# BIOLOGICAL OPINION ON THE EFFECTS OF THE ATLANTIC SHORES OFFSHORE WIND SOUTH ENERGY PROJECTS, OFFSHORE ATLANTIC COUNTY, NEW JERSEY ON THREE FEDERALLY LISTED SPECIES

Turbine rendering from atlanticshoreswind.com

Prepared for:
Bureau of Ocean Energy Management
Office of Renewable Energy Programs
Washington, D.C.

Prepared by:
U.S. Fish and Wildlife Service
New Jersey Field Office
Galloway, New Jersey

Preparers:
Wendy L. Walsh
Rose Kaforski

Assistant Project Leader:
Ross Conover

Project Leader:
Eric Schrading

December 2023

## TABLE OF CONTENTS

## LIST OF FIGURES

## LIST OF TABLES

## INTRODUCTION

This document represents the U.S. Fish and Wildlife Service's (Service) Biological Opinion (BO) in accordance with Section 7 of the Endangered Species Act of 1973, as amended (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq*.) (ESA), on the effects of operating the proposed Atlantic Shores Offshore Wind South (ASOWS) offshore wind energy projects on the federally listed (threatened) piping plover (*Charadrius melodus*) and rufa red knot (*Calidris canutus rufa*) and the federally listed (endangered) roseate tern (*Sterna dougallii dougallii*). In 2021, Atlantic Shores Offshore Wind, LLC (Atlantic Shores) submitted a Construction and Operations Plan (COP) for the ASOWS projects to the Bureau of Ocean Energy Management (BOEM) (COP lasted updated May 2023 (EDR 2023)). If approved by BOEM, the COP will authorize the construction, operation, and decommissioning of the ASOWS projects. BOEM is expected to issue its final decision by December 22, 2023.

The proposed ASOWS projects include offshore components located on the Outer Continental Shelf (OCS) approximately 8.7 miles (14 kilometers (km)) southeast of Atlantic City, Atlantic County, New Jersey. The projects also include onshore components proposed in Monmouth and Atlantic Counties, New Jersey. A Biological Assessment (BA) prepared by BOEM assessed project effects on 10 federally listed species, 1 species proposed for listing, 1 candidate for listing, and 1 species being evaluated for possible listing (13 species total) (BOEM 2023). Via the transmission cover letter to this BO, the Service is providing concurrence with BOEM's determination that the proposed ASOWS projects are not likely to adversely affect the 10 other species, leaving only the piping plover, rufa red knot, and roseate tern, collectively referred to as "listed birds" in this BO. Also in the cover letter, the Service has concurred with BOEM's determination that these listed birds are not likely to be adversely affected by onshore portions of the ASOWS projects, by the construction phase of the offshore components, by any stationary structures in the offshore environment (whether above or below the ocean surface), or as a result of behavioral changes[1] (*e.g.*, displacement, attraction) that the birds may exhibit as a result of wind turbine operation. Thus, this BO addresses only the risk that one or more listed birds will collide with any of the ASOWS wind turbines over the operational life of the projects.

---

[1] The Service has concluded that behavioral effects to listed birds are not reasonably certain to cause take, and are therefore not addressed in this BO. We recognize high uncertainty around this potential effect, and will continue to recommend data collection through the Avian and Bat Post Construction Monitoring Plan to better understand how listed birds do (or do not) respond behaviorally to the wind farm at micro, meso, and macro geographic scales.

## CONSULTATION HISTORY

In addition to the consultation milestones listed below, BOEM, Atlantic Shores, and the Service have coordinated regularly via calls, emails, and meetings since 2021.

| | |
|---|---|
| August 2, 2022 | BOEM requested Service review of a draft BA. |
| November 13, 2022 | The Service provided comments on the draft BA. |
| April 17, 2023 | BOEM submitted a revised BA and initiated consultation. |
| June 15, 2023 | The Service commented on the BA and requested additional information. |
| July 6, 2023 | BOEM provided a revised BA and additional information. |
| July 19, 2023 | The Service determined that the consultation package was complete. |
| August 28, 2023 | The Service provided a draft project description for BOEM review. |
| October 6, 2023 | The Service transmitted a draft BO for review. |
| November 2, 2023 | BOEM transmitted agency and company comments on the draft BO. |

## BIOLOGICAL OPINION

### DESCRIPTION OF THE PROPOSED ACTION

#### Project Description

The Federal action under consideration is approval by BOEM of a COP that would authorize the construction, operations and maintenance (O&M), and eventual decommissioning of two offshore wind energy projects within BOEM Renewable Energy Lease Area OCS-A 0499 (Lease Area) located on the OCS approximately 8.7 miles (14 km) east of Atlantic City, Atlantic County, New Jersey (Figure 1). Other Federal agencies with a role in these projects include the Bureau of Safety and Environmental Enforcement (BSEE), the U.S. Army Corps of Engineers, the U.S. Coast Guard (USCG), and the U.S. Environmental Protection Agency, each taking action under their respective statutory and regulatory authorities.

The two projects would be electrically distinct from each other. However, the ASOWS Project Design Envelope allows for allocating wind turbine positions within an Overlap Area to either project; thus, the final delineation of Lease space and infrastructure between Projects 1 and 2 will be determined at a future date. In this BO, we consider both projects together, and we evaluate the upper end of the Project Design Envelope. Detailed information on all aspects of the projects is available in the COP and the Environmental Impact Statement, both available online.[2]

---

[2] https://www.boem.gov/renewable-energy/state-activities/atlantic-shores-south

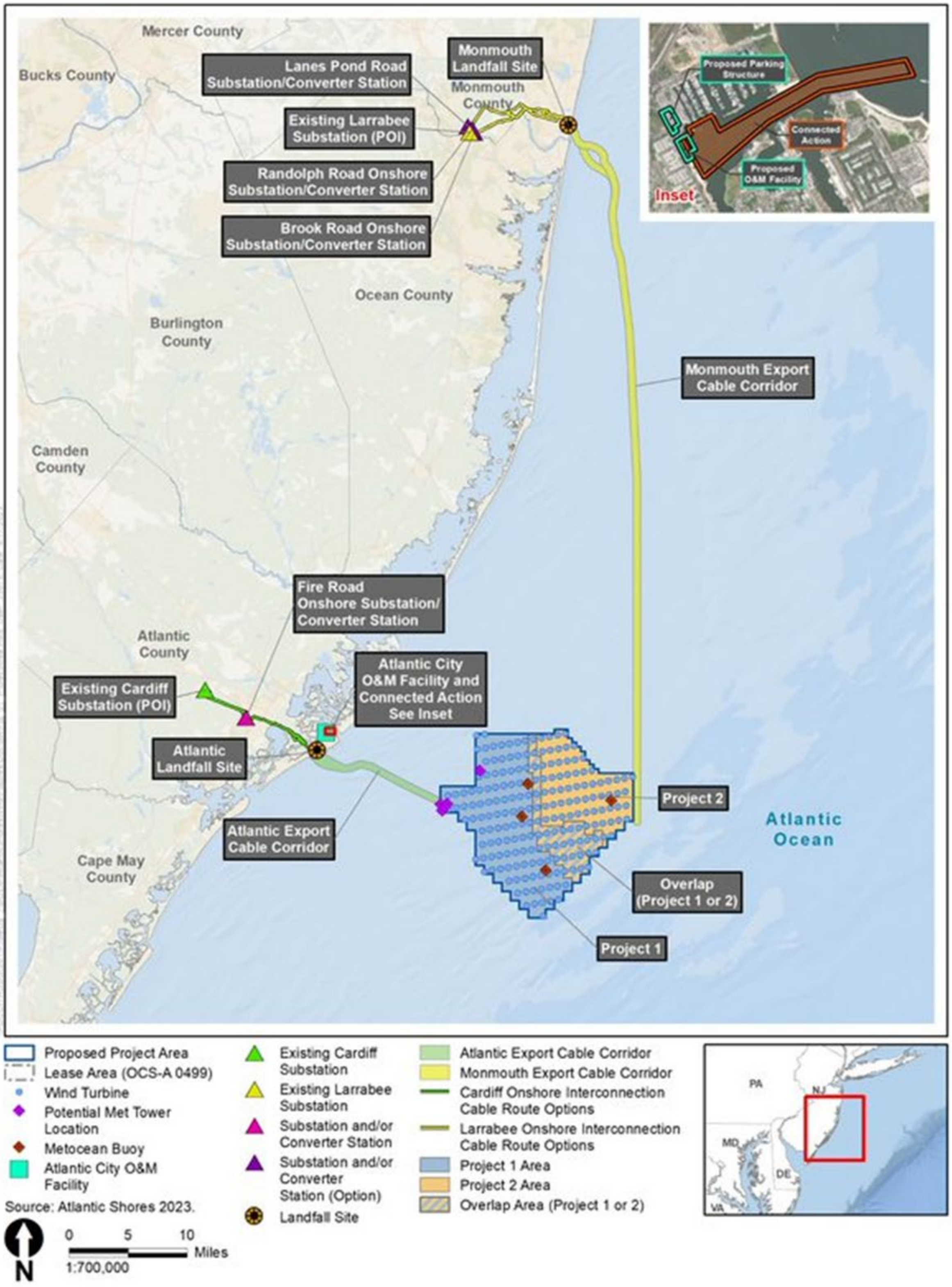


**Figure 1. Atlantic Shores Offshore Wind South Project Locations (BOEM 2023)**

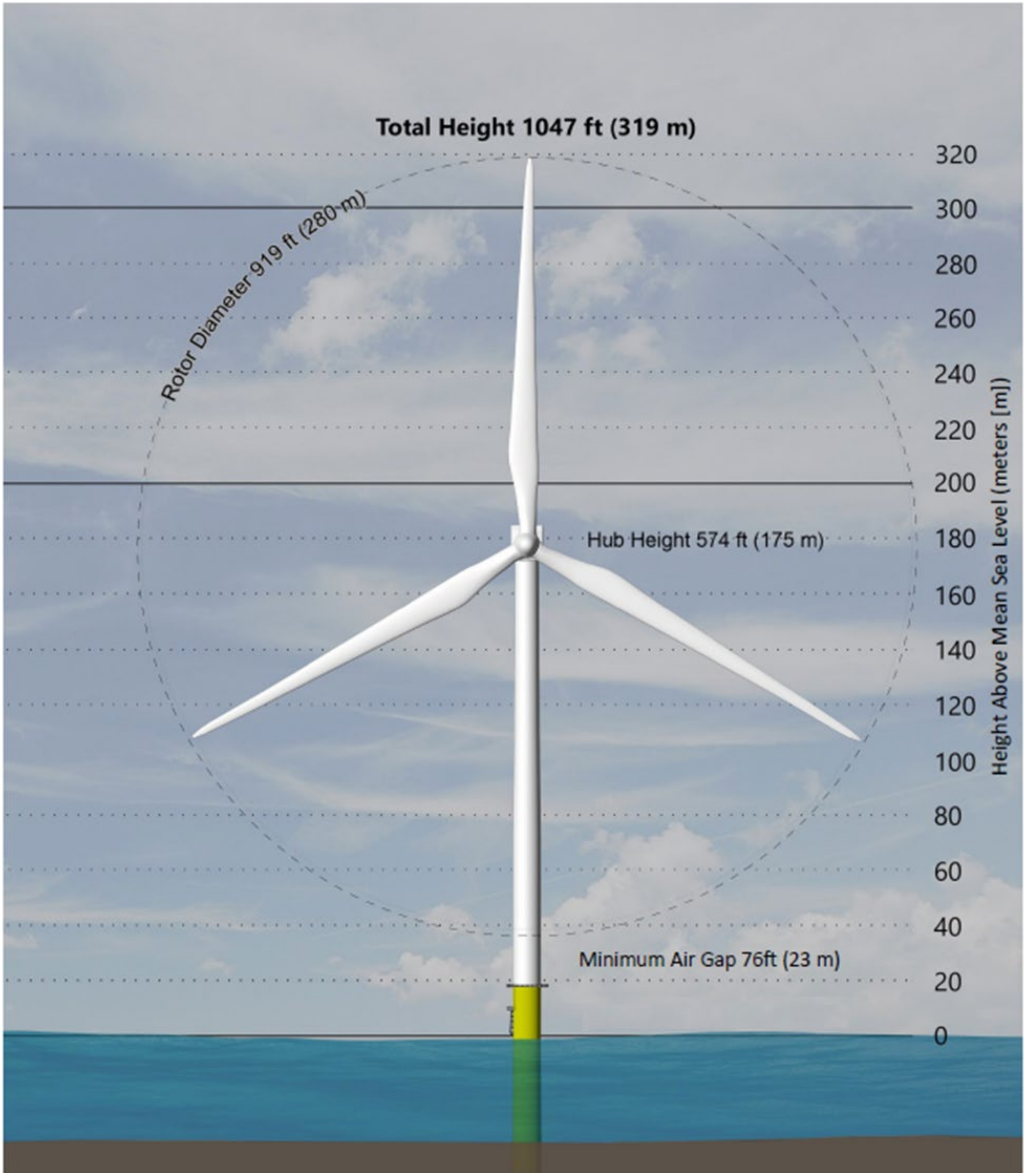


**Figure 2. Wind Turbine Schematic Under the Maximum Design Scenario (BOEM 2023)**

Within the Lease Area, ASOWS Projects 1 and 2 would be located in an approximately 102,124-acre (41,328-hectare) Wind Turbine Area (WTA) (Figure 1). Project 1 would be in the western 54,175 acres (21,924 hectares) of the WTA, and Project 2 in the eastern 31,847 acres (12,888 hectares). The proposed action includes a 16,102-acre (6,516-hectare) Overlap Area that could be used by either Project 1 or Project 2. The WTA consists of the combined spatial extent of ASOWS Projects 1 and 2 and occupies a portion of the Lease Area. The projects also include onshore components proposed in Monmouth and Atlantic Counties, New Jersey. However, this BO addresses only the risk that listed birds will collide with any of the ASOWS turbines over the operational life of the projects; thus, we are considering only those project elements within the WTA.

Project 1 has a capacity of up to 1,510 megawatts, while the capacity of Project 2 is to be determined. For consultation purposes, BOEM assumes that the proposed projects would have an operating period of 30 years. The ASOWS projects include up to 200 wind turbine generators (WTGs) as follows:

- Project 1: 105 to 136 WTGs
- Project 2: 64 to 95 WTGs
- Overlap Area: 31 WTGs (may be part of either project)

Proposed spacing is 0.6 by 1.0 nautical mile (1,100 by 1,852 meters) between WTGs in a nearly east-west orientation (Figure 1). Under the maximum design scenario, the nacelle of each proposed WTG would be 574 feet (175 meters (m) above mean sea level, and the rotor swept area would extend from 76 feet (23 m) to 1,047 feet (319 m) above mean sea level (Figure 2). The ASOWS projects also include: up to 10 offshore substations (OSSs) (with up to 5 in each of the two projects); up to 1 permanent meteorological tower (in Project 1); up to 4 temporary meteorological and oceanographic buoys (up to 3 in Project 1 and up to 1 in Project 2); and interarray and interlink cables connecting WTGs and OSSs within the WTA (BOEM 2023).

## Conservation Measures

The Service's Consultation Handbook defines "Conservation Measures" as "actions to benefit or promote the recovery of listed species that are included by a Federal agency as an integral part of a proposed action under ESA consultation. These actions <u>will be</u> taken by the Federal agency or applicant, and serve to minimize or compensate for, project effects on the species under review" (USFWS and NMFS 1998). Conservation Measures may include actions that the Federal agency or applicant have committed to complete in a BA or similar document. When used in the context of the ESA, "Conservation Measures" represent actions pledged in the project description that the action agency or the applicant <u>will implement</u> to further the recovery of the species under review and can contribute to the Federal agency's Section 7(a)(1) responsibilities. Such measures may be tasks recommended in the species' recovery plan, should be closely related to the action, and should be achievable within the authority of the action agency or applicant. Since Conservation Measures are part of the proposed action, their implementation is required under the terms of the consultation (USFWS and NMFS 1998). The following Conservation Measures have been adopted by BOEM (*i.e.*, in the BA[3] and/or via subsequent correspondence) to abate

---

[3] Conservation Measures that were taken from the BA are followed by the BA Table and Measure number in Italics.

the ongoing collision risk to listed birds posed by operation of the ASOWS turbines. These measures also include an ongoing, long-term commitment to reduce the uncertainty associated with the estimated rates of collision mortality for each of the three listed bird species.

### *1. Turbine Configuration and Maintenance*

a. The WTG design provides a wind turbine air gap (minimum blade tip elevation to the sea surface) to minimize collision risk to marine birds[4] (*e.g.*, roseate terns) that may fly close to the ocean surface.

b. Atlantic Shores will remove marine debris caught on offshore project structures, when safe and practicable, to reduce the risk of bird entanglement (*BA Table 2-6, Measure BIR-07*).

c. Atlantic Shores will reduce attraction to structures by using perch deterrents to the maximum extent practicable for offshore structures (*BA Table 2-6, Measure BIR-04*). To minimize attracting birds (*e.g.*, roseate terns) to operating turbines, Atlantic Shores must install bird perching-deterrent devices on WTGs and OSSs (*BA Table 2-7, Measure 1.a*). Atlantic Shores must submit for BOEM, BSEE, and Service review, and for BOEM and BSEE approval, a Bird Deterrent Plan to discourage perching on offshore infrastructure by roseate terns and other marine birds. Prior to approval of the plan, BOEM and/or BSEE will ensure all Service comments have been addressed. The Bird Deterrent Plan must include the type(s) and locations of bird perching-deterrent devices, include a maintenance plan for the life of the projects, allow for modifications and updates as new information and technology become available, and track the efficacy of the deterrents. The Bird Deterrent Plan will be based on best available science regarding the effectiveness of perching deterrent devices on minimizing collision risk. The location of bird-deterrent devices must be proposed by Atlantic Shores based on best management practices applicable to the appropriate operation and safe installation of the devices. Atlantic Shores must confirm the locations of bird-deterrent devices as part of the as-built documentation it must submit with the Facility Design Report (*BA Table 2-7, Measure 1.a*). A draft Bird Deterrent Plan must be submitted at least 90 days before the start of WTG construction, and a final plan must be approved at least 30 days before the start of construction.

### *2. Offshore Lighting*

Atlantic Shores must comply with all Federal Aviation Administration (FAA), USCG, and BOEM lighting, marking and signage requirements.

a. Atlantic Shores will limit lighting during offshore operations to the minimum required by regulation and for safety, minimizing the potential for any light driven attraction of birds (*BA Table 2-6, Measure BIR-03*).

---

Minor edits to the measures taken from the BA, and all additional measures, were reviewed and adopted by BOEM.

[4] Some Conservation Measures taken directly from the BA or BOEM correspondence include references to species other than the listed birds addressed in this BO. In such cases, the applicability of that measure to non-listed species is not a binding provision of this BO; however, its implementation may be required by BOEM under other authorities.

b. Atlantic Shores will use red flashing FAA lights on the WTGs instead of constant white light, to reduce further bird attraction, and consider Aircraft Detection Lighting System (ADLS) to significantly reduce the number of hours FAA lighting will be illuminated. (*BA Table 2-6, Measure BIR-03*). Atlantic Shores must use an FAA-approved vendor for the ADLS, which will activate the FAA hazard lighting only when an aircraft is in the vicinity of the wind facility to reduce visual impacts at night. Atlantic Shores must confirm the use of an FAA-approved vendor for ADLS on WTGs and OSSs in the Fabrication and Installation Report. (*BA Table 2-7, Measure 1.b*).[5]

c. Atlantic Shores will use yellow flashing marine navigation lights on the WTGs, instead of constant white light, to reduce further bird attraction (*BA Table 2-6, Measure BIR-03*) and will use down-lighting and down-shielding to the maximum extent practicable (*BA Table 2-6, Measure BIR-06*). Atlantic Shores must light each WTG and OSS in a manner that is visible by mariners in a 360-degree arc around the WTG and OSS. To minimize the potential of attracting migratory birds, the top of each light will be shielded[6] to minimize upward illumination (conditional on USCG approval) (*BA Table 2-7, Measure 1.c*). Coordination with USCG regarding maritime navigation lighting occurs post-COP approval, generally at least 120 calendar days prior to installation. Atlantic Shores will apply to USCG to establish Private Aids to Navigation (PATON), which includes a lighting, marking, and signaling plan. The PATON application will include design specifications for maritime navigation lighting.

Following approval of the PATON by the USCG, BOEM, BSEE, and the Service will work together to evaluate the USCG-approved navigation lighting system, in order to characterize the color, intensity, and duration of any light from maritime lanterns that is likely to reach the typical flight heights of listed birds, and will assess the degree to which the light is likely to attract or disorient listed birds. This information will be considered, as appropriate, in future estimates of projected collision levels (see Conservation Measure 4, below), in any future updates to the incidental take statement accompanying this BO, and in future iterations of the Compensatory Mitigation Plan (see Conservation Measure 7, below).

**Note:** The remaining measures are intended to address significant data gaps in avian use of offshore areas, collision modelling, and compensatory mitigation. They are not intended to avoid or minimize the collision risk at this time.

### *3. Collision Risk Model Support*

BOEM has funded the development of a Stochastic Collision Risk Assessment for Movement (SCRAM), which builds on and improves earlier collision risk modeling frameworks. The

---

[5] In the cover letter to this BO, the Service provides concurrence that aircraft obstruction lighting using the ADLS is expected to have negligible effect on the behavior of listed birds.

[6] The Service understands that the USCG-approved lights may not be shielded, *per se*, but that marine lanterns typically approved for this type of usage are designed to mainly illuminate a horizonal plane near the sea surface, and do not direct light skyward. On p. 110 of the BA, BOEM stated that shielding of lights may adversely affect navigation and is therefore subject to USCG approval and not committed to for the ASOWS projects at this time.

Service fully supports SCRAM as a scientifically sound method for integrating best available information to assess collision risk for the three listed bird species. The first generation of SCRAM was released in early 2023 and still reflects a number of consequential data gaps and uncertainties. BOEM has already committed to funding Phase 2 of the development of SCRAM. We expect that the current limitations of SCRAM will decrease substantially over time as more tracking data is incorporated into the model (*e.g.*, from more individual birds tagged in more geographic areas, improved bird tracking capabilities, and emerging tracking technologies), and as modeling methods and computing power continue to improve.

Via this Conservation Measure, BOEM commits to continue funding the refinement and advancement of SCRAM, or its successor, with the goal of continually improving the accuracy and robustness of collision mortality estimates. This commitment is subject to the allocation of sufficient funds to BOEM from Congress. This commitment will remain in effect until one of the following occurs:

i. the ASOWS turbines cease operation;
ii. the Service concurs that a robust weight of evidence has demonstrated that collision risks to all three listed birds from ASOWS turbine operation are negligible (*i.e.*, the risk of take from WTG operation is found to be discountable); or
iii. the Service concurs that further development of SCRAM (or its successor) is unlikely to improve the accuracy or robustness of collision mortality estimates.

### *4. Collision Risk Model Utilization*

BOEM will work cooperatively with the Service to re-run the SCRAM model (or its successor) for the ASOWS projects according to the following schedule:

- At least annually for the first 3 years of WTG operation.
- At least every other year for years 4 to 10 of WTG operation (*i.e.*, years 4, 6, 8, and 10).
- At least every 5 years between year 10 and the termination of WTG operation (*i.e.*, years 15, 20, 25, and 30).

Between these regularly scheduled model runs, BOEM will also re-run the SCRAM model (or its successor) within 90 days of each major model release or update, and at any time upon request by the Service or Atlantic Shores, and at any time as desired by BOEM. Prior to each model run, BOEM and the Service will reach agreement on model inputs based on best available science, and the agencies may opt for multiple model runs using a range of inputs to reflect uncertainties in the inputs.

The above schedule may be altered upon the mutual agreement of BOEM and the Service. The schedule is subject to sufficient allocation of funds to BOEM from Congress. This commitment will remain in effect until one of the following occurs:

i. the ASOWS turbines cease operation;
ii. the Service concurs that a robust weight of evidence has demonstrated that collision risks to all three listed birds from ASOWS turbine operation are negligible (*i.e.*, the risk of take from WTG operation is found to be discountable); or
iii. the Service concurs that further model runs are unlikely to improve the accuracy or robustness of collision mortality estimates.

BOEM is currently undertaking a programmatic analysis of proposed offshore wind activities in the New York Bight, including activity on leases contiguous with Atlantic Shores Lease OCS-A 0499. To account for potential additive and synergistic effects of offshore wind infrastructure buildout across this section of the coast, BOEM will consider collision mortality estimates for ASOWS in its assessment of overall collision risk for the New York Bight. The periodic updating of collision mortality estimates for ASOWS, according to the above schedule, may eventually be integrated into a regional or coastwide adaptive monitoring and impact minimization framework.

### *5. Monitoring and Data Collection*

In conjunction with BOEM and the Service, Atlantic Shores has implemented an Avian and Bat Survey Plan that included digital aerial surveys and a satellite telemetry study of the rufa red knot to further characterize the WTA and support consultations (*BA Table 2-6, Measure BIR-01*). Atlantic Shores has also used the Motus Wildlife Telemetry System (Motus) to track the offshore movement of nano-tagged bird species within the WTA, following Service guidance on how to integrate automated radio telemetry into pre- and post-construction monitoring plans for offshore wind farms (*BA Table 2-6, Measure BIR-02*).

Atlantic Shores will develop and implement an avian post-construction monitoring plan for the offshore area (*BA Table 2-6, Measure BIR-08*). BOEM will require that Atlantic Shores develops and implements an Avian and Bat Post-Construction Monitoring Plan[7] in coordination with the Service, NJDEP, and other relevant regulatory agencies. Annual monitoring reports will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring. Prior to commencing offshore construction activities, Atlantic Shores must submit an Avian and Bat Post-Construction Monitoring Plan for BOEM, BSEE, and Service review. BOEM and the Service will review the Avian and Bat Post-Construction Monitoring Plan and provide any comments on the plan within 30 calendar days of its submittal. Atlantic Shores must resolve all comments on the Avian and Bat Post-Construction Monitoring Plan to BOEM and the Service's satisfaction before implementing the plan (*BA Table 2-7, Measure 3*) and prior to the start of WTG operations. The objectives of the monitoring plan will include: (1) to advance understanding of how the target species utilize the offshore airspace and do (or do not) interact with the wind farm; (2) to improve the collision estimates from SCRAM (or its successor) for the three listed bird species; and (3) to inform any efforts aimed at minimizing collisions or other project effects on target species.

---

[7] The post-construction monitoring plan will address listed and non-listed birds and bats. This BO addresses only turbine collision risk for three listed birds, and only those elements of the plan related to collision of these three species are binding provisions of this BO. However, implementation of the full plan may be required by BOEM under other authorities. In addition, the Service may provide separate monitoring recommendations for other species (*e.g.*, listed bats, non-listed birds) and/or other issues (*e.g.*, assessing behavioral change of listed or non-listed species) as technical assistance pursuant to the ESA, the Migratory Bird Treaty Act (40 Stat. 755; 16 U.S.C. 703-712, as amended), and/or the National Environmental Policy Act (83 Stat. 852; 42 U.S.C. 4321 *et seq.*).

a. Monitoring. Atlantic Shores must conduct monitoring as outlined in the Atlantic Shores South Bird and Bat Monitoring Framework, which will use radio tags to monitor movement of listed birds in the vicinity of the projects (*BA Table 2-7, Measure 3.a*). The Avian and Bat Post-Construction Monitoring Plan will allow for changing methods over time (see Conservation Measure 5.d, below) in order to regularly update and refine collision estimates for listed birds. The plan will include an initial monitoring phase involving deployment of Motus radio tags on listed birds in conjunction with installation and operation of Motus receiving stations on turbines in the Lease Area following offshore Motus recommendations.[8] The initial phase may also include deployment of satellite-based tracking technologies (*e.g.*, GPS or Argos tags).

b. Annual Monitoring Reports. Atlantic Shores must submit to BOEM (at renewable_reporting@boem.gov), the Service, and BSEE (via TIMSWeb with a notification email sent to protectedspecies@bsee.gov) a comprehensive report after each full year of monitoring (pre- and post-construction) within 12 months of completion of the last avian survey. The report must include all data, analyses, and summaries regarding ESA-listed and non-ESA-listed birds and bats. BOEM, the Service, and BSEE will use the annual monitoring reports to assess the need for reasonable revisions (based on subject matter expert analysis) to the Avian and Bat Post-Construction Monitoring Plan. BOEM, BSEE, and the Service reserve the right to require reasonable revisions to the Avian and Bat Post-Construction Monitoring Plan and may require new technologies as they become available for use in offshore environments (*BA Table 2-7, Measure 3.b*) (see Conservation Measure 5.d, below).

c. Post-Construction Quarterly Progress Reports. Atlantic Shores must submit quarterly progress reports during the implementation of the Avian and Bat Post-Construction Monitoring Plan to BOEM (at renewable_reporting@boem.gov), and BSEE (via TIMSWeb with a notification email sent to protectedspecies@bsee.gov), and the Service by the 15th day of the month following the end of each quarter during the first full year that the Project is operational. The progress reports must include a summary of all work performed, an explanation of overall progress, and any technical problems encountered (*BA Table 2-7, Measure 3.c*).

d. Monitoring Plan Revisions. Within 30 calendar days of submitting the annual monitoring report, Atlantic Shores must meet with BOEM and Service to discuss the following: the monitoring results; the potential need for revisions to the Avian and Bat Post-Construction Monitoring Plan, including technical refinements or additional monitoring; and the potential need for any additional efforts to reduce impacts. If BOEM or the Service determines after this discussion that revisions to the Avian and Bat Post-Construction Monitoring Plan are necessary, BOEM may require Atlantic Shores to modify the Avian and Bat Post-Construction Monitoring Plan. If the reported monitoring results deviate substantially from the impact analysis included in the Final BA, Atlantic Shores must transmit to BOEM recommendations for new mitigation measures and/or monitoring methods (*BA Table 2-7, Measure 3.d*).

---

[8] https://motus.org/groups/atlantic-offshore-wind/

The frequency, duration, and methods for various monitoring efforts in future revisions of the Avian and Bat Post-Construction Monitoring Plan will be determined adaptively based on current technology and the evolving weight of evidence regarding the likely levels of collision mortality for each listed bird species. The effectiveness and cost of various technologies/methods will be key considerations when revising the plan. Grounds for revising the Avian and Bat Post-Construction Monitoring Plan include, but are not limited to: (i) greater than expected levels of collision of listed birds; (ii) evolving data input needs (as determined by BOEM and the Service) for SCRAM (or its successor); (iii) changing technologies for tracking or otherwise monitoring listed birds in the offshore environment that are relevant to assessing collision risk; (iv) new information or understanding of how listed birds utilize the offshore environment and/or interact with wind farms; and (v) a need (as determined by BOEM and the Service) for enhanced coordination and alignment of tracking, monitoring, and other data collection efforts for listed birds across multiple wind farms/leases on the OCS.

BOEM will require Atlantic Shores to continue implementation of appropriate monitoring activities for listed birds (under the current and future versions of the Avian and Bat Post-Construction Monitoring Plan) until one of the following occurs: (i) the ASOWS turbines cease operation; (ii) the Service concurs that a robust weight of evidence has demonstrated that collision risks to all three listed birds from ASOWS turbine operation are negligible (*i.e.*, the risk of take from WTG operation is found to be discountable); or (iii) the Service concurs that further data collection is unlikely to improve the accuracy or robustness of collision mortality estimates and is unlikely to improve the ability of BOEM and Atlantic Shores to reduce or offset collision mortality (see Conservation Measure 7, below).

e. Operational Reporting (Operations). Atlantic Shores must submit to BOEM (at renewable_reporting@boem.gov) and BSEE (via TIMSWeb with a notification email sent to protectedspecies@bsee.gov) an annual report summarizing monthly operational data calculated from 10-minute supervisory control and data acquisition (SCADA) data for all turbines together in tabular format: the proportion of time the turbines were operational (spinning at >x rpm) each month, the average rotor speed (monthly revolutions per minute[rpm]) of spinning turbines plus 1 standard deviation, and the average pitch angle of blades (degrees relative to rotor plane) plus 1 standard deviation. Any operational data considered by the Lessee to be privileged or confidential must be clearly marked as confidential business information and will be handled by BOEM and BSEE in a manner consistent with 30 CFR 585.114. BOEM and BSEE will use this information as inputs for avian collision risk models to assess whether the results deviate substantially from the impact analysis included in this BO (*BA Table 2-7, Measure 3.e*).

f. Raw Data. Atlantic Shores must store the raw data from all avian and bat surveys and monitoring activities according to accepted archiving practices. Such data must remain accessible to BOEM, BSEE, and the Service, upon request for the duration of the Lease. Atlantic Shores must work with BOEM to ensure the data are publicly available (*BA Table 2-7, Measure 3.f*). All avian tracking data (*i.e.*, from radio and satellite transmitters) will be stored, managed, and made available to BOEM and the Service following the protocols and procedures outlined in the agency document entitled *Guidance for Coordination of Data from Avian Tracking Studies*, or its successor.

### *6. Incidental Mortality Reporting* [9]

Atlantic Shores will report any dead or injured birds to BOEM on an annual basis. Birds with Service bands will be reported to the USGS Bird Banding Lab (BBL)[10] (*BA Table 2-6, Measure BIR-09*). Atlantic Shores must provide an annual report to BOEM and the Service documenting any dead (or injured) birds or bats found on vessels and structures during construction, operations, and decommissioning. The report must contain the following information: the name of species, date found, location, a picture to confirm species identity (if possible), and any other relevant information. Carcasses with federal or research bands must be reported to the BBL. Any occurrence of a dead listed bird or bat must be reported to BOEM, BSEE (via TIMSWeb with a notification email sent to protectedspecies@bsee.gov), and the Service as soon as practicable (taking into account crew and vessel safety), ideally within 24 hours and no more than 3 days after the sighting. If practicable, the dead specimen will be carefully collected and preserved in the best possible state, contingent on the acquisition of the necessary wildlife permits and compliance with the Atlantic Shores health and safety standards (*BA Table 2-7, Measure 4*). Also see Monitoring Requirements at the end of this BO.

## ACTION AREA

The action area is defined (at 50 CFR 402.02) as “all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action.” The action area for the overall ASOWS projects is considerably larger than the action area considered in this BO. The action area for the complete projects includes surface and subsurface portions of the offshore environment extending to the seabed, as well as areas of beach, estuarine, freshwater, and terrestrial habitats affected by onshore project components (see Figure 1). However, as discussed above, this BO addresses only the risk that one or more listed birds will collide with any of the ASOWS wind turbines over the operational life of the project. Thus, in this BO, we consider only a subset of the overall action area, limited to the offshore airspace within the WTA, extending from the ocean surface to the maximum height of the turbine blade tip, 1,047 feet (319 m) above the mean sea level (see Figure 2). For roseate terns, the action area also includes ocean waters to a depth of roughly 20 inches (50 centimeters (cm)), as this species feeds by plunge diving (Mostello 2015) and may occasionally do so within the WTA. For both projects together, the maximum dimensions of the WTA are about 16.4 miles (26.4 km) wide by 15.5 miles (24.9 km) long, with an area of about 102,124 acres (413 sq km) (BOEM 2023).

---

[9] Incidental observations are extremely unlikely to document any fatalities of listed birds that may occur due to turbine collision. While this Conservation Measure appropriately requires documentation and reporting of any fatalities observed incidental to O&M activities, the Avian and Bat Post-Construction Monitoring Plan will make clear that lack of documented fatalities in no way suggests that fatalities are not occurring. Likewise, the agencies will not presume that any documented fatalities were caused by colliding with a turbine unless there is evidence to support this conclusion.

[10] https://www.pwrc.usgs.gov/bbl/

## STATUS OF THE SPECIES

Per ESA Section 7 regulations (50 CFR 402.14(g)(2)), it is the Service's responsibility to "evaluate the current status of the listed species or critical habitat." The following is a summary of the listed bird species' general life history drawn primarily from Service assessment, listing, and recovery documents. According to the Consultation Handbook (USFWS and NMFS 1998), the Service's jeopardy analysis may be based on an assessment of impacts at the level of recovery units when those units are documented as necessary to both the survival and recovery of the species in a final recovery plan. The Consultation Handbook also notes that, when the Service's review in a BO focuses on the effects of the action on a discrete recovery unit, the species status section of the BO is to describe the status of that unit and its significance to the species as listed (USFWS and NMFS 1998). Thus, for piping plover and rufa red knot, the information and analysis that follows focus on birds from those recovery units that are expected to occur in the ASOWS action area.

### Piping Plover

#### *Listing and Life History*

Piping plovers breed in three discrete areas, the Atlantic Coast, the Great Lakes, and the Northern Great Plains of the United States and Canada. The Atlantic Coast and Northern Great Plains populations are listed under the ESA as threatened, while the Great Lakes population is listed as endangered. Each breeding population has its own recovery plan. Birds from all three populations winter along the U.S. coast from North Carolina to Texas, as well as in Mexico and the Caribbean (USFWS 2020a). We have no evidence that piping plovers from the Northern Plains population migrate or otherwise occur offshore New Jersey. Occasional migratory stopovers by Great Lakes piping plovers have been documented in New Jersey and Virginia (Stucker *et al.* 2010, Van Zoeren pers. comm. 2023). We have not assessed detection probability for birds from the Great Lakes population, and we currently know little about their routes to or from these sites (including wintering sites farther south). We consider the likelihood that Great Lakes birds will be affected by the proposed projects discountable and will re-evaluate this determination if warranted by new information or further analysis. Therefore, the two inland breeding populations are not considered in this BO. Within its Atlantic Coast breeding range, the piping plover was federally listed as threatened in 1986 (50 FR 50726).

Critical habitat for wintering piping plovers, including individuals from the Great Lakes and Northern Great Plains breeding populations as well as birds that nest along the Atlantic Coast, was designated in 2001 (66 FR 36038) and revised in 2008 (73 FR 62816-62841), and extends along the coasts from North Carolina through Texas (USFWS 2020a). The designated critical habitat for wintering piping plovers is restricted to the coasts and does not overlap the action area, and there is no proposed or designated critical habitat within the breeding range of the Atlantic Coast population. Therefore, critical habitat for this species is not considered in this BO.

The Atlantic Coast piping plover population breeds on coastal beaches from Newfoundland to North Carolina and winters along the Atlantic Coast from North Carolina south, along the Gulf Coast, and in the Caribbean (USFWS 1996). The Bahamas is a particularly important wintering area for piping plovers from the Atlantic Coast breeding population (USFWS 2020a). The piping plover is a small shorebird approximately 7 inches (18 cm) long with a wingspan of about 15 inches (38 cm). Piping plovers are present on the New Jersey shore during the breeding season, generally between March 1 and August 31, though migrants may be present through October. These territorial birds nest above the high tide line, usually on sandy ocean beaches and barrier islands, but also on gently sloping foredunes, blowout areas behind primary dunes, washover areas cut into or between dunes, the ends of sandspits, and deposits of suitable dredged or pumped sand. Piping plover nests consist of a shallow scrape in the sand, frequently lined with shell fragments and often located near small clumps of vegetation. Females lay up to four eggs that hatch in about 25 days. Piping plovers generally fledge only a single brood per season, but may renest several times if previous nests are lost or, infrequently, if a brood is lost within several days of hatching. Surviving chicks learn to fly (fledge) after about 25 to 35 days. The flightless chicks follow their parents to feeding areas, which include the intertidal zone of ocean beaches, ocean washover areas, mudflats, sandflats, wrack lines, and the shorelines of coastal ponds, lagoons, and salt marshes. Piping plover adults and chicks feed on marine macroinvertebrates such as worms, fly larvae, beetles, and crustaceans (USFWS 1996).

### *Threats*

Threats to piping plovers on the Atlantic Coast include habitat loss and degradation; human disturbance of nesting birds; predation; and oil spills (USFWS 1996). All of the major threats (habitat loss/degradation, disturbance, predation) identified in the 1986 ESA listing and 1996 revised recovery plan remain persistent and pervasive, and oil spills are a continuing moderate threat (USFWS 2020a). Habitat loss and degradation result from development, as well as from beach stabilization, beach nourishment, beach raking, dune stabilization, and other physical alterations to the beach ecosystem. Development and artificial shoreline stabilization pose continuing widespread threats to the low, sparsely vegetated beaches juxtaposed with abundant moist foraging substrates that breeding Atlantic Coast piping plovers rely on. Severe threats from human disturbance and predation remain ubiquitous along the Atlantic Coast. Human disturbance of nesting birds includes foot traffic, sunbathing, kites, pets, fireworks, mechanical raking, construction, and vehicle use. These disturbances can result in crushing of eggs, failure of eggs to hatch, and death of chicks (*e.g.*, through effects to their energy budgets). Predation on piping plover chicks and eggs is intensified by development because predators such as foxes (*Vulpes vulpes*), rats (*Rattus norvegicus*), raccoons (*Procyon lotor*), skunks (*Mephitis mephitis*), crows (*Corvus* spp.), and gulls (*Larus* spp.) thrive in developed areas and are attracted to beaches by human food scraps and trash. Unleashed and feral dogs (*Canis familiaris*) and cats (*Felis domesticus*) also disturb courtship and incubation and prey on chicks and adults (USFWS 1996, 2020a). The best available information indicates that disease, environmental contaminants other than oil spills, and overutilization are not current threats to Atlantic Coast piping plovers (USFWS 2020a).

Two new threats have been identified in recent Service reviews. Climate change (especially sea level rise) and wind turbines are likely to affect Atlantic Coast piping plovers throughout their annual cycle. Some aspects of climate change remain uncertain, but ongoing acceleration of sea level rise is well documented. Further increases in sea level rise rates are foreseeable with a high degree of certainty, and effects of sea level rise on Atlantic Coast piping plovers and their habitat will be partially determined by coastal management decisions (USFWS 2020a).

Although threats from offshore and onshore WTGs are foreseeable, their magnitude remains poorly understood (USFWS 2020a). In recent years, the advancement of BOEM's wind leasing and project reviews has increased the degree of certainty for future offshore project locations. In addition, with BOEM's support, important species-specific information has been acquired in the past decade (*i.e.*, Loring *et al.* 2019, 2020) to help assess project effects. However, some key risk factors (*e.g.*, avoidance rates) remain largely unknown, and information is lacking to assess site-specific and collective effects of wind energy projects. The number and locations of future proposed onshore turbines remain unclear, as do the timing and extent of full coastwide buildout of offshore WTGs. Any effects of the turbines on migrating birds (*e.g.*, collision, behavioral effects) are even more difficult to study and characterize offshore than on land. Seven offshore wind farm projects along the Atlantic Coast have completed Section 7 ESA formal consultations, with a total anticipated incidental take of up to 60 piping plovers (Table 1).

**Table 1. Summary of anticipated piping plover incidental take for Atlantic Coast offshore wind energy projects that have completed formal consultation with the Service (USFWS 2023a)**

| Date of Opinion Issuance | Project Name | Anticipated Take (Annual) | Project Duration | Anticipated Take[1] (Project Duration) |
|---|---|---|---|---|
| 5/12/2023 | Ocean Wind 1 [2] | <1 | 35 years | 5 |
| 5/30/2023 | Revolution Wind | <1 | 35 years | 3 |
| 6/22/2023 | Empire Wind | <1 | 35 years | 2 |
| 6/29/2023 | Sunrise Wind | <1 | 35 years | 2 |
| 8/31/2023 | CVOW-C | 1 | 33 years | 29 |
| 9/1/2023 | SouthCoast Wind | <1 | 35 years | 6 |
| 9/28/2023 | New England Wind | <1 | 33 years | 13 |
| **Total** | | **<7** | | **~60** |

[1] For the first four projects in this table, compensatory mitigation was included as a conservation measure in the respective BOs. For those four projects, compensatory mitigation plans are to be developed before the start of WTG operation, and tangible commitments are to be in place concurrent with the start of operations. Geographic considerations may include, but are not limited to: (a) any listed species recovery unit(s) or other management unit(s) determined to be disproportionally affected by or vulnerable to collision mortality; and/or (b) those portions of a species' range where compensatory mitigation is most likely to be effective in offsetting collision mortality. For the other three projects, we understand that BOEM intends to require compensatory mitigation as a condition of the COPs, but we have no information regarding the amount or type of mitigation that will occur.

[2] We are aware that Ørsted has announced it will cease development of the Ocean Wind 1 Project (https://oceanwindone.com/news-archive/2023/11/orsted). However, the project status remains "in progress" with regard to Federal permitting (https://www.permits.performance.gov/permitting-project/fast-41-covered-projects/ocean-wind-1-project). Thus, we still consider take authorized in the Ocean Wind 1 BO as part of the status of the species in this BO.

New information demonstrates the important effect of wintering site conditions on annual survival rates, a factor to which piping plover populations are highly sensitive as discussed below. Although progress toward understanding and managing threats in this portion of the range has accelerated in recent years, substantial work remains to fully identify and remove or manage migration and wintering threats, including habitat degradation and increasing human disturbance (USFWS 2020a).

### *Demographics and Population Trends*

Piping plovers are considered mature at age one (USFWS 1996) and may breed the first spring after hatching, although some birds do not breed their first year (Elliot-Smith and Haig 2020). Although some birds do not obtain a mate in some years, most birds breed each year (Elliot-Smith and Haig 2020). Although piping plovers have been documented to live more than 11 years, we estimate based on typical survival rates that the average lifespan is approximately 5 to 6 years (USFWS 2023b). Estimates of annual adult survival in the 2000s on Long Island (70 percent) and eastern Canada (73 percent) were similar to those reported from the late 1980s in Massachusetts (74 percent) and Maryland (71 percent). There is currently no information regarding the distribution of mortality across the annual cycle of Atlantic Coast piping plovers. Two Atlantic Coast population viability analyses (PVAs) conducted in the 2000s confirmed the consistent finding of earlier piping plover PVAs that extinction risk is highly sensitive to small changes in adult and/or juvenile survival rates. Progress toward recovery would be quickly slowed or reversed by even small, sustained decreases in survival, and it would be difficult to increase current fecundity levels sufficiently to compensate for widespread long-term declines in survival (USFWS 2009).

As a sparsely-distributed species with strict biological requirements, the Atlantic Coast piping plover is vulnerable to both stochastic environmental variation and catastrophic events. Thus, the security of this species is fundamentally dependent on even distribution of population growth across the breeding range, to conserve adaptive capacity as a buffer against these factors (USFWS 2020a). Accordingly, the recovery plan (USFWS 1996) delineates four recovery units: Eastern Canada (also called Atlantic Canada in some documents), New England, New York, New Jersey (NY-NJ) and Southern (Delaware, Maryland, Virginia, and North Carolina). Recovery criteria established in the recovery plan define population and productivity goals for each recovery unit, as well as for the population as a whole. Attainment of these goals for each recovery unit is an integral part of a piping plover recovery strategy that seeks to reduce the probability of extinction for the entire population by: (1) contributing to the population total; (2) reducing vulnerability to environmental variation (including catastrophes); and (3) increasing likelihood of genetic interchange among subpopulations. Recovery depends on attainment and maintenance of the minimum population levels for the four recovery units. Any appreciable reduction in the likelihood of survival of a recovery unit will also reduce the probability of persistence of the entire population (USFWS 1996). The Southern recovery unit is not addressed in this BO, as these birds spend their entire life cycle south of the action area. Some number of birds from each of the other three recovery units are expected to occur in the action area during spring and fall migration.

As described in the recovery plan (USFWS 1996), the conservation needs of the Atlantic Coast piping plover population include: (1) a total of 2,000 breeding pairs, distributed among the four recovery units sustained for at least 5 years; (2) a 5-year average productivity rate of 1.5 chicks per pair in each recovery unit; and (3) long-term maintenance of wintering habitat sufficient in quantity, quality, and distribution to maintain survival rates needed for a 2,000-pair population. These recovery criteria reflect the conservation tenets of representation, redundancy, and resiliency (3Rs).

The 2021 Atlantic Coast piping plover population estimate of 2,289 pairs was almost triple the estimate of 790 pairs at the time of the 1986 ESA listing. Overall population growth is tempered by very substantial geographic and temporal variability (Figure 3, Table 2). By far, the largest population increase between 1989 and 2021 occurred in New England (514 percent). Abundance in the NY-NJ recovery unit experienced a net increase of 81 percent between 1989 and 2021. However, this population declined sharply from a peak of 586 pairs in 2007 to 378 pairs in 2014, before rebounding to 576 pairs in 2021. Net growth in the Southern recovery unit population was 35 percent between 1989 and 2021, but the Southern population decreased 30 percent between 2016 and 2021. In Eastern Canada, where increases have often been quickly eroded in subsequent years, the population posted a net 23 percent decline between 1989 and 2021. Declines in the Eastern Canada and Southern recovery units typify long-standing concerns about the uneven distribution of Atlantic Coast piping plovers (USFWS 2022a).

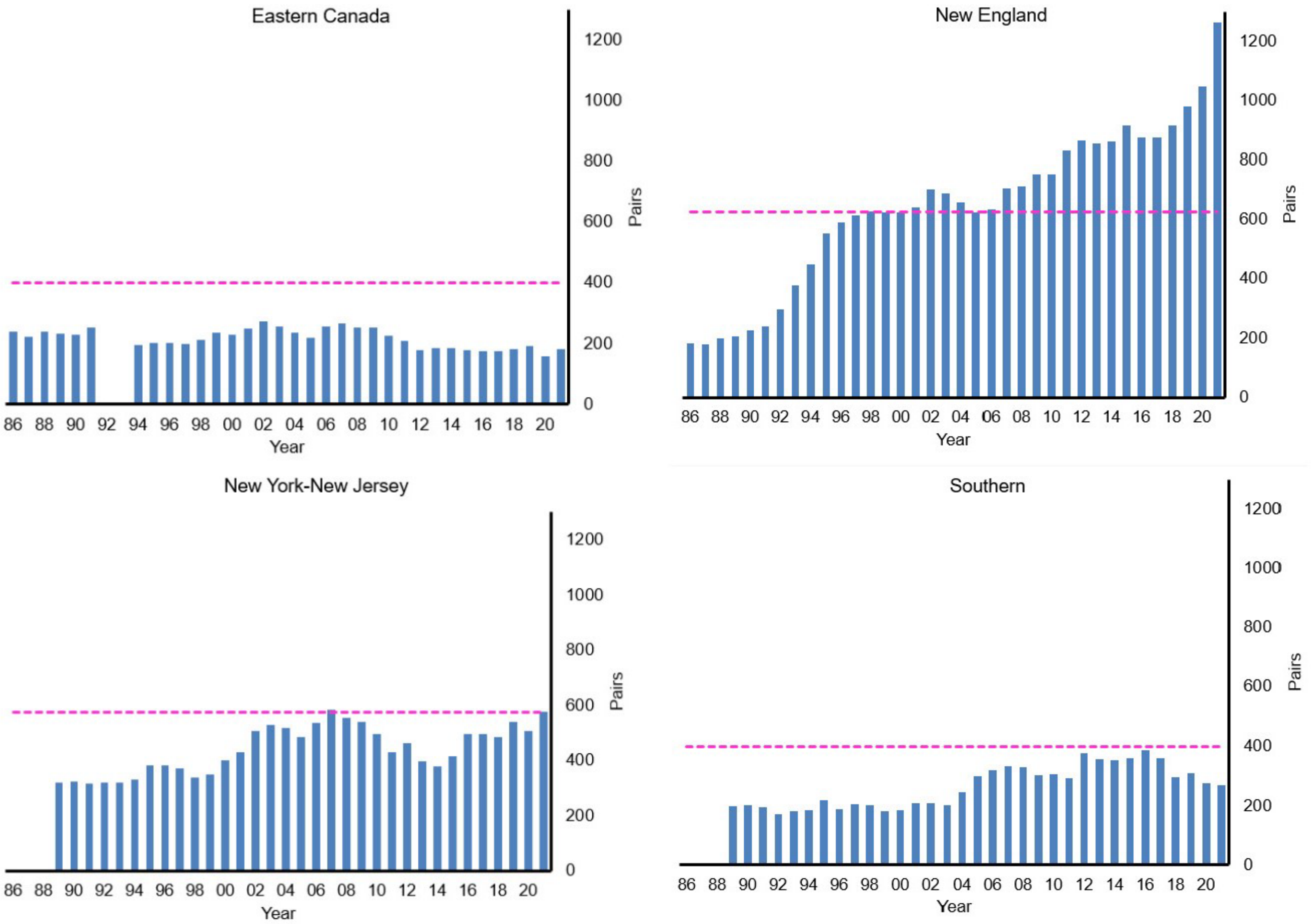


**Figure 3. Atlantic Coast Piping Plover Breeding Pairs by Recovery Unit, 1986-2021**

Blue bars denote the annual pair estimate. Dashed pink lines indicate abundance objectives established in the 1996 revised recovery plan (USFWS 2022a).

Atlantic Coast piping plover productivity is reported as number of chicks fledged per breeding pair. Rangewide productivity for the Atlantic Coast population from 1989 through 2006 was 1.35

chicks fledged per pair (annual range 1.16 to 1.54), and overall productivity decreased with decreasing latitude (Eastern Canada 1.61, New England 1.44, NY-NJ 1.18, Southern 1.19). Including more recent years, average annual productivity for the U.S. Atlantic Coast from 1989 to 2018 was 1.25 fledged chicks per pair. The overall U.S. Atlantic Coast productivity estimate was 1.38 fledged chicks per pair in 2019, 1.25 in 2020, and 1.09 in 2021—the fifth lowest since 1989 (USFWS 2022a).

Although overall population growth has reduced the Atlantic Coast piping plover's vulnerability to extinction since listing under the ESA, the distribution of population growth remains very uneven. The Eastern Canada recovery unit is experiencing a long-term decline, the New England recovery unit is increasing sharply, and the NY-NJ recovery unit is tenuously stable.

**Table 2. Estimated numbers of pairs* of Atlantic Coast piping plovers, 2012-2021 (USFWS 2022a)**

| | **Eastern Canada** | **New England** | **NY-NJ** | **Southern*** | **Total** |
|---|---:|---:|---:|---:|---:|
| 2012 | 179 | 865 | 463 | 377 | 1,884 |
| 2013 | 184 | 854 | 397 | 358 | 1,793 |
| 2014 | 186 | 861 | 378 | 354 | 1,779 |
| 2015 | 179 | 914 | 416 | 362 | 1,871 |
| 2016 | 176 | 874 | 496 | 386 | 1,932 |
| 2017 | 173 | 874 | 497 | 359 | 1,903 |
| 2018 | 181 | 916 | 486 | 295 | 1,878 |
| 2019 | 190 | 980 | 540 | 309 | 2,019 |
| 2020 | 158 | 1,047 | 508 | 277 | 1,990 |
| 2021 | 180 | 1,264 | 576 | 269 | 2,298 |
| average | 179 | 945 | 476 | 335 | 1,935 |

*Recovery criteria: Eastern Canada=400. New England=625. NY-NJ=575. Southern=400. Total=2,000
**Presented for context but not considered in this BO.

## Rufa Red Knot

### *Listing and Life History*

The rufa red knot was listed as threatened under the ESA in 2015 (79 FR 73705). Critical habitat for the rufa red knot was proposed in 2021 (86 FR 37410) and a revision to the proposal was published in April 2023 (88 FR 22530); no final rule has been published to date. The proposed critical habitat is restricted to the coasts and does not overlap the action area; therefore, critical habitat for this species is not considered in this BO.

The rufa red knot is a medium-sized (9 to 10 inches (23 to 25 cm) long) shorebird that migrates annually between its breeding grounds in the central Canadian Arctic and four wintering regions: (1) the Southeast United States and through the Caribbean; (2) the Western Gulf of Mexico from Mississippi through Central America and along the western coast of South America; (3) northern Brazil and extending west along the northern coast of South America; and (4) Tierra del Fuego at the southern tip of South America (mainly in Chile) and extending north along the Patagonian coast of Argentina. This subspecies has very high fidelity to its wintering region, with habitat, diet, and phenology varying appreciably among birds from different regions (USFWS 2014).

Some of these birds fly more than 9,300 miles (15,000 km) from south to north every spring and reverse the trip every autumn, making the rufa red knot one of the longest distance migrating animals. Migrating rufa red knots can complete non-stop flights of 1,500 miles (2,400 km) or more, converging on vital stopover areas to rest and refuel along the way. The single most important spring staging area is along the shores of Delaware Bay in Delaware and New Jersey, where rufa red knots achieve very high rates of weight gain feeding on the eggs of spawning horseshoe crabs (*Limulus polyphemus*). However, Delaware Bay is only one in a network of essential staging areas, where large numbers of birds recover from long migration flights, rapidly regaining weight before departing on the next leg of their journey. In addition to staging areas, rufa red knots also use other stopover habitats in smaller numbers and/or for shorter durations. Large and small groups of rufa red knots, sometimes numbering in the thousands, may occur in suitable habitats from the southern tip of South America to Central Canada during the migration seasons. The timing of spring and fall migration varies across the range (USFWS 2014).

Coastal habitats used by rufa red knots in migration and wintering areas are similar in character, generally coastal marine and estuarine habitats with large areas of exposed intertidal sediments. Migration and wintering habitats include both high-energy oceanfront or bayfront areas, as well as tidal flats in more sheltered bays and lagoons. Preferred nonbreeding microhabitats are muddy or sandy coastal areas, specifically, the mouths of bays and estuaries, tidal flats, and unimproved tidal inlets. In many wintering and stopover areas, high-quality high-tide roosting habitat (*i.e.*, close to feeding areas, protected from predators, with sufficient space during the highest tides, free from excessive human disturbance) is limited. In nonbreeding areas, rufa red knots require sparse vegetation to avoid predation. Unimproved tidal inlets are preferred nonbreeding habitats. Along the Atlantic Coast, dynamic and ephemeral features are important rufa red knot habitats, including sand spits, islets, shoals, and sandbars, features often associated with inlets. In coastal nonbreeding areas, rufa red knots feed by probing for prey in the intertidal zone (USFWS 2014).

On the breeding grounds, rufa red knots require upland tundra for nesting, with low, sparse, herbaceous vegetation (*e.g.*, *Dryas* spp., lichens, moss), located near freshwater wetland or lake-edge foraging habitats. Pair bonds form soon after the birds arrive on the breeding grounds, in late May or early June, and remain intact until shortly after the eggs hatch. Female rufa red knots lay only one clutch per season and typically do not lay a replacement clutch if the first is lost. The usual clutch size is four eggs, though three-egg clutches have been recorded. The incubation period lasts approximately 22 days from the last egg laid to the last egg hatched, and both sexes participate equally in egg incubation. Young are precocial, leaving the nest within 24 hours of hatching and foraging for themselves. The growth rate of knot chicks is very high compared to similarly sized shorebirds nesting in more temperate climates and is strongly correlated with weather-induced and seasonal variation in availability of invertebrate prey. Females are thought to leave the breeding grounds and start moving south soon after the chicks hatch in mid-July. Thereafter, parental care is provided solely by the males, but about 25 days later (around August 10) males also abandon the newly fledged juveniles and move south. Not long after, they are followed by the juveniles (USFWS 2014).

In nonbreeding areas, rufa red knots feed on invertebrates, especially small clams, mussels, and snails, but also crustaceans, and marine worms. Horseshoe crab eggs are a preferred food wherever they occur. On the breeding grounds knots mainly eat insects. The timing of food resources (*e.g.*, insect prey on the breeding grounds, horseshoe crab eggs or mollusks at stopover areas) is a critical need for this highly migratory subspecies (USFWS 2014).

### *Threats*

A Species Status Assessment (SSA) classified 24 threats to the rufa red knot (USFWS 2020b). Threats that are driving the rufa red knot's status as a threatened species under the ESA are classified as High Severity in the SSA. These include loss of breeding and nonbreeding habitat (including sea level rise, coastal engineering/stabilization, coastal development, and Arctic ecosystem change); indirect effects from disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of phenological asynchronies (*e.g.,* mismatched timing of migratory cycle with favorable food and weather conditions). Classified as Moderate Severity in the SSA are threats that cause additive mortality and that cumulatively exacerbate the effects of the High Severity threats. Moderate Severity threats include hunting; predation in nonbreeding areas (*e.g.*, by peregrine falcons (*Falco peregrinus*)); harmful algal blooms; and human disturbance, oil spills, and wind energy development especially near the coasts. Classified as Low Severity in the SSA are those threats that were evaluated in the final listing rule, but which the Service concluded are not contributing to the rufa red knot's threatened status under the ESA; these include beach cleaning, agriculture, research activities, and disease (USFWS 2020b). One new threat has been identified that was not considered at the time of listing, namely Arctic habitat damage caused by overabundant snow goose (*Chen caerulescens*) populations. At this time, we consider goose overpopulation a Moderate Severity threat, but recognize high uncertainty around how geese may be impacting rufa red knot reproductive rates (USFWS 2021).

Although threats from offshore and onshore WTGs are foreseeable, their magnitude remains poorly understood (USFWS 2021). Offshore wind energy development is likely to make at least modest additional contributions to mortality in the coming decades (USFWS 2021). Watts *et al.* (2015, pp. 37, 40) found that rufa red knots have notably low limits of sustainable mortality from anthropogenic causes, such as hunting, oil spills, and wind turbine collisions. In recent years, the advancement of BOEM's wind leasing and project reviews has increased the degree of certainty for future offshore project locations. In addition, important species-specific information has been acquired in the past decade (*i.e.*, Loring *et al.* 2018, Loring *et al.* 2021, Perkins 2023), much of it with BOEM support, to help assess project effects. However, some key risk factors (*e.g.*, avoidance rates) remain largely unknown, and information is lacking to assess site-specific and collective effects of wind energy projects. The number and locations of future proposed onshore turbines remain unclear, as do the timing and extent of full coastwide buildout of offshore WTGs. Any effects of the turbines on migrating birds (*e.g.*, collision, behavioral effects) are even more difficult to study and characterize offshore than on land. Seven offshore wind farm projects along the Atlantic Coast have completed Section 7 ESA formal consultations, with a total anticipated incidental take of up to 912 rufa red knots (Table 3).

### *Demographics and Population Trends*

Rufa red knots are considered typical of shorebird species that exhibit low fecundity, delayed maturity, and high annual survival. The rufa red knot's typical life span is at least 7 years, with the oldest known wild bird at least 21 years old. Age of first breeding is at least 2 years (USFWS

2014). Adult birds are known to sometimes forgo breeding and remain in nonbreeding habitats during the breeding season (USFWS 2014, Martínez-Curci *et al.* 2020) but it is unknown how prevalent this phenomenon is and whether it varies spatially or temporally. Breeding success of High Arctic shorebirds such as the rufa red knot varies dramatically among years in a somewhat cyclical manner. Two main factors seem to be responsible for this annual variation: abundance of small rodents (by indirectly affecting predation pressure on shorebirds) and weather (USFWS 2014).

**Table 3. Summary of anticipated rufa red knot incidental take for Atlantic Coast offshore wind energy projects that have completed formal consultation with the Service (USFWS 2023a).**

| Date of Opinion Issuance | Project Name | Anticipated Take (Annual) | Project Duration | Anticipated Take[1] (Project Duration) |
|---|---|---|---|---|
| 5/12/2023 | Ocean Wind 1 | 1 | 35 years | 35 |
| 5/30/2023 | Revolution Wind | 18 | 35 years | 630 |
| 6/22/2023 | Empire Wind | 1 | 35 years | 37 |
| 6/29/2023 | Sunrise Wind | <1 | 35 years | 31 |
| 8/31/2023 | CVOW-C | >2 | 33 years | 71 |
| 9/1/2023 | SouthCoast Wind | 2 | 35 years | 67 |
| 9/28/2023 | New England Wind | 2 | 33 years | 41 |
| **TOTAL** | | **~27** | | **912** |

[1] For the first four projects in this table, compensatory mitigation was included as a conservation measure. See additional notes below Table 1.

A preliminary analysis suggests an average reproductive rate of 1.5 to 2 chicks per pair may be necessary for a stable population (Wilson and Morrison 2018), but further work is needed to refine this estimate. Modeling by Schwarzer (2011) suggests that populations are stable at around 8.75 percent juveniles among wintering birds, but this is also a preliminary estimate. Analysis of 2005 to 2018 data from the Delaware Bay staging area, which supports an estimated 50 to 80 percent of all rufa red knots each spring, found a mean recruitment rate of 0.075 (95 percent Confidence Interval (CI) 0.011, 0.15) (ASMFC 2022).

Baker *et al.* (2004) estimated adult survival rates for the Delaware Bay stopover population at 84.6 percent from 1994 to 1998, but only 56.4 percent from 1998 to 2001. With a more recent data set, 1997 to 2008, McGowan *et al.* (2011) calculated a survival rate of about 92 percent for Delaware Bay. The most recent analysis, using Delaware Bay data from 2005 to 2018, found an annual apparent survival rate of 93 percent (95 percent CI 90 to 96 percent) (ASMFC 2022). For birds wintering in Florida, Schwarzer *et al.* (2012) found an average annual adult survival rate of 89 percent, with the 95 percent confidence interval overlapping the 92 percent survival estimate from McGowan *et al.* (2011). The similarity of Florida versus Delaware Bay survival rate estimates suggest that the key factors influencing survival may be doing so outside of the wintering grounds (Schwarzer *et al.* 2012).

The essential recovery strategy for the rufa red knot is to prevent erosion of this subspecies' limited inherent adaptive capacity by maintaining representation and improving resiliency and redundancy, to support the rufa subspecies as it copes with inexorably changing conditions (*i.e.*, from climate change) across its range and annual cycle. The Service has delineated four recovery units corresponding to the four wintering populations listed above. Conservation of each recovery unit contributes to each of the 3Rs and is essential for the recovery of the entire subspecies. The recovery plan establishes population targets for each recovery unit, based on a 10-year average abundance. The plan also addresses other conservation needs for the rufa red knot, chiefly a wide-ranging network of nonbreeding habitats managed in a manner compatible with the population goals (USFWS 2023c). Although birds from the Western Gulf of Mexico/Central America/Pacific South America (Western) recovery unit are known to occasionally occur in the Atlantic Coast (USFWS 2014), we consider the likelihood that they will be affected by the proposed project discountable. Therefore, the Western recovery unit is not addressed in this BO. Some number of birds from each of the other three recovery units are expected to occur in the action area during spring and fall migration and may also occur in the action area during the breeding and wintering seasons.

Based on best available information, the current total rangewide abundance estimate is just under 64,800 rufa red knots, distributed across the four recovery units (Table 4). We conclude with moderate confidence that the North Coast of South America (NCSA) and the Southeast United States/Caribbean (SEC) recovery units are stable relative to the 1980s. Several lines of evidence suggest the Western recovery unit may be declining, although certainty about this conclusion is low. The Southern wintering population (*i.e.*, birds wintering in Argentina and Chile) experienced a well-documented decline of about 75 percent during the 2000s, as well as a geographic contraction within these wintering grounds. The Southern wintering population has been stable since 2011 but has shown no signs of recovery to date (USFWS 2020b, Matus 2021, Norambuena *et al.* 2022).

The decline of the Southern population, which was the largest in the 1980s, drove a decline of the entire subspecies that mirrored the declines at several migration stopover areas and in analyses of various national and regional datasets. Overharvest of the horseshoe crab in Delaware Bay is considered the key causal factor in this decline, though numerous other past, ongoing, and emerging threats have also been identified as discussed above (USFWS 2020b). The Service has determined that the horseshoe crab bait harvest has been adequately managed to avoid further impacts to rufa red knots at least since 2013 (USFWS 2014, USFWS 2022b).

**Table 4. Current estimates of rufa red knot abundance by recovery unit***

| **Wintering Population** | **Current Abundance Estimate** | **Certainty** | **Source** |
|---|---:|---:|---:|
| Southeast U.S./Caribbean | 15,500 | Moderate | Lyons *et al.* 2017 |
| North Coast of South America | 31,065 | Moderate | Mizrahi 2020 |
| Southern (mean 2020-2022) | 12,704 | High | Matus 2021, WHSRN 2020, Norambuena *et al.* 2022 |
| Western** | 5,500 | Low | Newstead pers. comm. 2019, 2020 |
| **Total** | **64,769** | | |

*Recovery criteria: Southern=35,000. Western=10,000
North Coast of South America and the Southeast United States/Caribbean=stable or increasing
**Presented for context but not considered in this BO.

In summary, the overall status of the rufa red knot is stable but depleted. The NCSA and SEC recovery units are stable. The Southern recovery unit has stabilized, but at approximately 25 percent of its size as documented only about 40 years ago.

## Roseate Tern Status

### *Listing and Life History*

The North Atlantic roseate tern subspecies is divided into two populations because they breed in two discrete areas and rarely mix. The Northeastern population, federally listed as endangered, breeds on coastal islands from Eastern Canada, in Nova Scotia and Quebec, to New York. Federally listed as threatened, the Caribbean population breeds on islands in the Caribbean Sea from the Florida Keys to the Lesser Antilles. Both populations winter on the north and east coasts of South America (USFWS 2023d) and both were listed under the ESA in 1987 (52 FR 42064). The two populations have separate recovery plans. We have no evidence that roseate terns from the Caribbean population migrate or otherwise occur offshore New Jersey, and these birds spend their entire life cycle south of the action area. Therefore, the Caribbean population is not considered in this BO. There is no proposed or designated critical habitat for the roseate tern.

The roseate tern is a medium-sized sea tern about 15 inches (38 cm) long. This species is exclusively marine, usually breeding on small islands, but occasionally on sand dunes at the ends of barrier beaches. All recorded nesting activity in the Northeast has been in colonies of common terns (*Sterna hirundo*). Roseate terns usually select the more densely vegetated parts of the nesting area, and usually nest under or adjacent to objects that provide cover or shelter. Roseate terns arrive in the Northeast in late April. Most eggs are laid between May 18 and June 22, but small numbers of pairs continue to lay eggs in late June and throughout July. Eggs are laid in a shallow scrape on bare sand, soil or stones, but the birds gradually accumulate nesting material during incubation so that a substantial nest often results. The usual clutch size is one or two eggs, though a small minority of clutches contain three or even four eggs. Occasionally two females lay in the same nest. Both males and females incubate the eggs and brood and feed the chicks. The incubation period is about 23 days and begins when the first egg is laid. The chicks are brooded or tended by one parent while the other parent forages for food. Chicks usually fledge at ages between 25 and 29 days. Fledglings start to accompany their parents to the feeding grounds within 4 to 5 days. During the breeding season, roseate terns forage over shallow coastal waters around the breeding colonies (USFWS 1998).

Roseate terns are specialist feeders on small schooling marine fish, which they catch by plunging vertically into the water and seizing prey in their bills. Birds usually feed over open water, often in tidal channels, tide rips or over sandbanks where currents bring fish into relatively shallow water. Roseate terns tend to return regularly to the same fishing areas, sometimes far from the breeding colony. They tend to concentrate in places where prey fish are brought close to the surface, either by predatory fish chasing them from below or by vertical movements of the water. Roseate terns usually feed in clearer and deeper water than common terns from the same colony and rarely feed close to shore or in marshy inlets. Important prey species include American sand lance (*Ammodytes sp.*) and herring (Family Clupeidae) (USFWS 1998). The distribution and abundance of sand lance and herring have been positively associated with the spatial patterns of roseate terns, indicating the importance of these prey species to adults as well as chicks.

Although roseate terns show some trophic plasticity, their relatively narrow trophic niches suggest they may have less flexibility to withstand poor foraging conditions compared to other tern species. Foraging distances are related to prey availability; roseate terns forage over shallow coastal waters within 3 to 15 miles (4 to 24 km) of breeding colonies when fish are available but may forage as far as 50 to 60 miles (80 to 97 km) offshore (USFWS 2020c).

Roosting habitats for nonbreeding roseate terns along the Northeast/mid-Atlantic Coast include open beaches, coastal inlets, river mouths, sand spits, and tidal flats. Terns may also rest on the surface of open water, and on jetties or other artificial structures (von Oettingen pers. comm. 2022). During pre-migratory staging in August and September, roseate terns feed over coastal waters between Long Island, New York, and Maine. Staging birds have been observed feeding over inlets, tide rips, and probably feed offshore as well as inshore, resting and roosting on islands and outer beaches (USFWS 1998). Staging areas are critical for juvenile and adult birds to optimize their body condition in preparation for southbound migration (USFWS 2020c). Roseate terns migrate south from late August to mid-September (Mostello *et al.* 2014, Loring *et al.* 2019). Very small numbers occur at sea off North Carolina from late August to late September, with a peak in early September and the latest recorded in late October (Gochfeld and Burger 2020). Geolocator data from six roseate terns tagged at Bird Island, Massachusetts suggest that southbound migration flight paths are transoceanic until reaching the Caribbean, where birds may stopover for a period of time. The tagged birds stopped in the vicinity of Puerto Rico and the Dominican Republic. Resighting reports of marked birds from the Northeast population further suggest that Puerto Rico may be an important stopover area. Five of the six tagged birds continued their migration southward after a 7 to 13-day hiatus in the Caribbean, making prolonged stopovers in Suriname/Guyana and northern Brazil before arriving at wintering locations (Mostello *et al.* 2014, USFWS 2020c).

Some roseate terns arrive in northern South America before the end of August, but most documented occurrences are from October or later. Most Northeastern roseate terns are believed to winter on the north and east coasts of South America, particularly on and off the north coast of Brazil, but birds have also been documented in Guyana and Suriname. Wintering habitats include beaches and remote sandbars. Although several roost sites have been discovered along the coast, wintering birds appear to spend most of their time foraging at sea, and they frequently rest on the water for periods of minutes to hours both day and night (Mostello *et al.* 2014, Gochfeld and Burger 2020).

Adults from the Northeastern population have lingered in Puerto Rico into the breeding season, but do not mix with the Caribbean population. Roseate terns, probably migrants, have been documented in spring off southern Trinidad. There are occasional records at sea and onshore between North Carolina and New Jersey in May, and occasional single birds occur in Bermuda in May and June (Gochfeld and Burger 2020). Geolocator data are available from five individuals in spring (Mostello *et al.* 2014). These birds left wintering areas in April and arrived in the breeding area in May, with stopovers at several of the same areas they had used in fall. All birds stopped at fewer locations than they had during fall migration, and spring migration was completed more quickly. Spring migration paths between the West Indies and the breeding area fell to the west of the fall migration paths for four of five birds for which both spring and fall migration data were retrieved. However, none of these birds appeared to have flown on a straight path, as they did in fall. Two birds meandered for 5 to 7 days in mid-May off the coast of the Carolinas; it is suspected this behavior was abnormal, potentially an effect of carrying the geolocator. However, migrations otherwise followed expected routes at appropriate dates, based on prior knowledge, and were generally similar to those of common terns in a parallel study, so roseate terns were probably affected by the tags only late in their spring migrations. One of the meandering birds eventually moved north to the breeding area, while the other moved back to the northeastern Caribbean, where it spent 11 more days before travelling to the breeding area (Mostello *et al.* 2014).

Roseate terns are known to occur along the New Jersey coast from May through September. Although roseate terns have not been documented breeding in New Jersey since the 1980s, this species has been reported to utilize New Jersey beaches and offshore waters during its spring and fall migrations. Small numbers of nonbreeding adult and juvenile roseate terns may also occur in New Jersey during the nesting season. Most New Jersey habitat use by this species is transient, but in some areas, birds may persist longer at migration stopover or staging areas, often in mixed-species flocks (von Oettingen pers. comm. 2022). South of New Jersey, roseate terns are rarely seen on the U.S. coast in spring or fall (Gochfeld and Burger 2020).

### *Threats*

Threats identified in the roseate tern recovery plan include predation, limited food availability near colonies, storm events, an imbalanced sex ratio, and shoreline erosion impacting nesting habitat (USFWS 1998). Roseate tern habitat is impacted by invasive vegetation, as well as sea level rise driven by climate change. Climate change is also a factor in forage fish availability, including changes in fish community composition that favor less suitable prey species. Adults and fledged hatch-year birds are known to be impacted by human disturbance at staging areas. Aside from two documented instances, environmental contaminants have not been identified as a factor affecting long-term roseate tern survival or reproduction in the breeding range. Overutilization (*e.g.*, hunting, scientific study) and disease are not known to be threats (USFWS 2020c).

Although threats from offshore and onshore WTGs are foreseeable, their magnitude remains poorly understood (USFWS 2020c). In recent years, the advancement of BOEM’s wind leasing and project reviews has increased the degree of certainty for future offshore project locations. In addition, important species-specific information has been acquired in the past decade (*i.e.*, Mostello *et al.* 2014, Loring *et al.* 2019), much if it with BOEM’s support, to help assess project effects. However, some key risk factors (*e.g.*, avoidance rates, migration flight altitudes) remain largely unknown, and information is lacking to assess site-specific and collective effects of wind energy projects. The timing and extent of full coastwide buildout of offshore WTGs remains unclear. Any effects of the turbines on migrating birds (*e.g.*, collision, behavioral effects) are difficult to study and characterize in the offshore environment. Seven offshore wind farm projects along the Atlantic Coast have completed Section 7 ESA formal consultations. Of these, one included the roseate tern, with total anticipated incidental take of up to one bird (Table 5).

**Table 5. Summary of anticipated roseate tern incidental take for Atlantic Coast offshore wind energy projects that have completed consultation with the Service (USFWS 2023a)**

| Date of Opinion Issuance | Project Name | Anticipated Take (Annual) | Project Duration | Anticipated Take[1] (Project Duration) |
|---|---|---|---|---|
| 5/12/2023 | Ocean Wind 1 | <1 | 35 years | 1 |
| **TOTAL** | | **<1** | | **1** |

### *Demographics and Population Trends*

The oldest known roseate tern was over 25 years old, but a life span around 9 years may be more typical. Survival probability may be heterogeneous within the population (Gochfeld and Burger 2020, CTDEEP undated). Roseate terns begin breeding at age three or four. Breeding is thought to occur annually among Northeastern birds, but some mature adults (usually females) may be unmated in some years (Gochfeld and Burger 2020). There is an unequal sex ratio, with more females than males. Best available demographic estimates at the time of the recovery plan were associated with high uncertainty and were inconsistent with observed population trends. Those values were 0.83 for average annual adult survival, 1.2 fledglings per pair for average productivity at the largest colonies, and 0.20 for survival from fledging to first breeding (USFWS 1998). Low productivity (less than 0.9 chick fledged per pair) is generally limited to small colonies and/or to transitory incidents of predation. Regionwide, the long-term average annual productivity is about 1.1 young fledged/pair, somewhat higher at the large stable colonies, but lower at sites subject to higher predation (Gochfeld and Burger 2020).

Recent population modeling supported the assumption that smaller colonies appear to be more ephemeral. Although ephemeral, these smaller colonies support more unique genetic diversity than the larger, long-established populations. To assess the stability of the species, the colonization and abandonment of breeding colonies were modeled as discrete events. The modeled population would collapse to zero (within 50 years, with greater than 50 percent probability) for mean productivity less than 1.2, mean adult survival less than 0.82, or mean juvenile survival less than 0.7. These values are precariously close to recent estimates of mean values for these parameters, indicating that there is little margin for maintaining the population should adverse factors affect productivity, adult survival, or juvenile survival (USFWS 2020c).

The recovery plan establishes population targets of 5,000 peak period nesting pairs, at least 5 large colonies with at least 1 fledged chick per pair for 5 consecutive years. The plan also addresses other conservation needs for the roseate tern, chiefly long-term agreements to assure protection and management of breeding habitats (USFWS 1998). The Northeastern roseate tern population is assessed in two subregional groups: the warm-water group south and west of Cape Cod, and the cold-water group north and east of Cape Cod, including Canada. The warm-water subregion includes more than 90 percent of the total population, the majority of which breeds on only three islands. The cold-water subregion breeding colonies are more widely scattered and generally have less than 100 breeding pairs—none in some years. Diets may differ between subregions, and limited exchange of breeding birds occurs between them. Nevertheless, it is vital to maintain the genetic diversity of the metapopulation. The southern extent of the roseate tern range contracted significantly since the species was listed and appears to have been further reduced with the loss of small breeding colonies on southern and central Long Island. The northern extent of the breeding range has not contracted, although a number of small colonies in Canada and Maine are no longer occupied. The genetic viability of the species is dependent on the existence of small, cold-water subregion breeding colonies as well as the larger warm-water subregion colonies. Continued loss of these small colonies could preclude the species from recovering as the redistribution of genetic variation between the two subregions is affected (USFWS 2020c).

The total Northeastern roseate tern breeding population was estimated to be 4,374 breeding pairs at peak period count in 2019 (see Table 6). The U.S. breeding population has exceeded 4,000 breeding pairs annually since 2016. Canada's total roseate tern population has been below 100 breeding pairs since 2008, hovering between 50 and 65 breeding pairs. From 1987 to 1990, breeding pair numbers increased at average rates of 4 to 5 percent per year. From 1991 to 1992 numbers declined by about 20 percent, attributed to Hurricane Bob. The increasing trend resumed and then continued from 1992 to 2000 when it abruptly reversed. Declines of about 4 percent per year were observed from 2000 to 2008, possibly reflecting a change in post-fledging survival of hatch-year roseate terns and their recruitment into the breeding population. The increasing (1992-2000) and decreasing (2000-2008) trends were manifested at all the large colonies and evidently resulted from factors that affected the entire warm-water subregion. Between 2008 and 2013, the breeding pair population slowly increased, and from 2014 to 2019 the number of breeding pairs rapidly increased. The recent increase of about 5 percent per year, similar to the rate of increase from 1992 to 2000, was primarily attributed to a substantial increase in breeding pairs in the Buzzards Bay colonies (USFWS 2020c).

**Table 6. Peak period roseate tern breeding pair counts, 2010 to 2019 (USFWS 2020c)**

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
|---|---|---|---|---|---|---|---|---|---|---|
| Canada Subtotal | 43 | 65 | 43 | 54 | 51 | 51 | 63 | 49 | 51 | 63 |
| U.S. Subtotal | 2,970 | 3,043 | 3,089 | 3,136 | 3,560 | 3,901 | 4,021 | 4,446 | 4,542 | 4,311 |
| Rangewide total | 3,013 | 3,108 | 3,132 | 3,190 | 3,611 | 3,952 | 4,084 | 4,495 | 4,593 | 4,374 |

The combined average annual estimated productivity from 2010 to 2019 for the cold-water subregion breeding colonies (about 0.9 chick fledged per pair) appears to be nearing the warm water subregion colonies (about 1.0 chicks fledged per pair). Annual average productivity estimates for the two subregions were not always similar, most likely affected by predation events or limited accessibility to suitable forage fish. Although recent data indicate the roseate tern population is stabilizing from past fluctuations, there is great uncertainty as to the long-term population viability (USFWS 2020c). In summary, the overall status of the roseate tern is stable to increasing but punctuated by periods of decline. Population variability can affect the viability of a species as much or more than population size (USFWS and NMFS 1998).

## ENVIRONMENTAL BASELINE

In accordance with 50 CFR 402.02, the environmental baseline refers to the condition of the listed species in the action area, without the consequences to the listed species caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early Section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline.

## Status of the Species within the Action Area

Burger *et al.* (2011) used a weight-of-evidence approach to evaluate information from a review of technical literature regarding collision risk and concluded: (1) Piping plovers are not likely to be at risk during the breeding season but may be at risk during spring or fall migrations. (2) Rufa red knots are potentially exposed to some risk during migration, especially long-distance migrants whose migratory routes take them over the OCS. (3) Roseate terns are likely to be exposed to risk during the migratory and breeding season when they occur in the OCS, as well as while staging.

Normandeau (2011) conducted a region-wide, population-level, analysis of all available geospatial distributional data for the three listed birds in the marine and coastal portions of the OCS region, including an evaluation of hypothesized OCS-crossing migration pathways for piping plover and rufa red knot. This was based on datasets including extensive coastal land-based observations of these species. This analysis confirmed the pelagic migration tendency of roseate terns, but provided little additional insight into the three focal species' spatiotemporal patterns of occurrence in the offshore environment of the OCS. The analyses of coastal data suggested that both piping plovers and rufa red knots may have general tendencies to cross the OCS on long-distance single flights, rather than hugging the coastline with a series of shorter distance flights, though it is almost certain that some individual birds exhibit tendencies toward the latter. This suggests that piping plovers and rufa red knots are both likely to experience macroscale exposure to OCS wind facilities during migration, a finding has since been confirmed for piping plovers (Loring *et al.* 2020) and red knots (Loring *et al.* 2018, Feigin *et al.* 2022, Perkins 2023). The specific regions of the OCS in which this macroscale exposure occurs were not well known, though for rufa red knot it may be concentrated south of Cape Cod in fall and south of Delaware Bay-North Carolina in spring.

While providing useful frameworks, Burger *et al.* (2011) and Normandeau (2011) did not provide any insights specific to the ASOWS action area. As discussed above, the action area covered by this BO is limited to approximately 102,124 acres (413 sq km) of offshore airspace and, for roseate terns, the upper 20 inches (50 cm) of the ocean across this same area. Although the action area may occasionally support foraging terns, its primary value to listed birds is as part of a flight corridor. The action area is located within a migration corridor for all three species and may also be transited by seasonally resident rufa red knots undertaking regional movements across the OCS. Measured east to west, the WTA is about 16.4 miles (16.4 km) across. Based on the widths of the migration corridors we used for the Band (2012) collision risk model, discussed below, the action area occupies about 10 percent of the piping plover migration corridor, 1 percent of the rufa red knot corridor, and 5 percent of the roseate tern corridor. As the action area is limited to the maximum blade height of the WTGs, we focus our assessment on the rotor swept zone (RSZ), which is from 76 feet (23 m) to 1,047 feet (319 m) above mean sea level.

Tracking data used to assess the number and behavior of listed birds in the action area has been collected since 2007 and tracking technologies have advanced considerably over that time. However, studies far offshore are logistically and technologically challenging, and our understanding of how these species use the action area remains incomplete. Based on the accuracy of the tracking data available to date, we make the assumption that all parts of the action area are equally likely to be utilized by listed species (*i.e.*, we attempt to characterize levels of bird use within the action area relative to the surrounding OCS and adjacent coastline, but do not attempt to discern differences in bird utilization that may exist across the latitudinal or longitudinal gradients of the action area).

### *Piping Plover*

Loring *et al.* (2019) fitted 150 piping plovers with digital Very High Frequency (VHF) radio transmitters at select nesting areas in Massachusetts and Rhode Island from 2015 to 2017. Tagged individuals were tracked using an array of automated VHF telemetry stations within a study area encompassing a portion of the U.S. Atlantic OCS, extending from Cape Cod, Massachusetts to southern Virginia. Peak exposure of piping plovers to Federal waters occurred in late July and early August. Piping plovers departing from their breeding grounds in Massachusetts and Rhode Island primarily used offshore routes to stopover areas in the mid-Atlantic. Individual piping plovers were exposed to up to four Wind Energy Areas (WEAs) on offshore flights across the mid-Atlantic Bight. Flights in Federal waters and WEAs were strongly associated with southwest wind conditions providing positive wind support (Loring *et al.* 2019).

Of the 150 individuals tagged, 82 percent were detected by the telemetry array. Field staff observed that 25 percent of tagged birds dropped their transmitters on the breeding grounds. Tagged piping plovers were detected by the tracking array for an average of 46 days. Due to incomplete detection probability, 47 percent (70 of 150) individuals had sufficient detection data to model migratory departure from the breeding grounds. Migratory events were identified by southbound departures from breeding areas tracked by two or more towers within the telemetry array. Of the 70 individuals that were tracked during fall migration, 27 percent (19 birds) had estimated exposure to WEAs within the Study Area, including 2 birds intersecting the ASOWS Lease Area (OCS-A 0499). Estimated exposure to WEAs was higher for birds tagged in Massachusetts than for birds tagged in Rhode Island. For 22 birds tagged in Massachusetts, peak estimated WEA exposure occurred within four hours of local sunset (19:00 hours), with 36 percent (8 birds) of events occurring at night and 64 percent (14 birds) during daylight (Loring *et al.* 2019).

Across all years, many piping plovers were last detected departing from their nesting areas along trajectories that intersected Federal waters and headed towards WEAs just beyond the range of land-based towers to detect exposure, such as WEAs offshore of Nantucket, Massachusetts. Therefore, estimates of exposure to Federal waters and WEAs in Loring *et al.* (2019) should be interpreted in the context of detection probability of the telemetry array. It is plausible that additional piping plovers (beyond the 2 mentioned above) that appeared to be heading south intersected the ASOWS action area, but were out of the detection range of the land-based receivers. It is also important to note that tags were deployed in only two nesting areas, and the migration flights of these sampled populations may differ from piping plovers that nest in other parts of the Atlantic Coast range. For example, preliminary results from a previous mark/resight study found that 42 percent of piping plovers marked in Eastern Canada were subsequently detected in New Jersey and 52 percent were detected in North Carolina (Rock pers. comm. 2023). These Canadian nesters could have significant exposure to offshore wind that has not yet been assessed. Loring *et al.* (2019) noted differences in the migratory paths of birds tagged in Massachusetts versus Rhode Island, indicating that probability of occurrence in the action area does likely vary for piping plovers breeding in other portions of the range. It is also important to note that very little data on piping plover spring migration movements are available at this time (only two birds were tracked during partial northbound flights from the Bahamas (Loring *et al.* 2019)).

Loring *et al.* (2019) reported that an estimated 21.3 percent of piping plover flights in Federal waters occurred within the RSZ. However, the RSZ for that study was defined at 25 to 250 m above sea level and thus about 25 percent smaller than the ASOWS RSZ. Flight height distributions were generated for collision risk models using improved methods developed in Adams *et al.* (2023).

In summary, southbound piping plovers from the New England recovery unit likely occur in the ASOWS WTA on a somewhat regular basis between March and September. Upwards of two fifths of these birds may cross the action area within the RSZ. We have very little information on the flight paths or altitudes of spring migrants, but we presume for purposes of this BO that spring occurrence in the ASOWS RSZ is similar to fall. Although a few movements north of the breeding site have been documented (Loring *et al.* 2022-2023), current information indicates that the vast majority of piping plovers are likely to cross the WTA no more than two times per year, on northward and southward migration fights. We have no information regarding migration pathways of birds from the Eastern Canada or NY-NJ recovery units, but our analysis assumes they may also be present in the action area and that they would exhibit a similar flight height distribution.

### ***Rufa Red Knot***

Perkins (2023) summarized the migration patterns and wintering locations of rufa red knots based on 93 individuals tagged with 100 geolocators (Figure 4). Tags were deployed between 2009 and 2017. Birds had to be recaptured in order to acquire the data, and many tags collected data across multiple seasons, so that in the aggregate these tracks cover the rufa red knot's full annual cycle except for activity on the breeding grounds. Breeding status could not be confidently assessed from these data. Five individuals were captured and retagged on multiple occasions, and one individual was captured and retagged twice for a total of three separate geolocators. Tags on all but one bird were deployed and recaptured in the same areas. All rufa red knot tracks were reviewed and categorized into subpopulations following discussion with experts and draft recovery plan mapping. Individuals were assigned under the following subpopulations: SEC (31 birds, including 10 that wintered in the Caribbean), NCSA (22 birds), Western (24 birds), and Southern (9 birds). Seven individuals, all tagged in Texas, were unable to be classified confidently to a subpopulation. The location estimates are within an error margin of about 155 miles (250 km) (Perkins 2023).

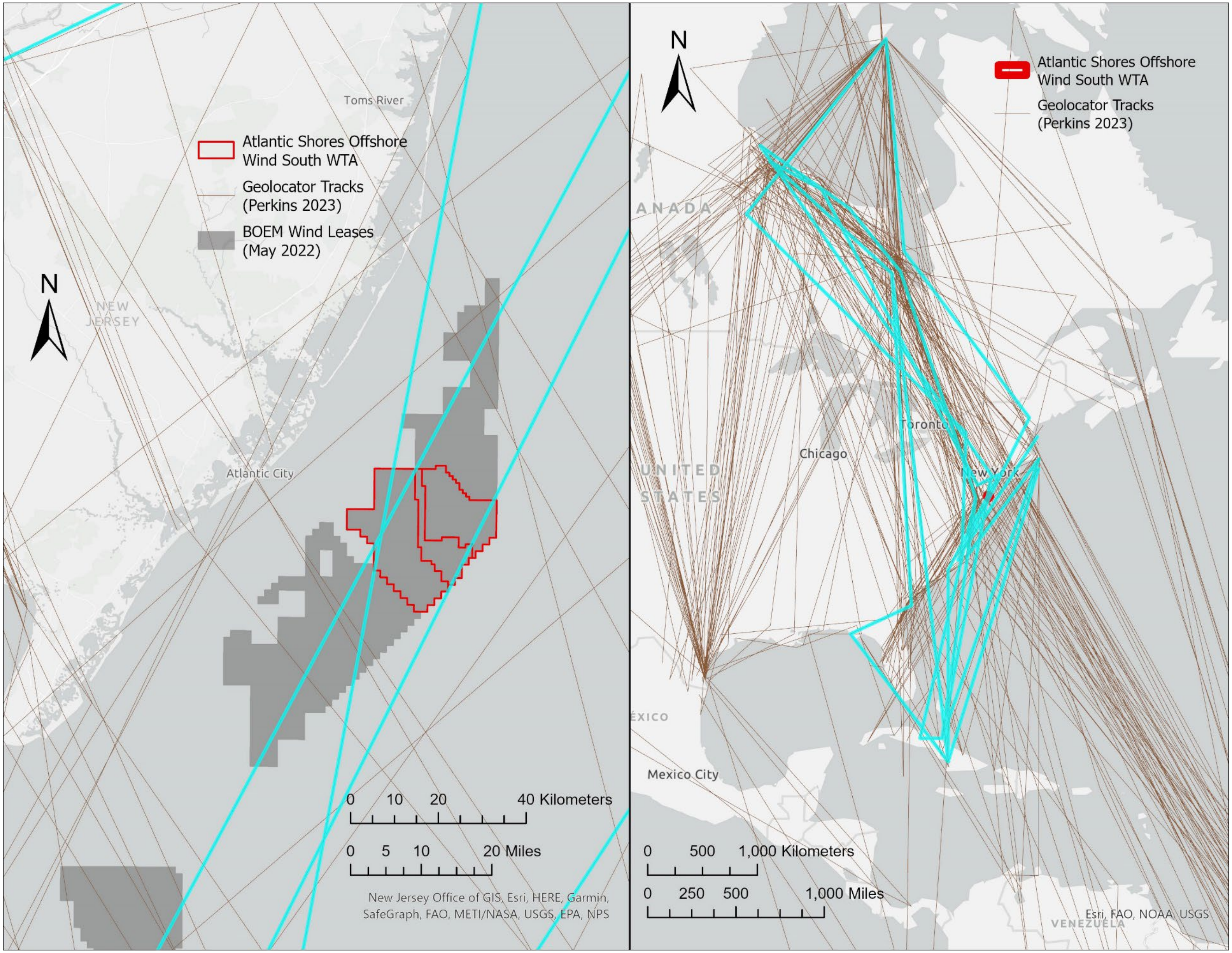


**Figure 4. Rufa Red Knot Geolocator Tracks (Perkins 2023)**

Geolocator birds from every recovery unit except Western were recorded in New Jersey in May. Birds from the SEC and NCSA units were also present in New Jersey during fall migration, and birds from the SEC unit were recorded in New Jersey in December. The geolocator tracks from three birds (3.2 percent of tagged birds) intersect the ASOWS action area (blue highlighted lines in Figure 4). All of these birds were tagged in Massachusetts and wintered in Cuba (SEC recovery unit). Tracks of five other birds (1 SEC, 2 NCSC, 2 Southern) pass within 3 miles (5 km) of the WTA (Perkins 2023). It is important to keep in mind the limited accuracy of the geolocators when considering these tracks in relation to the action area.

Smith *et al.* (2023) fitted digital VHF transmitters on 96 northbound rufa red knots in South Carolina from 2017 to 2019, and on 12 northbound knots in Florida in 2019. Of these 108 birds, 33 rufa red knots provided detection information from the Motus network of land-based receiving stations sufficient to evaluate whether there was passage and stopover in Delaware Bay. Most skipped or likely skipped Delaware Bay (73 percent, 24 of 33 birds) while the balance stopped or likely stopped in Delaware Bay (27 percent, 9 of 33 birds) for at least 1 day. The migration pathways of birds moving north from the Southeast U.S. as presented by Smith *et al.* (2023, Figure 2) are broadly similar to those described by Perkins (2023). Data from Smith *et al.* (2023) do not provide any further insights to use of the offshore airspace by rufa red knots, since cohorts departing for the breeding grounds from both the Southeast and the mid-Atlantic tend to fly overland directly to the Arctic.

In 2016, Loring *et al.* (2018) fitted 388 rufa red knots with digital VHF transmitters at major stopover areas during southbound migration in four locations: James Bay and the Mingan Archipelago in Canada; Massachusetts; and the Atlantic Coast of New Jersey. Tagged birds were tracked using an array of automated radio telemetry stations within a Study Area encompassing a portion of the U.S. Atlantic, extending from Cape Cod, Massachusetts to Back Bay, Virginia. A total of 59 of these 388 birds were tracked by the array in migration over Federal waters. Rufa red knots tagged within the Study Area had a high likelihood of being detected in the receiver array (greater than 75 percent), demonstrating that tag loss and tag failure rates were low. Despite this, only 3 to 22 percent of birds tagged at stopover sites in Canada were detected within the Study Area, and only two individuals tagged in Canada were estimated to be exposed to WEAs while transiting the Study Area. Comparatively, 54 percent of birds tagged in Massachusetts and New Jersey stopover areas were detected passing through Federal waters of the Atlantic OCS in the Study Area, and 11 percent were estimated to be exposed to one or more WEAs both during shorter-distance flights on staging grounds and longer-distance migratory movements. Of the 388 tagged birds, 3 were detected crossing Leases OCS-A 0499 and/or the adjacent 0498. However, since the tracking array likely missed flights that occurred within the Atlantic OCS Study Area (due to offline stations or limited detection ranges), and since we do not know if the final detections of birds corresponded with departure from the Study Area or were a result of tag loss, the estimates of exposure to Federal waters and WEAs should be considered a minimum (Loring *et al.* 2018).

Loring *et al.* (2018) found that offshore migratory departures primarily occurred within several hours of civil dusk. WEA exposure events occurred primarily at night (80 percent), from 3 hours before local sunset to 1 hour following local sunrise. Flights across WEAs occurred during fair weather, under clear skies (mean visibility greater than 62 feet (19 m)) with above-average barometric pressure, mild temperatures, and little to no precipitation. The majority (77 percent) of flights across WEAs were estimated to have occurred in the RSZ, with a mean altitude of 348 feet (106 m) (range 72 to 2,894 feet (22 m to 882 m)). However, these estimates were subject to large error bounds and should be interpreted with caution. Further, the RSZ for this study was defined as 66 to 656 feet (20 m to 200 m) above sea level, which is lower and smaller than the RSZ for ASOWS (Loring *et al.* 2018).

Loring *et al.* (2021) compiled movement data from 3,955 individuals of 17 shorebird species that were tagged with VHF transmitters from 2014 to 2017 at 21 sites widely dispersed across North and South America. The movements of tagged shorebirds were tracked using the collaborative Motus radio telemetry network, which has extensive coverage from automated radio telemetry stations distributed across eastern North America and additional coverage at key shorebird sites from Arctic Canada to South America. The Study Area encompassed a region of the U.S. Atlantic Coast extending from Cape Cod, Massachusetts to Back Bay, Virginia, where a network of BOEM-funded automated radio telemetry stations was established for monitoring avian movements throughout adjacent waters of the Atlantic OCS (Loring *et al.* 2018, Loring *et al.* 2019). These coastal stations had an effective detection radius of about 12 miles (20 km), therefore the bounds of the Study Area ranged from 12 miles (20 km) inland to 12 miles (20 km) offshore. To estimate broad-scale use of the Study Area by shorebirds, while accounting for transmitter loss, these authors examined the migratory tracks of all shorebirds detected by automated radio telemetry stations at least 31 miles (50 km) from their original tagging site and within 18 mi (30 km) of the Atlantic Coast from Mingan, Canada, in the north to the Texas-Mexico border in the south. Use of the Study Area was highest among three species including rufa red knots. Rufa red knots had the highest sample size in this study (1,175 birds) and the majority (86 percent) were detected within the Study Area (Loring *et al.* 2021).

BRI and WRP (2022) report on satellite tracking data from 17 rufa red knots tagged on the Atlantic Coast of New Jersey during fall migration in 2021. Of these 17 birds, 5 made migratory movements within the life of the tags, including 4 short-distance migrants and 1 long-distance migrant. Tracks indicate that one of the short-distance migrants may have flown through Lease Area OCS-A 0498, which is adjacent to the ASOWS WTA. A wind analysis indicates that the tagged rufa red knots generally initiated migration with favorable tailwinds, that the one long-distance migrant had favorable wind support throughout its offshore movements, and that the short-distance migrants flew in more variable wind conditions. Across all 17 birds, the majority of locations established by satellite tags were associated with relatively low altitude estimates, particularly for locations along the coast when birds were likely on the ground at staging areas. However, of the 5 birds detected greater than 0.6 mile (1 km) offshore, 4 had altitude ranges estimates overlapping the ASOWS RSZ of 76 to 1,047 feet (23 m to 319 m) (BRI and WRP 2022).

Feigin *et al.* (2022) reported on satellite tracking data from 40 rufa red knots tagged on the Atlantic Coast of New Jersey during fall migration in 2020 and 2021. Of the 40 tags, 27 collected data through the migratory departure period from staging areas in New Jersey. (Tags on the remaining 13 birds stopped collecting data while the birds were still at staging areas in New Jersey.) Based on three different methods of assessment, a total of 15 of the 27 birds (56 percent) may have crossed the ASOWS WTA. For these 15 birds, a majority departed during the night, with an average wind speed of 16.6 feet (5.06 m) per second blowing from the north, little to no precipitation, generally good visibility (*i.e.*, 12 miles (20 km)), and warm temperatures (77°F (25°C)). The conditions when the birds may have passed over Lease Area OCS-A 0499 were similar to the departure conditions (Feigin *et al.* 2022).

A growing body of evidence indicates that a substantial portion of northbound rufa red knots fly from the U.S. Atlantic Coast (Florida to Delaware Bay) on a northwest trajectory to their final stopover areas along Hudson Bay in Canada. Some birds do continue along the Atlantic Coast north of Delaware Bay, and some of those birds may cross the OCS. However, the overland route does appear to be the predominant flyway for this leg of the northbound migration (USFWS 2014, USFWS 2021, Loring *et al.* 2021, Perkins 2023, unpublished satellite data) and this route entirely avoids the OCS.

In addition to migration flights, seasonally resident rufa red knots are also known to make regional flights, some of which cross the OCS. Seasonally resident birds occurring in the mid-Atlantic may include nonbreeding adults during the breeding season, juveniles at any time of year, birds on extended stopover or staging visits, and birds during the early part of the wintering season. Rufa red knots are known to move considerable distances within their wintering regions during the core winter months (USFWS 2014). Rufa red knots also have been documented making regional flights opposite the main migration trajectory (*i.e.*, south in spring, north in fall), a phenomenon known as reverse migration that is likely an attempt to find optimal food or other conditions for the stopover period (USFWS 2014, Hunter pers. comm. 2022, Sanders pers. comm. 2023).

The prevalence of regional movements is reflected in available tracking data. Burger *et al.* (2012) found that rufa red knots outfitted with geolocators and recaptured in Massachusetts spent over half the year migrating, at stopovers, and wintering along the Atlantic Coast. While birds in this study crossed the OCS at least twice during long-distance flights, birds crossed even more often on shorter flights (Burger *et al.* 2012). Loring *et al.* (2018) reports that, of 99 rufa red knots tagged with radio transmitters, 17 birds (17 percent) were tracked moving through Federal waters during staging at migration stopover aeras. In this same study, 7 birds tagged in New Jersey were tracked crossing Federal waters during the staging period, as they moved between sites along the Atlantic Coast ranging from Long Island, New York to southern Virginia (Loring *et al.* 2018). Loring *et al.* (2021) found movements of rufa red knots tracked during spring were concentrated near tagging sites in the Delaware Bay and western Long Island, with some regional movements detected between staging areas. Several individuals crossed Federal waters during regional flights between staging and stopover sites located throughout the Study Area before departing northward towards the breeding grounds (Loring *et al.* 2021). Preliminary satellite data also confirm these kinds of regional movements.

In summary, rufa red knots from the SEC, NCSA, and Southern recovery units are known to occur in or near the action area, though it is not yet known if birds from these three regions use the airspace with similar frequency, timing, or altitudes. Far greater numbers of rufa red knots are believed to cross the OCS on fall migration flights compared to spring migration flights. However, this species is not limited to migration flights across the OCS, and also makes regional flights offshore during periods of seasonal residence in the mid-Atlantic. Best available information indicates substantial overlap between rufa red knot flight heights and the ASOWS RSZ.

***Roseate Tern***

Mostello *et al.* (2014) deployed geolocators on roseate terns on Bird Island, Massachusetts in 2007 and 2009 and retrieved six tags with useful data for southbound migration, including five that also had usable data for northbound migration. Depending on weather, date, and location, positional accuracy of the devices was estimated between 36 and 323 miles (59 to 520 km), with increasing latitudinal errors concomitant in closer proximity to the equinoxes and equator. All six birds staged around Cape Cod, Massachusetts, close to the breeding site, and flew south directly across the western North Atlantic Ocean to staging areas around Puerto Rico and the Dominican Republic. Northbound migration was estimated to be faster but less direct, and closer to shore (Mostello *et al.* 2014). Both spring and fall routes were estimated to be well east of the ASOWS action area.

Loring *et al.* (2019) fitted 150 adult roseate terns with digital VHF transmitters from 2015 to 2017 at two nesting areas: Buzzards Bay, Massachusetts and Great Gull Island, New York. Tagged individuals were tracked using an array of automated VHF telemetry stations within a Study Area encompassing a portion of the U.S. Atlantic OCS, extending from Cape Cod, Massachusetts to southern Virginia. Roseate terns were exposed to Federal waters and WEAs during the breeding period through post-breeding dispersal. The highest probability of exposure occurred during post-breeding dispersal (mid-July through late September), as terns from multiple colonies made extensive movements throughout the eastern Long Island Sound to the southeastern region of Massachusetts. Peak exposure of roseate terns to Federal waters primarily occurred in mid-July and August during morning hours and fair weather conditions (high atmospheric pressure).

No roseate terns were detected in the vicinity of the ASOWS WTA. However, this result must be considered in the context of the detection range of the land-based receiving stations, which is typically less than 12 miles (20 km) on average for birds in flight. Limited detection range is likely a key reason that only one roseate tern migratory track was documented south of Long Island (Loring *et al.* 2019). The easternmost portions of the ASOWS WTA are over 22 miles (35 km) from the nearest land. Thus, there were gaps in coverage of the Lease Area that could lead to underestimates of roseate tern occurrence in the action area. Approximately 17 to 30 miles (27 to 48 km) north of the ASOWS WTA, a few sightings of roseate terns have been reported 14 to 26 miles (23 to 43 km) offshore New Jersey (eBird 2023), confirming at least occasional occurrence of this species at distances off the New Jersey coast similar to the action area. Regular surveys of Horseshoe Island, located about 8.5 miles (13.7 km) northwest of the action area, consistently found small numbers of nonbreeding roseate terns from late May through late August 2023, with a maximum of 11 birds. Four of the birds were marked (Kopec pers. comm. 2023), but information is not yet available about where the leg markers had been attached.

When crossing Federal waters, roseate terns tracked by Loring *et al.* (2019) predominantly occurred below the RSZ. An estimated 6.4 percent of roseate tern flights within Federal waters occurred within the RSZ. However, the RSZ was defined for this study at 82 to 820 feet (25 to 250 m) above sea level and thus about 25 percent smaller than the ASOWS RSZ. Further, the flight altitude data collected during this study include only flights by pre-migratory (*i.e.*, staging) birds, and thus may not be representative of altitudes for migration flights (Loring *et al.* 2019). Burger *et al.* (2011) noted that migratory flight height is poorly known but reported an anecdotal observation of roseate terns presumed to be embarking on migration flying at approximately 400 to 498 feet (122 to 152 m). Based on published reports from other tern species and personal observations of roseate terns (Oswald *et al.* 2023), Nisbet (pers. comm. 2019) expected roseate terns to depart on migration flights an angle of about 1 vertical to 8 horizonal and ascend to heights of 3,280 to 9,843 feet (1,000 to 3,000 m). Roseate terns tracked via geolocators departing on migration across the ocean toward Puerto Rico flew throughout the first night and made contact with the water frequently during the next day (Nisbet pers. comm. 2019). Birds descending to rest on the water and then ascending again to continue migrating may represent another layer of complexity in assessing roseate tern exposure to the RSZ.

In summary, we conclude it is likely that roseate terns occasionally occur in the action area. Most migration flights are expected to occur well east of the ASOWS WTA, as suggested by a small (six birds) sample of geolocator tracks (Mostello *et al.* 2014). Seasonally resident birds in New Jersey (*e.g.*, juveniles, nonbreeding adults during the breeding season, staging birds) may occasionally forage in the ASOWS WTA; to date we have no evidence of this occurring but we also lack any reason to conclude that it does not occur. To the extent roseate terns utilize the action area, they are more likely to be from the warm-water population based on its much larger size and closer proximity to New Jersey. Flight height distribution of any roseate terns occurring the ASOWS WTA would be expected to overlap the ASOWS RSZ, but only to a low or moderate extent.

### Factors Affecting the Species within the Action Area

#### *Structures*

The only structure in the ASOWS Lease Area (OCS-A 0499) is a SEAWATCH™ Floating Light Detection and Ranging (FLiDAR) buoy (Sullivan pers. comm.2023). Thus, there are no current collision hazards or potential effects on bird behavior by way of structures or stationary sources of lighting or noise.

#### *Vessels*

The waters offshore New Jersey support a high density of commercial shipping activity (Thomas 2021), as well as other types of maritime activity (*e.g.*, military, fishing, recreational vessels). The COP (Volume II, Section 7.6.1.2) presents information on vessel traffic specific to the action area. A Navigation Safety Risk Assessment was conducted based on Automatic Identification System (AIS) data from 2017 through 2019 and adjusted to account for smaller vessels that are not typically equipped with AIS. The AIS data indicated that most unique vessels entering the WTA were recreational craft (34 percent) and cargo (27 percent); however, most unique vessel tracks that traversed the WTA were by commercial fishing vessels (41 percent). The traffic density for all vessels is concentrated in the nearshore and harbor areas west of the WTA and moderately heavy on north-south routes to the east of the WTA. The overall vessel traffic density within the WTA is relatively low, with two or more AIS-equipped vessels present in the 102,055 acre (413 square km) WTA for only 15.6 percent of the time (1,362 hours per year on average).

There is strong seasonality to the number of vessels transiting the WTA, varying from three transits per day on average in winter to 6.4 transits per day in summer (EDR 2023).

Compared to WTGs, vessels do not extend very high above the ocean surface and move at relatively slow speeds. Thus, we conclude that vessels do not present a collision hazard to listed birds in the action area. Noise, activity, lighting, and air emissions associated with vessel traffic in the action area could potentially influence the behavior and/or fitness (*i.e.*, survival, reproduction) of listed birds. Any such influences are likely greater on seasonally resident birds making lower-altitude movements within or across the OCS, compared to the typically higher-altitude migration flights (Loring *et al.* 2018, 2019).

Piping plovers are not known to occur on the OCS during the breeding season, and this species does not winter in New Jersey. Therefore, we expect piping plover use of the action area to be limited to migration flights, and thus conclude that vessel traffic in the action area has a negligible effect on this species.

Juvenile and nonbreeding adult rufa red knots can occur along New Jersey's Atlantic Coast during most months of the year and may spend longer in this region than birds stopping over during migration. Rufa red knots are also known persist in southern New Jersey into the early part of the wintering season (Burger *et al.* 2012, Perkins 2022, eBird 2023). Regional movements of rufa red knots are well documented (Burger *et al.* 2012, Loring *et al.* 2018) as discussed above. It is likely that moderate numbers of rufa red knots cross the WTA on relatively lower-altitude regional flights, and that some percentage of these birds encounter one or more vessels. Such birds may make a minor course adjustment or be temporarily disoriented by noise or lights, but we conclude such effects are minor and generally do not impact fitness of the affected birds.

Most New Jersey habitat use by roseate terns is transient, but in some areas birds may persist longer at migration stopover or staging areas. In addition to migrating birds, small numbers of nonbreeding adult and juvenile roseate terns may occur in New Jersey during the nesting season (von Oettingen pers. comm. 2022, Kopec pers. comm. 2023, eBird 2023). It is possible that roseate terns occasionally encounter a vessel while foraging in the action area, but we conclude this is likely a rare occurrence and unlikely to impact fitness of the affected birds.

### *Climate Change*

Variation in weather is a natural occurrence and is normally not considered a threat to the survival of species. However, persistent changes in the frequency, intensity, or timing of storms in the action area may impact listed birds using this air space. Storm impacts to birds during migration flights include time and energetic costs from a longer migration route as birds avoid storms, getting blown birds off course (*e.g.*, causing deviation from preferred routes or stopover locations, as well as time/energetic costs), and direct mortality (USFWS 2014). For example, one geolocator tracking study of rufa red knots found three of four birds likely detoured from normal migration paths to avoid adverse weather during the fall migration. These birds travelled an extra 640 to 1,000 miles (1,030 to 1,609 km) to avoid storms (Niles *et al.* 2010; Niles 2014). The extra flying represents substantial additional energy expenditure, which on some occasions may lead to mortality (Niles *et al.* 2010).

It is *likely*[11] that the global proportion of Category 3 to 5 tropical cyclone instances has increased over the past 4 decades (*i.e.*, hurricanes, on average, have increased in intensity). There is no trend in the global frequency of tropical storms (*i.e.*, no change in the average number of storms per year*; low to medium confidence*); however, the trend toward a higher proportion of higher intensity tropical storms is projected to continue with *high confidence*. The average location where tropical storms reach their peak wind intensity has *very likely* migrated poleward in some regions, and increasing global warming is associated with slower-moving tropical storms. The global frequency of tropical storm rapid intensification events has *likely* increased over the past four decades. None of these changes can be explained by natural variability alone (*medium confidence*). Regarding extratropical cyclones (*e.g.*, nor'easters), there is *low confidence* in past changes of maximum wind speeds and other measures of dynamical intensity, and future wind speed changes in extratropical storms are expected to be small. However, poleward shifts in the extratropical storm tracks could lead to substantial changes in extreme wind speeds in some regions (*medium confidence*). Both tropical and extratropical storms are associated with more rain (*low confidence* for past changes, *high confidence* for future projections). The frequency of spring severe convective storms (*e.g.*, tornadoes, large hail, and convective wind gusts) is projected to increase in the United States, leading to a lengthening of the severe convective storm season (*medium confidence*) (Seneviratne *et al.* 2021).

In addition to storms, flights of listed birds in the action area may also be impacted by climate-driven changes in weather, for example, shifting average or extreme temperatures or changing wind patterns (Simmons 2022, Fernández-Alvarez *et al.* 2023). We have little information to assess the extent to which piping plovers, rufa red knots, or roseate terns may be experiencing such shifts in climatic conditions in the action area, or their vulnerability to any such changes.

In addition to effects from weather and storms, roseate terns in the action area may also be affected by changing abundance or composition of forage fish in the action area. Anthropogenic climate change has exposed ocean and coastal ecosystems to conditions that are unprecedented over millennia (*high confidence*), and this has greatly impacted life in the ocean and along its coasts (*very high confidence*). Surface warming since the 1950s has shifted marine taxa and communities poleward at an average (mean ± *very likely* range) of 36.8 ± 9.6 miles (59.2 ± 15.5 km) per decade (*high confidence*), with substantial variation in responses among taxa and regions that leads to novel assemblages of species and fundamentally altered ecosystems. Ecosystem responses to warming water, fishing pressure, food-web changes, marine heat waves, and sea ice algal populations have been responsible for highly variable or collapsing populations of Northern Hemisphere high-latitude forage fish species including sand lances and herring (*Clupea* spp.). Declining stocks of forage fish are expected to have detrimental effects on seabirds (*medium confidence*) (Cooley *et al.* 2022). We have little information on the extent to which roseate terns forage in the action area, or their vulnerability to any such changes in this part of their range.

---

[11] Each finding of the International Panel on Climate Change is grounded in an evaluation of underlying evidence and agreement. A level of confidence is expressed using five qualifiers: very low, low, medium, high and very high, and shown Italics, for example, *medium confidence*. The following terms have been used to indicate the assessed likelihood of an outcome or result: virtually certain 99–100% probability; very likely 90–100%; likely 66–100%; about as likely as not 33–66%; unlikely 0–33%; very unlikely 0–10%; and exceptionally unlikely 0–1%. Additional terms (extremely likely 95–100%; more likely than not >50–100%; and extremely unlikely 0–5%) are also used when appropriate. Assessed likelihood is shown in Italics, for example, *very likely*.

### *Direct Mortality*

Listed bird populations in the action area may be indirectly affected by direct removals from their populations (*i.e.*, mortality) by human activities. The overall numbers of listed birds, rangewide and within different management units, may affect the frequency with which individuals occur in the action area, and could also influence flight behavior and/or energetics if overall abundance also influences flock sizes. In addition, changes in the relative population sizes of various management units may influence patterns of timing and trajectories of flights in the action area, because birds from different units are known to exhibit differences in migration timing and routes. Sources of direct removals from populations include vehicles, collisions with human structures, hunting, oil spills, harmful algal blooms, and research activities. Direct removals are generally considered to be exerting only a minor influence on the listed bird population sizes, and are not cited as a primary threat to any of the three species (USFWS 2020a, b, c), although we note that projected future removals are expected to increase based on the levels of take assessed in previous BOs for offshore wind projects (see Tables 1, 3, and 5). Any influence of these factors on bird use of the action area is unknown and would be extremely difficult to measure.

### *Synthesis*

There are currently no vertical structures in the action area, and thus no collision hazards. We conclude that baseline levels of vessel traffic in the action area are having a negligible effect on listed birds. Climate change is likely influencing listed birds during their offshore flights, but how such changes may be manifesting in the action area is unknown. Any climate-driven changes to the roseate tern prey base in the action area is considered negligible because there is no evidence that terns regularly forage in this particular portion of the OCS. Any terns that do forage in the action area would be limited to nonbreeding birds during the breeding season, and adults or juveniles staging or stopping over on the coast of New Jersey before or during migration. The magnitude of any effects from direct removal of individuals from populations of listed birds (*i.e.*, on the usage of the action area by the remaining members of the population) is highly uncertain but presumed to be small. In summary, the environmental baseline includes no factors that are appreciably diminishing or otherwise affecting usage of the action area by listed birds.

## EFFECTS OF THE ACTION

Effects of the action are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (50 CFR 402.02).

## Collision

The only effect evaluated in this BO is collision of listed birds with the ASOWS turbines (see Introduction, Consultation History). If any listed bird were to collide with any of WTGs, this would clearly result in take under the ESA, by wounding or, more likely, killing the bird. Thus, this analysis focuses on the probability of take occurring and, if take is anticipated, the likely number of affected birds. The Service's standard for issuance of an incidental take statement is "reasonable certainty" that take will occur (50 CFR 402.14(g)(7)). A conclusion of reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available (50 CFR 402.17).

### *Background*

Wind turbines are known to present a collision hazard to birds in flight (Drewitt and Langston 2006, Croll *et al.* 2022). The level of risk is associated with factors such as the number, location, height, lighting, and operational time of the WTGs; the population size and movement patterns of the bird species in question, its typical flight altitudes, and its ability to avoid collision; the landscape setting (*e.g.*, topography on land, distance offshore); and weather conditions. For most species, collision risk levels vary seasonally and differ between day and night (Drewitt and Langston 2006, Croll *et al.* 2022). Collision risk levels may change over time as population sizes expand or contract and as prevalent bird behaviors, major flyways, or patterns of habitat usage change in response to environmental trends or human-driven factors. For example, over time birds may become acclimated and better able to avoid WTGs. Conversely, on a local or regional scale, additive or synergistic effects on collision risk levels may emerge as various offshore wind projects go into operation. Listed birds will eventually encounter and be forced to negotiate up to 3,226 total WTGs projected upon full build out of currently planned offshore projects in New England and the mid-Atlantic, including 7 WTGs in State waters but not including additional areas under consideration for leasing such as the Central Atlantic and Gulf of Maine (Hildreth pers. comm. 2023). Additive or synergistic effects may also emerge between offshore wind operation and profound ecosystem shifts driven by climate change (*e.g.*, changing assemblages/distribution of prey species; phenological shifts; changing patterns of storm activity).

Meta-analyses performed on 88 bird studies containing information from 93 onshore wind farm sites (Thaxter *et al.* 2017) related collision rate to species-level traits and turbine characteristics to quantify the potential vulnerability of more than 9,500 bird species globally. Avian collision rate was affected by migratory strategy, dispersal distance and habitat associations. Larger turbine capacity (megawatts) increased collision rates; however, deploying a smaller number of large turbines with greater energy output reduced total collision risk per unit energy output. Areas with high concentrations of vulnerable species were also identified, including migration corridors. Predicted collision rates were highest for Accipitriformes (most diurnal birds of prey, but not falcons). Charadriiformes, the order of birds that includes all three of the listed species addressed in this BO, was identified as vulnerable. However, predicted collisions within Charadriiformes were relatively low for families Charadriidae (plovers) and Scolopacidae (which includes red knots), and relatively high for family Laridae (which includes roseate terns) (Thaxter *et al.* 2017 Appendix 6, Figure S9).

### *Available Collision Risk Models*

Technology does not currently exist to detect a collision of a listed bird with a WTG, and the likelihood of finding a bird carcass in the offshore environment is negligible. Thus, we anticipate relying on collision risk modeling to estimate collision rates after construction (see Conservation Measure 4), as well as for pre-construction assessments including this effects analysis. A body of literature has developed in recent decades and helps inform risk assessments for piping plover, rufa red knot, and roseate tern. However, considerable uncertainty remains, in part because most studies to date have been conducted at wind farms on land and/or in Europe. In the BA, BOEM (2023) presents results from two different models in order to estimate collision risk for listed birds from the ASOWS projects. The first, a model by Band (2012), estimates the number of annual collisions using input data on the target species (*e.g.*, numbers, flight height, avoidance, body size, flight speed) and turbine details (*e.g.*, number, size, and rotation speed of blades). Band (2012) is an established method to assess collision risk for offshore wind farms. However, the Band (2012) model has several known limitations, summarized here from Masden (2015) and Masden and Cook (2016).

1. Limited transparency. The Excel spreadsheet that underpins the Band (2012) model does not allow for easy reproducibility or review of underlying code and data, thus hindering independent verification of results.
2. Unable to account for variability, thus cannot reflect the inherent heterogeneity of the environment. The Band (2012) model is sensitive to the choice of input parameters. Variability in input parameters such as bird density, flight speed, and rotation speed are likely to contribute uncertainty to the final collision estimates.
3. Deterministic. Band (2012) is not a stochastic model, so it does not account for the stochasticity that pervades natural systems.
4. Limited ability to quantify uncertainty. Recent versions of the Band (2012) model guidance provide an approach under which uncertainty can be expressed. However, this approach is relatively simplistic and can only be applied when the sources of variability are independent of one another. Properly accounting for uncertainty becomes increasingly important as collision risk estimates are extrapolated over time, such as the 30-year lifespan of ASOWS.

The second model, SCRAM, builds on the Band (2012) model and introduces stochasticity via repeated model iterations. The wind farm and WTG operational inputs to SCRAM are similar to those used in the Band (2012) model. Unlike Band (2012), however, SCRAM estimates species exposure to a proposed wind farm using bird passage rates based on modeled flight paths of birds fitted with Motus tags (Adams *et al.* 2022), which are detected by a network of land-based receiving stations operated in coordination with the Motus network. Future versions of SCRAM will be updated with new tracking data as it becomes available, but the current version of SCRAM is informed by a fixed number of Motus tag detections that were collected from 2015 to 2017 for roseate terns and piping plovers, and in 2016 for rufa red knots. SCRAM estimates monthly collision risk for those months when the species-specific tracking data were collected, and these monthly collision estimates are summed to produce annual collision estimates reflecting the months evaluated (Adams *et al.* 2022). It is important to note that SCRAM currently evaluates collision risk only for those months with movement data from Motus.

Collection of movement data during the study periods was limited by: 1) tag battery life; 2) temporary tag attachment method/duration (*i.e.*, to minimize risks to tagged individuals); 3) locations of tag deployment; and 4) the detection range of land-based Motus stations (typically less than 12 miles (20 km)), which during the study periods were unevenly distributed along the U.S. Atlantic Coast, with core station coverage at coastal sites from Massachusetts to Virginia.

The Service appreciates BOEM's past and ongoing support for the development of SCRAM and inclusion of Conservation Measure 3, above. We continue to support the development and refinement of SCRAM as a scientifically sound method for integrating best available information to assess collision risk for these three listed birds. However, the first version of SCRAM was only released in early 2023 and still reflects a number of consequential gaps and uncertainties. In addition to the limited data available to inform the model parameters, discussed above, there has also been limited validation of the model structure, resulting in substantial uncertainty in model results (Adams *et al.* 2022). Specific gaps and uncertainties of concern include:

1. Sample size. The tracking data sample sizes that underpin the model are relatively small, and do not include all tracks now available (*e.g.*, newer Motus data; any satellite, GPS, or geolocator data).
2. Accuracy. All of the flight tracks and altitudes that underpin the model are estimated from land-based receiving stations and are thus of limited accuracy because offshore bird movements were interpolated rather than measured directly. Model evaluation using a simulated data set suggested that the interpolations were reasonably accurate nearshore (where the vast majority of the Motus stations are located) but less accurate farther offshore. Even in nearshore areas, movement estimates are biased by the detection range. Estimates of flight altitude from Motus data are currently coarse approximations (Adams *et al.* 2022).
3. Detection range. The detection range of Motus receiving stations varies with altitude of the tagged bird, but is typically less than 12 miles (20 km) on average for birds in flight. This is likely a key reason that only one roseate tern migratory track was documented south of Long Island during the tracking studies. The easternmost portions of the ASOWS WTA are over 22 miles (35 km) from the nearest land. Thus, there were gaps in coverage of the Lease Area that could lead to underestimates of collision risk.
4. Temporal gaps. Both movement and flight height data are currently limited to those times of year during which the tracking studies were carried out (Adams *et al.* 2022). There are no spring data for any of the three listed bird species in SCRAM due to small sample sizes of available data (*e.g.*, only two northbound piping plovers tagged in the Bahamas with tracks in the U.S.) and limited tagging locations (*e.g.*, most rufa red knots tagged in spring were in Delaware Bay). Any collision estimates from SCRAM are limited to the time periods listed below. Thus, "annual" SCRAM outputs should be considered only partial estimates of projected collision levels because they reflect summing across only those months for which data are available.
   Piping plovers:
   - Collision risk evaluated: mid-incubation period and through fall migratory departure from tagging sites
   - Collision risk NOT evaluated: latter portion of fall migratory flights, spring migration and staging

Roseate terns:
- Collision risk evaluated: mid-incubation period and to the post-breeding dispersal period
- Collision risk NOT evaluated: fall migration and spring migration to the mid-incubation period

Red knots:
- Collision risk evaluated: fall migratory departure from tagging sites
- Collision risk NOT evaluated: latter portion of fall migratory flights, spring migration and staging

5. Spatial bias. SCRAM assumes that the movement models represent bird airspace use in an unbiased manner. However, it is likely that collision risk outputs from SCRAM are biased by the proximity of a lease area to the locations of Motus tag deployment and/or its location relative to the distribution of land-based receiving stations during the tracking study periods (Lamb *et al.* 2022). As Motus stations are unequally distributed on the landscape, and different numbers of Motus stations were operated each year of the tracking study, the locations of each year's Motus stations inevitably bias resulting estimates of bird use of the offshore airspace (Adams *et al.* 2022). Thus, SCRAM could underestimate collision risk for projects more distant from the tagging areas or more distant from those receiving stations that were in operation during the study periods.

6. Bias in tagged birds. Both movement and flight height data are currently limited to those specific tagged populations tracked during the study periods (Adams *et al.* 2022). It is not yet clear if the bird tracks that underpin the current version of SCRAM are representative of all piping plovers, rufa red knots, and roseate terns utilizing the offshore airspace. Even within the seasons/regions for which tracks are available and incorporated into SCRAM, these tracks represent birds from a relatively small number of sites at which tagging took place. For example, the tracks informing SCRAM for piping plover were all derived from Motus tag deployment at just two nesting areas in New England. No tracks are yet available from the Eastern Canada portion of the piping plover breeding range, which is part of the taxon listed under the ESA and fully protected when they are in the U.S. Preliminary results from a previous mark/resight study found that 42 percent of piping plovers marked in Eastern Canada were subsequently detected in New Jersey and 52 percent were detected in North Carolina (Rock pers. comm. 2023). These Canadian nesters could have significant exposure to offshore wind that is not yet reflected in SCRAM collision risk estimates. Rufa red knot trapping sites covered a greater geographic area but may still not be fully representative of the overall population's use of the offshore airspace.

7. Variability. SCRAM cannot yet produce a range of plausible risk levels by varying certain "baked in" assumptions to which the model might be quite sensitive and which are associated with high uncertainty (*e.g.*, avoidance rate,[12] population size, flight height).

---

[12] Species-specific avoidance rates are critical to obtaining realistic and confident estimates of collision events (Masden and Cook 2016, Kleyheeg-Hartman *et al.* 2018). Both the Band and SCRAM models require inputs or make assumptions for bird flight height, speed and populations anticipated to occur within the WTG area. The species-specific data for these parameters are associated with large margins of error (Loring *et al.* 2018; Loring *et al.* 2019) and/or are based on surrogate species information developed for European species.

We appreciate BOEM's cooperative efforts to work with the Service on the development of SCRAM with the goal of reducing uncertainty around collision risk estimates (see Conservation Measure 3). We expect that many of the above-listed limitations of SCRAM will decrease substantially over time as Motus tags are deployed in more areas, as receiving stations are deployed offshore, and/or as new tracking technologies become available. However, at this time given the substantial limitations described above, we conclude that SCRAM outputs should be only one factor in assessing collision risk, and must be supplemented by other sources of information in order to satisfy the ESA requirement to utilize best available scientific and commercial data.

### ***Methods for Estimating Numbers of Collisions***

In light of the high uncertainty associated with both Band (2012) and SCRAM, as discussed above, we consider collision projections from both models. For SCRAM, we ran Version 1.0.3 using inputs provided by BOEM[13] (Bigger pers. comm. 2023). As discussed above, SCRAM uses estimated flight paths and altitudes of tagged birds, combined with monthly population size estimates, to assess exposure of each species to the RSZ. Compared to Band (2012), SCRAM uses the monthly population estimates in a different way. SCRAM uses movement modeling derived from Motus tracking data to determine monthly occupancy rates within half degree grid cells and then links those values to monthly population estimates to estimate species density across the Atlantic OCS where tracking data were available. SCRAM uses these density estimates at specific flight heights (data also derived from Motus tracking) along with other species and site characteristics (*e.g.*, species-specific flight speeds and number of turbines in a specified turbine array) to estimate collision risk for locations across a portion of the Atlantic OCS where tracking data were available (Adams *et al.* 2022).

Likewise for Band (2012) we input WTG specifications provided by BOEM (Bigger pers. comm. 2023), and we utilized the same species-specific flight height distributions (*i.e.*, derived from Motus radio tracking data) as are used in SCRAM (Adams *et al.* 2022). We followed the guidance from Band (2012) to develop a best estimate, not a "worst case" scenario. For all three species, we used Annex 6 – Assessing collision risks for birds on migration. We expect piping plovers in the action area to be limited to birds on migration flights. However, for rufa red knots and roseate terns, use of Annex 6 means omitting from the Band (2012) analysis birds that may be seasonally resident in the mid-Atlantic and present in the action area on non-migration flights (*i.e.*, regional movements for knots, foraging flights for terns). Although Annex 6 is unable to account for seasonally resident birds, we selected it for the following reasons: (1) Stage B of the Band (2012) basic model (*i.e.*, for resident birds) requires an estimate of observed bird density on an area basis, and this information is unavailable for any of the listed bird species in the vicinity of the ASOWS Lease Area during any month; and (2) far greater numbers of migrating knots and terns are present on the mid-Atlantic OCS compared to seasonally resident birds. Thus, we conclude that Annex 6 is the most appropriate application of the Band (2012) model to ASOWS.

---

[13] "Air gap," as measured between the water and lowest point of the WTG blade, is one input to both SCRAM and Band (2012). For both models, we used the air gap value provided by BOEM of 23.8 m. However, the COP indicates that the correct value should be 22 m when air gap measured relative to the Highest Astronomical Tide datum. It is unclear if this discrepancy had any effect on projected levels of collision mortality.

However, we note that if and when seasonally resident knots or terns occur offshore, they may spend more time in the action area, and at different flight heights, compared to migrants, and this represents an additional source of collision risk that is not reflected in the Band (2012) outputs given below.

Under Annex 6, Band (2012) makes the following assumptions:

1. the entire bird population uses a migratory corridor twice each year;
2. the birds are evenly distributed across a migration corridor; and
3. the width of the corridor can be measured at the latitude of the wind farm (*i.e.*, this "migratory front" is an imaginary line passing through the ASOWS WTA and extending to the western and eastern edges of the migratory corridor used by each species).

Regarding assumption 1, we conclude that it generally holds true that piping plovers and roseate terns cross the migratory front only twice per year. However, we know from tracking and resighting data that rufa red knots may engage in reverse migration over regional geographic scales in pursuit of favorable food and other stopover conditions (USFWS 2014). Thus, an unknown number of migrating knots violate this assumption by crossing the migratory front more than twice per year. Regarding assumption 2, we conclude from tracking data that none of the three listed birds species are evenly distributed across a migration corridor. However, it remains necessary and appropriate to consider Band (2012) outputs given the known gaps in SCRAM. Our application of the Band (2012) model, including inputs and interpretation of the outputs, was reviewed by an independent expert who concurred with our approach (Cook pers. comm. 2023).

We used best available tracking and other data (including range maps) to inform the delineation of the migration corridors (see Appendix A). To measure the width of the migration corridors, we projected the corridors in UTM18N in ArcGIS Pro, then created a new line shapefile (for each corridor) that intersected the centroid of the ASOWS lease area and snapped to the eastern and western edges of the corridor. We then calculated the length of the line in kilometers using the "calculate geometry" tool. For piping plover, the corridor was based on radio tracking data for birds departing on migration from Chatham, Massachusetts and several sites in Rhode Island (Loring *et al.* 2020, figures 5 and 6), as well as the known wintering distribution of the Atlantic Coast population (Blanco 2012, Elliott-Smith *et al.* 2015, Gratto-Trevor *et al.* 2016, Elliot-Smith and Haig 2020). The piping plover corridor measures 150 miles (241 km) wide at the latitude of the ASOWS Lease Area. A migratory corridor for roseate tern was delineated to include the entirety of their known breeding range and migration range for the Northeastern population, from Sable Island, Nova Scotia, south and west through North Carolina and southward to the West Indies (Gochfield and Burger 2020). The migratory corridor for roseate terns measures 291 miles (468 km) wide at the latitude of the ASOWS Lease Area.

For rufa red knot, we delineated a migration corridor based on geolocator tracking data collected from 93 individual birds (with tags deployed across the species range) between 2009 and 2017 (Perkins 2023). Measuring 1,488 miles (2,394 km) across at the latitude of the ASOWS Lease Area, the corridor encompasses all rufa red knot geolocator tracks except those that are clearly associated with the Western recovery unit. A considerable number of satellite/GPS tracking devices have been deployed on rufa red knots since 2020. Preliminary data from these satellite tags were evaluated but ultimately not utilized in delineating the migration corridor because the data are still undergoing quality control, and in many cases, metadata is not yet available. Although not relied upon for this mapping exercise, the preliminary satellite data do show broadly similar geographic patterns to the geolocator data and lend confidence to our delineation of the migration corridor. Likewise, GIS layers were unavailable for the migration tracks shown in Smith *et al.* (2023), but the migration pathways shown in Figure 2 of that paper are broadly similar to those in Perkins (2023) and further support our delineation.

The final input required to run Band (2012), Annex 6, is the number of birds crossing the migratory front each month. Table 7 presents the population data we used for this purpose. All monthly numbers were multiplied by 30 to estimate number of collisions over the operational life of the ASOWS turbines.

**Table 7. Population data inputs to Band (2012), Annex 6**

| | **Piping Plover** | **Rufa Red Knot** | **Roseate Tern** |
|---|---|---|---|
| Total northbound (NB) | 4,047 | 59,269 | 10,866 |
| Young of the year (YOY) | 2,632 | 27,041 | 5,433 |
| Total southbound (SB) | 6,679 | 86,310 | 16,299 |
| # of Jan crossings | 0 | 0 | 0 |
| # of Feb crossings | 0 | 0 | 0 |
| # of Mar crossings | 406 (10% of NB) | 0 | 0 |
| # of Apr crossings | 2,426 (60% of NB) | 0 | 3,622 (33% of NB) |
| # of May crossings | 1,215 (30% of NB) | 59,269 (100% of NB) | 3,622 (33% of NB) |
| # of Jun crossings | 671 (10% of SB) | 2,371 (3% of SB) | 3,622 (33% of NB) |
| # of Jul crossings | 4,004 (60% of SB) | 7,009 (8% of SB) | 0 |
| # of Aug crossings | 2,004 (30% of SB) | 25,893 (30% of SB) | 5,433 (33% of SB) |
| # of Sep crossings | 0 | 25,893 (30% of SB) | 5,433 (33% of SB) |
| # of Oct crossings | 0 | 15,651 (18% of SB) | 5,433 (33% of SB) |
| # of Nov crossings | 0 | 8,631 (10% of SB) | 0 |
| # of Dec crossings | 0 | 863 (1% of SB) | 0 |

**Table 7 Notes:**

Piping Plover:

(1) Population data are from 2021 (USFWS 2022a) and exclude an unknown (but likely small) number of nonbreeding birds.

(2) The Southern recovery unit population is excluded.

(3) The SB total includes YOY, calculated as the unweighted mean 20-year productivity rates (2002 - 2021) times the 2021 breeding pair estimate for each state within the Eastern Canada, New England, and NY-NJ recovery units.

(4) The eastern edge of the migration corridor runs southwest parallel to the general orientation of the coast to account for major migration staging areas in North Carolina (Weithman *et al.* 2018). The eastern edge of the corridor south of Cape Hatteras is also constrained westward to account for much larger numbers of piping plovers wintering in the western Bahamas (however, this has no effect on the width of the corridor at the latitude of the ASOWS Lease Area).

Rufa Red Knot

(1) Population data are from Table 4, above.

(2) Birds from the Western recovery unit population are sometimes documented on the Atlantic Coast. However, available tracking and resighting data show that the prevailing migration corridor for these

birds is overland across the mid-continent (USFWS 2014, USFWS 2021, Perkins 2023). On this basis, birds from the Western recovery unit are excluded from this analysis.

(3) In many years, a percentage of northbound birds do not depart the mid-Atlantic until early June. But for the purposes of this analysis, we attribute them all to May.

(4) Some juveniles and nonbreeding adults remain south of the migratory front, others cross the migratory front once in spring and spend the breeding season just south of the breeding grounds, while still others may remain resident in the mid-Atlantic for prolonged periods and may cross the migratory front multiple times. We have no estimate of the total number of nonbreeding adults in a typical year, or their distribution across the species nonbreeding range. However, we do estimate the total number of juveniles. Modeling by Schwarzer (2011) found that the Florida population was stable at around 8.75 percent juveniles among wintering birds, and available data suggest the three populations considered in this analysis are currently stable (USFWS 2021b). Thus, we assume 8.75 percent of the total wintering birds are juveniles (*i.e.*, of the 59,269 total birds, we assume 5,186 are juveniles.) We have little information on the distribution of juveniles across the species' range during any month. In light of data gaps, we assume all breeding adults, nonbreeding adults, and juveniles cross the migratory front twice per year.

(5) The SB total includes YOY, calculated as 1 chick per pair. Number of pairs is calculated as [the total wintering population (59,269) minus juveniles (5,186)] divided by 2. We have no way to estimate nonbreeding adults, so we include them with breeding adults, then attempt to compensate by using a reproductive rate of 1 chick per pair, below the range estimated by Wilson and Morrison (2018) as needed for a stable population.

Roseate Tern:

(1) Migration numbers were generated based on 2021 breeding population numbers and productivity rates from the US and Canada.

(2) Spring migration totals were calculated as the number of breeding pairs in each region multiplied by 2 adults per breeding pair.

(3) Fall migration totals included all adults from spring migration plus the approximate number of YOY.

(4) YOY totals were calculated by multiplying the number of breeding pairs in the US and Canada by the average productivity of these pairs (approximately 1 YOY per pair).

(5) Migration months were determined based on peak migration during the spring and fall migration seasons, as reported by Gochfeld and Burger (2020).

(6) Number of spring and fall migrants were then assumed to be divided evenly across migration months.

### *Analysis of Model Outputs and Projected Numbers of Collisions*

The complete SCRAM and Band (2012) output reports are provided in Appendix B, and summary information is presented in Table 8. As discussed at length in this BO, these estimates are associated with very high uncertainty. We consider these model outputs as one factor relevant to projecting the number of collisions (if any) of each listed bird species that is reasonably certain to occur over the life of the ASOWS projects. However, we do not restrict our analysis to these numerical outputs due to the model limitations, discussed above, as applied specifically to each listed species, as discussed below. Instead, we consider the model outputs in the context of other relevant quantitative and qualitative information. This approach is consistent with guidance from Band (2012), who concluded, ". . . given the uncertainties and variability in source data, and the limited firm information on bird avoidance behavior, it seems likely that for many aspects the range of uncertainty may have to be the product of expert judgement, rather than derived from statistical analysis." This approach is also consistent with ESA policy (80 FR 26837), which states, "While relying on the best available scientific and commercial data, the Services will necessarily apply their professional judgment in reaching these determinations and resolving uncertainties or information gaps. Application of the Services' judgment in this manner is consistent with the "reasonable certainty" standard."

**Table 8. Model-projected numbers of collisions over 30 Years of WTG operation**

| | Piping Plover | Rufa Red Knot | Roseate Tern |
|---|---|---|---|
| **SCRAM[1] (Ver. 1.0.3)** | 30 | 2,310 | 0 |
| **Band[2] (2012)** | 16 | 66 | 0 |
| **Average** | 23 | 1,188 | 0 |

[1] As discussed above, SCRAM outputs reflect only those months for which movement data are available and should thus be considered partial estimates of annual and operational collision risk. See Appendix B for the 95 percent CIs.
[2] The 93 percent avoidance rate is given for consistency with SCRAM and for the reasons discussed below. See Appendix B for projected collision levels under higher avoidance rates.

SCRAM uses a mean avoidance rate of 0.9295 with a standard deviation of 0.0047 for all three listed birds (Cook 2021, Adams *et al.* 2022). Collision risk models are sensitive to the selection of avoidance rates (Chamberlain *et al.* 2006, Robinson-Willmott *et al.* 2013, Gordon and Nations 2016, Masden and Cook 2016, Kleyheeg-Hartman *et al.* 2018). We are not aware of any empirical, species-specific avoidance rates available for piping plovers, rufa red knots, or roseate terns. The selection of 0.927 for use in SCRAM was based on a review of available literature for gulls and terns in Europe (Cook 2021). Cook (2021) presents avoidance rates for three tern species for use in the extended Band (2012) model, ranging from 85 to 99 percent; the average of 93 percent is consistent with the SCRAM model. We are unaware of any empirical avoidance rates specific to shorebirds.

In addition to the lack of species-specific empirical data, we note that blanket application of any avoidance rate does not account for differences among individual birds; acclimation to the wind farm; flocking behavior; flight height or type (*e.g.*, foraging, migratory, regional transit); weather conditions or visibility; time of day; and any behavioral influence of the wind farm on the bird (*e.g.*, displacement, attraction) (May 2015, Gordon and Nations 2016, Masden and Cook 2016, Marques *et al.* 2021). Based on Band (2012), Gordon and Nations (2016), Kleyheeg-Hartman *et al.* (2018), SNH (2018), Cook (2021), and Adams *et al.* (2022), we primarily consider the 93 percent avoidance rate in our analysis.

The collision estimates presented in Table 8 do not account for any attraction of listed birds to the action area by marine navigation lighting. Studying passerines migrating over the German Wadden Sea, Rebke *et al.* (2019) found that nocturnally migrating birds at sea were generally attracted by a single light source, and that even relatively weak sources of light (compared to others in the distant surroundings) attract nocturnal migrants flying over the sea. Based on the range of the microphones used to record bird calls in this study, the authors concluded that attraction of birds leads them close to the sources of light. The results of this study are consistent with the body of literature showing generally stronger avian attraction to artificial light during nights with cloud cover. In this study, no light variant (*e.g.,* color) was constantly avoided by nocturnally migrating passerines crossing the sea. While intensity did not influence the number attracted, birds were drawn more towards continuous than towards blinking illumination, when stars were not visible. Continuous green, blue, and white light attracted significantly more birds than continuous red light in overcast situations (Rebke *et al.* 2019). The applicability of this study to shorebirds and terns is not yet clear. Conservation Measure 2 provides for reassessment of collision projections for listed birds following approval of the maritime navigation lighting plan by the USCG.

The collision estimates presented in Table 8 also do not consider any potential synergistic effects of WTGs on adjacent lease areas. We have no information or basis to assess whether any behavioral response to WTGs on the previously evaluated Ocean Wind 1 project (Lease OCS-A 0498) may influence avoidance rates, flight heights, or flight paths of birds traversing the contiguous ASOWS WTA, and whether any such influence(s) may vary by species, weather conditions, time of day, or season.

### _Piping Plover_

Table 8 presents a range of 16 to 30 piping plover collisions over the life of the ASOWS projects. The SCRAM estimates may be low based on the lack of spring data, the limited detection range of land-based receivers, and the limited tag deployment sites that were restricted to only one of the three recovery units covered by this BO. As previously noted, estimates of flight altitude from Motus data are currently coarse approximations (Adams *et al.* 2022) and hence substantially limit our confidence in model outputs.

We know of no studies of avoidance behaviors for any shorebird species, and hence we believe that the 92.97 percent estimate recommended by Cook (2021) is the best available estimate for piping plovers. We recognize several factors suggesting the possibility of a piping plover avoidance rate greater than 92.97 percent. First, unlike the species studied by Cook (2021), piping plovers are not pelagic feeders. Hence, they will not be distracted by foraging activities during migration. Second, there is evidence of good nocturnal vision inferred by nocturnal foraging behavior (Staine and Burger 1994, Stantial and Cohen 2022) and nocturnal flights during the breeding season (Sherfy *et al.* 2012). Charadriidae (plovers) have specialized visual receptors and are known to possess excellent visual acuity with the ability to routinely forage during poor light conditions (del Hoyo *et al.* 2011). Third, agility of adult plovers has been observed in distraction displays, including abrupt flights to escape potential predators during broken-wing displays (Hecht pers. comm. 2023). Finally, Loring *et al.* (2020) found that visibility was high during their sample of southbound offshore piping plover flights (mean: 11 miles (18 km), range: 9 to 12 miles (14 to 20 km)). Loring *et al.* (2020) shows a range of southward migratory departure times and dates from Massachusetts and Rhode Island. Birds that departed on the same day often had variable flight durations to cover the similar distances. This information is consistent with informal observations of staggered arrivals and departures during both northward and southward migration and, in turn, reduces concerns that a large proportion of the plover population could simultaneously encounter weather conditions (*e.g.*, dense fog) that would impair visibility, exerting a large effect on the average avoidance rate (Hecht pers. comm. 2023). Countervailing information, however, includes data from 2 birds tagged in the Bahamas and tracked during their northbound offshore flights that included periods of low visibility and precipitation (Loring *et al.* 2019, Appendix I). It is also uncertain whether agility of flights and the plovers' attention to visual cues observed on land extend to their behaviors during offshore migratory flights.

We conclude that take of Atlantic Coast piping plovers from operation of the ASOWS turbines is reasonably certain to occur. Absent sufficient information to more precisely estimate avoidance rates and other data limitations described above, we considered the range of collision estimates presented in Table 8 and Appendix B. Although we cannot completely discount the high and low ends of the range of model outputs, we believe that the best available collision estimate is in the middle. We determined a single collision estimate by averaging the SCRAM and Band (2012) estimates. For the purpose of this BO, we project that up to 23 piping plovers will collide with the turbines over the life of the projects. We note that this estimated level of take is associated with high uncertainty, and we expect that it will be refined over time in accordance with Conservation Measures 3, 4, and 5.

*Rufa Red Knot*

Table 8 presents a range of 66 to 2,310 rufa red knot collisions over the life of the ASOWS projects. Several factors suggest collision rates on the higher end of this range:

- Data gaps bias SCRAM to underestimate collision (*e.g*., lack of spring data, limited deployment areas, limited detection range of land-based receivers).
- While Band (2012) assumes even distribution of birds across the migratory front, SCRAM accounts for the known spatial heterogeneity in rufa red knot tracks.
- While Band (2012) assumes each bird crosses the migratory front twice each year, SCRAM accounts for regional flights by seasonally resident birds, as it is informed by the full data set reported by Loring *et al.* (2018).
- Gordon and Nations (2016) used an avoidance rate of 93 percent in good weather and 75 percent in poor weather. As discussed above, rufa red knot migration flights are typically associated with fair weather (Loring *et al.* 2018), but birds have been known to encounter storms on their long flights (Niles *et al.* 2010, Niles 2014).

However, other factors suggest collision rates on the lower end of the range.

- Although important gaps still need to be addressed in the radio tracking data underpinning SCRAM, the sample sizes and distribution of tagging locations are far more robust for rufa red knots than for the other two listed birds, lending more weight to the SCRAM estimates.
- Because the vast majority of birds are known to fly overland in spring from the Atlantic Coast (Florida to Delaware Bay) directly to Hudson Bay in Canada:
    - the lack of spring data in SCRAM is less consequential for rufa red knots than for the other two species; and
    - Band (2012) almost certainly overpredicts collision of spring migrants, probably by a lot, by assuming even distribution of northbound birds across the migration front (*i.e.*, it does not account for the predominance of the overland route).
- SCRAM outputs for ASOWS are three orders of magnitude higher than for the contiguous Ocean Wind 1 project on Lease OCS-A 0498. Substantive differences exist between the Ocean Wind 1 and ASOWS projects (*e.g*., WTG numbers and sizes), and the two leases probably do exhibit real biological differences in their relative numbers of rufa red knot crossings (*e.g.*, compared to OW1, the ASOWS WTA is closer to shore and closer to the Little Egg Inlet, which is known to support high densities of rufa red knots). Preliminary

review of satellite/GPS tracking data suggests that birds from the Little Egg Inlet habitat complex may, in fact, be prone to cross the ASOWS lease area at higher rates than the OW1 lease area. Though still qualitative, the satellite/GPS data provide additional support for real differences in grid cell occupancy rates as determined by the Motus detection data that underpin SCRAM. However, it is unclear if the difference between these two adjacent lease areas is as extreme as suggested by the current generation of SCRAM, and we conclude that the magnitude of this difference in SCRAM outputs may be an artifact of the various model biases and limitations discussed above and in the following bullet.

- One of the SCRAM grid cells overlaps both the ASOWS WTA and as well as onshore and back bay portions of the Little Egg Inlet complex. SCRAM has attempted to correct for onshore Motus detections by applying a movement model to the Motus detection data to estimate behavioral states (transient, assumed to be flying versus area-restricted, assumed to be on land). Only birds in the transient state were included in collision risk estimates (Adams *et al* 2022). However, the occupancy rates of some land-covering cells are so high that this effort to correct for movement type is probably not enough to counteract the effect entirely.

We conclude that take of rufa red knots from operation of the ASOWS turbines is reasonably certain to occur. Absent sufficient information to more precisely estimate avoidance rates and other data limitations described above, we considered the range of collision estimates presented in Table 8 and Appendix B. Although we cannot completely discount the high and low ends of the range of model outputs, we believe that the best available collision estimate is in the middle. We determined a single collision estimate by averaging the SCRAM and Band (2012) estimates. For the purpose of this BO, we project that up to 1,188 rufa red knots will collide with the turbines over the life of the projects. We note that this estimated level of take is associated with high uncertainty, and we expect that it will be refined over time in accordance with Conservation Measures 3, 4, and 5.

### Roseate Tern

All of the collision risk model outputs presented in Table 8 and Appendix B project 0 roseate tern collisions over the life of the ASOWS projects. However, for reasons discussed at length above, we do not limit our analysis to these outputs. Due to the known gaps in SCRAM, and unsupported assumptions in Band (2012), we consider these outputs in the context of all best available information, and in the context of Service regulation and policy.

According to the ESA Section 7 Handbook, we must give the benefit of the doubt to the species whenever significant data gaps exist (USFWS and NMFS 1998). Where the best available information is equivocal (*i.e.*, an adverse effect may or may not occur), then we apply the benefit of the doubt to the species and assume the impact will occur to ensure we do not make an error of omission. On the other hand, the standard for issuance of an incidental take statement is "reasonable certainty" that take will occur (50 CFR 402.14(g)(7)). Application of the "reasonable certainty" standard is done in the following sequential manner using the best available scientific and commercial data to determine if incidental take is anticipated: (1) a determination is made regarding whether a listed species is present within the area affected by the proposed Federal action; (2) if so, then a determination is made regarding whether the listed species would be exposed to stressors caused by the proposed action (*e.g.*, noise, light, ground disturbance); and

(3) if so, a determination is made regarding whether the listed species' biological response to that exposure corresponds to the statutory and regulatory definitions of take (*i.e.*, kill, wound, capture, harm, etc.). Applied in this way, the "reasonable certainty" standard does not require a guarantee that a take will result, rather, only that the Services establish a rational basis for a finding of take. While relying on the best available scientific and commercial data, the Services will necessarily apply their professional judgment in reaching these determinations and resolving uncertainties or information gaps. Application of the Services' judgment in this manner is consistent with the "reasonable certainty" standard. The standard is not a high bar and may be readily satisfied (80 FR 26837). A conclusion of reasonably certain to occur must be based on clear and substantial information, using the best scientific and commercial data available (50 CFR 402.17). Below we consider best available information relevant to each of the sequential steps listed above.

*(1) A determination is made regarding whether a listed species is present within the area affected by the proposed Federal action;*

We conclude that roseate terns at least occasionally occur in the ASOWS WTA based on the following.

- Small numbers of roseate terns were consistently documented throughout summer 2023 on Horseshoe Island (Kopec pers. comm. 2023), about 8.5 miles (13.7 km) northwest of the action area. Multi-year data from eBird show birds along the coast of New Jersey, as well as in the OCS at about the same distance from shore as the ASOWS WTA (eBird 2023). This is consistent with anecdotal reports summarized by Gochfeld and Burger (2020).
- Known distances to feeding grounds extend offshore to and beyond the distance of the ASOWS WTA (USFWS 2020c).
- The eastern part of the ASOWS WTA lies beyond the typical limit of detection of the land-based receiving stations that were employed by Loring *et al.* (2019), which provides the positional and altitude data that underpin SCRAM.
- There are only seven tracks of breeding birds on migration flights south of Long Island (one from Motus tags, six from geolocators), and only five tracks of northbound birds (all from geolocators). All of these available tracks are associated with limited positional accuracy (Mostello *et al.* 2014, Loring *et al.* 2019).
- Where the best available information is equivocal, we apply the benefit of the doubt to the species.

*(2) if so, then a determination is made regarding whether the listed species would be exposed to stressors caused by the proposed action (e.g., noise, light, ground disturbance); and*

When present in the ASOWS WTA, we conclude that roseate terns will be at least occasionally exposed to the RSZ and susceptible to collision, based on the following.

- The estimate of 0 collisions output by the Band (2012) model is based on the same flight height distribution that is used in SCRAM, as collected by Loring *et al.* (2019). However, the flight altitude data collected during this study are limited to flights by breeding and pre-migratory (*i.e.*, staging) birds (Loring *et al.* 2019), and thus may not be representative of altitudes for migration flights (Nisbet pers. comm. 2019). In addition, roseate terns are known to rest on the surface of the ocean during migration transits (Oswald *et al.* 2023), further complicating efforts to characterize flight altitudes.

- Several factors may attract roseate terns to the action area, encourage them to spend more time there, and/or engage in more distracted behaviors while there.
    - Terns are known to perch on oil rigs offshore of Brazil (Loring *et al.* 2023). The addition of more than 200 new structures to the action area may result in perching by roseate terns. Birds known to perch or roost around wind turbines show increased collision risk (Marques *et al.* 2014).
    - The new structures may attract terns by concentrating forage fish (Degraer *et al.* 2020, Mavraki *et al.* 2021) or increasing water turbulence (Lieber *et al.* 2021). Birds engaged in foraging or other distracted behavior show increased collision risk (Marques *et al.* 2014).
    - Any effect of marine navigation lighting on roseate terns is unknown. As discussed above, this species is known to occur offshore at night (Nisbet pers. comm. 2019, Gochfeld and Burger 2020, Oswald *et al.* 2023), and many bird species are attracted by lighting (Rebke *et al.* 2019).

*(3) if so, a determination is made regarding whether the listed species' biological response to that exposure corresponds to the statutory and regulatory definitions of take (i.e., kill, wound, capture, harm, etc.).*

As discussed above, we conclude that 100 percent of collisions will result in take—most likely lethal take.

Considering the above information, we conclude that take of roseate terns from operation of the ASOWS turbines is reasonably certain to occur. The only point of reference we have regarding the likely number of collisions is that it is lower than for piping plover, based on comparison of the geographic distribution of these two species and our best understanding of how they use the airspace of the OCS. Compared to piping plovers, the roseate tern population size is nearly twice as large (see Tables 2 and 6), which increases collision risk. However, a small sample of tracked roseate terns utilized migration pathways well east of the ASOWS action area, and this species does not breed south of New York—both factors that considerably lower collision risk relative to the piping plover. Therefore, we project that 1 roseate tern will collide with the turbines over the life of the project. We note that this estimated level of take is associated with high uncertainty, and we expect that it will be refined over time in accordance with Conservation Measures 3, 4, and 5.

## CUMULATIVE EFFECTS

As used in the context of consultations under Section 7 of the ESA, cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Any proposed new structure in the action area would require authorization from BOEM and would thus be subject to consultation. We do not expect any change in the types or levels of non-project-related vessel traffic in the action area that would have any appreciable effect on listed birds. We expect direct mortality of listed birds from non-Federal actions to remain low and continue exerting negligible effects on birds in the action area. It is virtually certain that human caused climate change will continue into the foreseeable future, although there is large uncertainty around the pace and magnitude of climate change (mostly related to the uncertain trajectory of mitigation actions) (USFWS 2020b). There is also high uncertainty around how climate change may affect usage of the action area by listed birds. Therefore, no cumulative effects are anticipated.

## JEOPARDY ANALYSIS

"Jeopardize the continued existence" of a species, as defined in regulations implementing the ESA, means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both survival and recovery in the wild by reducing the reproduction, numbers, and distribution of that species (50 CFR 402.02). The following analysis relies on four components: (1) Status of the Species, (2) Environmental Baseline, (3) Effects of the Action, and (4) Cumulative Effects. The jeopardy analysis in this BO emphasizes the rangewide (or recovery unit wide) survival and recovery needs of the listed species and the role of the action area in providing for those needs. It is within this context that we evaluate the significance of the collision mortality, taken together with cumulative effects, for purposes of making the jeopardy determination.

### Effects to Individuals

For this analysis, we presume that 100 percent of listed birds that collide with a WTG will be fatally wounded and die.

### Effects to Populations

Watts (2010) used a form of harvest theory to estimate the following maximum sustainable annual limits from all sources of human-induced mortality for bird populations using the Atlantic Flyway:

piping plover - 61
rufa red knot - 451
roseate tern - 106

Sources of direct removals from populations other than collisions with WTGs include vehicles, collisions with other human structures, hunting, oil spills, harmful algal blooms, and research activities (USFWS 2020a, b, c). For example, a recent BO authorizes the mortality of up to 6 rufa red knots per year to be injured or killed incidental to research activities over the next 5 years (30 birds total) (USFWS 2023e). We note that the population estimates used by Watts (2010) are dated. For example, the rufa red knot's rangewide total abundance estimate is now more than three times higher due to improved survey methods (USFWS 2021), suggesting a higher sustainable limit. Further, maintaining a certain population level does not necessarily equate with recovery. ESA regulations define "jeopardize" as directly or indirectly reducing appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR 402.02). Removal of individuals from a population (*i.e.*, reduction in numbers, in this case via collision mortality) may jeopardize a species by reducing the likelihood of recovery even if the level of removal is projected to be below a sustainable limit for maintaining a population at its current size.

Robinson-Willmott *et al.* (2013) compiled data on population size, conservation importance, and ecological traits of bird species found in the vicinity of the Atlantic OCS and developed a method of ranking their relative sensitivity to the impacts of collision. In this framework, Final Collision Score is equal to Collision Sensitivity Score times Population Sensitivity. These authors ranked piping plover as lower, rufa red knot as medium, and roseate tern as higher Final Collision Score. However, most data utilized in this analysis represent global populations and are thus not restricted to the listed taxa addressed by this BO. In addition, the rufa red knot and roseate tern population data in this assessment were taken from Watts (2010) (Robinson-Willmott *et al.* (2013), and thus are dated.

While providing useful frameworks, Watts (2010) and Robinson-Willmott *et al.* (2013) do not provide any insights specific to population-level effects from collision mortality of listed birds. Thus, we consider best available information regarding species biology and demographics. At least for piping plovers, collision risk is not density-dependent (*i.e.*, the mortality rate does not increase or decrease with population size). The available information about piping plover migration suggests the birds appear to depart individually, supporting a linear (*i.e.*, non-density-dependent) relationship between population and take due to collisions (*e.g.*, a doubling of the population size doubles the projected number of collisions). It is unclear if this holds true for rufa red knots and roseate terns, which may occur in flocks. Rufa red knots, in particular, show strong tendencies to depart on migration flights in flocks (USFWS 2014).

### *Piping Plover*

We estimate that 23 piping plovers will be killed by WTG collisions over the 30-year life of the ASOWS projects. It is unlikely that multiple birds will be killed during a single migration event because piping plovers are not known to migrate in large flocks; thus, we assume even temporal distribution of up to one bird per year. The 10-year (2012 to 2021) average population size across the Eastern Canada, New England, and NY-NJ recovery units combined was 1,600 pairs, or 3,200 birds (USFWS 2022a) (see Table 2). That abundance level, and current demographic trends, do not yet reflect mortality authorized by previously issued BOs for offshore wind projects (see Table 1). Projected mortality over the operational life of ASOWS WTGs (23 birds) will be additive to mortality from 7 previous consultations (up to 60 birds). On an annual basis, the ASOWS projects will increase coastwide collision mortality from more than one bird per year to more than two birds per year, on average. Voluntary compensatory mitigation (*e.g.*, as described under Conservation Recommendations, below) may partially or fully offset mortality caused by the ASOWS projects but cannot be considered in our jeopardy analysis because it is uncertain whether Atlantic Shores and/or BOEM will implement compensatory mitigation for the ASOWS projects.

Distribution: The consistent loss of more than two birds per year from coastwide additive collision mortality may result in loss of one or more nesting areas. Many nesting areas support only a few breeding pairs, such that loss of one individual, combined with attrition from other causes of adult mortality, could cause pair numbers at a particular site to go to zero. Due to very high nest site fidelity, piping plovers are typically slow to recolonize a nesting area that has been extirpated. Further, once breeding birds are no longer present, regulatory protections for the habitat are often rolled back and management practices typically become less favorable, further reducing the prospects for recolonization. Thus, cumulative collision mortality from offshore wind has the potential to influence the distribution of nesting piping plovers at local and regional scales and may exacerbate the lack of habitat in the NY-NJ recovery unit. Local extirpations would be particularly concerning in New Jersey, where populations are persistently low, habitat-limited, and highly concentrated in just a few nesting areas. However, we do not anticipate any change in distribution as an indirect effect of losing up to one bird per year from the ASOWS projects.

Reproduction: Reproductive output is expected to decline as a result of direct removal of birds from the population through collision mortality. Thus, our analysis of numbers, below, qualitatively considers the loss of any likely offspring that the birds lost to collision would have produced over the rest of their lives.

Numbers: Extinction risk of Atlantic Coast piping plovers is highly sensitive to small changes in adult and/or juvenile survival rates (USFWS 2009). Based on a current population size of 3,200 birds, projected annual mortality from the ASOWS projects (less than 1 bird per year, on average) represents about 0.02 percent of total birds, and projected coastwide additive mortality (more than 2 birds per year, on average) represents about 0.08 percent of total birds. However, to assess population-level effects, we must consider differences across the three recovery units that occur in the action area. With available data, we are unable to quantify the proportion of individuals that are likely to be killed by collision across the three recovery units. Thus, we must make some assumptions in order to assess differential effects by recovery unit.

For purposes of this analysis, we assume that the ASOWS collision mortalities will be spread across the three units and proportional to the population size of each (Table 9). This assumption does not account for the possibility that exposure to offshore WTGs differs among the three recovery units (*i.e.*, that prevailing migration routes vary by nesting region) because to date tracking data are only available for birds from two nesting areas within the New England recovery unit.

**Table 9. Assumed distribution of ASOWS piping plover mortality across recovery units**

| Recovery Unit | % of Population Total Across All 3 Units (3,200 birds) | Presumed Collison ASOWS Mortality | Presumed Average Collision Frequency |
|---|---:|---:|---:|
| Eastern Canada | 11% | 3 | Every 10 years |
| New England | 59% | 14 | Every 2 years |
| NY-NJ | 30% | 7 | Every 4-5 years |
| Total | 100% | 23 | Up to every 1 year |

Even if the *level* of collision mortality is confirmed to be proportional to population size in each recovery unit, the *effect* of that mortality on the viability of each unit is disproportional. Loss of birds from the units that are farthest from recovery goals will cause the largest incremental increase in the vulnerability of that unit and its ability to provide redundancy and representation to the coastwide population.

- We presume that most of the collision losses from ASOWS will be from the New England unit. The large and increasing size of this unit make it the least vulnerable to demographic effects. We conclude that loss of 14 birds from the New England unit, spread out over 30 years, is unlikely to have any measurable effect on survival rates or population size of the New England unit.

- As discussed above, the NY-NJ recovery unit is tenuously stable. Any loss of individuals from this unit has the potential to negatively impact its stability. We conclude that loss of 7 birds from the NY-NJ unit will not appreciably affect survival rates or population size of the NY-NJ unit. This conclusion is based on the long time horizon for the projected take (30 years), and the assumption that most of these birds will be from New York based on its larger population size. The New York population has typically been more resilient than the New Jersey population.

- The Eastern Canada recovery unit is the most sensitive to the loss of individuals, with a long-term average of only 179 pairs (358 birds) and a long-term declining trend. Any loss of individuals could exacerbate the decline. However, with projected loss of only one bird per decade, we conclude that the ASOWS projects will not significantly affect survival rates or population size of the Eastern Canada unit. We note that available information suggests birds from the Eastern Canada unit may have significant exposure to collision risk, based on cumulative exposure (*i.e.*, these birds nest north of all the projects listed in Table 1), and based on sightings data of marked birds using migration stopovers along the Atlantic Coast (Rock pers. comm. 2023). These exposure factors have not yet been assessed and may supersede the assumption that underpins Table 9 (*i.e.*, that collision levels will be proportional to population size).

Based on current demographic data, we conclude that loss of up to one piping plover per year from the ASOWS projects, considered in context of at least one additional bird per year from previously authorized projects and considering lost lifetime reproduction of these birds, will have no significant effects on survival rates or population sizes of any of the three recovery units. Further, BOEM is requiring at least the first four projects in Table 1 to provide compensatory mitigation, which would offset the anticipated loss from those projects. Nonetheless, as cumulative collision mortality continues to increase with each successive BO, the likelihood of population-level effects increases, first for the Eastern Canada recovery unit, and then for the NY-NJ unit. We also note that demographic rates are associated with uncertainty and can change over the 30-year project life.

### *Rufa Red Knot*

We estimate that 1,188 rufa red knots will be killed by WTG collisions over the 30-year life of the ASOWS projects. It is possible that multiple birds will be killed during a single migration event because rufa red knots are known to migrate in flocks. We assume even temporal distribution of about 40 birds per year, which does allow for the possibility of multi-bird collision events in any particular year. The best available population size estimate across the SEC, NCSA, and Southern recovery units combined is 59,269 birds (see Table 4). That abundance level, and current demographic trends, do not yet reflect mortality authorized by previously issued BOs for offshore wind projects (see Table 3). Projected mortality over the operational life of the ASOWS WTGs (1,188 birds) will be additive to mortality from 7 previous consultations (912 birds). On an annual basis, the ASOWS projects will increase coastwide collision mortality from about 26 birds per year to about 66 birds per year,[14] on average. Voluntary compensatory mitigation (*e.g.*, as described under Conservation Recommendations, below) may partially or fully offset mortality caused by the ASOWS projects but cannot be considered in our jeopardy analysis because it is uncertain whether Atlantic Shores and/or BOEM will implement compensatory mitigation for the ASOWS projects.

Distribution: Rufa red knots show only moderate fidelity to migration routes and stopover areas. Use of a particular stopover habitat has been correlated with food availability, the presence of predators, and levels of disturbance from human activities. We conclude that such factors, along with overall habitat conditions, will remain the primary drivers of rufa red knot distribution along the mid-Atlantic coast. We have no evidence to suggest that loss of birds, singly or in flocks, will measurably affect stopover site selection. Thus, we do not anticipate any change in distribution as an indirect effect of losing up to 40 birds per year from the ASOWS projects.[15]

Reproduction: Reproductive output is expected to decline as a result of direct removals of birds from the population through collision mortality. Thus, our analysis of numbers, below, qualitatively considers the loss of any likely offspring that the birds lost to collision would have produced over the rest of their lives.

Numbers: Based on a current population size of 59,269 birds, projected annual mortality from the ASOWS projects (40 birds per year, on average) represents about 0.07 percent of total birds, and projected coastwide additive mortality (66 birds per year, on average) represents about 0.11 percent of total birds. However, to assess population-level effects, we must consider differences across the three recovery units that occur in the action area. With available data, we are unable to quantify the proportion of individuals that are likely to be killed by collision across the three recovery units. Thus, we must make some assumptions to assess differential effects by recovery unit.

For purposes of this analysis, we assume that the ASOWS collision mortalities will be spread across the three units and proportional to the population size of each (Table 10). This assumption does not account for the possibility that exposure to offshore WTGs differs among the three recovery units (*i.e.*, that prevailing migration routes vary by wintering region) because to date most tracking data has not been correlated with the wintering destination due to limits of the tracking technology.

---

[14] Total authorized incidental take increases to 67 birds per year when we consider that up to 1 bird per year is projected to be killed in the course of scientific research (USFWS 2023e). We anticipate an ongoing need for researchers to trap rufa red knots in support of recovery tasks, and therefore for the purpose of this analysis we assume that a similar level of incidental take from research will continue over the life of the ASOWS projects.

[15] Any behavioral response of rufa red knots to the ASOWS WTGs is essentially unknown. It is possible that the presence and/or operation of the WTGs may influence prevailing rufa red knot flight paths, which may, in turn, affect the distribution of birds across nonbreeding habitats. Based on information available at this time, behavioral responses are not reasonably certain to cause take and are therefore not covered by this BO. Also see Footnote 2.

**Table 10. Assumed distribution of ASOWS rufa red knot mortality across recovery units**

| Recovery Unit | % of Population Total Across All 3 Units (59,269 birds) | Presumed Collision ASOWS Mortality | Presumed Average Number of Collisions per Year |
|---|---:|---:|---:|
| SEC | 26% | 311 | 10 |
| NCSA | 52% | 623 | 21 |
| Southern | 21% | 255 | 9 |
| Total | 100% | 1,188 | 40 |

Even if the *level* of collision mortality is confirmed to be proportional to population size in each recovery unit, the *effect* of that mortality on the viability of each unit is disproportional. Loss of birds from the units that are farthest from recovery goals will cause the largest incremental increase in the vulnerability of that unit and its ability to provide representation to the rangewide population.

- We presume that most of the collision losses from ASOWS will be from the NCSA unit. The large and stable size of this unit make it the least vulnerable to demographic effects. We conclude that loss of 623 birds from the NCSA, spread out over 30 years, is unlikely to have a significant effect on overall survival rates or population size.

- The SEC recovery unit is estimated at only about half the size of the NCSA unit, but is believed to be stable over recent decades. We conclude that loss of 311 birds from the SEC unit will not have a significant effect on survival rates or population size. This conclusion is based on the long time horizon for the projected take (30 years), and the apparent resiliency of this unit to date. We note that available information suggests birds from the SEC unit may have significant exposure to collision risk with the ASOWS WTGs (Perkins 2023), which has not yet been assessed and which may supersede the assumption that underpins Table 10 (*i.e.*, that collision levels will be proportional to population size).

- The Southern recovery unit is the most sensitive to the loss of individuals, with the population size hovering around only 25 percent of its historic (1980s) level since 2011. The vulnerability of the Southern unit is based not only on its smaller size, but also the challenges that these birds face on their very long migrations (USFWS 2020b). Any loss of individuals could slow recovery of this unit. With projected loss of 9 birds per year from the Southern unit, we conclude that the ASOWS projects will not significantly affect survival rates or population size.

Based on the abundance estimates shown in Table 2, and apparent population stability (USFWS 2014, 2020b), we conclude that loss of up to 40 rufa red knots per year from the ASOWS projects, considered in the context of about 26 additional bird per year from previously authorized projects and considering lost lifetime reproduction of these birds, will have no significant effects on survival rates or population sizes of any of the three recovery units. Further, BOEM is requiring at least the first four projects in Table 3 to provide compensatory mitigation, which would offset the anticipated loss from those projects. Nonetheless, as cumulative collision mortality continues to increase with each successive BO, the likelihood of population-level effects increases, first for the Southern recovery unit, and then for the SEC unit.

We also note that demographic rates are associated with uncertainty and can change over the 30-year project life.

***Roseate Tern***

Current demographic conditions are such that roseate tern populations are sensitive to changes in adult mortality (USFWS 2020c). The 10-year (2010 to 2019) average population size of Northeastern roseate terns was 3,755 pairs, or 7,510 birds (Table 6). That abundance level, and current demographic trends, do not yet reflect mortality authorized by previously issued BOs for offshore wind projects (see Table 5). Projected mortality over the operational life of the ASOWS WTGs (1 bird) will be additive to mortality from previous consultations (1 bird). Given the current abundance level and long-term population trajectory, we conclude that loss of 1 bird from the ASOWS projects, considered in context of 1 additional bird from previously authorized projects and considering lost lifetime reproduction of these birds, will have no measurable effect on survival rates, and thus no effect on reproduction, numbers, or distribution. The cold-water unit is the most sensitive to loss of an individual, with a long-term average of only 54 pairs (108 birds). However, we conclude it is unlikely that the 1 projected collision would come from the cold-water unit, simply based on the much larger size (68 times larger) of the warm-water unit. Based on current demographic data, we conclude that loss of 1 Northeastern roseate tern over 30 years will have no measurable effects on roseate tern populations. This conclusion assumes that the affected bird is from the warm-water unit. Demographic rates are associated with uncertainty and can change over the 30-year project life.

### Effects to Species

Given our conclusion that the projected levels of collision mortality will have no measurable effect on any populations (*i.e.*, recovery or management units), we conclude that the operation of the ASOWS projects will have no appreciable effect on the numbers of any of the three listed bird species, and no effect on reproduction or distribution of any of the three listed bird species. Thus, the projects will not affect the viability of the Atlantic Coast piping plover, rufa red knot, or Northeastern roseate tern, and will not preclude the recovery of these species.

### Conclusion

We considered the current overall rangewide status of the piping plover (improving), rufa red knot (stable) and roseate tern (stable) and the stable condition of all three species within the action area (environmental baseline). We then assessed the effects of the proposed action and the potential for cumulative effects in the action area on individuals, populations, and the species as a whole. As stated in the Jeopardy Analysis, we do not anticipate any reductions in the overall reproduction, numbers or distribution of these species. It is the Service's Opinion that the operation of the ASOWS offshore wind energy projects, as proposed, is not likely to jeopardize the continued existence of the Atlantic Coast piping plover, the rufa red knot, or the Northeastern roseate tern.

## INCIDENTAL TAKE STATEMENT

### DEFINITION OF INCIDENTAL TAKE

Section 9 of the ESA and federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. Take is defined in section 3 of the ESA as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of Section 7(b)(4) and Section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement (ITS).

### EXTENT OF ANTICIPATED TAKE

The Service expects the following lethal take of listed species resulting from collision of birds with operating wind energy turbines on BOEM Renewable Energy Lease Area OCS-A 0498 over the 30-year life of the ASOWS projects:

23 piping plovers
1,188 rufa red knots
1 roseate tern

### EFFECT OF THE TAKE

The Service has determined that the level of take anticipated, as described above, from the Federal actions covered by this BO is not likely to result in jeopardy to these species.

### REASONABLE AND PRUDENT MEASURES

The measures described below are nondiscretionary, and must be undertaken by BOEM so that they become binding conditions of any grant or permit issued to the Atlantic Shores, as appropriate, for the exemption in Section 7(o)(2) to apply. BOEM, or another Federal agency (e.g., BSEE) under a transition of oversight responsibility, has a continuing duty to regulate the activity covered by this ITS. If BOEM: (1) fails to assume and implement the terms and conditions or (2) fails to require Atlantic Shores to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of Section 7(o)(2) may lapse. To monitor the impact of incidental take, BOEM must report the progress of the action and its impact on the species to the Service as specified in the ITS [50 CFR 402.14(i)(3)].

As discussed under Collision, above, the physical and operational parameters of WTGs are known to influence the risk of wildlife collision. At this time, the Service is not aware of any specific physical or operational WTG adjustments that would be reasonably likely to appreciably reduce collisions of listed birds in the offshore environment. However, technology and research in this area are advancing rapidly, and new methods for reducing collisions may become available over the long operational life of the ASOWS project. Therefore, the Service believes the following reasonable and prudent measures are necessary and appropriate to minimize take of piping plovers, rufa red knots, and roseate terns.

1. Periodically review current technologies and methods for detecting collisions of listed birds, including but not limited to: Motus stations, remote sensing, cameras, microphones, Doppler and NEXTRAD radar, and eDNA.

2. Periodically review current technologies and methods for minimizing collision risk of listed birds, including but not limited to: WTG coloration/marking, lighting, avian deterrents, and limited WTG operational changes.[16]

**Terms and Conditions**

In order for the above-described anticipated take to be exempt from the prohibitions of Section 9 of the ESA, BOEM must comply with the following terms and conditions, which implement the reasonable and prudent measure described above. These terms and conditions are nondiscretionary.

a) Prior to the start of WTG operations at ASOWS, BOEM must extract from existing project documentation (*e.g.*, the BA, other consultation documents, the final Environmental Impact Statement, the COP) a stand-alone summary of technologies and methods that were evaluated by BOEM to detect, reduce, or minimize bird collisions at the ASOWS WTGs.

b) Within 5 years of the start of WTG operation, and then every 5 years for the life of the project, BOEM must prepare a Collision Minimization Report, reviewing best available scientific and commercial data on technologies and methods that have been implemented, or are being studied, to reduce or minimize bird collisions at WTGs. BOEM must also prepare a separate Collision Detection Report, reviewing best available scientific and commercial data on technologies and methods that have been implemented, or are being studied, to detect bird collisions at WTGs. Both reviews must be global in scope and include both offshore and onshore WTGs.

c) BOEM must distribute a draft Collision Minimization Report and the Collision Detection Report to the Service, BSEE, Atlantic Shores, NJDEP, and the New Jersey Board of Public Utilities for a 60-day review period. BOEM must address all comments received during the review period and issue the final reports within 60 days of the close of the review period.

d) Following issuance of the final reports, the Service may request a meeting. Within 60 days of receiving the request, BOEM must convene a meeting with the Service, BSEE, and Atlantic Shores to discuss the reports and whether implementation of any technologies/methods is appropriate.

---

[16] Operational changes may include, but are not limited to, feathering, which involves adjusting the angle of the blades to slow or stop them from turning under certain conditions.

## MONITORING REQUIREMENTS

Exercise care in handling any specimens of dead or injured piping plovers, red knots, or roseate terns to preserve biological material in the best possible state. In conjunction with the preservation of any specimens, the finder has the responsibility to ensure that evidence intrinsic to determining the cause of death of the specimen is not unnecessarily disturbed. The finding of dead or non-viable specimens does not imply enforcement proceedings pursuant to the ESA. The reporting of dead specimens is required to enable the Service to determine if take is reached or exceeded and to ensure that the terms and conditions are appropriate and effective.
The discovery of a dead bird must be reported to the following Service offices:

Senior Resident Agent
U.S. Fish and Wildlife Service
Division of Law Enforcement
Sea Land Building, 2nd Floor
1210 Corbin Street
Elizabeth, New Jersey 07201
(973) 645-5910

and

U.S. Fish and Wildlife Service
New Jersey Field Office
4 E. Jimmie Leeds Road, Suite 4
Galloway, New Jersey 08205
(609) 646-9310

## COORDINATION OF INCIDENTAL TAKE STATEMENT WITH OTHER LAWS, REGULATIONS, AND POLICIES

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. S 703-712), if such take is in compliance with the Terms and Conditions specified herein. Take resulting from activities that are not in conformance with this BO (*e.g.*, deliberate harassment of wildlife) are not considered part of the proposed action and are not covered by this Incidental Take Statement and may be subject to enforcement action against the individual responsible for the act.

## CONSERVATION RECOMMENDATIONS

Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. For the Service to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations. The following recommendations are directed at BOEM but may apply to another Federal agency (e.g., BSEE) if there is a transition of oversight responsibility in the future.

**Recommendation 1: Establish an Offshore Wind Adaptive Monitoring and Impact Minimization Framework, developed and carried out through a partnership of government agencies and industry representatives, to guide and coordinate monitoring, research, and avian impacts coastwide.**

To address Service concerns related to potential effects of WTG operation on listed and other species of concern, at both the project and coastwide scales, we recommend that BOEM develop and adopt an Offshore Wind Adaptive Monitoring and Impact Minimization Framework (Framework) for flying wildlife. Many details will need to be worked out, but here we provide some basic principles for establishment, adoption, and operation of the Framework.

1. Establish a Framework Principals Group to consist of representatives from BOEM, BSEE, the Service, State natural resource agencies responsible for flying wildlife, and offshore wind energy developers/operators.

2. Develop and adopt a written Framework foundational document specifying:
   a. the governance structure of the Principals Group;
   b. the geographic coverage of the Framework (at a minimum, Federal waters from Maine to Virginia—optionally also Federal Atlantic waters from North Carolina to Florida and/or State waters);
   c. the species coverage of the Framework (at a minimum, federally listed, proposed, and candidate bird and bat species likely to occur in the offshore environment—optionally also other flying species of concern in the offshore environment such as certain Bird Species of Conservation Concern, At-Risk species, State-listed species, and Species of Greatest Conservation Need as identified in State Wildlife Action Plans); and
   d. the duration of the Framework (at a minimum, the entire length of time that any offshore wind energy generation is operational OR until all members of the Principals Group are in agreement that a robust weight of scientific evidence indicates that flying wildlife are not impacted by offshore WTG operation).

3. Establish an annual operating budget for the Framework to be funded by offshore wind energy developers/operators.

4. Arrange for the Principals Group to meet at least annually, and for the Framework foundational document to be updated at least every 5 years.

5. Provide for experts (both internal and external to the Principals Group) to regularly assess new and improved technologies and methods for estimating collision risk of covered species, and perhaps someday even measuring or detecting collisions. Adopt and deploy such methods deemed most promising by the Principals Group.

6. Coordinate monitoring and research across wind energy projects. Share and pool data and research results coastwide.

7. Provide for experts (both internal and external to the Principals Group) to regularly assess new and improved technologies and methods for minimizing collision risk of covered species, including but not limited to WTG coloration/marking, lighting, avian/bat deterrents, and limited WTG operational changes that would not unduly impact energy production. At local, regional, and coastwide scales, adopt and deploy such technologies/methods deemed most promising by the Principals Group.

8. Provide for experts (both internal and external to the Principals Group) to periodically assess new and improved technologies and methods for evaluating indirect effects to covered species from WTG avoidance behaviors (*e.g.*, impacts to time and energy budgets).

9. Periodically assess the level and type of compensatory mitigation necessary to offset any unavoidable direct effects (collision) and indirect effects (reduced survival rates from avoidance) of WTG operation on covered species. Adopt and deploy such levels and types of mitigation as deemed appropriate by the Principals Group.

10. Consider partnering with a stakeholder or cross-sector organization, such as the Regional Wildlife Science Collaborative for Offshore Wind[17], to provide administrative, institutional, and technical support to the Principals Group.

**Recommendation 2: Conduct a coastwide buildout analysis that considers all existing, proposed, and future offshore wind energy development on the Atlantic OCS.**

The definition of "cumulative effects" in the Section 7 handbook excludes future Federal actions because such actions will be subject to their own consultations. However, the analysis of environmental baseline conditions for each subsequent consultation will be limited to the action area of that particular project. This creates a situation where the effects analysis for each individual offshore wind energy project cannot fully take into account the possible additive and/or synergistic effects that may occur at full build-out of offshore wind infrastructure along the coast. Besides the two existing offshore wind energy facilities (Block Island Wind offshore Rhode Island and Coastal Virginia Offshore Wind Research Lease), we understand there are 27 additional projects in various stages of development offshore the U.S. Atlantic Coast. There are 24 projects offshore from Maine to Virginia and 3 projects offshore North Carolina and South Carolina (BOEM 2022). As the Department of Interior continues moving toward the national goal of deploying 30 gigawatts of offshore wind by 2030, we anticipate more projects beyond the 27 already in development (e.g., within the New York Bight, Central Atlantic, and Gulf of Maine). Many of the proposed projects are contiguous with one another. For example, three additional proposed projects (Ocean Wind 1 and 2, Atlantic Shores Offshore Wind North) are contiguous with ASOWS.

While a thorough and robust assessment of potential direct effects (collision) and indirect effects (behavioral change) will be completed for each individual offshore wind project, coastwide analysis may indicate or suggest additive and/or synergistic effects among projects.[18] Therefore,

---

[17] https://rwsc.org/

[18] Reinitiation of consultation for ASOWS may be necessary if the coastwide analysis reveals new information

the Service recommends that BOEM analyze potential aggregate effects from WTG operation at a coastwide scale. A coastwide analysis will work in concert with the Offshore Wind Adaptive Monitoring and Impact Minimization Framework to comprehensively assess, monitor, and manage avian impacts from wind energy development along the U.S. Atlantic Coast. (Programmatic consultation for wind energy development in the New York Bight is already underway and could set the stage for a full coastwide analysis.) Ultimately, a coastwide programmatic BO may emerge as the most effective and efficient mechanism for assessing, monitoring, minimizing, and offsetting effects to listed birds from WTG operation on the OCS.

**Recommendation 3. Require implementation of appropriate technologies and methods to detect and minimize collisions of listed birds.**

Following the periodic meetings and reports required by the above-listed Reasonable and Prudent Measures and their implementing Terms and Conditions, BOEM should work in cooperation with BSEE to require Atlantic Shores to adopt and deploy such detection and/or minimization technologies/methods as deemed appropriate. BOEM should specify the Service-approved timeframe in which any required detection or minimization measure(s) must be implemented, as well as any requirements to monitor, maintain, or adapt the measure(s) over time. BOEM should require Atlantic Shores to provide periodic reporting on the implementation of any measure(s) according to a schedule developed by BOEM and approved by the Service.

**Recommendation 4: Provide compensatory mitigation to offset collision mortality.**

To minimize population-level effects on listed birds, BOEM should provide (or require Atlantic Shores to provide) appropriate compensatory mitigation to offset projected levels of take of listed birds from WTG collision. Compensatory mitigation should be consistent with the conservation needs of listed species as identified in Service documents including, but not limited to, listing documents, Species Status Assessments, Recovery Plans, Recovery Implementation Strategies (RIS), and 5-Year Reviews. Compensatory mitigation should preferentially address priority actions, activities, or tasks identified in a Recovery Plan, RIS, or 5-Year Review, for piping plover, rufa red knot, and roseate tern; however, research, monitoring, outreach, and other recovery efforts that do not offset birds killed via collision mortality are not considered compensatory mitigation.

Compensatory mitigation may include, but is not limited to: restoration or management of lands, waters, sediment, vegetation, or prey species to improve habitat quality or quantity for listed birds; efforts to facilitate habitat migration or otherwise adapt to sea level rise; predator management; management of human activities to reduce disturbance to listed birds; and efforts to curtail other sources of direct human-caused bird mortality such as from vehicles, collision with other structures (*e.g.*, power lines, terrestrial wind turbines, window and building glass), hunting, oil spills, and harmful algal blooms. Geographic considerations may include but are not limited to: any listed species recovery unit(s) or other management unit(s) determined to be disproportionally affected by or vulnerable to collision mortality; and/or those portions of a species' range where compensatory mitigation is most likely to be effective in offsetting

---

relevant to the effects of this project.

collision mortality. Compensatory mitigation for the ASOWS projects may be combined with mitigation associated with other offshore wind projects, but in no case should compensatory mitigation be double-counted as applying to more than one offshore wind project.

BOEM should prepare a Compensatory Mitigation Plan prior to the commissioning of the first WTG. The Compensatory Mitigation Plan should provide compensatory mitigation actions to offset projected levels of take of listed birds at a ratio of at least 1:1 for the full 30-year lease. Higher ratios should be considered due to high uncertainty associated with both projected levels of collision mortality and effectiveness of mitigation actions.

The Compensatory Mitigation Plan should include:

- detailed description of one or more specific mitigation actions;
- the specific location for each action;
- a timeline for completion;
- itemized costs;
- a list of necessary permits, approvals, and permissions;
- details of the mitigation mechanism (*e.g.*, mitigation agreement, applicant-proposed mitigation);
- best available science linking the compensatory mitigation action(s) to the projected level of collision mortality as described in this BO;
- a schedule for completion;
- monitoring to ensure the effectiveness of the action(s) in offsetting the target level of take;
- flexibility to adjust mitigation actions based on documented effectiveness of implemented actions and the level of take projected by Band (2012) or SCRAM (or its successor), whichever is most appropriate for ASOWS taking into account model limitations;
- current information regarding any effects of offshore lighting on the species addressed in this BO; and
- the effectiveness of any collision minimization measures that have been implemented.

Compensatory Mitigation Plan development and implementation should occur according to the following schedule:

- At least 180 calendar days before the commissioning of the first WTG, BOEM should distribute a draft Plan to BSEE and the Service, appropriate state agencies, and other identified stakeholders or interested parties for a 60 calendar day review period.
- At least 90 calendar days before the commissioning of the first WTG, BOEM should transmit a revised Compensatory Mitigation Plan for approval by BSEE and the Service, along with a record of comments received on the draft Plan. BOEM should rectify any outstanding agency comments or concerns before final approval by BOEM, BSEE, and the Service.
- Before or concurrent with the commissioning of the first WTG, BOEM should provide documentation to BSEE and the Service showing financial, legal, or other binding commitment(s) to Compensatory Mitigation Plan implementation.

## REINITIATION – CLOSING STATEMENT

This concludes formal consultation on the action outlined in the request. As provided in 50 CFR 402.16, re-initiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species in a manner or to an extent not considered in this opinion or the project has not been completed within 5 years of the issuance of this biological opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending re-initiation.

## REFERENCES

### LITERATURE CITED

Adams EM, A Gilbert, P Loring, and KA Williams (Biodiversity Research Institute, Portland, ME and U.S. Fish and Wildlife Service, Charlestown, RI). 2022. Transparent Modeling of Collision Risk for Three Federally_-Listed Bird Species in Relation to Offshore Wind Energy Development: Final Report. Washington, DC: U.S. Department of the Interior, Bureau of Ocean Energy Management. Contract No.: M19PG00023. https://briloon.shinyapps.io/SCRAM/_w_76fb2514/SCRAM_manual_v103_031723.pdf [Accessed September 28, 2023]

Atlantic States Marine Fisheries Commission [ASMFC]. 2022. Revision to the Framework for Adaptive Management of Horseshoe Crab Harvest in the Delaware Bay Inclusive of Red Knot Conservation. Accepted for Management Use by the Horseshoe Crab Management Board January 26, 2022. Arlington, Virginia. 230 pp. http://www.asmfc.org/uploads/file/63d41dc32021ARM_FrameworkRevisionAndPeerReviewReport_Jan2022.pdf [Accessed April 6, 2023]

Baker, AJ, PM González, T Piersma, LJ Niles, I de Lima Serrano, PW Atkinson, NA Clark, CDT Minton, MK Peck, G Aarts, and et al. 2004. Rapid population decline in red knots: Fitness consequences of decreased refuelling rates and late arrival in Delaware Bay. Proceedings of the Royal Society Biological Sciences Series B 271(1541):875-882.

Band, B. 2012. Using a Collision Risk Model to Assess Bird Collision Risks for Offshore Wind Farms. Report by British Trust for Ornithology for The Crown Estate. Thetford, Norfolk, United Kingdom. 62 pp. https://tethys.pnnl.gov/publications/using-collision-risk-model-assess-bird-collision-risks-offshore-wind-farms [Accessed April 8, 2023]

Biodiversity Research Institute [BRI] and Wildlife Restoration Partners [WRP]. 2022. Ocean Wind 1 (OCW01) Tagging Short-Distance Migrant Red Knots in Coastal New Jersey. Unpublished report. Portland, Maine. 30 pp.

Blanco, P. 2012. Charadrius melodus Linnaeus, 1758 Frailecillo Blanco, piping plover. Libro rojo de los vertebrados de Cuba: 18:222-224.

Bureau of Ocean Energy Management [BOEM]. 2023. Atlantic Shores Offshore Wind South Biological Assessment for the United States Fish and Wildlife Service. Office of Renewable Energy Programs, Sterling, Virginia. 144 pp. + Appendices.

Bureau of Ocean Energy Management [BOEM]. 2022. Atlantic Offshore Wind Lease Areas. https://www.boem.gov/sites/default/files/documents/renewable-energy/state-activities/BOEM-NY-Bight-OCS-Renew-Energy-Lease-Area.pdf [Accessed November 20, 2023]

Burger, J, C Gordon, J Lawrence, J Newmanc, G Forcey, and LVlietstra. 2011. Risk evaluation for federally listed (roseate tern, piping plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. Renewable Energy 36 (2011) 338e351.

Burger, J, LJ Niles, RR Porter, AD Dey, S Koch, C Gordon. 2012. Using a shore bird (red knot) fitted with geolocators to evaluate a conceptual risk model focusing on offshore wind. Renewable Energy 43(2012):370-377.

Chamberlain, DE, MR Rehfisch, AD Fox, M Desholm, and AJ Anthony. 2006. The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. Ibis (2006)148:198–202.

Connecticut Department of Energy & Environmental Protection [CTDEEP]. Undated. Roseate Tern *Sterna dougallii* fact sheet. Hardford, Connecticut. https://portal.ct.gov/DEEP/Wildlife/Fact-Sheets/Roseate-Tern [Accessed April 11, 2023].

Cook, ASCP. 2021. Additional analysis to inform SNCB recommendations regarding collision risk modelling. BTO Research Report 739. Report to Natural England. Report by British Trust for Ornithology, Thetford, Norfolk, United Kingdom. 47pp. https://www.bto.org/sites/default/files/publications/bto_rr_739_cook_collision_risk_models_final_web.pdf [Accessed April 8, 2023]

Cooley, S, D Schoeman, L Bopp, P Boyd, S Donner, DY Ghebrehiwet, SI Ito, W Kiessling, P Martinetto, E Ojea, MF Racault, B Rost, and M Skern-Mauritzen. 2022. Oceans and Coastal Ecosystems and Their Services. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York, pp. 379–550, doi:10.1017/9781009325844.005.

Croll, DA, AA Ellis, J Adams, ASCP Cook, S Garthe, MW Goodale, CS Hall, E Hazen, BS Keitt, EC Kelsey, JB Leirness, DE Lyons, MW McKown, A Potiek, KR Searle, FH Soudijn, RC Rockwood, BR Tershy, M Tinker, EA VanderWerf, KA Williams, L Young, and K Zilliacus. Framework for assessing and mitigating the impacts of offshore wind energy development on marine birds. Biological Conservation 206(2022):109795.

del Hoyo, J., A Elliot, and J Sargatal. 2011. Handbook of the Birds of the World. Lynx Editions, Barcelona, Spain.

Drewitt, AL and RHW Langston. 2006. Assessing the impacts of wind farms on birds. Ibis(2006)148:29-42.

eBird 2023. Basic Dataset. Version: EBD_relFeb-2023. Cornell Lab of Ornithology, Ithaca, New York. February 2023. https://ebird.org/ [Accessed April 4, 2023]

EDR. 2023. Atlantic Shores Offshore Wind Construction and Operations Plan: Lease Area OCS-A 0499. Submitted by Atlantic Shores to the Bureau of Ocean Energy Management. 977 pp. +Appendices. https://www.boem.gov/renewable-energy/state-activities/atlantic-shores-offshore-wind-construction-and-operations-plan [Accessed September 28, 2023]

Elliott-Smith, E, M Bidwell, AE Holland, and SM Haig. 2015. Data from the 2011 International Piping Plover Census: U.S. Geological Survey Data Series 922.

Elliott-Smith, E and SM Haig. 2020. Piping Plover (*Charadrius melodus*), version 1.0. In Birds of the World (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. https://doi.org/10.2173/bow.pipplo.01 [Accessed April 6, 2023]

Feigin, S, L Niles, D Mizrahi, S Dodgin, A Gilbert, W Goodale, J Gulka, and I Stenhouse. 2022. Tracking Movements of Red Knots in the U.S. Atlantic Using Satellite Telemetry, 2020–2021. Unpublished report. Wildlife Restoration Partnerships LLC, Greenwich, New Jersey. 55 pp.

Fernández-Alvarez, JC, X Costoya, A Pérez-Alarcón, S Rahimi, R Nieto, and L Gimeno. 2023. Dynamic downscaling of wind speed over the North Atlantic Ocean using CMIP6 projections: Implications for offshore wind power density. Energy Reports 9(2023):873-885.

Gochfeld, M and J Burger. 2020. Roseate Tern (*Sterna dougallii*), version 1.0. In Birds of the World (S. M. Billerman, Editor). Cornell Lab of Ornithology, Ithaca, New York. https://doi.org/10.2173/bow.roster.01

Gordon, CE, and C Nations. 2016. Collision Risk Model for "rufa" Red Knots (*Calidris canutus rufa)* Interacting with a Proposed Offshore Wind Energy Facility in Nantucket Sound, Massachusetts. U.S. Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-045. 90 pp. + frontmatter and appendix. https://www.boem.gov/sites/default/files/environmental-stewardship/Environmental-Studies/Renewable-Energy/Red-Knot-Collision-Risk-Final-Report.pdf [Accessed April 8, 2023]

Gratto-Trevor, C, SM Haig, MP Miller, TD Mullins, S Maddock, E Roche, and P Moore. 2016. Breeding sites and winter site fidelity of piping plovers wintering in The Bahamas, a previously unknown major wintering area. Journal of Field Ornithology. 87(1):29-41.

Kleyheeg-Hartman, JC, KL Krijgsveld, MP Collier, MJM Poot, AR Boon, TA Troost and S Dirksen. 2018. Predicting bird collisions with wind turbines: Comparison of the new empirical Flux Collision Model with the SOSS Band model. Ecological Modelling 387(2018):144-153.

Lamb, JS, PH Loring, and PWC Paton. 2023. Distributing transmitters to maximize population-level representativeness in automated radio telemetry studies of animal movement. Movement Ecology (2023)11:1. https://doi.org/10.1186/s40462-022-00363-0

Lieber, L, R Langrock, and WAM Nimmo-Smith. 2021. A bird's-eye view on turbulence: seabird foraging associations with evolving surface flow features. Proceedings of the Royal Society Biological Sciences Series B 288: 20210592. https://doi.org/10.1098/rspb.2021.0592

Loring PH, JD McLaren, PA Smith, LJ Niles, SL Koch, HF Goyert, and H Bai. 2018. Tracking movements of threatened migratory rufa Red Knots in U.S. Atlantic Outer Continental Shelf Waters. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-046. 145 pp. https://espis.boem.gov/Final%20Reports/BOEM_2018-046.pdf [Accessed April 6, 2023]

Loring PH, PW Paton, JD McLaren, H Bai, R Janaswamy, HF Goyert, CR Griffin and PR Sievert. 2019. Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 149 pp. https://espis.boem.gov/final reports/BOEM_2019-017.pdf [Accessed May 4, 2023]

Loring, PH, JD McLaren, HF Goyert, and PWC Paton. 2020. Supportive wind conditions influence offshore movementsof Atlantic Coast Piping Plovers during fall migration. The Condor ornithological Applications 122:1-16. DOI: 10.1093/condor/duaa028

Loring PH, AK Lenske, JD McLaren, M Aikens, AM Anderson, Y Aubrey, E Dalton, A Dey, C Friis, D Hamilton, B Holberton, D Kriensky, D Mizrahi, L Niles, KL Parkins, J Paquet, F Sanders, A Smith, Y Turcotte, A Vitz, and PA Smith. 2020. Tracking Movements of Migratory Shorebirds in the US Atlantic Outer Continental Shelf Region. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2021-008. 104 p. https://www.boem.gov/sites/default/files/documents/renewable-energy/studies/Tracking-Migratory-Shorebirds-Atlantic-OCS.pdf [Accessed April 9, 2023]

Loring PH, TM Kuras, RA Revorêdo, DSD Farias, FJL Silva, PC Lima, S von Oettingen, J Walsh. 2023. Habitat use of Common and Roseate terns tracked with satellite transmitters in northeast Brazil. U.S. Department of the Interior, U.S. Fish and Wildlife Service. State of the Birds Program. 38 p. https://atlanticmarinebirds.org/downloads/Satellite_telemetry_report.pdf [Accessed August 14, 2023]

Loring, P., K Walker, T Kuras, and S Lawton. Piping Plovers - VA (Project514). 2022-2023. Data accessed from Motus Wildlife Tracking System, Birds Canada. Available: https://motus.org/. [Accessed August 15, 2023]

Lyons, JE, B Winn, T Teyes, and KS Kalasz. 2017. Post-Breeding Migration and Connectivity of Red Knots in the Western Atlantic. The Journal of Wildlife Management 82(Supplement 1):1-14.

Lyons, JE, BA Harrington, and S Koch. 2019. Stopover population dynamics and migratory connectivity of red knots at Cape Cod, Massachusetts. U.S. Fish and Wildlife Service unpublished report. 35 p.

Marques, AT, H Batalha, and J Bermandino. 2021. Bird Displacement by Wind Turbines: Assessing Current Knowledge and Recommendations for Future Studies. Birds 2021(2):460-475.

Marques, AT, H Batalha, S Rodigues, H Costa, MJ Ramos Pereira, C Fonseca, M Mascarenhas, and J Bernadino. 2014. Understanding bird collisions at wind farms: An updated review on the causes and possible mitigation strategies. Biological Conservation 179 (2014) 40–52.

Martínez-Curci, NS, JP Isacch, VL D'Amico, P Rojas, and GJ Castresana. 2020. To migrate or not: drivers of over-summering in a long-distance migratory shorebird. Journal of Avian Biology 2020: 02401. doi: 10.1111/jav.02401

Masden E. 2015. Developing an avian collision risk model to incorporate variability and uncertainty. Scottish Marine and Freshwater Science 6(14).

Masden EA and ASCP Cook. 2016. Avian collision risk models for wind energy impact assessments. Environmental Impact Assessment Review 56(2016):43–49.

Matus, R. 2021. Results of the 2021 Aerial Census at Bahía Lomas, Chile. Centro de Rehabilitación de Aves Leñadura. Guest author for the Western Hemisphere Shorebird Reserve Network. https://whsrn.org/results-of-the-2021-aerial-census-at-bahia-lomas-chile/ [Accessed April 6, 2023]

May, RF. 2015. A unifying framework for the underlying mechanisms of avian avoidance of wind turbines. Biological Conservation 2015(190):179–187McGowan, C.P., J.E. Hines, J.D. Nichols, J.E. Lyons, D.R. Smith, K.S. Kalasz, L.J. Niles, A.D. Dey, N.A. Clark, P.W. Atkinson, and et al. 2011a. Demographic consequences of migratory stopover: Linking red knot survival to horseshoe crab spawning abundance. Ecosphere 2(6):1-22.

Mizrahi, DS. 2020. Aerial Surveys for Shorebirds Wintering along Northern South America's Atlantic Coast with an emphasis on Semipalmated Sandpipers and Red Knots – Phase 2. Report to National Fish and Wildlife Foundation, Project # 59145. New Jersey Audubon Society, Cape May Court House, New Jersey. 26 pp.

Mostello, C. 2015. Roseate Tern *Serna dougalli* fact sheet. Natural Heritage & Endangered Species Program, Massachusetts Division of Wildlife & Fisheries. 5 pp. https://www.mass.gov/files/documents/2016/08/wh/roseate-tern.pdf [Accessed April 5, 2023]

Mostello, CS, ICT Nisbet, SA Oswald, and JW Fox. 2014. Non-breeding season movements of six North American Roseate Terns *Sterna dougallii* tracked with geolocators. Seabird (2014):1-21.

Niles, LJ 2014. Braving Brazil. Available at arubewithaview.com/2014/02/25/braving-brazil/. Accessed on March 11, 2014.

Niles, LJ, J Burger, RR Porter, AD Dey, CDT Minton, PM González, AJ Baker, JW Fox, and C Gordon. 2010. First results using light level geolocators to track red knots in the Western Hemisphere show rapid and long intercontinental flights and new details of migration pathways. Wader Study Group Bulletin 117(2):123-130.

Norambuena, HV, R Matus, A Larrea, and C Espoz. 2022. Censos aéreos de aves playeras en el santuario de la naturaleza Bahía Lomas, Enero 2022

Normandeau Associates, Inc. [Normandeau] 2011. New insights and new tools regarding risk to roseate terns, piping plovers, and red knots from wind facility operations on the Atlantic Outer Continental Shelf. A Final Report for the U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Report No. BOEMRE 048-2011. Contract No. M08PC20060. 287 pp. https://espis.boem.gov/final%20reports/5119.pdf [Accessed April 9, 2023]

Oswald SA, ICT Nisbet and CS Mostello. 2023. Common Terns *Sterna hiru*ndo and Roseate Terns *Sterna dougallii* frequently rest on the sea surface in winter quarters and during migration, Bird Study: DOI 10.1080/00063657.2023.2237232

Perkins, G. 2023. Geolocator Project Coordinator: Using geolocator tracking data to advance understanding of Red Knot migration habits. EC Contract No: 3000738325. Prepared For: Environment and Climate Change Canada, and the United States Fish and Wildlife Service by Ninox Consulting Ltd., Smithers, British Columbia, Canda. 36 pp. + Appendices.

Rebke, M, V Dierschke, CN Weiner, R Aumüller, and K Hill. 2019. Attraction of nocturnally migrating birds to artificial light: The influence of colour, intensity and blinking mode under different cloud cover conditions. Biological Conservation 233 (2019) 220–227.

Robinson Willmott, JC, G Forcey, and A Kent. 2013. The Relative Vulnerability of Migratory Bird Species to Offshore Wind Energy Projects on the Atlantic Outer Continental Shelf: An Assessment Method and Database. Final Report to the U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs. OCS Study BOEM 2013-207. 275 pp. https://espis.boem.gov/final%20reports/5319.pdf [Accessed April 10, 2023]

Schwarzer, AC. 2011. Demographic rates and energetics of red knots wintering in Florida. University of Florida, Gainesville, Florida, USA.

Schwarzer, AC., JA Collazo, LJ Niles, JM Brush, NJ Douglass, and HF Percival. 2012. Annual survival of red knots (Calidris canutus rufa) wintering in Florida. The Auk 129(4):725-733.

Scottish Natural Heritage [SNH]. 2018. Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model. Stilligarry, South Uist, Scotland. 4 pp. https://www.nature.scot/sites/default/files/2018-09/Wind%20farm%20impacts%20on%20birds%20-%20Use%20of%20Avoidance%20Rates%20in%20the%20SNH%20Wind%20Farm%20Collision%20Risk%20Model.pdf [Accessed April 8, 2023]

Seneviratne, SI, X Zhang, M Adnan, W Badi, C Dereczynski, A Di Luca, S Ghosh, I Iskandar, J Kossin, S Lewis, F Otto, I Pinto, M Satoh, SM Vicente-Serrano, M Wehner, and B Zhou. 2021. Weather and Climate Extreme Events in a Changing Climate. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V, P Zhai, A Pirani, SL Connors, C Péan, S Berger, N Caud, Y Chen, L Goldfarb, MI Gomis, M Huang, K Leitzell, E Lonnoy, JBR Matthews, TK Maycock, T Waterfield, O Yelekçi, R Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, New York, pp. 1513–1766, doi:10.1017/9781009157896.013.

Sherfy, MH, MJ Anteau, TL Shaffer, MA Sovada, and JH Stucker. 2012. Foraging ecology of least terns and piping plovers nesting on Central Platte River sandpits and sandbars: U.S. Geological Survey Open-File Report 2012–1059, Reston, Virginia. 50 pp. https://pubs.usgs.gov/of/2012/1059/of12-1059.pdf [Accessed April 10, 2023]

Simmons, AJ. 2022. Trends in the tropospheric general circulation from 1979 to 2022. Weather and Climate Dynamics 3:777–809. https://doi.org/10.5194/wcd-3-777-2022.

Smith, AD, FJ Sanders, KL Lefevre, JM Tibault, KS Kalasz, MC Handmaker, FM Smith, and T Keyes. 2023. Spring migration patterns of red knots in the Southeast United States disentangled using automated telemetry. March 30, 2023, PREPRINT (Version 1) available at Research Square. https://doi.org/10.21203/rs.3.rs-2741673/v1 [Accessed May 4, 2023]

Staine, KJ and J Burger. 1994. Noctural foraging behavior of breeding piping plovers (*Charadrius melodus*) in New Jersey. The Auk 111(3):579-587.

Stantial, ML and JB Cohen. 2022. Twenty-four hour activity patterns of breeding Atlantic coast Piping Plovers. Wader Study 129(1): 65–68.

Stucker, JH, FJ Cuthbert, B Winn, BL Noel, SB Maddock, PR Leary, J Cordes, and LC Wemmer. 2010. Distribution of non-breeding Great Lakes piping plovers (*Charadrius melodus*) along Atlantic and Gulf of Mexico coastlines: ten years of band sightings. Waterbirds: 33:22-32.

Thaxter, CB, GM Buchanan, J Carr, SHM Butchart, T Newbold, RE Green, JA Tobias, WB Foden, S O'Brien, and JW Pearce-Higgins. 2017. Bird and bat species' global vulnerability to collision mortality at wind farms revealed through a trait-based assessment. Proceedings of the Royal Society B 284: 20170829.http://dx.doi.org/10.1098/rspb.2017.0829

Thomas, P. 2021. Singapore top shipping centre for eighth year running: Top global shipping hubs and short-term bulk, oil and container outlook revealed in recently published Baltic-Xinhua report. https://www.marinetraffic.com/blog/singapore-top-shipping-centre-for-eighth-year-running/ Accessed [April 5, 2023]

U.S. Fish and Wildlife Service [USFWS]. 1996. Piping Plover (*Charadrius melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp. https://ecos.fws.gov/docs/recovery_plan/960502.pdf [Accessed April 6, 2023]

U.S. Fish and Wildlife Service [USFWS]. 1998. Roseate Tern Recovery Plan - Northeastern Population, First Update. Hadley, Massachusetts. 75 pp. https://ecos.fws.gov/docs/recovery_plan/981105.pdf [Accessed April 8, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2009. Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Northeast Region, Hadley, Massachusetts and Michigan Field Office, East Lansing, Michigan. 206 pp. https://ecos.fws.gov/docs/five_year_review/doc3009.pdf [Accessed April 6, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2014. Rufa red knot background information and threats assessment. Supplement to Endangered and Threatened Wildlife and Plants; Final Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*) [Docket No. FWS–R5–ES–2013–0097; RIN AY17]. Pleasantville, New Jersey. 376 pp. + Appendices. https://www.regulations.gov/document/FWS-R5-ES-2013-0097-0703 [Accessed April 6, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2020a. Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, Michigan Field Office, East Lansing, Michigan and Northeast Region, Hadley, Massachusetts. 164 pp. https://ecos.fws.gov/docs/five_year_review/doc6378.pdf [Accessed April 5, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2020b. Species status assessment report for the rufa red knot (*Calidris canutus rufa*). Version 1.1. Ecological Services New Jersey Field Office, Galloway, New Jersey. https://ecos.fws.gov/ServCat/DownloadFile/187781 [Accessed April 6, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2020c. Roseate Tern Northeastern North American Population (*Sterna dougallii dougallii*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, New England Field Office, Concord New Hampshire. 55 pp. https://ecos.fws.gov/docs/five_year_review/doc6559.pdf [Accessed April 8, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2021. Rufa Red Knot (*Calidris canutus rufa*) 5-Year Review: Summary and Evaluation. U.S. Fish and Wildlife Service, New Jersey Field Office, Galloway, New Jersey. 35 pp. https://ecos.fws.gov/docs/tess/species_nonpublish/3624.pdf [Accessed April 5, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2022a. Abundance and productivity estimates - 2021 update Atlantic Coast piping plover population. Hadley, Massachusetts. 16 pp. https://www.fws.gov/media/abundance-and-productivity-estimates-2021-update-atlantic-coast-piping-plover-population [Accessed April 5, 2023].

U.S. Fish and Wildlife Service [USFWS]. 2022b. U.S. Fish and Wildlife Service Evaluation of the Atlantic States Marine Fisheries Commission Horseshoe Crab/Red Knot Adaptive Resource Management Revision. Northeast Region, Hadley, Massachusetts. 8 pp. https://www.fws.gov/sites/default/files/documents/service-evaluation-of-atlantic-states-marine-fisheries-commission-horseshoe-crab-red-knot-adaptive-resource-management-revision.pdf [Accessed April 7, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2023a. Biological Opinion on the Effects of the SouthCoast Wind Project on the Rufa Red Knot (*Calidris canutus rufa*; threatened) and Piping Plover (*Charadrius melodus*; threatened).

U.S. Fish and Wildlife Service [USFWS]. 2023b. Piping Plover (web site). Washington, D.C. https://www.fws.gov/species/piping-plover-charadrius-melodus [Accessed April 6, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2023c. Recovery plan for the rufa red knot (*Calidris canutus rufa*). U.S. Fish and Wildlife Service, Northeast Region, Hadley, Massachusetts. 22 pages. https://www.fws.gov/species/rufa-red-knot-calidris-canutus-rufa [Available April 2023]

U.S. Fish and Wildlife Service [USFWS]. 2023d. Roseate Tern (web site). Washington, D.C. https://www.fws.gov/species/roseate-tern-sterna-dougallii-dougallii [Accessed April 8, 2023]

U.S. Fish and Wildlife Service [USFWS]. 2023e. Streamlined Restoration/Recovery Programmatic Biological Opinion for capture of rufa red knots (*Calidris canutus rufa*) and attachment of markers and tracking devices in Regions 2, 4, and 5. New Jersey Field Office, Galloway, New Jersey. 21 pp. + Appendices.

U.S. Fish and Wildlife Service and National Marine Fisheries Service [USFWS and NMFS]. 1998. Endangered Species Consultation Handbook Procedures for Conducting Consultation and Conference Activities Under Section 7 of the Endangered Species Act. 51 pp. https://www.fws.gov/sites/default/files/documents/endangered-species-consultation-handbook.pdf [Accessed April 5, 2023]

Watts, BD. 2010. Wind and waterbirds: Establishing sustainable mortality limits within the Atlantic Flyway. Center for Conservation Biology Technical Report Series, CCBTR-10-05. College of William and Mary/Virginia Commonwealth University, Williamsburg, VA. 43pp. https://www.ccbbirds.org/wp-content/uploads/2013/12/ccbtr-10-05_Watts-Wind-and-waterbirds-Establishing-sustainable-mortality-limits-within-the-Atlantic-Flyway.pdf [Accessed March 29, 2023]

Weithman, CE, D Gibson, KM Walker, S Maddock, JD Fraser, SM Karpanty, and DH Catlin. 2018. Discovery of an important stopover location for migratory Piping Plovers on South Point, Ocracoke Island, North Carolina. Waterbirds 41:56–62.

Western Hemisphere Shorebird Reserve Network [WHSRN]. 2020. Results of the 2020 Aerial Survey of rufa Red Knot in Tierra del Fuego. April 28, 2020 press release. https://whsrn.org/results-of-the-2020-aerial-survey-of-rufa-red-knot-in-tierra-del-fuego/ [Accessed April 6, 2023]

Wilson, S and RIG Morrison. October 2018. Appendix 1. Proportions of juvenile, sub-adult and adult birds in populations of Red Knot. Unpublished data. Committee on the Status of Endangered Wildlife in Canada, Ottawa, Canada. 2 pp.

## PERSONAL COMMUNICATIONS

Bigger, D. 2023. Environmental Protection Specialist. Email of September 1, 2023. Office of Renewable Energy Programs, Bureau of Ocean Energy Management, Sterling, Virginia.

Cook, A. 2023. Principal Ecologist – Offshore Renewable Energy. Email of June 6, 2023. British Trust for Ornithology, Thetford, Norfolk, United Kingdom.

Hecht, A. 2023. Endangered Species Biologist. Email of March 15, 2023. U.S. Fish and Wildlife Service, Sudbury, Massachusetts.

Hildreth, E. 2023. Policy Analyst. Email of September 25, 2023. Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Bureau of Ocean Energy Management, Sterling, Virginia.

Hunter, C. 2022. Regional Refuge Biologist. Email of July 6, 2022.U.S. Fish and Wildlife Service, National wildlife Refuge System, Division of Strategic Resource Management, Atlanta, Georgia.

Kopec, A. 2023. Beach Nesting Bird Field Crew Leader. Email of September 13, 2023. Conserve Wildlife Foundation of New Jersey, Princeton, New Jersey.

Newstead, D. 2020. Manager, Coastal Waterbird Program. Emails of March 6 and June 3, 2020. Coastal Bend Bays and Estuaries Program. Corpus Christi, Texas.

Newstead, D. 2019. Manager, Coastal Waterbird Program. Email of October 3, 2019. Coastal Bend Bays and Estuaries Program. Corpus Christi, Texas.

Nisbet, ICT. 2019. Email dated July 12, 2019. I. C. T. Nisbet & Company, North Falmouth, Massachusetts.

Rock, J. 2023. Wildlife Biologist. Electronic mail of February 1, 2023. Environment and Climate Change Canada. Sackville, New Brunswick, Canada.

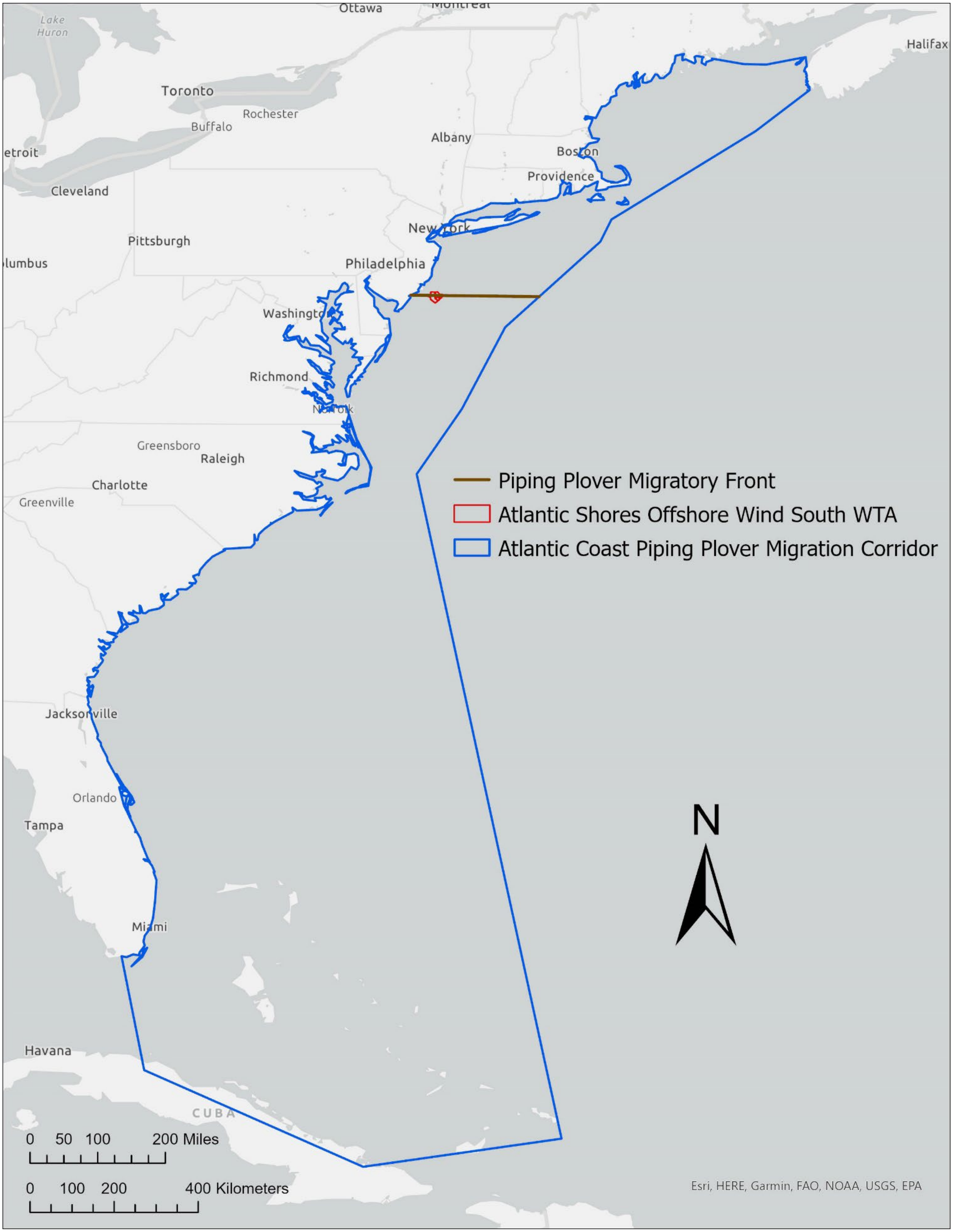
Sanders, F. 2023. Coastal Bird Conservation Project Supervisor. Email of August 9, 2023. South Carolina Department of Natural Resources, McClellanville, South Carolina.

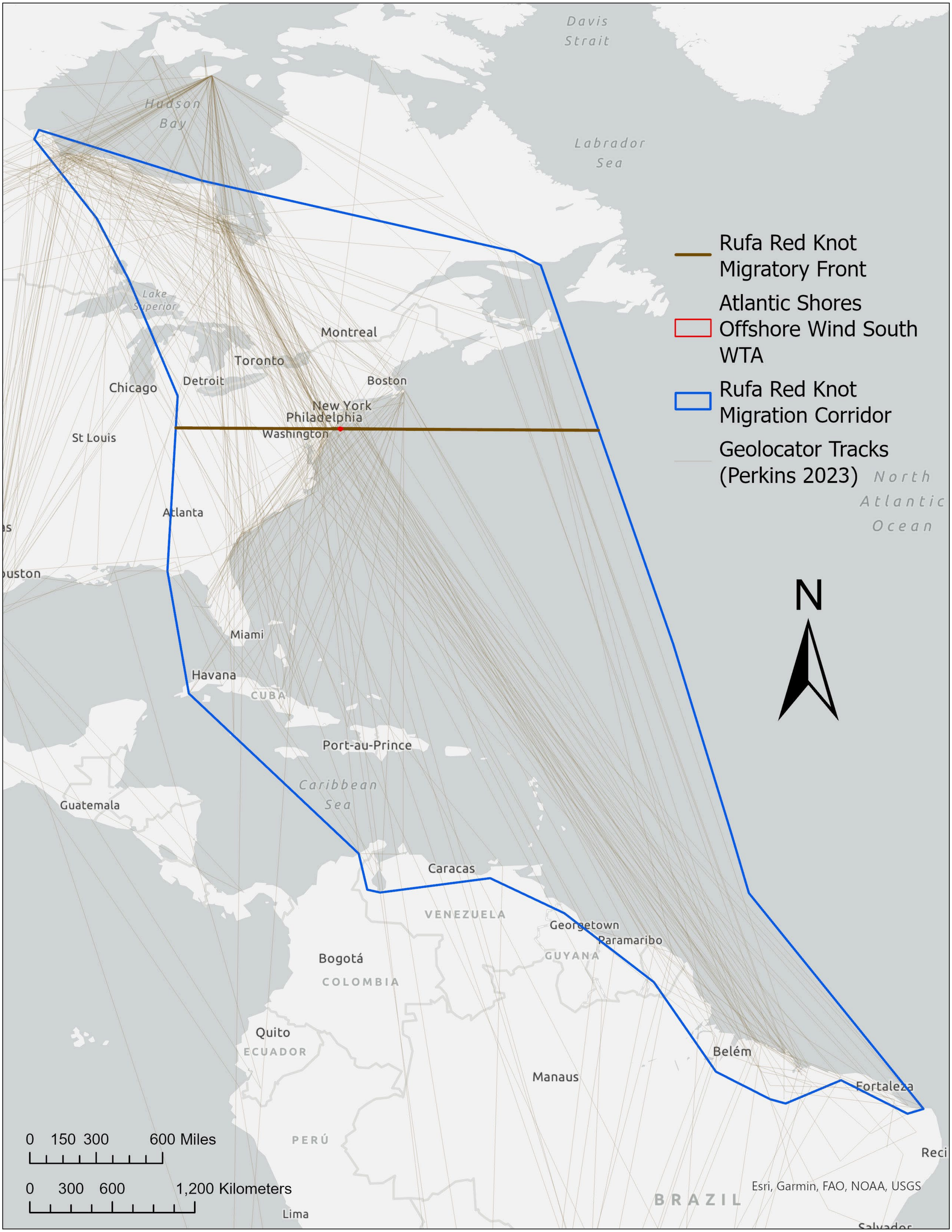
Sullivan, K. 2023. NEPA Coordinator. Email of September 26, 2023. Environment Branch for Renewable Energy, Bureau of Ocean Energy Management, Sterling, Virginia.

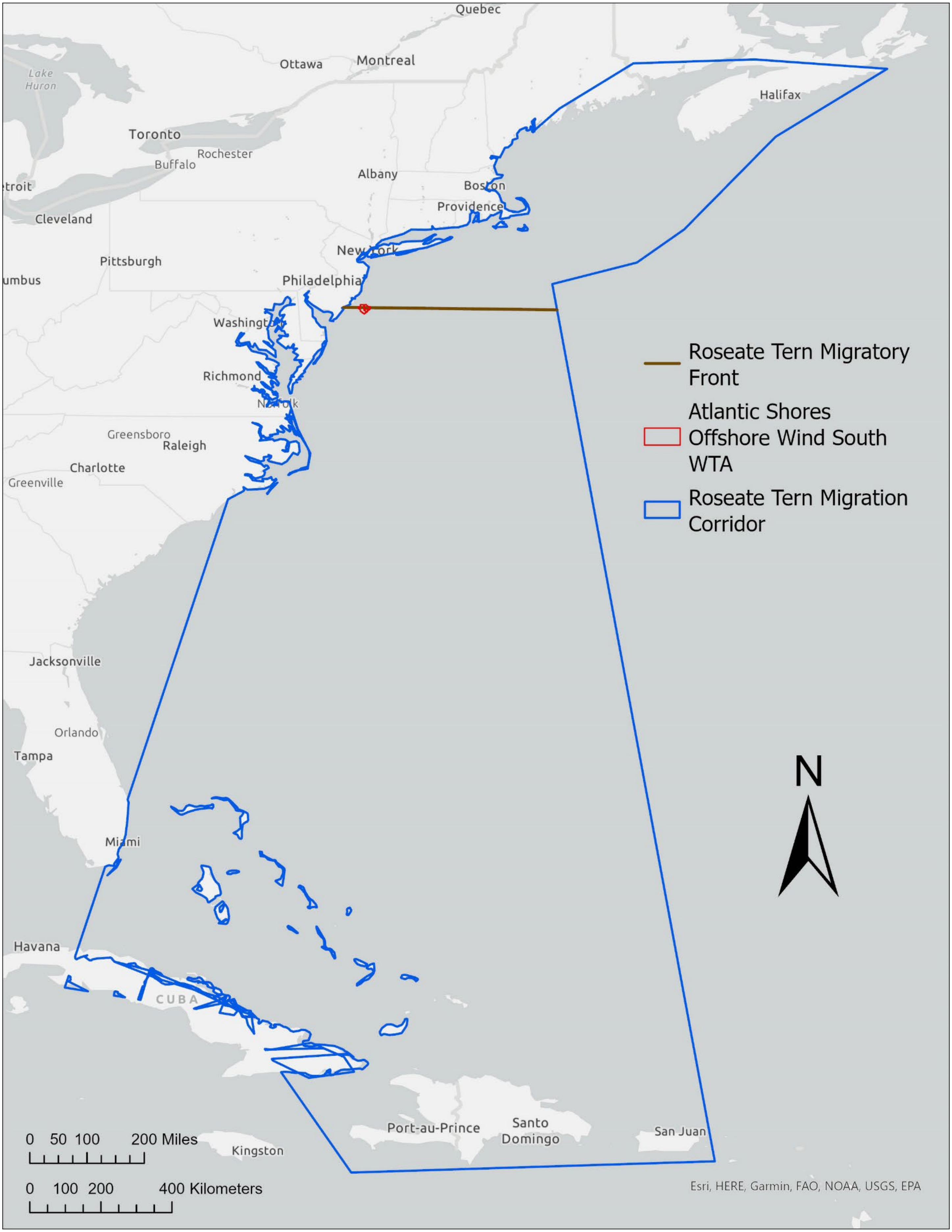
von Oettingen, S. 2022. Endangered Species Biologist. Email of March 8, 2022. New England Field Office, U.S. Fish and Wildlife Service, Concord, New Hampshire.

Van Zoeren, A. 2023. Seasonal Research Assistant. Email of August 18, 2023. University of Minnesota, St. Paul, Minnesota.

# APPENDIX A. MIGRATION CORRIDORS USED FOR BAND (2012)




Davis Strait
Hudson Bay
Labrador Sea
Rufa Red Knot Migratory Front
Atlantic Shores Offshore Wind South WTA
Rufa Red Knot Migration Corridor
Geolocator Tracks (Perkins 2023)
North Atlantic Ocean
N
Lake Superior
Montreal
Toronto
Detroit
Chicago
Boston
New York
Philadelphia
Washington
St Louis
Atlanta
as
uston
Miami
Havana
CUBA
Port-au-Prince
Caribbean Sea
Guatemala
Caracas
VENEZUELA
Georgetown
Paramaribo
GUYANA
Bogotá
COLOMBIA
Quito
ECUADOR
Belém
Manaus
Fortaleza
PERÚ
Reci
BRAZIL
Lima
Salvador
0 150 300 600 Miles
0 300 600 1,200 Kilometers
Esri, Garmin, FAO, NOAA, USGS

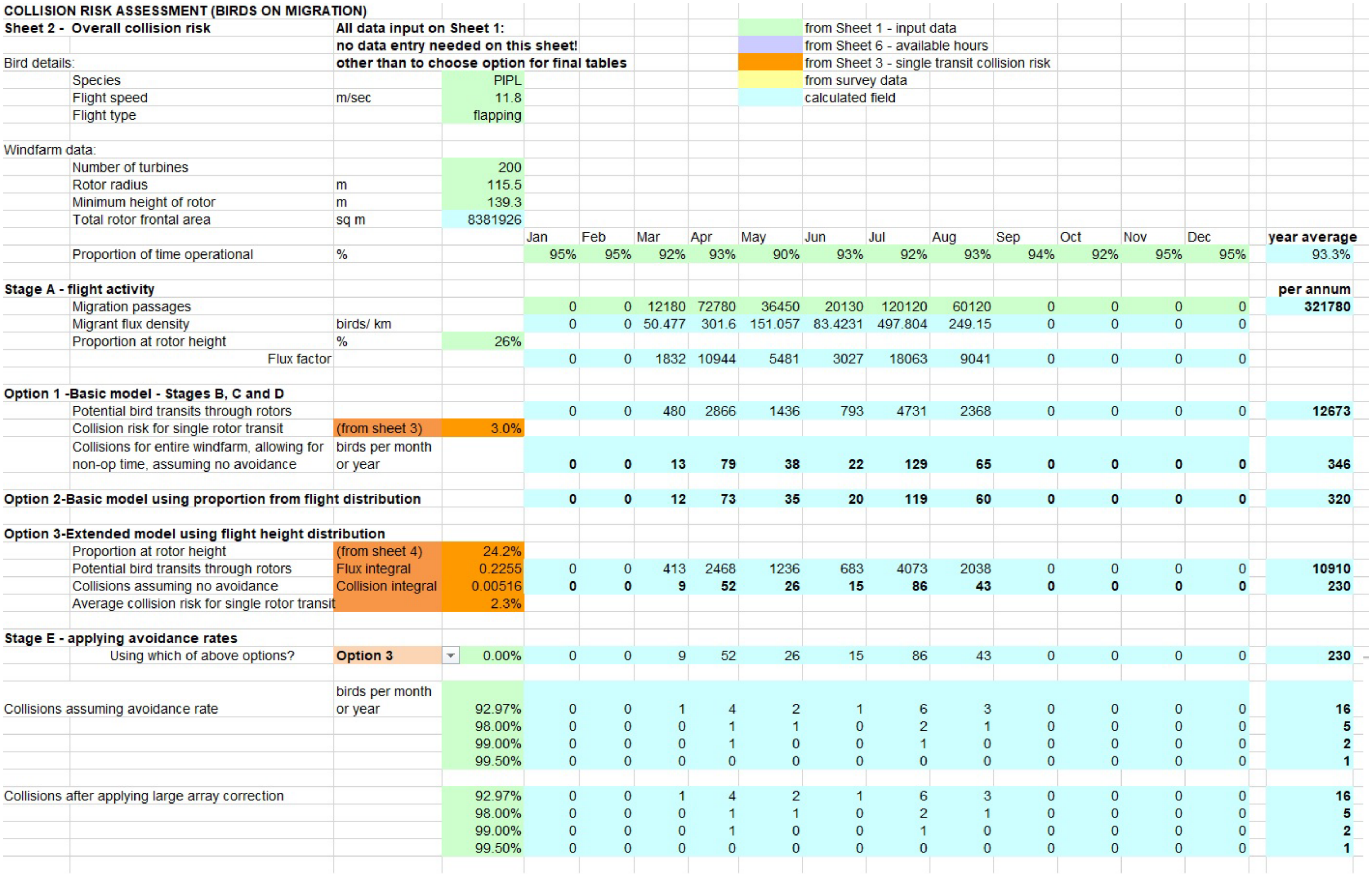

Quebec
Ottawa
Montreal
Lake Huron
Halifax
Toronto
Rochester
Buffalo
Albany
troit
Boston
Providence
Cleveland
New York
Pittsburgh
umbus
Philadelphia
Washington
Richmond
Norfolk
Greensboro
Raleigh
Charlotte
Greenville
Jacksonville
Orlando
Tampa
Miami
Havana
CUBA
Port-au-Prince
Santo Domingo
San Juan
Kingston
Roseate Tern Migratory Front
Atlantic Shores Offshore Wind South WTA
Roseate Tern Migration Corridor
N
0 50 100 200 Miles
0 100 200 400 Kilometers
Esri, HERE, Garmin, FAO, NOAA, USGS, EPA

# APPENDIX B. COLLISION RISK MODEL OUTPUTS

# Piping Plover – Band (2012) Inputs

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | 🟩 | used in overall collision risk sheet | | | | | | | 🟪 | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | 🟨 | used in migrant collision risk sheet | | | | | | | ⬜ | used in large array correction sheet | | | |
| | | 🟧 | used in single transit collision risk sheet or extended model | | | | | | | 🟥 | not used in calculation but stated for reference | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **PIPL** | | SCRAM | | | | | | | | | | |
| Bird length | m | 0.18 | | SCRAM | | | | | | | | | | |
| Wingspan | m | 0.38 | | SCRAM | | | | | | | | | | |
| Flight speed | m/sec | 11.8 | | SCRAM | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | | | N/A | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | SCRAM | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 12180 | 72780 | 36,450 | 20130 | 120120 | 60120 | 0 | 0 | 0 | 0 |
| Width of migration corridor | km | 241.3 | | | | | | | | | | | | |
| Proportion at rotor height | % | 26% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 8.6% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **ASOW** | | | | | | | | | | | | |
| Latitude | degrees | 39.29 | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | |
| Width of windfarm | km | 24 | | | | | | | | | | | | |
| Tidal offset | m | 0 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **V236-15MW** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 5.69 | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | |
| Hub height | m | 139.3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% |
| Max blade width | m | 5.100 | | | | | | | | | | | | |
| Pitch | degrees | 2 | | | | | | | | | | | | |
| | | | | **Data sources (if applicable)** | | | | | | | | | | |
| **Avoidance rates used in presenting results** | | 92.97% | X | | | | | | | | | | | |
| | | 98.00% | | | | | | | | | | | | |
| | | 99.00% | | | | | | | | | | | | |
| | | 99.50% | | | | | | | | | | | | |

# Piping Plover – Band (2012) Outputs



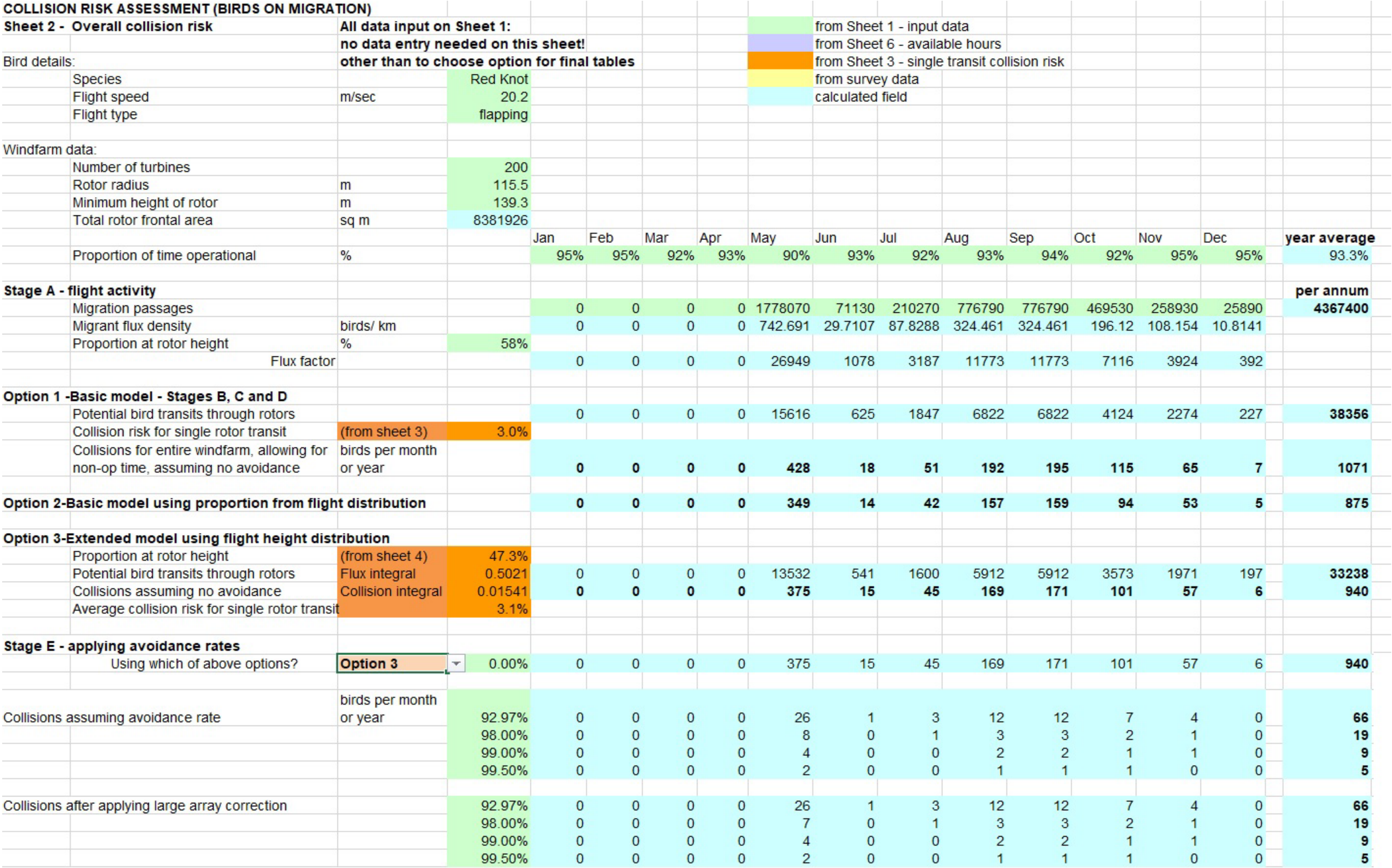
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)** | | | | | | | | | | | | | | | |
| **Sheet 2 - Overall collision risk** | **All data input on Sheet 1:** | | | | | | 🟩 | from Sheet 1 - input data | | | | | | | |
| | **no data entry needed on this sheet!** | | | | | | 🟪 | from Sheet 6 - available hours | | | | | | | |
| Bird details: | **other than to choose option for final tables** | | | | | | 🟧 | from Sheet 3 - single transit collision risk | | | | | | | |
| Species | | PIPL | | | | | 🟨 | from survey data | | | | | | | |
| Flight speed | m/sec | 11.8 | | | | | 🟦 | calculated field | | | | | | | |
| Flight type | | flapping | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Windfarm data: | | | | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | | |
| Minimum height of rotor | m | 139.3 | | | | | | | | | | | | | |
| Total rotor frontal area | sq m | 8381926 | | | | | | | | | | | | | |
| | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **year average** |
| Proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% | 93.3% |
| | | | | | | | | | | | | | | | |
| **Stage A - flight activity** | | | | | | | | | | | | | | | **per annum** |
| Migration passages | | | 0 | 0 | 12180 | 72780 | 36450 | 20130 | 120120 | 60120 | 0 | 0 | 0 | 0 | **321780** |
| Migrant flux density | birds/ km | | 0 | 0 | 50.477 | 301.6 | 151.057 | 83.4231 | 497.804 | 249.15 | 0 | 0 | 0 | 0 | |
| Proportion at rotor height | % | 26% | | | | | | | | | | | | | |
| Flux factor | | | 0 | 0 | 1832 | 10944 | 5481 | 3027 | 18063 | 9041 | 0 | 0 | 0 | 0 | |
| | | | | | | | | | | | | | | | |
| **Option 1 -Basic model - Stages B, C and D** | | | | | | | | | | | | | | | |
| Potential bird transits through rotors | | | 0 | 0 | 480 | 2866 | 1436 | 793 | 4731 | 2368 | 0 | 0 | 0 | 0 | **12673** |
| Collision risk for single rotor transit | (from sheet 3) | 3.0% | | | | | | | | | | | | | |
| Collisions for entire windfarm, allowing for non-op time, assuming no avoidance | birds per month or year | | **0** | **0** | **13** | **79** | **38** | **22** | **129** | **65** | **0** | **0** | **0** | **0** | **346** |
| | | | | | | | | | | | | | | | |
| **Option 2-Basic model using proportion from flight distribution** | | | **0** | **0** | **12** | **73** | **35** | **20** | **119** | **60** | **0** | **0** | **0** | **0** | **320** |
| | | | | | | | | | | | | | | | |
| **Option 3-Extended model using flight height distribution** | | | | | | | | | | | | | | | |
| Proportion at rotor height | (from sheet 4) | 24.2% | | | | | | | | | | | | | |
| Potential bird transits through rotors | Flux integral | 0.2255 | 0 | 0 | 413 | 2468 | 1236 | 683 | 4073 | 2038 | 0 | 0 | 0 | 0 | **10910** |
| Collisions assuming no avoidance | Collision integral | 0.00516 | **0** | **0** | **9** | **52** | **26** | **15** | **86** | **43** | **0** | **0** | **0** | **0** | **230** |
| Average collision risk for single rotor transit | | 2.3% | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Stage E - applying avoidance rates** | | | | | | | | | | | | | | | |
| Using which of above options? | **Option 3** | 0.00% | 0 | 0 | 9 | 52 | 26 | 15 | 86 | 43 | 0 | 0 | 0 | 0 | **230** |
| | | | | | | | | | | | | | | | |
| Collisions assuming avoidance rate | birds per month or year | 92.97% | 0 | 0 | 1 | 4 | 2 | 1 | 6 | 3 | 0 | 0 | 0 | 0 | **16** |
| | | 98.00% | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | **5** |
| | | 99.00% | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **2** |
| | | 99.50% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |
| | | | | | | | | | | | | | | | |
| Collisions after applying large array correction | | 92.97% | 0 | 0 | 1 | 4 | 2 | 1 | 6 | 3 | 0 | 0 | 0 | 0 | **16** |
| | | 98.00% | 0 | 0 | 0 | 1 | 1 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | **5** |
| | | 99.00% | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | **2** |
| | | 99.50% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **1** |

# Rufa Red Knot – Band (2012) Inputs

| | | | |
|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | 🟩 used in overall collision risk sheet | | 🟪 used in available hours sheet |
| **Sheet 1 - Input data** | 🟨 used in migrant collision risk sheet | | ⬜ used in large array correction sheet |
| | 🟧 used in single transit collision risk sheet or extended model | | 🟥 not used in calculation but stated for reference |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **Red Knot** | | SCRAM | | | | | | | | | | |
| Bird length | m | 0.24 | | SCRAM | | | | | | | | | | |
| Wingspan | m | 0.49 | | SCRAM | | | | | | | | | | |
| Flight speed | m/sec | 20.2 | | SCRAM | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | | | N/A | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | SCRAM | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 0 | 1,778,070 | 71130 | 210270 | 776790 | 776,790 | 469530 | 258930 | 25890 |
| Width of migration corridor | km | 2394.09 | | | | | | | | | | | | |
| Proportion at rotor height | % | 58% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 34.6% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **ASOW** | | | | | | | | | | | | |
| Latitude | degrees | 39.29 | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | |
| Width of windfarm | km | 24 | | | | | | | | | | | | |
| Tidal offset | m | 0 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **V236-15MW** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 5.69 | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | |
| Hub height | m | 139.3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% |
| Max blade width | m | 5.100 | | | | | | | | | | | | |
| Pitch | degrees | 2 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | **Data sources (if applicable)** | | | | | | | | | | |
| **Avoidance rates used in presenting results** | | 92.97% | X | | | | | | | | | | | |
| | | 98.00% | | | | | | | | | | | | |
| | | 99.00% | | | | | | | | | | | | |
| | | 99.50% | | | | | | | | | | | | |

# Rufa Red Knot – Band (2012) Outputs



**COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)**

**Sheet 2 - Overall collision risk**

**All data input on Sheet 1:**
**no data entry needed on this sheet!**
**other than to choose option for final tables**

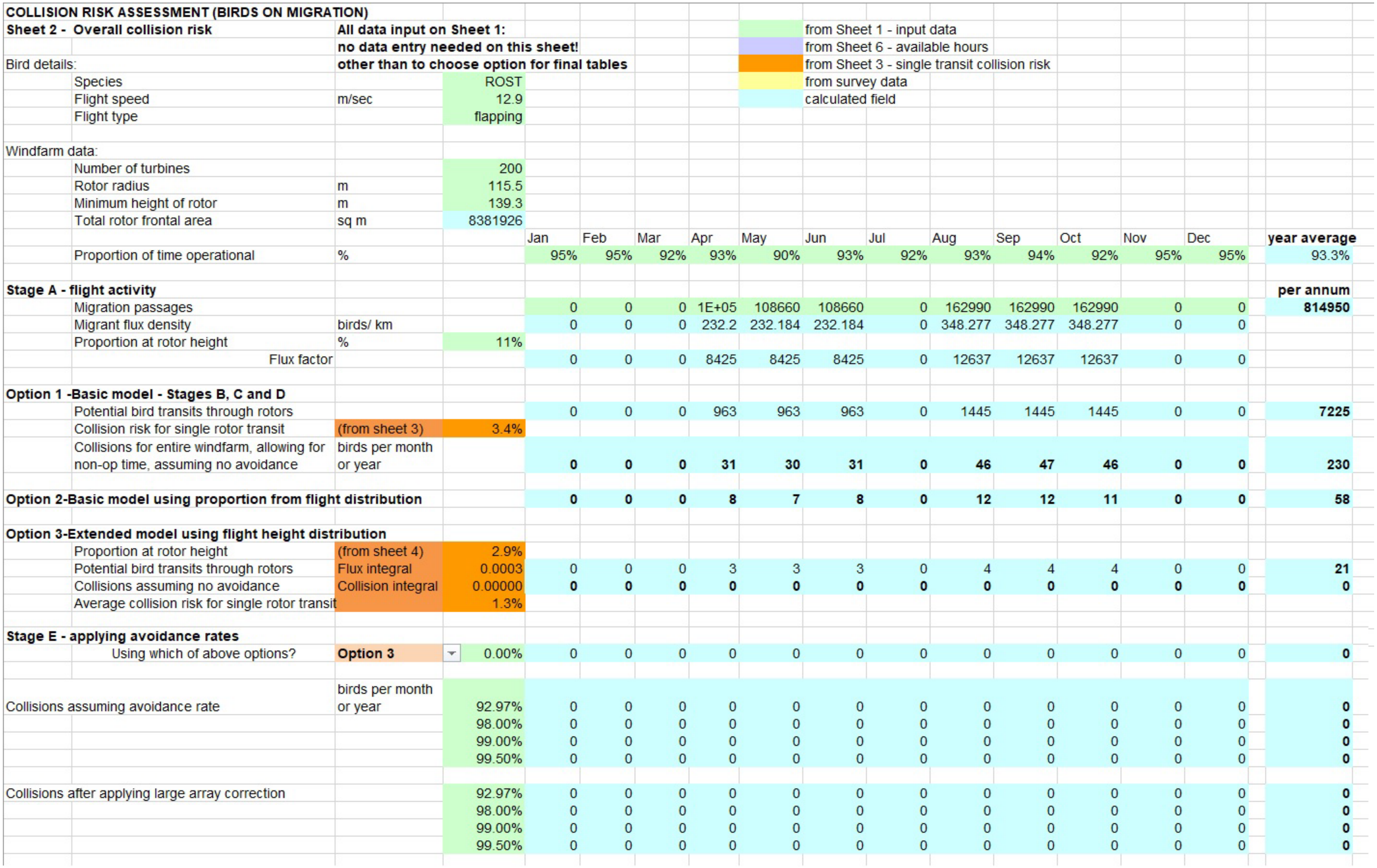
| | |
|---|---|
| 🟩 | from Sheet 1 - input data |
| 🟪 | from Sheet 6 - available hours |
| 🟧 | from Sheet 3 - single transit collision risk |
| 🟨 | from survey data |
| 🟦 | calculated field |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bird details: | | | | | | | | | | | | | | | |
| Species | | Red Knot | | | | | | | | | | | | | |
| Flight speed | m/sec | 20.2 | | | | | | | | | | | | | |
| Flight type | | flapping | | | | | | | | | | | | | |
| Windfarm data: | | | | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | | |
| Minimum height of rotor | m | 139.3 | | | | | | | | | | | | | |
| Total rotor frontal area | sq m | 8381926 | | | | | | | | | | | | | |
| | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **year average** |
| Proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% | 93.3% |
| **Stage A - flight activity** | | | | | | | | | | | | | | | **per annum** |
| Migration passages | | | 0 | 0 | 0 | 0 | 1778070 | 71130 | 210270 | 776790 | 776790 | 469530 | 258930 | 25890 | **4367400** |
| Migrant flux density | birds/ km | | 0 | 0 | 0 | 0 | 742.691 | 29.7107 | 87.8288 | 324.461 | 324.461 | 196.12 | 108.154 | 10.8141 | |
| Proportion at rotor height | % | 58% | | | | | | | | | | | | | |
| Flux factor | | | 0 | 0 | 0 | 0 | 26949 | 1078 | 3187 | 11773 | 11773 | 7116 | 3924 | 392 | |
| **Option 1 -Basic model - Stages B, C and D** | | | | | | | | | | | | | | | |
| Potential bird transits through rotors | | | 0 | 0 | 0 | 0 | 15616 | 625 | 1847 | 6822 | 6822 | 4124 | 2274 | 227 | **38356** |
| Collision risk for single rotor transit | (from sheet 3) | 3.0% | | | | | | | | | | | | | |
| Collisions for entire windfarm, allowing for non-op time, assuming no avoidance | birds per month or year | | **0** | **0** | **0** | **0** | **428** | **18** | **51** | **192** | **195** | **115** | **65** | **7** | **1071** |
| **Option 2-Basic model using proportion from flight distribution** | | | **0** | **0** | **0** | **0** | **349** | **14** | **42** | **157** | **159** | **94** | **53** | **5** | **875** |
| **Option 3-Extended model using flight height distribution** | | | | | | | | | | | | | | | |
| Proportion at rotor height | (from sheet 4) | 47.3% | | | | | | | | | | | | | |
| Potential bird transits through rotors | Flux integral | 0.5021 | 0 | 0 | 0 | 0 | 13532 | 541 | 1600 | 5912 | 5912 | 3573 | 1971 | 197 | **33238** |
| Collisions assuming no avoidance | Collision integral | 0.01541 | **0** | **0** | **0** | **0** | **375** | **15** | **45** | **169** | **171** | **101** | **57** | **6** | **940** |
| Average collision risk for single rotor transit | | 3.1% | | | | | | | | | | | | | |
| **Stage E - applying avoidance rates** | | | | | | | | | | | | | | | |
| Using which of above options? | **Option 3** | 0.00% | 0 | 0 | 0 | 0 | 375 | 15 | 45 | 169 | 171 | 101 | 57 | 6 | **940** |
| | birds per month | | | | | | | | | | | | | | |
| Collisions assuming avoidance rate | or year | 92.97% | 0 | 0 | 0 | 0 | 26 | 1 | 3 | 12 | 12 | 7 | 4 | 0 | **66** |
| | | 98.00% | 0 | 0 | 0 | 0 | 8 | 0 | 1 | 3 | 3 | 2 | 1 | 0 | **19** |
| | | 99.00% | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | **9** |
| | | 99.50% | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | **5** |
| Collisions after applying large array correction | | 92.97% | 0 | 0 | 0 | 0 | 26 | 1 | 3 | 12 | 12 | 7 | 4 | 0 | **66** |
| | | 98.00% | 0 | 0 | 0 | 0 | 7 | 0 | 1 | 3 | 3 | 2 | 1 | 0 | **19** |
| | | 99.00% | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 2 | 2 | 1 | 1 | 0 | **9** |
| | | 99.50% | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | **5** |

# Roseate Tern – Band (2012) Inputs

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT** | | 🟩 | used in overall collision risk sheet | | | | | | | 🟪 | used in available hours sheet | | | |
| **Sheet 1 - Input data** | | 🟨 | used in migrant collision risk sheet | | | | | | | ⬜ | used in large array correction sheet | | | |
| | | 🟧 | used in single transit collision risk sheet or extended model | | | | | | | 🟥 | not used in calculation but stated for reference | | | |
| | | | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Bird data** | | | | | | | | | | | | | | |
| Species name | | **ROST** | | SCRAM | | | | | | | | | | |
| Bird length | m | 0.37 | | SCRAM | | | | | | | | | | |
| Wingspan | m | 0.76 | | SCRAM | | | | | | | | | | |
| Flight speed | m/sec | 12.9 | | SCRAM | | | | | | | | | | |
| Nocturnal activity factor (1-5) | | | | N/A | | | | | | | | | | |
| Flight type, flapping or gliding | | flapping | | SCRAM | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Bird survey data** | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Daytime bird density | birds/sq km | | | | | | | | | | | | | |
| Proportion at rotor height | % | | | | | | | | | | | | | |
| Proportion of flights upwind | % | | | | | | | | | | | | | |
| | | | | **Data sources** | | | | | | | | | | |
| **Birds on migration data** | | | | | | | | | | | | | | |
| Migration passages | birds | | 0 | 0 | 0 | 108660 | 108,660 | 108660 | 0 | 162990 | 162,990 | 162990 | 0 | 0 |
| Width of migration corridor | km | 467.99 | | | | | | | | | | | | |
| Proportion at rotor height | % | 11% | | | | | | | | | | | | |
| Proportion of flights upwind | % | 37.5% | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Windfarm data** | | | | | | | | | | | | | | |
| Name of windfarm site | | **ASOW** | | | | | | | | | | | | |
| Latitude | degrees | 39.29 | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | |
| Width of windfarm | km | 24 | | | | | | | | | | | | |
| Tidal offset | m | 0 | | | | | | | | | | | | |
| | **Units** | **Value** | | **Data sources** | | | | | | | | | | |
| **Turbine data** | | | | | | | | | | | | | | |
| Turbine model | | **V236-15MW** | | | | | | | | | | | | |
| No of blades | | 3 | | | | | | | | | | | | |
| Rotation speed | rpm | 5.69 | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | |
| Hub height | m | 139.3 | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| Monthly proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% |
| Max blade width | m | 5.100 | | | | | | | | | | | | |
| Pitch | degrees | 2 | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| | | | | **Data sources (if applicable)** | | | | | | | | | | |
| **Avoidance rates used in presenting results** | | 92.97% | X | | | | | | | | | | | |
| | | 98.00% | | | | | | | | | | | | |
| | | 99.00% | | | | | | | | | | | | |
| | | 99.50% | | | | | | | | | | | | |

# Roseate Tern – Band (2012) Outputs



| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)** | | | | | | | | | | | | | | | |
| **Sheet 2 - Overall collision risk** | **All data input on Sheet 1:** | | | | | | | | | | | | | | |
| | **no data entry needed on this sheet!** | | | | | | | | | | | | | | |
| Bird details: | **other than to choose option for final tables** | | | | | | | | | | | | | | |
| Species | | ROST | | | | | | | | | | | | | |
| Flight speed | m/sec | 12.9 | | | | | | | | | | | | | |
| Flight type | | flapping | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Windfarm data: | | | | | | | | | | | | | | | |
| Number of turbines | | 200 | | | | | | | | | | | | | |
| Rotor radius | m | 115.5 | | | | | | | | | | | | | |
| Minimum height of rotor | m | 139.3 | | | | | | | | | | | | | |
| Total rotor frontal area | sq m | 8381926 | | | | | | | | | | | | | |
| | | | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | **year average** |
| Proportion of time operational | % | | 95% | 95% | 92% | 93% | 90% | 93% | 92% | 93% | 94% | 92% | 95% | 95% | 93.3% |
| | | | | | | | | | | | | | | | |
| **Stage A - flight activity** | | | | | | | | | | | | | | | **per annum** |
| Migration passages | | | 0 | 0 | 0 | 1E+05 | 108660 | 108660 | 0 | 162990 | 162990 | 162990 | 0 | 0 | **814950** |
| Migrant flux density | birds/ km | | 0 | 0 | 0 | 232.2 | 232.184 | 232.184 | 0 | 348.277 | 348.277 | 348.277 | 0 | 0 | |
| Proportion at rotor height | % | 11% | | | | | | | | | | | | | |
| Flux factor | | | 0 | 0 | 0 | 8425 | 8425 | 8425 | 0 | 12637 | 12637 | 12637 | 0 | 0 | |
| | | | | | | | | | | | | | | | |
| **Option 1 -Basic model - Stages B, C and D** | | | | | | | | | | | | | | | |
| Potential bird transits through rotors | | | 0 | 0 | 0 | 963 | 963 | 963 | 0 | 1445 | 1445 | 1445 | 0 | 0 | **7225** |
| Collision risk for single rotor transit | (from sheet 3) | 3.4% | | | | | | | | | | | | | |
| Collisions for entire windfarm, allowing for non-op time, assuming no avoidance | birds per month or year | | **0** | **0** | **0** | **31** | **30** | **31** | **0** | **46** | **47** | **46** | **0** | **0** | **230** |
| | | | | | | | | | | | | | | | |
| **Option 2-Basic model using proportion from flight distribution** | | | **0** | **0** | **0** | **8** | **7** | **8** | **0** | **12** | **12** | **11** | **0** | **0** | **58** |
| | | | | | | | | | | | | | | | |
| **Option 3-Extended model using flight height distribution** | | | | | | | | | | | | | | | |
| Proportion at rotor height | (from sheet 4) | 2.9% | | | | | | | | | | | | | |
| Potential bird transits through rotors | Flux integral | 0.0003 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 4 | 4 | 4 | 0 | 0 | **21** |
| Collisions assuming no avoidance | Collision integral | 0.00000 | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** | **0** |
| Average collision risk for single rotor transit | | 1.3% | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Stage E - applying avoidance rates** | | | | | | | | | | | | | | | |
| Using which of above options? | **Option 3** | 0.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | | | | | | | | | | | | | | |
| Collisions assuming avoidance rate | birds per month or year | 92.97% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 98.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 99.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 99.50% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | | | | | | | | | | | | | | |
| Collisions after applying large array correction | | 92.97% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 98.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 99.00% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |
| | | 99.50% | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | **0** |

| | |
|---|---|
| 🟩 | from Sheet 1 - input data |
| 🟪 | from Sheet 6 - available hours |
| 🟧 | from Sheet 3 - single transit collision risk |
| 🟨 | from survey data |
| 🟦 | calculated field |

# Summary of simulation results from SCRAM: a stochastic collision risk assessment for movement data

11 September 2023

SCRAM was developed by Biodiversity Research Institute, the University of Rhode Island, and the U.S. Fish and Wildlife Service with funding from the Bureau of Ocean Energy Management.

## SCRAM run details

```
## SCRAM - the Stochastic Collision Risk Assessment for Movement version
## Version: 1.0.3 - Cathartic Adela
## Iterations: 1000
## Type of model employed: trunc
## Model option: Option 3: slower but more precise assessment
## Proportion transient in model cell: 0.755
## Project: ASOW-PIPL
## Modeler: Pam Loring
## The model run was started at: Mon Sep 11 15:05:05 2023 EDT
## The model run was completed at: Mon Sep 11 15:27:45 2023 EDT
## Run 1: the probability of exceeding specified threshold (1) is 0.451.
```

## Model inputs used for this analysis

Table 1: Species input parameters (mean and 95 perc. range).

| Species | Turbine model | Avoidance | Wing span | Body length | Speed | Upwind Prop. |
|---|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | 0.929 (0.92, 0.938) | 0.381 (0.381, 0.381) | 0.175 (0.17, 0.18) | 11.808 (3.097, 20.784) | 0.086 (0.086, 0.086) |

Table 2: Species monthly (Jan-Jun) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|
| **Piping Plover** | 0 ± 0 | 0 ± 0 | 4578 ± 0 | 4578 ± 0 | 4578 ± 0 | 4578 ± 0 |

Table 3: Species monthly (Jul-Dec) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|
| **Piping Plover** | 4578 ± 0 | 7423 ± 0 | 7423 ± 0 | 7423 ± 0 | 0 ± 0 | 0 ± 0 |

*Population data assumptions/limitations:*
1) Entire Atlantic coast population could be present in area during months listed.
2) Occurrence through October to include birds stopping over in mid-Atlantic (e.g. North Carolina). Number of birds still present in Atlantic likely lower.
3) Estimate of HY fledges, uses the 20-year (2002 - 2021) average productivity (unweighted).

Table 4: Wind farm input parameters (mean and 95 perc. range).

| Species | Turbine model | Num. turbines | Rotor radius | Hub height (m) | Blade width (m) | Wind speed (mps) |
|---|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | 200 | 115.5 (115.5, 115.5) | 139.3 (139.3, 139.3) | 5.1 (5.1, 5.1) | 12.51 (11.49, 13.45) |

Table 5: Wind farm input parameters (mean and 95 perc. range).

| Species | Turbine model | Rotor speed (rpm) | Pitch (radians) | Farm width (km) | Lat. | Long. |
|---|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | 5.69 (5.22, 6.12) | 0.03 (0.03, 0.04) | 24 | 39.29 | -74.09 |

Table 6: Monthly (Jan-Jun) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| **Species** | **Turbine model** | **Jan Op.** | **Feb Op.** | **Mar Op.** | **Apr Op.** | **May Op.** | **Jun Op.** |
|---|---|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | 89.2 (85.5, 93) | 89.4 (85.4, 93.1) | 86.5 (82.9, 90.1) | 86.8 (83.2, 90.5) | 84.6 (81.1, 88) | 87.3 (83.7, 90.9) |

Table 7: Monthly (Jul-Dec) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| **Species** | **Turbine model** | **Jul Op.** | **Aug Op.** | **Sep Op.** | **Oct Op.** | **Nov Op.** | **Dec Op.** |
|---|---|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | 86.2 (82.4, 89.6) | 87.1 (83.4, 91) | 88.4 (84.6, 92.1) | 86.5 (82.8, 90) | 88.7 (84.8, 92.2) | 88.7 (84.8, 92.4) |

## Results for the SCRAM simulation

Table 8: The populations estimate for each month and the estimated daily number of (95 perc. prediction intervals) animals in the model cell and collisions at the wind farm. Results are not shown for months that do not have movement data. This does not mean that collisions could not occur in those months, but we do not have movement data to estimate collisions during these periods.

| **Species** | **Turbine model** | **Month** | **Population estimate** | **Est. daily num. of animals in the model cell** | **Est. daily num. of collisions in the wind farm** |
|---|---|---|---|---|---|
| **Piping Plover** | **V236-15MW** | **Jan** | **0** | | |
| **Piping Plover** | **V236-15MW** | **Feb** | **0** | | |
| **Piping Plover** | **V236-15MW** | **Mar** | **4578** | | |
| **Piping Plover** | **V236-15MW** | **Apr** | **4578** | | |
| **Piping Plover** | **V236-15MW** | **May** | **4578** | 0 ( 0, 0) | 0 ( 0, 0) |
| **Piping Plover** | **V236-15MW** | **Jun** | **4578** | 2.358 (2.351, 2.351) | 0.001 (0.000708, 0.00144) |
| **Piping Plover** | **V236-15MW** | **Jul** | **4578** | 4.894 (4.597, 5.746) | 0.00206 (0.00141, 0.00311) |
| **Piping Plover** | **V236-15MW** | **Aug** | **7423** | 69.4 (65.72, 73.94) | 0.0295 (0.0207, 0.043) |
| **Piping Plover** | **V236-15MW** | **Sep** | **7423** | 0 ( 0, 0) | 0 ( 0, 0) |
| **Piping Plover** | **V236-15MW** | **Oct** | **7423** | | |
| **Piping Plover** | **V236-15MW** | **Nov** | **0** | | |
| **Piping Plover** | **V236-15MW** | **Dec** | **0** | | |

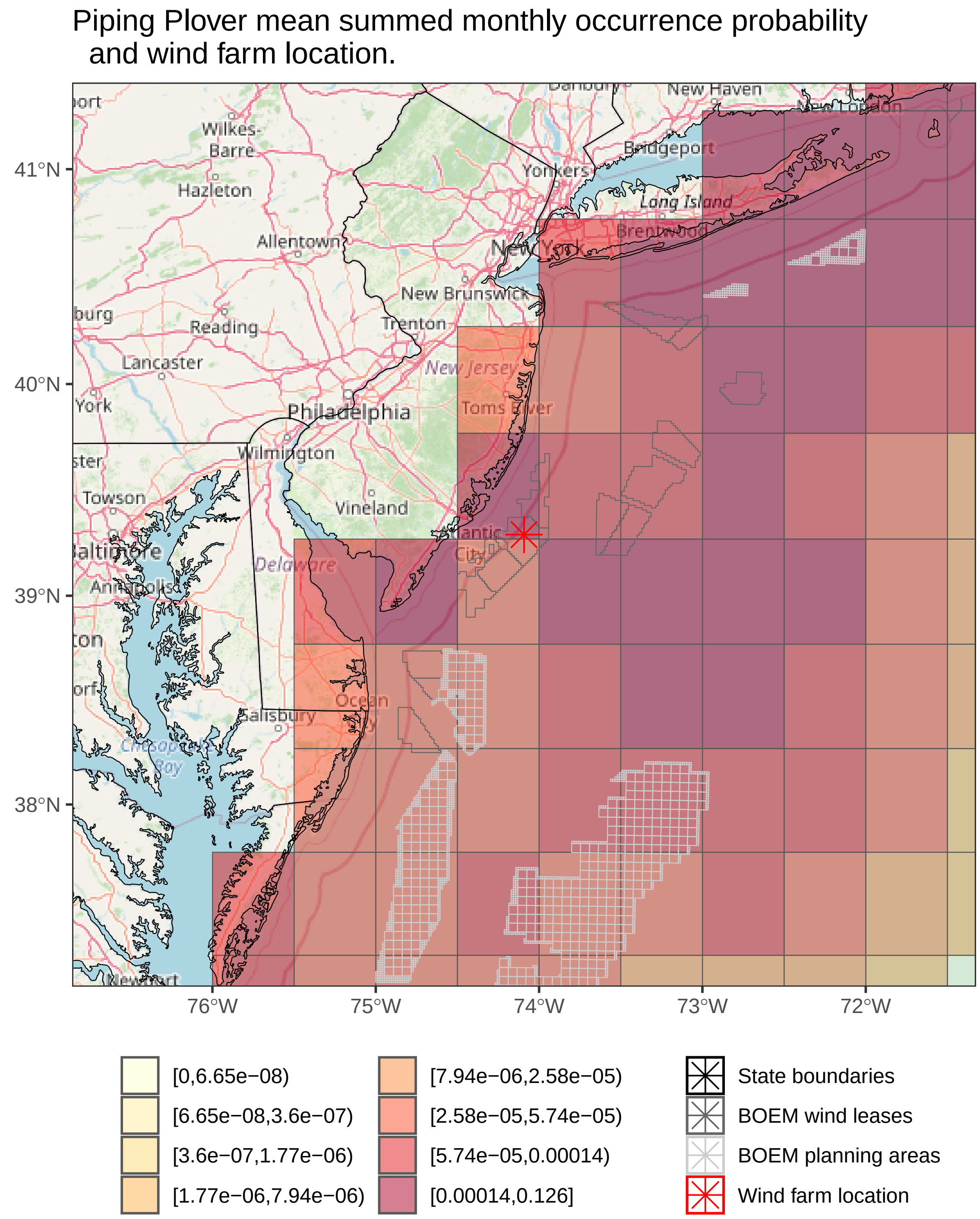


Figure 1: A map of the mean monthly species occurrence probabities (i.e., the mean of all summed daily occurrence probabilities across all months) and wind farm location. Collision estimates use summed daily occurrence probability rather than these values as shown; the values in this figure are presented for display purposes only to show relative differences in occurrence across the area of interest.

Table 9: The estimated monthly number (95 perc. prediction intervals) of collisions. Results are not shown for months that do not have movement data and does not mean that collisions could not occur in those months.

| **Species** | **Turbine model** | **month** | **Est. num. of collisions** |
|---|---|---|---|
| **Piping Plover** | **V236-15MW** | **Jan** | |
| **Piping Plover** | **V236-15MW** | **Feb** | |
| **Piping Plover** | **V236-15MW** | **Mar** | |
| **Piping Plover** | **V236-15MW** | **Apr** | |
| **Piping Plover** | **V236-15MW** | **May** | 0 ( 0, 0) |
| **Piping Plover** | **V236-15MW** | **Jun** | 0.0301 (0.0212, 0.0432) |
| **Piping Plover** | **V236-15MW** | **Jul** | 0.0639 (0.0436, 0.0965) |
| **Piping Plover** | **V236-15MW** | **Aug** | 0.916 (0.642, 1.33) |
| **Piping Plover** | **V236-15MW** | **Sep** | 0 ( 0, 0) |
| **Piping Plover** | **V236-15MW** | **Oct** | |
| **Piping Plover** | **V236-15MW** | **Nov** | |
| **Piping Plover** | **V236-15MW** | **Dec** | |
| **Piping Plover** | **V236-15MW** | **Annual** | 1.01 (0.706, 1.46) |

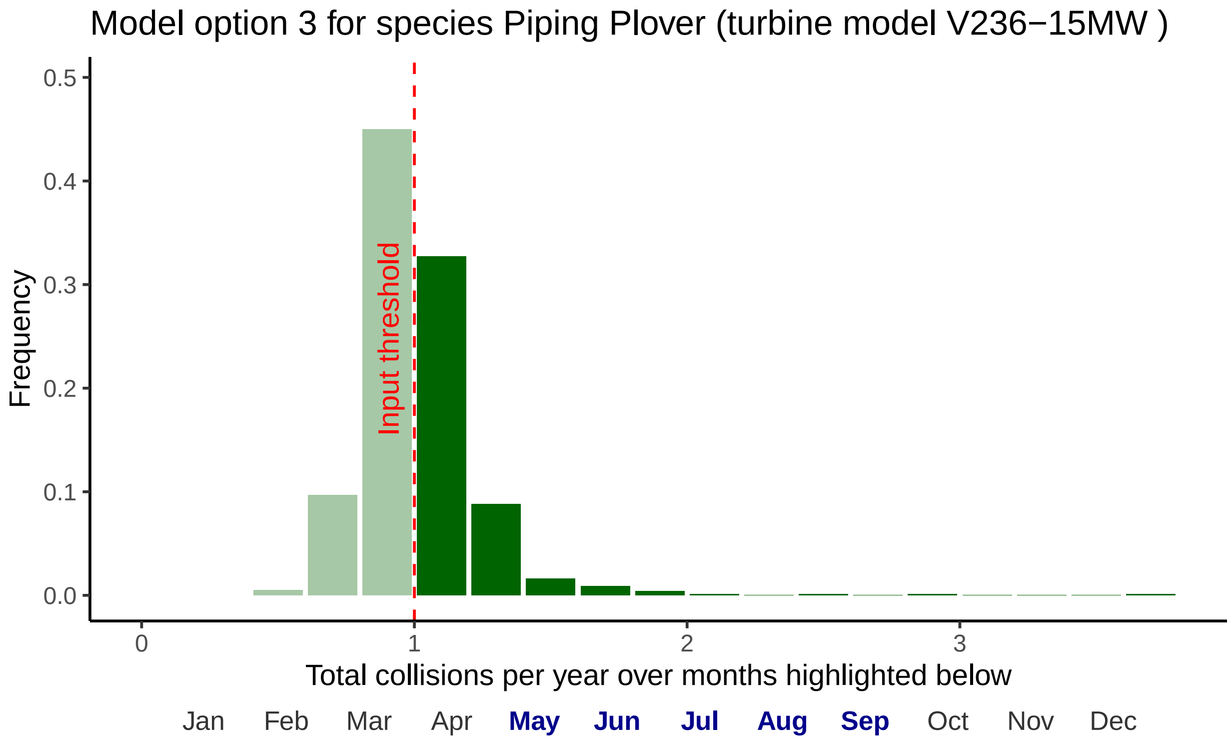


Figure 2: A frequency histogram of the total number of collisions per year. The heights of the bars show the relative frequency of each value. Months for which movement data were provided or available are shown in bold; only bold months are shown in histogram of annual collisions.

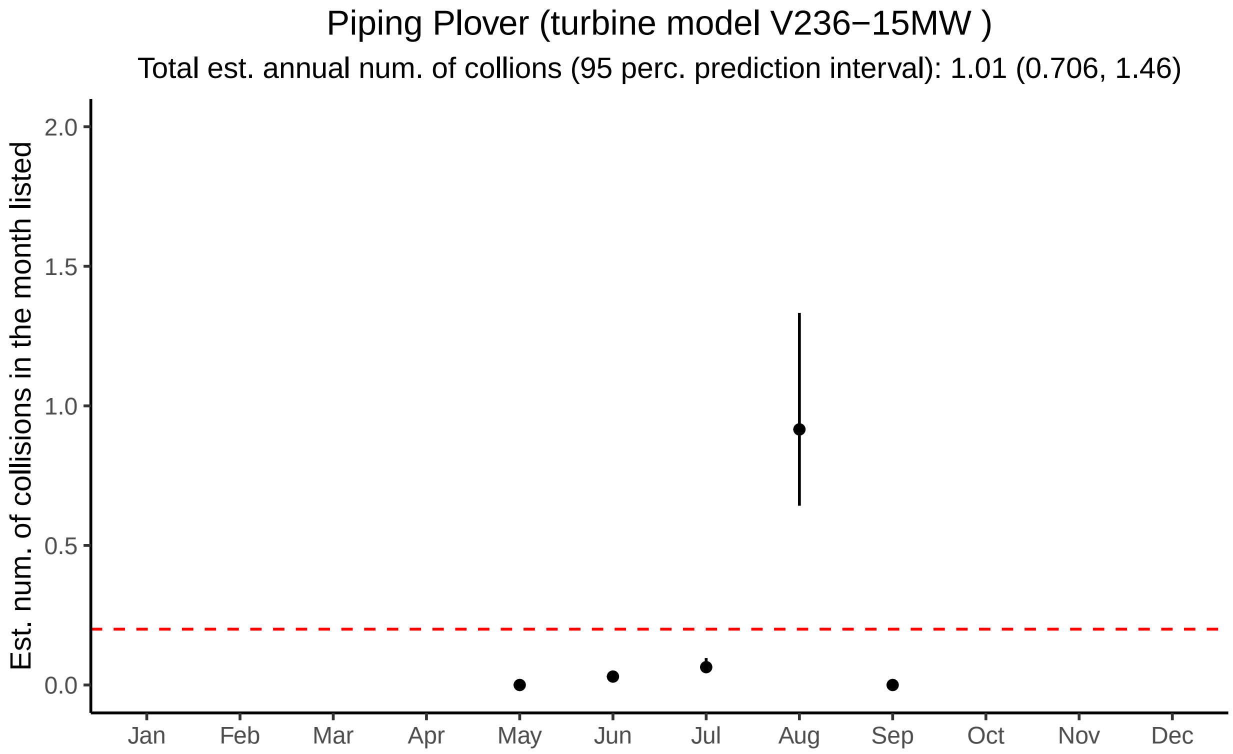


Figure 3: The predicted mean and 95 perc. prediction intervals of the number of collisions per month. Results are not shown for months that do not have movement data. Total annual collision rate and 95 perc. prediction interval are given at top. The threshold is shown divided by the number of months that movement data were available.

# Summary of simulation results from SCRAM: a stochastic collision risk assessment for movement data

11 September 2023

SCRAM was developed by Biodiversity Research Institute, the University of Rhode Island, and the U.S. Fish and Wildlife Service with funding from the Bureau of Ocean Energy Management.

## SCRAM run details

```
## SCRAM - the Stochastic Collision Risk Assessment for Movement version
## Version: 1.0.3 - Cathartic Adela
## Iterations: 1000
## Type of model employed: trunc
## Model option: Option 3: slower but more precise assessment
## Proportion transient in model cell: 0.342
## Project: ASOW-REKN
## Modeler: Pam Loring
## The model run was started at: Mon Sep 11 15:30:29 2023 EDT
## The model run was completed at: Mon Sep 11 15:53:36 2023 EDT
## Run 1: the probability of exceeding specified threshold (1) is > 0.999.
```

## Model inputs used for this analysis

Table 1: Species input parameters (mean and 95 perc. range).

| Species | Turbine model | Avoidance | Wing span | Body length | Speed | Upwind Prop. |
|---|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | 0.93 (0.92, 0.939) | 0.494 (0.452, 0.54) | 0.24 (0.23, 0.249) | 20.011 (16.239, 23.557) | 0.346 (0.346, 0.346) |

Table 2: Species monthly (Jan-Jun) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|
| **Red Knot** | 10400 ± 0 | 10400 ± 0 | 10400 ± 0 | 10400 ± 0 | 59200 ± 0 | 59200 ± 0 |

Table 3: Species monthly (Jul-Dec) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|
| **Red Knot** | 59200 ± 0 | 59200 ± 0 | 72520 ± 0 | 54720 ± 0 | 41400 ± 0 | 10400 ± 0 |

*Population data assumptions/limitations:*

1) All pass through in spring - #s consistent w/Lyons et al super-population estimate for 2020 in DE Bay: 40,444 (95 perc. credible interval: 33,627–49,966).
2) Winter population estimates represent the total # of adults and sub-adults (in general); they do not include hatch-year (HY) birds in the fall.
3) Southern and northern wintering birds could be present during July - Sept.
4) Only northern wintering birds could be present during Oct - Nov.
5) Only southeast US and Caribbean birds could be present during Dec.
6) Birds from western Gulf population are excluded from totals in Atlantic region due to lack of information on extent to which they use the Atlantic region.
7) Numbers do not include HY birds in fall.
8) Dec number coming from Lyons et al 2017. Just includes SE US Birds, not Caribbean.
9) Issues with double counting addressed because birds may be present in different areas of Atlantic region for weeks to months.

Table 4: Wind farm input parameters (mean and 95 perc. range).

| Species | Turbine model | Num. turbines | Rotor radius | Hub height (m) | Blade width (m) | Wind speed (mps) |
|---|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | 200 | 115.5 (115.5, 115.5) | 139.3 (139.3, 139.3) | 5.1 (5.1, 5.1) | 12.51 (11.51, 13.49) |

Table 5: Wind farm input parameters (mean and 95 perc. range).

| Species | Turbine model | Rotor speed (rpm) | Pitch (radians) | Farm width (km) | Lat. | Long. |
|---|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | 5.69 (5.23, 6.13) | 0.03 (0.03, 0.04) | 24 | 39.29 | -74.09 |

Table 6: Monthly (Jan-Jun) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| Species | Turbine model | Jan Op. | Feb Op. | Mar Op. | Apr Op. | May Op. | Jun Op. |
|---|---|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | 89.3 (85.5, 93.2) | 89.3 (85.4, 93.1) | 86.6 (83, 90.3) | 86.8 (83.1, 90.3) | 84.5 (80.8, 88.1) | 87.1 (83.5, 90.5) |

Table 7: Monthly (Jul-Dec) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| Species | Turbine model | Jul Op. | Aug Op. | Sep Op. | Oct Op. | Nov Op. | Dec Op. |
|---|---|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | 86.1 (82.5, 89.6) | 87.1 (83.7, 90.6) | 88.5 (84.8, 91.9) | 86.6 (83, 90.3) | 88.8 (85.1, 92.5) | 88.6 (84.8, 92.6) |

## Results for the SCRAM simulation

Table 8: The populations estimate for each month and the estimated daily number of (95 perc. prediction intervals) animals in the model cell and collisions at the wind farm. Results are not shown for months that do not have movement data. This does not mean that collisions could not occur in those months, but we do not have movement data to estimate collisions during these periods.

| Species | Turbine model | Month | Population estimate | Est. daily num. of animals in the model cell | Est. daily num. of collisions in the wind farm |
|---|---|---|---|---|---|
| **Red Knot** | **V236-15MW** | **Jan** | **10400** | | |
| **Red Knot** | **V236-15MW** | **Feb** | **10400** | | |
| **Red Knot** | **V236-15MW** | **Mar** | **10400** | | |
| **Red Knot** | **V236-15MW** | **Apr** | **10400** | | |
| **Red Knot** | **V236-15MW** | **May** | **59200** | | |
| **Red Knot** | **V236-15MW** | **Jun** | **59200** | | |
| **Red Knot** | **V236-15MW** | **Jul** | **59200** | | |
| **Red Knot** | **V236-15MW** | **Aug** | **59200** | 1078 ( 1074, 1082) | 0.763 (0.635, 0.908) |
| **Red Knot** | **V236-15MW** | **Sep** | **72520** | 1295 ( 1294, 1294) | 0.931 (0.769, 1.11) |
| **Red Knot** | **V236-15MW** | **Oct** | **54720** | 320.5 (320.5, 320.5) | 0.225 (0.188, 0.268) |
| **Red Knot** | **V236-15MW** | **Nov** | **41400** | 851.2 ( 849, 867.9) | 0.614 (0.513, 0.734) |
| **Red Knot** | **V236-15MW** | **Dec** | **10400** | | |

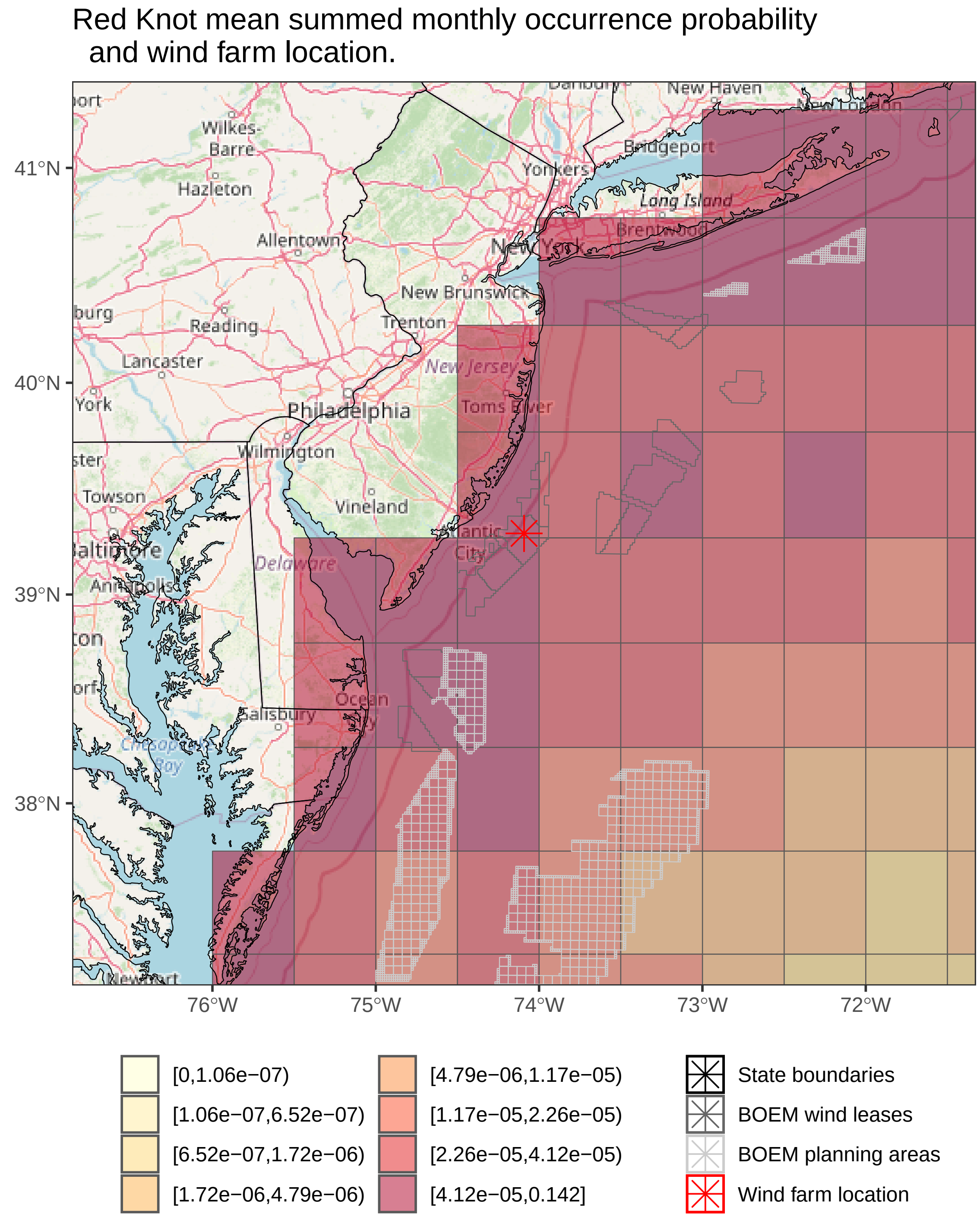


Figure 1: A map of the mean monthly species occurrence probabities (i.e., the mean of all summed daily occurrence probabilities across all months) and wind farm location. Collision estimates use summed daily occurrence probability rather than these values as shown; the values in this figure are presented for display purposes only to show relative differences in occurrence across the area of interest.

Table 9: The estimated monthly number (95 perc. prediction intervals) of collisions. Results are not shown for months that do not have movement data and does not mean that collisions could not occur in those months.

| **Species** | **Turbine model** | **month** | **Est. num. of collisions** |
|---|---|---|---|
| **Red Knot** | **V236-15MW** | **Jan** | |
| **Red Knot** | **V236-15MW** | **Feb** | |
| **Red Knot** | **V236-15MW** | **Mar** | |
| **Red Knot** | **V236-15MW** | **Apr** | |
| **Red Knot** | **V236-15MW** | **May** | |
| **Red Knot** | **V236-15MW** | **Jun** | |
| **Red Knot** | **V236-15MW** | **Jul** | |
| **Red Knot** | **V236-15MW** | **Aug** | 23.6 (19.7, 28.1) |
| **Red Knot** | **V236-15MW** | **Sep** | 27.9 (23.1, 33.3) |
| **Red Knot** | **V236-15MW** | **Oct** | 6.99 (5.82, 8.3) |
| **Red Knot** | **V236-15MW** | **Nov** | 18.4 (15.4, 22) |
| **Red Knot** | **V236-15MW** | **Dec** | |
| **Red Knot** | **V236-15MW** | **Annual** | 77 (64.4, 91.4) |

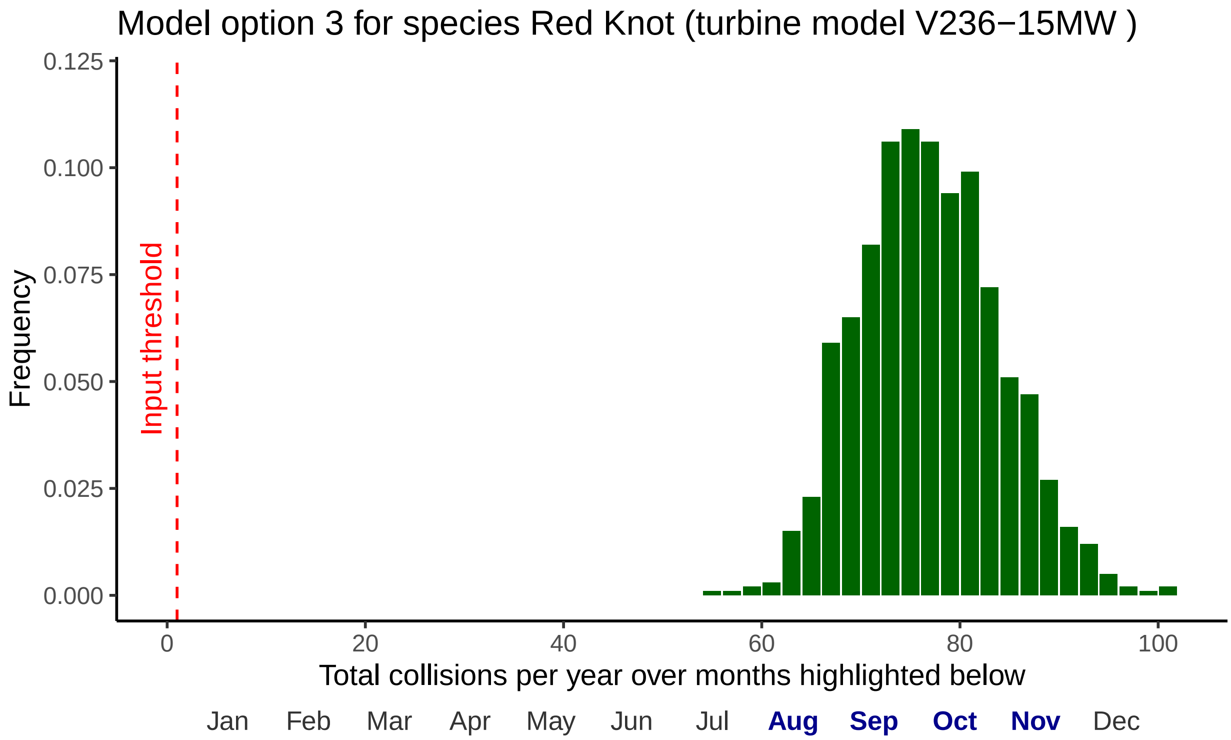


Figure 2: A frequency histogram of the total number of collisions per year. The heights of the bars show the relative frequency of each value. Months for which movement data were provided or available are shown in bold; only bold months are shown in histogram of annual collisions.

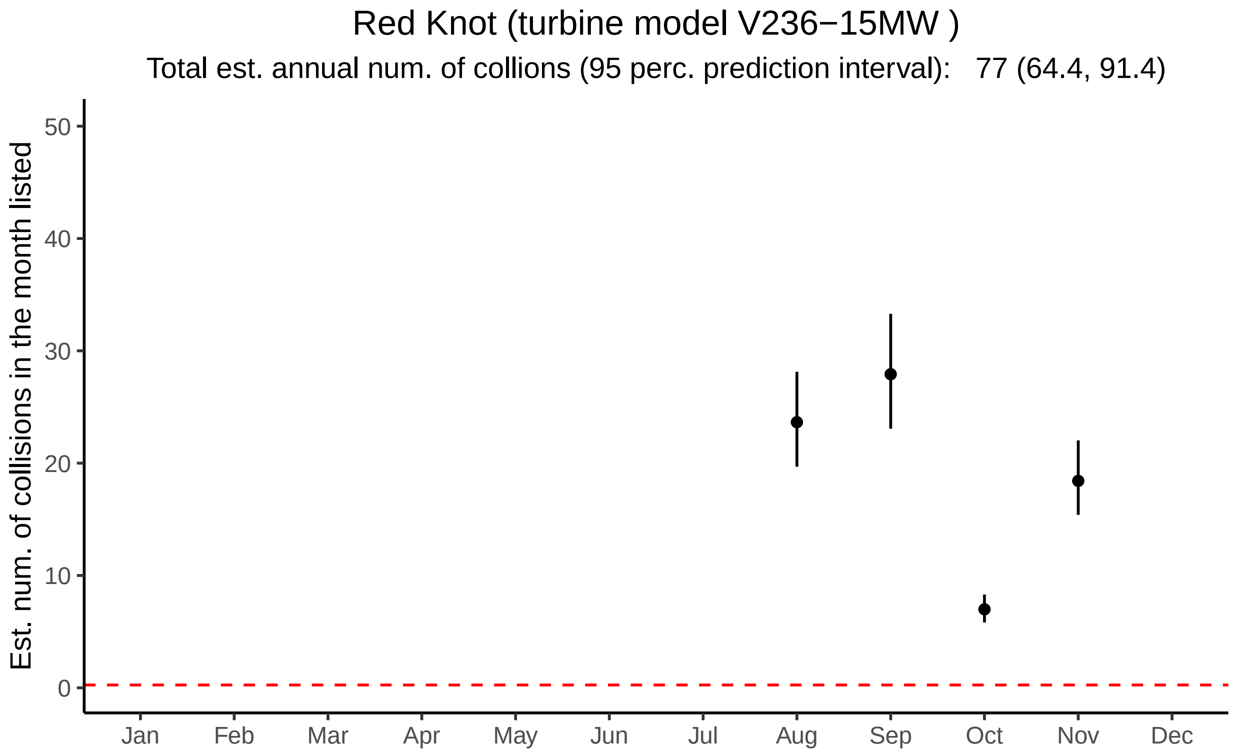


Figure 3: The predicted mean and 95 perc. prediction intervals of the number of collisions per month. Results are not shown for months that do not have movement data. Total annual collision rate and 95 perc. prediction interval are given at top. The threshold is shown divided by the number of months that movement data were available.

# Summary of simulation results from SCRAM: a stochastic collision risk assessment for movement data

11 September 2023

SCRAM was developed by Biodiversity Research Institute, the University of Rhode Island, and the U.S. Fish and Wildlife Service with funding from the Bureau of Ocean Energy Management.

## SCRAM run details

```
## SCRAM - the Stochastic Collision Risk Assessment for Movement version
## Version: 1.0.3 - Cathartic Adela
## Iterations: 1000
## Type of model employed: trunc
## Model option: Option 3: slower but more precise assessment
## Proportion transient in model cell: NA
## Project: ASOW-ROST
## Modeler: Pam Loring
## The model run was started at: Mon Sep 11 15:55:10 2023 EDT
## The model run was completed at: Mon Sep 11 16:18:17 2023 EDT
## Run 1: the probability of exceeding specified threshold (1) is < 0.001.
```

# Model inputs used for this analysis

Table 1: Species input parameters (mean and 95 perc. range).

| Species | Turbine model | Avoidance | Wing span | Body length | Speed | Upwind Prop. |
|---|---|---|---|---|---|---|
| Roseate Tern | **V236-15MW** | 0.929 (0.92, 0.939) | 0.76 (0.723, 0.802) | 0.37 (0.33, 0.41) | 12.732 (3.671, 22.053) | 0.375 (0.375, 0.375) |

Table 2: Species monthly (Jan-Jun) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jan | Feb | Mar | Apr | May | Jun |
|---|---|---|---|---|---|---|
| Roseate Tern | 0 ± 0 | 0 ± 0 | 0 ± 0 | 10916 ± 0 | 10916 ± 0 | 10916 ± 0 |

Table 3: Species monthly (Jul-Dec) population estimates ± SD and assumptions/limitations as specified by the USFWS using the most recent data.

| Species | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|
| Roseate Tern | 16251 ± 0 | 16251 ± 0 | 16251 ± 0 | 16251 ± 0 | 0 ± 0 | 0 ± 0 |

*Population data assumptions/limitations:*
1) Entire NW Atlantic pop could be present in area during months listed.
2) Average of most recent (2018 and 2019) productivity data from three largest colonies (representing >90 perc. of population) representative of entire population.
3) Fledging and post-breeding dispersal period occurs from July through Sept.
4) Numbers of non-breeding adults are not included.
5) Does not include non-breeding 1 and 2 year old birds that return but do not breed.
6) From Gochfeld and Burger (2020): Northeastern birds first arrive at Nantucket and Martha's Vineyard, MA, in large flocks, then disperse north as well as west. They arrive 26 Apr-20 May at Bird I., MA (Nisbet 1980, Nisbet 1981b, Nisbet 1989b), slightly later at Falkner I., CT, and Great Gull I., NY.
7) From Gochfeld and Burger (2020): Apparently all birds migrate directly from the staging area around Cape Cod across the w. North Atlantic to the West Indies (Nisbet 1984, C. Mostello). Very small numbers occur at sea off N. Carolina from late Aug to late Sep, with a peak in early Sep; the latest date was 28 Oct (D. Lee).

Table 4: Wind farm input parameters (mean and 95 perc. range).

| Species | Turbine model | Num. turbines | Rotor radius | Hub height (m) | Blade width (m) | Wind speed (mps) |
|---|---|---|---|---|---|---|
| Roseate Tern | **V236-15MW** | 200 | 115.5 (115.5, 115.5) | 139.3 (139.3, 139.3) | 5.1 (5.1, 5.1) | 12.49 (11.6, 13.57) |

Table 5: Wind farm input parameters (mean and 95 perc. range).

| **Species** | **Turbine model** | **Rotor speed (rpm)** | **Pitch (radians)** | **Farm width (km)** | **Lat.** | **Long.** |
|---|---|---|---|---|---|---|
| **Roseate Tern** | **V236-15MW** | 5.68 (5.27, 6.17) | 0.03 (0.03, 0.04) | 24 | 39.29 | -74.09 |

Table 6: Monthly (Jan-Jun) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| **Species** | **Turbine model** | **Jan Op.** | **Feb Op.** | **Mar Op.** | **Apr Op.** | **May Op.** | **Jun Op.** |
|---|---|---|---|---|---|---|---|
| **Roseate Tern** | **V236-15MW** | 89.1 (85.5, 92.9) | 89.3 (85.6, 93.2) | 86.6 (82.7, 90.2) | 86.9 (83.3, 90.7) | 84.6 (81.1, 87.9) | 87.2 (83.6, 90.8) |

Table 7: Monthly (Jul-Dec) wind farm operational percentage (mean and 95 perc. range) is given for each wind farm specification.

| **Species** | **Turbine model** | **Jul Op.** | **Aug Op.** | **Sep Op.** | **Oct Op.** | **Nov Op.** | **Dec Op.** |
|---|---|---|---|---|---|---|---|
| **Roseate Tern** | **V236-15MW** | 86.1 (82.6, 89.7) | 87 (83.3, 90.7) | 88.6 (84.9, 92.3) | 86.4 (83, 90) | 88.6 (84.7, 92.3) | 88.6 (85, 92.1) |

## Results for the SCRAM simulation

Table 8: The populations estimate for each month and the estimated daily number of (95 perc. prediction intervals) animals in the model cell and collisions at the wind farm. Results are not shown for months that do not have movement data. This does not mean that collisions could not occur in those months, but we do not have movement data to estimate collisions during these periods.

| Species | Turbine model | Month | Population estimate | Est. daily num. of animals in the model cell | Est. daily num. of collisions in the wind farm |
|---|---|---|---|---|---|
| **Roseate Tern** | **V236-15MW** | **Jan** | **0** | | |
| **Roseate Tern** | **V236-15MW** | **Feb** | **0** | | |
| **Roseate Tern** | **V236-15MW** | **Mar** | **0** | | |
| **Roseate Tern** | **V236-15MW** | **Apr** | **10916** | | |
| **Roseate Tern** | **V236-15MW** | **May** | **10916** | | |
| **Roseate Tern** | **V236-15MW** | **Jun** | **10916** | | |
| **Roseate Tern** | **V236-15MW** | **Jul** | **16251** | | |
| **Roseate Tern** | **V236-15MW** | **Aug** | **16251** | | |
| **Roseate Tern** | **V236-15MW** | **Sep** | **16251** | | |
| **Roseate Tern** | **V236-15MW** | **Oct** | **16251** | | |
| **Roseate Tern** | **V236-15MW** | **Nov** | **0** | | |
| **Roseate Tern** | **V236-15MW** | **Dec** | **0** | | |

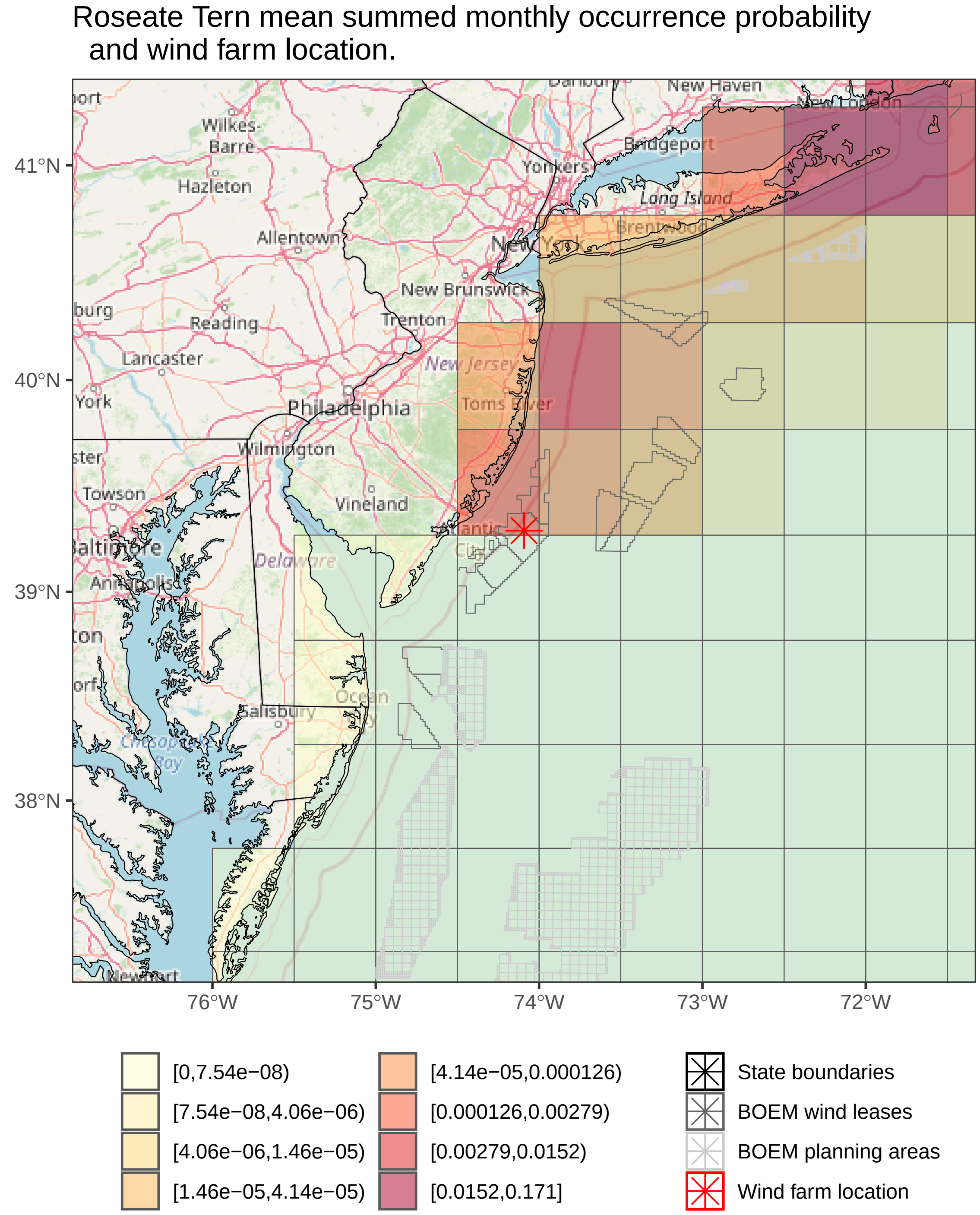


Figure 1: A map of the mean monthly species occurrence probabities (i.e., the mean of all summed daily occurrence probabilities across all months) and wind farm location. Collision estimates use summed daily occurrence probability rather than these values as shown; the values in this figure are presented for display purposes only to show relative differences in occurrence across the area of interest.

Table 9: The estimated monthly number (95 perc. prediction intervals) of collisions. Results are not shown for months that do not have movement data and does not mean that collisions could not occur in those months.

| **Species** | **Turbine model** | **month** | **Est. num. of collisions** |
|---|---|---|---|
| **Roseate Tern** | **V236-15MW** | **Jan** | |
| **Roseate Tern** | **V236-15MW** | **Feb** | |
| **Roseate Tern** | **V236-15MW** | **Mar** | |
| **Roseate Tern** | **V236-15MW** | **Apr** | |
| **Roseate Tern** | **V236-15MW** | **May** | |
| **Roseate Tern** | **V236-15MW** | **Jun** | |
| **Roseate Tern** | **V236-15MW** | **Jul** | |
| **Roseate Tern** | **V236-15MW** | **Aug** | |
| **Roseate Tern** | **V236-15MW** | **Sep** | |
| **Roseate Tern** | **V236-15MW** | **Oct** | |
| **Roseate Tern** | **V236-15MW** | **Nov** | |
| **Roseate Tern** | **V236-15MW** | **Dec** | |
| **Roseate Tern** | **V236-15MW** | **Annual** | 0 ( 0, 0) |

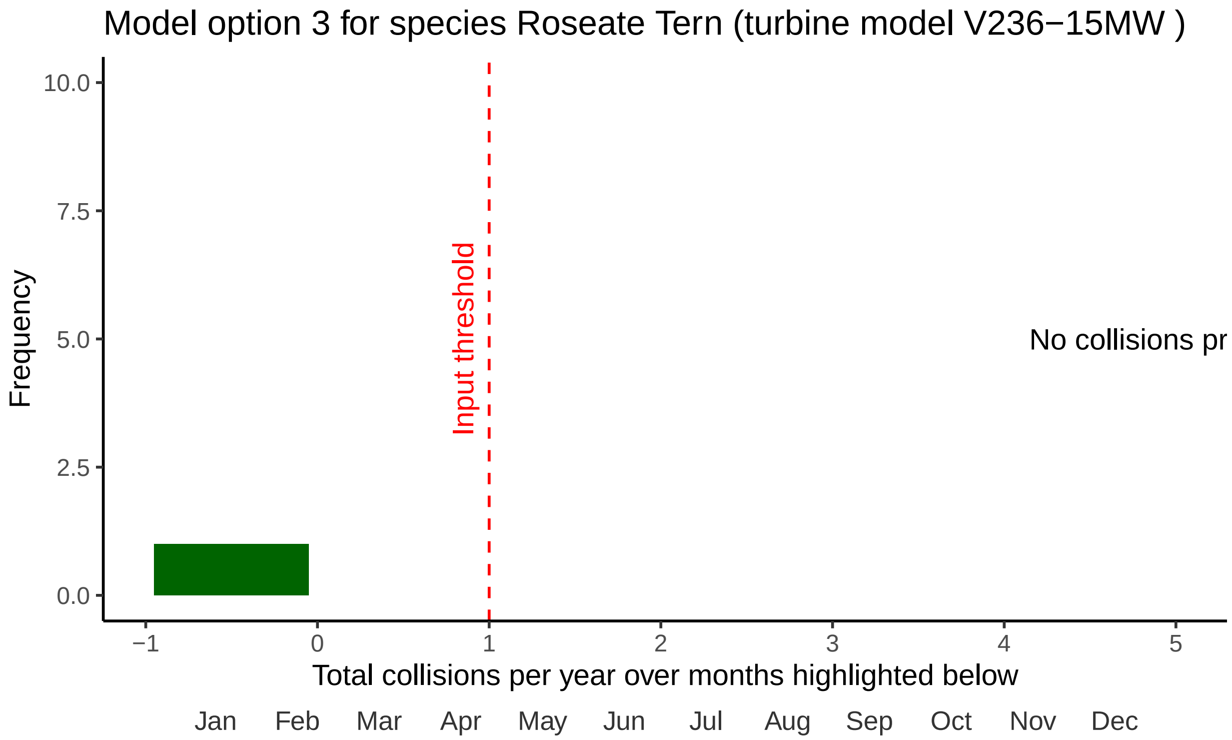


Figure 2: A frequency histogram of the total number of collisions per year. The heights of the bars show the relative frequency of each value. Months for which movement data were provided or available are shown in bold; only bold months are shown in histogram of annual collisions.

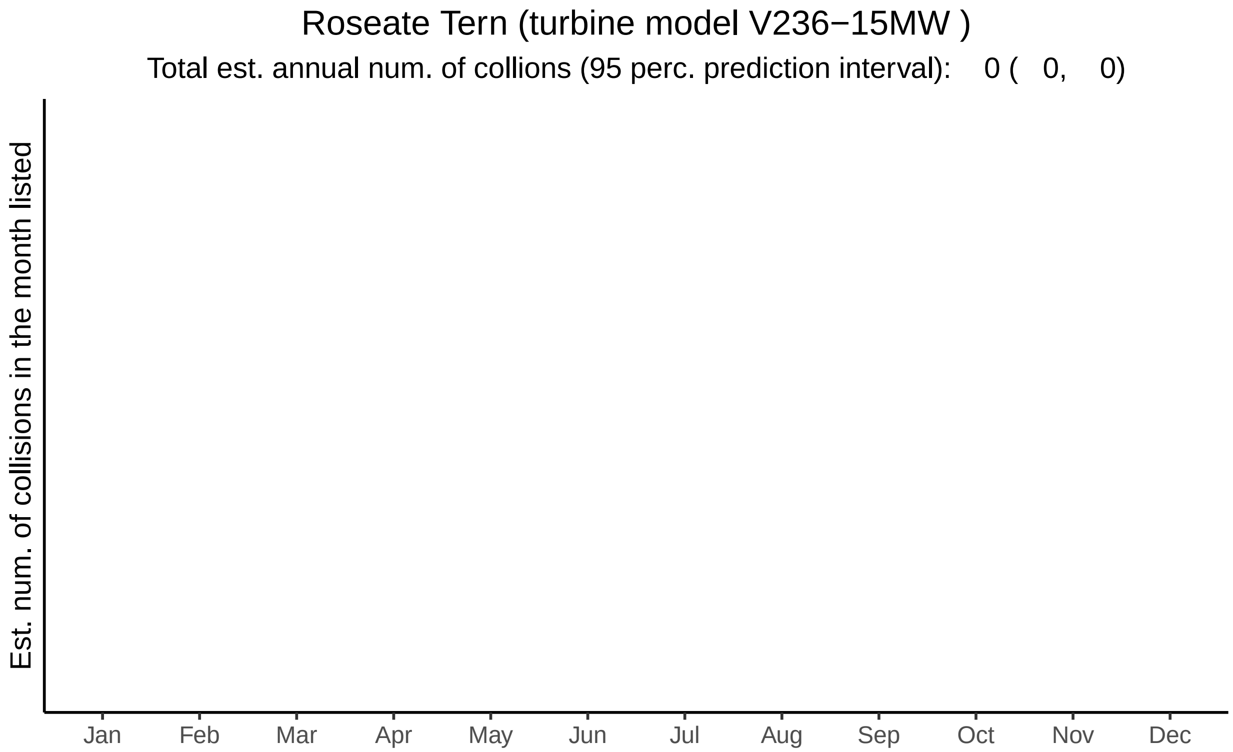


Figure 3: The predicted mean and 95 perc. prediction intervals of the number of collisions per month. Results are not shown for months that do not have movement data. Total annual collision rate and 95 perc. prediction interval are given at top. The threshold is shown divided by the number of months that movement data were available.

# APPENDIX C. GUIDANCE FOR COORDINATION OF DATA FROM AVIAN TRACKING STUDIES

## Guidance for Coordination of Data from Avian Tracking Studies

**Agency contacts:** Pam Loring, USFWS Division of Migratory Birds, pamela_loring@fws.gov [*Add additional agency contacts: Name, program, email*]

**Cooperator:** [*Add Recipient, Non-Federal Entity, etc. as appropriate: Name, affiliation, email*]

**Main objective:** Develop guidance for standardized data delivery and archiving practices to ensure the timely and consistent availability of data and metadata from avian tracking studies.

**Standardized data delivery and archiving practices:**

Studies that use electronic tags (including satellite and radio transmitters) to track animals provide invaluable data to benefit species conservation but also may subject individual animals to risk of injury, behavioral abnormalities, or mortality due to risks associated with capture and tagging activities. Therefore, the conservation value of data from tagging studies must be maximized by ensuring that all tracking data and metadata are complete, consistent, and available for use in resource assessments, conservation management decisions, and for other purposes. To help meet these information needs, the following guidance should be applied to any data collected using technology that involves attaching electronic tracking devices to animals.

Technologies and associated tracking devices associated with the guidance include:

1. Satellite telemetry technologies that use satellite systems to estimate locations and transmit data remotely
    a. Platform Transmitting Terminals (PTTs): operating on the Argos system (https://www.argos-system.org/)

2. Global Positioning System (GPS) technologies that use GPS satellites to estimate locations. Data is either stored on the tracking device (loggers) or transmitted remotely.
    a. GPS data loggers: data are stored on board and need to be recovered manually
    b. GPS-radio transmitters: data are transmitted to radio (VHF or UHF) base stations and downloaded manually
    c. GPS-satellite transmitters: data are transmitted remotely to a satellite system (e.g. Argos, Iridium)
    d. GPS-GSM transmitters: data are transmitted remotely to cellular networks

3. Automated radio telemetry technologies use radio transmitters and a network of automated receiving stations to track animals
    a. Motus Wildlife Tracking System (Motus): radio transmitters operating on coordinated frequencies (currently 166.380 MHz or 434 MHz in North America)

Workflows for satellite telemetry and GPS data:

Location data and metadata from animals tracked using satellite telemetry or GPS technologies should be stored in Movebank (www.movebank.org) using the workflow and minimum data standards described below. Movebank is a free, global database that is used by agencies and non-governmental organizations to manage, share, analyze and archive animal-borne sensor data. Movebank has long-term (>20 years) funding through the Max Planck Society and the University of Konstanz and has been developed with support from various funders including NASA, the US National Science Foundation, and the United Nations Convention on the Conservation of Migratory Species of Wild Animals (Convention on Migratory Species).

*Create a study*

Prior to deployment of satellite or GPS transmitters, the Cooperator will create a study in Movebank (https://www.movebank.org/cms/movebank-content/create-a-study) to manage data following best practices for study archival in Movebank: https://www.movebank.org/cms/movebank-content/archiving-best-practices. At this time, the Cooperator will add designated agency contacts listed above from Department of Interior to the Movebank study as 'Collaborators' with full access to view and download data.

*Add location data and sensor data*

For tag technologies that transmit data via satellite systems (e.g. Argos, Iridium) or cellular networks (e.g. GSM) the Cooperator will enable automated live data feeds (https://www.movebank.org/cms/movebank-content/live-data-feeds) for all transmitters in the study. For tag technologies with manual data downloads (e.g. GPS loggers, GPS-radio transmitters), the Cooperator will upload all location data and other sensor data to Movebank following the instructions found here: https://www.movebank.org/cms/movebank-content/create-study-overview. The Cooperator will add all location data and other sensor data to Movebank within 30 days following each data download. At this time, the Cooperator will quality control the data following instructions from Movebank, found here: https://www.movebank.org/cms/movebank-content/upload-qc.

*Add reference data*

Within 30 days following transmitter deployment, the Cooperator will enter reference data (information describing animals, tags, and deployments) for each tagged animal into Movebank (https://www.movebank.org/cms/movebank-content/upload-qc#add_deployments). A complete list of terms, definitions, and formatting requirements can be found in the Movebank Attribute Dictionary (https://www.movebank.org/cms/movebank-content/movebank-attribute-dictionary).

Reference data should include, but is not limited to, the following attributes:

1. 'Animal' information:
    a. Taxon: Genus and species (as defined by the Integrated Taxonomic Information System (www.itis.gov), e.g. *Calidris canutus*)
    b. Taxon detail: Use if appendix to scientific name (e.g. *rufa*)
    c. Sex (if known; allowed values: m=male, f=female, u=unknown)
    d. Animal ID: Unique identifier of animal (e.g. flag or aux band code)
    e. Animal comments: include information on auxiliary markers (e.g. leg flags)
    f. Ring ID: BBL band #

2. ‘Tag’ information:
    a. Tag ID: Unique identifier for the tag
    b. Tag manufacturer name (e.g. Lotek)
    c. Tag model (e.g. Sunbird Avian Argos PTT)
    d. Tag mass (in grams)
    e. Tag comments: other relevant info (e.g. auxiliary devices such as Motus tag or barometer)

2. 'Deployment' information:
    a. Start of tag deployment (deploy on timestamp): yyyy-MM-dd HH:mm:ss in UTC
    b. Deployment ID (uniquely identified to animal and tag combination, e.g. ‘animal id’-’tag ID’)
    c. Deployment comments: additional information about the deployment that is not described by other reference data terms (e.g. body length, animal condition at time of capture, etc.)
    d. Animal Life Stage: enter age code (e.g. HY, SY, ASY, AHY)
    e. Attachment type: see controlled list in the Movebank Attribute Dictionary (e.g. glue, leg-loop-harness, etc.)

    f. Deploy-on latitude and deploy-on longitude: latitude and longitude of deployment site (note: need to select “More fields” for this to appear)
    g. Duty cycle: transmission frequency (e.g. locations every 15-min during daylight hours / Nautical Twilight)

3. Following deployment, if tags are subsequently removed, dropped, or the tagged animal dies, the following information should be added:
    a. Deploy-off latitude and deploy-off longitude (latitude and longitude of known or approximate deployment end site)
    b. Deploy-off timestamp (yyyy-MM-dd HH:mm:ss in UTC)
    c. Deployment end type: see controlled list in the Movebank Attribute Dictionary (e.g. dead, fall-off, removal, unknown, etc.)

Workflows for automated radio telemetry data (Motus):

Motus Wildlife Tracking System (Motus) is an international collaborative automated radio telemetry network. Motus includes radio transmitters that currently operate on two frequencies in North America: 166.380 MHz and 434 MHz.

Prior to ordering Motus transmitters, the Cooperator will designate a new or existing project in Motus to add tags to. At this time, the Cooperator will add designated agency contacts from Department of Interior to the Motus project as 'Collaborators' with full access to view and download data. When ordering transmitters, provide the manufacturer (Lotek or CTT) the Motus project name and number so that the transmitters are registered to the project (https://motus.org/tag-deployment/).

During the time of tag registration, the Cooperator should record the following minimum information on tag properties in Motus:

1. Tag #
2. Burst interval (in seconds)
3. Manufacturer
4. Model
5. Codeset
6. Type

Tag registration information is recorded in Motus by the tag manufacturers and should be checked by the Cooperator for accuracy and completeness. Any errors or missing information on tag properties should be corrected in Motus prior to tag deployment.

Within 30 days following transmitter deployment, the Cooperator will record metadata for each tagged bird into Motus including:

1. Deployment Start Date/Time in UTC
2. Deployment location (Latitude and Longitude)
3. Species name
4. Band number: BBL band
5. Marker number: alphanumeric code of auxiliary marker code, if applicable
6. Marker type: type of auxiliary marker, if applicable
7. Sex: if known
8. Age: if known

Following deployment, if tags are subsequently removed, dropped, or the tagged animal dies, the Cooperator will update the following tag deployment information in Motus:

1. Deployment End Date/Time (UTC)
2. Tag deployment notes (record reason, if known dead, fall off, removed, unknown)