the diet breadth of the Common Terns broadened. After that shift, Common Terns showed signs of starvation, and fledging rates were reduced. Roseate Terns maintained high fledging rates.

Fecal DNA: We collect fecal DNA samples from both species, and from young and adults during the season, to add precision to our understanding of the diet of terns.

Predation Shifts: During 2023 we noted a large uptick in predation by Great Black-backed Gulls on adult terns on GGI, a behavior we had only rarely noted in previous years.

HPAI: We sampled dead and moribund chicks and adults for HPAI (highly pathogenic avian influenza), and instituted additional sanitation measures to reduce the possible spread of the disease. No disease was detected at GGI.

Array of experimental Roseate Tern nest boxes. P. Paton.

Roseate Tern chick with easy-to-read yellow band. Joan Walsh.

Staff in protective gear to reduce transmission of HPAI. Joan Walsh.

Seabird Tracking

Using GLS, TDR, and GPS to Track Alcids on the Newfoundland and Labrador Shelf

Contact: Gail Davoren, University of Manitoba, Department of Biological Sciences, gail.davoren@umanitoba.ca
Collaborators: Emily Runnells, Matthew Legard, Kristina McOmber, Megan Dalton, University of Manitoba, Department of Biological Sciences.

The Davoren Lab continued their decadal scale research on seabirds and their prey on the east coast of Newfoundland. Recent work has focused on alcids breeding on James Island. Between 10-15 GLS loggers have been deployed on Atlantic Puffins and Razorbills each year starting in 2019, with 20 and 28 tags per species recovered to date, respectively. Tagged Razorbills traveled all the way from the Labrador Sea down to Cape Hatteras in some years, while a diversity of movement paths was evident among the puffins, including some that gathered in the Gulf of Maine (see Figure). In 2021-2022, 30 combination GLS and TDR loggers were deployed on

Razorbills, with 11 tags retrieved to date. These GLS and GLS-TDR datasets, combined with stable isotope analysis on multiple tissues (feather, eggshell membrane, blood), will be used by students to study isotopic niche overlap among species and carry over effects, along with time-activity budgets during key under-studied parts of the annual cycle (e.g., moult, pre-laying) and the effects of personality on foraging behavior, non-breeding distribution and reproductive success. During 2023, GPS-TDR loggers were simultaneously attached to chick-rearing Atlantic Puffins (n = 6) and Razorbills (n = 20) for short-term (1-5 day) deployments. These tracking data will be combined with long-term monitoring of spawning capelin biomass to assess whether inter-annual variation in prey biomass differentially influences the foraging effort and breeding success of these two species. As Atlantic Puffins provision chicks with a high proportion of sand lance, these tracking data will also be used to inform ongoing ship-based research on sand lance density and distributional patterns in coastal Newfoundland.

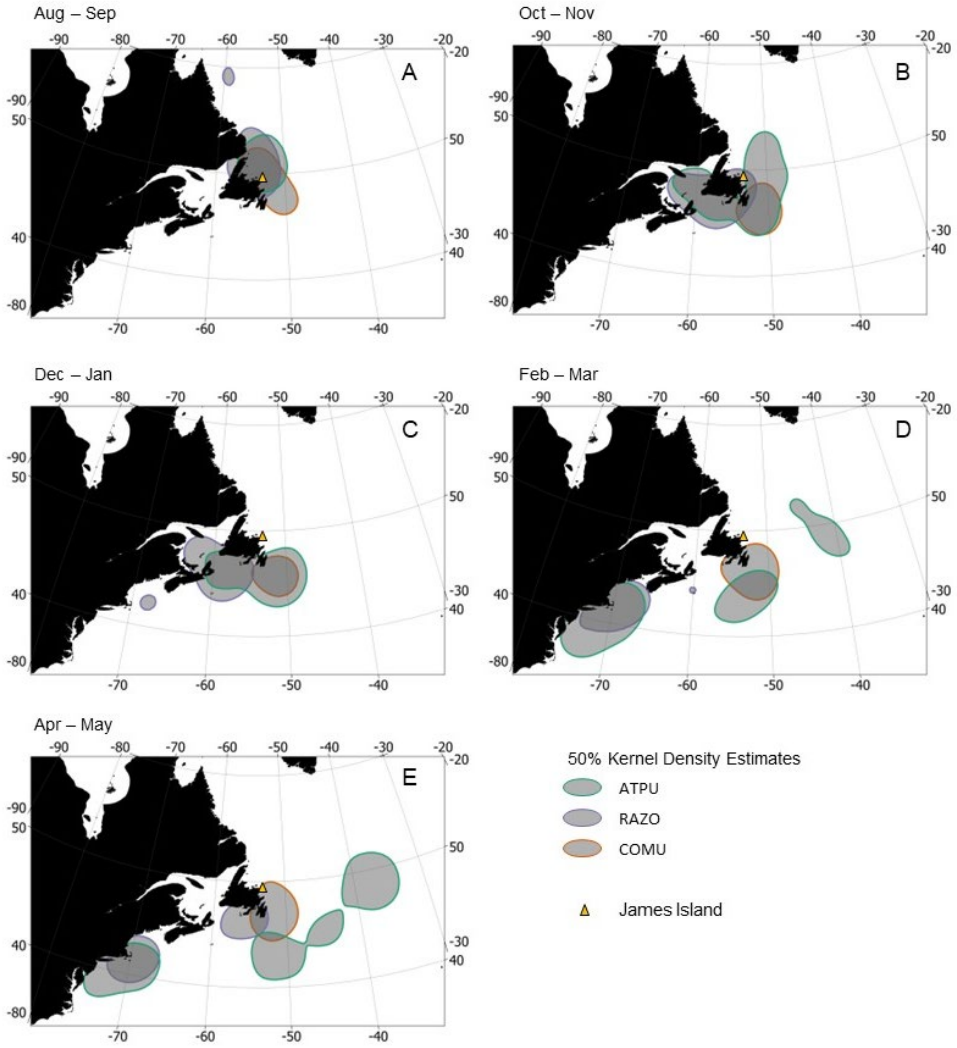


Figure: 50% Kernel density estimates during successive two-month periods of the non-breeding season for Atlantic puffins (ATPU), razorbills (RAZO), and common murres (COMU) from James Island, Newfoundland, Canada tracked with light-level geolocators. In August–September, there was some overlap of these core use areas among all three species in the waters off eastern Newfoundland (A), but this overlap generally decreased throughout the non-breeding season. Figure reproduced from data in Runnells et al., in revision at *Marine Ecology Progress Series*.

Using Tracking Technologies to Evaluate Overlap of Leach's Storm-petrel with Anthropogenic Threats in the Northwest Atlantic

Contact: April Hedd, Environment and Climate Change Canada, april.hedd@ec.gc.ca
Collaborators: Katharine Studholme, Joshua Cunningham, Laura McFarlane Tranquilla, Sabina Wilhelm, Rob Ronconi, Carina Gjerdrum, Jen Rock, Isabeau Pratte, Michelle Fitzsimmons, Neil Burgess, Environment and Climate Change Canada; Sydney Collins, Bill Montevecchi, Memorial University; Dave Shutler, Acadia University; Glenn Crossin, Manon Sorais, Dalhousie University; Bob Mauck, Kenyon College; Patty Jones, Bowdoin College; Amy-Lee Kouwenberg, Sue Abbott, Rielle Hoeg, Birds Canada; Vegard Sandøy Bråthen, Arnaud Tarroux, SEATRACK.

The Atlantic population of Leach's storm-petrel is in decline. The species has been listed as globally vulnerable since 2016 and the Atlantic population was assessed as threatened by the Committee on the Status of Endangered Wildlife in Canada in 2020. As Canada hosts >90% of the Atlantic breeding population of this species, Environment and Climate Change Canada is leading several studies to assess the potential drivers of these population declines. Of particular interest is improving our understanding of the nature and consequences of light attraction-based interactions with offshore industries in the northwest Atlantic. To assess regional habitat use and overlap with anthropogenic threats during both breeding and nonbreeding, we have deployed archival GPS (Pathtrack, GEO-mini) and light-based geolocation loggers (Migrate Technology, W30A9-SEA) at six major colonies in Atlantic Canada. In 2023, we completed data collection for this study with 262 incubating birds and 205 chick-rearing birds successfully tracked using GPS across 8 years (Figure 1), and 280 birds successfully tracked using GLS through the nonbreeding period across 5 years. Analysis of the GPS data is well underway, with behavioral states (transit, extensive search, intensive search) identified using Hidden Markov Models. Over the next year, these data will be used to develop species distribution models and continuous population maps (predicted density weighted by colony size) for use in assessing spatiotemporal exposure to multiple current and future threats. Geolocator data are being analyzed in partnership with SEATRACK and will initially be used to determine when and where these birds are using northwest Atlantic waters outside the breeding season. In addition, wet-dry data from these devices will be used to improve our understanding of breeding season behavior (foraging vs resting) and the vulnerability of this species to oiling. In future years, we will extend our threats assessment to the ocean-basin scale using the complete nonbreeding geolocator dataset, thus evaluating annual exposure. Preliminary results indicate that breeding birds from Newfoundland colonies primarily forage beyond the continental shelf break, while birds from Nova Scotia and New Brunswick routinely forage over the shelf. While the distribution of breeding birds from Witless Bay, Newfoundland, overlaps with oil and gas production platforms on the continental shelf, they do so primarily when transiting between the colony and their foraging grounds during the day when light attraction does not pose a threat. There is considerable overlap between foraging habitat and areas identified for future oil and gas development in Canadian waters, as well as overlap with potential wind development areas in both Canadian waters and the Gulf of Maine.

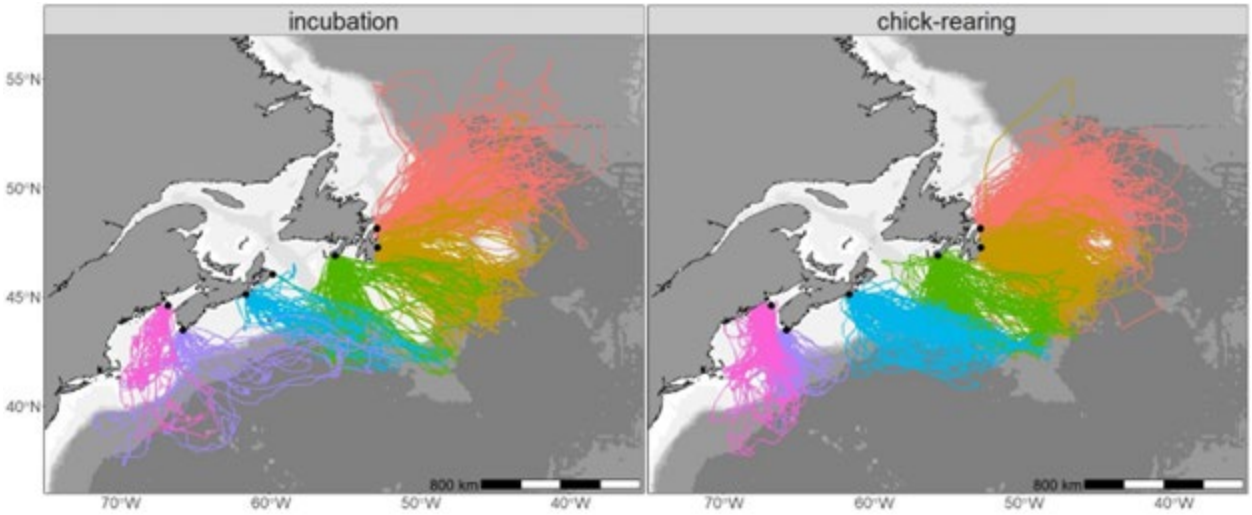


Figure 1. Foraging tracks from 467 Leach's storm-petrel breeding at six colonies in Atlantic Canada between 2016 and 2023. Birds were tracked either during incubation (n = 262) or during chick-rearing (n = 205) as foraging behavior varies by breeding stage.

Reducing Roseate Tern Winter Mortality at Power Distribution Lines in Galinhos, State of Rio Grande do Norte, Brazil

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This project is investigating the movement and collision risk of Roseate Terns (*Sterna dougallii*) along the northern coast of Brazil during the pre-migratory stage in late winter. From 2010-2019, researchers from Projeto Cetáceos da Costa Branca (PCCB, Costa Branca Cetacean Project), and the Universidade do Estado do Rio Grande do Norte (UERN, the University of the State of Rio Grande do Norte), discovered Roseate Terns and Common Terns (*Sterna hirundo*) were colliding with powerlines along the coast of Galinhos, Brazil, resulting in the mortality of over 100 Roseate Terns which is the highest known anthropogenic take of Roseate Terns. Since the initial discovery at Galinhos, it was found that collisions were occurring over a broader landscape in coastal Brazil, putting significant numbers of Roseate Terns at risks for powerline collisions. In addition to the threat of powerlines, offshore wind farms are currently being planned for development off the coast of Galinhos, thus increasing the potential collision risk. Roseate Terns also use offshore oil platforms for roosting during the non-breeding season, and the scale of this use, and the risk of oiling to this species, has not been evaluated.

For this project, we will be deploying GPS tags onto Roseate Terns in the Galinhos region of Brazil. Our main goal is to identify areas of the highest collision risk and gain a more complete picture to how these threats during the winter period are affecting the Northwest Atlantic population of Roseate Terns. The data gained in this project will be used to, identify potential hotspots for powerline collisions and direct powerline marking efforts to those sites; inform offshore wind developers where birds are concentrating offshore to avoid those areas for

development; and develop the most robust dataset on the winter ecology of Roseate Tern, which then can be used to further research and conservation efforts with partners in Brazil. We additionally aim to gain connectivity and migratory pathway data from the winter range to the breeding range as these individuals conduct northbound migration. This project will refine our perception of the threat landscape to Roseate Terns on their wintering grounds in Brazil by identifying offshore and onshore areas they use for foraging and roosting.

Figure 1. Study area to capture and tag Roseate Terns during the winter in Brazil.
Boxed region is the study area where we expect to gather winter movement data of Roseate Terns. The 'X' is the capture site at Galinhos, Brazil.

Habitat Use of Non-breeding Seabirds in the New York Bight

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Offshore wind energy development in North America is nascent but rapidly advancing, with plans to install thousands of offshore turbines along the Atlantic Coast of the United States in the coming decades. This ambitious development schedule has resulted in a need to rapidly acquire the baseline data needed to predict, measure, and minimize and/or offset ecological consequences of such development. This includes measuring distributions, movements, and habitat use of species of conservation concern, as well as developing protocols for monitoring the impacts of planned offshore wind energy installations on ecosystems and species. Seabirds occupy offshore waters year-round and depend on marine foraging habitats to ensure high adult survival, making them particularly vulnerable to the impacts of habitat alteration or loss resulting from offshore wind energy development. However, little is known about the habitat needs of

many seabird species during the non-breeding period, which is particularly crucial for long-lived seabird populations.

To fill key gaps in understanding by habitat use of non-breeding seabirds in wind lease areas, we are tracking Northern gannets (Morus bassanus) and great shearwaters (Ardenna gravis) in the New York Bight (NYB). These pelagic seabirds breed on remote islands in Atlantic Canada (gannets) and the southern Atlantic Ocean (shearwaters) and migrate to U.S. offshore waters during their non-breeding seasons to take advantage of productive foraging habitats. Gannets are known to be sensitive to displacement based on data collected from existing European wind farms. Prior tracking data suggests that New York Harbor is extremely important to wintering gannets, but these data were collected at relatively coarse spatial and temporal scales. Meanwhile, shearwaters are predicted to be at moderate to high risk of collision and displacement; however, since existing wind energy developments do not overlap with shearwater habitats, few observations are available to assess or validate vulnerability. No prior data are available on shearwater habitat use in the NYB, and studies from the Gulf of Maine show potential separation between non-breeding shearwater populations in this region and those in southern New England and mid-Atlantic waters. Given the imminent development of offshore wind in the NYB, little time remains for obtaining these key baseline data prior to construction.

To obtain data on habitat use by great shearwaters, we will capture shearwaters and gannets at-sea at the start of their respective non-breeding periods in 2023-2024, collect biological samples for sexing, physiology, and stable isotope analyses, and attach remote-downloading GPS transmitters. Transmitters will be attached using taped (gannets) or harnesses (shearwaters) and will collect GPS and accelerometry data at 10-minute intervals. We will use the resulting data to map habitat use and energetic expenditure, correlate local habitat use and diet with physical biomarkers, and simulate potential effects of wind energy buildout.

Credit: Carl LoBue

Foraging and Migratory Ecology of Breeding Terns and Gulls in the New York Bight

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Little is known about the movement ecology of breeding seabirds in offshore areas of the New York Bight. This is a particularly crucial data gap when evaluating potential effects of offshore wind energy development and establishing monitoring protocols. Compared to migratory or wintering individuals, breeding birds are more likely to experience detrimental effects of displacement due to offshore wind energy development, since they are tied to specific breeding sites and cannot readily shift to new locations if nearby foraging conditions become less optimal. Breeders rely on high-quality, readily-available prey within short distances of their breeding sites to successfully raise. Therefore, any changes that disturb the prey base or increase foraging distances could negatively affect both nestling survival and adult condition. Additionally, local breeders may be more likely to experience collision-related mortality or injury if they spend more time foraging among turbines than transient migrants.
To help fill these information gaps, we will use lightweight GPS transmitters to monitor the breeding season and annual cycle movements of three seabird species that breed in New York and occupy nearshore and offshore waters of Long Island Sound and the New York Bight: Common Terns (Sterna hirundo), Roseate Terns (Sterna dougallii), and Great Black-backed Gulls (Larus marinus). All three species are predicted to be at high risk of both collision and displacement resulting from the construction of offshore wind energy installations. Although they belong to the same family (Laridae), they differ in body size, prey specializations, and foraging behavior. We therefore expect these species to provide complementary information on habitat use, and tracking them simultaneously will allow us to We will deploy transmitters in 2024 and 2025 breeding seasons on Great Gull Island and use the resulting data to develop habitat use models, relate movements to diet and reproductive success observed at the colony, assess foraging habitat overlap and partitioning, identify hotspots of activity, and evaluate overlap with planned offshore wind energy development throughout the region.

Movements and Migratory Connectivity of Eastern Brown Pelicans (Pelecanus occidentalis carolinensis) Nesting in Virginia

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Over a decade of work on brown pelicans on the Gulf and Atlantic Coasts has provided valuable information on habitat use, prey associations, population patterns, and migratory routes of this species. Some gaps still remain, however, with limited data on pelicans breeding in the mid-Atlantic. We are continuing tracking work to fill these gaps, with additional tag deployments on

Virginia's Eastern shore. We deployed 7 transmitters in 2023, and plan a second round of deployments in 2024.

Credit: Zak Poulton

Dispersal, Range Expansion and Colonization by Seabirds

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Conventional understanding of migration cannot explain dramatic population expansions and instances of very long distance dispersal that have occurred in seabirds, including Northern Fulmars (*Fulmarus glacialis*), Laysan Albatrosses (*Phoebastria immutabilis*), Manx Shearwaters (*Puffinus puffinus*), Gentoo Penguins (*Pygoscelis papua*), Brown Boobies (*Sula leucogaster*), Elegant Terns (*Thalasseus elegans*) and several species of gulls including especially Lesser Black-backed Gulls (*Larus fuscus*). We propose that what is conventionally called "migration" can be better characterized as repeated instances of exploratory behavior. The similarity of or dissimilarity tracks followed year after year depends on the stability, or lack thereof, of the environment. Thus, what are often referred to as "vagrant" birds are actually not behaviorally different from other birds, nor have they made navigational mistakes, but they have encountered different conditions. These conditions may include density dependence from a growing population or scarcity of resources due to external factors. We tested these ideas by placing satellite-tracked ARGOS transmitters on 15 Lesser Black-backed Gulls of varying age classes at Nantucket, Massachusetts and asked whether their movement behavior was consistent with the process of exploration. We concluded that the rather erratic, back and forth action of these birds was consistent with our Hypothesis of exploration, and continued movement of the type we observed could lead to the dramatic expansion of their range that has been observed.

The Nunatsiavut Seabird Tracking Program: Understanding the Year-round Movements of Seabirds Breeding in Nunatsiavut Waters

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The waters of Nunatsiavut, NL support large numbers of breeding seabirds and provide an important food resource for Inuit beneficiaries. Eggs of gulls, Common Eiders and pigeons (Black Guillemot) are harvested at their colonies and pigeons and ducks are harvested in the fall. Many of these migratory marine bird species overwinter great distances from where they breed and face increased pressures from anthropogenic activities and climate change. To better understand the potential risks these birds face outside of Nunatsiavut waters, the Nunatsiavut Government and the Canadian Wildlife Service initiated the Nunatsiavut Seabird Tracking Program. The goal of the program is to examine year-round movements of seabirds breeding in Nunatsiavut and collect additional information to better understand their foraging ecology and potential relationships to food safety while providing the opportunity for shared learning. The team, composed of federal and Nunatsiavut Government employees, work together to develop projects that address shared interests, identify appropriate colonies, develop capture techniques and learn banding, sampling and tagging techniques. Since 2021, the team has deployed geolocator (GLS) tags on pigeons from two communities, solar-powered GPS-PTT tags on gulls (Herring, Great-black Backed, Glaucous) and GLS tags on Thick-billed Murres, with plans to deploy tags on Common Eiders in spring 2024. Tracking results to date reveal the fine-scale post-breeding movements of three species of gulls tagged off Nain, and the discovery that pigeons breeding at colonies offshore of Nain overwinter in the Gulf of St. Lawrence. These results highlight the need to consider how industrial development in offshore waters much farther south of Nunatsiavut may impact the health of marine bird populations upon which beneficiaries rely.

Forage Ecology, Diet & Prey

Multi-scale Relationships Between Marine Predators and Forage Fish

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Studying trophic relationships in the marine environment is particularly difficult due to the remote and variable natures of these ecosystems. Different tools are often needed to describe patterns in predators and prey. To better understand how prey availability influences predator behavior, distributions, and long-term trends, this study included: 1. Compiling digital aerial survey data of forage fish shoals in the Mid-Atlantic and New York Bight to understand the oceanographic factors that lead to forage fish shoals; 2. Using satellite telemetry data to describe the movements of Northern Gannets, Red-throated Loons, and Long-tailed Ducks and determine how forage fish availability influences movement behavior; 3. Combining aerial survey data for forage fish and seabirds to determine how shifts in forage fish distributions contribute to predator distributions; and 4. Quantifying decadal trends in forage fish distribution and predator distributions to determine how climate and other habitat changes have affected long-term trophic

relationships.The project finished in 2023 with two papers published and two more in the final stages of preparation. Chandra Goetsch published her work on forage fish community dynamics and their relationship to surface aggregations. We found that the factors influencing community composition and surface availability differed, with a particularly strong effect of stratification on surface availability. Julia Gulka published her paper comparing bird movements to forage fish distributions and areas of surface availability. Regions of freshwater input and high productivity influenced apparent foraging behavior in the seabird species, and these areas were often correlated with more coastal distributed forage fish and surface forage fish aggregations. We are working on two papers describing the importance of surface aggregations to the marine predator community (and interactions with the predator community) and another describing trends in forage fish and seabird distributional changes over the past 20 years. Both will be submitted in 2024. In these studies, we found a spatial correlation between forage fish aggregations and marine predators from digital aerial survey data. Using density modeling, we estimated that forage fish aggregations have strong relationships between both aerial (gulls and terns) and subsurface predators (fish and delphinids). These relationships varied across seasons, with the strongest correlations between forage fish distributions and predator abundance in the summer near freshwater inputs. Further, we assessed the annual trends in forage fish and seabird distributions from 2002–2019. Forage fish exhibited variable trends over the period, while seabirds mostly declined, with distribution shifts for both species groups across seasons. In total, these studies suggest complex relationships between marine predators and prey that must be accounted for when considering broadscale changes to the Northwest Atlantic.

Combining Bio-logging, Stable Isotopes and DNA Metabarcoding to Reveal the Foraging Ecology and Diet of the Endangered Bermuda Petrel, *Pterodroma cahow*

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The foraging range of central-place predators is limited by spatiotemporal and energetic constraints. Gadfly petrels Pterodroma spp. are seabirds well adapted to travel vast distances in oceans with sustained wind conditions, although our understanding of their foraging ecology in these heterogeneous and highly dynamic environments is still limited. We studied the foraging behaviour, habitat use, ecological niche and diet of the Endangered Bermuda petrel P. cahow, endemic to the western North Atlantic. We used GPS loggers to track foraging trips during incubation and early chick-rearing in 2019 and 2022, and employed DNA metabarcoding coupled with stable isotope analyses to reveal dietary habits. Our analyses showed that petrels travelled over a vast area of the western North Atlantic while foraging over deep, pelagic waters.

Specifically, in the early chick-rearing phase, they reduced their foraging range and time spent at sea compared to incubation. Foraging locations were associated with varying sets of environmental variables between breeding phases, including mesoscale oceanographic features, distance to the colony and wind speed. Petrels also showed narrow isotopic niches, and the ranges of δ15N and δ13C values suggested consistency in trophic habits. Finally, we found high taxonomic diversity in the diet, including exclusively meso-bathypelagic fishes and cephalopods. Our results contribute critical new knowledge on Bermuda petrel foraging-behaviour plasticity, a feature that can help predict how a small population of an endangered species may respond to climate-related changes in wind regimes and oceanic processes expected in the North Atlantic Ocean.

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From Presence/absence to Reliable Prey Proportions: A Field Test of Fecal Metabarcoding for Characterizing Seabird Diets

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Fecal metabarcoding is an increasingly popular method for studying the diets of birds and other taxa. While this approach can detect a wider range of prey than traditional methods, estimating prey proportions continues to be challenging. To test this in seabirds, we recorded the ID and length of fish provisioned to Common Tern chicks on the Isles of Shoals, NH, in 2017 – 2019 while also collecting fecal samples from chicks in the same colony for fecal metabarcoding. We used the popular MiFish primers to sequence a portion of the 12S gene from fecal samples and compared fish visual counts and biomass estimates to two common metabarcoding metrics: the frequency of occurrence (FOO) of prey species, which uses presence/absence, and the relative read abundance (RRA) of those species, which accounts for the relative number of recovered sequences. We found the lowest mean absolute error (MAE=0.06) and root mean squared error (RMSE=0.07) between the relative biomass consumed and RRA, showing that RRA is a surprisingly good metric for estimating prey proportions. RRA also outperformed FOO in detecting interannual changes in fish prey. Thus, RRA appears to be a suitable metric for estimating fish proportions in tern diets (and likely other seabirds) using fecal metabarcoding. To investigate the effect of fecal samples size on error rates, we simulated an annual monitoring protocol ranging from 10 – 40 samples per year and show that error rates reached a lower asymptote around 30-40 samples each year. Therefore, future studies of seabirds with similar levels of diet diversity should sequence 30 – 40 samples per colony/life stage and use RRA to estimate the proportions of prey consumed.

Fisheries Bycatch

Identifying Longline Vessel Related Fishing Tactics that Impact Seabird Bycatch Risk

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Western North Atlantic seabird bycatch in the U.S. pelagic longline fishery is a serious concern because of the diversity of seabird species and substantial number of species of special concern that frequent the area. The Pelagic Observer Program (POP) started in 1992 to monitor the Atlantic longline fishery bycatch including seabirds and other species of interest. Existing studies based on the POP data and a Bayesian spatial-temporal generalized linear model found that vessel ID is a significant factor in estimating seabird bycatch probability. In order to further understand the connection between vessel ID and seabird bycatch probability, this study compared the fishing tactics of vessels that do and do not have seabird bycatch. The objective of this study was probabilities to help reduce seabird bycatch by finding out the reason why vessel ID matters in seabird bycatch probability and to identify vessel related fishing tactics that might affect seabird bycatch. Because of the sample size issue, using a GLM or GAM did not find these fishing tactics significant. Instead, we compared the tactics differences between vessels that do and do not have a record of seabird bycatch using a series of Wilcoxon tests. In total 31 different tactics across four categories: effort, depth, lures, and miscellaneous, were compared in four different management regions. Two of the most heavily fished of these regions: the Gulf of Mexico (GOM) and the Mid Atlantic Bight (MAB), are fished by 63% of vessels. However, MAB has been found to frequently contain a hotspot of seabird bycatch while the GOM region did not. The data show that gear usage varies significantly between regions; for example, the GOM region has a higher mean set depth than other regions. Additionally, region-specific analysis showed all but 2 of 31 tactics had significant differences in use between bird and non-bird boats. Of all tactics tested, the gears that were the most consistently different and with the clearest trend between bird and non-bird boats across sites were hook density, light sticks and surf lights. Boats in regions with high bycatch rates had a much higher average hook density. The light stick and surf light results both showed that bird boats on average have significantly lower light stick and surf light densities. This finding is contradictory with most previous research, in which lights are correlated with increased bycatch and considered to act as a lure. The relationship of light sticks and seabird bycatch warrants further investigation. Some gears showed weaker trends, such as bird boats having shallower set depth, higher float density and lower density of added weight per mile of line, but the difference was only significant in one or two of the regions. Most of the remaining gears were not consistent in how they differed among the sites.

Table 1: Sample sizes for each region with a record of seabird bycatch. Bird boats are vessels that have caught at least 1 bird. Bird hauls are the number of hauls that included at least 1 bird.

AREA CODE	**BOATS**		**HAULS**		
	All Boats	Bird Boats	All Hauls	Bird Boat Hauls	Bird Hauls
MAB	103	26	3934	284	58
NEC	55	9	1438	75	17
GOM	142	8	9725	67	11
SAB	97	8	2605	51	10
NED	19	3	933	42	4
TUN	6	1	273	6	1
Totals	278	49	22367	527	101

Total Additional Weight Density		0.19 ± 0.82 0.09 ± 0.81	0 ± 0 0.05 ± 0.39	0.10 ± 0.20 0.23 ± 0.42
Number of Hooks Set	670.1 ± 231 645.8 ± 257.8	868.7 ± 202.6 871.2 ± 229.8	682.3±294.2704.5±305.7	800.1±216.0 728.2±204.8
Number of Hooks	636.3 ± 230.8 655.6 ± 231.9	861.7 ± 164.4 875.1 ± 182.7	684.6±291.0 704.5±296.0	803.8±208.0 736.3±187.1
Hook Density	63.0 ± 369.3 41.2 ± 26.7	36.6 ± 14.12 35.9 ± 21.8	34.7 ± 6.37 34.0 ± 19.6	27.6 ± 5.96 27.0 ± 15.9
Mainline Diameter (mm)	3.16 ± 0.223 3.17 ± 0.25	3.30 ± 0.177 3.26 ± 0.189	3.16 ± 0.11 3.21 ± 0.33	3.56 ± 0.23 3.49 ± 0.38

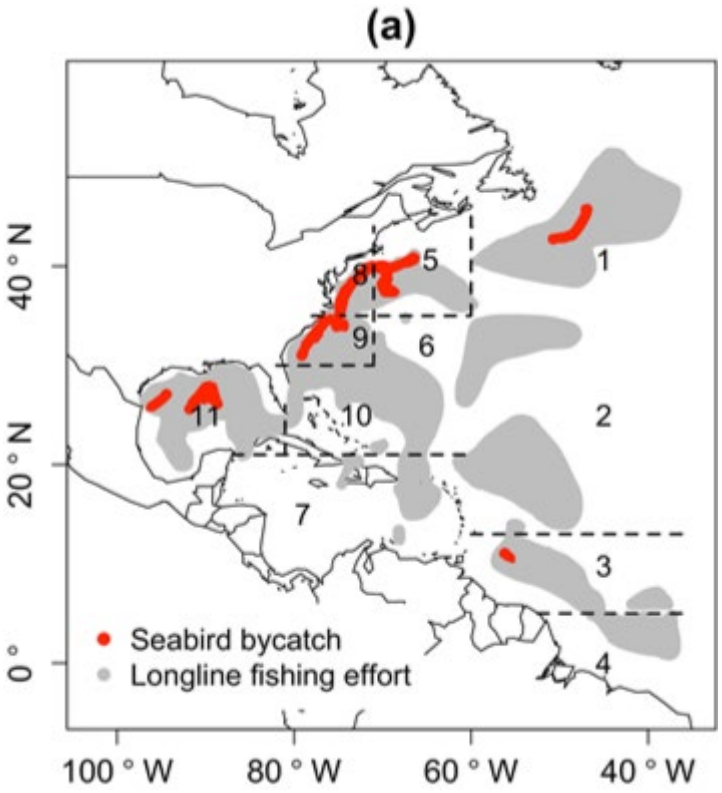

Figure 1: Map of U.S. Pelagic Longline effort (gray shading) with general areas of previous seabird bycatch (red shading). Numbers relate to POP NMFS-designated PLL effort areas as follows: 1 = NED, 2 = NCA, 3 = TUN, 4= TUS, 5 = NEC, 6 = SAR, 7 = CAR, 8 = MAB, 9 = SAB, 10 = FEC, 11 = GOM.

Disease & Mortality

HPAI-linked Mortalities in Eastern Canada: A Quiet year (2023) Follows a Year of Mass Mortalities (2022), but Population-level Impacts are Evident

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In early 2022, Highly Pathogenic Avian Influenza (HPAI - H5N1) emerged as an important wildlife disease in North America, causing unprecedented mass mortality events in domestic and wild birds. The incursion and transmission of the HPAI - H5N1 subtype were especially lethal on seabird breeding colonies in the northern hemisphere. To understand the potential population- and/or species-level effects of the virus during the last two years, it has been necessary to accurately document, quantify and model mortalities in affected species.

In eastern Canada between April and October 2022 (i.e., seabird and sea ducks breeding season), Environment and Climate Change Canada ~48,000 sick or dead migratory birds were reported, including tens of thousands of Northern Gannets, several thousand Common Murres, and several thousand American Common Eiders and gulls. Considering population sizes and trends, we expect that mortality in Northern Gannets and American Common Eiders has had population-level impacts.

During the 2023 breeding season, in anticipation of another mass mortality event, all six Northern Gannet colonies were surveyed, and key beaches were monitored for mortalities following standard Beacehd Bird Survey methods. In addition, disease surveillance efforts were increased. Contrary to expectations, no mass mortality has been reported during the 2023 breeding season, and the HPAI disease surveillance efforts have yielded minimal positive detections.

Using iNaturalist to Understand Marine Bird Mortality

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A collaborative research project, as reported in the December 2023 issue of the Bird Observer, delves into using the iNaturalist platform to comprehend marine bird mortality. The initiative unites ornithologists across North America with diverse objectives, including understanding species-specific mortality trends, investigating the impact of marine debris and fisheries bycatch on marine birds, and estimating mortality during mass mortality events. This undertaking transcends geographical boundaries and research niches to address common concerns.

The project, initiated by the Atlantic Marine Bird Cooperative (AMBC) in November 2022, leverages iNaturalist's vast user base, long-term data collection, and simplicity to aggregate baseline mortality data and study marine bird threats. The "Beached Birds" project filters the iNaturalist database for observations of dead birds within one kilometre of the shoreline, encompassing various avian taxa (Figure 1). Users can upload photos using the mobile app, enabling real-time tracking of bird die-offs. The iNaturalist Beached Bird project holds the

potential to monitor bird mortality during disease outbreaks, aiding wildlife health professionals in responding to unusual events and assisting in specimen collection for testing.

During the October 2023 AMBC meeting, Environment and Climate Change Canada (ECCC) researchers presented an analysis of the project. They reported 469 dead birds in the AMBC region, predominantly in the South Atlantic, Atlantic Canada, New Brunswick, and Nova Scotia. Notable species included the Northern Gannet, Common Loons, and various seabirds. The project also contributed to ECCC's dataset of over 40,000 wild birds during the highly pathogenic avian influenza (HPAI) outbreak in Eastern Canada from April to September 2022, with an initial capture of 100 observations. However, they found there is a significant hurdle to overcome as users often fail to annotate observations as "dead" when uploading via mobile phones, necessitating manual review for data accuracy. To enhance the viability of the iNaturalist Beached Bird project as a tool for understanding seabird mortality, project members will pursue revisions to the app, user training and recruiting volunteers to edit historical records. An instructional PDF has been developed (Figure 2): https://atlanticmarinebirds.org/downloads/iNat_How_to_report_dead_birds_properly_english_CAN_USA_Nov2023.pdf

The future of the "Beached Birds" project holds potential, as an evolving citizen science initiative for monitoring marine bird health, disease, and survival. Existing iNaturalist users can contribute by providing annotations, verifying species, and marking photos showing evidence of marine debris. Active participation offers an opportunity to contribute to ongoing research conducted by AMBC's Community Science & Marine Bird Health working group.

Figure 1. Northern Gannets on a beach in northern New Brunswick, reported by iNaturalist user @lewnannyichardson

iNaturalist

Your reported observations can support a better understanding of wild bird mortality!

ANNOTATING BIRDS AS 'DEAD' IN iNATURALIST HELPS!

An animal pandemic caused by the Highly Pathogenic Avian Influenza (HPAI) virus is underway. Tens of thousands if not millions of wild birds have died worldwide, but the true number is unknown. If you annotate your iNaturalist observations of dead birds as DEAD in the web browser, these records will automatically be captured in iNaturalist projects that have been set up to support our understanding of wild bird mortality (E.g., here[1]). This complements formal reporting channels that exist in Canada[2], the USA[3] and elsewhere.

HOW TO ENSURE YOUR OBSERVATION GETS INCLUDED:

STEP ONE

If you find a dead bird, proceed with recording the observation in the iNaturalist app as normal. The observation **must include a photo.**

STEP TWO

Using the **WEB BROWSER** version of iNaturalist, annotate the observation as **'DEAD'.**
See next page for step-by-step instructions.

1. https://www.inaturalist.org/projects/beached-birds
2. https://www.canada.ca/en/environment-climate-change/services/migratory-game-bird-hunting/avian-influenza-wild-birds.html#toc2
3. https://www.aphis.usda.gov/publications/animal_health/fs-hpai-dead-wild-bird.508.pdf

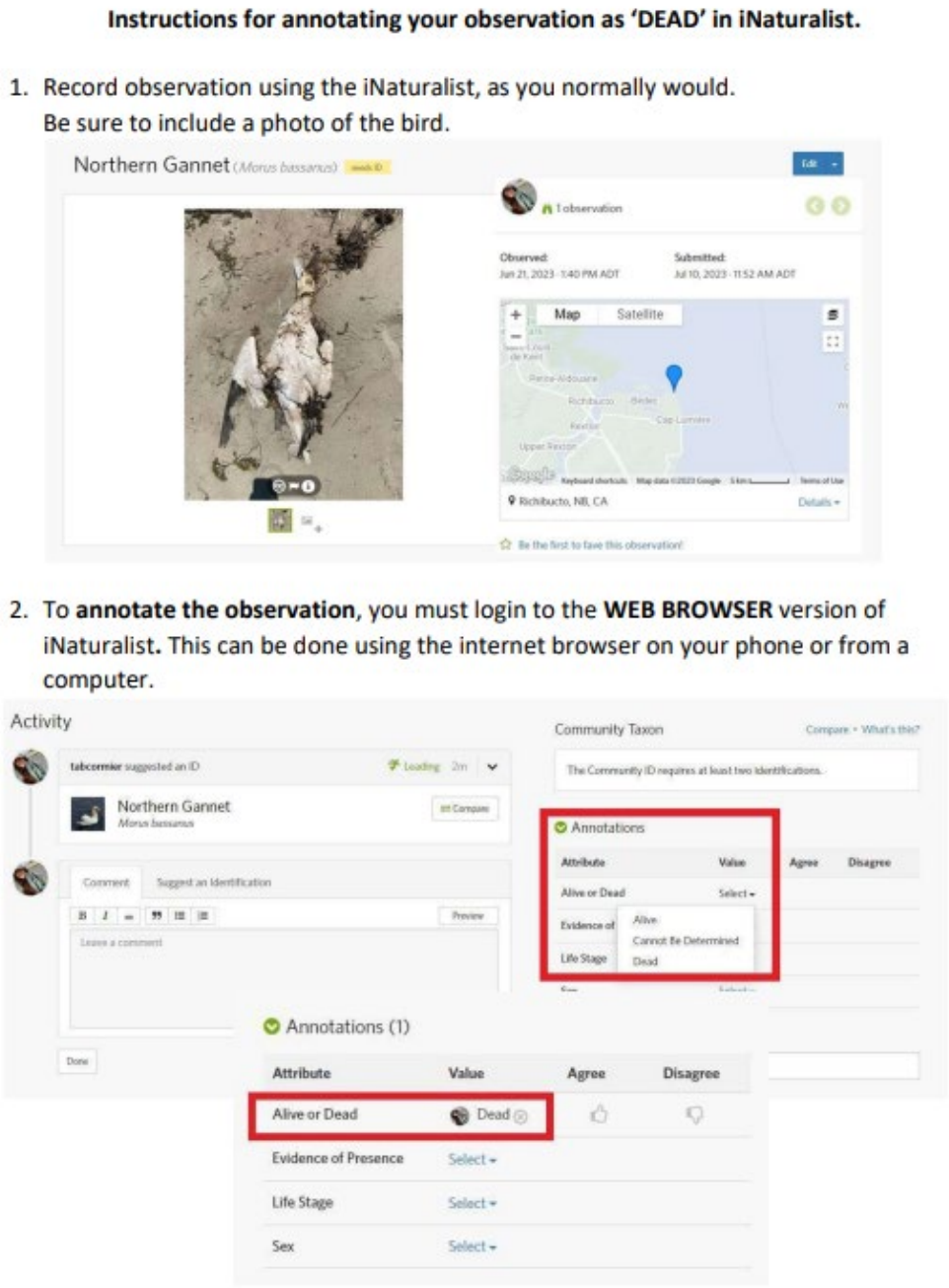

Figure 2. Instructions on how to properly report dead birds as dead in iNaturalist.

Year 1 after the 2022 Highly Pathogenic Avian Influenza (HPAI) Outbreak in Eastern Canada: Assessing Population Impacts on Seabirds Breeding in Atlantic Canada

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The Highly Pathogenic Avian Influenza (HPAI) virus H5N1 is causing unprecedented mortality of wild birds around the world. In eastern Canada, during the summer of 2022, it was minimally estimated that over 40,000 wild birds were reported sick or dead, attributed to HPAI. Most mortalities were observed in seabirds, with the highest numbers reported in Northern Gannet (Morus bassanus) and Common Murre (Uria aalge), and lower mortality levels in large gulls (Herring (Larus argentatus), Great Black-backed (L. marinus), and Ring-billed Gull (L. delawarensis)), Double-crested Cormorant (Phalacrocorax auratus), Atlantic Puffin (Fratercula arctica), and Black-legged Kittiwake (Rissa tridactyla). Monitoring the breeding colonies of impacted species in 2023 was deemed a priority to detect any evidence of continued mortality associated with HPAI and evaluate population changes to understand impacts of the 2022 outbreak. Despite high search effort, there was no evidence of HPAI persisting in colonies in 2023, allowing us to clearly assess the impacts of the 2022 outbreak. In Atlantic Canada, we updated the population trends for all three Newfoundland Northern Gannet colonies (Cape St. Mary's, Funk, and Baccalieu Islands), two regionally important Common Murre colonies in Newfoundland (Funk and South Cabot Islands), a regionally significant Herring Gull and Black-legged Kittiwake colony in insular Newfoundland (Gull Island, Witless Bay), all large gull and Double-crested Cormorant colonies in New Brunswick bordering the Gulf of St. Lawrence, and the region's second largest Atlantic Puffin colony in insular Newfoundland (Gull Island, Witless Bay). Results confirmed that the 2022 outbreak reduced the breeding population of Northern Gannets by -50% at Cape St. Mary's and Funk Island and reduced the Common Murre breeding population minimally by -10% at Funk Island and South Cabot Island. Significant population declines were also observed on the Herring and Great Black-backed Gull population breeding on New Brunswick's coastline (-54% and -66%, respectively) but not the colony monitored in insular Newfoundland. Double-crested cormorants breeding in New Brunswick also suffered population-level declines, upward of -70%. Finally, although HPAI was responsible for mortalities observed in Ring-billed Gulls, Atlantic Puffins and Black-legged Kittiwakes, these did not result in population level impacts at colonies monitored in 2023. These findings point to the importance of ongoing population monitoring at colonies where impact was observed to document future recovery.

Marine Debris & Pollution

PFAS Bioaccumulation in Coastal Seabirds from Charleston, SC

Contacts: Patrick Jodice, U.S. Geological Survey South Carolina Cooperative Fish and Wildlife Research Unit, pjodice@g.clemson.edu & Juliet Lamb, The Nature Conservancy, juliet.lamb@tnc.org
Collaborators: Anna Robuck, EPA; Rainer Lohmann, University of Rhode Island, South Carolina Department of Natural Resources.

Per-and polyfluoroalkyl substances (PFAS) are anthropogenic pollutants that are ubiquitous in human and natural environments, highly persistent, and associated with impacts at low levels of exposure in humans. PFAS are released into the environment via a number of pathways, including use and disposal of consumer products, manufacturing activities, and application of aqueous film forming foams (AFFF). Ecological risk assessment and site remediation is stymied by poor understanding of bioaccumulation and biomagnification of AFFF-derived PFAS in higher trophic level organisms like predatory avifauna. The poor understanding of these pathways and relationships is problematic considering avifauna, including seabirds, have been documented to contain elevated levels of PFOS and other PFAS, with limited data suggesting potential impacts on hormone disruption, lipid expression, and reproduction at current exposure levels.

In 2024, we will begin an investigation of the bioaccumulation and biomagnification of a wide range of PFAS in seabirds that rely on environments and food webs downstream from Joint Base Charleston within the Charleston, SC region, using a unique combination of a field sampling campaign paired with biologging efforts, coupled to analysis of targeted terminal PFAS, environmental precursors, EOF, and stable isotopes. We will study three seabird species with unique life history and foraging preferences (American Oystercatchers, Black Skimmers, and Brown Pelicans), reflecting unique but intertwined food webs across the estuarine continuum. A comprehensive field effort leveraging collaborative partnerships to sample environmental media (air, water, sediment) and prey food will be paired with spatial tracking efforts and biological sampling of adult seabirds, chicks, and eggs, to provide novel information about the bioaccumulation of PFAS in estuarine and marine avifauna.

Brown Pelican PFAS Assessment

Contact: Lindsay Addison, Audubon North Carolina, laddison@audubon.org
Collaborators: Amanda Williard, UNC-Wilmington; Natalie Karouna-Renier, USGS Eastern Ecological Science Center at Patuxent Research Refuge.

The Cape Fear River was the site of PFAS pollution by the DuPoint/Chemours factory in Fayetteville from the 1980s to the present day. Direct discharges into the Cape Fear River were only discovered and halted in 2017, and the impacts of these substances on waterbirds in North Carolina has not been previously studied. PFAS have been linked to a variety of health impacts. In 2023, we took blood samples from Brown Pelican chicks raised on the Cape Fear River and in the Pamlico Sound (presumed to be a less impacted waterbody). These samples will be analyzed for PFAS concentration and immune system function.

Offshore Wind Development – Assessment, Guidance & Planning

Avian Risk Assessment to Support New York's Offshore Wind Master Plan 2.0: Deep Water

Contact: Holly Goyert, Biodiversity Research Institute, holly.goyert@briwildlife.org
Collaborators: Andrew Gilbert, Sarah Dodgin, Dustin Meattey, Julia Gulka, Rich Brereton, Rebecca Stanley, Iain Stenhouse, Wing Goodale, Biodiversity Research Institute

The New York State Offshore Master Plan 2.0 Deep Water informs the development of offshore wind energy in regional waters greater than 60 m deep. One of five environmental studies, the avian risk assessment compiled existing data on bird species that may be sensitive to offshore wind development. As part of this study, we derived the exposure and vulnerability of birds to different phases of offshore wind development in the Area of Analysis (AoA). Calculations from Version 2 of the Marine-Life Data and Analysis Team (MDAT) models generated exposure scores for 47 marine bird species that use the Atlantic Outer Continental Shelf. Collision, displacement, and population vulnerability scores scaled risk up or down based on life history traits such as bird flight heights, attraction, and avoidance of offshore wind energy facilities. The spatial risk assessment combined scores across species and seasons to produce an overall risk map. Tracking data filled many data gaps, including areas of uncertainty corresponding to lack of boat-based or aerial survey effort. The findings suggest that the AoA is beyond the range of many breeding terrestrial and coastal bird species but is frequented by several species of offshore migrants and pelagics, including some listed as threatened or endangered. Further monitoring could address knowledge gaps and evaluate the most appropriate mitigation of impacts from stressors on birds within the region.

Transparent Modeling of Collision Risk for Three Federally-listed Bird Species in Relation to Offshore Wind Energy Development

Contact: Pam Loring, USFWS Migratory Birds, pamela_loring@fws.gov
Collaborators: David Bigger, BOEM; Evan Adams, Andrew Gilbert, and Kate Williams, Biodiversity Research Institute

Collision risk models are often used to estimate risk of avian collisions with offshore wind turbines. Such models typically use avian density data derived from observational survey datasets along with a suite of behavioral and site-specific variables that are thought to predict collision risk. However, very limited survey data are available for the Roseate Tern, Piping Plover, and Red Knot, three species of conservation interest that could interact with offshore wind energy development in the Northeastern Continental Shelf Ecosystem (NES). With funding from the Bureau of Ocean Energy Management, the U.S. Fish and Wildlife Service and Biodiversity Research Institute adapted existing stochastic collision risk models to use individual tracking data from the Motus Wildlife Tracking System for these three species of conservation interest. An online web application of the model, called Stochastic Collision Risk Assessment for Movement (SCRAM), accompanying user manual, and BOEM report are available at

https://briwildlife.org/scram/. The report documents the current published model, presents several case studies for its use in evaluating collision risk of Roseate Tern, Piping Plover, and Red Knot at offshore wind energy areas in the NES, and includes a preliminary framework for estimating cumulative collision risk across spatiotemporal scales. SCRAM updates are continuing through at least 2024 to add additional data and make updates to the model.

Assessment of Technologies for Monitoring Birds and Marine Mammals at Offshore Wind Farms

Contact: Kate Williams, Biodiversity Research Institute, kate.williams@briwildlife.org
Collaborators: Julia Stepanuk, Biodiversity Research Institute; Sarah Courbis, Aude Pacini, Heidi Etter, Fabiola Campoblanco, Megan McManus, Advisian Worley Group

It can be difficult to study the effects of offshore wind energy development on wildlife in a statistically robust way that meaningfully informs mitigation and adaptive management. Current monitoring technologies are often limited in their ability to collect the necessary types and amount of data required, and furthermore are seldom well-integrated into offshore wind infrastructure and operational procedures, which can limit their effectiveness and increase costs. The U.S. National Offshore Wind Research & Development (R&D) Consortium funded an assessment of current bird and marine mammal monitoring technologies' ability to 1) answer priority research/monitoring questions, 2) produce statistically robust data to inform meaningful adaptive management, and 3) integrate into normal equipment and operations for fixed and floating offshore wind energy development.
This assessment was built, in part, from existing databases of monitoring technologies, as well as a series of workshops in 2022-2023 with experts in bird and marine mammal research, wildlife monitoring technologies, and offshore wind energy. Expert stakeholders identified a variety of research and development opportunities to deploy technologies on different platforms, improve remote data access, and standardize the external resources needed by wildlife monitoring technologies (e.g., power, data transfer, physical space, etc.). Experts indicated that capacity designated for wildlife monitoring systems in turbine designs would greatly facilitate the ability of offshore wind developers to meet environmental monitoring requirements, which are typically finalized later in the development process than other aspects of wind farm design. It was also suggested that the development of clear government requirements for data sharing protocols, standards, or platforms could help to drive collaboration and innovation. Recommended R&D for tags and other animal-borne sensors focused on increasing sensor reliability and accuracy, further miniaturization of tags and improved battery life relative to tag size, improved attachment methods, and increasing remote download capabilities. More generally, experts noted the potential value of integrating a range of monitoring technologies that provide data of differing types or at complementary scales.

Ultimately, a combination of focused R&D, cross-sector coordination and streamlining, and acceleration of development and testing timelines were recommended to improve monitoring technologies. Continued discussions among multidisciplinary teams of offshore wind energy engineers, technology developers, wildlife biologists, regulators, operations and maintenance specialists, and other experts will be needed to ensure that wildlife monitoring technologies are developed that 1) better meet conservation and regulatory needs, and 2) can be more safely and

effectively integrated into OSW development and operations. Project reports and databases are available at https://nationaloffshorewind.org/projects/technology-development-priorities-for-scientifically-robust-and-operationally-compatible-wildlife-monitoring-and-adaptive-management/

Developing Guidance for Pre- and Post-Construction Monitoring to Detect Changes in Marine Bird Distributions and Habitat Use Related to Offshore Wind Development

Contact: Kate Williams, Biodiversity Research Institute, kate.williams@briwildlife.org
Collaborators: Julia Gulka, Iain Stenhouse, Holly Goyert, Biodiversity Research Institute; Kate McClellan Press, NYSERDA; Caleb Spiegel, USFWS; Tim White, BOEM

Offshore wind development is rapidly increasing in the U.S. Atlantic, bringing with it a range of potential effects to birds that use the marine environment. To ensure site-specific monitoring efforts are well-designed to answer research questions and reduce uncertainty surrounding potential effects of development on marine birds, a committee of subject matter experts (under the auspices of NYSERDA's Offshore Wind Environmental Technical Working Group) have developed guidance for conducting studies of macro- to meso-scale changes in bird distributions and habitat use at offshore wind facilities. The committee is chaired by representatives of U.S. federal regulatory agencies and includes experts from the U.S., Canada, and the UK.

This effort is intended to support (1) the generation of scientifically robust data from site-specific monitoring of individual wind facilities, and (2) the use of consistently collected site-level data to better understand potential cumulative effects of displacement across offshore wind projects. The guidance document was developed via a combination of review of existing guidance, literature review of existing studies from Europe, expert elicitation, and stakeholder engagement. It identifies key research questions regarding displacement, attraction, and macro-to meso-scale avoidance, and provides an overall process for the selection of research questions, focal taxa, and data collection methods. This includes guidance on the strengths and limitations of different study methods, and on designing studies to ensure adequate statistical power to detect effects. The guidance also includes specific recommendations for study design and data collection using observational surveys (e.g., digital aerial and boat-based surveys), including recommendations on the use of Before-After Gradient (BAG) designs, study area size, percent coverage of the study area during surveys, specific field and analytical methods, and other considerations. Finally, the effort includes recommendations on data consistency and transparency to ensure that the results of site-specific pre- and post-construction monitoring studies are available to inform meta-analyses, cumulative impact assessments, and other large-scale assessments of offshore wind effects on marine bird populations.

The recommendations derived from this effort are intended to be used by government and regulatory agencies, offshore wind developers and their consultants, and other stakeholders, to improve the quality of site-specific research and monitoring efforts, and improve our understanding of displacement, attraction, and avoidance effects to marine birds from offshore wind development. The final guidance is expected to be released in January 2024 and will be posted at www.nyetwg.com/avian-displacement-guidance.

Guidance for Regional Research and Monitoring of Offshore Wind Energy and Wildlife in the Eastern United States

Contact: Kate Williams, Biodiversity Research Institute, kate.williams@briwildlife.org
Collaborators: Julia Gulka, Biodiversity Research Institute; Kate McClellan Press, NYSERDA

An expert workgroup under the purview of the Environmental Technical Working Group (E-TWG) developed guidance for regional research and monitoring of offshore wind energy and wildlife in the eastern United States to inform study plans and the allocation of funding for regional research and monitoring. The workgroup developed two products, which were released in 2023:

- *Responsible Practices for Regional Wildlife Monitoring and Research in Relation to Offshore Wind Development.* This written guidance focuses on recommendations for regional research and includes definitions of common terminology to support regional communications, suggested criteria for prioritization of regional research topics, and general recommendations on study design and data transparency for regional-scale research efforts.
- *U.S. Atlantic Offshore Wind Environmental Research Recommendations Database.* This database compiles and synthesizes existing data gaps and research needs identified from existing sources (e.g., State of the Science Workgroups, federal and state agency efforts, previous E-TWG Specialist Committees) so that researchers and funders can easily access, sort, and prioritize topics. The database specifies focal taxa, spatial scale, and other information relating to each priority research topic.

Potential end users of these products include states and other government entities who are funding regional research in the next 1-3 years; offshore wind developers who are funding regional research and monitoring efforts; and Regional Wildlife Science Collaborative (RWSC) subcommittee processes. The regional synthesis workgroup included representatives from 18 organizations, listed on the workgroup webpage at www.nyetwg.com/regional-synthesis-workgroup. Technical support for the workgroup was provided by the Biodiversity Research Institute and the Synthesis of Environmental Effects Research (SEER) team at Pacific Northwest National Lab and the National Renewable Energy Lab. For more information about E-TWG activities and to sign up for the e-mail listserv, visit www.nyetwg.com.

Wildlife and Offshore Wind (WOW): A Systems Approach to Research and Risk Assessment for Offshore Wind Development

Contact: Kate Williams, Biodiversity Research Institute, kate.williams@briwildlife.org
Collaborators: Evan Adams, Julia Gulka, Biodiversity Research Institute; Lesley Thorne, Stony Brook University; Pamela Loring, USFWS; Doug Gobeille, Erik Carlson, University of Rhode Island

The U.S. Department of Energy and Bureau of Energy Management funded Project WOW in 2022. WOW is a five-year study focused on gathering data on the effects of the first commercial-

scale offshore wind energy developments in the U.S. on marine mammals, birds, and bats. Duke University leads the WOW team, a research consortium of more than 15 institutions with expertise in statistical and ecological modeling, geospatial data analysis, marine megafauna research, avian and bat ecology, bioacoustics and behavioral ecology, biological oceanography, and technology development. Avian study components are a collaborative effort among the Biodiversity Research Institute, Stony Brook University, USFWS, and University of Rhode Island. The avian research components of this project include GPS/GSM telemetry of Great Black-backed Gulls and Northern Gannets, the compilation of existing at-sea survey datasets to conduct regionwide integrated modeling in the MA/RI to NY region, and the further development of automated radio telemetry technologies (e.g., Motus) and processes for offshore deployments. To date, 16 and 15 tags have been deployed on Great Black-backed Gulls and Northern Gannets, respectively.

Multi-topic & Other

Least Tern Thermal Biology

Contact: Ray Danner, UNC Wilmington, dannerr@uncw.edu
Collaborator: Juan Zuluaga, UNC Wilmington

In 2023, PhD student Juan Zuluaga (PhD expected fall 2024) and Dr. Ray Danner in the Department of Biology and Marine Biology at UNC Wilmington and the Pine Knoll Shores Aquarium studied the thermal biology of Least Terns. Studies involved measuring energy use and evaporative water loss through respirometry, heat flux using thermal imaging cameras, and behavioral thermoregulation. Research took place at Pine Knoll Shores Aquarium.

Biology, Ecology, and Mortality of Loons (Gaviiformes)

Contact: Mark Pokras, mark.pokras@tufts.edu

Project summary/accomplishment description:

- Monitoring breeding common loon (*Gavia immer*) populations and improving management techniques.
- Banding loons and studying migratory and wintering patterns – also collection biological samples from live loons being banded for health, contaminant, and genetic studies.
- Developing environmental education programs around loon conservation
- monitoring loons as environmental sentinels for issues such as contaminants, disease, climate change, water quality, etc.
- Documenting & studying loon mortalities – collecting cadavers, saving samples for morphometric & plumage studies, histopathology, toxicology, parasite studies, genetics, plastic ingestion, virology, etc.
- Developing improved techniques for the rescue and rehabilitation of loons.

Loon Working Groups

A. Northeast Loon Study Working Group (NELSWG)
Founded in 1994, the Northeast Loon Study Working Group (NELSWG) is a consortium of federal and state agencies, universities, and non-profit organizations from New England states, New York, and eastern Canadian provinces created because of widespread concerns about the conservation and health of loons in the northeast. The group meets annually, typically in March. With input from participating members, NELSWG coordinates cooperative research and other actions on issues beyond the scope of any one of its member organizations.
This page (https://loon.org/nelswg/), though not up to date, serves as a source of information for NELSWG members and attendees, including plans for future meetings and an archive of meeting minutes and agendas from some previous meetings. The 2024 meeting will be held at LPC headquarters in Moultonborough, NH on March 14 & 15 and is planned for both in-person and virtual participation. For more information contact Harry Vogel (hvogel@loon.org), Executive Director, Loon Preservation Committee (NH).

Project Partners include:
Academia
- Tufts Univ. Wildlife Clinic
- Univ. of Pennsylvania
- Atlantic Vet. College
- SUNY Buffalo
- Univ. of New Hampshire
- Univ. of Vermont
- Univ. of Maine (Orono)
- College of the Atlantic

State Agencies
- NH Fish and Game Dept.
- NH Dept. of Env. Services
- Maine Dept. of Inland Fisheries and Wildlife
- Maine Dept. of Env. Protection
- VT Agency of Natural Resources
- Mass. Div. of Fish and Wildlife
- Mass. Dept. of Env. Protection
- NY Dept. of Env. Conservation

Non-Government Groups
- Biodiversity Research Inst.
- Maine Audubon Society
- Audubon Society of N.H.
- Loon Preservation Committee
- VT Inst. of Natural Science
- Vermont Center for Ecostudies
- Adirondack Center for Loon Conservation
- Atlantic Coop. Wildlife Ecology Research Network
- wildlife rehabilitation centers from around the region

Canadian/U.S. Gov't. Agencies

- U.S. Fish and Wildlife Service
- U.S. Geological Survey
- U.S. E.P.A.
- Parks Canada
- Canadian Wildlife Service

B. Virtual Loon Working Groups

In 2020, using Zoom, two international virtual loon working groups were formed, the **Community Science & Stewardship Science Working Group,** and the **Rescue, Triage, and Rehabilitation Working Group**. Each has monthly online meetings, and currently over 200 people from all over the US and Canada participate. The groups actively share information, build shared files of online resources (Google folders), and planning for extensive future collaborations. In late 2021, a third **Field Research Working Group** was established to bring together some of the scientific community focused on loon research. This group meets quarterly.

For more information about these groups, contact:
Community Science/ Stewardship: contact Jay Mager, Kathy Jones (volunteer@birdscanada.org)
Rescue, Triage & Rehabilitation: contact Mark Pokras (mark.pokras@tufts.edu), Jay Mager (j-mager@onu.edu)
Loon Field Research: contact Doug Tozer (dtozer@birdscanada.org)

Dead loon on Maine beach, Mark Pokras

NELSWG Meeting 2017, courtesy Loon Preservation Committee

Banding common loon chick, courtesy of Loon Preservation Committee

Recent Advances in the Research and Conservation the Endangered Diablotín Black-capped Petrel

Contact: Yvan Satgé, Department of Forestry and Environmental Conservation, Clemson University, ysatge@g.clemson.edu
Collaborators: Patrick Jodice, U.S. Geological Survey South Carolina Cooperative Fish and Wildlife Research Unit; Sarah Janssen, U.S. Geological Survey Mercury Research Laboratory; Gemma Clucas, Cornell Lab of Ornithology; Brian Patteson, Seabirding Pelagic Trips

The Diablotin Black-capped Petrel *Pterodroma hasitata* is a gadfly petrel found in the western North Atlantic. The species is listed as globally Endangered by the International Union for the Conservation of Nature, and is currently being reviewed for listing under the U.S. Endangered Species Act. At sea, the species is distributed over the western north Atlantic, Caribbean Sea, and northern Gulf of Mexico. Across its marine range, it is exposed to many conservation threats including, but not limited to, offshore energy development and shipping, associated marine pollution, and commercial fisheries. We measured mercury burdens in feathers of adult petrels breeding in the Dominican Republic and of non-breeding adults captured at sea offshore North Carolina, USA. We also used DNA metabarcoding of fecal samples to describe the diet of those same individuals. Results showed higher concentrations of total mercury in feathers compared to most *Pterodroma* worldwide, with mean concentrations of 30.3 ± 11.1 ppm dry weight (range: 15.2-53.9 ppm dry weight; n = 20). Although limited in sample size, diet was dominated by fish species, including a high proportion of mesopelagic groups such as myctophids, and fishes of

interest to artisanal and commercial Caribbean fisheries. These results confirm earlier suggestions of high susceptibility to mercury by Black-capped Petrels, likely through the consumption of mesopelagic prey, while also suggesting potential interactions with fisheries. A manuscript is under review, for publication in 2024.

During the last year, we also published an article on the spatial segregation of dark and light populations of Black-capped Petrels in the western North Atlantic (Satgé et al. 2023a) and published a revision of the Birds of the World Account for the species (Satgé et al. 2023b) Conservation work by our partners in the Caribbean is ongoing to support the species: more information may be found in the annual newsletter of the International Black-capped Petrel Conservation Group at www.diablotin.org.

Satgé Y.G., B.S. Keitt, C.P. Gaskin, J.B. Patteson, P.G.R. Jodice. 2023a. Spatial segregation between phenotypes of the diablotin black-capped petrel Pterodroma hasitata during the non-breeding period. Endangered Species Research 51:183-201. DOI:10.3354/esr01254

Satgé, Y., A. Brown, J. A. Wheeler, and K. E. Sutherland. 2023b. Black-capped Petrel (Pterodroma hasitata), version 2.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. DOI:10.2173/bow.bkcpet.02

Cooperative Roseate Tern Metapopulation Project (CRTMP)

Contact: Dr. Jeff Spendelow, Emeritus Research Wildlife Biologist, USGS, JSpendelow@usgs.gov
Collaborators: Julie McKnight, Jen Rock, EC-CWS; Shawn Craik, Université Sainte-Anne; Paula Shannon, Keenan Yakola, Don Lyons, National Audubon's Seabird Research Institute; Elizabeth Craig, Shoals Marine Lab; Jessica Whitmore, Kacey Srubas, USNPS CCNS; Eileen McGourty, Heather Williams, USFWS Monomoy NWR; Shea Fee, The Trustees; Kayla Kasacek, Silas Beers, Biodiversity Works; Peter Paton, Margaret Rubega, Joan Walsh, Great Gull Island Project; Kristina Vagos, USFWS Stewart B. McKinney NWR; Pedro Lima

I have been coordinating the CRTMP, a research program on the metapopulation dynamics and ecology of the endangered NW Atlantic breeding population of Roseate Terns (ROSTs, Sterna dougallii) for 35+ years. The primary goal of the CRTMP is to determine the major factors that are limiting the recovery and growth of this population. I rely on many cooperators to band and identify individual terns at their breeding colony sites, and since 2011 have focused my fieldwork on staging site studies in the "Cape and Islands" area of southeastern Massachusetts). This research involves sighting individuals with 3-character plastic field-readable (PFR) bands to analyze temporal and geographic variation in the use of staging sites by ROSTs of different ages coming from about a dozen colony sites spanning the entire breeding range.

As in 2022, in 2023 Covid-related events had relatively little direct impact on colony-site fieldwork, but the threat of Highly Pathogenic Avian Influenza, and predation of eggs/chicks at some sites resulted in fewer chicks being banding in Canada and the Gulf of Maine, but more being banded in the warmwater area than in 2022. In 2023, 14, 198, and 4 ROST chicks were colorbanded, respectively, in CT, NY & MA, and 304 ROST chicks were colorbanded in the

coldwater NH-NS area, so overall 520 ROST chicks received PFRs in 2023. Also, from October 2022 through March 2023, Pedro Lima's crew put 342 PFR bands on ROSTs wintering in Brazil. At a minimum, 54 of those birds were seen in North America at either or both the staging sites around Cape Cod, MA (CCMA or the coldwater colony sites north of this area, but as of when this report was written I had not received a list of resights from Great Gull Island, NY (GGNY) and so do not know how many PFR-banded ROSTs from Brazil were seen at GGNY in 2023.

In 2023, I started 11 days earlier than in 2022, but stopped a few days earlier than normal and so ended up spending 50 days from 18 July to 22 September doing fieldwork around CCMA. I did not make any trips to the Nantucket-Tuckernuck-Muskeget area and no one did systematic resighting there. However, as a result of the discovery by Keenan Yakola of a nocturnal roost site on Norton's Point, Martha's Vineyard (MV), I visited this location on two days to do resighting and saw my only HY COTE from GGNY on MV. I also received staging site data from Shea Fee (The Trustees) and several people from Biodiversity Works on MV, and by several staff members of Cape Cod National Seashore (CCNS) at various sites.

Although somewhat larger flocks than have been seen there in the last 2-3 years were recorded at the Nauset Estuary area, overall flock size estimates at most staging sites within CCNS were typically lower in 2023 than in recent years, and on only two occasions (9 & 27 August) were estimates of up to 4000-5000 terns made at North Beach, Chatham.

The average number of PFRs read/day on a weekly basis started off at the highest rate recorded so far for Period 5 of the staging period compared to prior years (Table 1), but that rate plateaued in the 50s for the next 3 weeks before peaking at 95 PFRs read/day in Period 9 (15-21 August). The rate then dropped back to the 50s again for the next 4 weeks, and then to 22/day for the final week. With the exception of Weeks 5 and 12-14, these rates were considerably lower than the resighting rates for the same periods in 2021-2022. Weekly average read/day did not exceed 100 in 2023, whereas there were two such weeks in 2021 and three in 2022 with the daily average exceeding 130 PFRs twice in each of those two years.

Overall, 108 COTEs of all ages, and for ROSTs: 249 HYs, 1022 known-age adults, and 173 first banded as adults were read, resulting in a total of just over 1550 PFRs of both species identified on CCMA in 2023. As in 2022, only one COTE chick from GGNY was seen as an HY, and no COTEs with PFRs from the Chesapeake Bay area in Maryland or Virginia were reported on CCMA in 2023. Only 87 (41%) of 212 ROST chicks from the CT-NY area, but 160 (53%) of 304 ROST chicks from the NH-NS area were seen as HYs on CCMA. No ROSTs from Ireland were seen, but 93 ROSTs given PFRs in Brazil in prior years were seen on CCMA in 2023.

Table 1. Weekly average observation statistics of staging terns with PFR bands on Cape Cod, MA.
Shown are the weekly average number of Roseate Terns and Common Terns (combined) with plastic field-readable (PFR) bands identified/day by Jeff Spendelow over a 14-week period starting as early as 20 June each year. Note the relatively low values (highlighted in yellow) for periods 10-13 in 2017 compared to the values from 2015-16 and 2018-23. nd = no data. Also note the drop in PFRs identified in periods 12-14 in 2021-2022 compared to 2018-2019 & 2023. *Note: In 2020 weekly periods began 3 days earlier & Week 11 was done in Rhode Island, not CCMA.

	Week Number and Starting Date (6-20 = 20 June; 9-19 = 19 September)													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Year	6-20	6-27	7-04	7-11	7-18	7-25	8-01	8-08	8-15	8-22	8-29	9-05	9-12	9-19
2014	3.7	1.4	1.3	1.6	3.3	2.5	41	27	32	59	64	19	10	6
2015	0.3	0	0.4	0.9	1.7	6.9	25	nd	43	36	55	66	49	15
2016	nd	4	4.7	6.1	14	34	58	77	50	40	50	49	38	nd
2017	nd	nd	nd	5.5	20	55	44	44	50	16	15	15	22	8.4
2018	nd	nd	nd	nd	nd	26	41	49	54	61	72	89	36	12
2019	nd	0	3.3	5	19	52	59	69	67	77	120	134	44	32
2020*	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	0.5*	76	38	4.4
2021	nd	nd	nd	nd	38	76	84	60	99	144	136	7	14	1
2022	nd	nd	nd	nd	nd	102	86	86	134	131	53	15	18	0.25
2023	nd	nd	nd	nd	45	57	54	54	95	47	58	72	48	22

Color Key:	0-5	6-15	16-40	41-75	76-150

Non-Breeding Life History, Ecology, and Mortality of the Common Loon: Long-term Studies at Chesapeake Bay, MD & VA; the Atlantic Coast of NC; and the Gulf Coast of FL

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This project report is a nearly completed book ms., intended for popular publication, which describes my scientific study methods, observations, and conclusions over an intermittent 33-year period, 1988 to 2021. My ms. title is **"Dark of the Loon"**, because much of what I report was little-known or unknown—and often not easy of access, given marine habitats, maritime weather, and cold seasons. Much of this challenge was waterborne work in small boats, based at marine labs in MD, VA, and NC. Land-based study of adult cross-continent dawn spring departure was done from an elevated platform overlooking Apalachee Bay, FL, at the St. Marks NWR, USFWS. I choose book form so I can present my studies of Common Loon life history in a unified manner. This work is not an academic monograph—but a more accessible, reader-friendly telling of highly original coastal exploratory science for a larger audience. I am emulating "synthesis" writers such as Aldo Leopold, Rachel Carson, and Carl Safina. I am actively seeking a friendly editor, a strong publisher, and financial support through completion of the work.

I separate adult Common Loons' annual non-breeding cycle into four major events:

1. Fall migration from northern breeding lakes; with stopover sites throughout; and cooperative flock-feeding on key prey species. Schooling juvenile "peanut" Atlantic Menhaden are prominent diet in the Chesapeake and NC. These and older age classes of Gulf Menhaden may be prominent prey in the Gulf of Mexico (currently unknown). (With CLs' heavy wing-loading and obligate dependence on bodies of water for landing and takeoff, both seasonal overland migrations are critical life-history events.)
2. Arrival at wintering sites (with strong annual adult fidelity). Extensive diving for prey in the benthic zone (down deep in the water column) occurs over both continental shelves.

3. Within the winter season, a long adult flightless period (5-6 weeks) of complete wingmolt, thus replacement of all remiges. This loss of mobility and high nutritional demand to grow new flight feathers makes CLs a **"sensitive species"** in the marine environment. There is always some annual "emaciation", and potential storm mortality. Rarely, a mass emaciation dieoff occurs. I studied such an event in NC in 1993—hundreds of dead loons--and concluded that Menhaden population scarcity and a series of stressful storms caused this flightless mortality, followed by mortality of flighted juveniles.
4. Early spring remigration to northern breeding grounds. I did a five-year intermittent study of adult cross-continent dawn migration departure from the FL GoM. I discovered a "flyway" concentration at Apalachee Bay, easily studied, with volunteers, at the St. Marks NWR. We observed extreme sensitivity to weather, plus a portion of return flights ("aborted missions") during the first half of the migration period. I argue these patterns are aerial evidence of "loon intelligence", when CL survival is on the line.

I plan on separate publication of these new findings in the Florida Field Naturalist.

Partners:
I published solo on the 1993 mortality event, and co-published with Tom Augspurger, FWS contaminants biologist, Raleigh, NC; and Chris Franson, senior diagnostic vet, National Wildlife Health Lab, USGS. I cite many others' work that contributed to my CL understanding: **"Collegiality is the Bread of Life".**
I was a guest scientist at:
The Cooperative Oxford Lab, Oxford, MD (for my lower Choptank River and Eastern Bay study areas)
Virginia Inst. of Marine Sciences on the York River (for the Virginia western shore of Chesapeake Bay)
The Beaufort, NC NOAA/NMFS Lab (Cape Lookout region; 6 seasonal residences 1991-96, total a year)
St. Marks NWR, USFWS, on Apalachee Bay, FL (for five CL spring migration studies during 2012-2021)

Photo credit: Amber Hart
1 Migrating CLs often rotate their trailing paddles 90 degrees, and press them together to form a "flight control surface" (= rudder).
2 Pic demonstrates CL's massive body and slender wings. This heavy wing loading requires 3 constant shallow wingbeats/second.

Stable Isotope and Mercury Analysis of Black-capped Petrel (Pterodroma hasitata) Feathers to Investigate Trophic Position and Foraging Areas of Light, Dark, and Intermediate Forms

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The Black-capped Petrel (*Pterodroma hasitata*) is a threatened seabird whose only documented nesting sites are in the mountains of Hispaniola in the Caribbean, and whose foraging range extends from the Caribbean and Gulf of Mexico northward to the northwestern Atlantic. Two variations of Black-capped Petrel occur, a light form and a dark form, with some individuals displaying intermediate characteristics between the two (Figures 1 & 2). These forms are known to have differences in mitochondrial DNA indicating at least two distinct nesting populations. Allochronic speciation could be one factor responsible for these differences since molt timing of the two forms is about one month apart suggesting temporal differences in their breeding. At-sea study allows us to assess the molt timing of the two forms of Black-capped Petrel, but some information can only be gleaned by having birds in the hand or observing them at their nesting colonies. Unfortunately only 100 burrows are known, all on Hispaniola, and of these all are either dark or intermediate forms; burrows hosting light form birds have yet to be discovered.

Studying differences in the foraging ecology of these different forms using individuals that are nesting is currently impossible.

I investigated the historical foraging ecology of these two forms and the intermediary by analyzing breast feathers from historic museum specimens at the North Carolina Museum of Natural Sciences collected by David Lee between 1978 – 1989 for three stable isotope ratios ($d^{13}C$, $d^{15}N$, and $d^{34}S$) and total mercury (THg) concentrations (Table 1). $d^{34}S$ has not commonly been applied to seabird studies and added an additional spatial component to this one. There were no significant differences among the color forms of Black-capped Petrel, but significant differences in $d^{15}N$ did exist by sex with females having a lower mean value than males. Average values of THg varied from 3.87+/- 0.37 mg/g (NCSM 9507) to 81.45+/- 2.10 mg/g (NCSM 9491) with high variability among feathers of individuals, intraindividual variation ranged from 5.0 to 40.0 µg/g in 37 of the 65 specimens sampled.

This study provides a baseline for investigating stable isotopes and THg levels in Black-capped Petrels and other species of *Pterodroma* in the north Atlantic. More research is needed within the Gulf Stream's dynamic ecosystem to unravel these isotopic relationships, but the results from these specimens collected at different times over an 11-year period are consistent indicating a distinct foraging ecology in this species. Regardless of differences in geographic range (studies and sighting information show light forms moving farther north and dark forms staying farther south) these birds are likely tied to Gulf Stream influenced waters, specifically those offshore of the Continental Shelf.

I believe that with more study the relationship between $\delta^{34}S$ and mercury in the Gulf Stream ecosystem and Black-capped Petrels could be elucidated. I recommend that future studies focusing on levels of THg in seabirds, especially those using body feathers, use analysis of multiple feathers due to high intraindividual variation.

Table 1.
Values for $\delta^{13}C$, $\delta^{15}N$, $\delta^{34}S$, and THg mean and +/- standard deviation for each group analyzed in this study.

		Mean	Sd	n
$\delta^{13}C$	All individuals	-15.05 ‰	+/- 0.33	63
	Dark form	-15.04 ‰	+/- 0.31	42
	Light form	-15.06 ‰	+/- 0.41	17
	Intermediate form	-15.10 ‰	+/- 0.25	4
	Female	-14.99 ‰	+/- 0.41	18
	Male	-15.08 ‰	+/- 0.30	43
$\delta^{15}N$	All individuals	12.32 ‰	+/- 0.75	63
	Dark form	12.34 ‰	+/- 0.70	42
	Light form	12.28 ‰	+/- 0.89	17
	Intermediate form	12.28 ‰	+/- 0.68	4
	Female	11.96 ‰	+/- 0.80	18
	Male	12.49 ‰	+/- 0.68	43
$\delta^{34}S$	All individuals	20.27 ‰	+/- 0.52	63
	Dark form	20.26 ‰	+/- 0.50	42
	Light form	20.25 ‰	+/- 0.60	17
	Intermediate form	20.48 ‰	+/- 0.44	4
	Female	20.45 ‰	+/- 0.57	18
	Male	20.19 ‰	+/- 0.50	43
THg	All individuals	26.92 µg/g	+/- 11.35	63
	Dark form	27.75 µg/g	+/- 11.55	42
	Light form	25.95 µg/g	+/- 11.36	17
	Intermediate form	22.28 µg/g	+/- 10.28	4
	Female	26.87 µg/g	+/- 13.25	18
	Male	27.15 µg/g	+/- 10.86	43

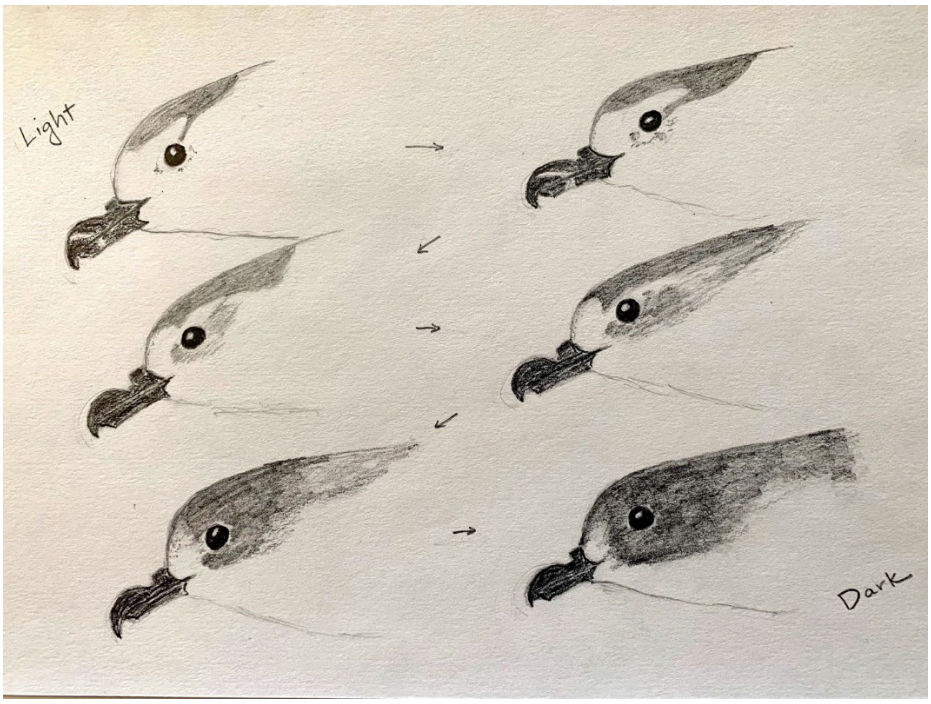

Figure 1. Facial patterns used for assigning forms © Kate E Sutherland


Figure 2. Underwing patterns of light (left) and dark (right) form Black-capped Petrels in the field. © Kate E Sutherland