South Fork Wind Farm and South Fork Export Cable - Development and Operation

Biological Assessment

January 2021

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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Contents

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Acronyms and Abbreviations

µPa	micro Pascal
AC	alternating current
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
dB_{peak}	Peak decibels
dB_{RMS}	root mean square decibels
EIS	Environmental Impact Statement
EMF	electromagnetic field
EPM	environmental protection measure
ESA	Endangered Species Act
FAA	Federal Aviation Administration
HDD	horizontal directional drill
Hz	hertz
kV	kilovolt
LIPA	Long Island Power Authority
mG	milligauss
mg/L	milligrams per liter
MLLW	mean lower low water
MMS	Minerals Management Service
MSL	mean sea level
MW	megawatt
NLAA	not likely to adversely affect
NLEB	Northern long-eared bat
O&M	operations and maintenance
OCS	Outer Continental Shelf
OSRP	oil spill response plan
OSS	offshore substation (a.k.a. electric service platform)
PDE	Project Design Envelope
RI/MA WEA	Rhode Island/Massachusetts Wind Energy Area

RSZ	rotor swept zone
SAP	Site Assessment Plan
SFEC – NYS	South Fork Export Cable – New York State waters element
SFEC – OCS	South Fork Export Cable – outer continental shelf element
SFEC – onshore	South Fork Export Cable – Onshore element
SFEC	South Fork Export Cable
SFWF	South Fork Wind Farm
SPCC	spill prevention, control, and countermeasures
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
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 South Fork Wind Farm (SFWF) and South Fork Export Cable (SFEC), a commercial wind energy facility. The SFWF would be constructed in the Rhode Island/Massachusetts Wind Energy Area (RI/MA WEA) on the Atlantic Outer Continental Shelf (OCS). The SFEC extends from the RI/MA WEA to eastern Long Island and includes appurtenant project elements in nearshore, coastal, and upland habitats on eastern Long Island. For simplicity, the BA refers to the SFWF and SFSC collectively as the “Project”.

The Project includes up to 15 wind turbine generators (WTGs or turbines) with a nameplate capacity of 6 megawatts (MW) to 12 MW per turbine, an offshore substation (OSS), and a submarine transmission cable network (the inter-array cable) connecting the WTGs to the OSS, all of which 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 19 miles (30.6 kilometers [km], 16.6 nautical miles [nm]) southeast of Block Island, Rhode Island, and 35 miles (56.3 km, 30.4 nm) east of Montauk Point, New York. The SFWF also includes an Operations and Maintenance (O&M) facility that will be located onshore at a commercial port facility in Lake Montauk Harbor in East Hampton, New York.

The SFEC is an alternating current (AC) electric cable that will connect the SFWF to the mainland electric grid in East Hampton, New York. The SFEC includes both offshore and onshore segments. Offshore, the SFEC is located in federal waters (SFEC – OCS) and New York State territorial waters (SFEC – NYS). The SFEC will be buried to a target depth of 4 feet to 6 feet below the seabed except in areas where substrate conditions are limiting. The onshore segment of the export cable (SFEC – onshore) will be located in East Hampton, New York. The SFEC – NYS will be connected to the SFEC – Onshore at a sea-to-shore transition point where the two cable segments will be spliced together. The SFEC includes a new Interconnection Facility to link the SFEC to the Long Island Power Authority (LIPA) electric transmission and distribution system. The Interconnection Facility will be located in the town of East Hampton, New York (Figure 1.1).

This biological assessment (BA) evaluates the potential effects on ESA-listed species resulting from the construction, operation, 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 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 CFR 585.

Deepwater Wind South Fork, LLC (the Applicant) has submitted the draft COP for the Project 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 Code of Federal Regulations (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 Operation 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

Before a lessee may build an offshore wind energy facility on their commercial wind lease, they must submit a COP for review and approval by BOEM (see 30 CFR 585.620(C)). 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 BOEM to consider the maximum impacts that could occur from the range of potential design parameters.

1.4 EIS Alternatives

The proposed action addressed in this BA is the PDE maximum impact scenario for the construction, operation, and decommissioning of the SFWF and SFEC as described in the COP. Likewise, the PDE is analyzed in the EIS, and consequently all alternatives analyzed in the EIS are within PDE, therefore, this BA 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 and roseate terns, 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 monopole 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.

On March 24, 2011, BOEM requested informal ESA Section 7 consultation with the USFWS for lease issuance and site assessment activities off New Jersey, Delaware, Maryland, and Virginia. On June 20, 2011, the USFWS concurred with BOEM's determinations that the risk to the roseate tern, piping plover, Bermuda petrel (*Pterodroma cahow*), and (then-candidate) *rufa* Red Knot (*Calidris canutus rufa*) from site characterization and site assessment activities (construction, operations, maintenance, and decommission of buoys and meteorological towers) associated with lease issuance was "small and insignificant" and therefore not likely to adversely affect the three ESA-listed species and one candidate species occurring in the action area.

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 MA WEA in 2012. The RI/MA WEA is comprised 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 (USCG) 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 is comprised of five 6-MW wind turbines within 3 miles (4.8 kilometers) of Block Island, Rhode Island. 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 is comprised 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 comprised of 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 SFWF and SFEC, BOEM provided this BA to the USFWS via email correspondence on January 8, 2021, for review and/or concurrence. On February 1, 2021, BOEM provided supplemental information regarding the Montauk Operations and Maintenance Facility and Horizontal Directional Drilling (Appendix B).

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 decommissioning of the SFWF and SFEC as described in the COP. The project area includes upland and coastal nearshore habitats on eastern Long Island and adjacent New York State waters, and ocean habitats in the RI/MA WEA on the OCS offshore of New York, Rhode Island, and Massachusetts (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 marine components. The terrestrial component includes the area affected –the onshore construction, operation, and decommissioning and the upland components of the O&M facility. The marine component includes the open ocean above and below the water surface affected by construction and operation of the wind farm and marine cabling.

Airborne and underwater noise associated with project construction are the most geographically extensive effects of the action. For this, BA the action area is defined by the largest distance required for 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 2-mile (3.2-km) airborne noise radius extending outward from each monopile foundation
- An 8.0-mile (12.9-km) underwater noise radius extending outward from each monopile foundation
- A 3,100-foot (950-meter) airborne noise radius extending outward from the sea-to-shore transition
- A 0.5-mile (0.8-km) underwater noise radius extending outward from the sea-to-shore transition location in a semi-circle bounded by the Long Island shoreline.
- A 250-foot (76-meter) airborne noise radius extending outward from upland construction activities

- A 250-foot (76-meter) airborne noise radius extending outward from dredging activities in Lake Montauk Harbor

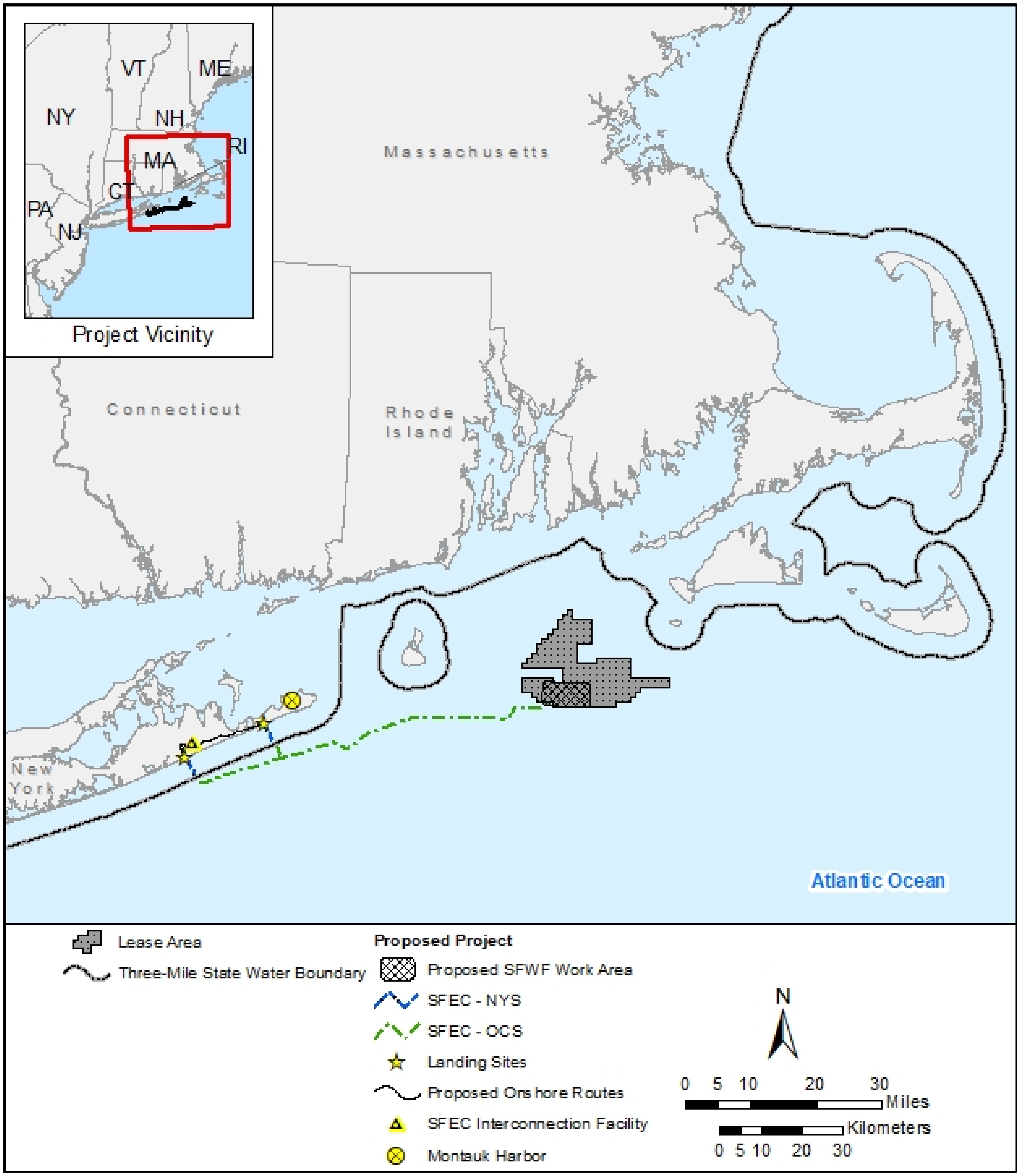


Figure 1.1 Project Area

2 Description of the Proposed Action

The proposed action is 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 SFWF and the SFEC 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 the design alternative that will result in the greatest potential impact on the environment. For example, the Applicant's COP says either 6-MW or 12-MW WTG may be used; therefore, the effects of the larger 12-MW design are analyzed for this Project because those 12-MW WTGs are larger and thus would affect a larger overall area.

PDE parameters for the Project are summarized in Table 2.1. Project construction, operation, and conceptual decommissioning methods, and proposed environmental protection measures, are described in the following sections.

2.1 South Fork Wind Farm

The SFWF includes two primary components: the offshore windfarm composed of WTGs, the inter-array cable, the OSS, and the portside O&M facility. 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 (Deepwater Wind 2018).

2.1.1 Construction

The SFWF would erect up to 15 WTGs and a single OSS within the proposed project area (Figure 1.1). The selected WTGs would be at least 6 MW but could be as large as 12 MW. The WTGs would be mounted on 36-foot (11-meter) diameter monopile foundations driven up to 150 feet (46 meters) into the seabed using an impact hammer deployed on a jack-up or heavy lift barge or similar purpose-built construction vessel. The OSS would be supported by a single monopile that is identical to a WTG's monopile and installed using the same construction methods. The OSS connects inter-array cable network to the SFEC transmission line. Monopile installation would require approximately 80 days, with each individual monopile requiring 4 to 5 days to install. 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 from 2 to 4 hours of continuous impact hammering to reach the desired installation depth. Pile driving would be restricted to daylight hours only.

The WTGs would be connected to the OSS by the inter-array cable network, 30 combined miles of transmission cables. A deep-sea 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 plow 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 rocks or concrete blankets. Additional details about this construction method are provided in the COP (Deepwater Wind 2018).

The Project includes the development of an onshore O&M facility, composed of office space for the operations center, warehouse and shop space for tools and replacement equipment, and a berthing area for maintenance vessels. The O&M facility would be developed in Lake Montauk Harbor, in Easthampton on Long Island, New York. The exact location has yet to be determined but it would most likely be on a property adjacent to the federally maintained navigation channel and boat basin. In-water and over-water construction elements may include dredging to achieve required depths for berthing the O&M vessels and possible pier improvements. The upland elements (office buildings and warehouse space) would repurpose existing buildings and/or be built on currently developed land.

Table 2.1 Project design envelope maximum impact table

Project Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact
SFWF	Turbine selection/spacing	Installation disturbance area	WTG size	12 MW
			Number of turbines	15
			Rotor height above mean sea level	840 feet at peak 105 feet minimum
			Spacing	1 statute mile
			Array area	9 square miles
	Monopile foundation installation	Habitat alteration, physical disturbance	Number of monopiles	16
			Monopile diameter	36 feet/11 meters
			Footprint area total (with scour protection)	15.6 acres
			Installation method	4,000 kJ impact hammer 1,500 strikes/day (typical) 3,000 strikes/day (difficult) 1 pile per day 80 days total (4-5 days between pile driving events)
			Underwater noise (approximate)	227 dB_{peak} 216 dB_{RMS}
	Inter-array cable construction	Physical disturbance, turbidity	Total length	30 miles
			Installation method	Cable trenching/burial 4 to 6 feet depth
			Disturbance area	87 acres
			Long-term disturbance footprint	12.5 acres
			Activity duration	30 days
	O&M facility construction	Dredging disturbance, entrainment, water quality effects	Activity duration	1 to 2 days
			Water quality effects	TSS levels up to 100 mg/L over activity duration
	Construction vessels	Physical disturbance, noise	Number of vessels	13
			Anchoring disturbance	821 acres
			Vessel noise	171 dB_{RMS} @1 meter
	Operation	Airborne disturbance area	Rotor swept area (per turbine/total)	424,173 square feet/turbine 6,362,595 square feet total

Project Element	**Design Envelope Element**	**Effect Mechanism**	**Measurement Parameter**	**Maximum Impact**
			Cut-in speed	Not Available
		Operational EMF	Transmission voltage	34.5 kV
			Magnetic field	9.14 mG (buried cable) 65.13 mG (exposed cable)
			Induced electrical field	Buried cable: 1.4 mV/m Exposed cable: 17 mV/m
		Vessel traffic	Number of vessels	2
			Anchoring disturbance	None
			Vessel noise	171 dB_{RMS} @1 meter
SFEC	Export cable construction	Installation disturbance area	Total length	OCS: 57.9 miles/93.2 km NYS: 3.5 miles/5.6 km‡
			Installation method	Cable trenching/burial 4 to 6 feet depth
			Disturbance area	OCS: 73 acres NYS: 4.4 acres
			Long-term disturbance footprint	OCS: 21.1 acres NYS: 1.3 acres
			Activity duration	74 days
		Vessel traffic	Number of vessels	11
			Anchoring disturbance	None
			Vessel noise	171 dB_{RMS} @1 meter
	Sea-to-shore transition construction	Cofferdam installation/removal	Cofferdam footprint	1,825 square feet
			Excavation/sidecast	825 cubic yards
			Sheetpile size	Z-Type typical
			Number of sheetpiles	100
			Underwater noise	185 dB_{RMS} @10 meters
			Airborne noise	101 dBA @50 feet
			Piles per day	100
			Total pile driving days	2
			Construction duration	12 weeks
	SFEC-onshore construction	Temporary disturbance	Habitat alteration (cable trenching, burial)	4.5 acres

Project Element	Design Envelope Element	Effect Mechanism	Measurement Parameter	Maximum Impact
			Vehicle operation (noise, disturbance)	15,090 engine hours (all equipment types)
		Long-term habitat alteration	Substation footprint	2.4 acres
	Operation	Operational EMF	Transmission voltage	138 kV
			EMF generation - ocean	76.62 mG
			Induced electrical field - ocean	17 mV/m
		Vessel traffic	Number of vessels	None

‡ Maximum potential SFEC length based on the Beach Lane landing site.

Notes:

dBA = A-weighted decibels
dB_{peak} = Peak decibels
dB_{RMS} = Root mean square decibels
EMF = Electromagnetic field
kJ = Kilojoules
mG = Milligauss
mV/m = Millivolts per meter
TSS = Total suspended solids

2.1.2 Operation

The SFWF includes up to 15 WTGs, with a capacity of up to 12 MW. The 12-MW turbine would stand 472 feet above mean sea level (MSL) at hub height, with three 358-foot rotors. The rotor-swept area would extend from 105 feet to a total height of 840 feet (32 to 256 meters) above MSL. The inter-array cables would operate at a transmission capacity of 38.5 kilovolts (kV) to 66 kV, conveying electricity from the WTGs to the OSS.

The SFWF will be remotely monitored and operated from the onshore O&M facility. The WTGs and OSS will be regularly inspected and maintained by service technicians delivered by a dedicated crew transport vessel from a nearby port. The Applicant does not expect the inter-array cable 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 SFWF 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 ports.

The O&M facility vessel berthing area would need periodic maintenance dredging during project operations. Lake Montauk Harbor supports an active commercial fishing and recreational vessel fleet and a USCG station. Routine maintenance dredging of federal navigation channel, boat basin, and associated commercial and private mooring areas is required to maintain access for deeper draft vessels. O&M facility maintenance dredging would likely follow a similar schedule and would not substantively alter the baseline levels of disturbance associated with existing harbor and navigation channel maintenance. Similarly, O&M vessel operation would not substantively increase vessel-related noise and disturbance effects relative to baseline levels in this busy commercial and recreational harbor.

2.1.3 Decommissioning and Site Clearance

When the facility reaches the end of its designed service life (approximately 25 to 30 years), the SFWF would to be decommissioned and removed. 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. After the removal of WTGs and the OSS, the monopiles will be cut off below the seabed and placed onto a barge for transport. A cable laying vessel would be used to remove as much of the inter-array cable 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.

2.2 South Fork Export Cable

The SFEC is a marine electrical cable with PDE transmission capacity of 138 kV to 260 kV. The SFEC is broken into three discrete segments: the offshore SFEC – OCS and SFEC – NYS segments, and the SFEC – Onshore segment. The SFEC-OCS and SFEC-NYS segments would be approximately 57.9 miles and 3.5 miles in length, respectively, for a potential total length of 61.4 miles. The SFEC - NYS 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 (Deepwater Wind 2018).

2.2.1 Construction

The offshore SFEC segments would be constructed using standard marine construction techniques described in the COP (Deepwater Wind 2018). 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 SFEC – Onshore segment includes the terrestrial or upland cable path from the shoreline to a proposed onshore substation connecting the project to the LIPA electrical grid. There are two possible SFEC – Onshore alignments: 1) a 4.1-mile route from the Beach Lane landfall in the Town of East Hampton; and 2) an 11.9-mile route from the Hither Hills landfall in the Town of Montauk. The effect analysis in this consultation considers the maximum potential length of each SFEC segment.

The SFEC – NYS and SFEC – Onshore components would be connected at a sea-to-shore transition point approximately 1,750 feet (535 meters) offshore from mean lower low water (MLLW). A horizontal directional drill (HDD) would be used to tunnel approximately 65 feet (20 meters) below the beach and 20 to 35 feet (8 to 11 meters) below the seabed to the transition point. A temporary sheetpile cofferdam would be placed around the transition point using a crane and vibratory hammer deployed from a construction barge. Vibratory pile installation would require 10 hours of hammer operation per day over 2 to 3 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 SFEC – NYS. The connected segments would then be sealed, reburied with native seabed sediments, and the cofferdam would be dismantled and removed. The sheet piles would be cut 4 feet (1.2 meters) above the sea floor for removal.

SFEC – Onshore construction includes installation of buried utility vaults and monitoring equipment at the onshoring site and excavation of an underground duct bank along the entire cable route. The duct bank will be constructed entirely within public rights-of-way and an existing rail corridor. The specific configuration of the duct bank is not yet determined; however, the ducts would be placed within a 4-foot × 8-foot trench along the onshore route. The duct bank would be constructed by clearing existing road or sidewalk surfaces where necessary, excavating a trench, constructing a section of duct bank, laying the cable and concrete armoring, and then reburying. Road surfaces, sidewalks, or railroad prism would be replaced. Disturbed ground would be revegetated with suitable species where appropriate.

2.2.2 Operation

The SFEC marine segments would be remotely monitored from an onshore facility. The Applicant does not expect the SFEC 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.

2.2.3 Decommissioning and Site Clearance

When the SFWF reaches the end of its designed service life (approximately 25 years to 30 years), the SFEC would be decommissioned and removed. The same types of vessels and equipment used to install the SFEC 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 SFEC transmission cable 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.

3 Threatened and Endangered Species Occurrence in the Action Area

In 2018, the USFWS IPaC system identified ESA-listed species under the USFWS’s jurisdiction that are likely to occur in the action area (see Append B in Stantec 2018). Of the six ESA-listed species under USFWS jurisdiction that have the potential to occur in the general vicinity of the proposed action, five 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**	
		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	N/A
Bats			
Northern Long-eared Bat (*Myotis septentrionalis*)	Threatened – 5/4/15 80 FR 17973	Yes	N/A
Plants			
Sandplain Gerardia (*Agalinis acuta*)	Endangered – 9/7/88 53 FR 34701	No	N/A
Seabeach Amaranth (*Amaranthus pumilus*)	Threatened – 4/7/93 58 FR 18035	Yes	N/A

3.1 Birds

The Atlantic coast is a major flyway for many migratory bird species. Three ESA-listed bird species 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 and 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, there is little risk of near-term extinction of the Atlantic Coast population of piping plovers (Plissner and Haig, 2000), and since that prediction, 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 2020). 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 extends from April through August, with piping plovers arriving at breeding locations in mid-March and into April. Post-breeding staging in preparation for migration extends from late July through September (USFWS 1996). 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). Nests 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 a narrow strip along the Atlantic coast. Due to the difficulty in detecting piping plovers in the offshore environment during migration because of the assumed nocturnal and high-elevation migratory flights, there are no definitive observations of this species in offshore environments greater than 3 miles from the Atlantic coast (Normandeau et al. 2011). There are no records of piping plovers in the offshore Action Area during surveys (USFWS 2018d).

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. After juveniles have fledged, adults and subadults stage in foraging areas from late July through September, rarely into October, to prepare for southward migration (USFWS 2009). Based on counts in 2017, there were 650 breeding pairs recorded in Massachusetts, 7 in New Hampshire, 64 in Maine, and 169 in Canada (USFWS 2018c); a total of 1,780 adult birds. The 3-year average nesting pair count in Massachusetts in 2017 was 658 (MDFW 2018).

Nesting piping plovers have also been documented annually on Long Island immediately to the east and west of the terrestrial component of the action area (Duryea *et al.* 2017, 2018; Stantec 2018). The Town of Southampton Endangered Species Program and partnering agencies have conducted annual plover nesting surveys on up to 26 miles of shoreline habitat on eastern Long Island since 2000 (Duryea *et al.* 2018). Nesting pairs have been observed in every survey year, ranging from 19 total pairs in 2000 to a high of 53 in 2017. In 2017 and 2018, Duryea *et al.* (2017, 2018) observed 49 and 44 nesting pairs of piping plovers, respectively, over a 16-mile coastal survey area approximately 5 miles to the west of the SFEC Beach Lane landing site. In 2017, six nesting pairs were observed at Napeague Beach, approximately 1-mile (1.6 km) west of the Hither Hills State Park landing site (Duryea *et al.* 2017). These findings indicate that nesting plovers could occur in the terrestrial component of the action area at either sea-to-shore transition site.

A small percentage of adult and subadult migrant piping plovers may fly over the offshore component of the action area. The RI/MA WEA lies within the migratory corridor for 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. They 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 SFWF while 20 percent (8 out of 40) plovers leaving Massachusetts nesting areas during fall migration flew directly through the RI/MA WEA (see Figure 3.1). In addition, 20% flew at wind speeds <=4 m/sec (Loring et al. 2019) - 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 waters on the OCS (i.e., more than 3 miles offshore). Observed behavior confirmed prior theory (e.g., Normandeau 2011) that this species tends to fly at altitudes above the typical rotor swept zone (RSZ) of offshore windfarms when migrating. The mean flight altitude over federal waters was 942 feet (287 meters), with a 5th to 95th percentile range of 157 to 1,237 feet (48 meters to 377 meters). However, while the bulk of observed flight altitudes were above the 105-foot to 840-foot (32-meter to 256-meter) RSZ of the SFWF, approximately 25 percent of observed flight altitudes were at rotor height. Observed altitudes within the WEAs were higher on average, approximately 15 percent of transmitter pings were within the SFWF RSZ.

In spring, a pilot study found that plovers fitted with transmitters in the Bahamas traveled north close to shore along the US Atlantic coast, each taking weeks to move northward (Appendix I in Loring et al. 2019). No plovers were detected north of Montauk, NY, and there is no empirical evidence to suggest that plovers fly near or through the lease area in spring (Appendix I in Loring et al. 2019). During migration, most flights were above the turbine height with 15.2% of the Piping Plover flights within the rotor swept zone (Loring et al., 2019). Therefore, very little, if any, Piping Plover activity is expected with relatively few (7% out of piping plovers from MA and northward) would be flying through or over the action area during migration.

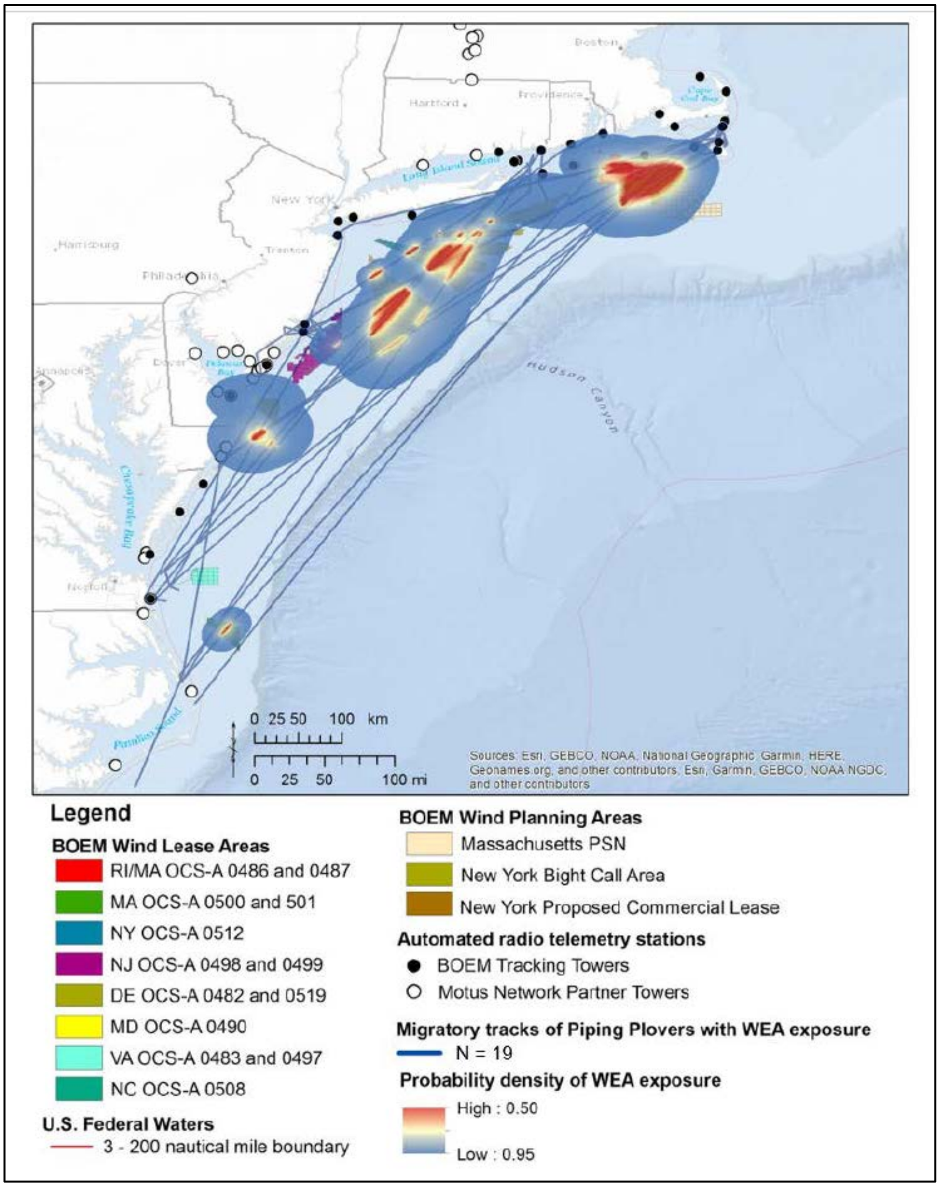


Figure 3.1. Modeled Migratory Tracks and Composite Probability Density of Piping Plovers with WEA Exposure in the Mid-Atlantic Bight, 2015 to 2017 (Loring et al. 2019, Figure 64).

3.1.2 Roseate Tern

The Roseate Tern is a small colonial tern. The Atlantic population segment breed from Long Island, New York, north and east to Quebec and Nova Scotia and winters along the northeastern coast of South America (USFWS 1998; USFWS 2010). Roseate Terns in the northwestern Atlantic population are listed under the ESA as endangered, while terns in the Caribbean population are listed as threatened (USFWS, 2010). No critical habitat has been designated for this species (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, and if time on the ocean was restricted to migration the population would be ranked medium.

The northwest Atlantic Ocean population of Roseate Tern breeds on small islands or on sand dunes at the ends of barrier beaches along the Atlantic coast, occurring in mixed colonies with Common Terns (*Sterna hirundo*). The breeding population of roseate terns is currently restricted to a small number of colonies located on predator-free islands from Nova Scotia to Long Island, New York, with as many as 87 percent breeding within just three colonies on islands off of Massachusetts and New York (BOEM 2012; USFWS 2010). Since 2010, the number of breeding pairs of roseate terns in the US and Canada has increased 45% from 3,013 to 4,374 in 2019 (USFWS, 2020). Breeding sites have also been documented on Little Gull and Gardiners islands north of the action area in Block Island Sound (Stantec 2018). Although roseate terns historically occurred in Rhode Island, there are currently no breeding colonies in the state (Paton *et al.* 2010; USFWS 2020a).

In the region, adult terns arrive at breeding sites beginning in April to initiate courtship prior to nesting (Gochfeld *et al.* 1998). Roseate terns dive <0.5 m into the water to forage primarily on the inshore sand lance (*Ammodytes americanus*) in shallow, 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 of their colony sites (Rock *et al.* 2007) but may occasionally travel as far as 30 km if necessary (Burger *et al.* 2011). Roseate Tern foraging behavior and ecology in the region is well described. Roseate Tern foraging flights are slow and range from 3 to 12 meters above the ocean surface. During the breeding season, most 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 2016, Loring et al. 2019; Figure 3.2). In sharp contrast to common terns, roseate terns are dietary specialists and exhibit strong fidelity to foraging sites and avoidance of clusters of other feeding tern species (Goyert 2015).

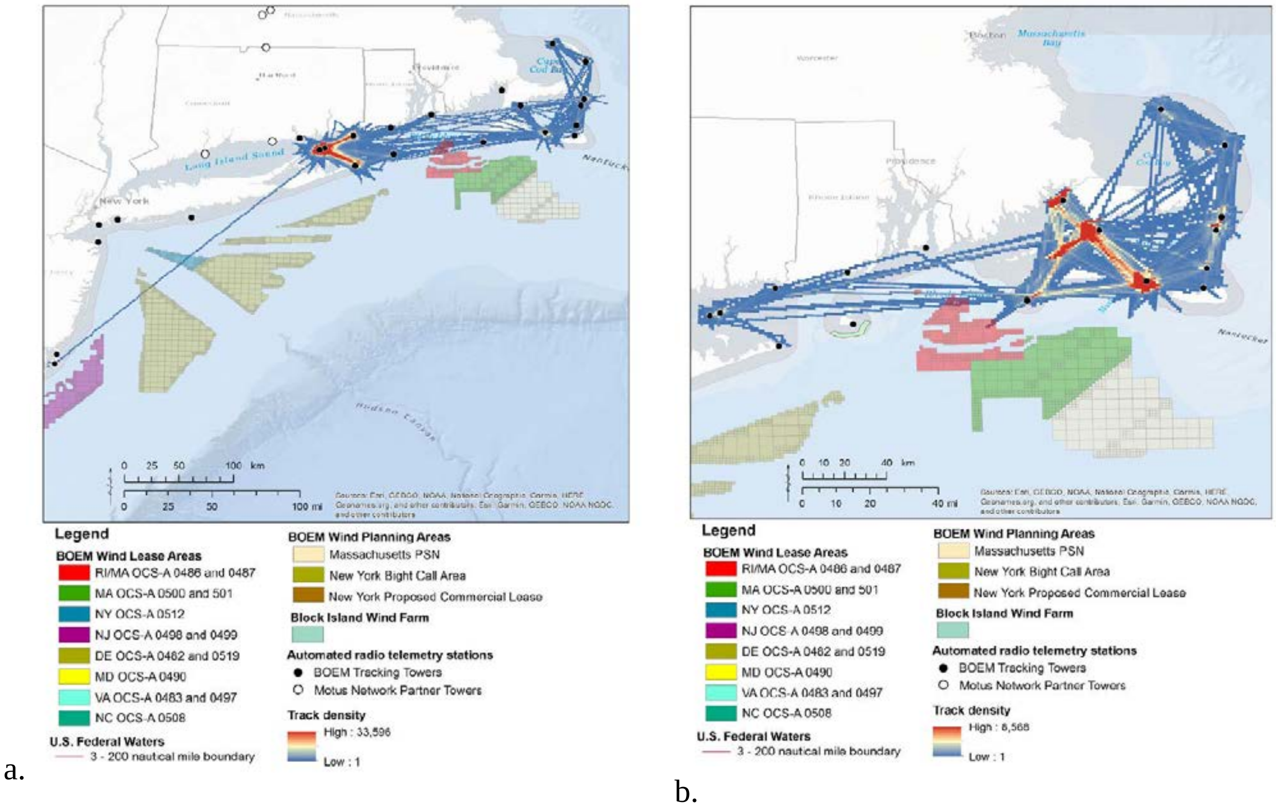
Juveniles fledge from late July to mid-August and the adults and subadults then occupy post-breeding staging areas through mid-September before migrating southward (Burger *et al.* 2011). The coastal region of southeastern Cape Cod, Massachusetts, in Buzzard's Bay near Chatham and Monomoy Island, is the most important post-breeding staging area for this species, supporting nearly the entire Northwestern Atlantic population (Burger *et al.* 2011).

The region including the lease area has been intensively surveyed over the years and across seasons for marine birds (Figure 3.3); no roseate terns were detected in the lease area or in the proposed offshore Action Area (USFWS 2018d and is illustrated in Figure 3.4). Modeling efforts based on those survey data predict that roseate terns are virtually absent from the offshore action area (Figure 3.5). 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 (terns that were not be identified as roseates were excluded from the analysis) and are 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. In addition, seasonal biomass estimates predict very little Sand Lance, the Roseate Tern's primary forage fish, in project area (Figure 3.6), thus explaining why there no roseate terns were observed in the project area (Figure 3.4) or predicted in the project area (Figure 3.5) and unlikely to forage in the project area.

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 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 greater than 5 km and departed the study area at low altitudes (Loring et al. 2019). In addition, 37.5% flew at wind speeds <=4 m/sec (Loring et al. 2019) - below the cut in speed for an offshore wind turbine. Roseate terns typically flew 11-20 meters above the water in the WEAs and flew below the rotor swept zone 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 WDA during migration; in fact, 6 percent (8 total) of the 145 terns tagged from 2015 through 2017 flew near the Lease Area during post-breeding dispersal (Loring et al. 2019; Figure 3.2).

Terns travel at 45 km per hour, so given that terns start their southward migration during good weather conditions, it is unlikely that they would encounter inclement conditions by the time they reached the lease area at that speed. However, in the unlikely event that the weather would suddenly change for the worse, terns could continue to fly low or ride it out by floating on the water until conditions improved.

In conclusion, based on the behavioral and foraging ecology, the telemetry data, the survey data, very little, if any, Roseate Tern activity is expected within marine waters in and around the WDA and should birds pass through the area they will be flying relatively close to the ocean surface during good weather conditions.



a.

b.

Figure 2.2. 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).

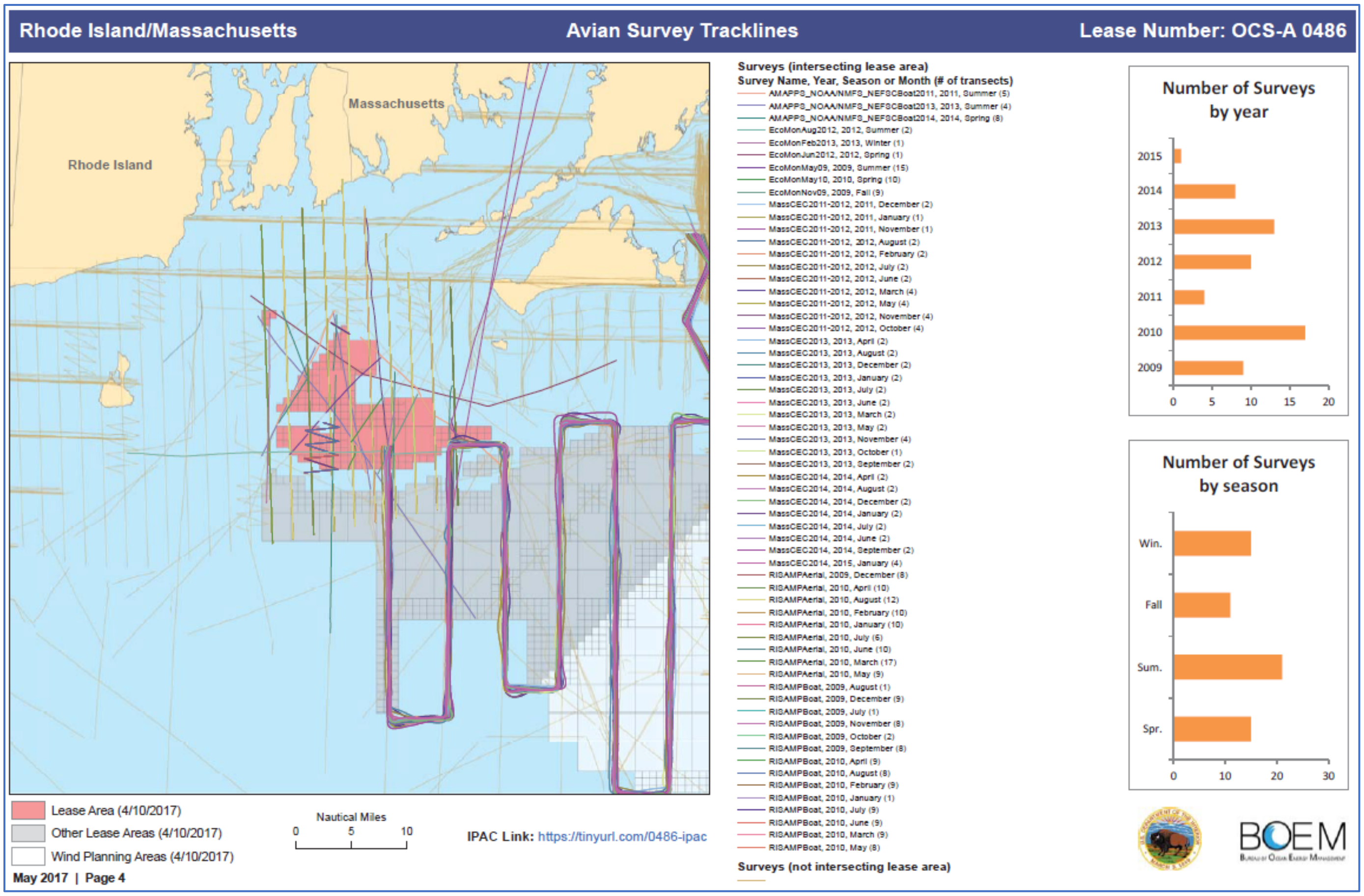
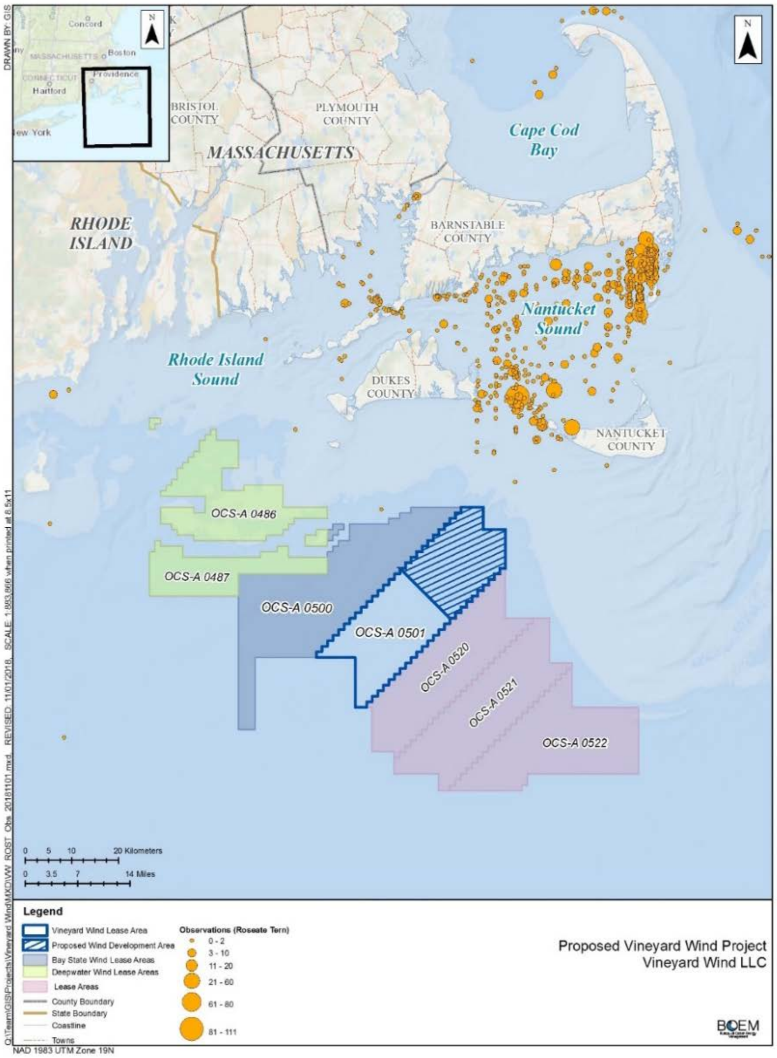


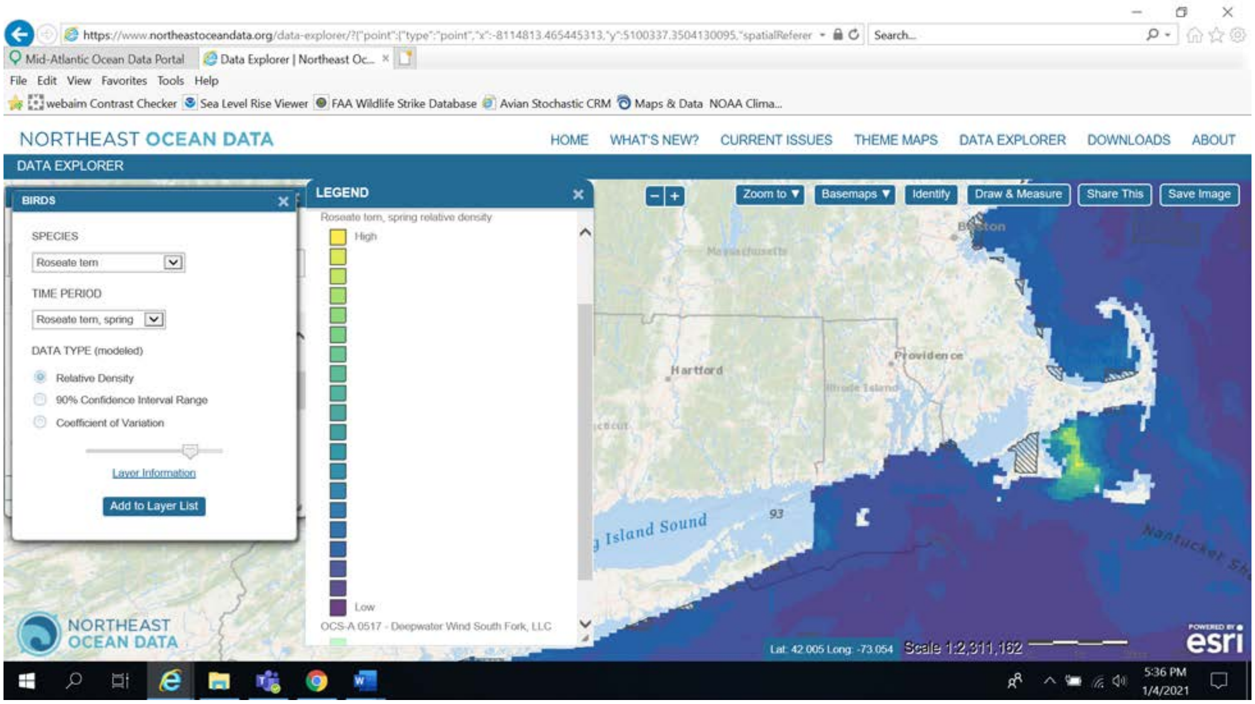
Figure 3.3. Avian surveys intersecting the area from 2009 to 2015.



Source: USFWS. 2018. Accessed through US Department of Interior, Northwest Atlantic Seabird Catalog, Version XX. Accessed 5 October 2018.

Figure 3.4. Roseate Tern Observations near the Proposed Action Area.

Spring – Roseate Tern



BIRDS

SPECIES: Roseate tern

TIME PERIOD: Roseate tern, spring

DATA TYPE (modeled)

● Relative Density
○ 90% Confidence Interval Range
○ Coefficient of Variation

Layer Information

Add to Layer List

LEGEND

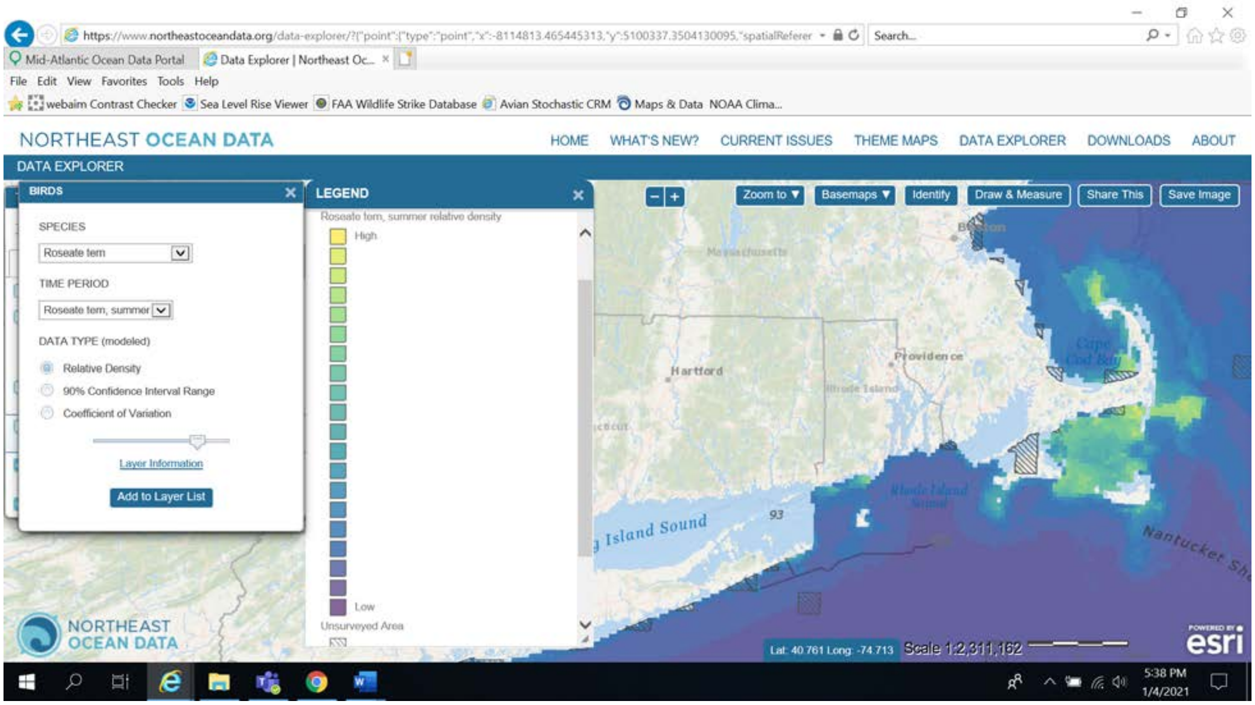
Roseate tern, spring relative density

High

Low

OCS-A 0517 - Deepwater Wind South Fork, LLC

Summer – Roseate Tern



BIRDS

SPECIES: Roseate tern

TIME PERIOD: Roseate tern, summer

DATA TYPE (modeled)

● Relative Density
○ 90% Confidence Interval Range
○ Coefficient of Variation

Layer Information

Add to Layer List

LEGEND

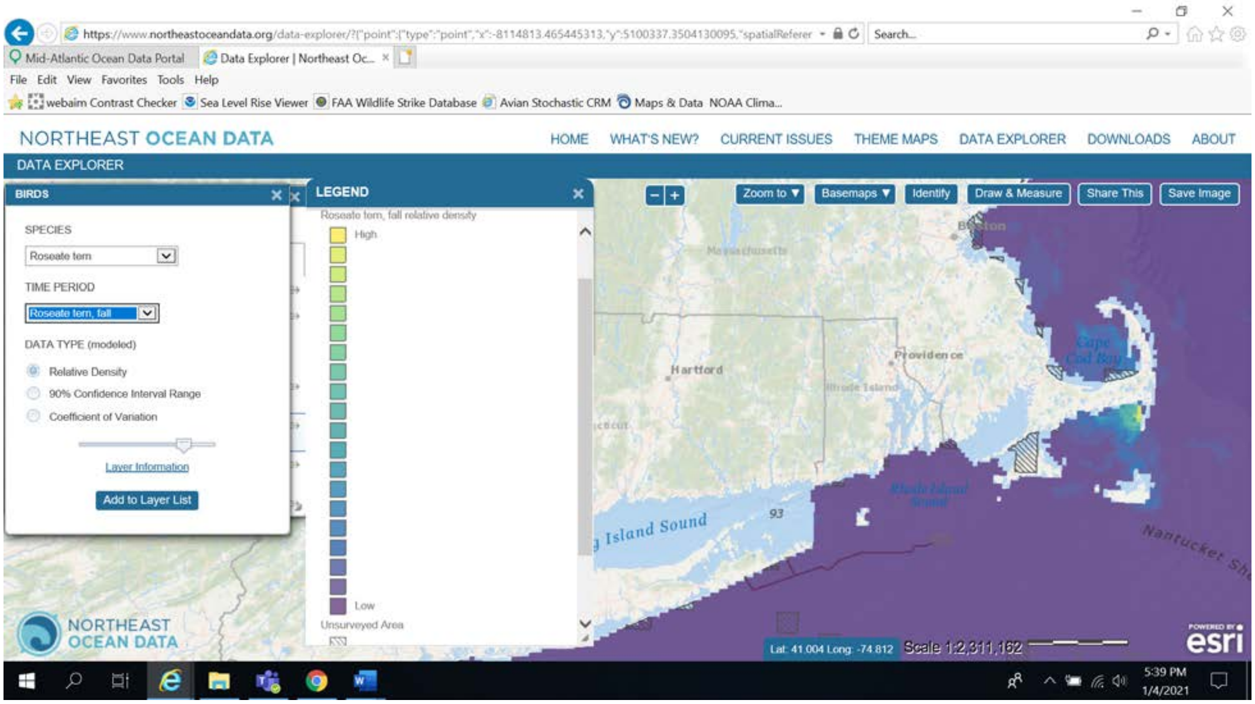
Roseate tern, summer relative density

High

Low

Unsurveyed Area ▨

Fall – Roseate Tern



SPECIES: Roseate tern

TIME PERIOD: Roseate tern, fall

DATA TYPE (modeled)

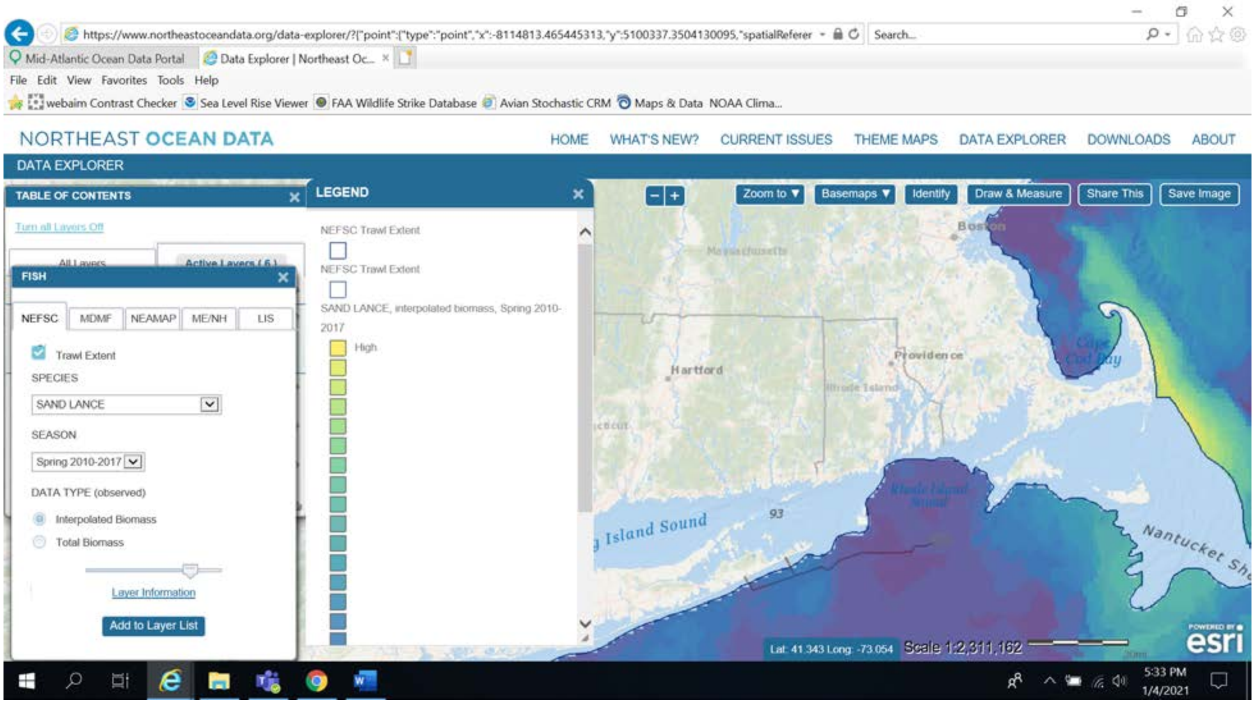
● Relative Density
○ 90% Confidence Interval Range
○ Coefficient of Variation

Roseate tern, fall relative density
High
Low
Unsurveyed Area

Note: Abundance model results are the long-term average relative number of individuals per unit area. Source data used to create the models are from January 1978 through October 2016. Model resolution is 2km x 2km grid cells, and models were generated with an original extent of approximately the entire US east coast EEZ. For more information about the modeling methodology and data sources used, see the MDAT Technical Report on the Methods and Development of Marine-life Data.

Figure 3.5. Predicted Seasonal Relative Density of Roseate Terns.

Spring – Sand lance



☑ Trawl Extent

SPECIES: SAND LANCE

SEASON: Spring 2010-2017

DATA TYPE (observed)

● Interpolated Biomass

○ Total Biomass

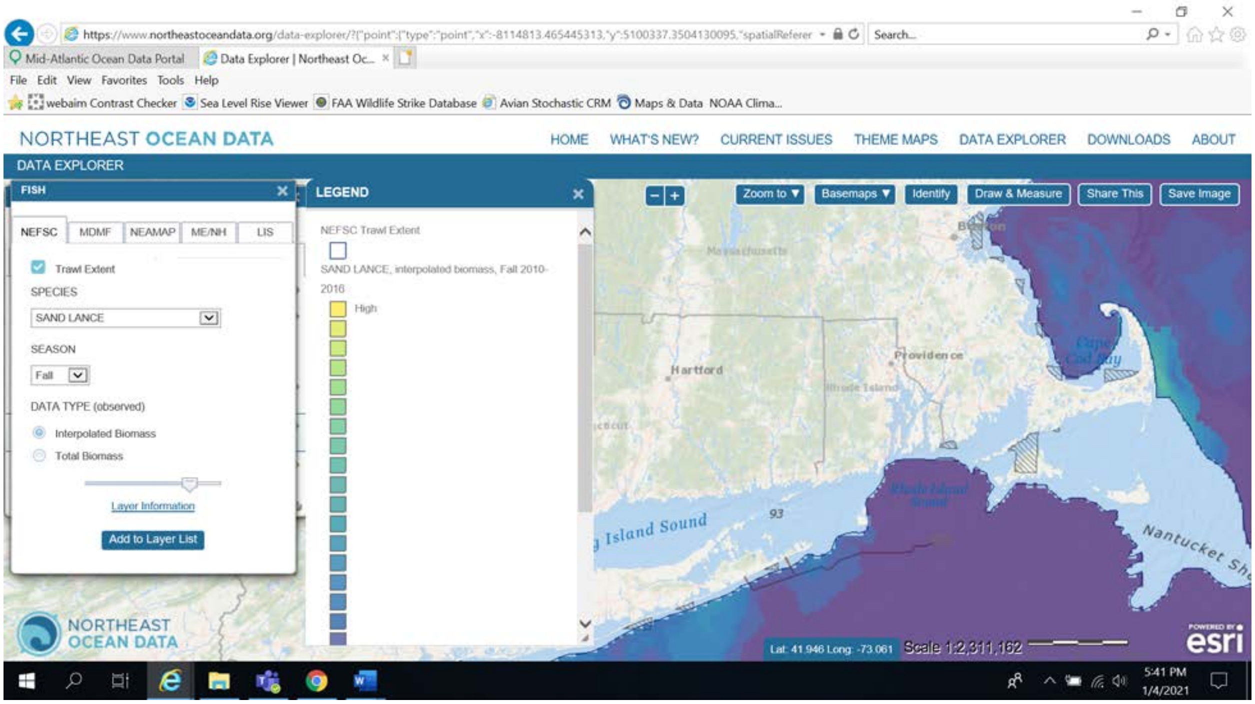
NEFSC Trawl Extent ☐

NEFSC Trawl Extent ☐

SAND LANCE, interpolated biomass, Spring 2010-2017

High

Fall – Sand lance



☑ Trawl Extent

SPECIES: SAND LANCE

SEASON: Fall

DATA TYPE (observed)

● Interpolated Biomass

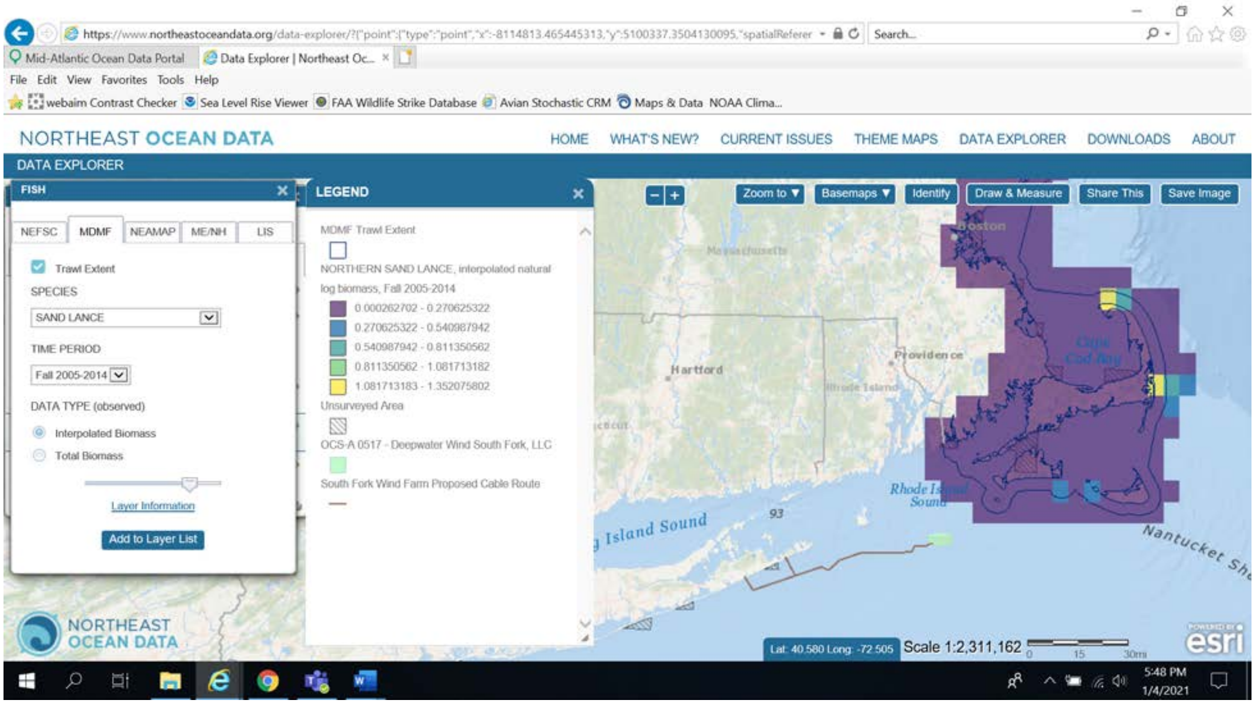
○ Total Biomass

NEFSC Trawl Extent ☐

SAND LANCE, interpolated biomass, Fall 2010-2016

High

Spring – Sand lance



☑ Trawl Extent

SPECIES: SAND LANCE

TIME PERIOD: Fall 2005-2014

DATA TYPE (observed)
- ● Interpolated Biomass
- ○ Total Biomass

LEGEND

MDMF Trawl Extent ☐

NORTHERN SAND LANCE, interpolated natural log biomass, Fall 2005-2014
- 🟪 0.000262702 - 0.270625322
- 🟦 0.270625322 - 0.540987942
- 🟦 0.540987942 - 0.811350562
- 🟩 0.811350562 - 1.081713182
- 🟨 1.081713183 - 1.352075802

Unsurveyed Area ▨

OCS-A 0517 - Deepwater Wind South Fork, LLC 🟩

South Fork Wind Farm Proposed Cable Route —

Note: Fish trawl data come from four primary sources: Northeast Fisheries Science Center (NEFSC/NMFS/NOAA) and Massachusetts Division of Marine Fisheries (MDMF). Each set of data sources have used standardized survey designs and data collection methodology but some have used different vessels and gears over time. Results have been normalized to account for these vessel and gear differences. Fall survey samples were collected primarily from September to November, and spring survey samples were collected primarily from February to April. These data products are based on observed data, not model predictions, for the selected time period. For more information about the modeling methodology and data sources used, see the MDAT Technical Report on the Methods and Development of Marine-life Data.

Figure 3.6. Predicted Seasonal Biomass of Sand Lance.

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). Over the last 20 years, 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 may be a likely cause of recent species declines (Niles et al. 2008; USFWS 2014). Due to observed population declines, the USFWS has listed the *Rufa* Red Knot as threatened. The USFWS has not designated any critical habitat for *Rufa* Red Knot (Threatened Species Status for the *Rufa* Red Knot, 79 Fed. Reg. 238 [December 11, 2018]). The *Rufa* Red Knot is one of 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). Despite the presence of many onshore turbines along the red knot's overland migration route (Diffendorfer et al., 2017), there are no records of knots colliding with 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 (USFWS 2012c), 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 that migrated during early fall departed from the Atlantic coast in a southeast direction, likely heading to long-distance wintering destinations in South America. In addition, red knots that migrated during late fall traveled southwest across the Mid-Atlantic Bight, likely heading to short distance wintering destinations in the southeastern US and Caribbean. Interestingly, red knots migrated through Federal waters of the Atlantic Outer Continental Shelf during evenings with fair weather and a tail-wind blowing in their direction of travel.

Only a small portion of *Rufa* population uses the US 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 the lease area (OCS-A 0486) during fall migration in November (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 MA before the fall migration, only five knots flew over the lease area (Loring et al, 2018). Most red knots departed from MA to the southeast during from mid-August through early September while the two that crossed the lease area left very late in mid-November traveling to the southwest and represent 5% of the fall staging population in MA. Given that up to 1,500 red knots stage in MA during fall (Gordon and Nations 2016), only 5% of those 1,500 staging red knots may pass through the lease area in fall. In spring, the vast majority of red knots fly directly overland from stopover areas in Delaware Bay to breeding areas in Hudson Bay Canada. However, some red knots do travel up the coast in spring as confirmed by a tracking study (see Appendix E in Loring et al. 2018). Ten percent of the fall staging population (150 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 occurred when visibility was ~20 km with little or no precipitation (Loring et al. 2018). In addition, 19.2% flew at wind speeds <=4 m/sec (Loring et al. 2018) - below the cut in speed for an offshore wind turbine. Red knots migrate at high altitudes from 1,640 to 3,281 feet (500 to 1,000 meters) (Alterstam et al. 1990; Gordon and Nations 2016), well above the highest proposed RSA of 840 feet (256 meters) (Table 1). In contrast to these observations, a study that estimated flights heights from telemetry data found that 83% of the 25 modeled flight paths occurred much lower and within 20-200 meters 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 over 1,000 meters (see Appendix F, Loring et al. 2018). Nevertheless, very little, if any, Red Knot activity is expected over the WDA with relatively few (5% of 1,500 birds) flying through or over the WDA during fall migration.

In summary, while *rufa* Red Knot exposure to the SFWF is limited overall, these findings indicate that individuals could migrate through the SFWF 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 US 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). Critical habitat has not been designated because disease, rather than habitat availability is the primary threat to the species. On January 14, 2016, 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 0.25 miles (0.4 kilometers) of a known occupied hibernation site; and
- No tree removal within 150 feet (45.7 meters) of a known occupied maternity roost tree between June 1 and July 31.

NLEB occurrence on Long Island appears seasonal and restricted to the summer based on the lack of suitable winter hibernacula (NYSDEC 2018). There are records of NLEB in all coastal counties of Long Island and Rhode Island in proximity to the proposed action (Cane 2011; NYSDEC 2018; RIDEM 2015), including the terrestrial component of the action area. NYDEC 2017 acoustic surveys did not identify NLEB within 2.4 km of the Beach Lane landing site; however, there were positive identifications within 2.4 km of the Hither Hills landing site (K. Jennings and K. Gaidasz, NYSDEC, pers.comm.; referenced in Stantec 2018). The proposed SFEC interconnection facility is located in an undeveloped tract of deciduous forest, which likely provides suitable bat habitat during summer.

In general, NLEB migrate to hibernacula in August or September, enter hibernation in October and November, and emerge from the hibernacula in March or April, although hibernation timing and duration can vary considerably by region (80 FR 17974). There are records of NLEB on the coastal islands of Rhode Island and Massachusetts (Dowling *et al.* 2017; Dowling and O'Dell 2018) indicating that some individuals traveled over open water to the islands. Dowling *et al.* (2017) detected NLEB on Martha's Vineyard in October and November. However, the occurrence of NLEB on the ocean is rare. During the offshore construction of the Block Island Wind Farm, bats were monitored with acoustic detectors on boats; no NLEB were detected among the 1,546 passes of bats (Stantec 2018). During post-construction monitoring from August 2017 to January 2018, no NLEB were detected out of the 1,086 passes recorded by bat acoustic detectors mounted on two turbines (Stantec 2018). However, during geo surveys near the offshore action area from July 15 to November 15, detectors on the boat recorded 34 NLEB passes out of 896 passes; out of these detections one pass by NLEB was detected in SFWF area on August 6, 2017 (Stantec 2018). It is important to note that most of these passes occurred during low wind speeds (Stantec 2018). During the post construction surveys 99% were during were when winds were less 5 meters per second (33% when there was no wind); likewise, almost 80% of the passes occurred when wind speeds were less than 5 meters per second.

Collectively, this information indicates that NLEB may occur in both the terrestrial components of the action area during non-hibernation periods (May through October). The occurrence of NLEB in the marine component of the action area will likely be very rare and in very small numbers and very likely when winds are below cut in speed for turbines.

3.3 Plants

USFWS (2019) identified two listed plant species as known or likely to occur in the action area and proximity: seabeach amaranth (*Amaranthus pumilus*) and sandplain gerardia (*Agalinis* *acuta*). The general life history, distribution in the project vicinity, and likelihood of occurrence in the action area are described in the following sections.

3.3.1 Seabeach Amaranth

Seabeach amaranth is a fleshy annual flowering plant native to the barrier island beaches of the U.S. Atlantic coast. The species was historically distributed from South Carolina to Massachusetts (58 FR 18035). The action area is located at the northern end of the current and historical range of the species.

Seabeach amaranth is an early successional member of the dune plant community that relies on periodic habitat disturbance to survive and proliferate (Bazzaz 1979). Seabeach amaranth is associated with the lower foredunes and upper wrack line of stable and accreting beaches. The species relies on periodic storm disturbance to clear vegetation from the seaside edge of coastal dunes, providing bare ground at a suitable tidal elevation for colonization.

The timing of seabeach amaranth germination and growth varies with distribution, typically occurring in June and July at the northern end of the species range. The plant grows outward in a branching network of stems spread low to the ground, reaching a diameter of up to 3 feet (1 meter) at maturation between August and September. The plant will continue to grow, bloom, and produce seeds into November. Seabeach amaranth has been observed in annual coastal habitat surveys conducted in immediate proximity to the action area since 2000 (Duryea *et al.* 2018; VHB 2018).

3.3.2 Sandplain Gerardia

Sandplain gerardia is an early-successional plant species that was historically common on Long Island when native maritime grass and shrublands dominated large portions of the landscape (NYNHP 2017). Its current distribution is restricted to remnant patches of native grass and shrubland habitat that are subject to periodic natural and anthropogenic disturbance at sufficient frequency to maintain local populations. The action area is outside the current known distribution of the species and does not contain suitable habitat (VHB 2018); this species could not occur in the action area under present habitat conditions and is not addressed further in this BA.

4 Effects of the Proposed Action

The action area is divided into two components for the purpose of the effects analysis: marine and terrestrial (see Section 2.0). The marine component includes the seabed, water column, and atmosphere over the ocean affected by the SFWF and marine elements of the SFEC. The terrestrial component includes the areas affected by all upland elements of the SFEC. 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	Affected Species	Exposure Type	Effect Level
SFWF Construction	Airborne noise and visual disturbance	Piping plover Roseate Tern Red Knot NLEB	Direct – Behavioral	Insignificant
	Underwater noise	Roseate Tern	Indirect – Prey availability	Discountable
	Seabed and water column disturbance			
	Vessel traffic	Piping plover Roseate Tern Red Knot NLEB	Direct – Behavioral	Insignificant
SFEC Construction	Airborne noise	Piping plover Roseate Tern Red Knot NLEB	Direct – Behavioral	Insignificant
	Underwater noise	Roseate Tern	Indirect – Prey availability	Insignificant
	Seabed and water column disturbance			
	Upland disturbance	NLEB	Indirect – Habitat modification	Insignificant
	Vessel and vehicle traffic	Piping plover Roseate Tern Red Knot NLEB	Direct – Behavioral	Insignificant
SFWF/SFEC Operation	Collision risk	Piping plover Roseate Tern Red Knot NLEB	Direct – Injury and mortality Direct – Behavioral	Insignificant and discountable
	EMF	NLEB	Direct – Behavioral	Insignificant
	Vessel and vehicle traffic	Piping plover Roseate Tern Red Knot NLEB	Direct – Behavioral	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 Roseate Tern, Piping Plover, and *Rufa* Red Knot

Roseate Tern, piping plover, and *rufa* Red Knot are likely to or could potentially occur in the marine component of the action area during project construction and operation. Piping Plover may also occur in shoreline habitats in the terrestrial component of the action area. 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:

- Collision risk: Risk of collision and/or interaction with WTGs, the SFWF offshore substation, monopile foundations, and marine construction equipment
- 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
- Airborne noise effects: Exposure to elevated airborne noise during project construction and operation
- Underwater noise: Risk of indirect underwater noise effects on forage fish prey availability for roseate tern from project construction and operation
- Vessel and vehicle traffic effects: Potential behavioral effects resulting from vehicle and vessel traffic disturbance

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 Collision Risk

The proposed action will place up to 15 WTGs and 1 OSS in the oversea migratory corridor used by ESA-listed bird species. Assuming the 12-MW WTG option is selected, this would equate to a rotor swept area of 6,362,595 square feet (424,173 square feet or 39,406 square meters per WTG), extending from 105 feet to 840 feet (32 meters to 256 meters) above MSL. Offshore turbines pose a potential collision and attraction risk to migrating marine birds (Huppop *et al.* 2009; Kerlinger *et al.* 2010). SFWF WTGs would be equipped with navigational safety lighting designed to avoid and minimize attractive effects to the extent practicable, following the recommendations developed by Orr *et al.* (2013). The effects of WTG operation on each ESA-listed species are described below.

4.1.1.1.1 Effects on Piping Plover

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 SFWF piping plover collision risk are presented in Appendix A.

Most of the model inputs (e.g., migration passage, proportion flying in the rotor swept zone, turbine specifications, and facility dimensions) were obtained or calculated from the COP and P. Loring et al. 2019 (see Appendix A 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 SFWF during the life of the project. 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[1] an estimated 929 piping plover could have migrated through the WEA in 2017, 356 in spring and 573 in fall.

A range of turbine avoidance rates (95% to 99%) were used for piping plovers were obtained from Hatch and Brault (2007) and Stantial (2014). The WDA had 15 operating 12MW turbines. The monthly proportion of time the turbines were in operation is based the wind speeds when piping plovers are flying (see Fig. 69 in Loring et al. 2019) rather than the proportional of the time the wind was above turbine cut-in and below cut-out speeds. The average rpm for a turbine operating at the site is not known, so the maximum rpm speed was used which is likely to be greater than the average – an increase in rpm will increase the estimated mortality. The flight height distribution was derived from the midpoints of 2,756 ten-minute observations of 62 piping plovers flying nonstop over federal waters (Loring et al 2018). Given that the flight height distribution is known for this species, fatalities estimated are based on calculations from the extended model (Option 3).

As shown in Appendix A, Band Model results indicate that approximately 75 plovers could have theoretically passed through the SFWF RSZ at observed breeding abundance and productivity levels for New England and Canada breeding populations. Of those 75 passes, 3 could have resulted in a rotor collision assuming no avoidance (the equivalent of being blind folded). However, when even the most conservative (i.e. lowest) avoidance modifier appropriate for plovers is applied,[2] the calculated collision rate drops to zero. These results indicate that plovers

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[1] Based on a breeding population abundance of 890 pairs in Massachusetts, New Hampshire, Maine, and Canada, and an abundance-weighted mean productivity of 1.22 chicks fledged per pair (USFWS 2018d), equating to 1,780 adults in spring and 2,862 adults and subadults in fall.

[2] Hatch and Brault (2007) and Stantial (2014) assumed that the collision avoidance rate for piping plover is likely between 95 and 99 percent. Avoidance rates of 95, 98, 99 and 99.5 percent were used in the Band Model analysis.

may encounter the SFWF RSZ and some individuals may have to alter their flight path to avoid the visual barrier, but the risk of injury or mortality from rotor collision is discountable.

4.1.1.1.2 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 offshore portions of the Action Area and the lack of suitable habitat in the Action Area generally preclude use by foraging adults. Second, the majority of roseate terns are closer to shore with only a small percentage of the population likely to encounter the RI/MA WEA in any given year. Third, 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, roseate terns typically fly below the RSZ, which minimizes exposure to potential collision.

BOEM used the Band Model to evaluate risk of injury or mortality to Roseate Tern from collision with turbines. Model input parameters and results are provided in Appendix A. The proportion of population that flies through the WDA during migration is not currently known; therefore, it was assumed that the birds will spread themselves evenly along a ‘migration front’ spanning 135 km between Block Island and Monomoy; only birds passing through the 12.4 km wide WDA would be exposed to the wind farm. For spring migration (April & May), the number of passages through the migration front was based on the number of US 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 NY, CT, and MA and survived to 2017. For fall migration, all US 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 98% was used for Roseate Tern (SNH 2018). The WDA had 15 operating 12MW turbines. The monthly proportion of time the turbines were in operation is based the wind speeds when roseate terns are flying (see Fig. 49 in Loring et al. 2019) rather than the proportional of the time the wind was above turbine cut-in and below cut-out speeds. The average rpm for a turbine operating at the site is not known, so the maximum rpm speed was used which is likely to be greater than the average – 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 (Loring et al. 2018). Given that the flight height distribution is known for this species, fatalities estimated are based on calculations from the extended model (Option 3).

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

These results indicate that roseate terns could encounter the SFWF in any given year, and that some of these individuals may have to alter their flight path to avoid the visual obstruction and collision risk. The likelihood of injury or mortality from rotor collision is discountable under even the most conservative behavioral assumption. Any associated behavioral effects are likely to be insignificant because this species would be able to detect and avoid the WTGs from distance with only a minimal change in course.

4.1.1.1.3 Effects on Red Knot

Rufa Red Knot do not use offshore habitats for foraging and would only occur in the SFWF area during migration. The information presented in Section 3.1.3 indicates that approximately 5 percent of red knots departing from staging areas in Massachusetts could fly through the RI/MA WEA. Applying this percentage to a staging population estimate of 1,500 migrants (Gordon and Nations 2016) equates to a total of approximately 83 red knots traveling through the SFWF lease area in any given year, 8 in spring and 75 in fall.

The Band Model input parameters and results for Red Knot are presented in Appendix A. The flight height distribution was derived from the midpoints of 379 ten-minute observations of 51 red knots flying nonstop over federal waters (Loring et al 2018). Turbine avoidance rate of 98% was used for Red Knot (SNH 2018). The WDA had 15 operating 12MW turbines. The monthly proportion of time the turbines were in operation is based the wind speeds when red knots are flying (see Fig. 12 in Loring et al. 2018) rather than the proportional of the time the wind was above turbine cut-in and below cut-out speeds. The average rpm for a turbine operating at the site is not known, so the maximum rpm speed was used which is likely to be greater than the average – an increase in rpm will increase the estimated mortality. Given that the flight height distribution is known for this species, fatalities estimated are based on calculations from the extended model (Option 3).

Applying a potential exposure of 83 adults with proportion at rotor height of 83 percent under the operating conditions shown, the Band Model estimates a total of 6 potential bird transits through the SFWF RSZ with zero collisions under a no-avoidance assumption. 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 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.

In summary, Band Model results indicate that some individual red knot may encounter the SFWF RSZ during annual migration and may have to alter their flight path to avoid the WTGs. Given that this species migrates under high-visibility conditions, individual birds would be able to detect and avoid the WTGs with an insignificant behavioral alteration. The risk of collision-related injury or mortality is discountable.

4.1.1.2 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 SFEC 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, *rufa* Red Knot, or Roseate Tern. 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. Based on compilation of best available reference sources (CalTrans 2015; WSDOT 2019), impact pile driving of 36-foot (11-meter) monopiles could produce airborne noise levels of up to 110 A-weighted decibels (dBA) at a reference distance of 10 meters. Using this value, the noise attenuation formulate 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 2 miles (3,160 meters) from the source. The duration of impact hammer use during each monopile installation would range from 2 hours to 4 hours per day during daylight hours only, with each installation separated by 4 days to 5 days over the 80-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 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.

Rufa Red Knot and piping plover would only be exposed to impact hammer noise if monopile installation occurs during the migratory period. Roseate terns are most likely to be exposed

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[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.

during the summer post-breeding foraging period and fall migration. Those are the only periods when these species are likely to occur in the RI/MA WEA and vicinity. Based on observed flight behavior,[5] migrating birds would 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 without apparent harm.[6]

Construction of the SFEC sea-to-shore transition construction includes the installation of a sheetpile cofferdam approximately 1,750 feet (533 meters) offshore using a vibratory hammer, and construction of the upland connection vault using a drill rig and other heavy equipment. These 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 nesting and 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 compilation of best available reference sources (CalTrans 2015; WSDOT 2019), vibratory hammer placement of the sheet pile cofferdam would produce an average peak noise level of 90 dBA (WSDOT 2019). Based on an 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 5,000 feet (1,524 meters) from the source, encompassing adjacent shoreline habitats.

Heavy equipment used to construct the SFEC – Onshore would also produce airborne noise that periodically exceeds ambient levels. VHB (2018) presented reference noise levels for probable types of construction equipment used for SFEC 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, SFEC construction noise could reach as high as 88 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 600 to 1,300 feet of the source.

ESA-listed bird species present within these effect areas may be exposed to periodic construction noise exceeding 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

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[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 during daylight hours only, construction activities would be clearly visible from miles away and easily avoidable.

[6] See footnote 3.

[7] Ambient noise levels along the SFEC – onshore corridor are estimated at 60 dBA to 66 dBA based on wind and wave noise at the shoreline (see footnote 3), area population density (Lambert 2016), and vehicle and rail traffic levels on action area rights of way (FTA 2006, 2018; NYSDOT 2016a; USDOT 1995).

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 affected shoreline is also popular for recreation and accessible to four-wheel-drive vehicles, and thousands of commercial and recreational vessels transit the adjacent nearshore zone on an annual basis (GHA 2018). All of these activities 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 SFWF boundary. Moller and Pedersen (2010) studied airborne noise from smaller onshore WTGs, 2-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 SFWF and within 1,000 feet (304 meters) of operating turbines. 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.

BOEM (2019) concluded that noise-related effects on USFWS ESA-listed species resulting from the nearby Vineyard Wind project would be insignificant and discountable. This conclusion was based on the limited extent of noise effects above potential thresholds sufficient to cause injury or alter behavior. These conclusions can also be reasonably applied to the proposed action.

4.1.1.3 Vessel and Vehicle Traffic Effects

Vessel traffic associated with the construction and operation of the SFWF and SFEC would not significantly alter the environmental baseline in the action area. Project construction will involve 13 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 1 year. 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

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[8] GHA (2018) summarized vessel traffic in the project vicinity from July 18, 2016, through July 18, 2017. There were 19,164 vessel crossings of a measurement line between Montauk and Sconticut Neck during this period. Approximately 75 percent of crossings were fishing or pleasure vessels. Tug and service vessels accounted for 74 percent of the 7,209 transits originating from Brooklyn and Staten Island. Fishing and pleasure vessels account for

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 effects 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 4.2.1.4), 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. The Long Island shoreline is popular for recreation and accessible to off-road vehicles, meaning that baseline conditions include routine disturbance by vehicle traffic on the beach. 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.

4.1.2 Indirect Effects

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 Plover and red knot do not submerge and prey on organisms that are unaffected 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 SFWF and along the SFEC 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. SFEC construction activities in the nearshore zone, specifically sea-to-shore transition cofferdam placement and associated dredging and sidecast, would create short-term underwater noise, disturbance, and suspended sediment effects. These effects could

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approximately 83 percent of vessels entering the SFWF. Recreational vessel traffic along the Long Island shoreline is similarly dense.

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) concentrations 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 3 miles (4.8 km) 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). Inspire Environmental (2018) encountered a mix of turbidity conditions during a benthic community survey of the SFEC – NYS. In some nearshore areas, turbidity levels were high enough to prevent observation of the benthos. Inferred TSS levels at these locations likely exceeded 100 mg/L based on camera distance from the bed (Inspire Environmental 2018a) and observed relationships between TSS and visibility (West and Scott 2016). These findings suggest that baseline TSS levels in the SFEC-NYS are variable, ranging from near zero to as high as 100 mg/L depending on location and timing.

Sidecast of materials excavated from the sea-to-shore transition cofferdam is expected to produce TSS levels similar to those produced by dredging of sand and gravel sediments. Anchor (2003) reviewed available literature on dredging-related water quality effects and found that TSS concentrations from 90 percent of monitored dredging activities were less than 200 mg/L. TSS levels typically returned to baseline within an hour after dredging ceased. This indicates that this specific construction activity would have a temporary but measurable water quality effect that exceeds the typical range of baseline variability in the SFEC – NYS. 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, given that roseate terns in the vicinity forage over broad areas in pursuit of prey (Loring *et al.* 2019), the 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.

4.1.2.2 Underwater Noise Effects

JASCO (2019) 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 JASCO 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 level of 205 decibels (dB) (re: 1 micro Pascal [µPa]) would attenuate to between 150 dB to 160 dB upon reaching the major shipping lanes that bound the action area. Large vessels like container ships and tankers generate 177 dB to 188 dB (re: 1µPa at a reference distance of 1 meter) predominantly in the lower frequency band below 40 hertz (Hz) (McKenna et al. 2012). This translates to 162 dB to 173 dB at a standardized reference distance of 10 meters. Given the baseline level of large vessel traffic and associated ambient noise levels present, the major shipping corridors to the east and south of the action area are likely to represent the outer boundary of detectable underwater noise resulting from the proposed action.

JASCO (2019) modeled both threshold distances for underwater noise from monopile installation. They determined that under the worst-case installation scenario using the most conservative impact thresholds, small fish <2 grams within 9.2 miles (14,883 meters) and fish >2 grams within 6.8 miles (10,868 meters) of pile driving could experience injury-level noise exposure. Fish within 8.04 miles (12,948 meters) of the activity would experience behavioral level effects, based on a behavioral effects threshold of 150 root mean square decibels (dB_{RMS} re: 1 µPa) defined by the Fisheries Hydroacoustic Working Group (FHWG 2008). This threshold is based on sound pressure levels associated with 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 along the coast to other nearshore foraging sites (Loring *et al.* 2019). These foraging habitats are a minimum of 8 miles (13 kilometers) 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. JASCO (2019) modeled the distance required to attenuate underwater noise from vibratory hammer installation of the sheetpile cofferdam. They calculated that underwater noise would attenuate to the fish behavioral effects threshold of 150 dB within 0.49 miles (779 meters) 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, even if disturbed fish were temporarily less available the resulting indirect effects on roseate terns would be insignificant. This conclusion is based on the same rationale presented above for seabed and water column disturbance.

Offshore WTGs produce audible underwater noise typically ranging from 110 to 130 dB_{RMS}, 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 SFWF, 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

NLEB are likely to occur the terrestrial component and rarely in the marine 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:

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

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

4.2.1.1 Collision Risk

Stantec (2018) documented NLEB in offshore habitats within and in proximity to the marine 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 marine component of the action area, including the SFWF, 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 SFWF 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 4.1.1.3, 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 meters per second (m/s) to 5 m/s, 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 6 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/s, 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 OSS on NLEB are less clear. In theory, bats foraging and migrating over distant offshore habitats in and around the SFWF 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 may be minimal if the SFWF WTG cut-in speeds are equal to or greater than 5 m/s.

Collectively, the available information indicates that NLEB indicate that occurrence of NLEB in the marine component is likely to very rare and in small numbers occur in the marine component of the action area. 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 significance of this behavior is unclear, but likely insignificant based on the rare occurrence of this species in the offshore environment.

4.2.1.2 Noise Effects

SFEC – Onshore construction would produce airborne noise in excess of ambient conditions in the action area (see Section 4.1.1.2). 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 4.1.1.2.

4.2.1.3 Electromagnetic Field Effects

The SFEC – Onshore transmission cable would produce an induced magnetic field in the immediate proximity of the cable path. Exponent Engineering (2018) modeled EMF effects from the operation of the buried onshore transmission cable. They determined that induced magnetic field strength would range from 110 milligauss (mG) to 140 mG in cable segments adjacent to roadways, and 260 mG to 300 mG in the segment adjacent to the rail corridor, at 3.2 feet (1 meter) above ground along the cable centerline. The range of values shown is dependent on transmission levels. EMF effects decrease rapidly with distance, effectively reaching zero at 50 feet on either side of the cable path regardless of initial field strength (Exponent Engineering 2018). The SFEC sea-to-shore transition would be buried more than 60 feet below the surface, so induced EMF effects on beach and shoreline habitats would be effectively unmeasurable.

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 SFEC – Onshore would potentially be detectable to bats occurring within 0 to 4 feet of the duct bank centerline adjacent to roads, and within 0 to 10 feet of the centerline adjacent to the rail corridor. Based on documented species occurrence within and in proximity to the action area, it is probable that individual NLEB would encounter detectable EMF levels from the SFEC over the lifetime of the project.

The potential significance of this exposure must be considered relative to existing conditions within the action area. The SFEC – Onshore would be operated in an environment with high baseline levels of EMF. Eastern Long Island is developed for rural residential and suburban land uses at a relatively high population density of 295 people/square mile (Lambert 2016) and the area is crisscrossed by electrical transmission lines and other sources that produce localized EMF effects. 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 upland 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. The New York Public Service Commission sets an interim EMF limit of 200 mG at 50 feet for overhead high voltage transmission lines carrying 100 kV to 230 kV (Exponent Engineering 2018). EMF levels from the SFEC – Onshore would be negligible by comparison.

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 much 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.

4.2.1.4 Vessel and Vehicle Traffic

Construction of the onshore components of the SFEC will involve a range of construction equipment types, from standard pickup trucks to HDD boring machines. CH2M (2018) 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 15,090 engine hours per year across all equipment types during construction, 6,120 hours per year for the SFEC interconnection facility, 4,020 for the transmission cable duct bank, and 4,950 for the sea-to-shore connection. A percentage of these hours will include active vehicle traffic on local roads adjacent to potential NLEB habitat.

Area roadways averaged from 600 to 24,000 vehicle trips per day in 2016, or 400 to 2,000 trips per hour, between local roadways and major thoroughfares, respectively (NYSDOT 2016a, 2016b, 2016c). This translates to millions of vehicle trips per year, including large commercial vehicles. In addition, the Long Island Railroad runs parallel to a significant proportion of the proposed SFEC route, carrying approximately 11 passenger train trips per day or 4,000 trips per year. In contrast, project construction will produce an estimated 41 hours of engine use per day across all equipment types. 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.

4.2.2 Indirect Effects

SFEC construction and operation would result in indirect effects on NLEB. Construction of the upland components of the SFEC would temporarily disturb up to 216.2 acres along the cable path. As stated in Section 2.2.1, the upland portion of the SFEC corridor runs adjacent to and largely within road and railroad right of ways. Most of the duct bank will be placed under existing road or rail right of ways to minimize property and habitat impacts. Approximately 91.7 percent of the affected cable right of way is in developed right of way. The remaining 8.3 percent, approximately 4.5 acres, crosses undeveloped tracts supporting patches of native vegetation. 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 during winter months 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 SFEC interconnection facility would permanently develop approximately 2.4 acres of undeveloped deciduous forest for electrical utility use. The affected tract is bracketed by the existing Cove Hollow substation and Long Island Railroad line to the east and north, respectively, and by residential development to the west and south. 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 northern long-eared bat NLEB are likely to be insignificant.

4.3 Seabeach Amaranth

Seabeach amaranth may occur in the terrestrial component of the action area defined by airborne noise associated with SFEC – Onshore construction. Plants are insensitive to visual disturbance and to noise at the levels anticipated from construction activity. The proposed action would not modify or measurably affect the quantity and quality of shoreline habitat available to this species. Therefore, the direct effects of the proposed action on seabeach amaranth would be insignificant. No indirect effects would occur.

5 Effect Determinations

BOEM has concluded that the construction, operation, and future decommissioning of the proposed SFWF and SFEC 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 5.1 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 5.1 Effect determination summary for USFWS ESA-listed species known or likely to occur in the action area

Species	**Effect Determination**	**Rationale**
Piping Plover	**May affect, not likely to adversely affect**	<u>The proposed action may affect Piping Plover because</u>: • The species would likely pass through the marine component of the action area during migration and be exposed to construction and operational activities. • The species is likely to occur in the terrestrial component of the action area during nesting and would be exposed to short-term construction noise. <u>The proposed action is not likely to adversely affect Piping Plover because</u>: • Migrating plovers would be able to detect and avoid SFWF construction effects with minor flight path changes, behavioral effects would be insignificant. • Risk of collision mortality from SFWF operation is discountable. • Nesting plover construction noise exposure would be insignificant relative to baseline conditions. • The proposed action will have no measurable effect on nesting and foraging habitat.
Roseate Tern	**May affect, not likely to adversely affect**	<u>The proposed action may affect roseate tern because</u>: • The species could potentially migrate through the marine component of the action area during construction and operation. • The species may forage in nearshore habitats affected by project construction.

Species	**Effect Determination**	**Rationale**
		The proposed action is not likely to adversely affect roseate tern because: • Migrating terns would be able to detect and avoid SFWF construction effects with minor flight path changes, behavioral effects would be insignificant. • Risk of collision mortality from SFWF operation is discountable. • The effects of SFEC construction on migration, nesting, and foraging habitat will be insignificant and discountable.
Rufa red knot	**May affect, not likely to adversely affect**	The proposed action may affect *rufa* red knot because: • The species could potentially migrate through the marine component of the action area during construction and operation. The proposed action is not likely to adversely affect *rufa* red knot because: • Migrating red knot would be able to detect and avoid SFWF construction effects with minor flight path changes, behavioral effects would be insignificant. • Risk of collision mortality from SFWF operation is discountable.
Northern long-eared bat	**May affect, not likely to adversely affect**	The proposed action may affect NLEB because: • The species is known to occur in the terrestrial component of the action area. • The proposed action will temporarily disturb up to 216.2 acres and convert 2.4 acres of upland, including potentially suitable habitat, into a utility substation. • The potential for periodic species occurrence in the marine component of the action area cannot be discounted. The proposed action is not likely to adversely affect NLEB because: • Low probability of occurrence in the marine component of the action area combined with SFWF design and environmental protection measures would render project effects on this species insignificant and discountable.

Species	**Effect Determination**	**Rationale**
		• Traffic and noise effects from project construction are insignificant relative to the environmental baseline in the terrestrial component of the action area. • The majority of upland habitat disturbance will occur in currently developed areas (e.g., roads and rail corridors), which do not provide suitable bat habitat. • Construction-related habitat disturbance would occur during winter months when bats are not present. • Foraging and roosting habitat are not limiting in the action area and vicinity; therefore, the loss of 2.4 acres of forested habitat would have an insignificant effect on habitat availability. • EMF and artificial lighting effects from project operation are insignificant relative to the environmental baseline.
Seabeach amaranth	**May affect, not likely to adversely affect**	<u>The proposed action may affect seabeach amaranth because:</u> • The species could occur in the terrestrial component of the action area defined by airborne noise. <u>The proposed action is not likely to adversely affect seabeach amaranth because</u>: • Plants are insensitive to noise at the levels likely to result from the proposed action. • The proposed action would have no measurable effect on the quality and quantity of suitable habitat for this species.

Based on the analysis in Section 5, the construction, operations and maintenance, and eventual decommissioning of the proposed action is not likely to adversely affect any USFWS ESA-listed species known or potentially occurring in the action area. This conclusion is based on the following rationale:

(1) ESA-listed bird species may occur in the marine 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 occur in 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 ESA-listed birds 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.
- 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 any species or foraging habitat for Piping Plover and Red Knot.
- Nesting Piping Plover could be exposed to upland construction noise and disturbance, but the levels experienced are within the range of existing background conditions and therefore insignificant.

Therefore, the project **may affect**, but is **not likely to adversely affect** Piping Plover, Roseate Tern, and *rufa* Red Knot.

(2) NLEB are known to occur in the terrestrial and marine 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.
- 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/s, 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.

(3) Seabeach amaranth may occur in the terrestrial component of the action area, but the effects of the proposed action would be insignificant and/or discountable because:

- The proposed action will have no measurable effect on shoreline habitats used by this species.

- Construction noise is the only measurable exposure resulting from the proposed action, anticipated noise levels are within the range of existing baseline conditions.
- Plants are insensitive to noise at the levels anticipated.

Therefore, the project **may affect**, but is **not likely to adversely affect** seabeach amaranth.

6 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.

6.1.1 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.
- 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 (SPCC) plan for upland construction activities.

6.1.2 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 FAA 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 FAA 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. Within the first year of operations, the Lessee to install digital VHF telemetry automated receiving

stations and acoustic monitoring devices 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 that include the potential need for reasonable revisions to the Monitoring Plan.

- An annual report shall be provided to BOEM and FWS 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/.

6.1.3 Decommissioning and Site Clearance

The Applicant's COP (Deepwater Wind 2018) describes EPMs included in the proposed scenario for decommissioning and removal of the SFWF and SFEC 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 15 feet (4.6 meters) below mudline. BOEM assumes the WTG towers and foundations can be removed using non-explosive severing methods. The inter-array and SFEC 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 SAP.

References

Anchor. 2003. Literature Review of Effects of Resuspended Sediments due to Dredging Operations. Prepared by Anchor Environmental CA, L.P. for the Los Angeles, CA, Sediments Task Force. 134 p. Available at: https://www.coastal.ca.gov/sediment/Lit-ResuspendedSediments.pdf

Astolfi, D.F. Castellani and L. Terzi. 2018. Wind Turbine Power Curve Upgrades. *Energies* 11: 1300; doi:10.3390/en11051300

Band, B. 2012. Using a collision risk model to assess bird collision risks for offshore wind farms (with extended method) Report to Strategic Ornithological Support Services; http://www.bto.org/sites/default/files/u28/downloads/Projects/Final_Report_SOSS02_Band1ModelGuidance.pdf (Accessed January 3, 2019).

Bazzaz, F.A. 1979. The physiological ecology of plant succession. *Annual review of Ecology and Systematics* 10: 351-371.

Betke, K., M. Shultz-von Glahn, and R. Matuschek. 2004. *Underwater noise emissions from offshore wind turbines.* Proceedings of the Joint Congress CFA/DAGA 2004 Conference, March 22-25, Strasbourg, France.

Bolin, K. and M. Åbom. 2010. Air-borne sound generated by sea waves. *Journal of the Acoustical Society of America* 127: 2771-2779.

BOEM (Bureau of Ocean Energy Management). 2013. *Commercial Wind Lease Issuance and Site Assessment Activities on the Atlantic Outer Continental Shelf Offshore Rhode Island and Massachusetts, Revised Environmental Assessment.* Office of Renewable Energy Programs. OCS EIS/EA. BOEM 2013-1131.

BOEM. 2019. Vineyard Wind Offshore Wind Energy Project Biological Assessment. Prepared for the U.S. Fish and Wildlife Service by the Office of Renewable Energy Programs. April 2019. 47 p.

Burger, J., C. Gordon, J. Lawrence, J. Newman, G. Forcey, and L. Vliestra. 2011. Risk evaluation for federally listed (roseate tern, Piping Plover) or candidate (red knot) bird species in offshore waters: A first step for managing the potential impacts of wind facility development on the Atlantic Outer Continental Shelf. *Renewable Energy* 36:338-351.

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

Burger, J., L.J. Niles, R.R. Porter, A.D. Dey, S. Koch, and C. Gordon. 2012b. Migration and overwintering of red knots (*Calidris canutus rufa*) along the Atlantic Coast of the United States. Condor 114:1-12.

CalTrans (California Department of Transportation). 2015. Technical Guidance for Assessment and Mitigation of the Hydroacoustic Effects of Pile Driving on Fish.

Cane, J. 2011. *Species Identification of Bats and their Associated Habitats*. Prepared for the U.S. Department of Energy Community College Institute Program by Suffolk Community College, Selden NY.

CH2M. 2018. South Fork Wind Farm and South Fork Export Cable Air Emissions Inventory - Calculations and Methodology. Appendix L in the *South Fork Wind Farm Construction and Operations Plan.* Prepared by CH2M for Deepwater Wind LLC.

Curtice, C., J. Cleary, E. Shumchenia, and P. Halpin. 2018. *Marine-life Data and Analysis Team (MDAT) Technical Report on the Methods and Development of Marine-Life Data to Support Regional Ocean Planning and Management.* Prepared by the Duke University Marine Geospatial Ecology Lab for the Marine-life Data and Analysis Team (MDAT). Available: http://seamap.env.duke.edu/models/MDAT/MDAT-Technical-Report.pdf. Accessed September 11,2018.

Deepwater Wind, LLC. 2018. *Construction and Operations Plan - Draft. 30 CFR 585. South Fork Wind Farm.* Prepared by CH2M Hill Engineers, Inc. for Deepwater Wind South Fork, LLC. June 2018.

Dowling, Z., P.R. Sievert, E. Baldwin, L. Johnson, S. von Oettingen, and J. Reichard. 2017. *Flight Activity and Offshore Movements of Nano-Tagged Bats on Martha's Vineyard, MA.* U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, Virginia. OCS Study BOEM 2017-054. 39 pp. + frontmatter.

Dowling, Z.R. and D.I. O'Dell. 2018. Bat Use of an Island off the Coast of Massachusetts. *Northeastern Naturalist* 25(3): 362-382.

Duryea, J., J. Papajohn, C. McCuen, T. Ruhle, and L. Jurow. 2017. 2017 Year End Report. Southampton Town Trustees Threatened and Endangered Species Management and Protection Program. Available at: https://www.southamptontownny.gov/Archive.aspx?AMID=51

Duryea, J., J. Papajohn, C. McCuen, T. Ruhle, and L. Jurow. 2018. 2018 Year End Report. Southampton Town Trustees Threatened and Endangered Species Management and Protection Program. Available at: https://www.southamptontownny.gov/Archive.aspx?AMID=51

Elliott-Smith, E. and S.M. Haig. 2004. Piping Plover (*Charadrius melodus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/002

Exponent Engineering, P.C. 2018. Deepwater Wind South Fork Wind Farm Onshore Electric and Magnetic Field Assessment. Appendix K2 in the *South Fork Wind Farm Construction and Operations Plan.* Prepared for Deepwater Wind, LLC by Exponent, Inc.

FHWG (Fisheries Hydroacoustic Working Group). 2008. Agreement in Principle for Interim Criteria for Injury to Fish from Pile Driving Activities. Available at: https://www.wsdot.wa.gov/sites/default/files/2018/01/17/ENV-FW-BA_InterimCriteriaAgree.pdf. Accessed: November 18, 2018.

FTA (Federal Transit Administration). 2006. *Transit Noise and Vibration Impact Assessment.* U.S. Department of Transportation, Federal Transit Administration, Office of Planning and Environment. FTA-VA-90-1003-06. 245 p.

FTA. 2018. *Transit Noise and Vibration Impact Assessment Manual.* U.S. Department of Transportation, Federal Transit Administration, Office of Planning and Environment. FTA Report No. 0123. 243 p.

Garrad Hassan America (GHA). 2018. South Fork Wind Farm Navigational Safety Risk Assessment. Appendix X in in the *South Fork Wind Farm Construction and Operations Plan.* Prepared by Garrad Hassan America, Inc. for Deepwater Wind South Fork, LLC. Document 10057311-HOU-R-01.

Greif, S., I. Borissov, Y. Yovel, and R.A. Holland. 2014. A functional role of the sky's polarization pattern for orientation in the greater mouse-eared bat. *Nature Communications* 5:4488 | DOI: 10.1038/ncomms5488

Gochfeld, M., J. Burger and I.C. Nisbet. 1998. Roseate Tern (*Sterna dougallii*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: http://bna.birds.cornell.edu/bna/species/370

Gordon, C. E., and C. Nations, 2016. Collision Risk Model for "rufa" Red Knots (*Calidris canutus rufa*) Interacting with a Proposed Offshore Wind Energy Facility in Nantucket Sound, Massachusetts. US Department of the Interior, Bureau of Ocean Energy Management, Sterling, Virginia. OCS Study BOEM 2016-045. 90 pp. + appendices.

Hatch, J. and S. Brault. 2007. Collision mortalities at Horseshoe Shoal of bird species of special concern. Report 5.3.2-1. Prepared for Cape Wind Associates, L.L. C., Boston, MA. 39 pp.

Hecht, A. and S.M. Melvin. 2009. Population Trends of Atlantic Coast Piping Plovers, 1986 – 2006. Waterbirds 32(1):64-72.

Holland, R.A., I. Borissov, and B.M. Siemers. 2010. A nocturnal mammal, the greater mouse-eared bat, calibrates a magnetic compass by the sun. *Proceedings of the National Academy of Sciences* 107(15): 6941-6945

Huppop, O., J. Dierschke, K.M. Exo, E. Fredrich, and R. Hill. 2006. Bird migration studies and potential collision risk with offshore turbines. *Ibis* 148:90-109.

Inspire Environmental. 2018. Pre-Construction Sediment Profile and Plan View Imaging Benthic Assessment Report. Appendix N in the *South Fork Wind Farm Construction and Operations Plan.* Prepared for CH2M Hill and Deepwater Wind, LLC.

Jansen, E. and C. de Jong. 2016. *Underwater noise measurements in the North Sea in and near the Princess Amalia Wind Farm in operation.* Proceedings of the Inter-Noise 2016 Conference, August 21-24, 2016, Hamburg, Germany.

JASCO. 2019. Turbine Foundation and Cable Installation at South Fork Wind Farm - Underwater Acoustic Modeling of Construction Noise. Prepared by JASCO Applied Sciences (USA) Inc. for Jacobs Engineering Group Inc. Document 01584. 46 p. + appendices.

Kerlinger, P., J.L. Gehring, W.P. Erickson, R. Curry, A. Jain, and J. Guarnaccia. 2010. Night migrant fatalities and obstruction lighting at wind turbines in North America. *The Wilson Journal of Ornithology* 122(4): 744-754.

Kinlan, B. P., A. J. Winship, T. P. White, and J. Christensen. 2016. Modeling at-sea occurrence and abundance of marine birds to support Atlantic marine renewable energy planning: phase I report. U.S. Department of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Sterling, VA. OCS Study BOEM 2016-039.

Lambert, P. 2016. Population and Population Density, Nassau and Suffolk Counties, New York. Suffolk County Planning. Spreadsheet download: http://www.suffolkcountyny.gov/Portals/0/planning/Research/2016/Population%20and%20Density%20by%20Town.xlsx. Accessed: December 5, 2018.

Loring, P.H., J.D. McLaren, P.A. Smith, L.J. Niles, S.L. Koch, H.F. Goyert, and H. Bai. 2018. *Tracking movements of threatened migratory rufa Red Knots in U.S. Atlantic Outer Continental Shelf Waters*. Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2018-046. 145 p.

Loring, P.H., P.W.C. Paton, J.D. McLaren, H. Bai, R. Janaswamy, H.F. Goyert, C.R. Griffin, and P.R. Sievert. 2019. *Tracking Offshore Occurrence of Common Terns, Endangered Roseate Terns, and Threatened Piping Plovers with VHF Arrays.* Sterling (VA): US Department of the Interior, Bureau of Ocean Energy Management. OCS Study BOEM 2019-017. 140 p.

Marmo, B., I. Roberts, M.P. Buckingham, S. King, and C. Booth. 2013. *Modelling of Noise Effects of Operational Offshore Wind Turbines including noise transmission through various foundation types.* Produced by Xi Engineering for Marine Scotland. Report no. MS-101-REP-F.

Massachusetts Department of Fish and Wildlife (MDFW). 2018. Massachusetts Habitat Conservation Plan for Piping Plover 2018 Annual Report. Prepared by the Natural Heritage & Endangered Species Program. 20 p.

McKenna, M.F., D. Ross, S.M. Wiggins, and J.A. Hildebrand. 2012. Underwater radiated noise from modern commercial ships. *Journal of the Acoustical Society of America* 131(1): 92-103.

Moller, H. and C.S. Pedersen. 2010. Low-frequency noise from large wind turbines. *Journal of the Acoustical Society of America* 129(6): 3727-3744.

NIH (National Institutes of Health). 2002. EMF – Electric and Magnetic Fields Associated with the Use of Electric Power. Prepared by the National Institute of Environmental Health Sciences, National Institutes of Health. Available: http://www.niehs.nih.gov/emfrapid. Accessed: December 5, 2018.

Nedwell, J., and D. Howell. 2004. *A Review of Offshore Windfarm Related Underwater Noise Sources*. Report No. 544 R 0308. October 2004. Commissioned by COWRIE.

NYNHP (New York Natural Heritage Program). 2017. Species Profile for sandplain gerardia. Available: http://acris.nynhp.org/report.php?id=9350. Viewed: 11/14/2018.

NYSDEC (New York State Department of Environmental Conservation). 2018. Protective Measures Required for Northern Long-eared Bats When Projects Occur within Occupied Habitat. Documented occurrence by town throughout New York State, June 18, 2018. Available: https://www.dec.ny.gov/animals/106090.html. Viewed: 11/14/2018.

NYSDOT (New York State Department of Transportation). 2016a. Traffic Volume Report, State Roads. Available at: https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services/traffic-data. Accessed: December 5, 2018.

NYSDOT. 2016b. Traffic Volume Report, County Roads. Available at: https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services/traffic-data. Accessed: December 5, 2018.

NYSDOT. 2016c. Traffic Volume Report, Local Roads. Available at: https://www.dot.ny.gov/divisions/engineering/technical-services/highway-data-services/traffic-data. Accessed: December 5, 2018.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, C. Espoz, P.M. González, B.A. Harrington, D.E. Hernández, K.S. Kalasz, R.G. Lathrop, R.N. Matus, C.D.T. Minton, R.I.G. Morrison, M.D. Peck, W. Pitts, R.A. Robinson, and I.L. Serrano. 2008. Status of the Red Knot (*Calidris canutus rufa*) in the Western Hemisphere. *Studies in Avian Biology No. 36*. Cooper Ornithological Society.

Niles, L.J., J. Bart, H. P. Sitters, A. D. Dey, K. E. Clark, P. W. Atkinson, A. J. Baker, K. A. Bennett, K. S. Kalasz, N. A. Clark, J. Clark, S. Gillings, A. S. Gates, P. M. González, D. E. Hernandez, C. D. T. Minton, R. I. Guy Morrison, R. R. Porter, R. K. Ross, And C. R. Veitch. 2009. Effects of Horseshoe Crab Harvest in Delaware Bay on Red Knots: Are Harvest Restrictions Working? Bioscience 59(2): 153–164.

Niles, L.J., J. Burger, R.R. Porter, A.D. Dey, C.D.T. Minton, P.M. Gonzalez, A.J. Baker, J.W. Fox, and C. Gordon. 2010. First Results Using Light Level Geolocators to Track Red Knots in the Western Hemisphere Show Rapid and Long Intercontinental Flights and New Details of Migration Pathways. Wader Study Group Bulletin 117(2): 123–130.

Nisbet, I.C.T. 1984. Migration and winter quarters of North American Roseate Terns as shown by banding recoveries. *Journal of Field Ornithology* 55:1-17.

Nisbet, I.C.T., M. Gochfeld, and J. Burger (2014). Roseate Tern (*Sterna dougallii*), version 2.0. In The Birds of North America (A. F. Poole, Editor). Cornell Lab of Ornithology, Ithaca, NY, USA. Available: https://doi.org/10.2173/bna.370. Accessed: July 25, 2019.

Normandeau (Normandeau Associates, Inc.). 2011a. *New insights and new tools regarding risk to roseate terns, piping plovers, and red knots from wind facility operations on the Atlantic Outer Continental Shelf.* A Final Report for the U. S. Department of the Interior, Bureau of Ocean Energy Management, Regulation and Enforcement, Report No. BOEMRE 048-2011. Contract No. M08PC20060. 287 pp.

Northeast Roseate Tern Recovery Team. 1998. Roseate Tern (*Sterna dougallii*) Northeastern Population Recovery Plan. First Update. Prepared for Northeast Region, U.S. Fish and Wildlife Service, Hadley, Massachusetts.

Orr, T., Herz, S., and Oakley, D. 2013. *Evaluation of Lighting Schemes for Offshore Wind Facilities and Impacts to Local Environments.* U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Office of Renewable Energy Programs, Herndon, VA. OCS Study BOEM 2013-0116. [429] pp.

Paton, P., K. Winiarski, C. Trocki, and S. McWilliams. 2010. Spatial Distribution, Abundance, and Flight Ecology of Birds in Nearshore and Offshore Waters of Rhode Island Interim Technical Report for the Rhode Island Ocean Special Area Management Plan 2010. University of Rhode Island, June 17, 2010.

Plissner, J.H. and S.M. Haig. 2000. Viability of piping plover, *Charadrius melodus*, metapopulations. Biological Conservation 92:163-173.

Popper, A.N. 2003. Effects of anthropogenic sounds on fishes. *Fisheries* 28(10): 24-31.

Popper, A.N., A.D. Hawkins, R.R. Fay, D.A. Mann, S. Bartol, T.J. Carlson, S. Coombs, W.T. Ellison, R.L. Gentry, M.B. Halvorsen, S. Lokkeborg, P.H. Rogers, B.L. Southall D.G. Zeddies, and W.N. Tavolga. 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1. ASA S3/SC1.4 TR-2014. ASA Press, Springer. DOI 10.1007/978-3-319-06659-2.

Rhode Island Department of Environmental Management (RIDEM). 2015. *Rhode Island Wildlife Action Plan*. Prepared by the Rhode Island Chapter of the Nature Conservancy and the University of Rhode Island.

Rock, J.C., M.L. Leonard, and A.W. Boyne. 2007. Foraging Habitat and Chick Diets of Roseate Tern, *Sterna dougallii*, Breeding on Country Island, Nova Scotia. Avian Conservation and Ecology 2(1):4. Available at: http://www.ace-eco.org/vol2/iss1/art4/

Safina, C. 1990. Foraging habitat partitioning in Roseate and Common Terns. *Auk* 107:351-358.

SNH (Scottish Natural Heritage). 2018. Avoidance Rates for the onshore SNH Wind Farm Collision Risk Model. Available at: https://www.nature.scot/wind-farm-impacts-birds-use-avoidance-rates-snh-wind-farm-collision-risk-model. Accessed: July 25, 2019.

Stantec. 2018. Avian and Bat Risk Assessment. Appendix Q in the South Fork Wind Farm and South Fork Export Cable Construction and Operations Plan. Prepared by Stantec Consulting Services, Inc. for Deepwater Wind South Fork, LLC. June 2018.

Stantial, M. L. 2014. Flight behavior of breeding Piping Plovers: implications for risk of collision with wind turbines. M.S. Thesis, State University of New York, Syracuse. Available at: https://njfishandwildlife.com/ensp/pdf/plover-turbine_stantialthesis14.pdf

Tian, L.X., Y.X. Pan, W. Metzner, J.S. Zhang, B.F. Zhang. 2015. Bats Respond to Very Weak Magnetic Fields. *PLOS One* DOI:10.1371/journal.pone.0123205

Tougaard, J., O.D. Henriksen, and L.A. Miller. 2009. Underwater noise from three types of offshore wind turbines: Estimation of impact zones for harbor porpoises and harbor seals. *Journal of the Acoustical Society of America* 125(6): 3766-3773.

USACE (U.S. Army Corps of Engineers). 1984. Exploration and Production of Hydrocarbon Resources in Coastal Alabama and Mississippi – Final Generic Environmental Impact Statement. USACE Mobile District.

USACE. 2004. Final Site Management and Monitoring Plan (SMMP) for the Rhode Island Sound Disposal Site. Appendix C in *Rhode Island Region Long-Term Dredged Material Disposal Site Evaluation Project – Final Environmental Impact Statement.* Available at: https://www.epa.gov/sites/production/files/2015-10/documents/r1_rhode_island_smmp_final.pdf. Accessed: July 15, 2019.

USACE. 2005. Encinitas and Solano Beach Shoreline Feasibility Study - San Diego, County California. Draft Feasibility Report. USACE Los Angeles District.

USDOE and USDOI (U.S. Department of Energy and U.S. Department of Interior) . 2016. National Offshore Wind Strategy. Facilitating the Development of the Offshore Wind Industry in the United States.

USDOI, MMS. 2007. Programmatic Environmental Impact Statement for Alternative Energy Development and Production and Alternate Use of Facilities on the Outer Continental Shelf, Final Environmental Impact Statement, October 2007. OCS Report MMS 2007-046. Available at: http://www.ocsenergy.anl.gov/.

USDOI, BOEMRE, OAEP (U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Office of Offshore Alternative Energy) Programs. 2011. Guidelines for Providing Geological and Geophysical, Hazards, and Archaeological Information Pursuant to 30 CFR Part 285. Online at: http://www.boem.gov/Renewable-Energy-Program/RegulatoryInformation/Index.aspx#Notices_to_Lessees,_Operators_and_Applicants. Accessed March 8, 2012.

USDOT (U.S. Department of Transportation). 1995. Highway Traffic Noise Analyses and Abatement: Policy and Guidance. U.S. Department of Transportation, Federal Highway Administration, Office of Environment and Planning, Noise and Air Quality Branch, Washington, D.C.

USFWS (U.S. Fish and Wildlife Service). Biological Opinion for the Cape Wind Energy Project, Nantucket Sound, Massachusetts. Concord, New Hampshire. 89 pp. + Appendix. Accessed: 10 August 2018. Available at: https://www.fws.gov/newengland/pdfs/CapeWind-BO-21November2008_withCovLttr.pdf. Accessed July 5, 2019.

USFWS. 2009. Piping Plover (*Charadrius melodus*) 5-year Review: Summary and Evaluation. September 2009. USFWS, Hadley, Massachusetts and USFWS, East Lansing, Michigan.

USFWS. 2010. Caribbean Roseate Tern and North Atlantic Roseate Tern (*Sterna dougallii dougallii*) 5-year Review: Summary and Evaluation. September 2010. USFWS, Boqeuerón, Puerto Rico and USFWS, Concord, New Hampshire.

USFWS. 2018a. U.S. Environmental Conservation Online System: Species Profile: Piping Plover (*Charadrius melodus*). Available at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B079. Accessed on October 15, 2018.

USFWS. 2018b. U.S. Environmental Conservation Online System: Species Profile: Roseate Tern (*Sterna dougalli dougalli*). Online at: http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=B07O. Accessed on October 15, 2018.

USFWS. 2018c. U.S. Environmental Conservation Online System: Species Profile: Red Knot (*Calidris canutus ssp. rufa*). Online at: https://ecos.fws.gov/ecp0/profile/speciesProfile?sId=1864. Accessed on October 15, 2018.

USFWS. 2018d. 2017 Atlantic Coast Piping Plover Abundance and Productivity Estimates (September 14, 2018). Online at: https://www.fws.gov/northeast/pipingplover/pdf/2017-Update-Final.pdf. Accessed July 15, 2019.

USFWS. 2019. Updated list of threatened and endangered species for the South Fork Wind Farm and South Fork Export Cable project. Automatically generated by the USFWS iPac system (https://ecos.fws.gov/ipac/). Consultation Code: 05E1LI00-2019-SLI-0043. Event Code: 05E1LI00-2019-E-01276. Generated July 9, 2019.

USFWS. 2020a. Piping Plover (*Charadrius melodus*) 5-Year Review: Summary and Evaluation. 164 pp.

USFWS. 2020b. Roseate Tern Northeastern North American Population (*Sterna dougallii dougallii*) 5-Year Review: Summary and Evaluation. 55 pp.

VHB (VHB Engineering, Surveying and Landscape Architecture). 2018. *Biological Resources Report South Fork Export Cable - Onshore Study Area Town of East Hampton and Village of East Hampton, Suffolk County, New York*. Appendix M in the South Fork Wind Farm and South Fork Export Cable Construction and Operations Plan. Prepared for Deepwater Wind South Fork, LLC. May 2018.

Van Bussel, G.J.W, C. Boussion, and C. Hofemann. 2013. A possible relation between wind conditions, advanced control and early gearbox failures in offshore wind turbines. Proceedings of the 2nd International Through-life Engineering Services Conference. *Procedia CIRP* 11:301–304; doi: 10.1016/j.procir.2013.08.001.

WSDOT (Washington State Department of Transportation). 2019. Biological Assessment Preparation Manual, 2018 Update. Prepared by the Washington State Department of Transportation, Olympia, Washington. Available: https://www.wsdot.wa.gov/environment/technical/fish-wildlife/policies-and-procedures/esa-ba/preparation-manual. Accessed December, 2018.

Wellig, S.D., S. Nussle, D. Miltner, O. Khole, O. Glaizot, V. Braunisch, M.K. Obrist, and R. Alrettaz. 2018. Mitigating the negative impacts of tall wind turbines on bats: Vertical activity profiles and relationships to wind speed. *PLoS ONE* 13(3): e0192493.

Witte, J. 2010. *Noise from moored ships.* Proceedings of the Inter-Noise 2010, Noise and Sustainability Conference, June 13-16 Lisbon, Portugal. Available: www.internoise2010.org. Accessed: September 11, 2018.

List of Preparers

Bureau of Ocean Energy Management

David Bigger

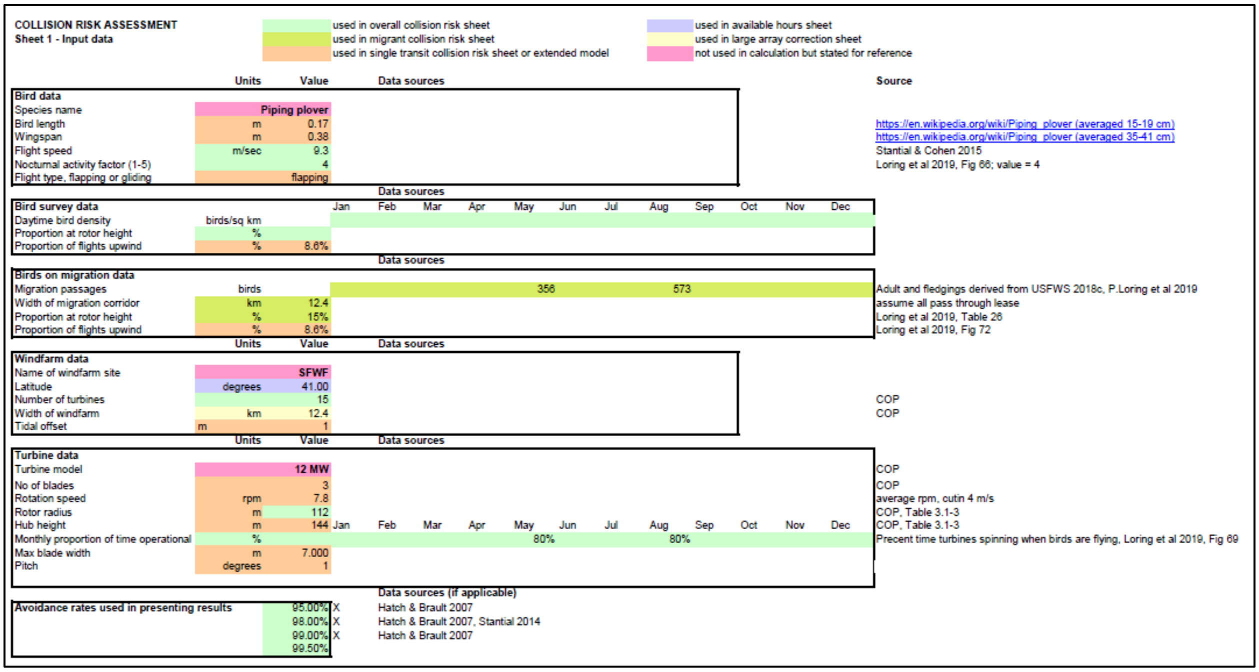
Confluence Environmental Company

Eric Doyle

Grant Novak

Appendix A – Band Model Inputs and Outputs

Piping Plover



COLLISION RISK ASSESSMENT
Sheet 1 - Input data

🟩 used in overall collision risk sheet
🟨 used in migrant collision risk sheet
🟧 used in single transit collision risk sheet or extended model
🟪 used in available hours sheet
⬜ used in large array correction sheet
🟥 not used in calculation but stated for reference

Bird data	Units	Value	Data sources	Source
Species name		Piping plover		
Bird length	m	0.17		https://en.wikipedia.org/wiki/Piping_plover (averaged 15-19 cm)
Wingspan	m	0.38		https://en.wikipedia.org/wiki/Piping_plover (averaged 35-41 cm)
Flight speed	m/sec	9.3		Stantial & Cohen 2015
Nocturnal activity factor (1-5)		4		Loring et al 2019, Fig 66; value = 4
Flight type, flapping or gliding		flapping		

Data sources

Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km													
Proportion at rotor height	%													
Proportion of flights upwind	%	8.6%												

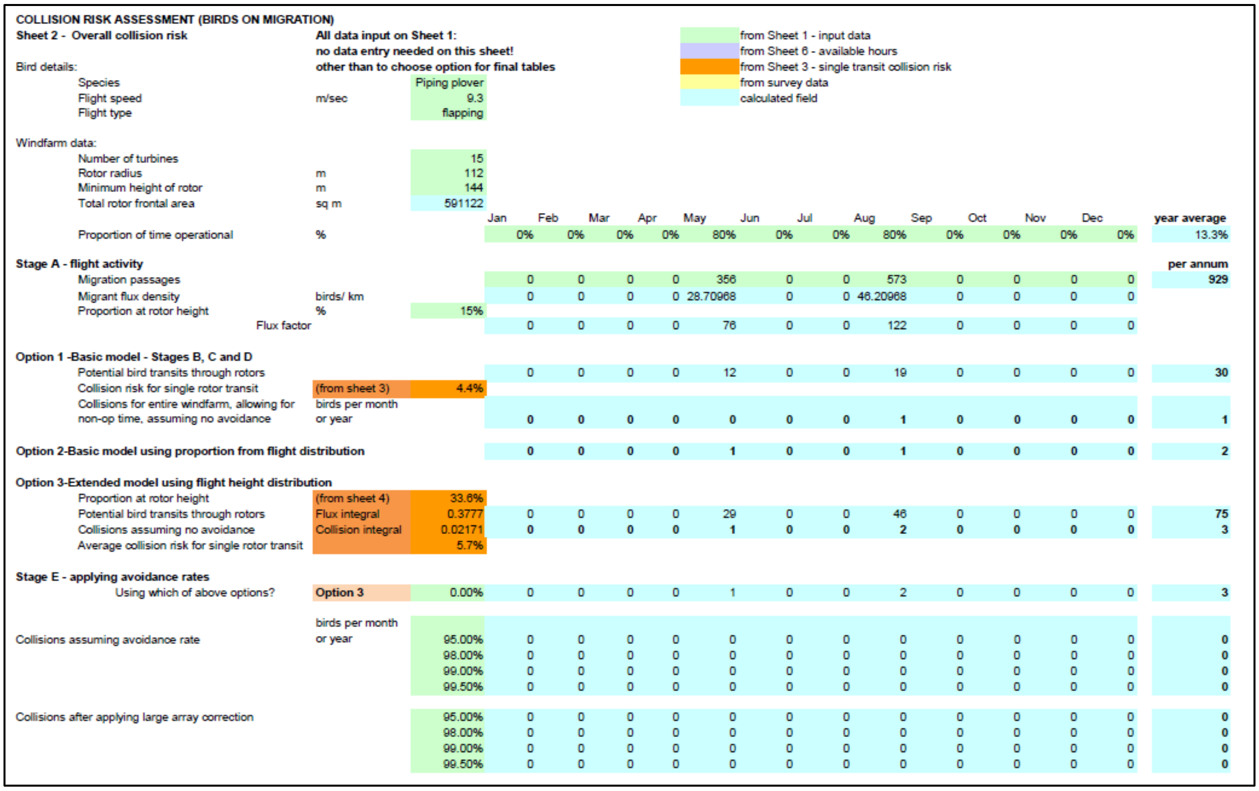
Data sources

Birds on migration data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Migration passages	birds						356			573					Adult and fledgings derived from USFWS 2018c, P.Loring et al 2019
Width of migration corridor	km	12.4													assume all pass through lease
Proportion at rotor height	%	15%													Loring et al 2019, Table 26
Proportion of flights upwind	%	8.6%													Loring et al 2019, Fig 72

Windfarm data	Units	Value	Data sources	
Name of windfarm site		SFWF		
Latitude	degrees	41.00		
Number of turbines		15		COP
Width of windfarm	km	12.4		COP
Tidal offset	m	1		

Turbine data	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Turbine model		12 MW													COP
No of blades		3													COP
Rotation speed	rpm	7.8													average rpm, cutin 4 m/s
Rotor radius	m	112													COP, Table 3.1-3
Hub height	m	144													COP, Table 3.1-3
Monthly proportion of time operational	%						80%			80%					Precent time turbines spinning when birds are flying, Loring et al 2019, Fig 69
Max blade width	m	7.000													
Pitch	degrees	1													

Avoidance rates used in presenting results			Data sources (if applicable)
	95.00%	X	Hatch & Brault 2007
	98.00%	X	Hatch & Brault 2007, Stantial 2014
	99.00%	X	Hatch & Brault 2007
	99.50%		



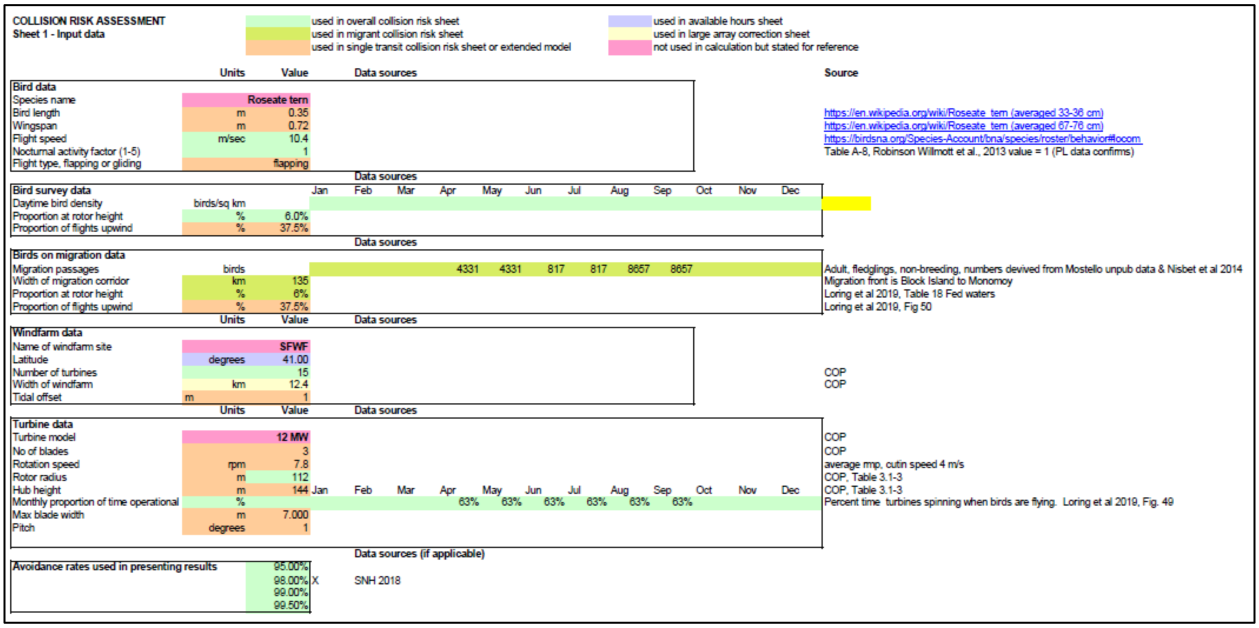
COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)
Sheet 2 - Overall collision risk

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

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

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	year average
Bird details:															
Species		Piping plover													
Flight speed	m/sec	9.3													
Flight type		flapping													
Windfarm data:															
Number of turbines		15													
Rotor radius	m	112													
Minimum height of rotor	m	144													
Total rotor frontal area	sq m	591122													
Proportion of time operational	%		0%	0%	0%	0%	80%	0%	0%	80%	0%	0%	0%	0%	13.3%
Stage A - flight activity															**per annum**
Migration passages			0	0	0	0	356	0	0	573	0	0	0	0	**929**
Migrant flux density	birds/ km		0	0	0	0	28.70968	0	0	46.20968	0	0	0	0	
Proportion at rotor height	%	15%													
Flux factor			0	0	0	0	76	0	0	122	0	0	0	0	
Option 1 -Basic model - Stages B, C and D															
Potential bird transits through rotors			0	0	0	0	12	0	0	19	0	0	0	0	**30**
Collision risk for single rotor transit	(from sheet 3)	4.4%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**1**
Option 2-Basic model using proportion from flight distribution			**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**2**
Option 3-Extended model using flight height distribution															
Proportion at rotor height	(from sheet 4)	33.6%													
Potential bird transits through rotors	Flux integral	0.3777	0	0	0	0	29	0	0	46	0	0	0	0	**75**
Collisions assuming no avoidance	Collision integral	0.02171	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**3**
Average collision risk for single rotor transit		5.7%													
Stage E - applying avoidance rates															
Using which of above options?	**Option 3**	0.00%	0	0	0	0	1	0	0	2	0	0	0	0	**3**
	birds per month or year														
Collisions assuming avoidance rate		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**

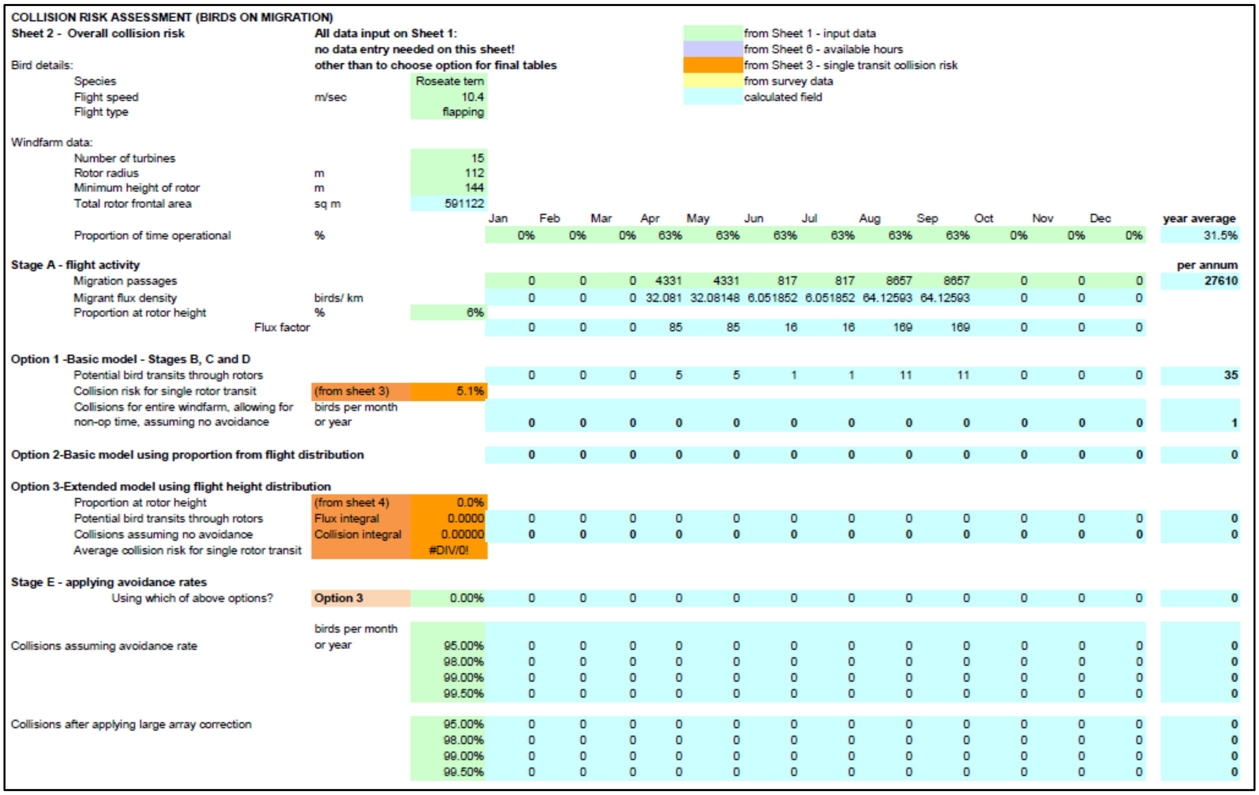
Roseate Tern



COLLISION RISK ASSESSMENT
Sheet 1 - Input data

🟩 used in overall collision risk sheet
🟩 used in migrant collision risk sheet
🟧 used in single transit collision risk sheet or extended model
🟪 used in available hours sheet
🟨 used in large array correction sheet
🟥 not used in calculation but stated for reference

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source
	Units	**Value**	**Data sources**												**Source**
Bird data															
Species name		**Roseate tern**													
Bird length	m	0.35													https://en.wikipedia.org/wiki/Roseate_tern (averaged 33-36 cm)
Wingspan	m	0.72													https://en.wikipedia.org/wiki/Roseate_tern (averaged 67-76 cm)
Flight speed	m/sec	10.4													https://birdsna.org/Species-Account/bna/species/roster/behavior#locom
Nocturnal activity factor (1-5)		1													Table A-8, Robinson Willmott et al., 2013 value = 1 (PL data confirms)
Flight type, flapping or gliding		flapping													
			Data sources												
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daytime bird density	birds/sq km														
Proportion at rotor height	%	6.0%													
Proportion of flights upwind	%	37.5%													
			Data sources												
Birds on migration data															
Migration passages	birds					4331	4331	817	817	8657	8657				Adult, fledglings, non-breeding, numbers devived from Mostello unpub data & Nisbet et al 2014
Width of migration corridor	km	135													Migration front is Block Island to Monomoy
Proportion at rotor height	%	6%													Loring et al 2019, Table 18 Fed waters
Proportion of flights upwind	%	37.5%													Loring et al 2019, Fig 50
	Units	**Value**	**Data sources**												
Windfarm data															
Name of windfarm site		**SFWF**													
Latitude	degrees	41.00													
Number of turbines		15													COP
Width of windfarm	km	12.4													COP
Tidal offset	m	1													
	Units	**Value**	**Data sources**												
Turbine data															
Turbine model		**12 MW**													COP
No of blades		3													COP
Rotation speed	rpm	7.8													average rmp, cutin speed 4 m/s
Rotor radius	m	112													COP, Table 3.1-3
Hub height	m	144	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	COP, Table 3.1-3
Monthly proportion of time operational	%					63%	63%	63%	63%	63%	63%				Percent time turbines spinning when birds are flying. Loring et al 2019, Fig. 49
Max blade width	m	7.000													
Pitch	degrees	1													
			Data sources (if applicable)												
Avoidance rates used in presenting results		95.00%													
		98.00%	X SNH 2018												
		99.00%													
		99.50%													



COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)

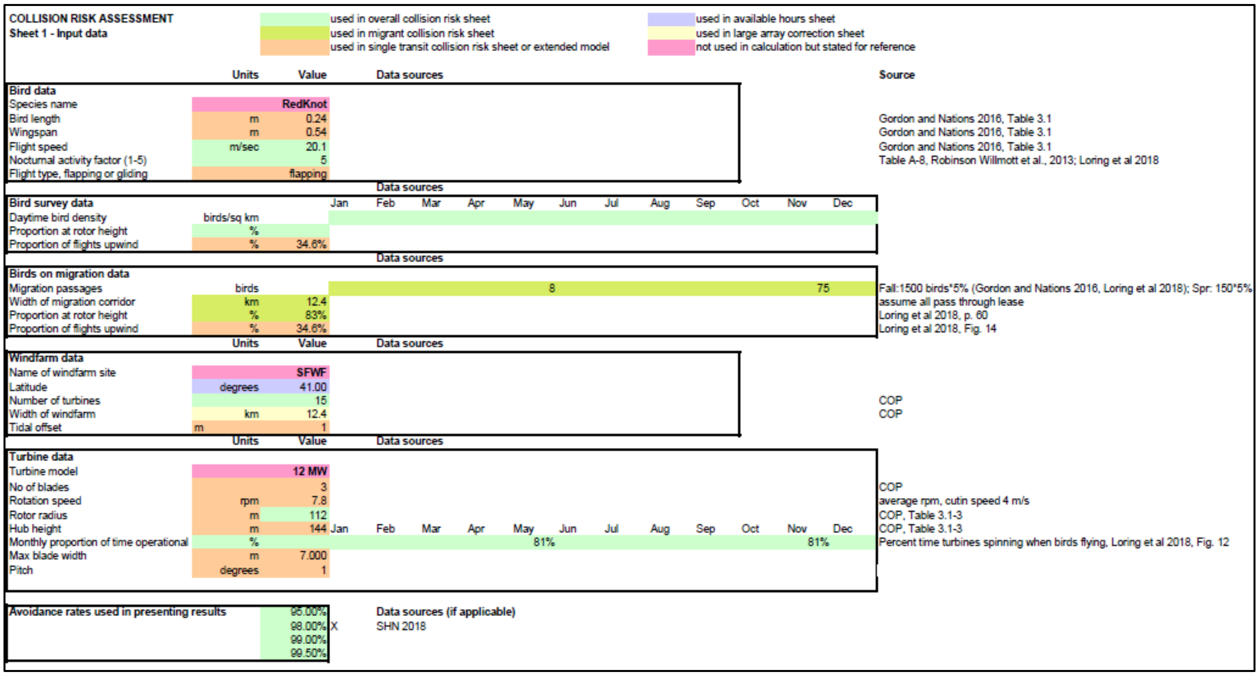
Sheet 2 - Overall collision risk

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

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

Bird details:															
Species		Roseate tern													
Flight speed	m/sec	10.4													
Flight type		flapping													
Windfarm data:															
Number of turbines		15													
Rotor radius	m	112													
Minimum height of rotor	m	144													
Total rotor frontal area	sq m	591122													
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**year average**
Proportion of time operational	%		0%	0%	0%	63%	63%	63%	63%	63%	63%	0%	0%	0%	31.5%
Stage A - flight activity															**per annum**
Migration passages			0	0	0	4331	4331	817	817	8657	8657	0	0	0	**27610**
Migrant flux density	birds/ km		0	0	0	32.081	32.08148	6.051852	6.051852	64.12593	64.12593	0	0	0	
Proportion at rotor height	%	6%													
Flux factor			0	0	0	85	85	16	16	169	169	0	0	0	
Option 1 -Basic model - Stages B, C and D															
Potential bird transits through rotors			0	0	0	5	5	1	1	11	11	0	0	0	**35**
Collision risk for single rotor transit	(from sheet 3)	5.1%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Option 2-Basic model using proportion from flight distribution			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Option 3-Extended model using flight height distribution															
Proportion at rotor height	(from sheet 4)	0.0%													
Potential bird transits through rotors	Flux integral	0.0000	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Collisions assuming no avoidance	Collision integral	0.00000	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Average collision risk for single rotor transit		#DIV/0!													
Stage E - applying avoidance rates															
Using which of above options?	**Option 3**	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	birds per month or year														
Collisions assuming avoidance rate		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**

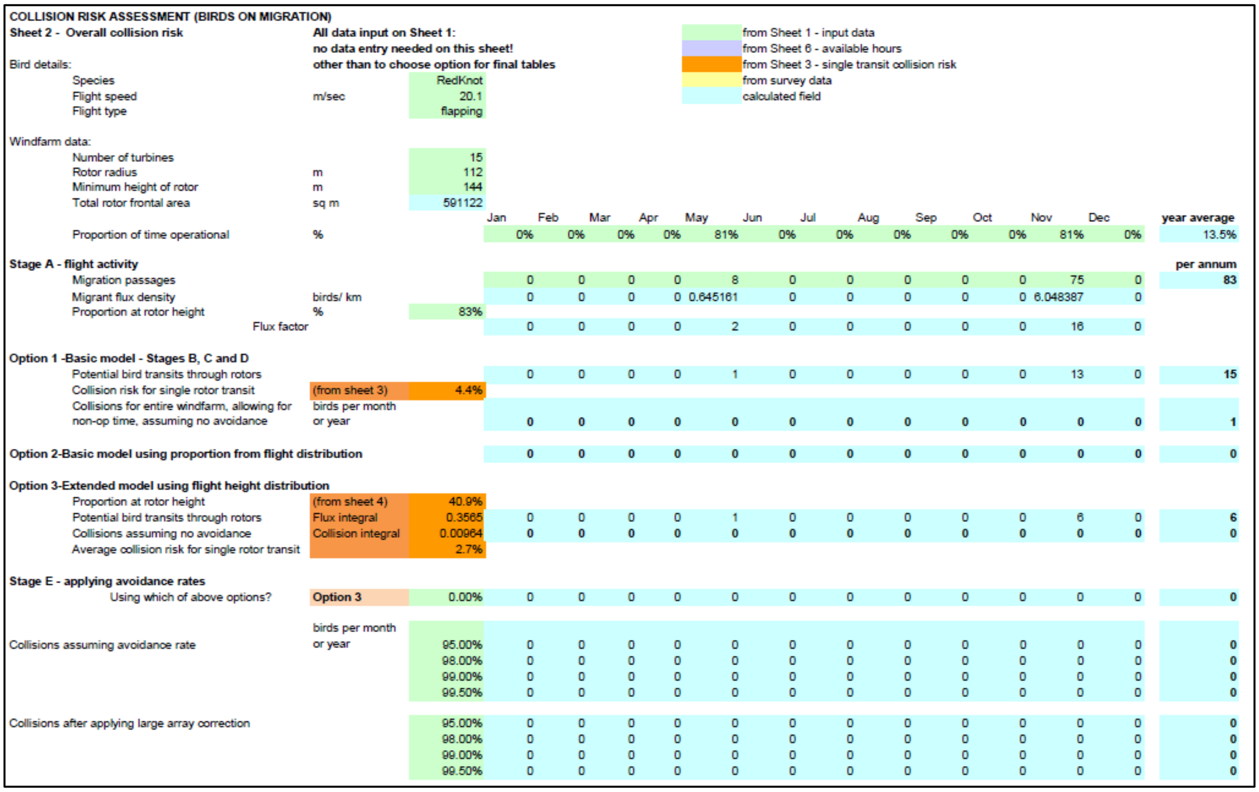
Red Knot



COLLISION RISK ASSESSMENT
Sheet 1 - Input data

🟩 used in overall collision risk sheet
🟩 used in migrant collision risk sheet
🟧 used in single transit collision risk sheet or extended model
🟪 used in available hours sheet
🟨 used in large array correction sheet
🟥 not used in calculation but stated for reference

	Units	Value	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Source
	Units	**Value**		**Data sources**											**Source**
Bird data															
Species name		**RedKnot**													
Bird length	m	0.24													Gordon and Nations 2016, Table 3.1
Wingspan	m	0.54													Gordon and Nations 2016, Table 3.1
Flight speed	m/sec	20.1													Gordon and Nations 2016, Table 3.1
Nocturnal activity factor (1-5)		5													Table A-8, Robinson Willmott et al., 2013; Loring et al 2018
Flight type, flapping or gliding		flapping													
				Data sources											
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daytime bird density	birds/sq km														
Proportion at rotor height	%														
Proportion of flights upwind	%	34.6%													
				Data sources											
Birds on migration data															
Migration passages	birds						8						75		Fall:1500 birds*5% (Gordon and Nations 2016, Loring et al 2018); Spr: 150*5%
Width of migration corridor	km	12.4													assume all pass through lease
Proportion at rotor height	%	83%													Loring et al 2018, p. 60
Proportion of flights upwind	%	34.6%													Loring et al 2018, Fig. 14
	Units	**Value**		**Data sources**											
Windfarm data															
Name of windfarm site		**SFWF**													
Latitude	degrees	41.00													
Number of turbines		15													COP
Width of windfarm	km	12.4													COP
Tidal offset	m	1													
	Units	**Value**		**Data sources**											
Turbine data															
Turbine model		**12 MW**													
No of blades		3													COP
Rotation speed	rpm	7.8													average rpm, cutin speed 4 m/s
Rotor radius	m	112													COP, Table 3.1-3
Hub height	m	144	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	COP, Table 3.1-3
Monthly proportion of time operational	%						81%						81%		Percent time turbines spinning when birds flying, Loring et al 2018, Fig. 12
Max blade width	m	7.000													
Pitch	degrees	1													
Avoidance rates used in presenting results		95.00%		**Data sources (if applicable)**											
		98.00%	X	SHN 2018											
		99.00%													
		99.50%													



COLLISION RISK ASSESSMENT (BIRDS ON MIGRATION)
Sheet 2 - Overall collision risk

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

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

			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Bird details:															
Species		RedKnot													
Flight speed	m/sec	20.1													
Flight type		flapping													
Windfarm data:															
Number of turbines		15													
Rotor radius	m	112													
Minimum height of rotor	m	144													
Total rotor frontal area	sq m	591122													
			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	**year average**
Proportion of time operational	%		0%	0%	0%	0%	81%	0%	0%	0%	0%	0%	81%	0%	13.5%
Stage A - flight activity															**per annum**
Migration passages			0	0	0	0	8	0	0	0	0	0	75	0	**83**
Migrant flux density	birds/ km		0	0	0	0	0.645161	0	0	0	0	0	6.048387	0	
Proportion at rotor height	%	83%													
Flux factor			0	0	0	0	2	0	0	0	0	0	16	0	
Option 1 -Basic model - Stages B, C and D															
Potential bird transits through rotors			0	0	0	0	1	0	0	0	0	0	13	0	**15**
Collision risk for single rotor transit	(from sheet 3)	4.4%													
Collisions for entire windfarm, allowing for non-op time, assuming no avoidance	birds per month or year		**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**
Option 2-Basic model using proportion from flight distribution			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Option 3-Extended model using flight height distribution															
Proportion at rotor height	(from sheet 4)	40.9%													
Potential bird transits through rotors	Flux integral	0.3565	0	0	0	0	1	0	0	0	0	0	6	0	**6**
Collisions assuming no avoidance	Collision integral	0.00964	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Average collision risk for single rotor transit		2.7%													
Stage E - applying avoidance rates															
Using which of above options?	**Option 3**	0.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
	birds per month														
Collisions assuming avoidance rate	or year	95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Collisions after applying large array correction		95.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		98.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.00%	0	0	0	0	0	0	0	0	0	0	0	0	**0**
		99.50%	0	0	0	0	0	0	0	0	0	0	0	0	**0**