Revolution Wind Farm and Revolution Export Cable - Development and Operation

Biological Assessment

November 16, 2022

For the U.S. Fish and Wildlife Service

U.S. Department of the Interior
Bureau of Ocean Energy Management
Office of Renewable Energy Programs

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Acronyms and Abbreviations

µPa	micro Pascal
AC	alternating current
ADLS	Aircraft Detection Lighting Systems
Applicant	Revolution Wind
BA	Biological Assessment
BOEM	Bureau of Ocean Energy Management
BOEMRE	Bureau of Ocean Energy Management, Regulation, and Enforcement
CFR	Code of Federal Regulations
COP	Construction and Operations Plan
dB	decibels
dBA	A-weighted decibels
EIS	Environmental Impact Statement
EMF	electromagnetic field
EPM	environmental protection measure
ESA	Endangered Species Act
ft/sec	feet/second
HDD	horizontal directional drill
HVAC	high-voltage alternating current
Hz	hertz
IAC	inter-array cable

IPaC	Information for Planning and Consultation
kJ	kilojoules
km	kilometer
kV	kilovolt
Lease Area 1	BOEM Renewable Energy Lease Area OCS-A 0486
m	meter
m/sec	meters per second
mG	milligauss
mg/L	milligrams per liter
MMS	Minerals Management Service
MSL	mean sea level
mV/m	millivolts per meter
MW	megawatt
nm	nautical miles
NMFS	National Marine Fisheries Service
NLEB	Northern long-eared bat
O&M	operations and maintenance
OCS	Outer Continental Shelf
OSRP	oil spill response plan
OnSS	onshore substation
OSS	offshore substation
PDE	Project Design Envelope
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area
rpm	revolutions per minute
RSZ	rotor swept zone
RWEC	Revolution Wind Export Cable
RWEC – OCS	RWEC within federal waters
RWEC – RI	RWEC within Rhode Island state waters
RWF	Revolution Wind Farm
SAP	Site Assessment Plan
SPL	sound pressure level
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USDOE	U.S. Department of Energy
USDOI	U.S. Department of Interior
USFWS	U.S. Fish and Wildlife Service
VHF	very-high frequency
WEA	wind energy area
WTG	wind turbine generator

1 Introduction

Pursuant to Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, the Bureau of Ocean Energy Management (BOEM) requests consultation with the U.S. Fish and Wildlife Service (USFWS) regarding species that may be affected by the approval of a Construction and Operations Plan (COP) for the for the Revolution Wind Farm (RWF) and Revolution Wind Export Cable (RWEC), a commercial wind energy facility. The RWF would be constructed in the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) on the Atlantic Outer Continental Shelf (OCS). The RWEC extends from the RI/MA WEA to North Kingstown, Rhode Island and includes appurtenant project elements in nearshore, coastal, and upland habitats in North Kingstown.

The RWF would include 74 to 100 wind turbine generators (WTGs or turbines) with capacities ranging from 8 megawatt (MW) to 12 MW connected by an inter-array cable (IAC) network and up to two offshore substations (OSSs) connected by one offshore substation-link cable (OSS-link cable). The RWF will be located in BOEM Renewable Energy Lease Area OCS-A 0486 (Lease Area 1), located within the RI/MA WEA. Lease Area 1 is located in federal waters of the OCS approximately 15 nautical miles (nm) (18 statute miles) southeast of Point Judith, Rhode Island; approximately 13 nm (15 miles) east of Block Island, Rhode Island; approximately 7.5 nm (8.5 miles) south of Nomans Land Island National Wildlife Refuge (uninhabited island); and between approximately 10.0 and 12.5 nm (12 and 14 miles) south/southwest of varying points of the Rhode Island and Massachusetts coastlines. The RWF would also include an Operations and Maintenance (O&M) facility. The O&M facility would be located onshore at an existing commercial port. Currently, the Port of Montauk at Montauk in East Hampton, New York or Port of Davisville-Quonset Point in North Kingstown, Rhode Island are being considered as the O&M facility sites, with the former potentially serving as a central O&M hub for multiple offshore wind energy facilities. No specific port improvements are included in the Proposed Action.

The RWEC would comprise two high-voltage alternating current (HVAC) electric cables (export cables) routed on generally parallel paths along a single corridor within federal waters (RWEC – OCS) and Rhode Island state waters (RWEC – RI), and in an underground duct bank connecting the onshore transition joint bay to the onshore substation (OnSS). The RWEC – RI will be connected to the RWEC – Onshore at a sea-to-shore transition point where the two cable segments will be spliced together. An interconnection facility would connect the RWF OnSS to the existing onshore regional electric transmission grid at the Davisville Substation in North Kingstown, Rhode Island (Figure 1.1).

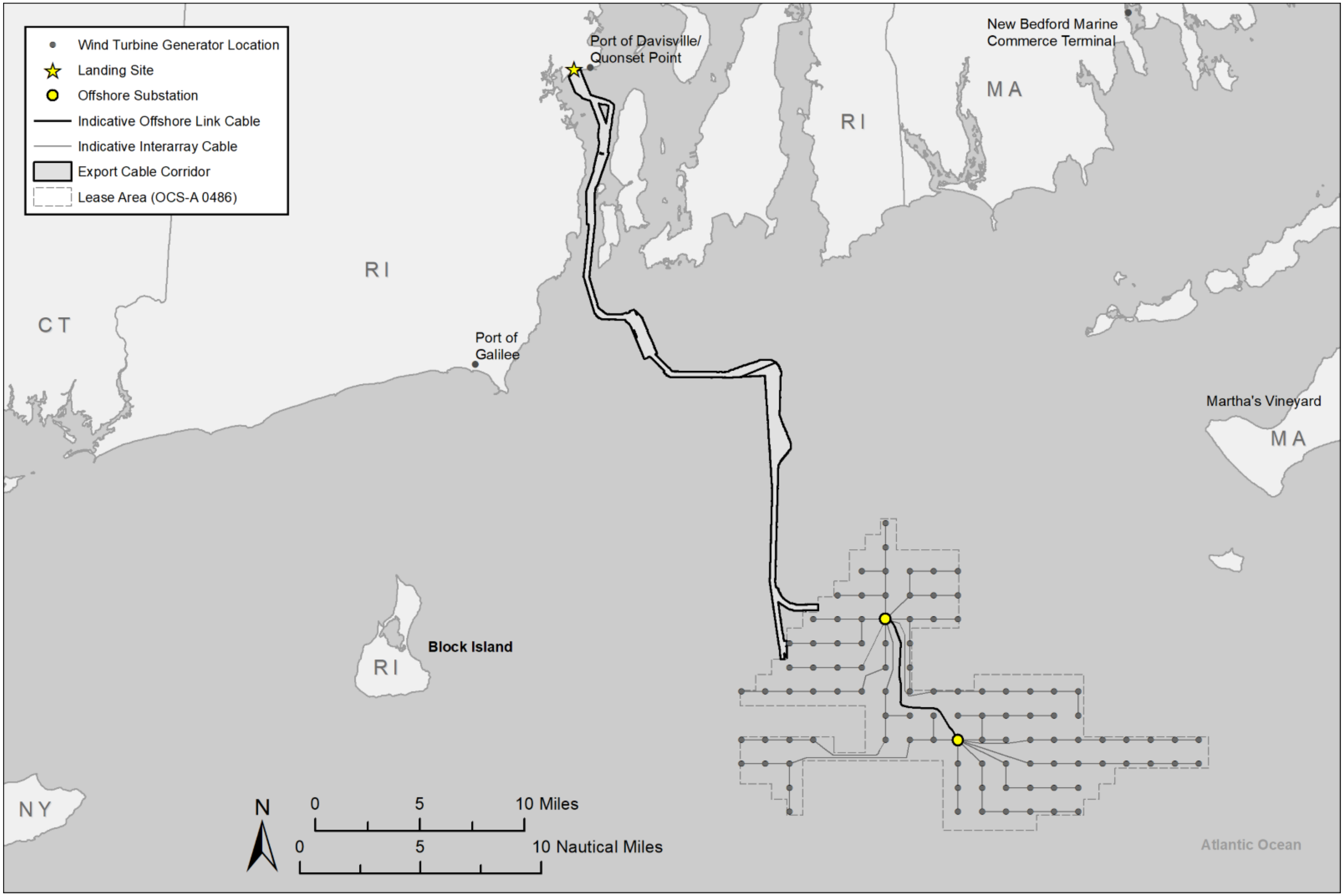


Figure 1.1 Project Area and Vicinity

This biological assessment (BA) evaluates the potential effects on ESA-listed species resulting from the construction, O&M, and decommissioning of the proposed action consistent with the requirements of Section 7 of the ESA. This BA addresses project effects to listed species under the jurisdiction of the USFWS. Effects to listed species under the jurisdiction of the National Marine Fisheries Service (NMFS) are addressed in a separate consultation.

1.1 Background

The Energy Policy Act of 2005, Public Law No. 109-58, added Section 8(p)(1)(C) to the Outer Continental Shelf Lands Act, which grants the Secretary of the Interior the authority to issue leases, easements, or rights-of-way on the OCS for the purpose of renewable energy development (43 U.S.C. § 1337(p)(1)(C)). The Secretary delegated this authority to the former Minerals Management Service (MMS), now BOEM. On April 22, 2009, BOEM (formerly the Bureau of Ocean Energy Management, Regulation, and Enforcement [BOEMRE]) promulgated final regulations implementing this authority at 30 Code of Federal Regulations (CFR) 585.

Revolution Wind (the Applicant) has submitted the draft COP for the RWF and RWEC to BOEM for review and approval. Consistent with the requirements of 30 CFR 585.620 to 585.638, COP submittal occurs after BOEM grants a lease for the proposed project and the Applicant completes all studies and surveys defined in their site assessment plan. BOEM's renewable energy development process is described in the following section. The Applicant is working with BOEM to address additional information needs to finalize the COP. This BA relies on the most current information available for the Project.

1.2 Renewable Energy Process

Under BOEM's renewable energy regulations, the issuance of leases and subsequent approval of wind energy development on the OCS is a staged decision-making process. BOEM's wind energy program occurs in four distinct phases:

1. **Planning and Analysis.** The first phase is to identify suitable areas to be considered for wind energy project leases through collaborative, consultative, and analytical processes using the state's task forces, public information meetings, input from the states, Native American Tribes, and other stakeholders.
2. **Lease Issuance.** The second phase is the issuance of a commercial wind energy lease. The competitive lease process is set forth at 30 CFR 585.210 to 585.225, and the noncompetitive process is set forth at 30 CFR 585.230 to 585.232. A commercial lease gives the lessee the exclusive right to subsequently seek BOEM approval for the development of the leasehold. The lease does not grant the lessee the right to construct any facilities; rather, the lease grants the right to use the leased area to develop its plans, which must be approved by BOEM before the lessee can move on to the next stage of the process (30 CFR 585.600 and 585.601).

3. **Approval of a Site Assessment Plan (SAP).** The third stage of the process is the submission of a SAP, which contains the lessee's detailed proposal for the construction of a meteorological tower and/or the installation of meteorological buoys on the leasehold (30 CFR 585.605 to 585.618). The lessee's SAP must be approved by BOEM before it conducts these "site assessment" activities on the leasehold. BOEM may approve, approve with modification, or disapprove a lessee's SAP (30 CFR 585.613). As a condition of SAP approval, meteorological towers will be required to have visibility sensors to collect data on climatic conditions above and beyond wind speed, direction, and other associated metrics generally collected at meteorological towers. These data will assist BOEM and USFWS with evaluating the impacts of future offshore wind facilities on threatened and endangered birds, migratory birds, and bats.
4. **Approval of a Construction and Operations Plan.** The fourth and final stage of the process is the submission of a COP, a detailed plan for the construction and operation of a wind energy project on the lease (30 CFR 585.620 to 585.638). BOEM approval of a COP is a precondition to the construction of any wind energy facility on the OCS (30 CFR 585.628). As with a SAP, BOEM may approve, approve with modification, or disapprove a lessee's COP (30 CFR 585.628).

The regulations also require that a lessee provide the results of surveys with its SAP or COP, including a shallow hazards survey (30 CFR 585.626 (a)(1)), geological survey (30 CFR 585.616(a)(2)), geotechnical survey (30 CFR 585.626(a)(4)), and an archaeological resource survey (30 CFR 585.626(a)(5)). BOEM refers to these surveys as "site characterization" activities. Although BOEM does not issue permits or approvals for these site characterization activities, it will not consider approving a lessee's SAP or COP if the required survey information is not included. *See* "Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 585," (USDOI, BOEMRE, OAEP, 2011).

1.3 Design Envelope

Pursuant to 30 CFR 585.626, the COP must include a description of all planned facilities, including onshore and support facilities, as well as anticipated project easement needs for the project. It must also describe all activities related to project construction, commercial operations, maintenance, decommissioning, and site clearance procedures. There are benefits to allowing lessees to describe a reasonable range of project designs in a COP, because of the project complexity, the unpredictability of the environment in which it will be constructed, and/or the rapid pace of technological development within the industry. In the renewable energy industry, a permit application or plan that describes a reasonable range of project designs is referred to as a Project Design Envelope (PDE) approach.

BOEM has decided that it will give offshore renewable energy lessees the option to use a PDE approach when submitting a COP for environmental review, as stated in in its September 2016

National Offshore Wind Strategy (see Action 2.1.3 *in* USDOE and USDOI [2016]). The PDE is a permitting approach that allows a project proponent the option to submit a reasonable range of design parameters within its permit application, allowing the reviewing agency to consider the maximum impacts that could occur from the range of potential design parameters.

1.4 EIS Alternative

The proposed action addressed in this BA is the PDE maximum impact scenario for the construction, operation, and decommissioning of the RWF and RWEC as described in the COP. The PDE is analyzed in the Environmental Impact Statement (EIS) and all alternatives analyzed in the EIS are within the PDE. This BA therefore covers all alternatives within the EIS.

1.5 Consultation History

This BA represents the initiation of the Section 7 consultation process for the proposed action; there is no prior consultation history specific to this project. However, a considerable consultation history exists for the implementation of BOEM's Renewable Energy Process for the Atlantic OCS and the subsequent issuance of leases to develop other wind energy facilities in the region. This history is summarized here to provide context and consistency for the analyses and effect determinations presented in this document.

BOEM was involved in consultation with USFWS regarding the construction, operations, maintenance, and decommissioning of offshore wind turbines for the Cape Wind Energy Project in federal waters of Nantucket Sound, Massachusetts. The consultation was initiated on the finding that the Cape Wind Energy Project would be "likely to adversely affect" piping plovers (*Charadrius melodus*) and roseate terns (*Sterna dougallii*), and that an incidental take statement was provided to address mortality of these species due to the potential for rotor swept collisions. The USFWS determined in the Cape Wind Energy Project Biological Opinion dated November 21, 2008, that effects due to monopile collisions, habitat loss and disturbance, prey species attraction, barriers and displacement, increased predation, lighting, oil spills, pre- and post-construction activities, routine maintenance activities, and decommissioning activities were insignificant and discountable.

BOEM completed ESA Section 7 consultation on the Issuance of Leases for Wind Resource Data Collection on the Outer Continental Shelf Offshore within the RI/MA WEA and the Massachusetts WEA in 2012. The RI/MA WEA consists of 13 whole and 29 partial lease blocks (Figure 1.1). This consultation addressed activities associated with the site assessment process, including geological and geophysical surveys (sonar and sediment work), wind resource assessments (meteorological towers and buoys), biological assessments, and cultural/archeological assessments. On November 1, 2012, USFWS concurred with BOEM's determination that the proposed action is not likely to adversely affect the roseate tern or piping plover or jeopardize the continued existence of the then-candidate *rufa* red knot. USFWS concluded that the likelihood of these species occurring in the action area was discountable, while acknowledging that the extent to which these species occur 8 or more miles offshore was not well known at that time. USFWS also concluded that the greatest potential threat posed to avian species from site assessment activities was the risk of a catastrophic oil spill resulting from vessel collision with meteorological towers. USFWS concluded that the risk of such an event was low given the number of proposed structures, the implementation of recommended visibility sensors, and U.S. Coast Guard requirements to ensure these structures are clearly marked and outside of established navigational corridors. To date, no meteorological towers have been placed on the OCS.

BOEM was a cooperating agency with the U.S. Army Corps of Engineers (USACE) on a 2013 informal USFWS consultation for the Deepwater Wind Block Island Wind Facility and Block Island Transmission System. The wind facility consists of five 6-MW wind turbines within 4.8 km (3 miles) of Block Island, Rhode Island. Note the difference in turbine size between this project and the proposed action; impacts are expected to be similar in nature but potentially different in extent. On July 31, 2013, USFWS concurred that this proposed action was not likely to adversely affect the American burying beetle (*Nicrophorus americanus*), roseate tern, piping plover, or *rufa* red knot, concluding that the effects of the proposed action on those species would be insignificant and/or discountable.

In 2015, BOEM conducted an informal consultation with USFWS for the Virginia Offshore Wind Technology Advancement Project, now called the Coastal Virginia Offshore Wind Project, as the lead action agency. The project consists of two 6-MW wind turbines 24 nm offshore with a subsea export cable making landfall on Camp Pendleton Beach. On January 29, 2015, USFWS concurred with the determinations of "no effect" on potential nesting areas for hawksbill (*Eretmochelys imbricata*) and leatherback sea turtles (*Dermochelys coriacea*) and "not likely to adversely affect" the green sea turtle (*Chelonia mydas*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), loggerhead sea turtle (*Caretta caretta*), piping plover, red knot, roseate tern, Bermuda petrel, and black-capped petrel (*Pterodroma hasitata*). On March 27, 2019, USFWS completed its review of the revised plan and determined the proposed action would not adversely affect these listed species or any designated critical habitat.

Starting in 2018, BOEM conducted an information consultation with USFWS for Vineyard Wind 1 Offshore Wind Energy Project comprising up to 100 turbines. On July 8, USFWS sent a draft letter concurring with BOEM's determination that this activity may affect, but is not likely to adversely affect, roseate terns, piping plovers and/or red knots. On September 2, 2020, USFWS found the onshore activity of clearing forest for the substation consistent with activities analyzed in the Service's January 5, 2016, Programmatic Biological Opinion for Northern long-eared bat (Consultation Code: 05E1NE00-2019-TA-1790). On September 3, 2020, BOEM sent an updated BA to USFWS for concurrence. The USFWS provided an ESA concurrence letter to BOEM dated October 16, 2020, for the Vineyard Wind 1 Offshore Wind Energy Project.

For the South Fork Wind Farm, BOEM provided a draft BA to the USFWS via email correspondence on January 8, 2021, for review and/or concurrence. In this document, BOEM indicated that the activity may affect, but is not likely to adversely affect, roseate terns, piping plovers, *rufa* red knots, Northern long-eared bats (*Myotis septentrionalis*), and seabeach amaranth (*Amaranthus pumilus*). On February 1, 2021, BOEM provided supplemental information regarding the Montauk Operations and Maintenance Facility and Horizontal Directional Drilling, although the original effect determinations were not changed. The USFWS provided an ESA concurrence letter to BOEM dated March 4, 2021, for the South Fork Wind Farm project.

1.6 Project Area and Action Area

The proposed action addressed in this BA is the PDE maximum impact scenario for the construction, operation, and theoretical decommissioning of the RWF and RWEC as described in the COP. The project area includes upland and coastal nearshore habitats in North Kingstown, Rhode Island and adjacent Rhode Island State waters, and ocean habitats in the RI/MA WEA on the OCS offshore of New York, Rhode Island, and Massachusetts. The RWF and RWEC project area and vicinity are shown in Figure 1.1.

Under federal ESA Section 7 consultation guidance the action area is defined as “all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action” (50 CFR §402.02). The action area includes the project area (i.e., the project footprint), all areas exposed to temporary and long-term project effects that measurably alter environmental conditions from the environmental baseline, and the direct and indirect effects of any interrelated or interdependent actions resulting from the proposed action. The potential effects of the proposed action on the environment and the methods used to define the physical extent of these effects are described in Section 4. For the purpose of this consultation, the action area includes separate terrestrial and aquatic components. The terrestrial component includes the area affected by RWEC – Onshore construction, operation, and decommissioning. The marine component includes the open ocean above and below the water surface affected by construction and operation of the RWF, RWEC – OCS, and RWEC – RI.

Airborne and underwater noise associated with project construction are the most geographically extensive effects of the action. For the purpose of this BA, the terrestrial and aquatic components of the action area are defined by the largest distance required for airborne and underwater construction noise to attenuate to established behavioral effects thresholds for fish prey species that occur in the project vicinity. The resulting effect areas are as follows:

- A 7.1-kilometer (km) (4.4-mile) airborne noise radius extending outward in a hemisphere from each RWF monopile foundation
- A 14.6-km (9.1-mile) underwater noise radius extending outward from each RWF monopile foundation

- A 950-meter (m) (3,100-foot) airborne noise radius extending outward from the RWEC sea-to-shore transition
- A 0.8-km (0.5-mile) underwater noise radius extending outward from the RWEC sea-to-shore transition location in a semi-circle bounded by the North Kingstown shoreline.
- An 84-m (275-foot) airborne noise radius extending outward from upland construction activities

2 Description of the Proposed Action

The proposed action is the approval of the construction, operation, and conceptual decommissioning of an offshore wind energy facility on the Atlantic OCS in the RI/MA WEA. The action includes two major components: the RWF and the RWEC as described in Section 1. These components are differentiated in the project description and effects analysis where appropriate to clarify the potential impacts of the action on ESA-listed species.

The Applicant has elected to use a PDE approach for describing the proposed action consistent with BOEM policy (see Section 1.3). For the purpose of ESA consultation, BOEM assumes that the Applicant will select the design alternative resulting in the greatest potential impact on the environment. For example, the Applicant has indicated they are considering WTGs with nameplate capacities of 8 to 12 MW for the project, with the final design selection based on a number of factors. As such, BOEM is presenting the effects of an 8-MW design with up to 100 WTGs and a 12-MW design with up to 74 WTGs in ESA consultation representing a range of possible configurations. While the latter represents the upper bound of the PDE, an intermediate design option with up to 80 11-MW WTGs is being considered as the most likely option. The effect determinations presented herein are based on the 11 MW design option. However, the collision risk modeling results provided herein consider the full range of alternatives including the 12 MW option. Where applicable, collision modeling results are presented for the 12 MW option to demonstrate that the effect determinations for the 11 MW option are conservative.

PDE parameters for the RWF and RWEC are summarized in Table 2.1. Construction and installation of the RWF and RWEC are scheduled to take place over 2 years within applicable seasonal work windows. Construction durations for the different Project components are provided below in Figure 2.1. Project construction, operation, and conceptual decommissioning methods, and proposed environmental protection measures, are described in the following sections.

2.1 Revolution Wind Farm

The RWF components and their construction and operation footprints includes up to 100 WTGs, up to two OSSs (OSS1 and OSS2), an IAC network of up to 155 miles in total length, and one OSS-link cable up to 9 miles long to connect the two OSSs. PDE construction and operational parameters pertinent to this consultation are summarized in Table 2.1 and described in the following sections. Specific vessel and equipment types, construction quantities and methods, and approximate construction schedule are detailed in the project COP (vhb 2022).

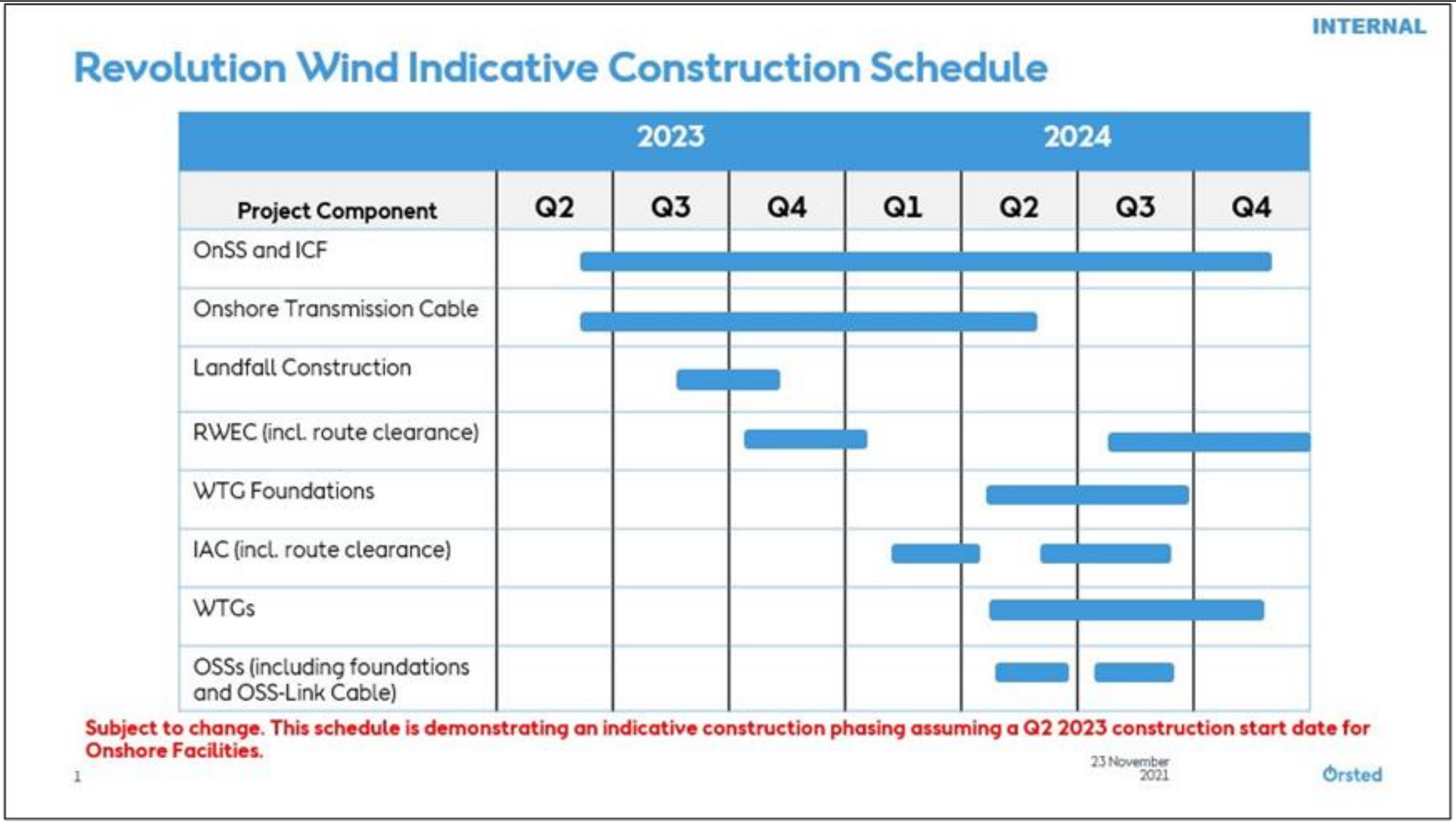


Figure 2.1 Revolution Wind Farm Indicative Construction Schedule

Table 2.1 Project Design Envelope Maximum Impacts

Project Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact		
RWF	Turbine selection/spacing	Installation disturbance area	WTG size	12 MW	11 MW	8 MW
			Number of turbines	74	80	100
			Hub height	156 m (552 feet)	133 m (436 feet)	118 m (387 feet)
			Rotor radius	110 m (361 feet)	97 m (318 feet)	82 m (269 feet)
			Rotor swept zone (RSZ)	38,000 m^2 (409,000 square feet)	31,400 m^2 (338,000 square feet)	21,100 m^2 (227,100 square feet)
			OSS size	15-m		
			Number of OSSs	2		
			Spacing	1 nautical mile (1.15 linear miles)		
			Array area	2,471 acres		
	Monopile foundation installation	Habitat alteration, physical disturbance	Number of monopiles	102		
			Monopile diameter	WTG: 12 m (39 feet) OSS: 15 m (49 feet)		
			Footprint area total (with scour protection)	810.9 acres‡		
			Installation method	4,000 kJ impact hammer 10,740 strikes/pile (WTG) 11,564 strikes/pile (OSS) Up to 3 WTG piles per day 1 OSS pile per day 36 days total		
	Inter-array cable construction	Physical disturbance, turbidity	Total length	155.3 miles		
			Installation method	Cable trenching/burial 4 to 6 feet depth		
			Disturbance area	2,471 acres		
			Long-term disturbance footprint	81.2 acres		
	OSS-link cable construction	Physical disturbance, turbidity	Total length	9.3 statute miles		
			Installation method	Cable trenching/burial 4 to 6 feet depth		
			Disturbance area	110 acres		
			Long-term disturbance footprint	4.4 acres		

Project Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact
	Construction vessels	Physical disturbance, noise	Number of vessels	61
			Anchoring disturbance	3,165 acres
			Vessel source SPL[1]	150–180 dB re 1 µPa-m
	Operation	Airborne disturbance area	Rotor swept zone (per turbine/total)	8 MW: 227,329 square feet/turbine 22,732,878 square feet total 12 MW: 409,415 square feet/turbine 30,296,747 square feet total
			Cut-in speed	7 to 11 miles per hour (3 to 5 m/sec)
		Operational EMF	Transmission voltage	Inter-array cable: 72 kV OSS-link: 275 kV
			Magnetic field*	Inter-array Cable Buried cable: 57 mG Exposed cable: 522 mG OSS-Link Buried cable: 147 mG Exposed cable: 1,071 mG
			Induced electrical field*	Inter-array Cable Buried cable: 2.1 mV/m Exposed cable: 5.4 mV/m OSS-Link Buried cable: 4.4 mV/m Exposed cable: 13 mV/m
		Vessel traffic	Anchoring disturbance	None
			Vessel source SPL[1]	171 dB re 1 µPa-m
RWEC	Export cable construction	Installation disturbance area	Total length	OCS: 19 miles from OSS1, 16.5 miles from OSS2 RI: 23 miles
			Installation method	Cable trenching/burial 4 to 6 feet depth
			Disturbance area	OCS: 593.1 acres RI: 731.4 acres
			Long-term disturbance footprint	OCS: 17.8 acres RI: 42.7 acres
		Vessel traffic	Number of vessels	22
			Anchoring disturbance	None
			Vessel source SPL[1]	171 dB re 1 µPa-m
	Sea-to-shore transition construction	Cofferdam installation/removal	Cofferdam footprint	5,412 square feet each, 10,824 square feet total for two cofferdams
			Excavation/sidecast	2,004 cubic yards each

Project Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact
			Sheetpile size	Z-Type typical
			Airborne noise (vibratory sheet pile driver)	95 dBA @50 feet
			Piles per day	100
			Total pile driving days (including removal)	56
			Construction duration	12 weeks
	RWEC-onshore construction	Temporary disturbance	Habitat alteration (cable trenching, burial, facility construction)	14.2 acres
			Vehicle operation (noise, disturbance)	203,500 engine hours (all equipment types)
		Long-term habitat alteration	Substation/interconnection facility footprint	5.4 acres
	Operation	Operational EMF	Transmission voltage	275 kV
			EMF generation* - ocean	Buried cable: 147 mG Exposed cable: 1,071 mG
			Induced electrical field* - ocean	Buried cable: 4.4 mV/m Exposed cable: 13 mV/m
		Vessel traffic	Number of vessels	None

Notes:

dBA = A-weighted decibels
EMF = Electromagnetic field
kJ = Kilojoules
m/sec = meters per second
mG = Milligauss
mV/m = Millivolts per meter
TSS = Total suspended solids
‡ Total includes seabed preparation (731 acres), monopile foundations and scour protection (72.8 acres), and cable protection systems extending beyond scour protection footprint (7.1 acres).
*Magnetic field and electrical field values assume measurement at the seabed.
[1] Source: Denes et al. 2021, Kusel et al. 2021

2.1.1 Construction

The RWF would erect up to 100 WTGs and up to two OSSs within the proposed project area (Figure 1.1). The selected WTGs would be at least 8 MW and could be as large as 12 MW. The WTGs would be mounted on 12-m (39-foot) diameter monopile foundations (tapering to a smaller diameter above the water surface) driven up to 50 m (164 feet) into the seabed using an impact hammer deployed on a jack-up or heavy lift barge or similar purpose-built construction vessel. The RWF OSSs would be supported by a single 15-m (49-foot) diameter monopile identical to the WTG foundations and installed using the same construction methods. The substations connect the RWF inter-array cable network to the RWEC transmission lines. Monopile installation is expected to be completed in a single 5-month campaign, with up to 3 WTG monopiles installed per day and 2 OSS monopiles installed per day under the most aggressive possible installation scenario. The installation process includes vessel positioning and anchoring, placement and centering of the pile using a crane, and installation to depth using an impact hammer. Each monopile would require up to 6 hours of continuous impact hammering to reach the desired installation depth. Pile driving would be restricted to daylight hours only, except under special circumstances.[1]

The WTGs would be connected to the RWEC by the IAC network, comprising up to 155 combined miles of transmission cable connecting each of the WTGs to one of the OSSs. The OSSs themselves would be connected by an OSS-link cable up to 9 miles in length. A cable laying vessel would be used to trench and bury the cables 4 to 6 feet below the bed surface using standard marine construction techniques. The vessel would tow a jet or mechanical plow that will excavate a trench while simultaneously laying the cable. The cable would then be buried as the suspended sediments and side of the trench settle and collapse. Where unavoidable bed features like boulder fields or bedrock outcroppings prevent burial, the cable would be laid on the bed surface and armored with a layer of rock or concrete mattresses. Additional details about this construction method are provided in the COP (vhb 2022).

2.1.2 Operation & Maintenance

The RWF includes up to 100 WTGs, with capacities ranging from 8-MW to 12-MW depending on the design option selected. The 12-MW turbine represents the largest WTG in the PDE and would stand approximately 552 feet above mean sea level (MSL) at hub height, with three 722-foot diameter rotors. The 8-MW turbine represents the smallest WTG in the PDE and would stand 387feet above MSL at hub height, with three 538-foot diameter rotors. The 11-MW turbine is intermediate in dimension, standing at 436 feet above MSL with three 636-foot diameter rotors. The rotor swept zone (RSZ) for the three WTG sizes presented would extend from 118 feet to 656 feet above MSL for the 8-MW turbine, from 118 feet to 754 feet above MSL for the 11-MW turbine, and from 191 feet to 913 feet above MSL for the 12-MW turbine. The

[1] Nighttime pile driving may be required when an installation begins during daylight, is delayed due to unforeseen circumstances, and must be completed after dark for safety and/or foundation integrity reasons.

operational cut-in and cut-out speeds for the WTGs are assumed to be 4 meters per second (m/sec) and 28 m/sec, respectively. This equates the WTGs being operational between wind speeds of approximately 9 and 63 miles per hour. When cut-in and cut-out wind speed limitations are considered, the Applicant anticipates that WTGs would be operating between 85.1 and 93.8 percent of the time over the course of the year (Orsted 2022). Table 2.2 provides a breakdown of anticipated operational time by month, along with the percentage of time at wind speeds within different operational categories for an 11 MW WTG. The estimates are based on a 40-year hindcast time series with data corresponding approximately to 10-minute average wind speeds. Based on the assumptions, the assessment is considered to provide a conservative estimate for the percentage of time a WTG would be operating per month.

The IAC would operate at a HVAC transmission capacity of up to 72 kilovolts (kV), conveying electricity from the WTGs to the RWEC via the OSSs. The OSS-link cable connecting the OSSs would operate at 275 kV HVAC.

The RWF will be remotely monitored and operated from the onshore O&M facility. RWF WTGs and the OSSs will be regularly inspected and maintained by service technicians delivered by dedicated crew transport vessels from a nearby port. Service operations vessels may also be used for O&M. The Applicant does not expect the IAC to require planned maintenance but will maintain a stockpile of cable for emergency repairs as needed. Should unplanned maintenance be required, support vessels may travel directly to the RWF from locations to be determined based on the type of maintenance required and vessel availability. These vessels may originate from the Gulf of Mexico, Atlantic Coast, Europe, or other worldwide ports.

2.1.3 Decommissioning and Site Clearance

The RWF is anticipated to have an operating period of 35 years and would theoretically be decommissioned and removed at that time. The same types of vessels and equipment used to construct the project would be employed for decommissioning, with the exception that pile driving would not be required. This process would emphasize the recovery of valuable materials for recycling. The WTGs and OSSs would be removed and the monopiles cut off below the seabed and recovered to a barge for transport. A cable laying vessel would be used to remove as much of the inter-array and OSS-link cables from the seabed as practicable to recover and recycle valuable metals. Cable segments that cannot be easily recovered will be cut and left buried below the seabed or rock armoring. The decommissioning process would produce similar effects to those described for project construction, with the exception that airborne and underwater noise levels would be lower.

Table 2.2 Operational Time and Wind Speeds by Month for 11 MW WTG

	January	February	March	April	May	June	July	August	September	October	November	December
Overall Operational Time												
Average [%]	93.8	93.5	91.7	90.8	88.4	88.9	86.3	85.1	86.8	90.8	93.3	93.7
Std. Dev. [pp]	2.3	2.3	2.7	3.0	4.0	4.0	3.5	4.3	3.9	3.4	2.4	2.8
Percentage Time at Specified Wind Speeds*												
WS < 4 m/sec [%]	5.7	6.2	7.8	9.1	11.6	11.1	13.7	14.9	13.1	9.0	6.4	5.6
4 ≤ WS < 6.5 m/sec [%]	9.0	10.2	12.0	15.2	17.9	20.7	23.5	24.7	19.7	14.0	10.8	9.4
6.5 ≤ WS < 10 m/sec [%]	19.5	22.0	24.0	27.6	32.4	35.7	36.4	36.3	32.6	27.1	21.6	20.3
WS ≥ 10 m/sec [%]	65.8	61.7	56.2	48.1	38.1	32.4	26.4	24.1	34.6	49.9	61.3	64.7
*Wind speeds (WS) are the 10-minute average wind speed. WTGs are considered operational at wind speeds between 4 m/sec and 28 m/sec.												

2.2 Revolution Wind Export Cable

The RWEC will consist of two subsea cables, each originating at a respective OSS with a PDE transmission capacity of up to 275 kV. The RWEC is broken into three discrete segments: the offshore RWEC – OCS and RWEC – RI segments, and the RWEC – Onshore segment. The RWEC – OCS segments would total 19 miles from OSS1 and 16.5 miles from OSS2; each RWEC – RI segment would total 23 miles in length. The RWEC – RI extends from the offshore into the nearshore zone and connects to the onshore segment via the sea-to-shore transition. PDE construction and operational parameters pertinent to this consultation are summarized in Table 2.1 and described in the following sections. Additional information about project operation and maintenance requirements is provided in the project COP (Revolution Wind 2021).

2.2.1 Construction

The offshore RWEC segments would be constructed using standard marine construction techniques described in the COP (vhb 2022). The cable would be buried to a target depth of 4 to 6 feet along the majority of its length using a jet or a mechanical plow. Where burial is not possible, the cable would be laid on the bed surface armored by a rock layer or concrete blanket. The RWEC – Onshore segment includes the terrestrial or upland cable path from the shoreline to a proposed onshore substation connecting the project to the electrical grid.

The RWEC – RI and RWEC – Onshore components would be connected at a sea-to-shore transition point approximately 518 m (1,700 feet) offshore from mean lower low water. A horizontal directional drill (HDD) would be used to tunnel below the beach and seabed substrate to the transition point. A temporary sheet pile cofferdam would be placed around the transition point using a crane and vibratory hammer deployed from a construction barge. A gravity cell cofferdam, a casing pipe with goal posts, or no containment structure may also be used, but would result in fewer impacts. Therefore, the installation of the sheet pile cofferdam is analyzed throughout as the design alternative with the maximum potential impact. Vibratory pile installation and removal would each take approximately 28 days. The interior of the cofferdam would be dewatered and the overlying substrates excavated and sidecast to expose the cable tunnel. The sea-to-shore transition cable would be threaded through the tunnel to the transition point and connected to the RWEC – RI. The connected segments would then be sealed, reburied with native seabed sediments, and the cofferdam would be dismantled and removed.

Construction of RWEC – Onshore would involve site preparation, duct bank installation, cable installation, cable jointing, final testing, and final restoration. The duct bank containing the onshore components of the RWEC will be buried to a minimum depth of 3 feet below the land surface. Installation would generally require excavation of an approximate 8-foot-wide trench within a 25-foot-wide temporary disturbance corridor; however, the disturbance area at the transition joint bays would be 30 feet wide × 75 feet long. The approximately 1-mile-long onshore transmission cable ROW would be maintained free of vegetation that exceeds 15 feet in height.

The onshore transmission cable would travel from the landfall work area approximately 1 mile to the OnSS, trending northwest to the OnSS via Circuit Drive and Camp Avenue (see Figure 2.2). The OnSS and interconnection facility would be constructed adjacent to the existing Davisville Substation to support interconnection of the Project to the existing electrical grid. The OnSS would include a compacted gravel driveway, stormwater management features, and associated landscaped or managed vegetation areas totaling up to 7.1 acres inclusive of the up to 4-acre operational footprint of the facility. The interconnection facility would have a limit of work of an additional 4.0 acres, including an operational footprint of up to 1.6 acres.

2.2.2 Operation & Maintenance

Like the RWF and its components, the RWEC (including both offshore and onshore facilities) would be remotely monitored from an onshore facility. The Applicant does not expect the RWEC to require planned maintenance but would maintain a stockpile of equipment and materials for emergency repairs as needed in the unlikely event of failure or mechanical damage to the transmission cable (e.g., by a ship anchor). Should unplanned maintenance or repairs be required, support vessels could mobilize directly to the site from any global port as determined by the availability of vessels and crews with appropriate capabilities. RWEC – Onshore facilities will include vegetation management on the OnSS and interconnection facility parcels, as well as preventative maintenance on the OnSS, interconnection facility, and line equipment will be performed as required.

2.2.3 Decommissioning and Site Clearance

The RWEC would be decommissioned and removed when the RWF reaches the end of its approximate 35-year operating period. The same types of vessels and equipment used to install the RWEC would be employed for decommissioning, with the exception that cofferdam placement and a horizontal drilling rig would not be required. A cable laying vessel would be used to remove as much of the RWEC transmission cables from the seabed as practicable to recover and recycle valuable metals. The upland segments would be removed from the underground duct bank. Cable segments that cannot be easily recovered would be cut and left buried. The decommissioning process would produce similar effects to those described for project construction, with the exception that airborne and underwater noise levels would be lower because vibratory pile driving would not be required.

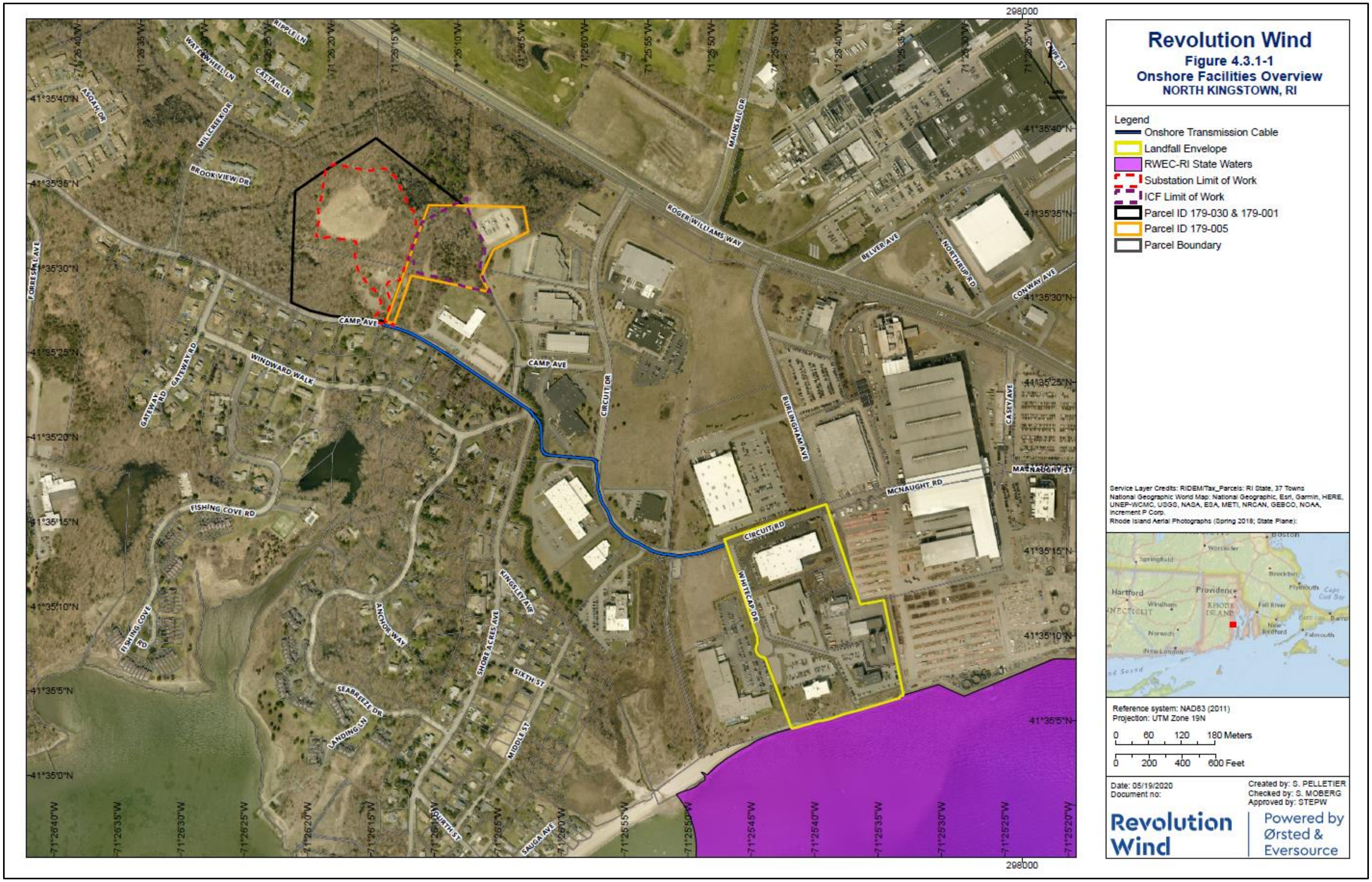


Figure 2.2 Onshore Facilities Overview

Source: vhb 2022

3 Threatened and Endangered Species Occurrence in the Action Area

The authors consulted the USFWS Information for Planning and Consultation (IpaC)system to identify ESA-listed species under the USFWS's jurisdiction that are likely to occur in the action area. The IpaC species list is provided in Appendix A (2022-0023298, 2022-0023308, 2022-0023318). Four ESA-listed species under USFWS jurisdiction are known or have potential to occur in the action area, and there is no designated critical habitat in the action area (Table 3.1).

Table 3.1 ESA-Listed Species under USFWS Jurisdiction with the Potential to Occur in the Action Area and Vicinity

Species	Listing Status	Known or Likely Occurrence in Action Area	
		Species	Critical Habitat
Birds			
Piping plover (*Charadrius melodus*)	Threatened – 12/11/85 50 FR 50726	Yes	No
Roseate tern (*Sterna dougallii dougallii*)	Endangered – 11/2/87 52 FR 42064	Yes	No
Rufa red knot (*Calidris canutus rufa*)	Threatened – 1/2/15 79 FR 73705	Yes	Proposed*
Bats			
Northern long-eared bat (*Myotis septentrionalis*)	Threatened** – 5/4/15 80 FR 17973	Yes	N/A

N/A – Critical habitat has not been designated.
*Critical habitat has been proposed for the Rufa red knot (86 FR 37410).
**Northern long-eared bat is proposed to be listed as endangered (87 FR 16442).

3.1 Birds

The Atlantic coast is a major flyway for a wide variety of migratory bird species. Three ESA-listed bird species are known to occur in coastal Rhode Island and Massachusetts in proximity to the action area (Table 3.1). The general life history, distribution in the project vicinity, and likelihood of occurrence in the action area are described in the following sections.

3.1.1 Piping Plover

The piping plover is a small migratory shorebird that breeds along the Atlantic coast, the Great Lakes, and the Great Plains regions of the United States and winters in coastal habitats of the southeastern United States, coastal Gulf of Mexico, and the Caribbean (Elliot-Smith and Haig 2004; USFWS 1996; USFWS 2009). The USFWS listed the Atlantic coast breeding population as threatened. Critical wintering habitat has been established along the coasts of North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas (66 FR 36038). Only the Atlantic coast population has the potential to occur within the proposed action area during the breeding season, as well as spring and fall migration. Coastal development is the primary anthropogenic threat to piping plovers. Other threats include disturbance by humans, dogs, and vehicles on sandy beaches and dune habitats (Elliott-Smith and Haig, 2004; USFWS, 2009). Despite these population pressures, the Atlantic Coast population has been steadily growing. In fact, since the time of its listing in 1985, the Atlantic Coast piping plover population has increased 239 percent from a low of 790 breeding pairs to an estimated 1,879 breeding pairs in 2018 (USFWS 2020a). However, much of this increase has occurred within the New England recovery unit; the other three recovery units remain well below established abundance objectives (USFWS 2022). The piping plover is among 72 species (out of 177 species on the Atlantic OCS) that ranked moderate in its relative vulnerability to collision with wind turbines (Robinson Willmott et al. 2013).

The breeding range of the Atlantic Coast population includes the Atlantic coast of North America from Canada to North Carolina. The piping plover breeding season occurs from April through August, with piping plovers arriving at breeding locations in mid-March into April. In spring, adult Atlantic Coast piping plovers arrive at breeding locations in proximity to the action area beginning in mid-March and nest from April through August. Post-breeding staging of adults and subadults in preparation for southward migration extends from early July through mid-September, rarely into October (USFWS 1996, USFWS 2009, Loring et al. 2020). Piping plover breeding habitat consists of generally undisturbed, sparsely vegetated, flat, sand dune-beach habitats such as coastal beaches, gently sloping foredunes, sandflats, and washover areas to which they are restricted (USFWS 1996; USFWS 2009). Nest sites are shallow, scraped depressions in a variety of substrates situated above the high-tide line (USFWS 1996). Piping plovers forage in the intertidal zone. Foraging habitat includes intertidal portions of ocean beaches, washover areas, mudflats, sandflats, as well as shorelines of coastal ponds, lagoons, and saltmarshes where they feed on beetles, crustaceans, fly larvae, marine worms, and mollusks (USFWS 1996).

While the precise migratory pathways along the Atlantic coast and to the Bahamas are not well known (USFWS 2009; Normandeau et al. 2011), both spring and fall migration routes are believed to follow along the Atlantic coast but may extend up to 200 km (124 miles) offshore (Loring et al. 2020). Due to the difficulty in detecting piping plovers in the offshore environment during migration, there are no definitive observations of this species in offshore environments greater than 3 miles from the Atlantic coast (Normandeau et al. 2011).

Based on counts in 2021, there were 967 breeding pairs recorded in Massachusetts, 13 in New Hampshire, 125 in Maine, and 180 in Eastern Canada subpopulation, which may pass through the project area during migration (USFWS 2022). Piping plover breeding in Rhode Island is concentrated primarily on sandy beaches along the state's southern coast. The highest nesting population of piping plovers in Rhode Island occurs at the Trustom Pond National Wildlife Refuge, accounting for 31 percent of nesting pairs monitored by USFWS staff in Rhode Island in 2018 (Loring et al. 2019, 2020). Inland shorelines within Narraganset Bay (i.e., near the sea-to-shore transition) are generally not considered to be suitable nesting habitat for piping plovers, although one pair does nest in a restricted area of the Quonset Airport, adjacent to the sea-to-shore transition (Loring pers. comm. 2022).

Based on known fall migration routes, a percentage of adult and subadult migrant piping plovers may fly over the aquatic component of the action area. Knowledge of piping plover flight patterns are limited, especially considering distinct migration routes from different breeding grounds and detection probability from land-based arrays; the following discussion is based on best available science. The RI/MA WEA lies within the migratory corridor for piping plovers leaving nesting and staging grounds in and north of Massachusetts in the fall. Loring et al. (2019) studied the flight patterns of migratory plovers in proximity to WEAs on the mid-Atlantic Bight using radio telemetry. Radio telemetry relies on land-based towers to detect flight patterns and is therefore limited to the range of these towers (Appendix G in Loring et al. 2019). The researchers tagged 150 plovers captured in nesting areas in Rhode Island and Massachusetts from 2015 to 2017 with lightweight very-high frequency (VHF) transmitters and tracked their migratory behavior using regional receiver array network. None of the 30 plovers tracked during migratory departure from Rhode Island entered the RWF, while 20 percent (8 out of 40) plovers leaving Massachusetts nesting areas during fall migration flew directly through the RI/MA WEA, resulting in a high probability of exposure to the RWF (see Figure 3.1). Additionally, individuals were detected heading towards WEAs that were just beyond the detection range of land-based towers and may have been crossed the RI/MA WEA. However, using available low-resolution meteorological data (NOAA 2017), 20 percent of plovers flying through the WEA (n=35) flew at wind speeds ≤4 meters per second (m/sec) (Loring et al. 2019); that is, below the cut-in speed for an offshore wind turbine.

Loring et al. (2019) also used telemetry data to estimate migratory flight altitudes over Federal OCS waters (i.e., >3 miles offshore). Observed behavior confirmed the prior hypothesis (e.g., Normandeau et al. 2011) that this species tends to fly at altitudes above the typical RSZ of offshore windfarms when migrating. Most migratory flights were above typical turbine heights with 84.8 percent of the piping plover flights above the RSZ (Loring et al., 2019) (Figure 3.2). The flight altitude estimates were interpolated values from land-based stations were above the RSZ (estimated for analysis as between 25 and 250 m [82 and 820 feet] above MSL. The mean flight altitude over federal waters was 942 feet), with a 5th to 95th percentile range of 48 m to 377 m (157 to 1,237 feet).

During the spring migration, a pilot study fitted 10 plovers with transmitters in the Bahamas; only two plovers that had enough data for analysis traveled north along the U.S. Atlantic coast. The migration period lasted for a period of several weeks, during which the two birds stayed close to shore and were not detected north of Montauk, New York (Appendix I in Loring et al. 2019). While tracking data gives some indication of piping plover activity during spring migration in the RWF, information on the extent of piping plover activity in RWF is limited due to small sample size.

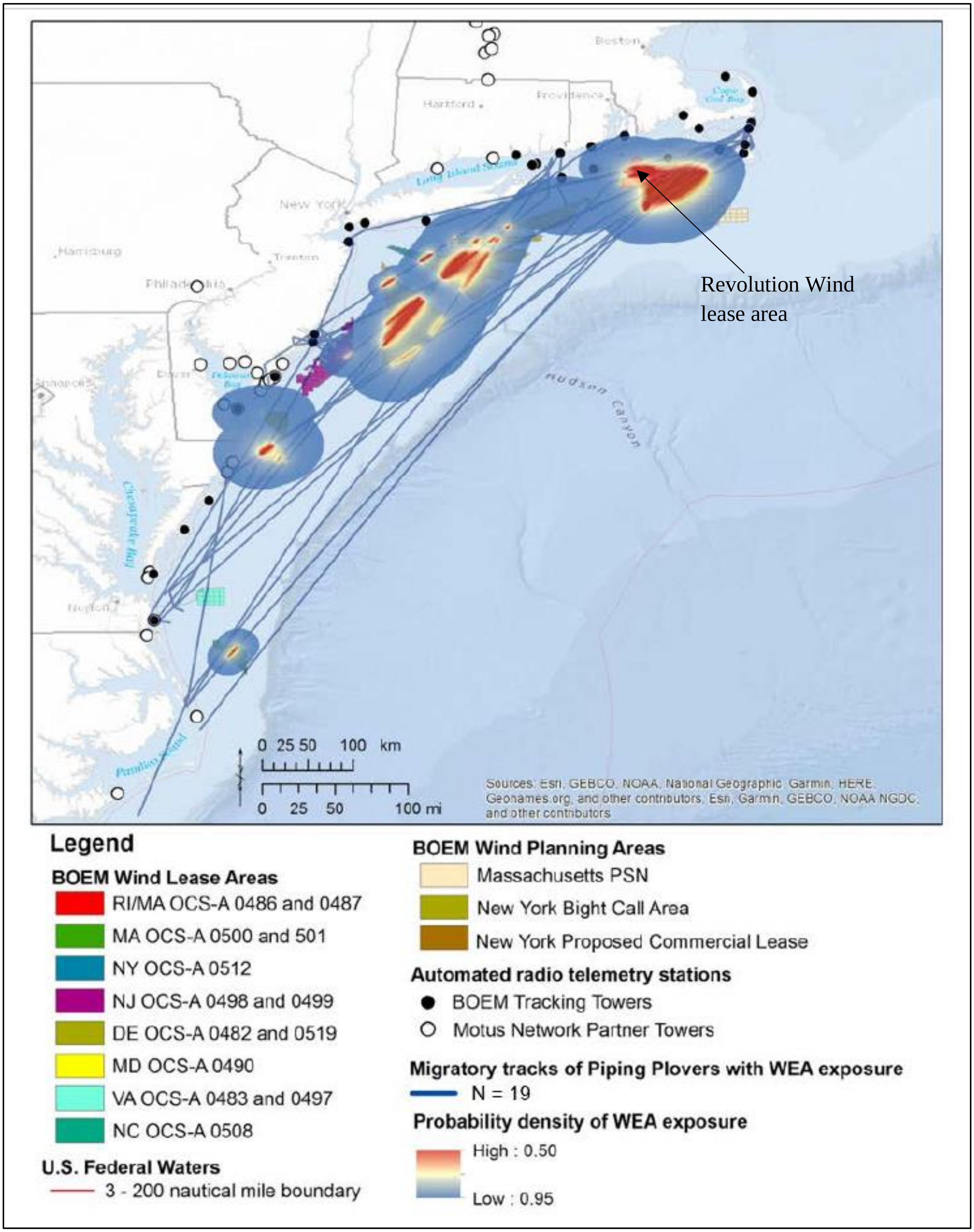


Figure 3.1. Migratory Tracks and Composite Probability Density of Piping Plovers with WEA Exposure in the Mid-Atlantic Bight, 2015 to 2017 (Loring *et al.* 2019, Figure 64)

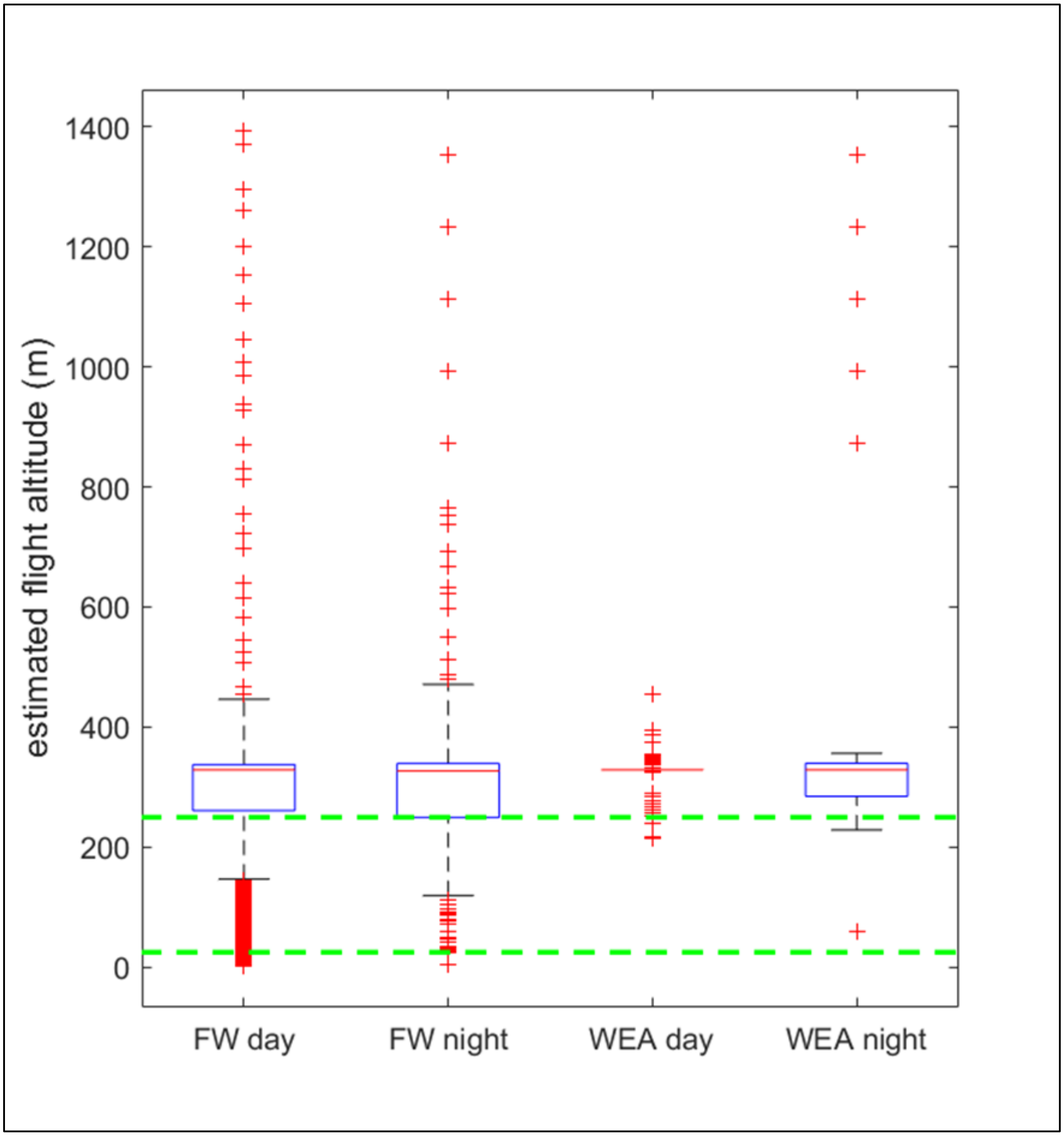


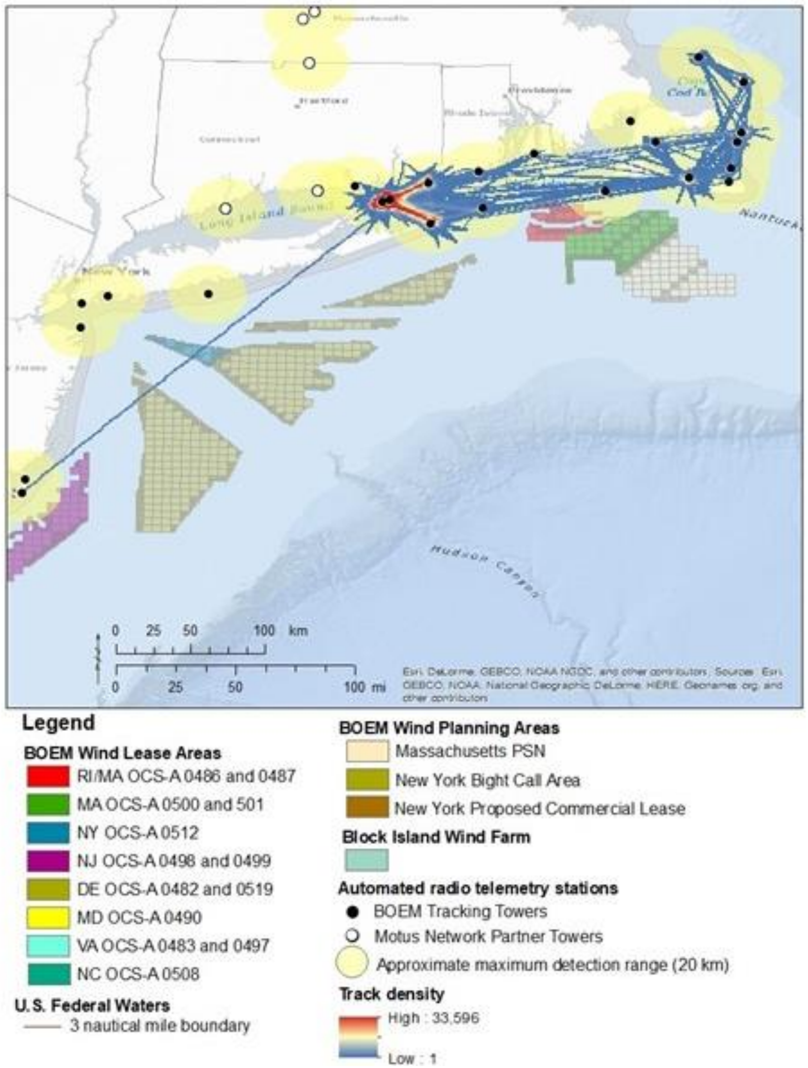
Figure 3.2. Estimated Flight Altitude Ranges (m) of Piping Plovers During Exposure to Federal Waters (FW, Altitude When Crossing from State into Federal Waters) and WEAs (Altitude When Flying Through WEAs) During Day and Night. The Green-Dashed Lines Represent the Lower and Upper Limits of the RSZ (25-250 m; Loring et al. 2019).

3.1.2 Roseate Tern

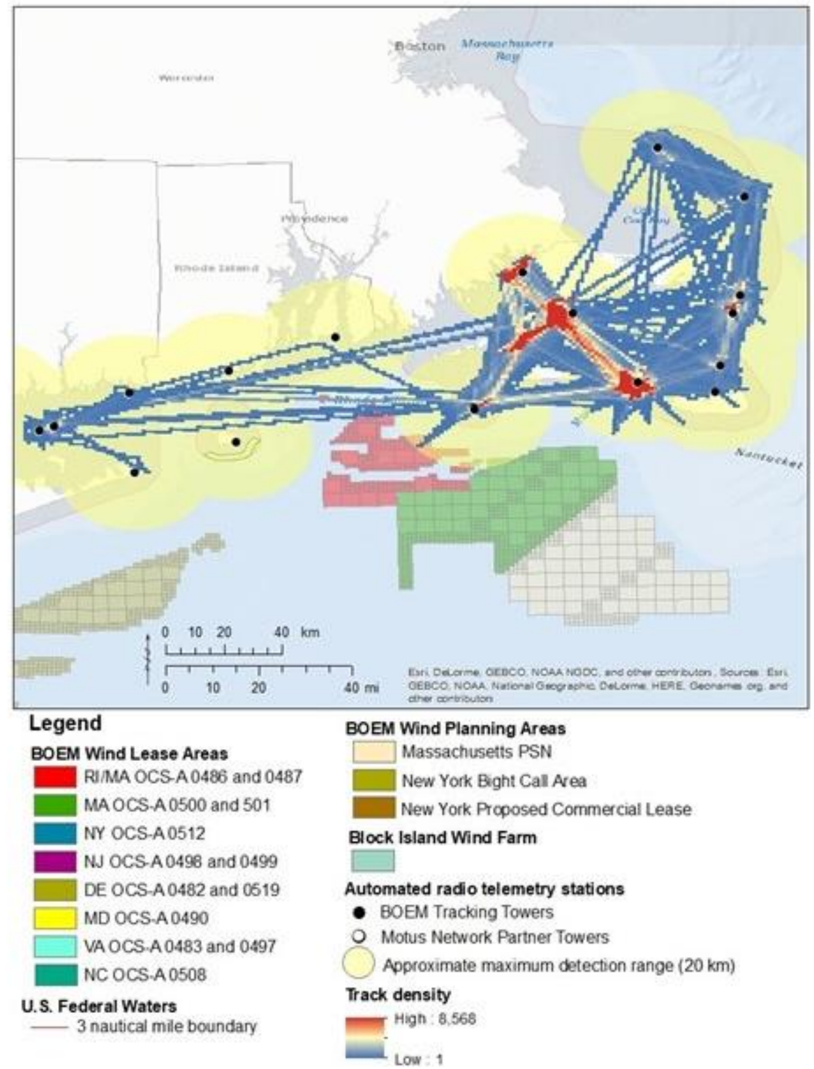
The roseate tern is a marine bird species that breeds in large colonies in the northern hemisphere and migrates thousands of miles to overwintering habitats in the southern hemisphere (USFWS 2010). This species is composed of several discrete populations defined geographically by breeding area, only one of which is likely to occur in the action area and only during migration. Northwestern Atlantic roseate terns breed along the coast of the northeastern United States and the maritime provinces of Canada and overwinter in South America. This population is listed as endangered under the ESA (USFWS 2010), but critical habitat has not been designated (52 FR 42064). The USFWS has recently initiated a 5-year review for this species (83 FR 39113 39115). The roseate tern is one among 61 species (out of 177 species on the Atlantic OCS) that ranked high in its relative vulnerability to collision with wind turbines (Robinson Willmott et al. 2013). This high ranking is partially driven by the amount of time the species spends foraging on the ocean, but if the time on the ocean was restricted to migration, the population would be ranked medium.

The breeding population of roseate terns is restricted to a few colonies located on predator-free islands with colonies of common terns (*Sterna hirundo*) between Nova Scotia and Long Island, New York. Up to 88 percent of the breeding roseate terns occur on just three islands off Massachusetts and New York (BOEM 2012; USFWS 2020b). Since 2010, the number of breeding pairs of roseate terns in the United States and Canada has increased 45 percent from 3,013 to 4,374 in 2019 (USFWS 2020b). Although roseate terns historically occurred in Rhode Island, there are currently no breeding colonies in the state (Paton et al. 2010; USFWS 2020b).

In the region, adult roseate terns arrive at breeding sites beginning in April to initiate courtship prior to nesting (Gochfeld et al. 1998). Telemetry and geolocator data from common and roseate terns are consistent and show individuals arriving in the northeast starting in late April and early May (Nisbet et al. 2011, Loring et al. 2019, Gochfeld and Burger 2020). During the nesting period, roseate terns dive <0.5 m (1.6 feet) into shallow water to forage primarily on the inshore sand lance (*Ammodytes americanus*) in the warmer waters near shoals, inlets, and rip currents close to shore (e.g., Safina 1990; Heinemann 1992; Rock et al. 2007). Nesting adults typically forage within 7 km (4.3 miles) of their colony sites (Rock et al. 2007) but may travel as far as 50 km (31 miles) if necessary to forage offshore on sand lance, juvenile herring (*Clupea harengus*), and hake (*Merluccius merluccius*) (Loring et al. 2019, Yakola 2019). Roseate tern foraging behavior and ecology in the region is well described. Roseate tern foraging flights are slow and range from 3 to 12 m (9.8 to 39.4 feet) above the ocean surface. During the breeding season, most roseate terns from colonies on Great Gull Island and Buzzards Bay forage relatively close to their colonies, but some do travel along the coast to other nearshore foraging sites (Loring et al. 2019; Figure 3.3). Research indicates that roseate terns, as dietary specialists, exhibit strong fidelity to foraging sites but do often forage in mixed flocks with other terns (Goyert 2015, Gochfeld and Burger 2020).



a.



b.

Figure 1.3 Modeled Track Densities of Roseate Terns from the (a) Great Gull Island and (b) Buzzards Bay Colonies during Breeding and Post-Breeding Periods in 2016 and 2017 (Loring et al. 2019, Figures 14 and 15)

Roseate tern juveniles fledge from late July to mid-August and the adults and subadults then occupy post-breeding staging areas through mid-September before migrating southward (Burger et al. 2011). Additionally, failed breeders may travel offshore among colony sites and staging areas following nest failure starting in late June (Loring 2016). For the last 5 decades and continuing today, the coastal region of southeastern Cape Cod, Massachusetts, in Buzzard's Bay near Chatham and Monomoy Island, has been the most important post-breeding staging area for this species, supporting nearly the entire Northwestern Atlantic population (Burger et al. 2011, Atwood 2022).

The region including Lease Area 1 has been intensively surveyed over the years and across seasons for marine birds; no roseate terns have been detected in Lease Area 1 or in the proposed aquatic component of the action area (Figure 3.4). Modeling efforts based on those survey data predict that roseate terns are virtually absent from the aquatic component of the action area (Curtice et al. 2019). This prediction is based on a statistical model that used 354 roseate tern sightings from many scientific surveys throughout the Atlantic OCS during the spring, summer, and fall months (Winship et al. 2018). The modeling effort only used terns that were identified as roseate terns and is based on the relationship between roseate terns and surface chlorophyll a, distance from shore, turbidity, and other factors (see Winship et al. 2018). Goyert and others (2014) found a similar distribution pattern in a separate modeling effort that related a small subset of the roseate tern count data used by Winship and others (2018) to the amount of forage fish in spring. Seasonal biomass estimates predict very few sand lance (primary prey for roseate terns) in the project area, likely explaining why no roseate terns were observed or predicted to occur in the project area (NROC 2009, Staudinger et al. 2020). Consistent with data on roseate tern occurrence, sand lance were concentrated around Cape Cod in both spring and fall months (Staudinger et al. 2020). The distribution of sand lance is largely driven by seasonal oceanographic conditions, circulation, and distribution of lower trophic level species; predicted changes within the Northeast US shelf ecosystem may result in a shift in availability of sand lance over the next century. While the specifics are uncertain, these changes could lead to reduced sand lance distribution in Southern New England and a general shift in abundance to the north (Staudinger et al. 2020, Suca et al. 2021).

Probability densities based on the movement tracks of roseate terns (n=8) near WEAs do suggest that roseate terns are likely to fly across Lease Area 1 (see Figure 3.5; Loring et al. 2019). During the post-breeding season, the beaches of outer Cape Cod support staging for most of the roseate tern population. Recent research suggests that large numbers of roseate terns may also stage on New York and Rhode Island beaches (Spendelow 2018, Davis et al. 2019). Geolocator data suggest that roseate terns begin their southward migration in late August through September (Mostello et al. 2014).

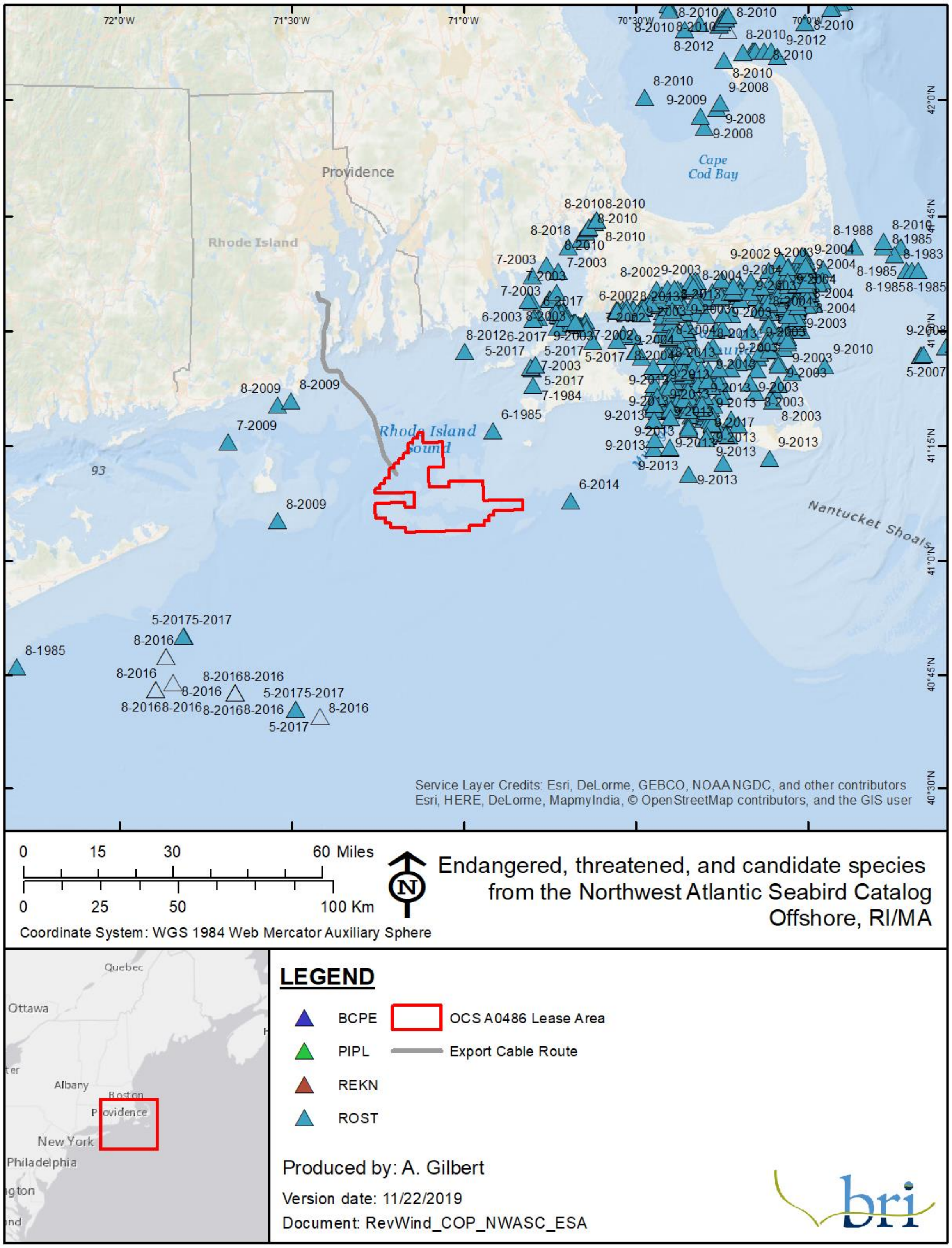


Figure 3.4 Roseate Tern Observations near the Action Area (bri 2021)
BCPE = Black-capped petrel; PIPL = Piping plover; REKN = Red knot; ROST = Roseate tern
Note lack of at-sea observations of piping plover and red knot.

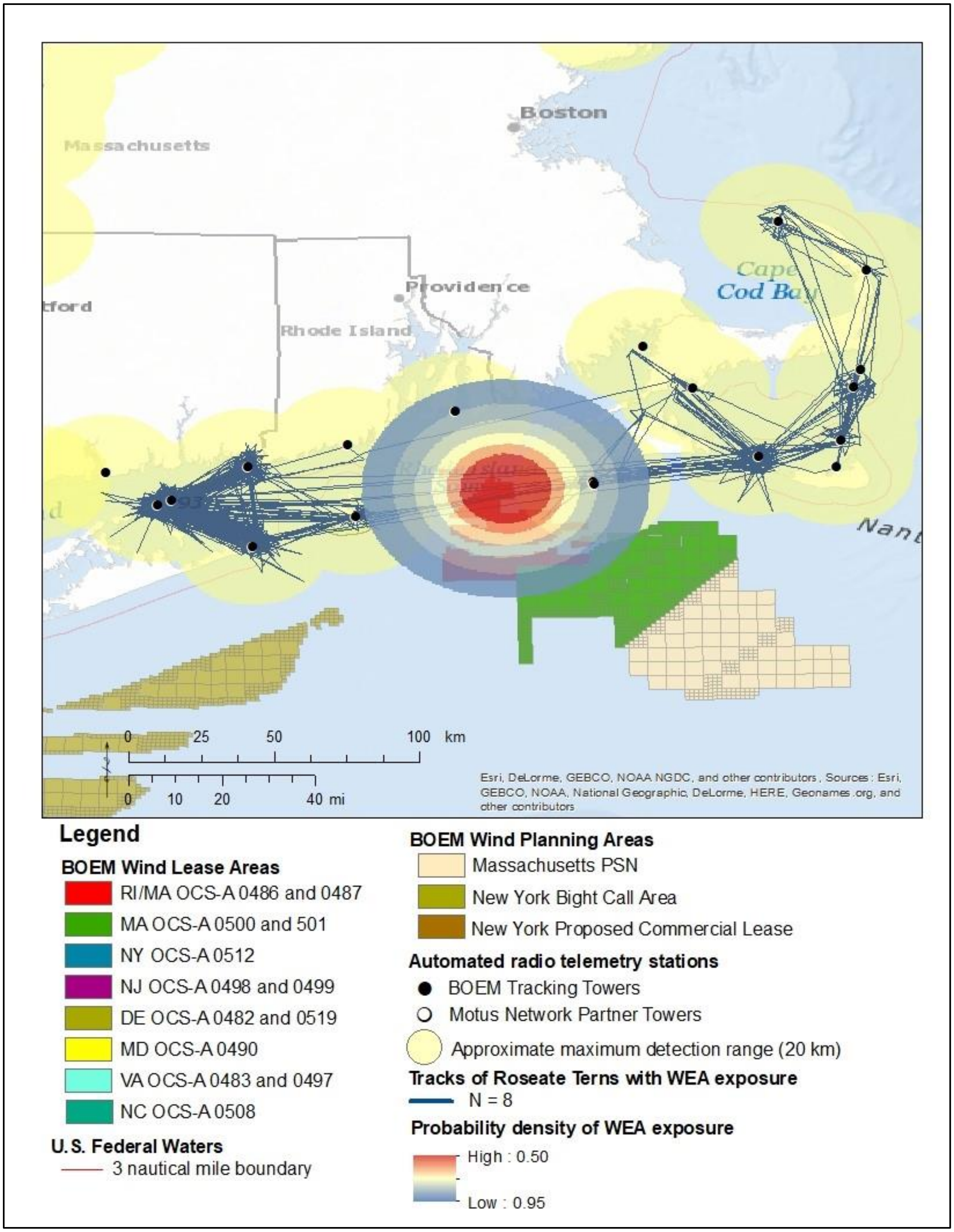


Figure 3.5 Estimated movement tracks and composite probability density across WEAs of Roseate Terns (n=8), with estimated exposure to WEAs, 2016 and 2017 (Loring et al. 2019, Figure 45)

Loring et al. (2019) studied the flight patterns of foraging and migratory roseate terns on the mid-Atlantic Bight using radio telemetry to determine potential exposure to wind energy development areas. They captured 150 roseate terns from nesting colonies in New York (Great Gull Island) and Massachusetts (Penikese, Ram, and Bird islands) and tagged them with lightweight VHF transmitters. Foraging and migratory movements and flight behavior were tracked using a regional radio telemetry array network. Roseate terns flew offshore when visibility was > 5 km (3.1 miles) and departed the study area at low altitudes (Loring et al. 2019). In addition, 37.5 percent flew at wind speeds ≤4 m/sec (13.1 feet per second [ft/sec]) (Loring et al. 2019), which is below the cut-in speed for an offshore wind turbine. Roseate terns typically flew 11 to 20 m (36.1 to 65.6 feet) above the water in the WEAs (Figure 3.6) and flew below the RSZ near the turbines in the Block Island Wind Farm (Loring et al. 2019). Given that roseate terns migrate mainly offshore during spring and fall (Nisbet et al. 2014), it is possible that some birds pass through the WEA during migration. A pilot study on common terns (n=5) investigating offshore migratory routes found that at least one tern intersected Lease Area 1 or adjacent lease areas during both spring and fall migration, suggesting that roseate terns may follow similar offshore routes (Loring et al. 2019). In fact, interpolating from land-based tracking stations, 6 percent (8 total) of the 145 terns tagged from 2015 through 2017 flew near Lease Area 1 during post-breeding dispersal (Loring et al. 2019; Figure 3.3). Based on available data, the most likely exposure of roseate terns to Lease Area 1 would occur during post-breeding dispersal and migration (mid-July through late September) (Loring et al. 2019).

In conclusion, based on behavioral and foraging ecology, telemetry data, and survey data, there is potential that low numbers of roseate terns may be present within marine waters in and around the WEA. While data is limited regarding exact flight heights and paths, a small portion of the roseate tern population may traverse the aquatic portion of the Revolution project area at heights within the RSZ.

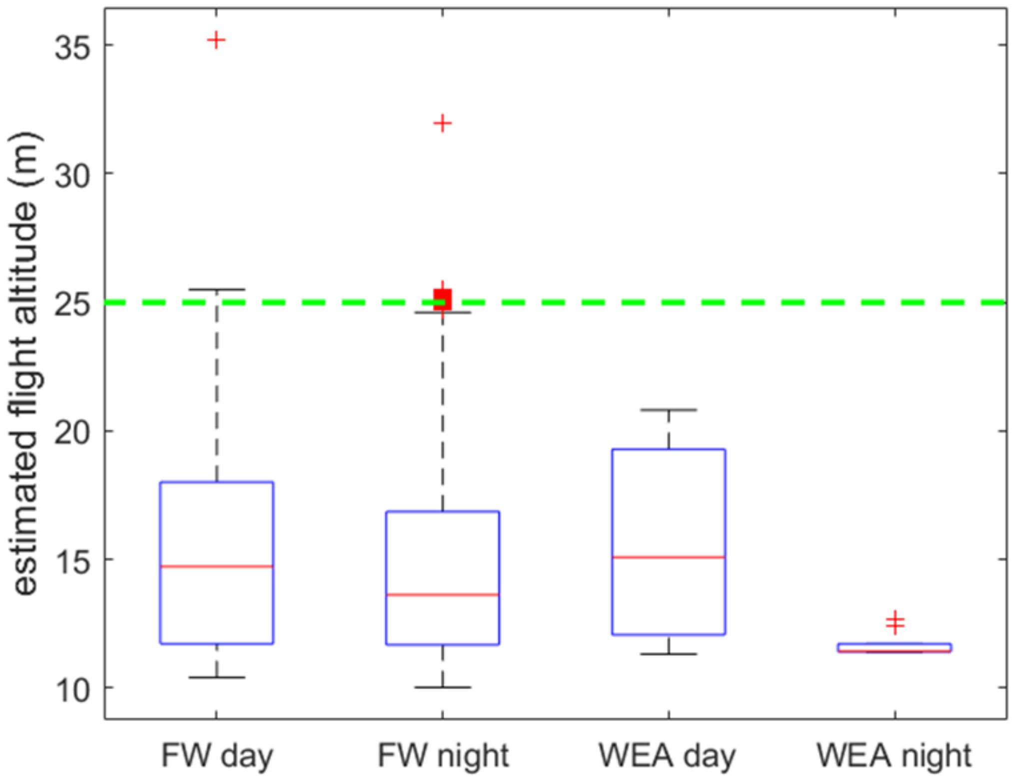


Figure 3.6. Estimated Flight Altitude Ranges (m) of Roseate Terns During Exposure to FW (Altitude on Transition From State to FW) and WEAs (Altitude When Flying Through WEAs) During Day and Night. The Green-Dashed Line Represents the Lower Limit of the RSZ (25 m).

3.1.3 Red Knot

The *rufa* red knot is a medium-sized member of the sandpiper family that breeds in the Canadian Arctic and winters along the northwest coast of the Gulf of Mexico, along the U.S. Atlantic coast from Florida to North Carolina, and along the Atlantic coasts of Argentina and Chile (USFWS 2014). Between approximately 1988 and 2008, the *rufa* red knot has declined from a population estimated at 100,000 to 150,000, down to 18,000 to 33,000 (Niles et al. 2008). The primary threat to the *Rufa* red knot population is the reduced availability of horseshoe crab (*Limulus polyphemus*) eggs in Delaware Bay arising from elevated harvest of adult crabs (Niles et al. 2008). Horseshoe crab eggs are an important dietary component during migration, and reduced availability at key migratory stopover sites are a likely cause of recent species declines (Niles et al. 2008, 2009). Due to observed population declines, the USFWS has listed the *rufa* red knot as threatened. The USFWS has issued a proposed critical habitat designation for *rufa* red knot (86 Fed. Reg. 37410 [July 15, 2021]). The proposed designation comprises known coastal foraging and roosting habitats in coastal areas of the Atlantic Ocean and Gulf of Mexico in multiple U.S. states extending from Massachusetts to Texas. None of the proposed critical habitat units are located in the action area. The *rufa* red knot is one of 72 species populations (out of 177 species on the Atlantic OCS) that ranked moderate in its relative vulnerability to collision with wind turbines (Robinson Willmott et al. 2013). Despite the presence of many onshore turbines along the red knot's overland migration route (Diffendorfer et al., 2017), there are no records of red knots colliding with wind turbines (78 FR 60024).

Rufa red knot occurrence on the Atlantic coast is strictly seasonal. A large concentration of northerly migrants congregates in shoreline foraging areas in the mid-Atlantic region in spring, and a similarly large concentration of southern migrants congregates in the north-Atlantic region in the fall (Niles *et al.* 2010; Normandeau 2011; Burger *et al.* 2012a, 2012b). Coastal Massachusetts and Rhode Island are known migratory staging areas during southern migration, with Cape Cod and Massachusetts Bay being particularly important (Niles *et al.* 2008).

A telemetry study by Loring et al. (2018) found that red knots migrating during early fall departed from the Atlantic coast in a southeast direction, likely heading to long-distance wintering destinations in South America. In contrast, red knots that migrated during late fall traveled southwest across the Mid-Atlantic Bight, likely heading to short distance wintering destinations in the southeastern United States and Caribbean. Red knots migrated through Federal waters of the Atlantic OCS during evenings with fair weather and a tailwind.

Only a small portion of *rufa* population uses the U.S. Atlantic coast during the southward migration (Loring et al. 2018). A recent study that tracked 388 red knots fitted with nanotags found that only five flew over Lease Area 1 during fall migration in November based on flight paths interpolated from land-based tracking stations (see Table 2 in Loring et al. 2018). Most of the knots (254) were tagged at stop over sites in James Bay and Mingan Islands, Canada, and most headed directly south over open ocean (Loring et al. 2018). Of the 99 red knots tagged while staging in Massachusetts before the fall migration, only five knots flew over the Lease Area 1 (Loring et al, 2018). However, due to migratory departure flights and tag loss, the paths of only 50 individuals could be used for analysis, so the minimum occurrence within the Lease Area is considered to be 10 percent (5/50 = 10 percent). Most red knots departed from Massachusetts to the southeast from mid-August through early September. However, the five that crossed the Lease Area left very late in mid-November traveling to the southwest and represent 10 percent of the fall staging population in Massachusetts. Given that up to 1,500 *rufa* red knots stage in Massachusetts during fall (Gordon and Nations 2016), only 10 percent of those 1,500 staging *rufa* red knots may pass through Lease Area 1 in fall. In spring, the vast majority of *rufa* red knots fly directly overland from stopover areas in Delaware Bay to breeding areas in Hudson Bay, Canada. However, some *rufa* red knots do travel up the coast in spring as confirmed by a tracking study (see Appendix E in Loring et al. 2018). Based on expert opinion, 10 percent of the fall staging population (i.e., 150 *rufa* red knots) may pass through the Nantucket area in spring (Gordon and Nations 2016).

Contrary to previous assumptions (see Gordon and Nations 2016), fall migration flights primarily occurred when visibility was ~20 km (12.4 miles) with little or no precipitation (Loring et al. 2018) but some individuals have also been documented flying during low visibility conditions with precipitation (Appendix E in Loring et al. 2018). Of individuals that were tracked, 19.2 percent flew at wind speeds ≤4 m/sec (13.1 ft/sec) (Loring et al. 2018), which is below the cut-in speed for an offshore wind turbine. Red knots typically migrate at high altitudes from 500 to 1,000 m (1,640 to 3,281 feet) (Alterstam et al. 1990), well above the highest proposed total turbine height of 266 m (873 feet), but they may descend to immediately above the sea surface under certain conditions. A study that estimated flights heights from telemetry data found that 83 percent of the 25 modeled flight paths occurred within 20 to 200 m (65.6 to 656.2 feet) above water (Loring et al. 2018). Yet, the confidence intervals around the estimated flight heights were very broad and in several cases spanning from near the ocean surface to >1,000 m (3,281 feet) (see Appendix F, Loring et al. 2018). The flight height distribution was derived from the midpoints of 379 10-minute observations of 51 *rufa* red knots flying nonstop over federal waters (Loring et al. 2018); approximately 50 percent flew within the rotor RSZ (as mentioned above, the estimated error is large, ranging from 100 to 200 m). However, more recent telemetry studies using GPS satellite tags yielded more precise results and found that none of the fall migrating red knots traveled within the RSZ, but instead mostly flew below the RSZ (BRI and Wildlife Restoration Partnerships 2022; Feigin et al. 2022). Therefore, the flight height data suggest that it is unlikely that migrating *rufa* red knots would collide with operating WTGs based on how high rufa red knots fly with respect to the Projects' spinning turbine blades.[2] Relatively very little, if any, *rufa* red knot activity is expected over the WEA with relatively few (10 percent of 1,500 individuals) flying through or over the WEA during fall migration. However, given the lack of coverage of tracking stations within the WEA, this should be considered a minimum estimate; additional data is needed to further refine *rufa* red knot exposure.

In summary, while *rufa* red knot exposure to the RWF is limited overall, these findings indicate that individuals could migrate through the RWF in small numbers during spring and fall.

3.2 Northern Long-Eared Bat

The Northern long-eared bat (NLEB) is broadly distributed across the Midwest and eastern United States from Montana to Maine and south to Louisiana and Georgia, with its range extending northward into the boreal forests of Canada. The once common species was listed as threatened across its range due to dramatic population declines caused by the spread of white nose syndrome (78 FR 72058). Due to the status of the species, there is a current proposal to elevate the listing to endangered (87 FR 16442). Critical habitat has not been designated because disease, rather than habitat availability is the primary threat to the species. On January 14, 2016,

[2] The flight height distribution derived from GPS tracked red knots from the Biodiversity Research Institute and Wildlife Restoration Partnerships (2022) and Feigin et al. (2022) studies is not available at this time.

the USFWS published a final ESA §4(d) rule that permits the incidental take of the NLEB from forest clearing activities under certain scenarios, providing compliance with required conservation measures (4(d) Rule for the Northern Long-Eared Bat, 81 FR 1900-1922). Incidental take of NLEB is exempt from prohibition if the following criteria are met:

- No impacts on known occupied hibernation sites;
- No tree removal within 0.4 km (0.25 miles) of a known occupied hibernation site; and
- No tree removal within 45.7 m (150 feet) of a known occupied maternity roost tree between June 1 and July 31.

There are records of NLEB in all coastal counties of Rhode Island in proximity to the proposed action (Cane 2011; RIDEM 2015), including the terrestrial component of the action area (see Figure 2.2). There are several fragmented forested areas within the Project Area that provide potentially suitable summer habitat for NLEB. Based on a recent analysis of summer occupancy of bats in North America, the NLEB had an average occupancy probability of less than 0.5 throughout Rhode Island as of 2019, indicating a low likelihood of occurrence (Udell et al. 2022). Occurrences of NLEB within Rhode Island are tracked by the Rhode Island Department of Environmental Management (RIDEM) and no new occurrences were recorded in 2020 (vhb 2022). Additionally, bat-acoustic presence/absence surveys were conducted in July 2020 targeting NLEB along the RWEC – Onshore and near the OnSS parcels. No NLEB were identified during the survey (as indicated in acoustic survey data forms provided in Appendix F in vhb 2022).

Outside of the Action Area, a recent tracking study conducted on Martha's Vineyard did not record any offshore movements of eight tagged NLEB from July to October (Dowling et al. 2017). Additionally, stationary acoustic detectors positioned on two WTGs within the operational Block Island Wind Farm (Rhode Island) did not detect any NLEB calls (Stantec 2020). Similarly, monitoring associated with the Coastal Virginia Offshore Wind Pilot project detected over 400 bat calls, none of which were NLEB (Dominion Energy 2022). In conclusion, there is little evidence of consistent use of the offshore environment near WTGs by NLEB, and this species' presence offshore in the Action Area is not anticipated.

Collectively, this information indicates that NLEB may occur in the terrestrial component of the action area during non-hibernation periods (May through October). However, NLEB are unlikely to occur in the aquatic component of the action area, including the RWF. While NLEB were not detected during surveys of the OnSS, this species may periodically use the forested habitat within and around the onshore construction footprint for summer foraging.

4 Effects of the Proposed Action

The action area is divided into two components for the purpose of the effects analysis: aquatic and terrestrial (see Section 2.0). The marine component includes the seabed, water column, and atmosphere over the ocean affected by the RWF and marine elements of the RWEC. The terrestrial component includes the areas affected by all upland elements of the RWEC. Each of these components is exposed to different project-related effects and is used differently by ESA-listed species. The effects of the proposed action on the environment were analyzed using the project PDE maximum impact scenario described in Section 1.4. The effect mechanisms from project construction and operation that have the potential to affect ESA-listed species under USFWS jurisdiction are summarized in Table 4.1.

Table 4.1 Effect Mechanisms from Construction and Operation

Activity	Effect Mechanism	Exposure Type	Effect Level by Species			
			Piping plover	Roseate tern	Red knot	NLEB
RWF Construction	Airborne noise and visual disturbance	Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant
	Underwater noise Seabed and water column disturbance	Indirect – Prey availability	No effect	Discountable	No effect	No effect
	Vessel traffic	Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant
RWEC Construction	Airborne noise	Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant
	Underwater noise Seabed and water column disturbance	Indirect – Prey availability	No effect	Insignificant	No effect	No effect
	Upland disturbance	Indirect – Habitat modification	No effect	No effect	No effect	Insignificant
	Vessel and vehicle traffic	Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant
RWF/RWEC Operation	Collision risk	Direct – Injury and mortality Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant
	EMF	Direct – Behavioral	No effect	No effect	No effect	Insignificant
	Vessel and vehicle traffic	Direct – Behavioral	Insignificant	Insignificant	Insignificant	Insignificant

The potential effects of these mechanisms on ESA-listed species are determined by: 1) characterizing the timing, magnitude, and duration of the impact relative to the environmental baseline; 2) determining the likelihood of direct and indirect exposure to those effects, and; 3) evaluating the significance of any direct or indirect exposure that is likely to occur. The effect analysis is presented by species grouping in the following sections.

4.1 Piping Plover, Roseate Tern, and Rufa Red Knot

Piping plover, roseate tern, and *rufa* red knot are likely to or could potentially occur in the aquatic component of the action area during project construction and operation. The potential direct and indirect effects of the proposed action on these species are addressed below.

4.1.1 Direct Effects

Potential direct effect mechanisms resulting from construction, operation, and decommissioning of the proposed action on these species include:

- Airborne noise effects: Exposure to elevated airborne noise during project construction and operation
- Vessel and vehicle traffic effects: Potential behavioral effects resulting from vehicle and vessel traffic disturbance
- Lighting effects: Potential behavioral effects resulting from lights during construction and operations, especially during low visibility conditions
- Collision risk: Risk of collision and/or interaction with WTGs, the RWF offshore substations, monopile foundations, and marine construction equipment

The likelihood of exposure to and significance of these potential effect mechanisms on ESA-listed bird species are evaluated in the following sections.

4.1.1.1 Airborne Noise Effects

ESA-listed bird species addressed in this BA could be exposed to airborne noise when migrating through, foraging, and/or staging in the action area and vicinity. Noise-producing construction elements include placement of the WTG monopile foundations, temporary cofferdam placement for RWEC sea-to-shore transition construction, construction vessel operation, and upland construction activities and vehicle use. Once construction is completed, the WTGs will produce operational airborne noise in the offshore marine environment.

There are currently no established in-air noise exposure thresholds for piping plover, roseate tern, or *rufa* red knot. Therefore, potential species effects are evaluated based extent and magnitude of effects relative to baseline conditions and the likelihood of species exposure. The magnitude and significance of airborne noise exposure for ESA-listed bird species are described below.

Placement of the WTG monopile foundations using an impact pile driver will produce the loudest airborne noise effects associated with the proposed action. Impact pile driving of 12-m (39-foot) monopiles could produce airborne noise levels of up to 137 A-weighted decibels (dBA) (vhb 2022). Using this value, the noise attenuation formula described in WSDOT (2019), and an estimated average ambient airborne noise level of 60 dBA (compiled from Bolin and Åborn 2010; McKenna *et al.* 2012; USACE 1984, 2005; Witte 2010),[3] WTG foundation installation would generate airborne noise exceeding baseline levels up to 7,079 m (4.4 miles) from the source. The duration of impact hammer use during each monopile installation would be up to 6 hours during daylight hours only, with up to 3 WTGs or 2 OSSs installed each day over the 36-day construction period. The noise effect area at any given time would be limited to the effect radius around the pile being installed. The effect radius formulae are conservative in that they do not factor in sea-surface and atmospheric parameters that limit noise propagation.[4] Therefore, this value likely overestimates the extent of audible noise effects in the action area.

Piping plovers, roseate terns, and *rufa* red knots would only be exposed to impact hammer noise if monopile installation occurs during the migratory period. Based on timing restrictions proposed for pile driving, installation activities are likely to occur between May and October (vhb 2022). Therefore, piping plovers and roseate terns may be exposed to pile driving noise during spring migration, post-breeding dispersal, and fall migration. *Rufa* red knot may be exposed during fall migration. Based on observed flight behavior,[5] migrating birds are likely to be able to detect and avoid noise-producing activities at a considerable distance with a minimal shift in flight path. Individual birds may hear project-related noise but would be able to limit exposure without significantly altering behavior. This conclusion is supported by the fact that these species are periodically exposed to elevated baseline noise levels from sources like large ships and wind noise without apparent harm.[6]

Construction of the RWEC sea-to-shore transition construction includes the installation of a sheetpile cofferdam approximately 518 m (1,700 feet) offshore using a vibratory hammer, and construction of the upland connection vault using a drill rig and other heavy equipment. These

[3] Bolin and Åborn (2010) measured ambient noise levels on Baltic Sea shorelines associated with wind and wave action. They recorded baseline noise levels ranging from 50 dBA to 70 dBA correlated with wind strength and wave height. The USACE (1984, 2005) characterized ambient noise levels ranging from 58 dBA to as high as 69 dBA in shoreline environments, using a combination of measurement and modeling methods. While wave characteristics differ in the open ocean, ambient airborne noise levels from wave action are likely to be comparable to these reported values. In addition, large commercial vessels can generate airborne noise from 85 dBA to 115 dBA up to 200 feet from the hull (McKenna et al. 2012; Witte 2010), significantly elevating baseline noise levels around busy shipping lanes.

[4] For example, atmospheric scattering, wind noise, and ocean surface conditions can produce an additional 20 dB to 30 dB of sound attenuation at long distances (WSDOT 2019), while ocean surface conditions can reduce sound propagation by 5 dB to 7 dB.

[5] Loring et al. (2018, 2019) observed that *rufa* red knot, piping plover, and Roseate Tern typically initiate migratory and foraging flights during clear and calm weather. Given that pile driving activities will take place primarily during daylight hours, except under special circumstances (vhb 2022), construction activities would be clearly visible from miles away and easily avoidable.

[6] See footnote 3.

activities will produce airborne noise in excess of ambient levels in this portion of the action area, which includes nearshore and shoreline habitats potentially used by foraging piping plover. As stated previously, foraging roseate terns and *rufa* red knot could theoretically occur in this component of the action area but the likelihood is discountable based on current distribution and known habitat use.

Based on the compilation of best available reference sources (CalTrans 2015; WSDOT 2019), vibratory hammer placement of the sheetpile cofferdam would produce an average peak noise level of 105 dBA (WSDOT 2019). Based on the average ambient noise level of 60 dBA and the attenuation formulae described in the previous section, this activity would produce audible in air noise up to 1,524 m (5,000 feet) from the source, encompassing adjacent shoreline habitats.

Heavy equipment used to construct the RWEC – Onshore would also produce airborne noise that periodically exceeds ambient levels. Vhb (2021) presented reference noise levels for probable types of construction equipment used for RWEC construction adjacent to the nearshore zone. Applying the rules of decibel addition (WSDOT 2019) assuming concurrent use of three of the loudest construction equipment sources, RWEC construction noise could reach as high as 92 dBA. Applying this value and the ambient noise levels in the terrestrial component of the action area,[7] construction noise would attenuate to ambient levels within approximately 150 to 275 feet of the source.

ESA-listed species that occur within these effect areas may be exposed to periodic construction noise that exceeds ambient levels. Combined with the visual disturbance created by construction activity, this exposure could theoretically lead to behavioral effects, including potential avoidance of the affected area. However, this potential must be placed in context with the natural variability in ambient conditions and baseline disturbance from vessel and vehicle traffic and other human activity. Ambient noise from wind and wave action on marine shorelines commonly reaches as high as 69 dBA, meaning that construction noise would be less audible under certain conditions. The proximity of the affected shoreline to ambient noise sources including surrounding commercial and industrial land uses and the Quonset State Airport would also influence the ambient noise levels in the area. All of these sources create routine noise and disturbance in excess of the ambient levels assumed in this analysis. In this context, the short-term effects of cofferdam construction would not significantly alter baseline conditions and are therefore unlikely to adversely affect the behavior of ESA-listed bird species.

WTG operation would generate airborne noise effects within the RWF boundary. Localization of the noise associated with operating turbines found that noise production is concentrated towards the outer edge of the blade, primarily during downward movement (Oerlemans et al. 2007, Ocker et al. 2021). Moller and Pedersen (2010) studied airborne noise from smaller onshore WTGs, 2-

[7] Ambient noise levels along the RWEC – Onshore corridor are estimated at 43.9 dBA to 50.5 dBA based on ambient sound measurements conducted at three sites near the OnSS and the Landfall Work Area envelope between August 27 and August 31, 2019 (vhb 2021).

MW in size, and determined they produced peak airborne noise levels ranging as high as 90 dBA. Assuming an average ambient airborne noise level of 60 dBA to 70 dBA, peak WTG operational noise would theoretically be detectable in the RWF and within 304 m (1,000 feet) of operating turbines, leading to potential behavioral effects. However, this calculation likely overestimates noise effects given that turbine noise, background ocean noise, and the noise attenuating effect of surface waves all increase concurrently with wind speed.

4.1.1.2 Vessel and Vehicle Traffic Effects

Vessel traffic associated with the construction and operation of the RWF and RWEC would not significantly alter the environmental baseline in the action area. Project construction will involve 23 different vessel types ranging in size from small inflatable support vessels to large derrick barges and cable laying vessels, with construction occurring over a period of approximately 2 years. Large vessels will typically remain on-station during construction, supported by a smaller crew transfer vessel. This equates to several dozen vessel trips during project construction and an equivalent number during future decommissioning. Project operations would rely on two small crew transport vessels traveling periodically between shoreside ports and offshore facilities for planned maintenance. The associated number of vessel trips per year would likely number in the low dozens.

In comparison, thousands of vessels, ranging in class from private pleasure craft and fishing boats to large cargo ships, travel through the action area on an annual basis.[8] The additional vessel trips associated with the proposed action would not significantly alter the marine traffic baseline in the action area. ESA-listed marine birds would only encounter the increased vessel traffic when migrating through the action area. Given the negligible increase in vessel traffic relative to baseline and the limited nature of exposure, the effect of project-related vessel traffic on ESA-listed bird species is likely insignificant.

Project-related vehicle use would not significantly alter baseline vehicle traffic levels on the upland road network (see Section 4.2.1.3), and no vehicle use would occur on or in proximity to shoreline habitats known or potentially used by ESA-listed birds. ESA-listed birds in proximity to the sea-to-shore transition area may be able to detect noise and visual disturbance created by construction and maintenance vehicles and associated activity, but that disturbance is likely insignificant relative to existing baseline conditions. Construction and maintenance vehicle activity would not significantly increase or alter these existing levels of disturbance, therefore any related effects on listed bird species in the vicinity would be insignificant.

[8] DNV GL (2020) summarized vessel traffic in the vicinity of the proposed action based on AIS data from July 1, 2018, through June 30, 2019. The data include eight vessel classes: cargo/carrier, fishing, other and unidentified, passenger, pleasure, tanker, tanker – oil, and tug and service. Most vessels sail between 8 and 12 knots. There were 113,697 vessel crossings of a measurement line at the entrance of Narragansett Bay via East Passage. Approximately 75 percent of these crossings were pleasure vessels (58 percent) and Tug/Service vessels (21 percent). Fishing and other/unidentified vessels account for approximately 70 percent of the vessels that went into the RWF.

4.1.1.3 Lighting Effects

Under poor visibility conditions (fog and rain), some migrating birds may become disoriented and circle around lighted communication towers instead of continuing on their migratory path, thus greatly increasing their risk of collision with the tower and guy wires (Huppop et al., 2006). Tower lighting would have the greatest impact on bird species during evening hours when nocturnal migration occurs. However, red flashing aviation obstruction lights are commonly used at land-based wind facilities without any observed increase in avian mortality compared with unlit turbine towers (Kerlinger et al., 2010). Revolution Wind includes the use of red flashing aviation obstruction lights in accordance with FAA and BOEM requirements (vhb 2022). Aircraft Detection Lighting Systems (ADLS) would also be installed so that obstruction lights would only be activated when an aircraft is near the turbines. The use of ADLS would dramatically reduce the amount of time the obstruction lights are on to an estimated 3.5 hours per year (vhb 2022). Additionally, BOEM anticipates that any additional work lights on support vessels or Project structures would be hooded downward, directed when possible to reduce illumination of adjacent waters, and would be used only when required to complete a project task (vhb 2022). Therefore, the potential impacts from artificial lighting of structures and vessels during construction, operations and maintenance, and decommissioning of the Proposed Action on listed bird species would be insignificant and discountable.

4.1.1.4 Collision Risk

This section discusses the potential for impacts on federally listed species resulting from collisions with WTGs, OSSs, and construction/maintenance vessels associated with the Proposed Action. Collision risk is evaluated here based on specific species flight behavior and distribution within the aquatic action area. Based on occurrence and the potential for behavioral avoidance, the likelihood of collisions with fixed structures or vessels associated with the Proposed Action would be insignificant and discountable.

4.1.1.4.1 Effects on Piping Plover

The distance from shore to the offshore portions of the Action Area precludes use by nesting and foraging piping plovers. As discussed previously, migration occurs mostly along the coast during favorable weather conditions. In addition, there is a chance that a small percentage of plovers from Massachusetts and northward will fly over the operating turbines, and only 15 percent of the birds could be flying within the rotor swept zone, while the remaining birds are expected to easily avoid turbines that are spaced 0.70 to 1 nautical miles apart.

Although “take” (a fatality due to colliding with a turbine) is unlikely due to reasons described above, a quantitative analysis was conducted. Typically, quantitative analyses are performed when “take” is expected and there is a need to estimate the amount of “take.” Nevertheless, the quantitative analysis was conducted as an alternative approach to determine if there will be “take.” BOEM used the Band Model (Band 2012) to estimate the risk of bird collision with operating WTGs in offshore wind farms. The Band Model factors bird size and flight behavior, the number individuals passing through the migratory corridor (i.e., the WEA), migratory corridor and windfarm width, number of turbines, RSZ area, percentage of individuals flying at altitudes within the RSZ, predicted operating time during the migration season by month, and a behavioral avoidance modifier to estimate collision risk. The Band Model parameters used to estimate RWF piping plover collision risk are presented in Appendix B.

Most of the model inputs (e.g., migration passage, proportion flying in the RSZ, turbine specifications, and facility dimensions) were obtained or calculated from the COP and Loring et al. 2019 (see Appendix B for a snapshot of the model inputs). Radio telemetry studies of piping plover migratory behavior in the vicinity of the action area indicate that piping plover are likely to fly through the RWF during the life of the project. Using interpolated flight paths from land-based tracking stations, Loring et al. (2019) found that 20 percent (8 out of 40) of tagged plovers leaving breeding areas in Massachusetts during fall migration flew through the RI/MA WEA. Extrapolating that percentage to recent population size[9] an estimated 1,368 piping plover could have migrated through the WEA in 2022, 514 in spring and 855 in fall.

A range of turbine avoidance rates (95 percent to 99 percent), based on best available science, were used for piping plovers and were obtained from Hatch and Brault (2007) and Stantial (2014). Two scenarios were considered within the model: 1) 100 operating 8-MW turbines or 2) 74 operating 12-MW turbines. The monthly proportion of time the turbines were in operation is based on the proportion of time the wind was above turbine cut-in speeds. The average revolutions per minute (rpm) for a turbine operating at the site is not known, so the maximum rpm speed was used. This is likely to be greater than the average and an increase in rpm will increase the estimated mortality. The flight height distribution was derived from the midpoints of 2,756 10-minute observations of 62 piping plovers flying nonstop over federal waters; note that the error associated with these observations was relatively large (Loring et al. 2018). Given that the flight height distribution has been estimated for this species, modeled fatalities are based on calculations from the extended model (Option 3).

As shown in Appendix B, the Band Model results indicate that approximately 146 plovers could have theoretically passed through the RWF RSZ under the 8-MW option at the observed breeding abundance and productivity levels for New England and Canada breeding populations. Under the 12-MW option, approximately 163 plovers could have theoretically passed through the RWF RSZ. Of those 146 or 163 passes, 7 or 9 could have resulted in a rotor collision assuming no avoidance (the equivalent of flying blind folded). Based on the collision risk model, the estimated annual mortality rate for migrating piping plovers was zero when avoidance was 95 percent or greater.

[9] Based on a breeding population abundance of 2,570 pairs in Massachusetts, New Hampshire, Maine, and eastern Canada, and an abundance-weighted mean productivity of 1.33 chicks fledged per pair (USFWS 2022), equating to 2,570 adults in spring and 4,276 adults and subadults in fall.

To further inform this ESA consultation, BOEM used the Stochastic Collision Risk Assessment for Movement (SCRAM) to estimate the likelihood of "take" or fatality due to collision with a rotating turbine blade – more specifically, to estimate the relative likelihood of the take of one individual in a year and during the 35-year operation period of the wind farm. SCRAM uses bird passage rates based on modeled flight paths of birds fitted with nanotag transmitters (Gilbert et al. 2022). The use of tracking data is representative of bird movements, because the locations are recorded day and night for weeks and even months regardless of weather conditions. The wind farm and turbine operational inputs were similar to those used in the analysis using the Band model, and the developer also provided estimates of wind speed and monthly turbine down time (refer to Table 2.2). The SCRAM analysis considered the same two scenarios assessed under the Band model: 1) 100 operating 8-MW turbines or 2) 74 operating 12-MW turbines. The 8-MW turbine scenario assumed a 36 m air gap, and the 12-MW scenario assumed a 46 m air gap. As recommended, the model was run for 1,000 iterations using Option 3 (Gilbert et al. 2022). The threshold number of collisions was set at one – this represents a take of one or more individuals.

The estimated annual mortality using the Band model was zero (Appendix B; Table 4.2). The probability of at least one take from the SCRAM model for both scenarios was < 0.001; thus a single collision during fall migration is extremely unlikely. In other words, a once in a thousand-year event (Appendix B; Table 4.2). The probability of a collision event during the 35-year operational period is therefore also very small 0.034 (= $1\text{-}(1\text{-}0.001)^{35}$ years).

Table 4.2 Band and SCRAM Model Results for Piping Plover

		Turbine	**8MW**	**12MW**
		Number	**100**	**74**
		Air gap	**36**	**46**
Model	**Metric**	**Period**		
BAND	**Fatalities**	Annual	0	0
SCRAM	**Probability of lethal take**	Annual	0.001	0.001
	Probability of lethal take	35 years	0.034	0.034
	Years until a lethal take		1,000	1,000
	Annual Fatalities	1 year	NA	NA
	Fatalities project lifetime	35 years	NA	NA

Based on the results from both models, the chance of a fatality due to collision is extremely unlikely, and thus the estimated annual number of fatalities for migrating piping plover is **zero**. Likewise, the estimated number of fatalities during the 35-year operations term is also **zero**. Based on the above findings, the likelihood of collision fatalities resulting from the Proposed

Action would be too small to be measured or evaluated (**insignificant**) and unlikely to occur (**discountable**), and the proposed action is not likely to adversely affect piping plovers.

4.1.1.4.2 Effects on Roseate Tern

Roseate terns are unlikely to experience adverse migratory corridor effects from the proposed action for several reasons. First, the distance from shore to the aquatic portions of the action area and the lack of suitable habitat in the action area likely preclude use by foraging adults during breeding; however non-breeding adults may forage further offshore in response to prey availability (Loring et al. 2019, Yakola 2019). Second, the species typically migrates under high-visibility conditions, below turbine cut-in speed, and would be able to see and avoid the WTGs from considerable distance without significantly modifying their flight path. Finally, available data (i.e., Loring et al. 2019) suggest that roseate terns typically fly below the RSZ, which minimizes exposure to potential collision.

Although “take” (a fatality due to colliding with a moving turbine blade) is unlikely due to reasons described above, a quantitative analysis was conducted. Typically, quantitative analyses are performed when “take” is expected and there is a need to estimate the amount of “take”. Nevertheless, the quantitative analysis was conducted as an alternative approach to determine if there will be “take”.

BOEM used the Band Model (Band 2012) to evaluate risk of injury or mortality to roseate tern from collision with turbines. Model input parameters and results are provided in Appendix B. The proportion of the population that flies through the wind development area during migration is not currently known. Therefore, it was assumed that the birds will spread themselves evenly along a ‘migration front’ spanning 135 km (83.9 miles) between Block Island and Monomoy and only birds passing through the approximately 38 km (23.6) wide WDA would be exposed to the wind farm. For spring migration (April to May), the number of passages through the migration front was based on the number of United States and Canadian breeding adults in 2016. In June and July, the number of passages by second year birds migrating from South America was based on the number that fledged in 2015 in New York, Connecticut, and Massachusetts and survived to 2017. For fall migration, it is assumed that all United States and Canadian breeding adults (2017), fledglings (2017), and 2nd year birds (2015 birds that survived to 2017) passed through the front. Turbine avoidance rate of 95.01 percent was used for roseate tern (Cook 2021). Two scenarios were considered within the model: 1) 100 operating 8-MW turbines or 2) 74 operating 12-MW turbines. The monthly proportion of time the turbines were in operation is based on the proportion of the time the wind was above turbine cut-in speeds. The average rpm for a turbine operating at the site is not known, so the maximum rpm speed was used. This is likely to be greater than the average and an increase in rpm will increase the estimated mortality. The flight height distribution was derived from the midpoints of 1,758 ten-minute observations of 75 roseate terns flying nonstop over federal waters; note that the error associated with these observations was relatively large (Loring et al. 2018). Given that the flight height distribution has been estimated for this species, modeled fatalities are based on calculations from the extended model (Option 3).

Using these inputs and the operational parameters specified in Appendix B, no roseate terns would occur at rotor height or would fly through the RSZ in any given year, and thus, the number of fatalities due to collision is zero (Appendix B).

As described above for piping plover, BOEM used the SCRAM model to further inform the ESA consultation and to estimate the likelihood of "take" or fatality due to collision with a rotating turbine blade – more specifically, to estimate the relative likelihood of the take of one individual in a year and during the 35-year operation period of the wind farm. SCRAM uses bird passage rates based on modeled flight paths of birds fitted with nanotag transmitters (Gilbert et al. 2022). The use of tracking data is representative of bird movements because the locations are recorded day and night for weeks and even months regardless of weather conditions. The wind farm and turbine operational inputs were similar to those used in the analysis using the Band model, and the developer also provided estimates of wind speed and monthly turbine down time (refer to Table 2.2). The analysis considered the same two scenarios assessed under the Band model: 1) 100 operating 8-MW turbines or 2) 74 operating 12-MW turbines. The 8-MW turbine scenario assumed a 36 m air gap, and the 12-MW scenario assumed a 46 m air gap. As recommended, the model was run for 1,000 iterations using Option 3 (Gilbert et al. 2022). The threshold number of collisions was set at one – this represents a take of one or more individuals.

The probability of at least one take from the SCRAM model for both scenarios was < 0.001, thus a single collision during fall migration is extremely unlikely – in other words, a once in a thousand-year event (Appendix B; Table 4.3). The probability of a collision event during the 35-year operational period is also very small 0.034 (= $1-(1-0.001)^{35}$ years).

Table 4.3 Band and SCRAM Model Results for Roseate Tern

		Turbine	**8MW**	**12MW**
		Number	**100**	**74**
		Air gap	**36**	**46**
Model	**Metric**	**Period**		
BAND	**Fatalities**	Annual	0	0
SCRAM	**Probability of lethal take**	Annual	0.001	0.001
	Probability of lethal take	35 years	0.034	0.034
	Years until a lethal take		1,000	1,000
	Annual Fatalities	1 year	NA	NA
	Fatalities project lifetime	35 years	NA	NA

Based above information and the results from both the Band and SCRAM models, the chance of a fatality due to collision is extremely unlikely, and thus the estimated annual number of fatalities for migrating roseate tern is **zero**. Likewise, the estimated number of fatalities during the 35-year operations term is also **zero**. Therefore, based on the above findings, the likelihood of collision fatalities resulting from the Proposed Action would be too small to be measured or evaluated (**insignificant**) and unlikely to occur (**discountable**), and the proposed action is not likely to adversely affect to roseate tern.

4.1.1.4.3 Effects on Red Knot

Rufa red knot do not use offshore habitats for foraging and would only occur in the RWF area during migration. The information presented in Section 3.1.3 indicates that approximately 10 percent of red knots departing from staging areas in Massachusetts could fly through the RI/MA WEA. Applying this percentage to the fall staging population estimate of 1,500 migrants (Gordon and Nations 2016) equates to a total of approximately 165 red knots (150 in the fall [divided equally across July-September] and 15 in the spring) traveling through the RWF lease area in any given year.

Although "take" (a fatality due to colliding with a moving turbine blade) is unlikely due to reasons described above, a quantitative analysis was conducted. Typically, quantitative analyses are performed when "take" is expected and there is a need to estimate the amount of "take". Nevertheless, the quantitative analysis was conducted as an alternative approach to determine if there will be "take".

The Band Model (Band 2012) input parameters and results for *rufa* red knot are presented in Appendix B. The flight height distribution was derived from the midpoints of 379 ten-minute observations of 51 red knots flying nonstop over federal waters; note that the error associated with these observations was relatively large (Loring et al 2018). Turbine avoidance rate of 98 percent was used for *rufa* red knot (SNH 2018). Two scenarios were considered within the model: 1) 100 operating 8-MW turbines or 2) 74 operating 12-MW turbines. The monthly proportion of time the turbines were in operation is based on the proportion of the time the wind was above turbine cut-in speeds. The average rpm for a turbine operating at the site is not known, so the maximum rpm speed was used. This likely to be greater than the average and an increase in rpm will increase the estimated mortality. Given that the flight height distribution has been estimated for this species[10], modeled fatalities are based on calculations from the extended model (Option 3).

Applying a potential exposure of 165 adults with proportion at rotor height of 83 percent under the operating conditions shown, the Band Model estimates a total of 18 and 15 potential bird transits through the RWF RSZ under both the 8 MW and 12 MW options (respectively) with one

[10] The flight height distribution derived from GPS tracked red knots from the Biodiversity Research Institute and Wildlife Restoration Partnerships (2022) and Feigin et al. (2022) studies are not available at this time.

collision under a no-avoidance assumption (this is equitant to flying blind-folded). *Rufa* red knots typically fly under high-visibility conditions (Loring *et al.* 2018), indicating they would be able to detect and avoid the WTGs from distance without significantly altering their flight path. Previous analyses (Gordon and Nations 2016) have applied avoidance rates of 95 percent or greater to *rufa* red knot, similar to those cited above for piping plover. When avoidance is considered, the likelihood of injury or mortality from rotor collision is negligible.

To further inform this ESA consultation, BOEM used the SCRAM model to estimate the likelihood of "take" or fatality due to collision with a rotating turbine blade – more specifically, to estimate the relative likelihood of the take of one individual in a year and during the 35-year operation period of the wind farm. SCRAM uses bird passage rates based on modeled flight paths of birds fitted with nanotag transmitters (Gilbert et al. 2022). The use of tracking data is representative of bird movements, because the locations are recorded day and night for weeks and even months regardless of weather conditions. The wind farm and turbine operational inputs were similar to those used in the analysis using the Band model, and the developer also provided estimates of wind speed and monthly turbine down time. The analysis for red knot considered the same two scenarios assessed under the Band model, along with a third, intermediate scenario: 1) 100 operating 8-MW turbines, 2) 74 operating 12-MW turbines, 3) 80 11-MW turbines. The 8-MW turbine has a 36 m air gap, and the 12-MW turbine has a 46 m air gap. The 11-MW turbine scenario was assessed with both a 36 m air gap and 46 m air gap. As recommended, the model was run for 1,000 iterations using Option 3 (Gilbert et al. 2022). The threshold number of collisions was set at one – this represents a take of one or more individuals.

The estimated annual mortality using the Band model was zero (Appendix B). The probability of at least one take from the SCRAM model for the 8-MW scenario was < 0.001, thus a single collision during fall migration is extremely unlikely – in other words, a once in a thousand-year event (Appendix D; Table 4.4). The probability of a collision event during the 35-year operational period is also very small 0.034 (= $1\text{-}(1\text{-}0.001)^{35}$ years). The probability of collision under the 11-MW turbine scenario with a 36 m air gap was consistent with the results of the 8-MW scenario; a single collision during fall migration is extremely unlikely. Under the 11-MW scenario with a 46 m air gap, the probability of at least one take in a given year was 0.003, or just 0.100 over the 35-year operational period. No fatalities were predicted under this scenario and the effect is considered to be discountable.

Table 4.4 Band and SCRAM Model Results for Red Knot

		Turbine	8MW	11MW	11MW	12MW
		Number	100	80	80	74
		Air gap	36	36	46	46
Model	**Metric**	**Period**				
BAND	**Fatalities**	Annual	0	NA	NA	0
SCRAM	**Probability of lethal take**	Annual	0.001	0.001	0.003	0.754
	Probability of lethal take	35 years	0.034	0.034	0.100	1.00
	Years until a lethal take		1,000	1,000	333.3	1.3
	Annual Fatalities	1 year	NA	NA	NA	1.074
	Fatalities project lifetime	35 years	NA	NA	NA	28.343

In summary, based on the results from both models, the chance of a fatality due to collision is extremely unlikely under the 8-MW and 11-MW turbine scenarios, and the estimated annual number of fatalities for migrating red knot under those scenarios is **zero**. Likewise, the estimated number of fatalities during the 35-year operations term is also **zero**. Based on indications from the developer, the 11-MW turbine design option is the most likely to be chosen. Collision fatalities resulting from the Proposed Action under this option are unlikely to occur and are therefore **discountable**.

4.1.2 Indirect Effects

Potential indirect effect mechanisms resulting from construction, operation, and decommissioning of the proposed action on these species include:

- Seabed and water column disturbance: Risk of indirect effects on forage fish prey availability for roseate tern from short-term disturbance of the nearshore seabed
- Underwater noise: Risk of indirect underwater noise effects on forage fish prey availability for roseate tern from project construction and operation

Roseate tern is the only species with the potential to be indirectly affected by the construction, operation, and decommissioning of the proposed action. Potential indirect effect mechanisms on this species include seabed and water column disturbance and underwater noise that could alter forage fish behavior and potentially affect foraging efficiency.

The likelihood of any ESA-listed bird species being directly exposed to seabed disturbance and underwater noise effects is discountable. Piping plovers and *rufa* red knots do not submerge and prey on organisms that are affected by underwater noise. While roseate terns do dive when pursuing prey, they are unlikely to be directly exposed to project effects based on known distribution and behavior relative to potentially harmful activities. Disturbance and underwater noise effects on roseate tern prey resources are the only conceivable indirect effect mechanisms likely to result from the proposed action. These indirect effects would be insignificant, as described in the following sections.

4.1.2.1 Seabed and Water Column Disturbance

Project construction and operation will result in disturbance of the seabed and water column within the RWF and along the RWEC corridor, including temporary construction-related disturbance and water quality impacts in the nearshore zone used by roseate terns. These effects are detailed in Table 2.1. RWEC construction activities in the nearshore zone, specifically sea-to-shore transition cofferdam or casing pipe placement and associated dredging and sidecast, would create short-term underwater noise, disturbance, and suspended sediment effects. These effects could potentially affect baitfish behavior and availability for roseate tern predation within the affected area. The prey organisms used by shoreline foraging piping plover and red knot would not experience these effects; therefore, these species would not be indirectly affected by this effect mechanism.

For the purpose of Section 7 consultation, elevated total suspended solids (TSS) concentration in nearshore areas used by forage fish is the relevant parameter for evaluating potential indirect effects on roseate terns. Indirect effects from underwater noise are addressed in the following section. TSS effects are considered by comparing the magnitude of likely effects to the environmental baseline. Baseline TSS conditions in the action area are variable depending on proximity to the nearshore zone. Ocean waters beyond 4.8 km (3 miles) offshore typically have low TSS on the order of 0.1 milligrams per liter (mg/L) to 7.4 mg/L (USACE 2004). TSS levels generally increase in shallower waters close to shore where wave and current action more readily agitate the seabed, periodically increasing suspended sediment loads (BOEM 2013). For sediment transport modeling associated with Project construction, RPS (2021) assumed that ambient TSS levels near the sea-to-shore transition location would be 0 mg/L. However, this is likely a conservative estimate of TSS levels to provide a worst-case scenario result and likely does not consider wave and current action.

If no containment methods are employed (no cofferdam or casing pipe), excavation of the HDD exit pit at the sea-to-shore transition site may produce TSS levels up to 500 mg/L within several hundred meters of construction that persist above 100 mg/L for up to 70 hours (RPS 2021). The duration of impact is determined primarily by the slow nature of HDD pit excavation. Installation of the RWEC-RI segments in areas with high concentrations of mud and silt in sediments are also expected to produce TSS levels above ambient for several days. Modeled TSS levels above 0 mg/L are likely to persist for up to 85 hours at locations where dredging is used to level and excavate the seabed, and for up to 70 hours and along the remainder of the cable installation route where normal jet plow installation methods are used. Predicted maximum TSS concentrations from each of these methods would drop below 100 mg/L within 19 and 4.5 hours, respectively. Nonetheless, the model results indicate that cable installation would have a temporary but measurable water quality effect that exceeds the typical range of baseline variability in nearshore areas used for foraging by roseate terms. These effects would likely be limited to a few hundred feet from the point of disturbance. Elevated TSS would decrease visibility and could alter forage fish behavior. The resulting effects on prey availability and roseate tern predation efficiency are difficult to predict and could be negative or beneficial. However, although roseate terns specialize on sand lance, which are patchily distributed, the terns forage over broad areas in pursuit of prey (Loring *et al.* 2019) and localized temporary indirect effects on prey availability would likely be insignificant relative to the abundant foraging habitat available in the vicinity and the documented ability of terns to move readily between foraging areas.

In addition to nearshore disturbance, presence of WTG and OSS structures offshore has the potential to alter habitat through reef effects, changes in substrate, and hydrodynamic effects. Such habitat alteration, which would occur for the life of the project, could result in shifts in the availability of roseate tern prey resources. Habitat could become more suitable for offshore sand lance, for example, although this species remains on the bottom during the day (Collette and Klein-MacPhee 2022) and is therefore largely unavailable for roseate terns to forage on. Thus, while habitat alterations may occur, whether these alterations would result in an increased availability of roseate tern prey is speculative.

4.1.2.2 Underwater Noise Effects

Kusel et al. (2021) estimated underwater noise levels likely to result from monopile installation using a proprietary noise propagation model. This model accounts for additional sound attenuation factors, such as water temperature, surface conditions, thermal gradients, and sound scattering, that are not considered in the spherical spreading loss model typically used by NMFS and USFWS. The model produces a more realistic assessment of likely noise effects from impact pile driving. The results of this analysis indicate that a peak pile driving-related underwater noise would attenuate to between 150 dB to 160 dB re 1 µPa upon reaching the major shipping lanes that bound the action area. Large vessels like container ships and tankers generate source levels of 177 dB to 188 dB re 1 µPa-m predominantly in the lower frequency band below 40 hertz (Hz) (McKenna et al. 2012). Given the baseline level of large vessel traffic and associated ambient noise levels present, the major shipping corridors overlapping and to the east and west of the action area are likely to represent the outer boundary of detectable underwater noise resulting from the proposed action.

As noted above, Kusel et al. (2021) modeled threshold distances for underwater noise from monopile installation. They determined that under the worst-case installation scenario[11] using the most conservative impact thresholds, small fish <2 grams within 14,609 m (9.1 miles) and fish >2 grams within 10,940 m (6.8 miles) of pile driving could experience injury-level noise exposure (Table 25 in Kusel et al. 2021). Fish within 10,888 m (6.8 miles) of the activity would

[11] The worst-case installation scenario assessed for fish assumed either two 12-m monopiles installed in a 12-hour period or one 15-m monopile installed in a 12-hour period.

experience root mean squared sound pressure levels (SPL) over the behavioral threshold of 150 dB re 1 µPa defined by the Fisheries Hydroacoustic Working Group (FHWG 2008). This threshold is based on observed behavioral effects sufficient to negatively affect survival and fitness (Popper 2003; Popper *et al*. 2014).

These results indicate that monopile installation would be unlikely to measurably affect prey availability for roseate terns based on known foraging behavior and distribution relative to the area of effect. During the breeding season, most terns from colonies Great Gull Island and Buzzards Bay forage relatively close to their nests, but some do travel up to approximately 50 km (31 miles) along the coast to other nearshore foraging sites (Loring *et al.* 2019). These foraging habitats are a minimum of approximately 30.5 km (19 miles) distant from the outermost bound of potential fish behavioral effects, indicating underwater noise effects from this project element are likely insignificant.

Forage fish in proximity to the sea-to-shore transition may be affected by underwater noise from cofferdam installation. For the South Fork Wind Farm project, Denes et al. (2021) modeled the distance required to attenuate underwater noise from vibratory hammer installation of the sheetpile cofferdam. Given the similarity in methods, the modeling results are also applicable here. They calculated that underwater noise would attenuate to the fish behavioral effects threshold of 150 dB re 1 µPa within 779 m (0.49 miles) of the source. This indicates that vibratory pile driving would produce behavioral level noise effects in habitats used by inshore sand lance and, potentially, by foraging roseate terns. The significance of these behavioral effects is difficult to predict. For example, disturbed sand lance could become more or less available to predation depending on the nature of their behavioral response. However, if disturbed fish were temporarily less available the potential for adverse effects on roseate terns would be discountable as few if any roseate terns are likely to occur in this portion of the action area (see Section 3.2 and Figure 3.4).

Measured underwater root mean squared SPL of offshore WTGs typically range from 110 to 130 dB re 1 µPa, mostly in lower frequency bands, depending on operational speed and reference distance (Betke *et al.* 2004; Jansen and de Jong 2016; Marmo *et al.* 2013; Nedwell and Howell 2004; Tougaard *et al.* 2009). Based on prior observations by Jansen and de Jong (2016) and ambient noise levels described above, operational underwater noise would not be audible outside the immediate vicinity of the RWF, would not exceed fish injury or behavioral thresholds, and would therefore have no measurable effect on prey availability for roseate terns.

4.2 Northern Long-Eared Bat

The NLEB may occur in the terrestrial component and rarely in the aquatic component of the action area during project construction and operation. Potential direct and indirect effects of the proposed action on NLEB are addressed below.

4.2.1 Direct Effects

Potential direct effect mechanisms resulting from construction, operation, and decommissioning of the proposed action on NLEB include:

- Noise effects: Exposure to elevated airborne noise during project construction
- Electromagnetic field (EMF) effects: Exposure to induced magnetic fields associated with the RWEC – onshore
- Vessel and vehicle traffic effects: Exposure to disturbance from and interaction with project-related vehicles and vessels
- Collision risk: Risk of collision and/or interaction with WTGs, the RWF offshore substations, and marine construction equipment

The likelihood of exposure to and significance of these potential effect mechanisms on NLEB are evaluated in the following sections.

4.2.1.1 Noise Effects

RWEC – Onshore construction would produce airborne noise in excess of ambient conditions in the action area (see Section 4.1.1.1). The Applicant would comply with 4(d) Rule requirements for avoiding adverse effects on NLEB, meaning that tree removal, vegetation clearing, and other major noise-producing activities in proximity to potential bat habitat would take place during winter months when NLEB are not present. Other airborne construction and operational noise effects on NLEB are likely to be insignificant based on the same rationale presented for ESA-listed bird species in Section 4.1.1.1.

4.2.1.2 Electromagnetic Field Effects

The RWEC – Onshore transmission cable would produce an induced magnetic field in the immediate proximity of the cable path. Exponent (2020) modeled EMF effects from the operation of the buried onshore transmission cable. They determined that induced magnetic field strength would peak at 73 milligauss (mG) directly above the cable centerline and decrease rapidly to 11 mG or less at a distance of 3.8 m (12.5 feet). The range of values shown is dependent on transmission levels. EMF effects decrease rapidly with distance, effectively reaching zero at 25 feet on either side of the cable path regardless of initial field strength (Exponent 2020). The RWEC sea-to-shore transition would be buried more than 60 feet below the surface, so induced EMF effects on shoreline habitats would be effectively unmeasurable.

The potential significance of EMF exposure must be considered relative to existing conditions within the action area. The RWEC – Onshore would be operated in an environment with high baseline levels of EMF. The National Institutes of Health (NIH) (2002) determined that approximately 95 percent of the U.S. population has an average daily EMF exposure of approximately 4 mG. This value is likely representative of average conditions in the terrestrial portion of the action area based on its developed suburban character. Localized EMF levels in proximity to electrical power grid sources are considerably higher. Typical magnetic fields within 50 feet of distribution lines range from 10 mG to 20 mG for main feeders and 3 mG to 10 mG for laterals under typical loads, reaching as high as 40 mG to 70 mG under peak loads depending on the amount of current being carried (NIH 2002). High voltage overhead transmission lines produce even higher EMF levels. EMF levels from the RWEC – Onshore would be negligible by comparison.

Bats use the Earth's magnetic field for spatial orientation during migration and foraging, calibrating their magnetic compass against visual cues like the sky's polarization pattern and the location of the sun on the horizon (Greif *et al.* 2014; Holland *et al.* 2010). The available evidence indicates that bats are sensitive to magnetic fields at least as low as 100 mG (Tian *et al.* 2015). Assuming this level of sensitivity, EMF effects from the RWEC – Onshore would not be detectable by bats, even directly above the duct bank centerline. Thus, NLEB are not expected to encounter detectable EMF levels from the RWEC over the lifetime of the project.

Given this context, potential EMF effects on NLEB are likely insignificant for two reasons. First, NLEB in the terrestrial action area experience baseline EMF levels from existing sources that are higher than those likely to result from the proposed action. Second, bats have the documented ability to calibrate their magnetic compass to localized field variations using other environmental cues (Greif *et al.* 2014; Holland *et al.* 2010; Tian *et al.* 2015). NLEB persistence in the terrestrial component of the action area despite the presence of existing EMF sources indicates that the species can also adapt to the comparatively minimal EMF effects of the proposed action without significant physiological or behavioral consequences.

4.2.1.3 Vessel and Vehicle Traffic

Construction of the onshore components of the RWEC will involve a range of construction equipment types, from standard pickup trucks to HDD boring machines. Tech Environmental (2021) inventoried equipment and vehicles required for construction of each project element and calculated hours per year of engine operation for the COP air emissions inventory. They estimated a total of approximately 203,500 engine hours per year across all equipment types during construction and installation of the OnSS and RWEC-Onshore. A percentage of these hours will include active vehicle traffic on local roads adjacent to potential NLEB habitat.

State highways in Rhode Island totaled 868,942 vehicles in 2019 (BTS 2021). While engine hours and vehicle trips are not directly comparable, their relative magnitude indicates that project construction will have a negligible effect on baseline vehicle traffic in the action area. Therefore traffic-related disturbance effects on NLEB would be insignificant.

4.2.1.4 Collision Risk

Stantec (2018) documented NLEB in offshore habitats within and in proximity to the aquatic component of the action area. Based on the findings of this site-specific study and observations of bat use of offshore habitats in the scientific literature, NLEB could occur in the aquatic component of the action area, including the RWF, in small numbers during project construction and operation. This in turn indicates the potential for interaction with construction vessels and equipment, and the operating WTGs and offshore substation once the RWF is operational.

Bats flying over the open ocean are attracted to available structures, including vessels and, potentially, the OSS and WTG towers (Stantec 2018). Bats are agile fliers, so collision risks associated with the OSS, stationary construction vessels, and even moving project vessels are negligible. NLEB may use project vessels as temporary roosting habitat, providing beneficial resting habitat. As stated in Section 4.1.1.2, the proposed action will not significantly alter the baseline levels of vessel traffic in the action area, meaning that any effects on offshore roosting behavior would likely be insignificant relative to baseline conditions.

Observed bat mortality at onshore wind farms and the attractive effect of WTG structures suggests potential risk of injury from collision or barotrauma. The likelihood of injury is a function of bat flight behavior relative to WTG operational speeds. Modern WTGs typically have cut-in speeds on the order of 3 m/sec to 5 m/sec (9.8 to 16.4 ft/sec), with larger structures typically on the higher end of this scale (Astolfi *et al.* 2018; van Bussel *et al*. 2013). While the Applicant has not selected a final design, the selected WTGs will be large, either 8 MW or 12 MW, suggesting that cut-in speed could be towards the higher end of this range. Insectivorous bats typically fly at night when wind speeds are less than 5 m/sec, indicating that adverse WTG effects on bats could largely be avoided using cut-in speeds above this threshold (Wellig *et al*. 2018).

The effects of the WTG Towers and the OSSs on NLEB are less clear. Bats foraging and migrating over distant offshore habitats in and around the RWF could benefit from the presence of temporary resting areas. In contrast, the attractive nature of these structures could be detrimental if they increase injury risk. However, these risks are likely discountable because few if any NLEB are likely to occur in the RWF and occurrence is most likely when winds are below WTG cut-in speeds (see Section 3.2).

Collectively, the available information indicates that occurrence of NLEB in the marine component is likely to be very rare and in small numbers. Any exposure is unlikely to result in injury-level effects because NLEB are unlikely to fly at operational wind speeds. Although it is possible that NLEB may take advantage of roosting areas provided by offshore structures, the resulting effects of this behavior are unclear. They are likely insignificant based on the rare occurrence of this species in the offshore environment.

4.2.2 Indirect Effects

RWEC construction and operation could result in indirect effects on NLEB. Construction of the upland components of the RWEC would temporarily disturb up to 14.2 acres along the cable path and within the OnSS and interconnection facility footprints. As stated in Section 2.2.1, the upland portion of the RWEC corridor runs adjacent to and largely within road and railroad right of ways. Most of the duct bank will be placed under existing road right of ways to minimize property and habitat impacts. Heavy construction equipment would be used to clear surface material, dig the trench, install the duct bank, and lay the transmission line, followed by reburial and resurfacing. These activities would take place during daylight hours and, in the case of vegetation clearing in potentially suitable habitat, would occur outside of the bat roosting period between May 1 and August 15, when NLEB are not present in the action area. Habitats disturbed during trench placement will be reseeded with native vegetation where practicable.

Construction of the RWEC OnSS and interconnection facility would permanently develop approximately 5.4 acres of primarily undeveloped ruderal forested swamp and mixed oak/white pine forest for electrical utility use. Consistent with the 4(d) rule (81 FR 1900-1922), the proposed winter construction schedule would effectively avoid direct impacts because there are no hibernacula present in this area or the vicinity. While the substation would eliminate suitable foraging and roosting habitat, the affected area represents a negligible percentage of suitable habitat in the vicinity so indirect effects on habitat availability would be insignificant. Bats may be attracted to insect prey drawn by facility lighting, but this would not represent a substantial behavioral alteration given the baseline levels of artificial lighting present in the terrestrial component of the action area and vicinity. Lighting-related effects will be minimized using minimum intensity, motion activation, and shielding and downward angling of light sources where practicable. Based on project timing, the limited area of effect relative to available habitat, and proposed impact avoidance and minimization measures, the indirect effects of the proposed action on NLEB are likely to be insignificant.

5 Cumulative Effects

Cumulative effects are those effects associated with future local, state, or private actions not involving federal actions that are reasonably certain to occur within the project action area of the federal action subject to consultation (50 FR 402.02).

State, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government or private actions may include changes in land and water uses, including ownership and intensity, any of which could adversely affect listed species or their habitat. While specific government actions are subject to political, legislative, and fiscal uncertainties, changes in the economy that have occurred in the last 15 years are likely to continue, with less large-scale resource extraction, more targeted extraction, and significant growth in other economic sectors.

6 Effect Determinations

BOEM has concluded that the construction, operation, and future decommissioning of the proposed RWF and RWEC project **may affect** but is **not likely to adversely affect** ESA-listed species under USFWS jurisdiction that are known to or could potentially occur in the action area. The supporting rationale for this effect determination is summarized by species in Table 6.1 and described further below. No currently designated critical habitat for USFWS ESA-listed species occurs in the action area; therefore, the proposed action will have **no effect** on critical habitat.

Table 6.1 Effect Determination Summary for USFWS ESA-Listed Species Known or Likely to Occur in the Action Area for each activity (or stressor)

Species	Overall Effect Determination	Effect Level by Mechanism											
		RWF Construction				RWEC Construction					RWF/RWEC Operation		
		Airborne noise and visual disturbance	Underwater noise	Seabed and water column disturbance	Vessel traffic	Airborne noise	Underwater noise	Seabed and water column disturbance	Upland disturbance	Vessel and vehicle traffic	Collision risk	EMF	Vessel and vehicle traffic
Piping plover	**May affect, not likely to adversely affect**	I	N	N	I	I	N	N	N	I	I	N	I
Roseate tern	**May affect, not likely to adversely affect**	I	D	D	I	I	I	I	N	I	I	N	I
Rufa red knot	**May affect, not likely to adversely affect**	I	N	N	I	I	N	N	N	I	I	N	I
Northern long-eared bat	**May affect, not likely to adversely affect**	I	N	N	I	I	N	N	I	I	I	I	I
N – No effect, I – Insignificant, D – Discountable, S – Significant													

Based on the analysis in Section 4, the construction, operations and maintenance, and eventual decommissioning of the proposed action is not likely to affect the USFWS ESA-listed species known or potentially occurring in the action area. This conclusion is based on the following rationale:

(1) Piping plover, roseate tern, and *rufa* red knot may occur in the aquatic component of the action area, but the effects of the proposed action would be insignificant and/or discountable because:

- Piping plover, roseate tern and *rufa* red knot may occur in the aquatic component of the action area but do so during high-visibility conditions and would be able to detect and avoid WTGs at considerable distance with insignificant effects on behavior.
- Based on the best available evidence and modeling methods, the likelihood of injury-level effects on piping plover, roseate, tern and *rufa* red knot from WTG collisions is discountable.
- Project design and environmental protection measures will avoid and minimize the potential for attraction to and collision with in-water structures (vhb 2022, Appendix R in vhb 2022).
- Construction noise and disturbance will have an insignificant effect on prey availability for roseate terns and no measurable effect on prey availability for piping plover and red knot.
- The proposed action will have no measurable effects on nesting habitat for roseate terns or *rufa* red knot or foraging habitat for red knot.

Therefore, the project **may affect**, but is **not likely to adversely affect** roseate tern and *rufa* red knot.

(2) NLEB are known to occur in the terrestrial and aquatic components of the action area, but the effects of the proposed action would be insignificant and/or discountable because:

- Construction-related impacts on upland habitat would take place during winter months when bats are not present in the activity area.
- Upland bat foraging and roosting habitat is not currently limiting in the action area and proximity.
- Project-related construction noise and traffic effects would be insignificant relative to the environmental baseline.
- Project-related EMF and lighting effects would be insignificant relative to the environmental baseline.
- WTG design and operation, including low impact lighting designs and cut-in speeds above 5 m/sec, will minimize the potential for blade collision.
- The presence of offshore structures may provide beneficial roosting habitat during offshore foraging and migration.

- Project construction and operation will not significantly alter marine vessel traffic in the action area relative to existing baseline conditions; therefore, any associated attractive effects on foraging and migrating bats would likely be insignificant.

Therefore, the project **may affect**, but is **not likely to adversely affect** Northern long-eared bat.

7 Environmental Protection Measures

This section outlines the environmental protection measures (EPMs) included in the proposed action to avoid and minimize potential impacts to protected species including ESA-listed species. Additional conditions, including mitigation, monitoring, or reporting measures, may be included in any BOEM-issued lease or other authorization, including those resulting from the ESA Section 7 consultation process.

7.1 Construction

The proposed action includes the following construction EPMs to avoid and minimize impacts on ESA-listed species:

- Conduct marine construction activities during approved in-water work windows developed in consultation with the Services. EPMs and additional mitigation measures are expected to restrict pile driving activities to between May and October to protect species sensitive to underwater noise.
- Develop and implement an approved construction monitoring plan using Protected Species Observers.
- Use best available noise attenuation technology and methods where practicable.
- Comply with the Northern Long-Eared Bat 4(d) rule (81 FR 1900-1922) to avoid and minimize long-term impacts on the species and sensitive upland habitats.
- Develop and implement an approved oil spill response plan (OSRP) for marine and upland construction activities. OSRPs are intended to limit the size of accidental spills and provide a plan for rapid cleanup to avoid and minimize effects on aquatic habitat.
- Develop and implement an approved Spill Prevention, Control, and Countermeasures plan for upland construction activities.

7.2 Operation

The proposed action includes the following operational design elements to avoid and minimize impacts on ESA-listed species:

- Lighting would be designed to avoid and minimize potential attractive or behavior-altering lighting effects as follows:
    - The Lessee will only use red flashing strobe-like lights that meet Federal Aviation Administration requirements for aviation obstruction lights.
    - Any additional lighting (e.g., work lights) on WTG towers and support vessels must be used only when necessary, hooded downward, and directed when possible to reduce upward illumination and illumination of adjacent waters.
    - Use of ADLS, which would only activate the Federal Aviation Administration hazard lighting when an aircraft is in the vicinity of the wind facility.

- The Lessee will coordinate with the Lessor and USFWS to finalize a bird and bat post-construction monitoring plan prior to the commencement of operations. A draft of the proposed monitoring plan has been developed and is provided in Appendix C (Goodale et al. 2022). A summary of the proposed avian and bird monitoring activities is provided below in Table 7.1 Within the first year of operations, the Lessee is to install digital VHF telemetry automated receiving stations and acoustic monitoring devices according to guidance for offshore automated radio telemetry to estimate the exposure of ESA species and other migratory birds to the operating wind facility. In addition, the Lessee will install acoustic bat detectors and acoustic/imaging detectors for birds. The monitoring plan will include periodic monitoring progress reports plus comprehensive annual reports followed by a discussion of each year's results with BOEM and USFWS. DOI will use the annual monitoring reports to assess the need for reasonable revisions (based on subject matter expert analysis) to the Monitoring Plan. DOI reserves the right to require reasonable revisions to the Monitoring Plan and may require new technologies as they become available for use in offshore environments. If the reported monitoring results deviate substantially from the impact analysis included in the FEIS/BA, the Lessee must transmit to DOI recommendations for new mitigation measures and/or monitoring methods.
- To minimize attracting birds to operating turbines, the Lessee must install bird-deterrent devices on turbines and the OSS. The location of bird-deterrent devices must be proposed by the Lessee based on best management practices applicable to the appropriate operation and safe installation of the devices. The Lessee must confirm the locations of bird-deterrent devices as part of the as-built documentation it must submit with the FDR.
- An annual report shall be provided to BOEM and USFWS 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 United States Geological survey Bird Band Laboratory, available at https://www.pwrc.usgs.gov/bbl/. Any occurrence of a dead ESA bird or bat must be reported to BOEM, BSEE, and USFWS as soon as practicable (taking into account crew and vessel safety), but no later than 24 hours after the sighting, and if practicable, carefully collect the dead specimen and preserve the material in the best possible state.

Table 7.1. Avian and Bat Monitoring Objectives, Questions, and Proposed Monitoring Approach and Duration (Goodale et al. 2022).

Taxa	Monitoring Objective	Primary Questions	Approach	Duration
Bats	Monitor occurrence of bats	What times of year and under what environmental conditions are bats detected in the wind farm?	Acoustics	2 years
Birds	Monitor use by ESA listed birds	What times of year and under what environmental conditions are ESA birds present in the wind farm?	Radio-tags	up to 3 years
Birds	Monitor use by nocturnal migratory birds	What are the flux rates and flight heights of nocturnally migrating birds?	Radar	1–2 years
Birds	Monitor movement of marine birds around the turbines	What are the avoidance rates of marine birds?	Radar	1–2 years
Both	Document mortality	What dead or injured species are found incidentally?	Incidental observations	Project lifetime

7.3 Decommissioning and Site Clearance

The Applicant’s COP (vhb 2022) describes EPMs included in the proposed scenario for decommissioning and removal of the RWF and RWEC at the end of facility service life. The purpose of decommissioning is to remove and recover valuable recyclable materials, meaning that the majority of project features will be removed from the environment. Per 30 CFR 585.910(a), the WTG foundations must be removed by cutting off the piles at least 4.6 m (15 feet) below mudline. BOEM assumes the WTG towers and foundations can be removed using non-explosive severing methods. The inter-array and RWEC transmission cables would be extracted from the seabed using methods and equipment similar to those used for construction. Cable segments that cannot be recovered would be cut and left buried.

As detailed in 30 CFR Part 585.902, the lessee must submit an application and receive approval from BOEM before commencing with the decommissioning process. Final approval of this application is a separate process from approval of the conceptual decommissioning methodology in the COP.

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Appendix A – Species List

Appendix B – Collision Risk Model Inputs and Outputs

The following pages present the outputs of two models used to assess collision risk of birds through wind farms. The results were generated by BOEM in November 2022 using a revised version of the Band (2012) model and the Stochastic Collision Risk Assessment for Movement (SCRAM) model (Gilbert et al. 2022). Two scenarios were assessed for each of the three ESA-listed bird species included in this BA: 1) 100, 8-MW turbines with a 36 m air gap, and 2) 74, 12-MW turbines with a 46 m air gap. Additionally, for red knot, a third scenario was run: 80, 11-MW turbines with both a 36 m and 46 m air gap. Refer to the following information for details on the model inputs and results. Pages 3-4 of each of the SCRAM outputs provides the model inputs, and the results are provided on pages 5-10. For the Band model, the first sheet of each output provides the details of the model inputs. The second sheet presents the overall collision risk applying the number of bird transits, flight timing, flight height distribution, and avoidance rates. The results for each bird species are summarized in Section 4.1.1.4 of the BA.

Appendix C – Avian and Bat Post-Construction Monitoring Framework