Atlantic Marine Bird Cooperative - General Presentation Abstracts
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Transparent modeling of collision risk for three federally-listed bird species in relation to offshore wind energy development

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Collision risk models (CRMs) are used to estimate the risk of avian collisions with offshore wind turbines. Empirical evidence of offshore collision rates is lacking, so CRMs fill this gap by incorporating information on bird movements and turbine specifications into a model that approximates the collision process. Such models typically use avian density data derived from surveys. However, minimal survey data are available for the Roseate Tern, Piping Plover, and Red Knot, three species of conservation concern 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 an established stochastic collision risk model (stochCRM) to incorporate individual tracking from the Motus Wildlife Tracking System. An online web application of the model, called Stochastic Collision Risk Assessment for Movement (SCRAM) is now publicly available. A report is in review that documents the tool, presents case studies for evaluating collision risk of the three focal species at offshore wind energy areas in the NES, and includes a preliminary framework for estimating cumulative collision risk.

Avian Influenza Outbreak on Coquet Island, Northumberland, UK, 2022

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Coquet Island supports around 40,000 pairs of breeding seabirds. These include four UK Red Data list (high conservation concern) species, Roseate Tern *Sterna dougallii* (c.150 pairs), Puffin *Fratercula artica* (c. 30,000 pairs), Kittiwake *Rissa tridactyla* (c. 500 pairs) and Herring Gull *Larus argentatus*, as well as six Amber listed (lower conservation concern) species, Common Tern *S. hirundo* (c. 1,900), Sandwich Tern *S. sandvicensis* (c. 2,000 pairs), Arctic Tern *S. paradisaea* (c. 1,600 pairs), Fulmar *Fulmaris glacialis* (c. 65 pairs), Black-headed Gull *Chroicocephalus ridibundus* (c. 5,000 pairs) and Lesser black-backed gull *L. fuscus.* A recent outbreak of Avian Influenza (AI) affected mostly Tern's species, resulting in the death of adults and chicks. AI has wiped out almost all chicks from 1,964 Sandwich Tern nests, while Roseate Terns (Adults) have lost 55.84 percent of their population, with the lowest productivity since 1985, 170 dead chicks, and 73 fledglings. Several measures were taken to prevent the spread of disease, including disinfectant footbaths throughout the colonies, disinfectant bird ringing tools, and removing the dead birds from the nesting plots. As soon as the birds left, the disinfectant solution was sprayed inside and outside all nesting boxes and it was sprayed on the shingle layer before it was removed from the nesting area. Natural England will conduct an environmental sampling project

with the Animal and Plant Health Agency at Coquet Island (RSPB), Farne Islands (National Trust) and Lindisfarne (Natural England) over the winter to monitor traces of the AI virus. Together with stakeholders and experts, we are reviewing the practices we used to protect birds against AI during the last season with the goal of optimizing them if an AI outbreak occurs in the future.

Seabird bycatch in the Eastern Canadian Arctic

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The global Arctic is an emerging area of study for fishery impacts on seabird populations. Opportunities for fishing in the Arctic have increased and are expected to continue to grow as a result of retraction of summer sea ice, shifts northward of targeted fish species, and increased infrastructure supporting fishing enterprises. With this increase in potential fishery operations, the risk to Arctic-breeding seabirds from fisheries bycatch is likely to increase as well. In the eastern Canadian Arctic, northern fulmars are most at risk to fisheries operations, constituting 74% of seabird bycatch observations by At-Sea Observers between 2010-2019. This presentation outlines current ongoing research on seabird bycatch issues in Baffin Bay and Davis Strait, Canada, with a focus on impacts to northern fulmars across this region and their entire North Atlantic range. In addition, we will describe efforts to incorporate fisher knowledge in practical mitigation strategies to reduce bycatch.

Highly Pathogenic Avian Influenza (HPAI) in Canadian Seabird Colonies

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Historically, Highly Pathogenic Avian Influenza (HPAI) was almost exclusively a poultry disease, but it has emerged as a wildlife disease through repeated spillover events. In 2022, a novel phenomenon was the incursion and subsequent transmission of the HPAI virus in many seabird breeding colonies in the northern hemisphere, with a high mortality rate. To gauge the scale of outbreaks, and their population- or species-level effects, it is necessary that mortalities in affected species are carefully documented. In Canada, infections of HPAI were first detected in December 2021 and significant mortality events associated with HPAI were reported in eastern Canada beginning in May 2022. We present preliminary results on the spatio-temporal trends of the HPAI outbreaks as well as species-specific estimates of mortalities/morbidities across eastern Canada. Our preliminary estimates are informed by observations on land, water and at breeding colonies, and will be revised to estimate at-sea losses based on drift modelling. Our results will facilitate the assessment of population-level impacts for species that suffered significant mortality globally (Northern Gannets) and to support harvest management decisions for hunted species in eastern Canada (Common Eiders, Common Murres).

Seabird Conservation in a Coastal Urban Setting: An Adaptive Management Challenge
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The South Island of the Hampton Roads Bridge-Tunnel (HRBT) complex in the City of Hampton, Virginia, supported the Commonwealth's largest seabird colony through the 2019 breeding season and the start of the HRBT Expansion Project, which mandated that all nesting activity cease on South Island. In February 2020, the Virginia Department of Wildlife Resources (DWR) was charged with providing temporary nesting habitat for seabirds displaced by the Expansion Project. Ft. Wool, an existing historic site connected to South Island by a rock revetment, was transformed into a 1.5 acre seabird breeding site. An additional acre of habitat was created on the topsides of flat-top barges anchored in the Ft. Wool embayment. Audio lures and decoys were deployed to help attract target species. Seabirds successfully nested at both locations in 2020 and in even greater numbers in 2021 and 2022. These sites, however, do not represent a permanent solution for the birds, as each has its own challenges. The U.S. Army Corps of Engineers received congressional approval to construct an artificial nesting island within 21 km of South Island and is currently in the project feasibility study phase. Construction of the new island is expected to begin in early 2025.

Build an Island – Terns will Come!
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In 2021 a 1,024 sq. ft. floating raft was constructed and installed to provide critically needed breeding habitat for nesting waterbirds in Maryland coastal bays. The raft was enlarged in 2022 to 2,304 sq. ft and consisted of 9 raft segments joined with dock hinges. The hinges allow the whole raft to flex during storms. Twenty-three pairs of Common Tern (*Sterna hirundo*) produced 19 fledged chicks from the raft in 2021. Eighty percent of the terns that nested on the raft in 2021 returned to breed on the 2022 raft. The 2022 breeding colony produced 155 nests and fledged ~152 chicks (1.0 fledglings per nest). Mean clutch size (±SD) was 1.9±0.58. In 2022 91 adult Common Terns and 157 chicks from the raft were banded with field readable bands. In 2022 two terns banded as chicks at Chesapeake Bay colonies were recorded as breeding adults on the raft and three terns banded on the wintering grounds in Punta Rasa, Argentina were recorded as breeding adults. The raft hosted the largest Common Tern breeding colony in the Maryland coastal bays in 2022, demonstrating the lack of natural sand islands for nesting.

Spatiotemporal variation in Common Tern (*Sterna hirundo*) foraging movements
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For mobile consumers, movements are defining characteristics of foraging strategies. During the breeding season, seabirds exhibit central place foraging strategy in which movements are restricted in space around the breeding colony. The availability of prey items surrounding the colony might highly impact reproductive success and energy expenditure for foraging (via foraging movements). Our study therefore assesses the foraging movements of Common Terns (*Sterna hirundo*) on a Gulf of Maine breeding colony across three years

with variable reproductive success and prey availability. Specifically, we asked 1) to what extent foraging movement effort (metrics including range, trip distance, and trip duration) varied across three years with variable reproductive success, and 2) whether prey provisioning impacted any observed variations in foraging movement effort. Tern movement data were collected via GPS satellite tags deployed during the 2019 (n=11), 2021 (n=20), and 2022 (n=11) breeding seasons. Foraging movements were extracted from the GPS data using Hidden-Markov Models (HMM) and were used to generate foraging range distributions via Kernel Density Estimation. Prey provisioning data were collected during observational surveys of terns provisioning their chicks and prey items easily characterized as "high" or "low" quality were extracted. Foraging range size and foraging trip metrics (distance, duration) were analyzed across years and prey conditions via Generalized Linear Models (GLMs). We found that foraging effort (range, duration, and distance) increased in years with lower population-level reproductive success and during periods of increased provisioning of low-quality prey items.

Marginal effects of oceanographic variables and wind on the foraging behaviour and habitat preferences of the endangered Bermuda petrel *Pterodroma cahow*

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Reproduction is a crucial event in animals' annual cycle and in procellariform seabirds it can be extremely long requiring behavioural and physiological adjustments. For pelagic gadfly petrels that cover vast oceanic areas, the pursuit of foraging opportunities can be very challenging due to the high spatio-temporal variability of environmental conditions and resources. Wind is emerging as a key driver of gadfly petrels' foraging strategy but our general understanding of which factors shape their foraging strategy is limited. Here we GPS-tracked the foraging trips of the endangered Bermuda petrel, *Pterodroma cahow,* during incubation and chick-rearing (2019 and 2022). Results showed they travelled over a vast area of the western North Atlantic while foraging over deep oceanic waters; the decision of when and where to forage was only marginally affected by oceanographic parameters and wind conditions with males and females behaving similarly. Petrels had also remarkably narrow isotopic niches and $\delta^{15}N$ and $\delta^{13}C$ ranges suggesting consistency in trophic habits. Finally, the taxonomic diversity of prey found in the diet was extraordinary, including exclusively meso-bathypelagic fishes and cephalopods. This information is crucial to understanding the ecological role of gadfly petrels and their flexibility in responding to projected climate changes in the North Atlantic.

Reassessing the presence of tick-borne pathogens transmitted by the seabird tick *Ixodes uriae* in Gulf of Maine seabird colonies

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The seabird tick *Ixodes uriae* has a circumpolar distribution in the Northern and Southern Hemispheres attributed to dispersal by colonial seabirds. Because migratory seabirds allow the ticks to overcome geographic barriers, the pathogens carried by *I. uriae* are diverse. Seabird ticks are researched extensively in Eurasia, but the Northwest Atlantic's *I. uriae* populations are understudied. Previous studies detected no tick-borne pathogens in *I. uriae* collected from the Gulf of Maine's offshore seabird colonies, but found *Borrelia garinii*, a causative agent of Lyme disease in Eurasia, in ticks from Newfoundland's Atlantic puffin colonies. The recent spread of *B. garinii* in Newfoundland indicates the need for vector surveillance in other *I. uriae* populations in the Northwest Atlantic. With assistance from the Gulf of Maine Seabird Working Group and the University of Maine Diagnostic and Research Laboratory, we conducted qPCR pathogen analyses on seabird ticks collected from six alcid colonies in the Gulf of Maine to determine the presence or absence of bacterial tick-borne pathogens. Our results represent the first record of *Borrelia spp.* and a *Rickettsia*-like organism detected in *Ixodes uriae* from the Gulf of Maine, and necessitate future surveillance despite the low pathogen prevalence found in these populations.

Stellwagen Sanctuary Seabird Stewards (S4) program
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The Stellwagen Sanctuary Seabird Stewards (S4) program is a community science research and monitoring effort that collects data on seabirds in and around NOAA's Stellwagen Bank National Marine Sanctuary. Standardized boat-based surveys follow a dedicated transect throughout the Sanctuary, with a recorder and observer team collecting information on sightings within 300 m of the vessel. The S4 program is run by SBNMS staff and skilled volunteers with extensive seabird knowledge and training. Some goals of the program include collecting systematic baseline data on spatial and temporal distribution of seabirds, informing and educating the public, and training volunteers as seabird observers. We're excited to share some of our findings from 11 years of data collection!

Preliminary Findings for Camera-Based Tern Chick Diet Monitoring
Sarah Guitart, University of Massachusetts Amherst

Seabird reproductive success is linked to readily available prey species throughout the chick-rearing period. Monitoring chick diet provides critical insight into prey availability; however, in-situ methods can be logistically prohibitive. This study continues the work of several promising camera-based studies piloted in 2021. We set up motion-triggered trail cameras on productivity plots to monitor chick provisioning on Roseate (*Sterna dougallii*) and Common tern (*Sterna hirundo*) islands in Buzzards Bay, Massachusetts. We also conducted in-situ and video-based monitoring to determine the efficacy of trail cameras as a novel method in tern diet monitoring. While results from the 2022 season are unavailable, we gained valuable insight and believe this methodology will be successful in capturing tern chick diets. We also believe that structure-nesting Roseate terns are well suited for camera-based monitoring. Data from these efforts will be used to identify current prey species, explore novel prey species, and compare the biodiversity and frequency of occurrence from prior provisioning studies. The results of this study are useful for seabird colony managers and other stakeholders interested in monitoring chick diets and similar marine bird conservation efforts.

Research applications from GoMMAPPS seabird surveys to offshore wind energy development in the Gulf of Mexico

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Conservation risks to marine birds from offshore wind energy are additive and cumulative to impacts from hydro-carbon development and exposure in the industrialized waters of the Gulf of Mexico (GoM). From 2017-2019, a multi-taxa project funded by BOEM gathered broad-scale information on distribution and abundance of seabirds using aerial and vessel surveys for priority species. Vessel surveys from the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS) aggregated ~9,300 detections of 44,000 seabirds for 44 species over 2,300 hours, 293 days, and 41,700 km of total effort. Based on pilot analyses of seasonally- and spatially explicit data, we illustrate three applications of marine spatial planning to the mitigation hierarchy (avoid, minimize, compensate). At a broad scale, habitat models for 24 seabird species were used to create a composite map of least-conflict and lowest impact zones for siting wind energy areas (WEAs) across the entire GoM call area (see pp. 32-34 here). For vulnerable species, incorporating aerial survey coverage and statistical outlier analysis helped identify proximity of seabird hotspots to individual WEAs. For all individuals of each species detected in GoMMAPPS vessel surveys, flight heights (9 height categories available in Program SEEBIRD Vers. 4.3.7; Ballance and Force 2016) were estimated to inform collision risk models. In 2023 and 2024, joint seabird and marine mammal surveys will resume on NOAA ships in the GoM using the same transect lines and data-gathering protocols.

Respiratory fungal disease in the Common Loon, *Gavia immer*

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Abstract – Common loons (*Gavia immer*) face a variety of anthropogenic and natural threats to health, including respiratory fungal disease (RFD). RFD in *G. immer* has been reported to be predominantly caused by *Aspergillus fumigatus,* a globally distributed, ubiquitous species. It is not known how and where loons are commonly infected with *A. fumigatus* or other fungi causing RFD. Previous studies of bird nesting substrate found high levels of *A. fumigatus,* leading us to hypothesize that *G. immer* may be exposed to high quantities of fungal spores while on nest. We used culture-based methods to test for fungi from: the upper respiratory tracts of postmortem *G. immer* across New England from 2008-2022, the choanae of wild-caught *G. immer*, and natural and artificial nests in Maine and Vermont. Preliminary data illustrates that, while with no choanal samples yielding fungi, a diversity of fungi was cultured from both postmortem *G. immer* and their nesting substrate. Thus far, 50.7% of loons sampled postmortem (n=71) have produced fungal cultures from respiratory swabs, lung tissue, or fungal plaques. These fungal cultures are evaluated by DNA sanger sequencing and represent a diversity of pathogenic fungi such as Penicillium, Mucor, Aspergillus, and Candida

Species. Continued culture-based methods and DNA sequencing may provide additional insight into avian mycoses.

The northern Gulf of Mexico seabird colony atlas and registry: a forthcoming resource

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The coastal zone of the northern Gulf of Mexico supports a diverse array of breeding nearshore seabirds that nest colonially. Although nest-site fidelity is common among seabirds, the coastal zone's dynamic nature can result in interannual shifts in the locations of colonies and in the existence, size, or stability of the habitats that support them. Such changes can affect the location of breeding sites, population size or structure, and foraging locations. Overlaid on this dynamic system is a stakeholder network 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 scattered among the stakeholder network and difficult to source. The strategic monitoring guidelines recently released by the Gulf of Mexico Avian Monitoring Network highlighted the need for a spatial inventory of breeding sites to support energy development and marine spatial planning, oil spill response, restoration planning, habitat management, and monitoring and research. We seek to address this information gap by creating an atlas and registry for seabird colonies that integrates existing data. This is a critical step in understanding the distribution and status of breeding seabirds in the region.

Preliminary results from Two summers of monitoring Atlantic puffin (*Fratercula arctica*) diet using fecal DNA metabarcoding

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The Gulf of Maine (GoM) has warmed rapidly in recent decades, coinciding with dramatic changes in the diet of Atlantic Puffin (*Fratercula arctica)* chicks at monitored colonies. Chick diet has traditionally been assessed by photographing prey carried externally by provisioning adults. While effective for monitoring chick diet, this technique cannot be used to examine the diet of adult puffins, as they consume their prey at sea. To determine what puffins in the GoM feed upon, we collected fecal samples from chicks and adults of known breeding status during the 2021 and 2022 breeding periods at Matinicus Rock, Maine. After amplifing 12S and 18S rRNA sequences from prey taxa within these samples, we used DNA metabarcoding to analyze what prey species were detected. Prey taxa frequency of occurrence was then examined by breeding stage and bird age, allowing for unique comparisons between the diets of puffin adults and chicks. We present preliminary results revealing variation in puffin diet between age groups as well as both within- and between-years. These results are encouraging and support metabarcoding as an efficient means of monitoring how puffin diet composition continues to evolve within the rapidly-warming GoM.

Fifty years of changes in concentrations of mercury and organohalogenated contaminants in the Northern Gannet of the Gulf of the St. Lawrence

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The St. Lawrence is a vast and complex ecosystem where biological productivity is high. It is subjected to many stressors including acidification, hypoxia, ship traffic, fisheries, invasive species, warming of the sea surface temperature, and pollution. The Northern Gannet was selected as a sentinel species to monitor the state of the Gulf of the St. Lawrence half a century ago after organochlorine pesticides were found to impact reproductive output and eventually, population size. In the last decade, their reproductive success was once more challenged, but by reductions in prey distribution and abundance. This study aims to determine the latest trends of contaminants in eggs of gannets between 1969 and 2019. Eggs were collected every five years to measure concentrations of mercury, legacy organochlorine contaminants (e.g., DDT and PCBs), and brominated flame retardants. In addition, stable isotopes were measured to indicate possible diet shifts. Most contaminants decreased in the last decades, but recently the rate of decline decelerated, with contaminant concentrations increasing in some cases. Foraging ecology tracers such as stable isotopes revealed trophic shifts that partially explained these fluctuations of contaminants concentrations. Recent studies showed that climate change affected prey availability and shifted diet composition, which could in turn affect trophic transfer of contaminants up to gannets.

28 years of seabird monitoring at Machias Seal Island

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At the Machias Seal Island Migratory Bird Sanctuary, 2022 marked our 28thconsecutive year of concentrated monitoring of the island's nesting seabird populations. The primary goal of our monitoring program is to understand how changes in the marine environment are driving changes in seabird ecology. Specifically, phenology, productivity, chick growth, and chick provisioning rates. Given that the waters around Machias Seal Island (i.e., Bay of Fundy and Gulf of Maine) are warming at a rapid rate and our focal seabird species are nesting at the southern extent of their range, our monitoring program is uniquely positioned to evaluate how seabirds might respond to a warming ocean. Our data show variability in all metrics both among species and years. In particular, we note changes in phenology, wide variations in productivity, changes in prey species fed to chicks, and contrasting changes to nesting population sizes.

Atlas of Sea Duck Key Habitat Sites in North America

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Sea ducks are a unique group of waterfowl that inhabit coastal marine habitats throughout arctic and subarctic North America. Since 2001, the Sea Duck Joint Venture (SDJV) partnership has completed surveys and studies of sea ducks that provide information on distribution and abundance throughout the annual cycle. Using this information and other available sources, the SDJV developed the Sea Duck Key Habitat Sites Atlas describing 85

sites throughout North America that constitute important sea duck habitats, including many sites in the northwest Atlantic coast. Criteria for inclusion in this atlas were strict, relative to criteria used for other bird habitat designations, to highlight those habitats most critical to sea ducks during at least one season. Key site descriptions include a synopsis of sea duck abundance and temporal importance of the site to sea ducks, as well as sensitivities or potential conflicts that may impact sea ducks or their habitats. The Atlas is intended to heighten awareness of valuable sea duck habitats, aid in prioritizing habitat conservation and protection efforts such as oil spill prevention and response, and provide information for environmental assessments. The Atlas and associated data products can be found at seaduckjv.org.

Malaria parasites, disease, and death in Common Loons (*Gavia immer*)

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Malaria parasites (genus *Plasmodium*), vectored by mosquitoes, are notoriously rare or absent in seabirds worldwide. In this study we surveyed Common Loons (*Gavia immer*), a species long thought to be malaria parasite free, across the southern edge of their breeding range for malaria parasite infection. Through collaborative and ongoing research efforts including capturing and blood sampling of live breeding loons, necropsy and histopathology of deceased loons found in the wild, sampling of mosquito vectors, and molecular diagnostic methods including PCR screening and sequencing, we have been able to document a wide diversity of malaria parasites in Common Loons across the southern edge of their breeding range as well as malaria induced mortality in breeding loons in the northeastern US. Through the screening of mosquitoes we have also identified a number of mosquito species that transmit the malaria parasite species found in Common Loons. Mortality in Common Loons from malaria appears mid breeding season. Our findings highlight the widespread distribution of malaria parasites in Common Loons, disease and death by malaria parasite infection in loons, and the importance of parasite surveillance in northerly distributed seabird species previously not thought to be infected with malaria parasites.

Evaluating the Effectiveness of Gull Control as a Management Tool for Increasing Common Eider Duckling Survival

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Duckling survival has been identified as a significant limiting factor for a sustainable population of the American Common Eider (*Somateria mollissima dresseri*). It has been demonstrated that Common Eider duckling survival in the Gulf of Maine is greatly impacted by avian predation, mostly by Great Black-backed Gulls, and to a lesser degree, Herring Gulls. Intensive seabird population monitoring and research, along with active gull management efforts conducted in the Gulf of Maine, have concluded that gull management can be effective in maintaining and restoring viable seabird populations. However, its use as a method for increasing eider duckling survival within a localized area has not been adequately evaluated. During three seasons (2016, 2018-19), we collected baseline data on eider nesting propensity, nest success, and eider duckling survival at a colony in Casco Bay, ME prior to implementing targeted gull management efforts. Duckling survival following the first round of gull management (2021) showed an encouraging increase from previous years. However, the 2022 season was marred by extremely low survival, potentially related to especially high rates of HPAI circulating in the environment. To better assess the efficacy of active gull management on increasing eider duckling survival, these efforts will continue in 2023.

Lessons Learned and Early Results on the Automated Classification of Seabirds from Digital Aerial Imagery

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In a collaborative effort, the U.S. Fish and Wildlife Service, Bureau of Ocean Energy Management, and U.S. Geological Survey are combining aerial remote sensing with deep learning methodology to support the Atlantic Marine Assessment Program for Protected Species (AMAPPS). Since 2021, we have collected >2.5M very-high resolution digital images from aerial surveys over the Atlantic Ocean. The 'Wildlife Annotation Tool' software is distributing this imagery to experts across federal agencies and associated partners. A seabird imagery guide to species of the Atlantic Ocean has been drafted to facilitate species labeling. This labeled imagery is the foundation for training deep learning algorithms to detect seabirds and predict species classifications. An exploration of algorithms to detect and classify seabirds has been initiated using pilot datasets. An in-flight detection algorithm has been tested and has proven useful. Convolutional neural networks and cutting-edge vision transformer models show high accuracy of species classifications can be achieved with modest sample sizes. Future work will need to encompass more diverse wildlife species to understand realistic scenarios of model performance. The results will improve our knowledge of seabird distribution and abundance to inform environmental assessments and impact analyses of offshore energy development and other population assessments.

Satellite tracking of shearwaters in the Gulf of Maine

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The Stellwagen Bank National Marine Sanctuary (SBNMS – NOAA/NOS) has been conducting satellite tracking studies of shearwaters in the SW Gulf of Maine (GOM) since 2013. Great Shearwaters (*Ardenna gravis*) (GRSH), the most abundant shearwater in the GOM, has been the focal species and birds have been satellite-tagged in

every year, except 2020. Much information is collected when birds are captured (*i.e.*, fecal samples for diet; breath, blood, and feather samples for stable isotopes for diet; molt for migration and age; morphometric measurements), and other studies have been woven into these datasets (*i.e.*, plastic ingestion, Dynamic Ocean Management (DOM) concepts). Distribution analyses from tracking provide information on (1) annual variation in feeding areas for shearwaters, (2) definition of habitats used, (3) age characterization and evidence developmental learning, (4) role of wind when feeding and during migration, and (5) mortality from gillnet fishing. In 2022, we sampled all birds for avian flu and started to track Cory's Shearwaters (*Calonectris diomedea borealis*) (COSH) to examine how their habitat requirements differ from GRSH. GRSH use the entire North Atlantic during their non-breeding season, while COSH primarily stay on the S New England Shelf and Georges Bank, as expected from prior shipboard studies.

Investigating Great Shearwater mass mortality events along the US East Coast using a collaborative necropsy program

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Large-scale mortality events involving Great Shearwaters have been qualitatively documented along the US East Coast for decades, but little empirical evidence has yet identified specific drivers of these events. Here we describe ongoing efforts to better understand these events, using a comparative necropsy and analysis program involving multiple federal and academic partners. The effort relies on beached birds collected during mass mortality events in 2017 and 2022 in tandem with apparently healthy Great Shearwaters obtained as fisheries bycatch from 2008 until the present. Limited data from 2017 beached birds indicates beached birds were hatch year individuals in poor body condition generally ingesting more plastic items compared to bycaught individuals from the same region. However, the 2017 beached bird dataset (n = 9) was too small to support meaningful conclusions. Collection of beached birds in 2022 resulted in a sample set of over 100 beached individuals from multiple locations; these birds will be subject to necropsy and compared to existing data to better constrain potential causes and/or symptoms of this year's mass mortality event. We will specifically describe necropsy and analysis activities planned for these 2022 beached Great Shearwaters to seek input and discussion from interested partners.

Exploring the use of great shearwaters as a dynamic ocean management tool to mitigate threats to large whales

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As climate change drives increased variability in ocean conditions and species' distributions, conservation and management may require dynamic strategies that are as flexible in space and time as ocean conditions, species, and users. However, few tools exist to inform dynamic approaches. As ecological indicators, seabirds could serve as valuable tools for implementing dynamic management by identifying productive areas or habitats of species in need of protections, such as whales. Our goal was to explore the use of satellite-tagged great shearwaters as near-real time dynamic management tools to identify humpback whale aggregation areas to address conservation threats (entanglement, vessel strike). We identified shearwater habitat use areas with 50% kernel density utilization distributions in the Gulf of Maine, at yearly, monthly, and weekly scales using satellite-telemetry data (2013-2018). We quantified overlap between tagged shearwaters and humpbacks using sightings and satellite telemetry data at two spatial scales: Stellwagen Bank National Marine Sanctuary and the Gulf of Maine. Results show that satellite-tagged great shearwaters can be indicators of humpback whale spatial and temporal habitat use. With further study, tagged great shearwaters may provide near-real time information necessary to operationalize dynamic management to mitigate human impacts on humpback whales.

Spatial heterogeneity in highly pathogenic avian influenza outbreaks among terns and gulls in New England
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In early 2022, an outbreak of highly pathogenic avian influenza (HPAI) caused by the H5N1 subtype began to spread across the United States. This strain of HPAI has since caused large die-offs of seabirds along the Atlantic coast, posing a critical threat to seabird conservation. The common tern Sterna hirundo and the federally endangered roseate tern Sterna dougallii nest in large colonies in Buzzards Bay, alongside nesting herring gulls and great black-backed gulls. The purpose of this study was to determine HPAI infection status of these seabirds; all birds tested on Bird, Ram, and Penikese Islands in Buzzards Bay were negative for avian influenza. These results could then be mapped alongside known HPAI infections in New England to provide critical information about the geographic distribution of the virus and the effects it may have on seabird conservation.

Modeling past and future spatial distributions of marine bird species in US Atlantic waters
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The spatial distributions of Atlantic marine bird species have changed over time and will potentially change in the future, for example due to climate change. The objective of this study is to extend existing species

distribution models to allow for changes over time and to project potential future changes. At-sea counts of marine birds from surveys during the past 20-25 years were compiled, primarily from the Northwest Atlantic Seabird Catalog database. 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). A statistical modeling framework is being used to estimate the relationships between contemporaneous bird counts and environmental variables, and those relationships are then applied to project potential changes in bird distributions during the next several decades. We will report preliminary results of this modeling study. The final results will provide updated estimates of the current distributions of marine bird species in US Atlantic waters as well as projected changes in bird distributions under an idealized climate change scenario.

Post-breeding distribution of Common Eiders in the Grand Manan Archipelago, Bay of Fundy, NB.
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The southern portion of the Common Eider breeding population (*dresseri*) is exhibiting considerable population declines, including the lower Bay of Fundy, which historically supported large numbers of breeding and overwintering eiders. Within the lower Bay of Fundy, eiders are exposed to a suite of anthropogenic and environmental stressors including aquaculture development, high vessel traffic, declining food resources, contaminants and disease. Understanding important post-breeding foraging areas, when female eiders and their young are most vulnerable to oiling and disturbance, can inform conservation management strategies. To examine fine-scale habitat use post-breeding, 21 GPS-GSM tags were deployed on late-incubating females among five islands within the Grand Manan and the Wolves Archipelagoes. To confirm status of tracked birds, interpret tracking data and estimate brood survival, bi-weekly boat-based surveys were to be conducted after peak fledging. Total number of tracking days ranged from 12-73 (mean = 41). Preliminary results show high use of coastal waters around colonies before dispersion to others areas within the Archipelagoes, particularly some areas with finfish aquaculture. Limited boat-based surveys did not allow for brood survival estimates, but collected population-level data on crèche sizes and locations. Habitat selection models will be developed to better understand key drivers of post-breeding eider distribution.

Tern and Storm-Petrel Tracking in the Gulf of Maine
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In recent years there has been rapid advancement in the planning stages for offshore wind energy development and the siting of forthcoming commercial lease areas in the Gulf of Maine. Given the region's diverse breeding seabird community and proximity to potential lease areas, it is crucial that we understand the movement ecology of at-risk species. Additionally, it will be important to consider how seabirds utilize the Gulf of Maine during different life history stages including breeding, staging and migration, in which collision or displacement risk may vary. During the summer of 2022, Leach's Storm-Petrels (Hydrobates leucorhous), Arctic (Sterna paradisaea) and Common terns (S. hirundo) were fitted with GPS tags at several monitored seabird colonies across mid-coast Maine. Our initial focus was to understand foraging movements during the breeding season, but with the advancement of GPS technology and tag attachment techniques we have also gathered data on post-breeding dispersal and migration. Here we give a thorough overview of our efforts during the 2022 breeding season, share preliminary results, and discuss our future directions. This work is led by PhD student Keenan Yakola, is funded by the National Audubon Society Seabird Institute, and is conducted in collaboration with Maine Coastal Islands NWR.