4.3.2 Benthic and Shellfish Resources

The description of the affected environment and assessment of potential impacts for benthic and shellfish resources were determined by reviewing public data sources and conducting project-specific studies. Sources reviewed included state and federal agency-published papers and databases (McMullen et al., 2009; RI CRMC, 2010; LaFrance et al., 2010; Poppe et al., 2014a; Collie and King, 2016; Siemann and Smolowitz, 2017), published journal articles (McMaster, 1960), online data portals and mapping databases (Northeast Ocean Data, 2017; USGS, 2017), academic theses (Malek, 2015), and correspondence and consultation with federal and state agencies. Project-specific studies conducted to aid in the characterization of the affected environment and to address BOEM Benthic Habitat Guidelines (2013) for benthic and shellfish resources included:

- G&G Surveys, completed by Fugro on December 30, 2017, characterized and evaluated seafloor conditions (Appendix H).
- Benthic Habitat Surveys, conducted by INSPIRE Environmental (INSPIRE) on November 11–15, 2017 and November 20, 2018, identified and confirmed dominant benthic macrofaunal and macrofloral communities (Appendix N1).
- Benthic Habitat Mapping, conducted by INSPIRE to support Essential Fish Habitat Consultation, further characterized benthic habitat types within the Project Area (Appendix N2).

Benthic and shellfish resources are described in the following subsections in terms of benthic habitat types and commonly associated taxa, including SAV, macroalgal assemblages, and micro- and macrobenthic communities. A brief discussion of ecologically and economically important shellfish species is also included. These descriptions and discussion of habitat distribution within the SFWF and along the SFEC are followed by an evaluation of potential project-related impacts.

4.3.2.1 Affected Environment

Regional Overview

The RI-MA WEA is located offshore on the northeastern Atlantic continental shelf in Rhode Island Sound. The waters in the vicinity of the SFWF and SFEC are transitional waters that separate Narragansett Bay and Long Island Sound from the OCS. Benthic communities in these areas are adapted to survive in this dynamic environment. In general, the benthic communities of the OCS areas are diverse, with lower densities of organisms than in the northern portion of the Mid-Atlantic Bight and in deeper areas of the OCS (DOI-MMS, 2007).

The area is composed of a mix of soft and hard bottom environments defined by dominant sediment grain size and composition. The U.S. Geological Survey (USGS) conducted sediment studies in the vicinity of Block Island and in Rhode Island Sound. These areas were found to have sandy sediments that ranged from very fine to medium sand; very fine sands were prevalent in deeper, lower energy areas, while coarser sediments were found in shallower and higher energy areas (McMullen et al., 2007a, 2007b, 2008; Poppe et al., 2011, 2014a, 2014b, 2014c). The USGS data and other data available for the SFWF area (RI CRMC 2010; Malek et al., 2014; USGS, 2017; Collie and King, 2016; BOEM, 2017) suggest that surface sediment cover in the SFWF and along the SFEC comprise mostly sandy sediments with some areas of coarser material (gravel or small cobble) and boulder fields, but there was very little site-specific data available (McMaster, 1960; Poppe et al., 2014a; McMullen et al., 2009; LaFrance et al., 2010).

This range of grain sizes is typical of OCS glacial moraine depositional environments that include Holocene marine transgressive deposits. O'Hara and Oldale (1980) and subsequent authors recognized that within the broad distribution of the glacial moraine identified in the RI-MA WEA there are deep channels cut into the glacial moraine by meltwaters and subsequent reworking and deposition as the glaciers retreated and transgressive seas flooded the area. These processes have left a complex mosaic of geological deposits across the surface of the RI-MA WEA and SFEC-OCS. Site-specific surveys revealed more detailed information on surficial and subsurface geology (Figure 4.3-4 and Appendix H).

The OSAMP assessed sediment data collected from two areas: (1) within state waters around the southern end of Block Island, and (2) in federal waters west of Martha's Vineyard in Rhode Island Sound (RI CRMC, 2010). Some OSAMP data from the federal waters west of Martha's Vineyard were collected from portions of the overall North Lease Area north of the SFWF. Results showed a wide range of depositional environments dominated by coarse sand and sand sheets (LaFrance et al., 2010). Sediment types found in lower areal coverages included boulder gravel concentrations, cobble gravel pavement, and sand waves.

The NYSDOS commissioned the Offshore Atlantic Ocean Study to better understand the biological and physical characteristics of the OCS waters (NYSDOS, 2013). This study, which encompassed the New York Offshore Planning Area (an area roughly the extent of the New York Bight), ended immediately west of the RI-MA WEA. However, this data set covers much of the SFEC - OCS and predicts a high likelihood of fine to coarse sand with areas of granules and pebbles (i.e., small, mobile gravels).

Marine substrata and surface sediments provide context and settings for many aquatic processes and living space for benthic biota. The Coastal and Marine Ecological Classification Standard (CMECS) (FGDC, 2012), the use of which is recommended by BOEM Benthic Habitat Survey Guidelines (2013), provides a means to categorize sediments using the Substrate Component. CMECS uses standard (Udden-Wentworth) grain size classes to define sediment types; these classes pair measurements to common terminology. For example, all grain sizes larger than 5/64 of an inch (2 mm) constitute gravels, which are further classified in order of increasing size as granules, pebbles, cobbles, and boulders. Habitats predominantly composed of larger gravels constitute hard bottom habitats, along with rock outcrops and rocky reefs. These habitats are considered stable and are not readily moveable by currents and wave energy. In contrast, soft bottom habitats composed of sands, silts, and clays are readily moved by such hydrodynamic forces. Sand is further divided into very fine sand (0.06 to 0.125 mm), fine sand (0.125 to 0.25 mm), medium sand (0.25 to 0.5 mm), coarse sand (0.5 to 1 mm), and very coarse sand (1 to 2 mm) and is very common on the OCS. Fine-grained sediments (silts and clays, 0.002 to 0.06 mm and 0.001 to 0.002 mm, respectively) are typically found in quiescent depositional environments.

Sediment grain size influences the biological communities likely found in each habitat (Steimle, 1982), and the CMECS Biotic Component provides a useful means to examine these relationships. The Biotic Component of CMECS is a classification of the living organisms of the seabed and water column, together with their physical associations at a variety of spatial scales. The Biotic Component is organized into a branched hierarchy of five nested levels: Biotic Setting, Biotic Class, Biotic Subclass, Biotic Group, and Biotic Community. The Biotic Subclass is a key CMECS classifier that presents valuable information about the surveyed area in terms of physical habitat and the potential presence of sensitive taxa. Although Biotic Subclasses are not directly based on sediment grain size distributions, they reflect those distributions at the scale of relevance to the dominant fauna present, thus integrating physical and biological characteristics of the seafloor. CMECS expressly states that "…substrate type is such a defining aspect of the Faunal Bed Subclass that CMECS Faunal Bed Subclasses are assigned as physical-biological associations involving both biota and substrate" (FGDC, 2012). Further, the Biotic Subclass is a key classifier that presents valuable information in terms of physical habitat and the potential presence of sensitive habitats.

Most relevant to the study region are the Attached Fauna and Soft Sediment Fauna Biotic Subclasses, which provide excellent broad-scale categories for seafloor habitats. The Soft Sediment Fauna Subclass in the Northwest Atlantic OCS typically includes common taxa, such as sand dollars, tube building worms, and clams, whereas the Attached Fauna Subclass indicates the dominant presence of sessile biota (macroalgae, sponges, bryozoans) living on hard bottom substrata. Attached Fauna habitats are also referred to in some documents as "live bottom." These hard bottom habitats are considered to be potentially valuable and sensitive resources for regionally important taxa, such as Atlantic cod and lobster. Hard bottom habitats are limited in regional distribution compared to sandy and soft bottom habitats (CoastalVision and Germano and Associates, 2010).

Cobble and boulder habitat can serve as a nursery ground for juvenile lobster and as preferable habitat for squid to deposit their eggs. Both lobster and squid are specific in their habitat requirements and are also economically important species in New England. For these reasons, federal and state agencies consider evidence of these taxa to indicate the presence of potentially sensitive habitats. Along with valuable hard bottom habitats, additional potentially sensitive seafloor habitats include areas with corals present and submerged aquatic vegetation beds (BOEM, 2013). Corals are not predicted to commonly occur within the SFWF or along the SFEC, as corals are more commonly found at deeper depths in the Northwest Atlantic. SAV beds are not predicted to occur within the SFWF or along the SFEC - OCS route due to depth limitations and are not predicted to be present along the SFEC - NYS primarily due to wave energy in nearshore waters.

Benthic community structure has only been inferred from studies in surrounding areas, including the OSAMP and related publications (RI CRMC, 2010; LaFrance et al., 2010), studies conducted at the Block Island Wind Farm study (CoastalVision and Germano and Associates, 2010; DWW, 2012; INSPIRE, 2016), and BOEM-funded research (Collie and King, 2016; Siemann and Smolowitz, 2017). Data available from most of these studies only suggest which physical substrata and biotic communities may be present within the SFWF and SFEC; although one study, which included lobster trawls, examined the RI-MA WEA in terms of lobster habitat and confirmed the importance of the lease area as lobster habitat compared to inshore areas (Collie and King, 2016).

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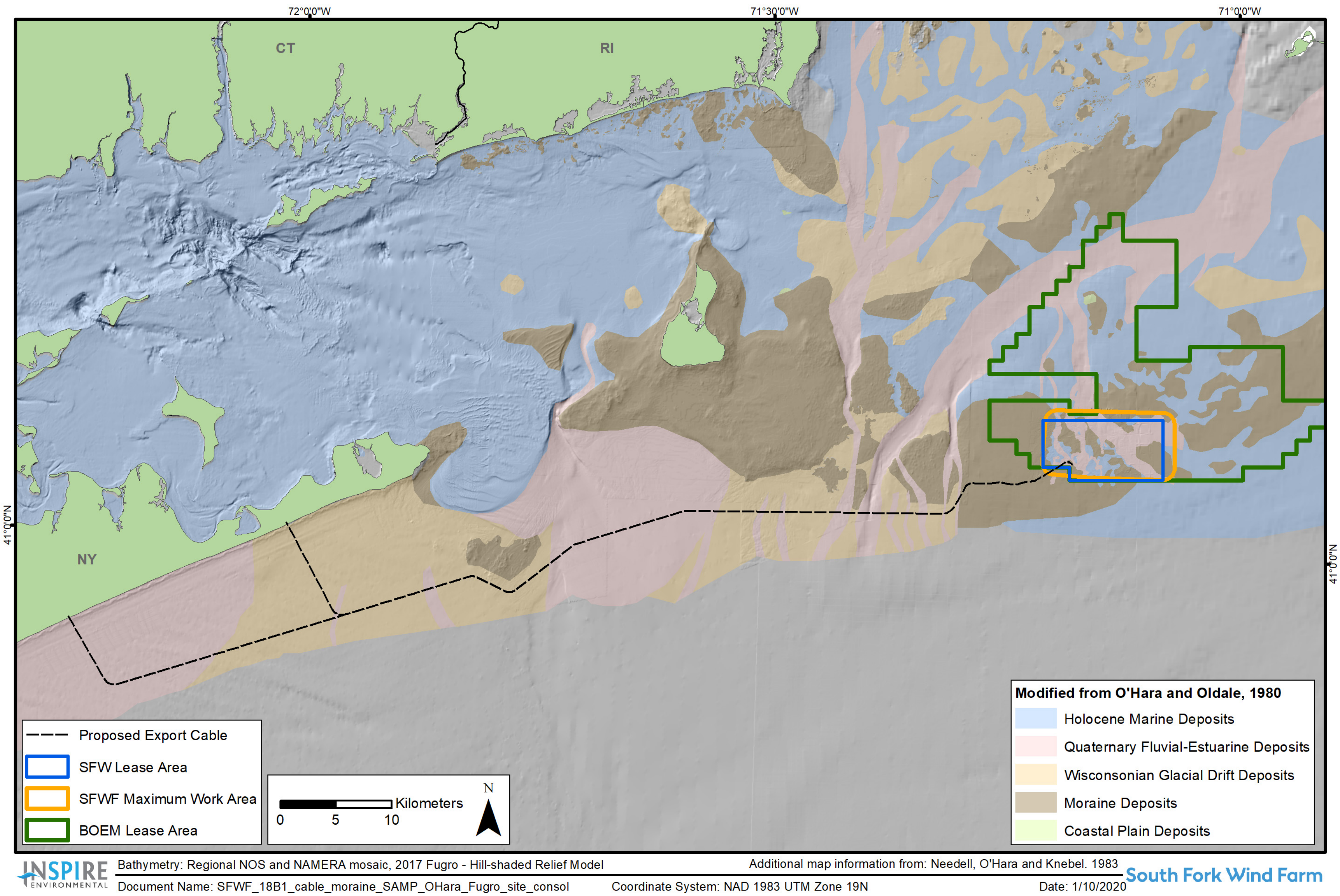

Figure 4.3-4. Interpreted Geologic Units Based on MBES and Shallow Seismic Data

Illustration of geologic units in relation to project components

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Benthic Habitats and Biota

Benthic Habitat Types

To better understand the site-specific benthic characteristics of the SFWF and the SFEC, DWW conducted a G&G survey (Appendix H) in the fall of 2017 and geophysical ground truthing and benthic habitat assessments (Appendix N1) in the fall of 2017 and 2018. A combined Sediment Profile and Plan View Imaging (SPI/PV) system was used to gather data to ground truth G&G data (multibeam echosounder and side scan sonar), and to provide a thorough characterization of surface sediment and biota found at the SFWF and along the SFEC. These data were used to meet BOEM Benthic Habitat Guidelines (BOEM, 2013) to characterize surface sediments; delineate and characterize hard bottom areas; identify and confirm benthic flora and fauna, including sessile and slow-moving invertebrates; identify sensitive habitats; establish preconstruction baseline benthic conditions against which postconstruction habitats can be compared; and determine the suitability of a sampled reference area to serve as a control site for future monitoring and assessment. These objectives were met, and more details are provided in the full SPI/PV reports presented as part of Appendices H and N. As part of the G&G survey, surficial and subsurface geological interpretation was conducted to determine and map the location of glacial and post-glacial deposits. The distribution of these geologic deposits provides context for the distribution of sedimentary habitats (Figure 4.3-5). A detailed map of the distribution of boulders on the seabed surface was derived from site-specific surveys MBES and sidescan sonar surveys in the SFWF MWA (Figure 3.1-1 and Appendix H).

Data provided by these site-specific surveys are discussed here in concert with previously existing data on surface sediments, biota, and habitat types found and likely to be found in the region. A list of species commonly associated with benthic habitats and the depth ranges found at the SFWF and the SFEC are provided in Table 4.3-3 (flora), Table 4.3-4 (fauna), and Table 4.3-5 (ecological and economically important shellfish). The depth ranges within the NYS portion of the SFEC route are shallower than along the SFEC - OCS, and differences in species distributions related to these depths and wave energy exposure in nearshore areas are discussed in the SFEC habitat distribution section.

It is important to note that most of the macroalgae species identified in Table 4.3-3 are found in shallow intertidal and subtidal waters that are not present within the SFWF or along most of the SFEC route; the only living macroalgae observed was coralline algae at two stations within the SFWF (Appendix N1). Similarly, the depth ranges and habitats found at the SFWF and along most of the SFEC route preclude the possibility of SAV (e.g., eelgrass, widgeon grass), which are found in quiescent habitats shallower than 20 feet (6.1 m); none were observed during the benthic survey (Appendix N1). Additionally, no known invasive species (i.e., those listed by the Northeastern Aquatic Nuisance Species Panel) were observed during the benthic survey (Appendix N1). Demersal (bottom-dwelling) fish species and commercially harvested shellfish and invertebrates associated with hard bottom habitats are described further in Section 4.3.3 and Appendix O.

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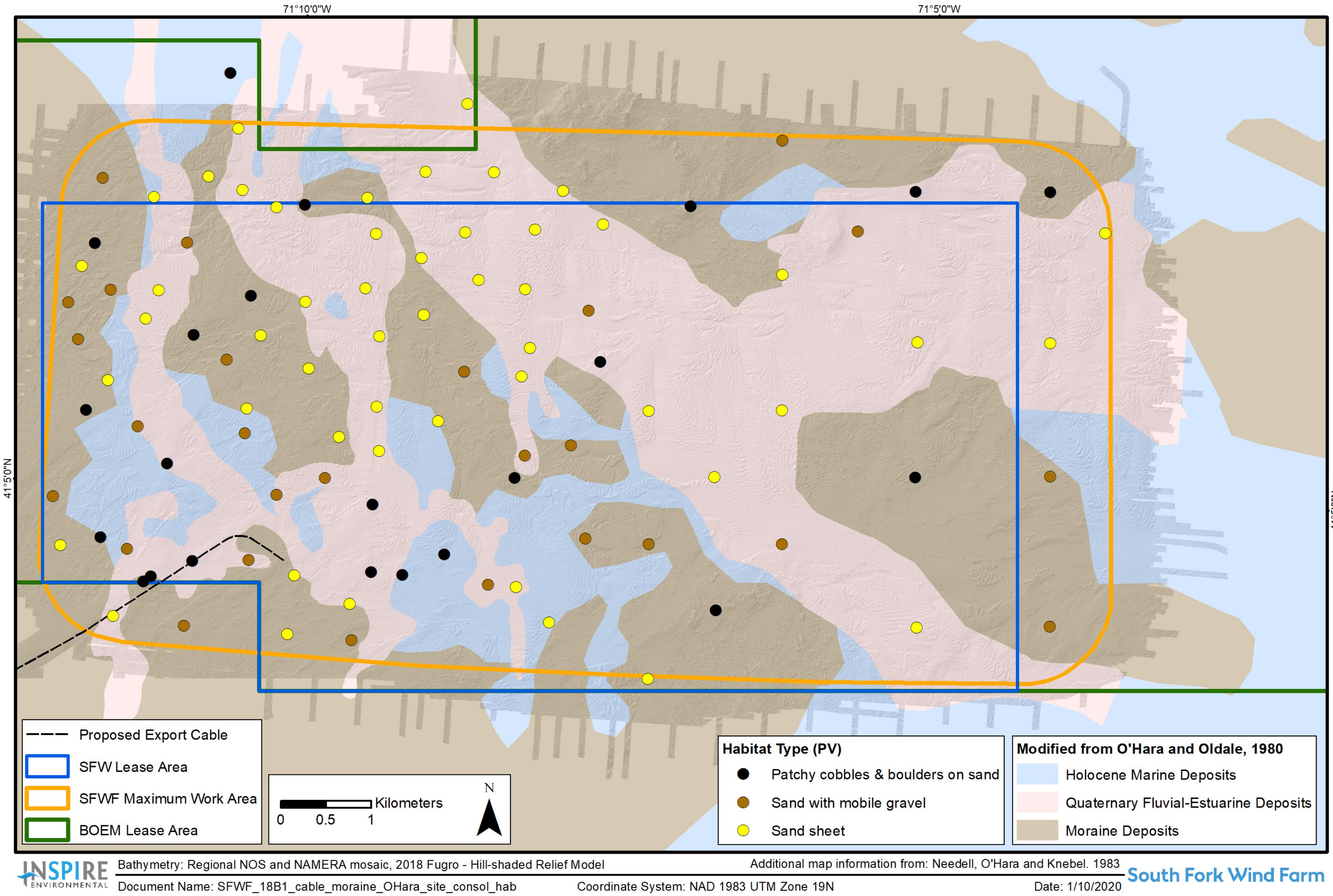

Figure 4.3-5. Interpreted Habitat Types Based on MBES and Shallow Seismic Data

Habitat types identified in plan-view images (PV) collected and interpreted by INSPIRE (Appendix N1).

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Benthic habitat types are used here as a construct to describe repeatable physical-biological associations found within the SFWF, SFEC, and reference area. These were derived from CMECS classifiers, and specific classification data for the Substrate and Biotic Component are provided in Appendices H and N. Three unique benthic habitat types were observed: patchy cobbles and boulders on sand; sand with mobile gravel, and sand sheets (Figure 4.3-6 and Appendix N1). On Figure 4.3-6, images (A) and (B) represent patchy cobbles and boulders on sand with associated fauna annotated. Figure 4.3-6 image (C) represents sand with mobile gravel and image (D) represents sand sheet habitats, shown here with infaunal tubes annotated in the SPI image and sand dollars in the PV image. The species found in these types of habitats are typically described as infaunal species, those living in the sediments (e.g., polychaetes, amphipods, mollusks), and epifaunal species, those living on the seafloor surface (mobile, e.g., sea stars, sand dollars) or attached to substrates (sessile, e.g., barnacles, anemones).

(A) and (B) represent patchy cobbles and boulders on sand with associated fauna annotated. (C) represents sand with mobile gravel; (D) represents sand sheet habitats, shown here with infaunal tubes annotated in the SPI image and sand dollars in the PV image. Note: PV image width is approximately 3.2 feet (1 m), and SPI image height is approximately 7.9 inches (20 centimeters [cm]).

Sand, generally fine to coarse sand grain sizes, was the predominant surface sediment across all three habitat types. These sands are mobile, influenced by bottom currents that form ripples on the seafloor surface; which, in turn, influence sediment resuspension, deposition, and sorting. For example, deposition of fine sediment grains and organic material in ripple troughs is promoted by the structure of the ripple. The sand with mobile gravel habitat type has small-sized gravels (granules, pebbles, and small cobbles) that are also influenced by bottom currents (tides, storms) and are transported often enough, appearing “washed clean,” that biota are not able to attach and grow on their surfaces. In these habitats, gravel tends to gather in the troughs between sand ripples (Figure 4.3-6 and Appendix N1).

The frequent hydrodynamic forcing and subsequent sediment mobility in sand sheet and sand with mobile gravel habitats creates a dynamic environment for biota. Therefore, these habitats do not include more than occasional sparse presence of attached flora or sessile attached epifauna and are, instead, inhabited by mobile epifauna, such as sand dollars, Jonah crabs, American lobster, and small tube-building and burrowing infauna (Tables 4.3-3 and 4.3-4). The dynamic nature of these environments results in high turnover of infauna, and, combined with the very low organic loads found in medium and coarse sands, limits the development of infaunal successional stages to Stage 1 and Stage 2 taxa; Stage 3 head-down deposit feeders would not be expected in these habitats (Appendix N1). Because they are accustomed to a certain degree of natural disturbance, the benthic biological communities associated with these habitat types are considered generally resilient to change and quick to recover.

In CMECS terms, the dominant Biotic Subclass of these habitats is Soft Sediment Fauna; and the dominant Biotic Groups include Small Surface-Burrowing Fauna, Small Tube-Building Fauna, and Sand Dollar Beds (Appendix N1). However, there is still potential that hydrozoans, anemones, and encrusting sponges will be present in low densities in sand with mobile gravel habitat, particularly when in close proximity to boulders and cobbles. Economically important species, including sea scallops, horseshoe crabs, surf clams, and the ocean quahog, are associated with these sandy habitats (Table 4.3-5).

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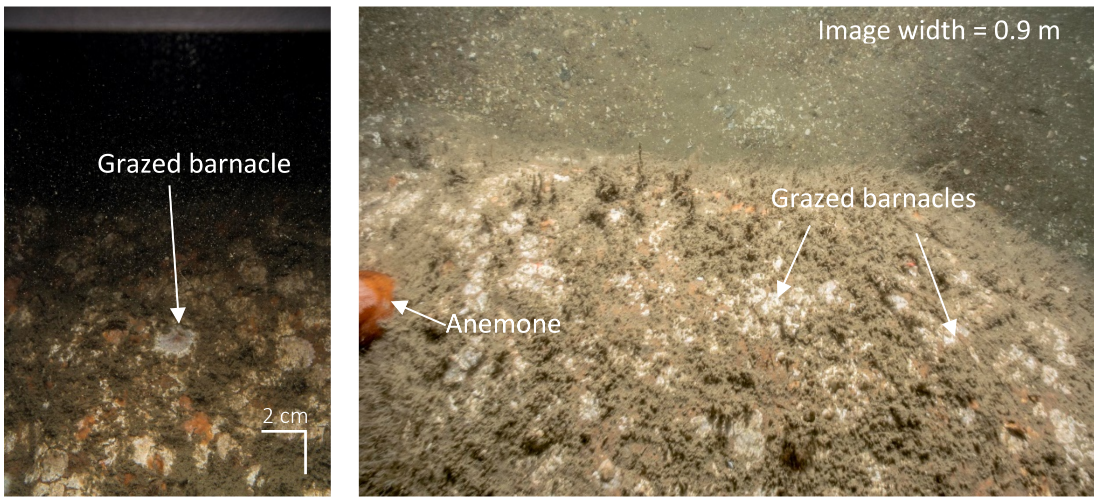
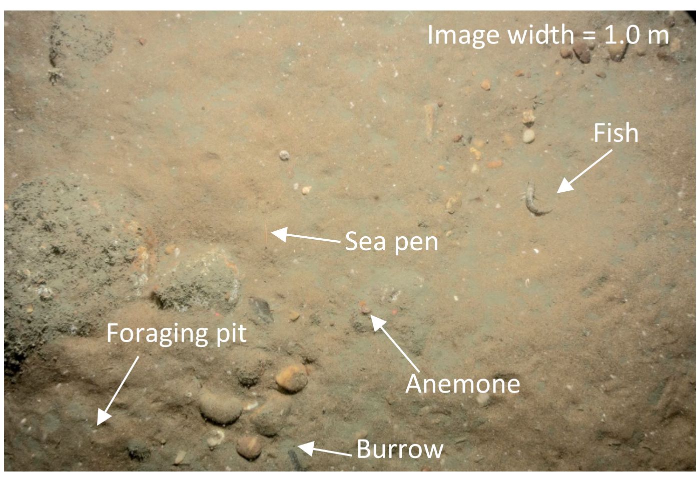
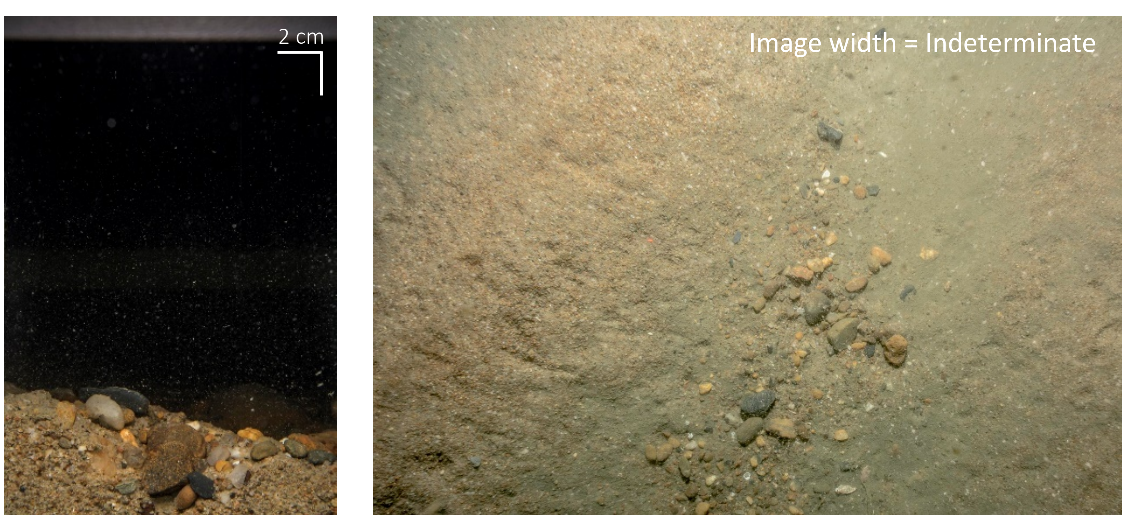


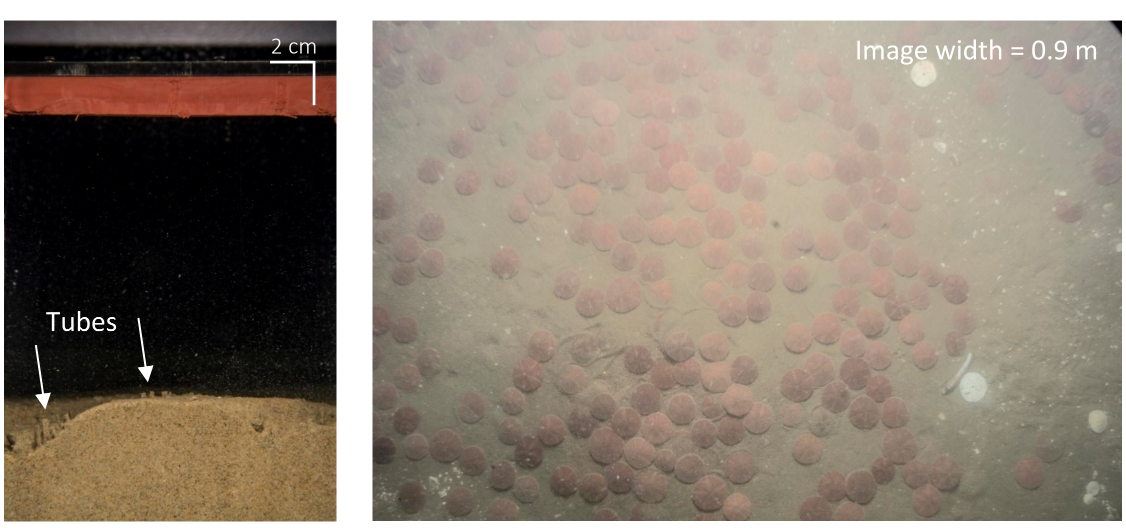
(A) The boulder is colonized by hydroids and barnacles, many of which have been grazed. A large orange anemone is attached to the boulder on the far left of the PV image.



(B) Hydroids and grazed barnacles are visible on the large cobbles and boulder. A sea pen and anemone are near the center of the image. A small unidentified fish is visible on the right side of the image. Infaunal burrows are present in the bottom center of the PV image and fish foraging pits in lower right and lower left.



(C) Small gravels washed clean by frequent water motion gather in throughs beneath ripples of mobile sand.



(D) Sand sheet habitats characterized by tube-building infauna and mobile epifauna, in this case sand dollars (*Echinorachnius parma*).

Figure 4.3-6. Representative Sediment Profile Imaging and Plan View Images for Each Habitat Type

SPI images of three unique benthic habitat types observed: patchy cobbles and boulders on sand with associated fauna (A and B); sand with mobile gravel (C), and sand sheets (D)

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The third benthic habitat type observed was patchy cobble and boulder on sand. These hard substrates generally support increasingly diverse epifaunal assemblages as grain sizes increase. The cobbles and boulders in these habitats provide substrate and stability on which biota can attach and grow; additionally, these habitats provide variable topography that creates complexity and additional niches for fauna to occupy. Where present, these large gravels were colonized by attached epifauna, predominantly hydroids, barnacles, and occasional anemones (Appendix N1). Other attached epifauna that have the potential to be found in this habitat type include encrusting sponges, serpulid polychaetes, sea pens, and mussels, among others (Table 4.3-3). Because presence of cobbles and boulders is patchy, these areas are interspersed with sandy habitats, further increasing diversity within these areas.

Because dominant CMECS Biotic Subclasses and Biotic Groups are strongly correlated with surficial sediments, the classifications of these habitats were a mix of Soft Sediment Fauna and Attached Fauna; biota associated with sand was found in the patches of sand between the cobbles and boulders, on which the attached fauna were found (Appendix N1). Within the Attached Fauna Subclass, dominant CMECS Biotic Groups included Attached Hydroids, Barnacles, Diverse Colonizers, Egg Masses, and Pennatulid Bed (Appendix N1). Mobile epifauna are often associated with the Attached Fauna Subclass and include taxa such as crabs, sea stars, moon snails, and lobster (FGDC, 2012; Table 4.3-4). Macroalgae, such as foliose red algae and coralline algae, also have the potential to grow attached to cobbles and boulders in these habitats, and coralline algae was observed at two stations within the SFWF (Table 4.3-3). Economically important species, notably lobster and squid, are associated with these hard bottom habitats (Table 4.3-4).

The structure provided by the cobbles and boulders in these habitats can also serve as nursery habitat for juvenile lobster, feeding ground for fish such as cod and black sea bass, and substrate upon which squid (including longfin squid, *Doryteuthis (Amerigo) pealeii*) lay their eggs (Table 4.3-4 and Figure 4.3-7). Further, the presence of boulders in mixed bottom types has been noted as an important feature for understanding the distribution of lobsters (*Homarus americanus*) and Jonah crab (*Cancer borealis*) in the region of the SFWF (Collie and King, 2016; Table 4.3-5).

The distribution of habitat types within the SFWF and along the SFEC as it travels from the SFWF along the OCS south of Block Island and Montauk to the nearshore areas within NYS waters are variable and are discussed in the following sections. The likelihood of encountering the taxa listed in the tables within the SFWF or along any particular segment of the SFEC - OCS is directly related to the distribution of habitat types found in each area. Because the depths and exposure to wave energy in the nearshore portion of the SFEC in New York State waters differs from the SFWF and SFEC - OCS, there are some differences in taxa expected; these are discussed in the SFEC habitat distribution section.

Figure 4.3-7. PV Image from the SFWF Showing Extensive Coverage of Polymastia sp. Sponge Indicating Cobbles and/or Boulders Covered with a Thin Layer of Sand

PV image indicating area with cobbles and/or boulders covered in a thin layer of sand from the SFWF

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Agarum cribrosum	Rocks, cobble	Subtidal to approximately 131 feet (40 m)	Single blade up to 59 inches (150 cm) with stipe attached to a holdfast	Limited potential for occurrence on boulders at the SFWF because of the depth at the site. Limited potential along the SFEC route segment near the SFWF where boulders and cobble are present.[a, b]
Coral weed (*Corallina officinalis*)	Rocks, cobble, large gravel, shells	Lower intertidal and subtidal	Coralline red algae that can encrust on rocks and shells; grows to about 4 inches (10 cm)	No potential at the SFWF and SFEC - OCS because of depth, and no potential at the SFEC - NYS because no cobble and boulder were present in the surveyed area. [c]

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Coralline red algae (Order Corallinales)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal	Algal crusts	Coralline algae observed at two stations within the SFWF and may be present at other locations within the SFWF and along the SFEC where boulders and cobble are present. [a, b]
Foliose red algae (Phylum Rhodophyta)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal	Low-growing, foliose red algae	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC and potentially suitable habitat is present in the SFWF and the portions of the SFEC near the SFWF. [a, b]
Green Thread (*Chaetomorpha linum*)	Free floating or drifting; often entangled with other algae	Upper Intertidal, and free-floating mats	Filamentous clumps and tangles	Potential for occasional presence at the SFWF and SFEC as free-floating mat. [c]
Gut weed (*Ulva intestinalis*)	Rocks, mud, sand, tide pools, epiphyte on other algae and shells	Intertidal-Upper Intertidal and free-floating mats	Unbranched, flattened, gas-filled tubes with undulating edges to approximately 16 inches (40 cm) long	Potential for occasional presence at the SFWF and SFEC as free-floating mat. [c, d]
Hooked red weed (*Bonnemaisonia hamifera*)	Rocks, cobble, large gravel, often epiphytic on shells and algae	Subtidal	Small, highly branched red foliose algae growing to 4 inches (10 cm)	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC, and potentially suitable habitat is present in the SFWF and the portions of the SFEC near the SFWF.[c]
Horsetail kelp (*Laminaria digitata*)	Rocks, large cobble	Subtidal in wave exposed areas	Large, wide, brown blade with central holdfast; grows to 39 inches (1 m)	Very limited potential for occurrence on boulders at the SFWF and portions of the SFEC near the SFWF because of depth, habitat, and offshore location.[c]

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Irish moss (*Chondrus crispus*)	Rocks	Lower intertidal and shallow subtidal	Shrub-like, densely branched; grows to 6 inches (15 cm)	No potential at the SFWF and most of the SFEC route because they are located in waters too deep for this species. Limited potential in nearshore intertidal areas along the SFEC - NYS route if rocks or boulders are present.[c]
Kelp (*Saccharina latissimi, S. longicruris*)	Rocks, large cobble, rocky reef	Subtidal to approximately 115 feet (35 m)	Single blades with stipe that grow to 36 feet (11 m) (S. longicruris)	Very limited potential for occurrence on boulders at the SFWF and portions of the SFEC near the SFWF because of depth, habitat, and offshore location. [a, c]
Lacy red weed (*Callophyllis cristata*)	Rocks, cobble, large gravel, or epiphytic on shells or algae	Subtidal, deeper waters	Small, highly branched red foliose algae growing to 2 inches (5 cm)	Potential presence at both the SFWF and SFEC. Known to occur in the region within depth ranges for both the SFWF and SFEC, and potentially suitable habitat is present at the SFWF and portion of the SFEC near the SFWF.[c]
Sargasso weed (*Sargassum filipendula*)	Free floating	Open water and embayments	Multibranched with small, gas-filled nodules	Potential for occasional presence at the SFWF and SFEC as free-floating mat.[c]
Sea lettuce (*Ulva lactuca*)	Rocks and rocky reefs, epiphyte on other algae and shells	Intertidal-Upper Intertidal and free-floating mats	Attached via holdfast; grows to approximately 7.1 inches (18 cm) in length	Very limited potential for species to occur as free-floating mat at the SFWF and SFEC because of the distance to nearshore habitat where this species occurs. More likely to occur along the SFEC - NYS. [c, d]

Table 4.3-3. Common Macroalgal Species Known from the Vicinity of the SFWF and SFEC and Their Potential to Occur

Species	Preferred Habitat	Depth Range	Growth Type	Potential for Presence at the SFWF and SFEC
Wire weed (*Ahnfeltia plicata*)	Rocks and drift	Subtidal	Branched algae attached to bottom substrate or drifting	Limited potential for species to occur as drift algae at the SFWF and SFEC because of the distance to nearshore habitat where this species occurs. More likely to occur along the SFEC - NYS. [c]

Note: Coralline algae was the only living macroalgae observed during the SPI and PV survey (Appendix N1).

[a] Vadas and Steneck, 1988

[b] McGonigle et al., 2011

[c] Van Patten and Yarish, 2009

[d] Shimada et al., 2003

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
Sand substrates	Asteroidea	Blood star	DWW, 2012
	Bivalvia	Atlantic sea scallop (*Plactopecten magellanicus*) *., ocean quahog (*Artica islandica*), *Nucula proxima*, Waved astarte (*Astarte undata*), chestnut astarte (*A. castanea*), Atlantic surf clam (*Spisula solidissima*)	Steimle, 1982; Zajac, 1998; Fay et al., 1983; Meyer et al., 1981; Cargnelli et al., 1999a; Appendix N1
	Cephalopoda	Squid egg masses and newly hatched larvae	Macy and Brodziak, 2001; NEFSC, 2005
	Crustacea	Tube forming amphipods *: including *Ampelisca agassizi* and *A. vadorum* American lobster, Atlantic rock crab, sand shrimp (*Crangon septemspinosis*), hermit crabs *, Genus *Haustorid, Phoxocephalid, Leptocuma, Chiridotea, and Cancer* spp. Jonah crab (*Cancer borealis*)	Steimle, 1982; Wigley, 1968; DWW, 2012; Robichaud et al., 2000; Williams and Wigley, 1977; Appendix N1
	Echinoidea	Sand dollar *. (*Echinarachnius parma)*	Wigley, 1968; DWW, 2012; Appendix N1
	Gastropoda	Northern moon snail (*Lunatia heros*), *Nassarius* spp., channeled whelk (*Busycotypus canaliculatus*), common slipper shell *	Wigley, 1968; DWW, 2012; Peemoeller and Stevens, 2013; Appendix N1

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
	Ophiuroidea	Not listed	Poppe et al., 2014b
	Polychaeta	Surface feeding: *Exogone verugera, Prionospio steenstrupi, Anobothrus gracilis,* and *Paraonis gracilis* Tube forming *: *Spirorbis borealis, Ophelia bicornis,* and *Travisia carnea*	Steimle, 1982; Wigley, 1968; Appendix N1
	Xiphosura	Horseshoe crab	ASMFC, 2010; NJDEP, 2016
Gravel/granule substrates	Asteroidea	Sea star *, blood star, common sea star	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Appendix N1
	Bivalvia	Waved astarte, chestnut astarte, genus *Placopecten,* including Atlantic sea scallop *, eastern oyster (*Crassostera virginica*), ocean quahog	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Wigley, 1968; Jenkins et al., 1997; Hargis and Haven; 1999; Appendix N1
	Cephalopoda	Squid egg masses·, including longfin squid and newly hatched larvae	Macy and Brodziak, 2001; NEFSC, 2005
	Crustacea	Tube-forming Amphipods *·: *Ampelisca agassizi* and *A. vadorum* American lobster, sand shrimp *·, hermit crabs, Genus *Haustorid, Phoxocephalid, Leptocuma, Chiridotea*, and *Cancer* spp., Jonah crab (*Cancer borealis*), Atlantic rock crab	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Cobb and Wahle, 1994; Appendix N1
	Gastropoda	Northern moon snail, *Nassarius* spp., channeled whelk, common slipper shell	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980
	Ophiuroidea	Genus *Ophiopholis* and *Ophiacantha*	Collie et al., 1997; Wigley, 1968
	Polychaeta	Tube-forming *·: *Phyllochaetopterus socialis*, *Filograna implexa, Chone infundibuliformis, Protula tubalaria* Carnivorous and omnivorous: *Nephtys incisa, Eunice norvegica* Deposit feeding: *Thelephus cincinnatus*	Collie et al., 1997; Redmond and Scott, 1989; Dickinson et al., 1980; Appendix N1

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
Cobbles, boulders, rocky reef, rock outcrop	Anthozoa	Sea anemones *., Order Alcyonacea (both gorgonians and non-gorgonians) tulacea[b.]	Poppe et al., 2011; Northeast Ocean Data, 2017; DWW, 2012; Appendix N1
	Asteroidea	Blood star, common sea star, genus *Solaster* and *Crossaster*	DWW, 2012; Wigley, 1968; Collie et al., 1997
	Bivalvia	Horse mussel (*Modiolus modiolus*), eastern oyster, Atlantic sea scallop *., waved astarte, chestnut astarte, genus *Brachiopoda, Placopecten, Anomia,* and *Musculus*	DWW, 2012; Wigley, 1968; Jenkins et al., 1997; Hargis and Haven; 1999; Appendix N1
	Bryozoa	Not listed *.	DWW, 2012
	Cephalopoda	Squid egg masses. and newly hatched larvae including longfin squid	Macy and Brodziak, 2001; NEFSC, 2005
	Chordata	Tunicates (*Boltenia* spp.)	Wigley, 1968
	Crustacea	Tube-forming Amphipods *.: *Ampelisca agassizi* and *A. vadorum* Barnacles *.(Infraclass Cirripedia and genus *Balanus*), America lobster, sand shrimp*., hermit crabs*., Genus *Cancer* and *Hyas**., Jonah crab, Atlantic rock crab	DWW, 2012; Wigley, 1968; Appendix N1
	Echinoidea	Green sea urchin (*Strongylocentrotus droebachiensis*)	Collie et al., 1997; Wigley, 1968
	Gastropoda	Northern moon snail, *Nassarius* spp., limpet *, channeled whelk, knobbed whelk (*Busycon carica*), whelk (*Sinistrofulgur sinistrum*), common slipper shell, genus *Neptunea, Dendronotus*, and *Doris*	Poppe et al., 2014b; Wigley, 1968, Appendix N1
	Hydrozoa	Hydroids[b.], including genuses *Eudendrium, Sertularia,* and *Bougainvilia*	Poppe et al., 2011; DWW, 2012; Appendix N1
	Ophiuroidea	*Ophiopholis aculeate* and *Ophiacantha* spp.	Collie et al., 1997; Wigley, 1968
	Polychaeta	Tube-forming and suspension feeding*.: *Phyllochaetopterus socialis*, *Filograna implexa, Chone infundibuliformis, Protula tubalaria,* genus *Serpula* and *Spiorbis* Carnivorous and omnivorous: *Nephtys incisa, Eunice norvegica*	Wigley, 1968; DWW, 2012; Appendix N1

Table 4.3-4. Common Species by Benthic Habitat Type

Habitat Type	Phylum or Class	Species (With Common Name if Available)	References
	Porifera	Encrusting sponges of genus's *Halichondria, Clathria, Polymastia, Clionia, and Myxilla*	Poppe et al., 2011; DWW, 2012; Wigley, 1968

Note: The potential for each species to occur at the SFWF and along the SFEC - OCS and SFEC - NYS is related to the distribution of benthic habitat types within each area

* Indicates taxa were observed in SPI/PV imagery for the SFWF or SFEC (Appendix N1).

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
American lobster (*Homarus americanus*)	All	Prefers rocky habitat, including mixed bottom types, but may burrow in featureless sand or mud habitat.	Year-round	Potential presence in the vicinity of rocky areas within the SFWF and along the SFEC near the SFWF; may seasonally pass through the SFWF, SFEC - OCS, and SFEC - NYS, including nearshore waters during migratory movements.	Collie and King 2016; ASMFC, 2015; Cobb and Wahle, 1994
Atlantic rock crab (*Cancer irroratus*)	All	Prefers depths ranging from 20 to 1,496 feet (6 to 456 m), but most common in waters less than 65 feet (20 m) deep. Prefers rocky and gravely substrate but also occurs in sand.	Year-round	Limited potential for presence within the SFWF and along the SFEC near the SFWF because species prefers areas that are shallower than the SFWF. Potential presence in the SFEC - NYS and in nearshore waters.	Krouse, 1980; Robichaud et al., 2000; Williams and Wigley, 1977

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Atlantic sea scallop (*Plactopecten magellanicus*)	All	Found on sand, gravel, shells, and other rocky habitat. Larvae settle out on gravel and rocky substrate. Found from mean low water to depths of 656 feet (200 m). This species also has designated EFH in the SFWF, SFEC-OCS, and SFEC-NYS (see Appendix O).	Year-round	Potential for presence throughout the SFWF and SFEC route.	NEFSC, 2004; Mullen and Moring, 1986
Atlantic surf clam (*Spisula solidissima*)	All	Prefers depths ranging from 26 to 216 feet (8 to 66 m) in medium-grained sand but may also occur in finer-grained sediments. Burrows up to 3 feet (0.9 m) below the sediment-water interface. This species also has designated EFH along part of the SFEC-OCS and SFEC-NYS (see Appendix O).	Year-round	Potential for presence in sandy substrates within the SFWF and along the SFEC route.	Fay et al., 1983; Meyer et al., 1981; Cargnelli et al., 1999a
Channeled whelk (*Busycotypus canaliculatus*)	All	Commonly found in nearshore and offshore environments, but preferred depth range is not known. Occurs in sandy and fine-grained sediments where they can bury themselves. Eggs are laid on sand in intertidal and subtidal areas.	Year-round	Potential for presence in sandy substrates within the SFWF and along the SFEC route. Potential for eggs to be laid in nearshore portions of the SFEC route.	Fisher, 2009; Peemoeller and Stevens, 2013
Eastern oyster (*Crassostera virginica*)	All	Larvae and adults can be found on hard bottom substrate or shell substrate to a depth of 36 feet (11 m) but is most common between 8 to 18 feet (2.5 to 5.5 m) deep.	Year-round	Not expected to occur at the SFWF or SFEC, as no shellfish beds are known from the vicinity.	Jenkins et al., 1997; Hargis and Haven, 1999

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
Horseshoe crab (*Limulus polyphemus*)	All	Prefer depths shallower than 98 feet (30 m) but known to occur in depths greater than 656 feet (200 m). Occurs commonly on sandy substrate but is a habitat generalist and may be found on gravel and cobbles as adult. During full moon tides in spring and summer, migrates inshore to shallow bays and sandy beaches to spawn. Juveniles use shallow nearshore areas as nurseries before moving into deeper waters.	Year-round	Potential presence throughout the SFWF and SFEC route. Juveniles may be present in higher densities in the vicinity of nearshore portions of the SFEC route.	NJDEP, 2016; ASMFC, 2010
Jonah crab (*Cancer borealis*)[a.]	Adults	Prefers depths ranging from 164 to 984 feet (50 to 300 m), but also occurs in shallower waters, perhaps associated with circadian rhythms. Found across sediment types, from sand, to small gravel, to rocky areas.	Year-round	Presence at the SFWF and potential presence along the SFEC route. Studies found higher abundances in fine sand, followed by coarse sand, and boulders on sand.	Appendix N; Collie and King 2016; Robichaud and Frail, 2006; Jeffries, 1966
Longfin squid (*Doryteuthis (Amerigo) pealeii*)[a.]	All	May-November found in inshore waters, and adults are demersal during the day. Eggs are laid on a variety of substrates, including sand and hard bottom. Newly hatched squid become demersal then migrate to offshore waters. December-April: Offshore waters between 328 and 550 feet (100 and 168 m) deep. This species also has	May-November	Potential presence within the SFWF and potential presence along the SFEC route where rocky and gravelly areas are found between May-November; eggs have been observed at the SFWF and may be laid along the SFEC. Not expected to be present between	Macy and Brodziak, 2001; NEFSC, 2004

Table 4.3-5. Ecologically and Economically Important Shellfish Species and Potential for Occurrence at the SFWF and SFEC

Species	Life Stage Present	Preferred Habitat	Potential Time of Year in Region	Potential Presence at the SFWF and SFEC	References
		designated EFH in portions of the SFWF, SFEC-OCS, and SFEC-NYS, including EFH for eggs (see Appendix O).		December and April.	
Northern quahog clam (*Mercinaria mercinaria*)	All	Mud and sandy habitats to depths up to 50 feet (15 m). Burrow into the sediments to a depth of 2 to 4 inches (5 to 10 cm).	Year-round	No potential to occur at the SFWF, may occur in nearshore portions of the SFEC route, but species prefers finer sediments than those found along the SFEC route.	Hill, 2004; DFO, 1996
Northern shortfin squid (*Illex illecebrosus)*	Adults	Prefers depths ranging from 328 to 656 feet (100 to 200 m) but is also known to occur in waters shallower than 60 feet (18 m). Egg masses are thought to be neutrally buoyant.	Year-round	Preferred depth range is deeper than the SFWF and SFEC but may occasionally be present within the SFWF and along the SFEC route. Neutrally buoyant egg masses may occasionally be present throughout both the SFWF and SFEC routes.	Black et al., 1987; Grinkov and Rikhter, 1981; O'Dor and Balch, 1985
Ocean quahog clam (*Artica islandica*)	Juveniles and Adults	Prefers depths ranging from 82 and 200 feet (25 and 61 m) in medium to fine grain sand. This species also has designated EFH in the SFWF and in portions of the SFEC-OCS and SFEC-NYS (see Appendix O).	Year-round	Potential presence within the SFWF and deeper portions of the SFEC route. Nearshore portions of the SFEC route are outside of the preferred depth range of the species.	Cargnelli et al., 1999b

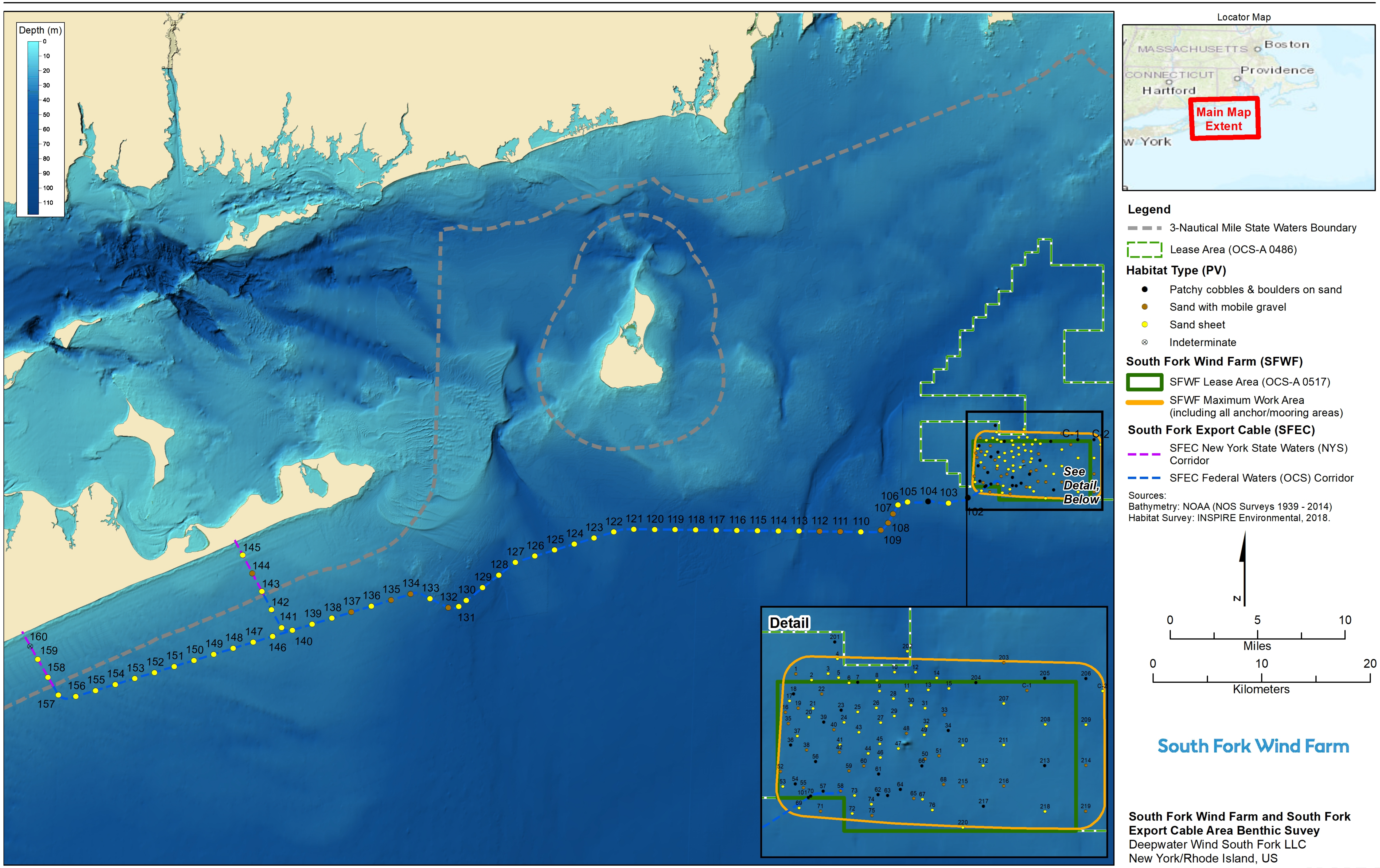
Note: Indicates taxa were observed in SPI/PV imagery for the SFWF or SFEC (Appendix N1).

Shellfish Resources

Ecologically and economically important shellfish species in the vicinity of the SFWF and SFEC are presented in Table 4.3-5. The economic and fisheries importance of these species is discussed further in Section 4.6.5. The patchy cobble and boulder habitat type is considered suitable, and potentially important regionally (Collie and King, 2016), for the American lobster. Sand sheet and sand with mobile gravel habitat types appear to be suitable for the following species: Atlantic sea scallop, Jonah crab, Atlantic rock crab, channeled whelk, ocean quahog clam, Atlantic surf clam, and horseshoe crab (Table 4.3-5). Longfin squid are expected to seasonally be present in the vicinity; they are demersal during the day and lay their eggs on the bottom substrate in patchy cobble and boulder on sand and sand with mobile gravel habitats. Table 4.3-5 includes a summary of these species, likelihood of presence, and the potential time of year that they could be present in the region.

South Fork Wind Farm Benthic Habitat Distribution

Based on data from these surveys, the SFWF has a highly variable and patchy distribution of benthic habitats, including sand sheets, sand with mobile gravel, and patchy cobbles and boulders on sand (Figure 4.3-8 and Appendix N1). Although sand sheets were the most common habitat type encountered during the benthic surveys, the heterogeneity of sediment types on small scales was high, with variable presence of gravel (i.e., granules, pebbles, cobbles, boulders) on sandy substrates characterizing much of the SFWF (Appendix H). The presence of cobbles and boulders at the SFWF was patchy at both the sub-square meter scale of the SPI/PV images and at a larger landscape scale (Appendix H). Patchy presence of cobbles and boulders with attached fauna within and near the SFWF indicate that there is likely greater relative areal coverage of these features than was captured in SPI/PV images. Further, landscape scale data collected during the G&G survey show that boulders are present throughout the site with a much higher frequency than could be captured with SPI/PV (Appendix H). These data show that the highest density of boulders was found in the western and central portion of the SFWF (Appendix H). Site-specific sidescan sonar surveys revealed boulder density in relation to project components and show that greatest boulder density occurs in the western, southern, and northeastern parts of the MWA, with three higher density boulder areas near the center of the MWA (Figures 3.1-1 and 3.1-2, Appendix H). Areas of low boulder density correspond to quaternary fluvial-estuarine deposits identified in shallow seismic data (glacial meltwater channels; Figure 4.3-5 and Appendix H).



Note: inset map is zoomed-in view of the SFWF.

Figure 4.3-8. Dominant Benthic Habitat Types Observed Across the Surveyed Area

Illustration of dominant benthic habitat types in relation to Project components

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The dominant CMECS Biotic Subclass across the SFWF was Soft Sediment Fauna. Attached Fauna were present as the CMECS Biotic Subclass or Co-occurring Biotic Subclass at approximately one-third of the stations sampled within the SFWF. The attached fauna were associated with presence of hard bottom substrate; for example, extensive coverage of sponges captured at one station indicates the presence of hard bottom buried by a thin layer of sand (Figure 4.3-7). Sensitive taxa were not observed in SPI/PV images at the SFWF, although they have the potential to occur in areas with cobble and boulder presence. Because only a small portion of the boulders that exist at the SFWF were captured by SPI/PV images, data on the prevalence of attached and potentially sensitive fauna associated with these features (Appendix N1) should be considered an underrepresentation of their presence at the SFWF, and data should be extrapolated over the boulder presence density noted in the geophysical data (Appendix H).

South Fork Export Cable Benthic Habitat Distribution

All three benthic habitats were observed along the SFEC route; however, their distribution varied with distance from the SFWF and as the SFEC routes near land in NYS waters, where waters are shallower than 25 feet (7 m) (Figure 4.3-8 and Appendix N1). The SFEC route was dominated by sand sheet habitats except for the following SFEC segments, where this habitat type was interspersed with other habitat types. Areas of the SFEC - OCS immediately adjacent to the SFWF were more heterogenous than the remainder of the SFEC, with patchy cobble and boulder on sand habitats observed within 19-25 miles (30-40 km) of the SFWF. Sand with mobile gravel habitats were observed along the SFEC - OCS route between the SFWF and for about half the distance along the SFEC - OCS to due south of Block Island. These habitats were also present in the section of the SFEC - NYS south of Montauk Point and near the Hither Hills landing point within NYS waters (Figure 4.3-8 and Appendix N1). Within New York State waters, sand sheets were the predominant benthic habitat type, with mobile gravel present at one station (Appendix N1), and sediment grain size was largely homogeneous (Appendix H). Sediment grain size was moderately variable on small scales along the SFEC - OCS, but most of the variability was between grain size classes within the overall sand category. Deposits of very fine silt, on the order of 6 inches (15 cm) thick, were observed overlying sand at two locations offshore of the Beach Lane SFEC landing location; one of these locations fell within New York State waters (Appendix H).

The dominant CMECS Biotic Subclass along the SFEC route was Soft Sediment Fauna at all stations where Biotic Subclass could be determined. Attached Fauna was present as the CMECS Co-occurring Biotic Subclass at a handful of locations along the SFEC, on patchy boulders close to the SFWF and on small pebbles or cobbles in sand sheet and sand with mobile gravel habitats. The Attached Fauna Biotic Subclass was not observed along the SFEC - NYS. No sensitive taxa were observed along either the SFEC - OCS or SFEC - NYS (Appendix N1).

The nearshore portion of the SFEC - NYS passes through areas that are shallow enough for SAV to be present; however, all known SAV beds identified in the vicinity are on the northern side of Long Island. No eelgrass beds were identified near the routes during a review of historical aerial imagery from the vicinity of the routes (Tiner et al., 2003; NYSDOS Seagrass Taskforce, 2009; Stephenson, 2009). In addition, because these portions of the route are open to wave activity and are not located in shallow, sheltered, estuarine habitat, it is unlikely that SAV occurs along these routes. Similarly, depth and wave energy are anticipated to limit macroalgae that may be present in the nearshore areas of the SFEC - NYS; floating algal masses and drifting algae composed of species such as sea lettuce and wire weed are the most likely to occur (Table 4.3-3). Neither eelgrass beds nor macroalgae were observed in the nearshore areas of the SFEC - NYS (Appendix N).

As the majority of the SFEC is located at a similar depth as the SFWF, the macrobenthic communities associated with each benthic habitat type present are expected to be similar (Table 4.3-4). In shallower areas with greater exposure to waves and shifting sands in New York State waters, benthic communities and organisms are expected to be less prevalent than in deeper areas because of higher wave energy and more frequent disturbance patterns, preventing large populations of epifauna and infauna from becoming established. There is also expected to be a shift in dominant ecologically and economically important species in the shallower nearshore waters of the SFEC - NYS, with increased densities of Northern quahog clam, Atlantic rock crab, Atlantic surf clam, horseshoe crab, and a limited potential for eastern oyster if shell beds are present. These shallower nearshore areas of the SFEC - NYS are also less suitable for lobster, Atlantic sea scallop, Jonah crab, and as egg-laying sites for longfin squid than benthic habitats within the SFWF and along the SFEC - OCS.

Reference Area Benthic Habitat Distribution

The physical and biological characteristics of the reference area were within the range observed across the SFWF and SFEC. Therefore, the area can serve as a valid reference area for the SFWF project. The potential presence of macroalgae (Table 4.3-3), macrofauna (Table 4.3-4), and ecologically and economically important shellfish species (Table 4.3-5) in the reference area is expected to be similar to that predicted for the SFWF and the SFEC-OCS in direct relation to the complement of habitat types present.

All three benthic habitat types were observed in the reference area (Figure 4.3-8 and Appendix N1). Sediments exhibited low to medium heterogeneity and were composed of mostly coarse and medium sands, with pebbles and cobbles present at the western and eastern ends of the area and a boulder observed at the eastern end (Appendix H). The dominant CMECS Biotic Subclass in the reference area was Soft Sediment Fauna, and Attached Fauna was the Co-occurring Biotic Subclass at the eastern edge of the reference area where sea pens and hydroids were observed attached to cobbles (Appendix N1). Sensitive taxa were not observed within the reference area.

4.3.2.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to cause both direct and indirect impacts on benthic resources and shellfish, as discussed in the following sections. IPFs associated with the construction, O&M, and decommissioning phases for the SFWF and SFEC are described in Section 4.1.

An overview of the IPFs for benthic and shellfish resources associated with the SFWF and SFEC is presented on Figure 4.3-9. IPFs not expected to impact benthic resources are depicted with slashes through the circle. For the IPFs that could impact benthic resources but were found to be negligible in the analyses in Section 4.1, the circle is gray without a slash. The IPFs with potential to impact benthic resources are indicated by gray shading.

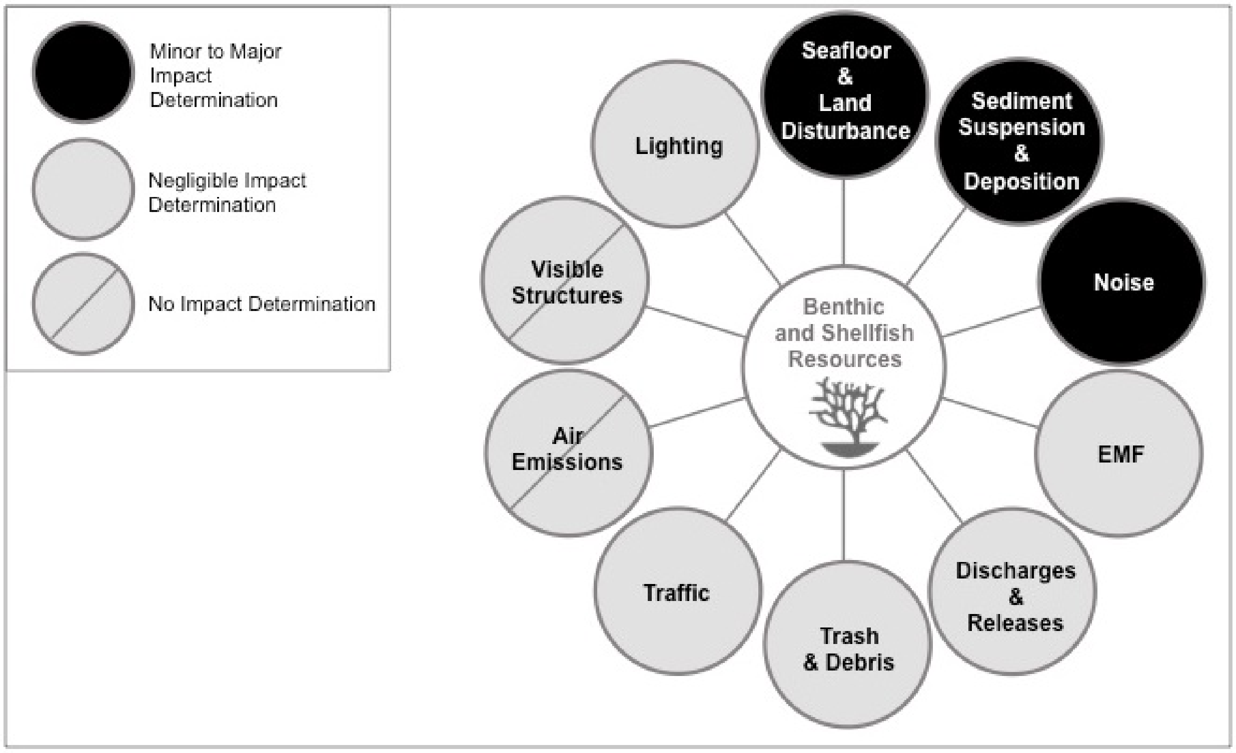

Figure 4.3-9. IPFs on Benthic and Shellfish Resources

Illustration of potential impacts to benthic and shellfish resources resulting from SFWF and SFEC activities.

South Fork Wind Farm

Impacts associated with the construction, O&M, and decommissioning of the SFWF to benthic species overall are expected to be ***negligible to minor, localized, and short-term***. Impacts to sessile species and species with limited mobility are more likely to experience ***minor impacts***, while more mobile species are more likely to experience ***negligible impacts***. See Section 4.1 for the acreage range of benthic habitat that is expected to be affected by construction.

Following completion of construction and during O&M of the SFWF, the majority of the substrates at the SFWF will return to pre-project conditions and allow for continued use by benthic species. Boulders relocated during construction will be in new locations and may be in new physical configurations in relation to other boulders. Short-term loss of attached fauna is expected during relocation. Concerning these spatial and physical attributes, the boulders are not expected to return to pre-project conditions. However, relatively rapid (< 1 year) recolonization of these boulders is expected (Guarinello et al., 2017) and will return these boulders to their pre-project habitat function. Additionally, if relocation results in aggregations of boulders, these new features could serve as high value refuge habitat for juvenile lobster and fish as they may provide more complexity and opportunity for refuge than surrounding patchy habitat. Benthic infauna and epifauna are expected to recolonize the area after sediment disturbance, allowing these areas to continue to serve as habitat. The exception is the conversion of soft substrate to hard substrate associated with the WTGs, scour protection, and protective armoring. The acreage of benthic habitat that is expected to be affected by construction (Section 4.1) is small relative to the total area of available surrounding habitat and EFH. Impacts to EFH for shellfish are discussed in Appendix O.

Construction

Table 4.3-6 summarizes the level of impacts expected to occur to benthic and shellfish resources during the construction and decommissioning phases of the SFWF. Decommissioning of the SFWF is included in Table 4.3-6 because the structures are expected to be removed, and their removal will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to benthic and shellfish resources from the various IPFs of the SFWF during construction are described in the following sections.

Table 4.3-6. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Seafloor preparation	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Pile driving and foundation installation	Minor short-term direct	Minor short-term direct
	OSS platform installation	Minor short-term direct	Minor short-term direct
	SFWF Inter-array Cable installation	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible long-term indirect
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Pile driving	Minor short-term direct Minor short-term indirect	Minor short-term direct Minor short-term indirect
	Vessel noise, trenching noise, aircraft noise	Negligible short-term direct	Negligible short-term direct
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct
Discharges and releases [c]		Negligible	Negligible
Trash and debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category. For further information on potential impacts associated with the IPFs, see the following sections.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Releases and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance
Seafloor disturbance during construction of the SFWF occurs during the following activities: seafloor preparation, pile driving and foundation installation, OSS platform installation, the SFWF Inter-array Cable installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce ***minor direct impacts*** to species, depending on the mobility of the benthic species and shellfish species. See Section 4.1 for the impact area associated with the Inter-array Cable and impact areas associated with the monopile foundation that is planned to be installed for the WTGs and OSS.

Seafloor Preparation
Seafloor preparation activities at the SFWF during construction include removal of obstructions and debris within a 100-foot radius of the WTG installation location and along the route of the Inter-array Cable. A PLGR will be used to clear debris from the area prior to laying the Inter-array Cable. In addition, boulder relocation may be required within the foundation work area for some of the foundations and within 49 feet (15 m) of each side of the Inter-array Cable centerline where boulders are present. Temporary seabed disturbance from boulder relocation related to preparation for foundation placement could be up to 14.8 acres (6 ha) and temporary seabed disturbance from boulder relocation related to Inter-array Cable installation could be up to 61.1 acres (24.7 ha).

These activities are expected to result in ***minor, short-term direct impacts,*** including mortality to benthic species within the area of impact. Benthic species are expected to recolonize the impact area following construction activities, and this may occur within months or 1 to 3 years of disturbance (BERR, 2008; BOEM, 2012; Guarinello et al., 2017). In a study of particular regional relevance, boulders that were moved by anchoring activity during construction at the Block Island Wind Farm (BIWF) were recolonized to pre-construction coverage levels within 1 year of seafloor disturbance (Guarinello et al., 2017). Recolonization rates of benthic habitats are driven by the benthic communities inhabiting the area surrounding the impacted region. Communities well adapted to disturbance within their habitats (e.g., sand sheets) are expected to quickly recolonize a disturbed area, while communities not well adapted to frequent disturbance (e.g., deep boulder communities) may take upwards of a year to begin recolonization, resulting in ***minor, long-term, indirect impacts***. Impacts to benthic resources will be limited to the area of direct disturbance. ***Minor, short-term, direct impacts*** may also include disruption of feeding during seafloor preparation; however, post-seafloor preparation predatory infaunal and epifaunal species may be attracted to the area to prey upon dislodged or injured organisms.

Pile Driving and Foundation Installation
In disturbed areas where no structures are placed, benthic species are expected to recolonize following the disturbance. In areas where foundations and associated scour protection are placed ***minor, short-term, direct impacts*** to benthic species through crushing and displacement of all life stages of species, including eggs and larvae are anticipated. Long-term impacts to benthic species because of the presence of the foundations and scour protection are discussed in the O&M section for the SFWF.

Offshore Substation Platform Installation
Impacts associated with the installation of the OSS platform are expected to be similar to those described for seafloor preparation and pile driving and foundation installation.

SFWF Inter-Array Cable Installation
Installation of the Inter-array Cable is expected to result in impacts similar to these described for seafloor preparation, pile driving and installation of foundations resulting in ***minor, short-term,***

direct impacts to benthic species. Sessile and slow-moving benthic species, including infaunal species that cannot get out of the way of the cable installation equipment, may be subject to mortality and injury to individuals. Because of the slow speed of equipment and limited size of the impact area, it is expected that most mobile benthic species, such as American lobster, crabs, Atlantic sea scallops, and juvenile and adult squid, will be able to move out of the way and not be subject to mortality, but may still experience ***minor, short-term, direct impacts***. Sessile and slower moving species, such as clams, oysters, whelks, and egg masses for a variety of species, including squid, may be subject to mortality or injury if within the impact area. The Inter-array Cable may also require armoring, and the installation of this armoring is expected to result in ***minor, short-term, direct impacts***.

Similar to seafloor preparation, ***minor to negligible, long- and short-term, direct impacts*** may include longer-term recolonization of the affected area, and short-term disruption of feeding of benthic species.

Vessel Anchoring (Including Spuds)
Impacts associated with vessel anchoring are similar to those discussed for seafloor preparation and pile driving and foundation installation. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary, depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, direct impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition
Increases in sediment suspension and deposition during construction can result from seafloor disturbance associated with foundation placement and Inter-array Cable installation, as well as vessel traffic and anchoring. These activities have the potential to cause localized increases in sediment suspension and deposition in adjacent areas as the suspended sediment settles out of the water column. ***Direct impacts*** associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. ***Minor, long-term, direct impacts*** associated with habitat loss through sediment deposition in surrounding areas would be anticipated. Vessel mooring or anchoring activity resulting in sediment suspension and deposition is expected to be limited to areas of the seafloor immediately adjacent to the spuds or anchors. For cable installation activities, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from jet plow installation of the Inter-array Cable, one of three potential types of equipment to be used for cable installation (Appendix I).

To estimate the extent of potential impacts from sediment suspension and deposition generated by jet plow installation, one of three potential types of equipment to be used for cable installation, a modeling simulation was conducted on a representative section of the Inter-array Cable, which indicated that the maximum modeled TSS concentration from the SFWF Inter-array Cable installation using a jet plow is 100 mg/L. Water column concentrations of 100 mg/L are predicted to extend up to 131 feet (40 m) from the jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) within 18 minutes (0.3 hour) from the conclusion of jet plow trenching. The model predicted that sediment deposition resulting from the installation of the Inter-array Cable using a jet plow will be limited to the area immediately adjacent to the burial route, typically extending no more than 196 feet (60 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.4 inch (10 mm) and limited to within 26 feet (8 m) of the burial route, covering an estimated cumulative area of 0.1 acre (0.04 ha) (Appendix I).

Increased deposition could result in mortality of benthic organisms through smothering and irritation to respiratory structures; however, mobile benthic organisms are expected to temporarily vacate the area and move out of the way of incoming sediments (DOI-MMS, 2007). Eggs and larval organisms are especially susceptible to smothering through sedimentation, and smaller organisms are likely more affected than larger organisms, as larger organisms may be able to extend feeding tubes and respiratory structures above the sediment (BERR, 2008). Maurer et al. (1986) found that several species of marine benthic infauna (the clam *Mercenaria mercenaria*, the amphipod *Parahaustorius longimerus*, and the polychaetes *Scoloplos fragilis* and *Nereis succinea*) exhibited little to no mortality when buried under up to 3 inches (8 cm) of various types of sediment (from predominantly silt-clay to pure sand). This suggests that burial with 0.4 inch (10 mm) of sediment will have little impact on some species of benthos if they are present near the trench.

Recolonization of areas covered in sediment may take months to years to occur, and studies associated with cable laying found that benthic infauna were still recovering 2 years after the cable-laying activity had ceased (Gill, 2005; DONG Energy et al., 2006).

Increased sediment suspension and deposition could also result in a reduction in feeding success of benthic species because prey species may be covered or temporarily vacate the area. Levels of TSS could also reach lethal or sublethal levels for benthic species; however, given the limited extent and duration of the elevated project-related TSS concentrations, this would be considered a minor impact to the benthic population. Indirect impacts may also include mobilization of contaminants within the sediments; however, the Inter-array Cable is not located near a known disposal site or area of contamination, so this is unlikely.

Sand sheet and mobile sand with gravel habitats as found near the SFWF are often more dynamic in nature; therefore, they are quicker to recover than more stable environments, such as fine-grained (e.g., silt) habitats and rocky reefs (Dernie et al., 2003). Species found in these more dynamic areas are often adapted to deal with more dynamic habitats and handle increases in sedimentation associated with wind and waves.

Noise

Direct impacts associated with noise during construction of the SFWF may occur during pile driving and installation of the Inter-array Cable. Noise associated with vessels and aircrafts may also cause impacts during construction. Pile driving is expected to cause ***minor, short-term, direct impacts***, while the other sources of noise are expected to have ***negligible impacts***. Expected impacts from these activities are discussed separately in the following sections. Criteria for assessing injury to invertebrates associated with sound levels and sound exposure levels have not been established.

Pile Driving Noise

Little scientific research has been conducted on noise impacts on benthic species and shellfish; however, because benthic species and shellfish lack gas-filled organs, they are likely to be less sensitive than finfish and marine mammals to pressure waves. Few marine invertebrates have the sensory organs to perceive sound pressure, but many can perceive particle motion (Vella et al., 2001). ***Minor, short-term, direct impacts*** are expected for benthic resources and shellfish from pile driving noise. Increased underwater noise may result in short-term behavioral changes, including area avoidance by mobile species. ***Minor, short-term, direct impacts*** may be associated with increased underwater noise, resulting in an increased potential for predation, and potential interruption of communication leading to behavioral changes.

Vessel Noise, Trenching Noise, Aircraft Noise

Little research has been conducted on how benthic resources and shellfish are affected by underwater noise from vessels, trenching, or aircraft noise. Vessel noise may cause short-term behavioral changes; however, this is not expected to be different than what currently occurs when vessels transit the area. Similarly, trenching noise levels are not expected to result in adverse impacts to benthic resources. As a result, ***short-term, negligible, direct impacts from*** trenching, vessel noise, and aircraft noise could be anticipated

Traffic

Impacts associated with vessel traffic during the SFWF construction are expected to be ***negligible*** and ***short-term*** related to benthic resources.

Lighting

BOEM does not identify potential impacts to benthic or shellfish species from lighting at offshore facilities (Orr et al., 2013). There is the potential that lighting associated with construction of the OSS may serve to attract species such as squid to the area at night; however, because of the limited size of the lit area during construction and the depth of the water at the SFWF, potential impacts are expected to be ***short-term*** and ***negligible***.

Operations and Maintenance

Table 4.3-7 summarizes the level of impacts expected to occur to benthic and shellfish resources during the O&M phases of the SFWF. ***Minor, long-term, indirect impacts*** during O&M are largely associated with the presence of the SFWF. Additional details on potential impacts to benthic and shellfish resources from the various IPFs during O&M are described in the following sections.

Table 4.3-7. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact[a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Foundation	Minor long-term indirect	Minor long-term indirect
	OSS platform	Minor long-term indirect	Minor long-term indirect
	SFWF Inter-array Cable	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Vessel Anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Vessel Noise and Aircraft Noise	Negligible short-term direct	Negligible short-term direct
	WTG Operational Noise	Negligible long-term direct	Negligible long-term direct
EMF		Negligible	Negligible

Table 4.3-7. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact[a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Traffic		Negligible short-term direct	
Lighting		Negligible long-term direct	Negligible long-term direct
Discharges and Releases [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category. For further information on potential impacts associated with the IPFs, see the following sections.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Releases and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

During O&M of the SFWF, the presence of the foundations, Inter-array Cable, and vessel anchoring may result in seafloor disturbance. See Sections 3.1.2.2 and 4.1 for the expected impact areas associated with the monopile foundation that is planned to be used to support the WTGs and OSS, and the impact area associated with the Inter-array Cable and vessel anchoring.

Foundations

The presence of the foundations and associated scour protection is expected to result in ***minor, long-term, direct impacts*** to benthic organisms because of the conversion of existing sand sheet or sand with mobile gravel habitat to hard bottom habitat. This conversion to hard-bottom habitat would result in ***long-term, minor direct impacts*** to species that occur in soft-bottom because of loss of habitat. Species that are associated with hard bottom habitat are expected to experience ***long-term benefits*** due to an increase of hard bottom habitat.

Habitat conversion is expected to cause a ***long-term, minor, indirect impact*** resulting in a potential shift in species assemblages towards those found in rocky reef and rock outcrop habitat; this is known as the "reef effect" (Wilhelmsson et al., 2006; Wilhelmsson and Malm, 2008; Maar et al., 2009; Reubens et al., 2013). This effect is also well known from other anthropogenic structures in the sea, such as oil platforms, artificial reefs piers, and shipwrecks (Claudet and Pelletier, 2004; Wilhelmsson et al., 2006; Seaman, 2007; Langhamer and Wilhelmsson, 2009; Langhamer et al., 2009). The impact is expected to be minor because both soft and hard bottom habitats are already present in and around the SFWF. Data collected as part of the G&G survey at the SFWF (Appendix H) indicate that sand sheet habitat is not a limiting habitat in the region, and that numerous hard bottom boulder habitats are also present within the area. As a result, the conversion of a small area of sand sheet habitat to hard bottom habitat is unlikely to result in perceptible changes to the benthic community outside of the immediate area impacted.

These converted hard bottom habitat areas may serve as artificial reefs and are expected to be colonized by fouling organisms, including macroalgae, shellfish, barnacles, tunicates, and bryozoans (Gill and Kimber, 2005). Recruitment of marine organisms to new structures such as foundations primarily occurs in two different ways: by migration of adults from the surrounding substrate or by settling of larvae and juveniles. This recruitment will be influenced by the local hydrodynamic regime that will be carrying the larvae to the area (Jonsson et al., 2004), the material and texture of the foundations and structures (Glasby, 2000), the location of the foundations and structures with respect to water depth (Relini et al., 1994), and temperature (Anil et al., 1995; Verween et al., 2007). Design components may influence the specific species that settle and colonize scour protection structures, as structural complexity of exposed surfaces is an important factor (Petersen and Malm, 2006; Langhamer and Wilhelmsson, 2009; Langhamer, 2012).

The use of gravel or boulders for scour protection around the foundations will create new hard substrate, and this substrate is expected to be initially colonized by barnacles, tube-forming species, hydroids, and other fouling species found on existing hard bottom habitat in the region. Mobile organisms, such as lobsters and crabs, may also be attracted to and occur in and around the foundation in higher numbers than surrounding areas. Hard substrate generally has a higher biodiversity and species abundance than surrounding soft bottoms (Linnane et al., 2000).

Monopiles, if treated with anti-fouling paint, may deter some species, but still attract barnacles and filamentous algae (Petersen and Malm, 2006). As these foundations extend from below the seafloor to above the surface of the water, there is expected to be a zonation of macroalgae from deeper growing red foliose algae and coralline algae, to kelps and other species, including those that may grow in subtidal, intertidal, and splash zone areas. Foundations typically also have crevices that increase structural complexity of the area and attract finfish and invertebrate species seeking shelter, including crabs and American lobster. Other species that may be beneficially affected include sea anemones and other anthozoans, bivalves such as horse mussel, green sea urchin, barnacles, hydrozoans, sponges, and other fouling organisms. There is expected to be a similar zonation of these species with depth, as well. Species that prefer softer bottom habitat may be adversely affected, and these include ocean quahog, waved and chestnut astarte clam, Atlantic surf clam, sand shrimp, channeled whelk, and horseshoe crab. For further information on preferred habitat of benthic species, see Table 4.3-3.

Hard bottom habitat is present but limited in the area and conversion of soft bottom habitat to hard bottom habitat is expected to provide ***long-term benefits*** that may increase diversity and biomass of benthic and shellfish species in the vicinity of the SFWF, including those species discussed in the cobbles, boulders, rocky reef, and rock outcrop portion of Table 4.3-3. The conversion to hard bottom associated with the WTGs is expected to have a ***minor, long-term, impact*** on species associated with sandy bottom habitats. Because of the amount of surrounding sand sheet soft bottom habitat in the area, sand sheet habitat is not expected to be a limiting factor on benthic resources and shellfish. In addition, because of the dispersed nature and small spatial footprint of the WTGs and other locations that may be converted to hard bottom, any reef effect observed will be limited to the immediate vicinity of that structure and will not cover the entire area where the SFWF is located.

Offshore Substation Platform
Impacts associated with the presence of the OSS platform during operation are expected to be similar to those described for the foundation.

SFWF Inter-Array Cable
Some portions of the Inter-array Cable may require armoring, which will result in conversion of existing habitat to hard bottom, as described in the Foundation section. Areas that require armoring are expected to result in ***minor, long-term impacts*** to benthic organisms and their habitat, as described in the Foundation section.

Benthic organisms are expected to experience ***minor, short-term, direct impacts*** if the Inter-array Cable requires maintenance that will expose the Inter-array Cable. Maintenance of the Inter-array Cable is considered a nonroutine event and is not expected to occur regularly. Impacts associated with exposing the Inter-array Cable will be similar but less frequent to those described for the SFWF Inter-array Cable installation during the construction and decommissioning stage.

Vessel Traffic - Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the Inter-array Cable or WTGs require maintenance. Impacts associated with potential vessel anchoring during operation are expected to be similar to but less frequent than those discussed for vessel anchoring during the construction phase. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M will primarily result from vessel anchoring and any maintenance activities that require unburying or reburying the Inter-array Cable. Both activities are expected to be nonroutine events and not expected to occur with regularity. Sediment suspension and deposition impacts resulting from vessel activity during the SFWF O&M are expected to be similar to vessel-related sediment suspension and deposition impacts described for the construction phase.

Noise

Noise associated with O&M activities is expected to have ***negligible impacts*** on the benthic resources at the SFWF.

Vessel and Aircraft Noise

Vessel and aircraft noise during the SFWF O&M are expected to have ***negligible, short-term, direct impacts*** and will be similar to or less than those impacts described in the construction phase.

WTG Operational Noise

The WTGs will produce low-level continuous underwater noise (infrasound) during operation; however, there are no conclusive studies associating WTG operational noise with impacts on benthic resources and shellfish. Because of this, direct impacts are expected to be ***long-term*** and ***negligible*** for WTG operational noise. No indirect impacts are expected.

Electromagnetic Field

Operation of the WTG does not generate EMF; however, once the Inter-array Cable becomes energized, the cable will produce a magnetic field, both perpendicularly and in a lateral direction around the cable. The Inter-array Cable will be shielded and buried beneath the seafloor. Shielded electrical transmission cables do not directly emit electrical fields into surrounding areas but are surrounded by magnetic fields that can cause induced electrical fields in moving water (Gill et al., 2012). Exposure to EMF could be short- or long-term, depending on the mobility of the species. Mobile species are likely to pass through the area and be exposed for a short duration. Sessile species, which are unable to move, will be exposed for the entire duration that the Inter-array Cable is energized (BERR, 2008; Woodruff et al., 2012; Love et al., 2015, 2016).

Compared to fish and elasmobranchs, relatively little is known about the response of marine invertebrates to AC EMF, and how this might impact migration, orientation, or prey identification. Aquatic crustaceans, a group that includes commercially important crab and lobster species, have been observed to use geomagnetic fields to guide orientation and migration, which suggests that this group of organisms is capable of detecting static magnetic fields (Ugolini and Pezzani, 1995; Cain et al., 2005; Boles and Lohmann, 2003; Lohmann et al. 1995). The ability to detect geomagnetic fields, however, is likely integrated with other environmental cues, including slope, light, currents, and water temperature. Furthermore, Project cables will produce AC magnetic fields, which differ from the static geomagnetic fields to which magnetosensitive marine invertebrates are attuned; therefore, operation of the Inter-array Cable is not expected to adversely impact benthic invertebrate orientation or migration.

As described in Appendix K, data from field studies constitute the best source of evidence to assess population-level impacts to benthic invertebrates. These demonstrate that impacts on benthic invertebrate behavior or distribution are not expected due to the presence of energized cables. Field surveys on the behavior of large crab species at 60-Hz AC submarine cable sites indicate that the project's calculated magnetic-field levels are not likely to impact the distribution and movement of large epibenthic crustaceans. Ancillary data and observations from these field studies also suggest that cephalopod predation is similarly unaffected by the presence of 60-Hz AC cables (Appendix K).

Appendix K provides more detail on field study evidence that supports the conclusion that large benthic and epibenthic invertebrates will not be affected by the installation of the SFWF Inter-array Cable. Impacts on sea urchin embryonic development observed in laboratory studies were minor and were only documented to occur after exposure to magnetic fields between 500 and 34,000 mG (Appendix K). These levels are much higher than magnetic fields expected to be produced by the SFWF and SFEC cables. Based on these studies, negligible impacts to benthic invertebrates are expected from the EMF associated with operation of the SFWF Inter-array Cable.

Traffic
Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting
Impacts associated with lighting are expected to be similar to impacts described in the construction phase. Because of the limited size of lit area during O&M at the OSS and individual WTGs, the depth of the water at the SFWF, the limited area associated with artificial lighting, and the height of the lights above the water, these potential impacts are expected to be ***negligible*** but would occur over the duration of the O&M of the SFWF.

Decommissioning

Decommissioning of the SFWF is expected to have similar impacts as those described for construction of the WTGs, OSS, and Inter-array Cable, and. the SFWF area is expected to return to pre-project conditions after completion of decommissioning.

South Fork Export Cable

Similar to the SFWF Inter-array Cable, the construction, installation, and decommissioning of the SFEC is not expected to have more than minor long-term impacts on benthic or shellfish resources. Impacts are largely expected to be ***negligible to minor, localized,*** and ***short-term*** in nature. See Section 4.1 for the acreage of benthic habitat that is expected to be affected by construction.

Following completion of construction and during O&M of the SFEC, the substrates along the SFEC are expected to fundamentally remain the same as pre-project conditions, since the SFEC will be buried below the seafloor. This will allow for benthic species to recolonize the disturbed areas. The exception is the conversion of sand sheet and sand with mobile gravel habitats to hard bottom habitat associated with the protective armoring for discrete portions of the SFEC. This acreage is small relative to the total area of available surrounding benthic habitat, and such adverse impacts to benthic species are expected to be ***localized*** and ***minor at the short- and long-term***.

SFEC – OCS and SFEC - NYS

Construction and Decommissioning

Table 4.3-8 summarizes the level of impacts expected to occur to benthic and shellfish resources during the construction and decommissioning phases of the SFEC. Decommissioning of the SFEC is included in Table 4.3-8 because decommissioning of the structures will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to benthic and shellfish resources from the various IPFs during construction are described in the following sections. Impacts to EFH for shellfish are discussed in Appendix O.

Table 4.3-8. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources for the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	Seafloor preparation	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Pile driving and cofferdam installation	Minor short-term direct	Minor short-term direct
	SFEC installation	Minor short-term direct	Minor short-term direct
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Noise	Pile driving	Minor short-term direct	Minor short-term direct
	Vessel noise, trenching noise, aircraft noise	Negligible short-term direct	Negligible short-term direct
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct

Table 4.3-8. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources for the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Discharges [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Seafloor disturbance, associated with construction of the SFEC, results from the following activities: seafloor preparation, cofferdam installation, cable installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce ***minor direct*** and ***indirect impacts*** to species depending on the mobility of the benthic species and shellfish species. See Section 4.1 for the expected impact areas associated with the SFEC cable and HDD cofferdam.

Seafloor Preparation

Seafloor preparation activities at the SFEC during construction include removal of obstructions and installation trials prior to installing the SFEC. A PLGR will be used to clear debris from the area prior to laying the SFEC. Up to five installation trials may be conducted, resulting in a temporary seabed disturbance of up to 9.3 acres (3.75 ha). In addition, boulder relocation may be required within 49 feet (15 m) of each side of the cable centerline where boulders are present. Temporary seabed disturbance from boulder relocation related to preparation for SFEC-OCS installation could include a total temporary disturbance of up to 124.9 acres (50.5 ha). Boulder relocation will not be required along the SFEC-NYS.

Impacts associated with seafloor preparation are expected to be similar to those described for the SFWF Inter-array Cable, with the one difference that shallower areas will be affected as the SFEC nears shore. These shallower areas are expected to have slightly different species assemblages than the deeper offshore areas near the SFWF. See Tables 4.3-3 and 4.3-4 for species that may occur in these areas and be affected by seafloor preparation.

Pile Driving and Cofferdam Installation

Vibratory pile driving will be used to install the temporary cofferdam at the HDD exit point. Direct impacts will be primarily associated with the placement of the piles and the potential to crush benthic species. This is expected to be a ***minor, short-term impact*** for sessile and slow-moving species, while mobile species are expected to have a reduced potential for direct impacts because they are expected to temporarily vacate the area where the piles will be placed. These impacts are expected to be similar to those described for pile driving at the SFWF; however, at a much smaller spatial and temporal scale.

SFEC Installation

Installation of the SFEC is expected to result in direct impacts similar to those described for the SFWF Inter-array Cable. Nearshore portions of the SFEC and the HDD to transition the onshore cable to the submarine cable will take place in shallower waters than the SFWF. During the HDD event, fluids are pumped into the borehole to lubricate it and aid in the return of drilled sediments. These fluids typically consist of bentonite clay and water with some stabilizing compounds (i.e., drilling mud).

During the HDD event, the bentonite-sediment slurry is managed landside at the entry pit through a recycling system. However, the bentonite slurry can be released to the seafloor into the water column. The pressure from boring causes an upward rupture of the seafloor or at the terminus of the borehole. When an unexpected rupture occurs followed by a release of drilling mud, this is known as a frac-out.

In the event of a frac-out, a series of containment and cleanup procedures are implemented. These procedures are typically described in an HDD inadvertent release control plan. The bentonite slurry is viscous and tends to easily coagulate. These properties allow for cleanup of releases, if necessary, through a vacuum or suction dredge system designed for that purpose.

In the event of drilling mud release out of the end of the completed borehole, the cofferdam (steel sheet piles or gravity) contains the material in a confined space. Any significant volume of the material within the confined space can be recovered as described. In either case, drilling mud will not be purposely released into the marine environment. If it does, it is expected to be confined and cleaned up so that a plume will not move through and about the water column.

If a drilling mud release occurs, it is expected to result in a ***minor, short-term impacts*** due to seafloor disturbance at the frac-out location. If any benthic organisms are in the vicinity of the release, impacts to those few individuals will occur. Species such as Atlantic rock crab and horseshoe crab are mobile and expected to vacate the impact area associated with the installation of the SFEC and any areas requiring cable armoring. Northern quahog clam, eastern oyster, and Atlantic surf clam may be subject to mortality or injury if they are present in the impact areas.

Vessel Anchoring (Including Spuds)

Impacts associated with vessel anchoring and the use of spuds during construction of the SFEC are expected to be similar to those described for the SFWF. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during construction of the SFEC will result from seafloor disturbance caused by vessel anchoring, installation of the SFEC, and limited excavation required at the cofferdam. Direct impacts associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. Indirect impacts to benthic and shellfish resources from increases in sediment suspension and deposition are expected to be ***minor*** and ***long-term*** for sessile species, and ***negligible*** and ***long-term*** for mobile species, as described for the SFWF. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For cable installation at the SFEC - OCS and SFEC - NYS, and excavation at the cofferdam, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from jet plow installation, one of three potential types of equipment to be used for cable installation (Appendix I). A summary of the modeling results for these three project components is provided in the following subsections.

SFEC - OCS Installation

The modeling results indicate that the maximum modeled TSS concentration from SFEC - OCS installation using a jet plow is 1,347 mg/L. The highest TSS concentrations using this type of cable installation equipment are predicted to occur in locations where the jet plow passes over pockets of finer sediments (e.g., between VC-217 and VC-220, and again between VC-235 and the end of the route – see Appendix H), but concentrations exceeding 30 mg/L otherwise remain within approximately 328 feet (100 m) of the source during the simulation. Water column concentrations of 100 mg/L or greater are predicted to extend up to 1,115 feet (340 m) from the jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.4 hours after the conclusion of jet plow trenching.

The model predicted that sediment deposition resulting from installation of the SFEC - OCS using a jet plow will be limited to the area immediately adjacent to the burial route, typically, extending no more than 328 feet (100 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.45 inch (11.4 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.74 ha) of the seabed (Appendix I).

SFEC - NYS Installation

The modeling results indicate that the maximum modeled TSS concentration from SFEC - NYS installation using a jet plow is 578 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 394 feet (120 m) from the jet plow, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.3 hours after the conclusion of jet plow trenching. A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The maximum predicted TSS concentration from suction dredging at the HDD site is 562 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 476 feet (145 m) from the source, and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.1 hours after the conclusion of suction dredging (Appendix I).

The model predicted that sediment deposition resulting from installation of the SFEC - NYS using a jet plow will also be limited to the area immediately adjacent to the burial route, as described. The maximum predicted deposition thickness is estimated to be 0.39 inch (9.9 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.72 ha) of the seabed (Appendix I).

Cofferdam Installation

A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The model predicted that sedimentation will be limited to the area immediately adjacent to the exit pit (within 656 feet [200 m] of the source). Unlike previous scenarios where sediment is resuspended along a linear path, the dredge and side-cast operation occur from a single point within the model domain. For this reason, the deposit is thicker, but is far more limited in extent. The maximum predicted deposition thickness is 12.5 inches (318 mm). Sedimentation at or above 10 mm extends a maximum of 177 feet (54 m) from the side-cast point and covers a cumulative area of only 1.38 acres (0.56 ha) of the seabed (Appendix I).

Potential impacts to benthic organisms from increase in sediment suspension and sediment deposition are similar to those described for the SFWF. Given the limited extent and duration of the elevated TSS and sedimentation based on the predictive modeling described, direct impacts are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species; indirect impacts are expected to be ***minor*** and ***long-term*** and associated with short-term habitat loss through sediment deposition in surrounding areas.

Noise

Pile Driving Noise and Vibration
Direct impacts associated with noise and vibration during construction of the SFEC may occur during vibratory hammer pile driving for the cofferdam and cable installation of the SFEC. Pile driving is expected to cause ***minor, short-term, direct impacts*** on benthic organisms in the proximity of the SFEC – NYS cofferdam installation. Project-related underwater sounds were modeled as a part of the broader acoustic modeling effort presented in Appendix J. Vibratory hammer pile driving in water causes sound energy to radiate directly into the water by vibrating the pile between the surface of the water and the bottom and causes ground-borne vibration at the bottom substrate. Direct impacts will be experienced by those organisms close enough to the vibratory hammer pile driving to be exposed to injurious or disturbing sounds and vibrations. Indirect impacts are expected to be similar to those discussed in the Pile Driving section for the SFWF. In general, because of the shorter duration (12 to 24 hours) expected for vibratory hammer pile driving associated with the SFEC cofferdam and the continuous, nonimpulsive sounds, as opposed to impulse sounds from pile driving for the foundations, noise impacts to benthic organisms are expected to be less than those described for the SFWF pile driving.

Vessel Noise, Trenching Noise, Aircraft Noise
Impacts associated with vessel noise, trenching noise, and aircraft noise are expected to be similar to those described for the SFWF and include ***negligible, short-term, direct impacts***.

Traffic
Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting
Lighting will be associated with the vessels that will be conducting the work and installing the SFEC. Potential impacts associated with vessel lighting are expected to be ***negligible*** and similar to those discussed for the SFWF construction phase. These impacts will be ***short-term*** and localized, as the vessels installing the SFEC are expected to pass quickly through each location during laying of the cable. They will be similar to impacts that currently occur in the vicinity when vessels pass through the area. As such, impacts associated with lighting are expected to be ***negligible***.

Operations and Maintenance

Table 4.3-9 summarizes the level of impacts expected to occur to benthic and shellfish resources during the O&M phases of the SFEC. ***Minor, long-term impacts*** during O&M are associated with the presence of the SFEC and associated cable armoring. Additional details on potential impacts to benthic and shellfish resources during O&M are described in the following sections.

Table 4.3-9. IPFs and Potential Levels of Impact on Benthic and Shellfish Resources at the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact [a]	
		Sessile Species and Species with Limited Mobility [b]	Mobile Species and Life Stages
Seafloor Disturbance	SFEC	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
	Vessel Anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible long-term indirect
Vessel and Aircraft Noise		Negligible short-term direct	Negligible short-term direct
Electromagnetic Field		Negligible	Negligible
Traffic		Negligible short-term direct	
Lighting		Negligible short-term direct	Negligible short-term direct
Discharges [c]		Negligible	Negligible
Trash and Debris [c]		Negligible	Negligible

[a] Maximum level of impact is the highest impact level for direct or indirect impacts. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Including eggs and larvae of mobile species.

[c] Supporting information on the negligible level of impact for the Discharges and Trash and Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Seafloor disturbance during O&M of the SFEC may result from maintenance to the SFEC and vessel anchoring (including spuds). See Section 4.1 for the expected impact areas associated with the SFEC and HDD cofferdam.

South Fork Export Cable

Benthic organisms are expected to experience ***minor, short-term, direct impacts*** if the SFEC requires maintenance that will expose it. Similar to the maintenance of the SFWF Inter-array Cable, maintenance of the SFEC is considered a nonroutine event and is not expected to occur with regularity. Impacts associated with exposing the SFEC are expected to be similar but less frequent to those described for the construction phase. Benthic organisms are expected to experience ***negligible, short-term, direct impacts*** from the presence of the SFEC because it will be buried beneath the seabed. However, some areas of the SFEC may require armoring, which will result in conversion to hard bottom, as described for the SFWF Inter-array Cable. Areas that require armoring are expected to result in ***minor, long-term impacts*** to benthic organisms and their habitat.

Vessel Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the SFEC requires maintenance. Impacts associated with potential vessel anchoring during O&M of the SFEC are expected to be similar to those described for the SFWF. ***Minor, short-term, direct impacts***, including mortality or injury of slow-moving or sessile species within in the impact area of the spuds, anchor, or area swept by the anchor chain, may occur. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite; as these numbers increase, the associated impact areas will also increase. ***Minor, long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M of the SFEC will primarily result from vessel anchoring and maintenance activities that will require exposing the SFEC. Both activities are expected to be nonroutine events and not expected to occur with regularity. Sediment suspension and deposition impacts resulting from vessel activity during O&M of the SFEC are expected to be similar to vessel-related sediment suspension and deposition impacts described for the SFEC construction phase, but less frequent and at a smaller scale. Direct impacts associated with increased sediment suspension and deposition are expected to be ***minor*** and ***short-term*** for sessile species and species with limited mobility, and ***negligible*** and ***short-term*** for mobile species. Indirect impacts to benthic and shellfish resources from increases in sediment suspension and deposition are expected to be ***minor*** and ***long-term*** for sessile species, and ***negligible*** and ***long-term*** for mobile species, as described for the SFWF.

Noise

Direct impacts to benthic organisms associated with noise during O&M of the SFEC may occur associated with vessels and aircraft. Impacts associated with vessel noise and aircraft noise are expected to be similar to those described for the SFWF and include ***negligible, short-term, direct impacts***.

Electromagnetic Field

Negligible impacts to benthic organisms from the EMF associated with the SFEC are expected and impacts are expected to be similar to those described for the Inter-array Cable at the SFWF. Appendix K1 provides an assessment of potential effects on marine life from submarine cables.

Traffic

Impacts associated with vessel traffic during the SFWF construction are expected to be negligible and short-term related to benthic resources.

Lighting

There will be no artificial lighting associated with the SFEC in nearshore and aquatic areas during O&M. As such, ***negligible*** direct and indirect impacts associated with lighting will only occur from vessels during maintenance activities on the SFEC. These activities are expected to be ***short-term*** and ***localized,*** and similar to those discussed for the construction phase of the SFEC.

Decommissioning

Decommissioning of the SFEC is expected to have similar impacts as construction. The SFEC area is expected to return to pre-project conditions after decommissioning.

4.3.2.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to benthic resources.

- The SFWF and SFEC - Offshore will minimize impacts to harder and rockier bottom habitats to the extent practicable. Installation of the SFWF Inter-array Cable and SFEC - Offshore will occur using equipment such as mechanical cutter, mechanical plow, and/or jet plow. Compared to open cut dredging, this method will minimize long-term impacts to the benthic habitat.
- Use of monopiles with associated scour protection will minimize impacts to benthic habitat, compared to other foundation types.
- The SFWF Inter-array Cable and SFEC - Offshore will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m).
- Use of DPV for cable installation for the SFWF Inter-array Cable and SFEC - Offshore will minimize impacts to benthic and shellfish resources, as compared to use of a vessel relying on multiple-anchors.
- The sea-to-shore transition will be installed with HDD to avoid impacts to the dunes, beach, and near-shore zone, including benthic and shellfish resources.
- A plan for vessels will be developed prior to construction to identify no-anchor areas inside the MWA to protect sensitive areas or other areas to be avoided.

4.3.3 Finfish and Essential Fish Habitat

The description of the affected environment and assessment of potential impacts for finfish and EFH was evaluated by reviewing current public data sources related to finfish and EFH, including state and federal agency-published papers and databases, published journal articles, online data portals and mapping databases, and correspondence and consultation with federal and state agencies. DWSF has completed a benthic habitat assessment as described in Section 4.3.2. Finfish and EFH within the potentially affected environment are described below, followed by an evaluation of potential project-related impacts.

4.3.3.1 Affected Environment

Regional Overview

The regional waters off the coast of Rhode Island, Massachusetts, and Long Island, New York are transitional waters that separate Narragansett Bay and Long Island Sound from the OCS (BOEM, 2013). These waters straddle the Mid-Atlantic and New England regions and serve as the northern boundary for some Mid-Atlantic species and the southern boundary for some New England species. The species evaluated as possibly present in the SFWF and SFEC areas reflect the transitional nature of this regional area.

Habitat and spatial factors (temperature, salinity, pH, current, etc.) affect the distribution of fish within the oceans. Major habitat types expected to be found within the SFWF and SFEC are described in Section 4.3.3. As summarized in BOEM's Revised Environmental Assessment (BOEM, 2013), finfish off the coasts of Rhode Island and Massachusetts include demersal, pelagic, and shark finfish assemblages. In addition, there are important shellfish (Section 4.3.2) and migratory pelagic finfish throughout the Southern New England-New York Bight.

BOEM (2013) states that demersal species (groundfish) spend at least their adult life stage on or close to the ocean bottom. They are generally considered to be high-value fish and are sought by both commercial and recreational anglers. Pelagic fishes are generally schooling fish that occupy the mid- to upper water column as juveniles and adults and are distributed from the nearshore to the continental slope. Some species are highly migratory and are reported to be present in the near-coastal and shelf surface waters of the Southern New England-New York Bight in the summer, taking advantage of the abundant prey in the warm surface waters. Coastal migratory pelagics include fast-swimming schooling fishes that range from shore to the continental shelf edge and are sought by both recreational and commercial anglers. These fish use the highly productive coastal waters of the more expansive Mid-Atlantic Bight during the summer months and migrate to deeper and/or distant waters during the remainder of the year (BOEM, 2013). Pelagic sharks, large coastal sharks, and small coastal sharks also occupy this region. The sections below identify these groups of finfish species and their associated habitats that may be found within the SFWF and SFEC.

South Fork Wind Farm

This section describes finfish resources (demersal and pelagic) within and surrounding the areas of the SFWF. Also, outlined in this section are the finfish species and their habitats that may be affected by the SFWF project activities. Benthic resources, including shellfish and habitat types, are described in Section 4.3.2. A thorough EFH Assessment for designated species in the SFWF and SFEC is provided as Appendix O.

Table 4.3-10 summarizes species of economic or ecological importance potentially present within the region of the SFWF and SFEC, generally characterized by their life stage and location in the water column. The species listed in Table 4.3-10 were selected based on literature review, agency correspondence, fish sampling results from the BIWF, and EFH source document review. This table does not include every species that has the potential to occur in the SFWF or SFEC, but focuses on those that are abundant, commercially or recreationally important, important prey species, or have designated EFH within the areas of the SFWF or SFEC. The table delineates species characteristics, including: habitat preference (demersal versus pelagic), early life stage presence, EFH designation, commercial/recreational importance, potential prey species, and seasonality in the region. The type or types of potential impact(s) of the SFWF on each species is related to these characteristics.

Demersal species occur near the bottom of the water column in benthic habitats, and pelagic species occupy space near the surface and within the water column. Benthic and pelagic invertebrates are discussed in Section 4.3.2. Each species type that is ecologically or economically important is described in more detail in relation to proposed SFWF activities in the following sections.

Demersal Finfish in the South Fork Wind Farm

Demersal habitat includes the bottom substrate within continental shelf and shallow areas (Scotti et al., 2010). Demersal species interact with and consume benthic organisms. Because of this interaction, demersal species are reliant on the complex relationship between benthic habitats and species. More diverse fish communities occupy more complex habitats (Malek, 2015 and Malek et al., 2016). Some demersal species are present year-round; however, there are distinct variations in local populations because of seasonal migrations and inter-annual population dynamics (declines and increases) (Malek, 2015). Within nearby Narragansett Sound, demersal fish community structure has been changing over the past six decades with some demersal species declining (winter flounder, whiting, and red hake), while others have increased (Atlantic butterfish, scup, and squid) (Collie et al., 2008). These population changes are related to overfishing, fishery closures, changes in food sources, and changes in habitat (ASMFC, 2018).

Many of the members of the New England groundfish complex (cod, haddock, pollock, and various species of hake and flounders, monkfish, whiting, scup, and black sea bass), have been collected in local surveys (Petruny-Parker et al., 2015). Groundfish are an important part of the ecosystem within the SFWF and have an important economic role for the region.

Some demersal fish species migrate seasonally to the SFWF area. These migrations are often correlated with seasonal variation in water temperature. Most demersal species are abundant nearshore and offshore, extending along the continental shelf in winter and spring, (the cold season), and decline as they migrate out of the area during the summer and fall months, (the warm season) (Scotti et al., 2010).

Anadromous species are those which migrate between ocean and riverine environments. These types of fish spend their lives in both freshwater and marine environments. Juveniles from anadromous species leave coastal rivers and estuaries in the spring to enter the ocean. During this period, they grow and mature prior to returning to estuarine habitat to spawn, generally during fall months. There are two demersal species of anadromous fish that are potentially present within the SFWF area: striped bass and Atlantic sturgeon (BOEM, 2013; Scotti et al., 2010).

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
DEMERSAL/BENTHIC								
Atlantic Cod (*Gadus morhua*)[b]			■	■	X	X		Year-round, peak in winter and spring
Atlantic Halibut (*Hippoglossus hippoglossus*)[b]			■	■		X		Year-round
Atlantic Herring (*Clupea harengus*)[b]	■					X	X	Winter
Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*)			■	■				October to May
Barndoor skate (*Dipturus laevis*)			SFEC*	SFEC*	X			Year-round
Black Sea Bass (*Centropristis striata*)[b]			■	■	X	X		Spring to summer; summer to fall
Cunner (*Tautogolabrus adspersus*)			■	■			X	Year-round, hibernate in mud over winter
Haddock (*Melanogrammus aeglefinus*)[b]			■	SFEC*	X	X		Winter and spring
Little Skate (*Leucoraja erinacea)*			■	■	X	X		Year-round
Monkfish (*Lophius americanus*)[b]			SFEC*	■	X	X		Summer to fall
Northern sea robin (*Prionotus carolinus*)[b]			■	■		X		Spring through fall
Ocean Pout (*Macrozoarces americanus*)	■		■	■	X	X	X	Late summer to winter
Pollock (*Pollachius virens*)[b]			■	■	J	X		Collected in November at BIWF
Red Hake (*Urophycis chuss*)[b]			■	SFEC*	X	X	X	Shallow waters in spring and summer; offshore waters in the fall and winter. Collected from April to July at BIWF

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
Sand Lance (*Ammodytes americanus*)	■	■	■	■			X	Year-round
Sand Tiger Shark (*Carcharias taurus*) [d]		■	■		X			May to September
Sandbar Shark (*Carcharhinus plumbeus*) [b,d]		SFEC*	■	■	X			May to September
Scup (*Stenotomus chrysops*)			■	■	X	X	X	Juveniles: offshore in winter and spring, inshore in summer, near-coastal waters in fall; Adults: Fall, spring, and summer
Sea Raven (*Hemitripterus americanus*)	■	■	■	■				Collected Year-Round at BIWF
Smooth Dogfish (*Mustelus canis*)[d]		■	■	■	X			Fall to winter Collected spring through fall at BIWF
Spiny Dogfish (*Squalus acanthias*)[b]				■	X	X		Fall, winter, and summer Collected summer and fall at BIWF
Striped Bass (*Morone saxatilis*)			■	■		X		April to September
Summer Flounder (*Paralichthys dentatus*)[b]			SFEC*	■	X	X		Winter to spring Collected year-round at BIWF
Tautog (*Tautoga onitis*)			■	■		X	X	Winter
Tilefish (*Lopholatilus chamaeleonticeps*)		■	■			X		Larvae: July to September; Juveniles: April to July
White hake (*Urophycis tenuis*) [b]			SFEC*		X			Migrate inshore in warmer months; disperse into deeper waters in colder months
Whiting (*Merluccius bilinearis*)[b]			SFEC*	■	J	X		Winter to spring

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
Windowpane Flounder (*Scophthalmus aquosus*)[b]			■	■	X	X	X	Summer to fall Collected year-round at BIWF
Winter Flounder (*Pseudopleuronectes americanus*)[b]	■	■	■	■	X	X	X	Eggs/Larvae: winter to early spring; Juveniles and Adults: year-round
Winter Skate (*Leucoraja ocellate*)			■	■	X	X		Summer and fall Collected year-round at BIWF
Wolffish (*Anarhichas lupus*)			■	■				November to June
Yellowtail Flounder (*Limanda ferruginea*)[b]			■	■	X	X	X	Year-round
PELAGIC								
Albacore Tuna (*Thunnus alalunga*)			■	■	X	X		Summer to fall
Alewife (*Alosa pseudoharengus*)			■	■		X	X	Mid July to October Collected January to May at BIWF
American Eel (*Anguilla rostrata*)		■	■	■		X		Juveniles or Adults: March through December. One adult collected in April at BIWF
American Plaice (*Hippoglossoides platessoides*)		■	■	■		X		Year-round Collected April to May at BIWF
American Shad (*Alosa sapidissima*)			■	■		X		Spring to summer
Atlantic Bonito (*Sarda sarda*)			■	■		X		Summer to fall

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
Atlantic Butterfish (*Peprilus triacanthus*)	■	■	■	SFEC*	X	X	X	Eggs/Larvae: July to September; Juveniles/Adults: spring Adults: Collected in summer and fall at BIWF
Atlantic Cod[c]	■	■			X	X	X	Winter and spring
Atlantic Halibut[c]	■	■				X	X	Winter and spring
Atlantic Herring[c]		■	■	■	X	X	X	Larvae: August to December; Juveniles/Adults: spring and fall Juveniles/Adults: Collected January to March at BIWF
Atlantic Mackerel (*Scomber scombrus)*	■	■	SFEC*	■	E,L,J	X	X	Eggs/Larvae: April to June; Juveniles/Adults: late summer to fall Juveniles/Adults: Collected January through February at BIWF
Atlantic Menhaden (*Brevoortia tyrannus*)			■	■		X	X	Spring to summer
Atlantic silverside (*Menidia menidia*)			■	■			X	Late fall to early spring
Basking Shark (*Cetorhinus maximus*)[d]		■	■	■	X			Summer to fall
Bay anchovy (*Anchoa mitchilli*)	SFEC	SFEC	SFEC	SFEC			X	Eggs and Larvae: spring, summer, fall Juveniles and Adults: year-round Populations expected to be low and more evident in the SFEC - NYS than the SFEC - OCS.
Black Sea Bass[c]	■	■				X	X	July to September

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
Blueback Herring (*Alosa aestivalis*)			■	■		X	X	Summer to winter Collected in the winter at BIWF
Bluefin Tuna (*Thunnus thynnus*)			■	■	X	X		Spring to winter
Bluefish (*Pomatomus saltatrix*)	■	■	SFEC*	■	X	X	X	Eggs: March to May; Larvae: June to August; Juveniles collected in September, October, and December at BIWF Adults: August to September; Adults collected in September, October, November, and May at BIWF
Blue shark (*Prionace glauca*) [d]		■	■	■	X			June to November
Common Thresher Shark (*Alopias vulpinus*) [d]		■	■	■	X			June to December
Conger Eel (*Conger oceanicus*)			■	■				Collected November to June at BIWF
Dusky Shark (*Carcharhinus obscurus*) [d]		■	■	■	X			June to November
Haddock[c]	■	■			L	X	X	Winter and spring
Monkfish[c]	■	■			X	X	X	Summer to fall
Northern sea robin[c]	■	■				X		Summer to fall
Pollock[c]	■	■			X	X		Eggs: October to June Larvae: September to July
Red Hake[c]	■	■			X	X	X	May to December
Sandbar Shark (*Carcharhinus plumbeus*) [c,d]		SFEC*	■	■	X			May to September

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]
Shortfin Mako Shark (*Isurus oxyrinchus*) [d]		■	■	■	X			June to December
Skipjack Tuna (*Katsuwonus pelamis*)			■	■	X	X		Year-round
Spiny Dogfish (*Squalus acanthias*)[c]				■	X	X		Fall, winter, and summer Collected summer and fall at BIWF
Spot (*Leiostomus xanthurus*)			■	■		X		October to May
Summer Flounder[c]	■	■			X	X	X	Fall
Tiger Shark (*Galeocerdo cuvieri*)			SFEC*	SFEC*	X			May to September
Weakfish (*Cynoscion regalis*)			■	■		X	X	Adults: June
White Shark (*Carcharodon carcharias*) [d]		■	■	■	X			Summer to fall
White hake (*Urophycis tenuis*) [c]			SFEC*		X			Migrate inshore in warmer months; disperse into deeper waters in colder months
Whiting[c]	■	■			X	X	X	Year-round
Windowpane Flounder[c]	■	■			X	X	X	Spring
Winter Flounder[c]		■			X	X	X	Winter to spring
Witch Flounder	■	■			X	X	X	Year-round
Yellowfin Tuna (*Thunnus albacares*)			■	■	X	X		Year-round
Yellowtail Flounder[c]	■	■			X	X	X	March to August

Sources:

Table 4.3-10. Economically and Ecologically Important Finfish Species in the SFWF and SFEC

Species	Eggs	Larvae	Juveniles	Adults	EFH	Commercial/ Recreational Importance	Prey Species	Potential Time of Year in Region [a]

Bohaboy et al., 2010; Cargnelli et al., 1999c; Cargnelli et al., 1999d; Cargnelli et al., 1999e; Chang et al., 1999; Collette and Klein-MacPhee, 2002; Collie et al., 2008; Collie and King, 2016; Cross et al., 1999; Curtice et al., 2016; Demarest, 2009; Fahay et al., 1999a; Fahay et al., 1999b; Fairchild, 2017; Fisheries Hydroacoustic Working Group, 2008; Florida Fish and Wildlife Conservation Commission, 2017; Florida Museum of Natural History, 2017; GARFO, 2016; Hasbrouck et al., 2011; Johnson et al., 1999a; Johnson et al., 1999b; Knickel, 2017; Lipsky, 2014; Malek, 2015; Malek et al., 2010; Malek et al., 2014; Massachusetts Department of Energy and Environmental Affairs, 2017; MA EOEEA, 2015; McBride et al., 2002; McGuire et al., 2016; Morse et al., 1999; Morton, 1989; NOAA, 2010, 2015, 2016a, 2017a, 2017b, and 2017c; North Carolina Department of Environment and Natural Resources: Division of Marine Fisheries, 2017; NEFSC, 2017; Northeast Ocean Data, 2017; Packer et al., 1999, 2003a, 2003b, and 2003c; Pereira et al., 1999; Petruny-Parker et al., 2015; Popper et al., 2014; Reid et al., 1999; Rooker et al., 2007; Scotti et al., 2010; Siemann and Smolowitz, 2017; Steimle et al., 1999a, 1999b, 1999c, 1999d, and 1999e; Studholme et al., 1999; USFWS, 2017; URI EDC, 1998a and 1998b; Wilber et al., 2017.

[a] Time of year information obtained from sources listed in the reference section. When available, species presence based on survey information from the BIWF was provided from Wilber et al., 2017.

[b] This species also has life stages that are pelagic.

[c] This species also has life stages that are demersal.

[d] For sharks, if larvae stage is checked, it refers to the neonate stage. Neonate sharks are considered more similar to the juvenile life stage of other finfish.

Notes:

■ - denotes that the life stage is potentially present in both the SFWF and SFEC.

SFWF* – denotes that the life stage is potentially present only in the SFWF, according to EFH designations.

SFEC* – denotes that the life stage is potentially present only in the SFEC, according to EFH designations.

EFH column – X indicates EFH is designated for all life stages checked in that row. E, L, J, A indicates that only certain life stages have EFH. E=eggs, L=larvae, J=juveniles, A=adults.

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Many species listed in Table 4.3-10 have demersal life stages that are considered commercially or recreationally important in New England regional waters and have the potential to occur in the SFWF. Management for each species is dictated by state regulations for waters within 3 miles (4.8 km) of the coast and by federal regulations beyond 3 miles (4.8 km). Federal waters like those of the SFWF are managed under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Species such as Atlantic cod, black sea bass, scup, whiting, summer flounder, winter flounder, yellowtail founder, and winter skate are demersal species that are important to both the stability and resiliency of the local marine community and have a large impact on federal fisheries (RI CRMC, 2010). For more information about the commercial and recreational fishing activity within the SFWF (Section 4.6.5).

The Atlantic sturgeon, a federally listed demersal species, has a possible presence within the SFWF from October to May, when juveniles and adults return to the oceans after spawning occurs in estuarine and riverine environments, including the Hudson River. Atlantic sturgeon are discussed in further detail in the Threatened/Endangered Finfish section that follows.

Atlantic cod is a demersal species potentially present within the SFWF that is known to have spawning habitat within localized regions near the SFWF. Cod spawn in the winter and may demonstrate strong spawning site fidelity, returning to the same fine-scale bathymetric locations year after year (Hernandez et al., 2013; Siceloff and Howell, 2013). An active Atlantic cod spawning ground is identified in a broad geographical area that includes Cox Ledge (Zemeckis et al., 2014). Kovach et al. (2010) collected cod with an otter trawl on Cox Ledge and the majority collected were in spawning condition. These collections included 158 individuals in January 2007 and 118 individuals in April 2007.

In other studies, Atlantic cod was not among the consistently prevalent (top 25) species collected during multi-year sampling by otter trawl and beam trawl in areas that included Cox Ledge (Malek et al., 2014). Cod were collected in the SFWF area during fall sampling by Northeast Fisheries Science Center (NEFSC) from 1989 to 2002 and in the spring from 2003 to 2016. Groundfish distributions (including Atlantic cod) were assessed as low to medium densities by the vessel monitoring system (VMS; NOAA NMFS) within the SFWF (Section 4.6.5).

DWSF is conducting a hook and line survey to assess the potential for Atlantic cod spawning activity at the SFWF and at nearby designated areas during winter and spring of 2018. The hook and line survey will assess site-specific spawning activity by determining the maturation stage of collected adult Atlantic cod. Reports from this study will be compiled and presented as part of an overarching SFWF and SFEC fisheries survey and monitoring plan.

Nineteen of the species that have demersal life stages listed in Table 4.3-10 have designated EFH in the SFWF. Additional information regarding EFH is described in Appendix O.

Pelagic Finfish in the South Fork Wind Farm

Pelagic species occupy the surface to midwater depths (0 to 3,281 feet [0 to 1,000 m] depth) from the shoreline to the continental shelf and beyond. There are 33 ecologically or commercially important finfish species that have pelagic life stages listed in Table 4.3-10 potentially present within the regional area that contains the proposed SFWF. Some pelagic species potentially present within the region include Atlantic sea herring, blueback herring, alewife, and Atlantic mackerel (Petruny-Parker et al., 2015). Pelagic finfish species are characterized as estuarine, marine, and anadromous species. Estuarine species tend to reside nearshore, whereas marine species are found offshore in deeper waters. Anadromous species prefer both nearshore and offshore areas but migrate up rivers to lower salinity environments for spawning. There are five pelagic species of anadromous fish that are potentially present within the region: American shad, alewife, blueback herring, Atlantic menhaden, and the Atlantic sea herring (BOEM, 2013; Scotti et al., 2010).

Some pelagic fish species migrate seasonally to the SFWF area. These migrations are often correlated with seasonal variation in water temperature. Seasonal variations in temperature and finfish migrations directly affect abundance of food and species of fish present (Bohaboy et al., 2010). Pelagic species are present nearshore and offshore in the warm season, and decline during the cold season (Scotti et al., 2010).

Certain pelagic species in federal waters are managed under the Atlantic Highly Migratory Species Fishery Management Plan (FMP). NMFS consults with and considers the comments of the Highly Migratory Species Advisory Panel when preparing and implementing FMPs or FMP amendments for Atlantic tuna, swordfish, billfish, and sharks. Species in Table 4.3-10 potentially present within the regional area that contains the proposed SFWF that are classified as highly migratory include: blue shark, common thresher shark, shortfin mako shark, and yellowfin tuna (NOAA, 2004).

Many species of finfish that have pelagic life stages within the regional area that contains the SFWF are considered commercially or recreationally important in federal waters. Twenty-seven of the finfish species with pelagic life stages listed in Table 4.3-10 have designated EFH within the SFWF. For more information regarding designated EFH within the SFWF (Appendix O).

Common Habitat Types of Species within the South Fork Wind Farm

New England waters have diverse habitats that are defined by their temperature, salinity, pH, physical structure, biotic structure, depth, and currents. The unique combination of habitat characteristics shapes the community of finfish species that inhabit the area. Habitat varieties determine species, distribution, and predator/prey dynamics. Each habitat structure supports a community of finfish species that rely on the habitat to survive. Multiple factors directly affect spatial and temporal patterns of fish species. A summary of common habitat types for the finfish species that could potentially occur in the SFWF or SFEC is provided in Table 4.3-11.

As described in Section 4.3.2, the SFWF has a highly variable and patchy distribution of benthic habitats including sand sheets, sand with mobile gravel, and patchy cobbles and boulders on sand (Appendix N1). Although sand sheets were the most common habitat type encountered during the benthic surveys, the heterogeneity of sediment types on small scales was high, with variable presence of gravel (i.e., granules, pebbles, cobbles, boulders) on sandy substrates characterizing much of the SFWF (Appendix H). The presence of cobbles and boulders at the SFWF was patchy; interpretation of sidescan sonar survey data show detail of boulder density in relation to project components and show that greatest boulder density occurs in the western, southern, and northeastern parts of the MWA, with three higher density boulder areas near the center of the MWA (Figures 3.1-1 and 3.1-2 and Appendix H).

Table 4.3-11. Common Habitat Types for Finfish Species known to occur in the Region

Species	Habitat Type by Lifestage
DEMERSAL/BENTHIC	
Atlantic Cod	Juveniles: Cobble substrates both nearshore and offshore; wide temperature ranges. Adults: On or near the bottom along rocky slopes of ledges; depths between 131 and 426 feet (40 and 130 m) but also midwater.
Atlantic Halibut	Juveniles: Coastal areas 65 to 196 feet (20 to 60 m) deep; sandy bottom. Adults: Areas at depths of 328 to 2,296 feet (100 to 700 m) over sand, gravel, or clay bottoms.
Atlantic sea herring	Eggs: Spawned at depths of 131 to 262 feet (40 to 80 m) on George's Bank on gravel (preferred); sand, rocks, shell fragments, aquatic macrophytes, and lobster pot structures.
Atlantic Sturgeon	Juveniles: In the wintertime, juveniles congregate in a deep-water habitat in estuaries. Most are found over clay, sand, and silt substrates. Adults: Primarily a marine species that is found close to shore; however, it does migrate long distances.
Black Sea Bass	Juveniles: Collected at depths of 65 to 787 feet (20 to 240 m) in channel environments. Adults: At depths of 98 to 787 feet (30 to 240 m) in shipwrecks, rocky and artificial reefs, mussel beds, and other structures along the bottom.
Cunner	All Life Stages: Coastwise fish that prefers eel grass, rock pools, or pilings at depths 13 to 23 feet (4 to 7 m).
Haddock	Adults: Pebble gravel bottom at depths of 131 to 492 feet (40 to 150 m).
Little Skate	All Life Stages: Sandy/gravely bottoms at a depth range of less than 233 to 298 feet (71 to 91 m).
Monkfish	Juveniles/Adults: Bottom habitat, sand/shell mix, gravel or mud along the continental shelf, depths 82 to 656 feet (25 to 200 m).
Northern sea robin	Juveniles and Adults: Smooth, hard-packed bottom.
Ocean Pout	All Life Stages: Bottom habitats with rocky shelter from the intertidal continental shelf to 656 feet (200 m) deep.
Pollock	All Life Stages: Schooling fish living at various depths from near the surface to at least 600 feet (182 m) deep.
Red Hake	Juveniles: Use of shells and substrate as shelter; found less than 393 feet (120 m) to low tide line.
Sand Lance	All Life Stages: Throughout water column over sandy substrates
Sand Tiger Shark	All Life Stages: Nearshore ranging in depths from 6 to 626 feet (2 to 191 m); inhabit surf zone, shallow bays, and rocky reefs, and deeper areas around the OCS. Generally found near bottom in sand, mud, and rocky substrates.

Table 4.3-11. Common Habitat Types for Finfish Species known to occur in the Region

Species	Habitat Type by Lifestage
Sandbar Shark	All Life Stages: Prefer bottom habitats. Sand, mud, shell, and rock sediments/benthic habitat. Also, pelagic (see pelagic section).
Scup	Juveniles: Nearshore in sandy, silty-sand, mud, mussel beds, and eel grass at depths of 16 to 55 feet (5 to 17 m). Adults: Soft, sandy bottom, near structures (ledges, artificial reefs, mussel beds) at a depth range less than 98 feet (30 m).
Sea Raven	All Life Stages: Prefer rocky ground; hard clay, pebbles, or sand from 300 to 630 feet (91 to 192 m) deep.
Smooth Dogfish	All Life Stages: Mostly nearshore but some have a depth range of 870 to 990 feet (145 to 165 m); prefer bottom habitats.
Spiny Dogfish	All Life Stages: Collected over sand, mud, and mud-sand transitions at depths ranging from 3 to 1,640 feet (1 to 500 m); do not travel to maximum depths in the fall. Also, pelagic (see pelagic section).
Striped Bass	All Life Stages: Open waters along rocky shores and sandy beaches.
Summer Flounder	Adults: Prefer sandy habitats; captured from shoreline to 82 feet (25 m) deep.
Tautog	All Life Stages: Require complex, structured habitats with a hard bottom substrate; depths of 82 to 989 feet (25 to 30 m).
Tilefish	All Life Stages: 262- to 590-foot (80- to 180-m) depth along the outer part of the continental shelf to upper part of continental shelf.
White hake	Juveniles: Benthic phase juveniles occur on fine-grained, sandy substrates in eelgrass, macroalgae, and un-vegetated habitats.
Whiting	Juveniles: Bottom habitats; all substrate types; depths of 65 to 885 feet (20 to 270 m). Adults: Bottom habitats; all substrate types; depths of 98 to 1,066 feet (30 to 325 m).
Windowpane Flounder	Juveniles and Adults: Fine, sandy sediment; nearshore less than 246 feet (75 m) deep.
Winter Flounder	Eggs: Nearshore; mud to sand or gravel. Emerging evidence that spawning occurs offshore. Larvae: Nearshore; fine sand to gravel. Juveniles: 59 to 88 feet (18 to 27 m) deep; mud or sand-shell. Adults: Mostly nearshore up to 98 feet (30 m) deep; mud, sand, cobble, rocks, or boulders substrate.
Winter Skate	All Life Stages: Prefer sandy or gravelly substrates; spring depths from 3 to 984 feet (1 to 300 m); fall depths from 3 to 1,312 feet (1 to 400 m).
Wolffish	All Life Stages: Occupy complex habitats with large stones or rocks at a depth range of 131 to 787 feet (40 to 240 m).

Table 4.3-11. Common Habitat Types for Finfish Species known to occur in the Region

Species	Habitat Type by Lifestage
Yellowtail Flounder	Juveniles: Sand or sand and mud; depth range of 16 to 410 feet (5 to 125 m). Adults: Sand or sand and mud; depth range of 32 to 1,181 feet (10 to 360 m).
Pelagic	
Albacore Tuna	All Life Stages: Deepwater habitats; depth range of 0 to 1,968 feet (0 to 600 m).
Alewife	Adults: Shorelines; shallower waters near estuaries.
American Eel	Larvae: Drift with Gulf Stream toward Atlantic Coast. Juveniles: Glass eels and elvers migrate to brackish waters; some remain in marine waters. Adults: Freshwater, coastal, and marine waters.
American Plaice	Eggs and Larvae: Open waters; depth maximum 328 feet (100 m). Juveniles and Adults: High concentrations around 328-feet (100-m) deep; prefer sand and gravel substrates.
American Shad	Juveniles: Nearshore open waters Adults: Open ocean.
Atlantic Bonito	All Life Stages: Open waters both nearshore and offshore.
Atlantic Butterfish	Eggs: Surface waters along the edge of the continental shelf to estuaries and bays. Larvae and Juveniles: Surface waters from continental shelf to bays. Adults: Surface waters from depths of 885 to 1,377 feet (270 to 420 m).
Atlantic Cod	Eggs: Bays, harbors, offshore banks; float near water surface. Larvae: Open ocean and continental shelf area.
Atlantic Halibut	Eggs: Offshore drift suspended in the water column. Larvae: Nearshore areas near the water surface.
Atlantic Mackerel	Eggs: Shoreward side of the continental shelf; 32 to 1,066.27 feet (10 to 325 m) deep. Larvae: Offshore waters and open bays; 32 to 426 feet (10 to 130 m) deep. Juveniles: Nearshore areas; 164 to 229 feet (50 to 70 m) deep. Adults: Offshore, 32 to 1,115 feet (10 to 340 m) deep.
Atlantic Menhaden	All Life Stages: Nearshore and offshore.
Atlantic sea herring	All Life Stages: High energy environments; gravel seafloors.
Atlantic silverside	Juveniles and Adults: Found at great depths offshore from late fall through early spring. In the summer, they are found along the shore, within a few feet of the shoreline along sandy or gravel shores.

Table 4.3-11. Common Habitat Types for Finfish Species known to occur in the Region

Species	Habitat Type by Lifestage
Basking Shark	All Life Stages: Coastal and offshore; sometimes enters inshore bays.
Bay anchovy	Eggs/Larvae: Eggs are found throughout the water column but tend to be concentrated near the surface. Larvae move upstream to lower salinity waters in the spring and then move to more saline waters in the fall. Juveniles and Adults: shallow and moderately deep offshore waters, nearshore waters off sand beaches, open bays, and muddy coves.
Black Sea Bass	Eggs: Coastal, upper water column. Larvae: Nearshore, mouths of estuaries, upper water column.
Blueback Herring	Adults: High energy environments; gravel seafloors.
Bluefin Tuna	All Life Stages: Nearshore and offshore.
Bluefish	Eggs: Across continental shelf; transported further offshore. Larvae: Near edge of continental shelf; associated with surface. Juveniles: Nearshore; associated with surface. Adults: Nearshore to offshore.
Blue Shark	All Life Stages: Nearshore and offshore, surface dwelling, concentrated near fishing activity.
Common Thresher Shark	Juveniles: Shallower waters over the continental shelf (less than 656 feet [200 m] deep) in areas of upwelling or mixing. Adults: Present near and offshore, but more common nearshore, in areas of upwelling or mixing.
Conger Eel	All Life Stages: Near the coast line to the edge of the continental shelf, 50 to 142 fathoms deep
Dusky Shark	All Life Stages: Near and offshore.
Haddock	Eggs: Near the surface of water column. Larvae: Depths of 32 to 164 feet (10 to 50 m) with a maximum depth of 492 feet (150 m).
Monkfish	Eggs: Surface waters in areas that have depths of 49 to 3,280 feet (15 to 1000 m). Larvae: Pelagic waters in areas that have depths of 49 to 3,280 feet (15 to 1000 m).
Northern sea robin	Eggs and Larvae: Pelagic waters of the continental shelf.
Pollock	Eggs and Larvae: Pelagic inshore and offshore habitats, including bays and estuaries.
Red Hake	Eggs: Water column within the inner shelf. Larvae: Coastal waters less than 656 feet (200 m) in depth.

Table 4.3-11. Common Habitat Types for Finfish Species known to occur in the Region

Species	Habitat Type by Lifestage
Sandbar Shark	All Life Stages: Waters on continental shelves, oceanic banks, and island terraces, but also found in harbors, estuaries, at the mouths of bays and rivers, and shallow turbid water. Mostly at 65 to 213 feet (20 to 65 m) deep. Also, benthic/demersal.
Shortfin Mako Shark	All Life Stages: Various areas of the water column; ranging depths, maximum depth 2,427 feet (740 m).
Skipjack Tuna	All Life Stages: Epipelagic, oceanic species.
Spiny dogfish	All Life Stages: Pelagic and epibenthic habitats.
Spot	All Life Stages: Coastal, nearshore, and offshore continental shelf areas.
Summer Flounder	Eggs and Larvae: Nearshore areas within eel grass beds and pilings.
Tiger Shark	All Life Stages: Coastal, nearshore, and offshore continental shelf areas.
Weakfish	All Life Stages: Nearshore, shallow waters along open sandy shores and estuaries.
White hake	Juveniles: Mixed and high salinity zones to a maximum depth of 984 feet (300 m). Pelagic phase juveniles remain in the water column for about 2 months.
White Shark	All Life Stages: Nearshore and offshore, mostly spotted near the surface.
Whiting	Eggs: Surface waters over continental shelf at depths of 164 to 492 feet (50 to 150 m). Larvae: Surface waters over the continental shelf at depths of 164 to 426 feet (50 to 130 m).
Windowpane Flounder	Eggs and Larvae: Occupy multiple areas in water column less than 229-foot (70-m) depths.
Winter Flounder	Larvae: Both nearshore and offshore.
Witch Flounder	Eggs: Deep; pelagic waters 164- to 278-foot (50- to 85-m) depths. Larvae: 0- to 820-foot (0- to 250-m) depths.
Yellowfin Tuna	All Life Stages: epipelagic, oceanic fish found in the upper 328 feet (100 m) of the water column.
Yellowtail Flounder	Eggs: Pelagic – near-surface continental shelf waters. Larvae: Pelagic – mid-water column; movement limited to currents.

Sources:

Auster and Stuart, 1986

Collette and Klein-MacPhee, 2002

Malek et al., 2016

Common Prey Species in the South Fork Wind Farm

Finfish species depend on a system of multiple trophic levels. Both demersal/benthic and pelagic fish species consume fish, shellfish, planktonic organisms, and detritus. Shellfish, worms, copepods, and other invertebrates are predominant types of prey for finfish in New England. The most common vertebrate finfish prey include alewife, Atlantic menhaden, northern sand lance, and whiting. Common prey of juvenile and adult finfish species that could potentially occur in the SFWF or SFEC are summarized in Table 4.3-12. Invertebrate and shellfish prey species and their relationships with habitat are described further in Section 4.3.2.

Table 4.3-12. Common Prey Species of Juvenile and Adult Finfish Species

Species	Prey Species
Demersal/Benthic	
Atlantic Cod	Benthic invertebrates
Atlantic Halibut	Whiting, sand lance, ocean pout, and alewife
Atlantic Sturgeon	Benthic invertebrates
Black Sea Bass	Invertebrates and zooplankton
Cunner	Pipefish, mummichog, and invertebrates
Haddock	Amphipods
Little Skate	Sand lance, alewife, herring, cunner, silversides, tomcod, and whiting
Monkfish	Sand lance and monkfish
Northern sea robin	Shrimp, crabs, amphipods, squid, bivalve mollusks, and segmented worms
Ocean Pout	Sand dollars
Pollock	Herring and crustacea
Red Hake	Crustaceans
Sand Lance	Plankton
Sand Tiger Shark	Small sharks, rays, squid, and lobster
Sandbar Shark	Menhaden and crustaceans
Scup	Fish eggs and invertebrates
Sea Raven	Herring, lance, sculpins, tautog, whiting, and both sculpin and sea-raven eggs
Smooth Dogfish	Crustaceans, particularly lobsters
Spiny Dogfish	Squid and fish
Striped Bass	Menhaden, anchovy, spot, amphipods, and sand lance

Table 4.3-12. Common Prey Species of Juvenile and Adult Finfish Species

Species	Prey Species
Summer Flounder	Windowpane, winter flounder, northern pipefish, Atlantic menhaden, bay anchovy, red hake, whiting, scup, Atlantic silverside, American sand lance, bluefish, weakfish, mummichog, rock crabs, squids, and shrimp
Tautog	Copepods and shellfish
Tilefish	Crabs, squid, shrimp, shelled mollusks, annelid worms, sea urchins, sea cucumbers, and sea anemones
White hake	Polychaetes, shrimp, and other crustaceans
Whiting	Crustaceans
Windowpane Flounder	Invertebrates
Winter Flounder	Clams
Winter Skate	Smaller skates, eels, alewife, blueback herring, menhaden, smelt, sand lance, chub mackerel, butterfish, cunner, sculpins, whiting, and tomcod.
Wolffish	Mollusks and shellfish
Yellowtail Flounder	Invertebrates
PELAGIC	
Albacore Tuna	Longfin and shortfin squid and crustaceans
Alewife	Herring, eels, sand lance, cunners, and alewife
American Eel	Small fish of many varieties, shrimp, crabs, lobsters, and smaller crustacea
American Plaice	Sand dollars
American Shad	Various fish
Atlantic Bonito	Mackerels, menhaden, and sand lance
Atlantic Butterfish	Small fish, squid, and crustaceans
Atlantic Mackerel	Copepods and crustaceans
Atlantic Menhaden	Diatoms and crustaceans
Atlantic sea herring	Copepods
Atlantic silverside	Zooplankton, copepods, shrimp, amphipods, young squid, worms, insects, and algae
Basking Shark	Small crustaceans
Bay anchovy	Mysid shrimp, copepods, small crustaceans and mollusks, and larval fish
Blueback Herring	Zooplankton

Table 4.3-12. Common Prey Species of Juvenile and Adult Finfish Species

Species	Prey Species
Bluefin Tuna	Herring and eels
Bluefish	Invertebrates and crustaceans
Blue Shark	Herring, mackerel, spiny dogfish, and various others
Common Thresher Shark	Pelagic fish and squid
Conger Eel	Butterfish, herring, eels, and invertebrates
Dusky Shark	Various pelagic fish
Sandbar Shark	Menhaden and crustaceans
Shortfin Mako Shark	Mackerels, tuna, and bonito
Skipjack Tuna	Pelagic fish and invertebrates
Spiny Dogfish	Squid and fish
Spot	Bristle worms, mollusks, crustaceans, and plant and animal detritus
Tiger Shark	Fish and squids
Weakfish	Crabs, amphipods, mysid and decapod shrimps, squid, shelled mollusks, and annelid worms, menhaden, butterfish, herring, scup, anchovies, silversides, and mummichog
White Shark	Fish, rays, squid, other sharks, and marine mammals
White hake	No documentation of prey species for pelagic phase.
Yellowfin Tuna	Large pelagic fish and squids

Sources:

Auster and Stuart, 1986
Collette and Klein-MacPhee, 2002
Florida Fish and Wildlife Conservation Commission, 2017
Florida Museum of Natural History, 2017
Knickel, 2017
NOAA, 2010
USFWS, 2017
URI EDC, 2017

Threatened and Endangered Fish

There are two sturgeon species that could potentially occur within the SFWF area, the Atlantic sturgeon and the shortnose sturgeon; however, as indicated below, the shortnose sturgeon is extremely unlikely to be present in the SFWF area.

Atlantic Sturgeon

The Atlantic sturgeon is listed as endangered under the ESA and is the more common sturgeon species in the SFWF area. Within the United States, five distinct population segments (DPSs) of Atlantic sturgeon are identified by NMFS. The population of concern associated with the SFWF is the New York Bight DPS. Atlantic sturgeon is a large anadromous species that utilize rivers, bays, estuaries, coastal, and continental shelf waters during their life cycle. They can grow up to 14 feet (4.3 m) long and 800 pounds (370 kilograms) (Vladykov and Greely, 1963). Declines in stock began with intensive fisheries for caviar in the late 1800s, and further declines are attributed to damming of spawning rivers and degradation of water quality (see review in Hilton et al., 2016).

Estimated the abundance of age 0-1 Atlantic sturgeon in the Delaware River in 2014 was 3,656 individuals (Hale et al., 2016), which is similar in magnitude to age-1 estimates in the Hudson River for 1995 (Petersen et al., 2000). The Atlantic Sturgeon stock assessment (ASMFC, 2017) indicate that the all DPS stocks are depleted but recovering. It is estimated that biomass and abundance are currently higher than in 1998 (last year of available survey data) for the New York Bight DPS (75% average probability).

Adult Atlantic sturgeon in the New York Bight DPS travel upstream in spawning rivers along southern New England (e.g., Connecticut River), New York (e.g., Hudson River), and in the Delaware River in the spring and early summer (ASMFC, 1990, 2017). Historically, Atlantic sturgeon also spawned in the Taunton River (Massachusetts), however, their current status in this river is unknown (ASMFC, 2017). During this period, most spawning age adults will be found in natal rivers.

Adult Atlantic sturgeon travel upstream in spawning rivers along southern New England (e.g., Connecticut River) and New York (e.g., Hudson River) in the spring and early summer (ASMFC, 1990). During this period, most spawning age adults will be found in natal rivers. Adult Atlantic sturgeon live in coastal and offshore waters during the remainder of the year. Juvenile and sub-adult Atlantic sturgeon undergo yearly coastal foraging migrations after leaving their natal estuaries (Hilton et al., 2016). Within the SFWF area, many juvenile and adult Atlantic sturgeon have been captured in otter trawls and sink gill nets (Stein et al., 2004). Through an aggregation of commercial bycatch data, Stein et al. (2004) found the greatest occurrence of offshore Atlantic sturgeon in Massachusetts and Rhode Island waters to occur from November through May. Data from this study indicate that adult Atlantic sturgeon are found within the SFWF area. See Appendix P1 for additional species information.

Sturgeon are believed to be low-frequency hearing specialists (Popper et al., 2014). ANSI-accredited hearing thresholds, derived from Popper et al. (2014), categorize sturgeon as a fish species that has a swim bladder, but the swim bladder is not thought to play a role in hearing. For this category of fish, peak sound pressure levels ($L_{P,\mathrm{PK}}$) greater than 207 dB re 1μPa^2 have the potential to cause injury.

Shortnose Sturgeon
Like the Atlantic sturgeon, the shortnose sturgeon is listed as endangered under the ESA and much of the distribution information is the same for the two species which co-occur in habitats along the Atlantic coast. In a 2010 Biological Assessment (Shortnose Sturgeon Status Review Team, 2010), shortnose sturgeon were described as spending less time in open ocean habitats and spawning farther upriver than Atlantic sturgeon. The Northeast shortnose sturgeon population uses freshwater habitat more than any of the other shortnose sturgeon populations (Kynard et al., 2016). They are considered more of an amphidromous species (defined as a species that spawns and remains in freshwater for most of its lifecycle but spends some time in saline water) rather than fully anadromous. Marine migrations do occur, and individuals have been recorded traveling 87 miles (140 km) in 6 days when moving between rivers (Kynard et al., 2016). Because the shortnose sturgeon prefer freshwater and estuarine habitats, the potential for shortnose sturgeon to be present in the SFWF area is considered extremely unlikely. See Appendix P1 for additional species information.

Giant Manta Ray

The giant manta ray (*Manta birostris*) is listed as threatened under the ESA. The giant manta ray occurs in tropical, sub-tropical, and temperate waters (IUCN, 2018, NOAA, 2018). Their distribution in the Atlantic ranges from the Carolinas to Brazil and they are very rarely found in colder waters of the northwest Atlantic. Giant manta rays may reach disc widths of over 7 m (reviewed by IUCN [2018]).

Commercial fishing is the primary threat to the giant manta ray (NOAA, 2018). The species is targeted and caught as bycatch in several global fisheries throughout its range. Additionally, they are slow-growing, highly migratory animals with sparsely distributed and fragmented populations throughout the world. Regional population sizes are small (between 100 to 1,500 individuals) (IUCN, 2018; NOAA, 2018).

Giant manta rays undergo seasonal migrations, timing their visits to productive coastlines with regular upwelling, oceanic island groups, and offshore pinnacles and seamounts. They are generally found at depths below 10 m, although tagging studies indicate dives of up to 200 to 450 m (NOAA, 2018). They are often observed in estuarine waters, near oceanic inlets, potentially using these habitats as nursery grounds. The giant manta ray is commonly encountered on shallow reefs and is also occasionally observed in sandy bottom areas and seagrass beds (IUCN, 2018). Mantas have been reported as far north as Canada in the northeast Atlantic; however, its propensity for warmer waters makes its presence is unlikely in the SFWF.

Essential Fish Habitat

EFH is an important part of the MSFCMA regulations and is defined as: "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 U.S.C. 1802(10)). Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities. Necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. Spawning, breeding, feeding, or growth to maturity covers a species' full life cycle. EFH is described by the regional fishery management councils in amendments to FMPs and is approved by the Secretary of Commerce acting through NOAA Fisheries" (50 CFR 600.10).

EFH has been designated for a total of 34 finfish species that occur within the SFWF. These species and their EFH are further described in the EFH Assessment (Appendix O).

South Fork Export Cable

SFEC – OCS and SFEC – NYS

This section describes finfish resources (demersal and pelagic) within and surrounding the areas of the SFEC - OCS and SFEC - NYS. The affected environment in the SFEC for finfish is generally the same as described for the SFWF. Some differences in resources occur at lower water depths nearshore as described in more detail in the following sections. Benthic resources, including shellfish and habitat types, are described in Section 4.3.2. A thorough EFH Assessment for designated species in the SFWF and SFEC is provided as Appendix O.

Species of economic or ecological importance potentially present within the region of the SFEC are summarized in Table 4.3-10. As described for the SFWF, this table does not include every species that has the potential to occur in the SFEC, but focuses on those that are abundant, commercially or recreationally important, important prey species, or have designated EFH within the area of the SFEC.

Demersal and pelagic species that are ecologically and economically important are described in more detail in relation to proposed SFEC activities in the following sections.

Demersal Finfish along the South Fork Export Cable Route

Table 4.3-10 summarizes ecologically or commercially important finfish with demersal life stages potentially present within the regional area that contains the proposed SFEC. The species with demersal life stages that may reside within the areas of the SFEC may also reside in the SFWF area (see previous SFWF section).

Some demersal fish are seasonal visitors to the SFEC area, which spans both federal and state waters. Most demersal species are abundant in the cold season nearshore and offshore extending along the continental shelf, which is associated with the eastern portions of the SFEC and decline in the region during the warmer months (Scotti et al., 2010). Two demersal species of anadromous fish are potentially present within the SFEC area: striped bass and Atlantic sturgeon (BOEM, 2013; Scotti et al., 2010).

Many finfish that have demersal life stages in Table 4.3-10 are considered commercially or recreationally important in New England and New York State waters. Fisheries in federal waters are managed under the MSFCMA. Portions of the SFEC route are within the boundaries of New York State waters. Fisheries in New York State waters are primarily managed by NYSDEC.

Black sea bass, bluefish, scup, and summer flounder are each individually managed under respective New York State Quota Distribution Programs. There is additional management for Atlantic cod, haddock, yellowtail flounder, American plaice, witch flounder, redfish, white hake, and pollock under the Groundfish Disaster Program (NYSDEC and NYSDOS, 2017). The Groundfish Disaster Program was put into effect because NYSDEC determined in 2013 that these fish stocks were headed towards collapse and needed to have drastic reductions to their fishing quotas. The Groundfish Disaster Program proposed protection to their habitats to continue to sustainably fish those species. Summer flounder and scup were the top two finfish species landed by pounds by commercial fishermen in New York State waters from the years 2008 to 2010 of all demersal species listed in Table 4.3-10 (Scotti et al., 2010). Species summarized in Table 4.3-10 as potentially occurring in the SFEC may be present within the areas of the SFEC and have a regional presence in New York State waters. More information about commercial and recreational fishing and their socioeconomics is described in Section 4.6.5.

Of the species that have demersal life stages listed in Table 4.3-10, 21 species have designated EFH in the SFEC. Additional information regarding EFH is described in Appendix O.

Pelagic Finfish along the South Fork Export Cable Route

Table 4.3-10 summarizes ecologically or commercially important finfish species with pelagic life stages that are potentially present within the regional area containing the proposed SFEC. Pelagic species are potentially abundant nearshore and offshore along the proposed SFEC route in the warm season, and decline during the cold season (Scotti et al., 2010).

There are five pelagic species of anadromous fish that are potentially present within the SFEC: American shad, alewife, blueback herring, Atlantic menhaden, and the Atlantic sea herring (BOEM, 2013; Scotti et al., 2010). Of the species with pelagic life stages potentially present in the SFEC, many are considered commercially or recreationally important within federal and New York State waters. The top two commercially fished finfish in 2010 in New York State waters by abundance were: Atlantic menhaden and American shad (Scotti et al., 2010). More detailed information regarding recreational and commercial important finfish species is described in Section 4.6.5. The following pelagic species listed in Table 4.3-10 are managed under the

Atlantic Highly Migratory Species FMP: blue shark, common thresher shark, shortfin mako shark, and yellowfin tuna (NOAA, 2004). Additionally, 29 species in Table 4.3-10 with pelagic life stages have designated EFH within the region of the SFEC area. For more information regarding designated EFH within the SFEC (Appendix O).

Common Habitat Types of South Fork Export Cable Species

Much of the habitat characteristics along the SFEC route are as described in the SFWF section. As described in Section 4.3.2, all three benthic habitats (sand sheets, sand with mobile gravel, and patchy cobbles and boulders on sand) were observed along the SFEC route; however, their distribution varied with distance from the SFWF and as the SFEC route nears land in New York State waters, where waters are shallower than 25 feet (7 m). The SFEC route was dominated by sand sheet habitats with a few exceptions where this habitat type was interspersed with other habitat types.

The SFEC - OCS in areas immediately adjacent to the SFWF were more heterogenous than the remainder of the SFEC, with patchy cobble and boulder on sand habitats observed within 18.6 to 24.9 miles (30 to 40 km) of the SFWF. Sand with mobile gravel habitats were observed along the SFEC - OCS route between the SFWF and for about half the distance along the SFEC - OCS to due south of Block Island. These habitats were also present in the section of the SFEC - NYS south of Montauk Point and near the Hither Hills landing point within New York State waters. Within New York State waters, sand sheets were the predominant benthic habitat type, with mobile gravel present at one station, and sediment grain size was largely homogeneous. Sediment grain size was moderately variable on small scales along the SFEC - OCS, but most of the variability was between grain size classes within the overall sand category. Deposits of very fine silt, on the order of 6 inches (15 cm) thick, were observed overlying sand at two locations offshore of the Beach Lane SFEC - NYS landing location; one of these locations fell within New York State waters (see Section 4.3.2 for more detail).

A summary of common habitat types for finfish species that may occur in the SFWF and SFEC is provided in Table 4.3-11.

Common Prey Species along the South Fork Export Cable Route

Common prey of juvenile and adult species that potentially occur within the SFEC route options are described in Table 4.3-12.

Threatened and Endangered Fish

There are two sturgeon species that could potentially occur within the SFEC area, the Atlantic sturgeon and the shortnose sturgeon; however, as indicated below, the shortnose sturgeon is extremely unlikely to be present in the SFEC area. The giant manta ray is not expected at the SFEC.

Atlantic Sturgeon

General information regarding the life history and conservation status of Atlantic sturgeon can be found in the SFWF section. While information is sparse regarding the offshore habitat use of Atlantic sturgeon, there has been more extensive research conducted in recent years on coastal and estuarine movements of the species. A trawl study conducted by Dunton et al. (2015) along the south coast of Long Island, New York found that Atlantic sturgeon use the coastal areas along the entire region, with most individuals caught at depths less than 49 feet (15 m) and in areas of previously known aggregations. Data analyzed within this study also indicated that adult and juvenile Atlantic sturgeon are found further offshore as seen in commercial otter trawl and sink gill net bycatch databases. Spring was identified as the time of year with the greatest bycatch rates along the eastern end of Long Island. Data from the Dunton et al. (2015) trawl survey and the Northeast Fisheries Observer Program bycatch database indicate that Atlantic sturgeon are present along the SFEC. See Appendix P1 for additional species information.

Shortnose Sturgeon
General information regarding the life history and conservation status of shortnose sturgeon can be found in the SFWF section. Because the shortnose sturgeon prefers freshwater and estuarine habitats, the potential for shortnose sturgeon to be present in the SFEC area is considered extremely unlikely. See Appendix P1 for additional species information.

Essential Fish Habitat

Waters within the SFEC route have been designated as EFH for a total of 37 finfish species that are further described in the EFH Assessment (Appendix O).

4.3.3.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the project have the potential to impact finfish species and EFH through both direct and indirect impacts, as discussed in the following sections. Neither the SFWF nor the SFEC is expected to have major long-term impacts to finfish or EFH resources during any of the project phases. An overview of the potential impacts to finfish and EFH associated with the Project is presented in Figure 4.3-10.

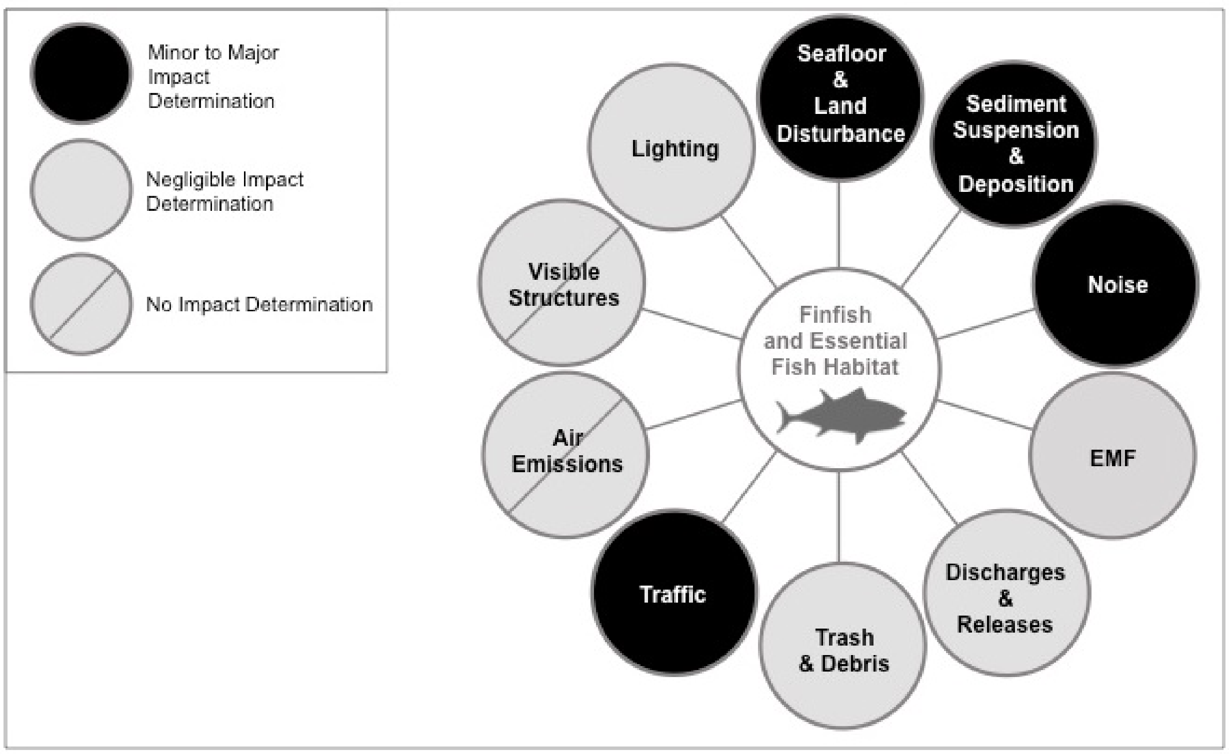

Figure 4.3-10. IPFs on Finfish and Essential Fish Habitat
Illustration of potential impacts to finfish and EFH resources resulting from SFWF and SFEC activities.

IPFs associated with the construction, O&M, and decommissioning phases for the Project are described in Section 4.1. The phase of the project during which these IPFs will occur is also described in Section 4.1.

South Fork Wind Farm

Construction

Table 4.3-13 summarizes the level of impacts expected to occur to finfish and EFH during the construction and decommissioning phases of the SFWF. Decommissioning of the SFWF is included in Table 4.3-13 because the structures are expected to be removed and their removal will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to finfish and EFH from the various IPFs during construction of the SFWF are described in the following sections.

Table 4.3-13. IPFs and Potential Levels of Impact on Finfish and EFH for the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/Demersal Early Life Stages[b]	Pelagic Early Life Stages[b]	Benthic/Demersal Later Life Stages[b]	Pelagic Later Life Stages[b]
Seafloor/Land Disturbance	Seafloor Preparation	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
	Pile Driving/Foundation Installation	Minor short-term direct	Negligible short-term direct	Minor short-term direct	Negligible short-term direct
	OSS platform installation	Minor short-term direct	Negligible short-term direct	Minor short-term direct	Negligible short-term direct
	SFWF Inter-array Cable installation	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible short-term indirect
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Negligible short-term direct Negligible long-term indirect	Negligible short-term direct Negligible short-term indirect

Table 4.3-13. IPFs and Potential Levels of Impact on Finfish and EFH for the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/Demersal Early Life Stages[b]	Pelagic Early Life Stages[b]	Benthic/Demersal Later Life Stages[b]	Pelagic Later Life Stages[b]
Noise	Pile Driving	Moderate short-term direct	Moderate short-term direct	Moderate short-term direct	Moderate short-term direct
	Ship Noise, Trenching Noise, Aircraft Noise	Minor short-term direct	Minor short-term direct	Minor short-term direct	Minor short-term direct
Traffic		See Seafloor disturbance, noise (ship, trenching, aircraft), sediment suspension and deposition, and lighting IPFs.			
Lighting		Negligible short-term direct	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct
Discharges and Releases [c]		Negligible			
Trash and Debris [c]		Negligible			

[a] Maximum level of impact is the highest impact levels for direct or indirect effects. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Early life stages include eggs and larvae. Later life stages include juveniles and adults.

[c] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

IPFs associated with seafloor disturbance during construction of the SFWF has been split into seafloor preparation, pile driving/foundation installation, OSS platform installation, SFWF Inter-array Cable installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce negligible to minor levels of direct and indirect impacts to species depending on the life stages present for each species. Other IPFs that are interrelated with seafloor disturbance such as pile driving noise and sediment suspension and deposition are discussed in subsequent sections. See Section 3.1.2.1 for the expected impact areas associated with the monopile foundation that will be used to support the WTGs and OSS and the impact area associated with the Inter-array Cable.

Of the species identified in Table 4.3-10 as possibly present at the SFWF, many have a completely pelagic life cycle, and many others have pelagic early life stages that are not dependent on benthic habitat. As such, modification or disturbance of the substrate is expected to have a ***negligible impact*** on the habitat or EFH of pelagic species, if present. There may be some impacts to finfish habitat and EFH of demersal/benthic species, including the federally endangered Atlantic sturgeon, resulting from the Project, but these are expected to be ***negligible to minor, localized, and short-term*** in nature.

Following completion of construction and during O&M of the SFWF, the substrates at the SFWF will fundamentally remain the same as pre-project conditions, and allow for the continued use by finfish species, including those with designated EFH. The exception is the conversion of soft substrate to hard substrate associated with the WTGs, scour protection, and protective armoring. As discussed in Section 4.3.2, benthic infauna and epifauna are expected to recolonize the area after sediment disturbance, allowing this area to continue to serve as foraging habitat for finfish species. The acreage range of benthic habitat that is expected to be affected by construction (Section 4.1) is small relative to the total area of available surrounding habitat and EFH and impacts to finfish habitat and EFH during O&M are expected to be ***minor and short-term to long-term***.

Seafloor Preparation

Seafloor preparation activities at the SFWF during construction include removal of obstructions and debris within a 100-foot radius of the WTG installation location and along the route of the Inter-array Cable. A PLGR will be used to clear debris from the area prior to laying the Inter-array Cable. In addition, boulder relocation may be required within the foundation work area for some of the foundations and within 49 feet (15 m) of each side of the Inter-array Cable centerline where boulders are present. Temporary seabed disturbance from boulder relocation related to preparation for foundation placement could be up to 14.8 acres (6 ha) and temporary seabed disturbance from boulder relocation related to Inter-array Cable installation could be up to 61.1 acres (24.7 ha).

Benthic/demersal early life stages of species that have suitable habitat at the SFWF are expected to experience ***minor, short-term, direct impacts*** from seafloor preparation and will most likely be subject to injury or mortality. While some mortality could occur to benthic/demersal early life stages, this impact is considered minor given the small area of impact in relation to the total area of surrounding habitat. Benthic/demersal later life stages, including Atlantic sturgeon, are expected to experience ***minor to negligible, short-term, direct impacts*** because older life stages are more mobile and more likely to leave the area during seafloor preparation. However, individuals of these species may also experience limited injury or mortality. These impacts are only expected for finfish species that have benthic/demersal life stages associated with sand sheets, sand with mobile gravel, or patchy cobble and boulder on sand habitats. Those that are associated with fine-grained sediments (silt and clay) are expected to have negligible impacts as these are not expected to occur or only occur occasionally in the area. Areas requiring boulder relocation will experience temporary disturbance to attached fauna and any species sheltering in the boulders or cobble will have to relocate to a nearby similar habitat. Relatively rapid (< 1 year) recolonization of these boulders is expected (Guarinello et al., 2017) and will return these boulders to their pre-project habitat function. Additionally, if relocation results in aggregation of boulders, these new features could serve as high value refuge habitat for juvenile lobster and fish as they may provide more complexity and opportunity for refuge than surrounding patchy habitat. See Table 4.3-11 for a summary of common habitat types for finfish species that may occur in the SFWF.

Pelagic early and later life stages are generally more mobile and reside higher in the water column, so direct impacts associated with seafloor preparation are expected to be ***negligible and short-term***. These species are expected to either temporarily vacate the area or may drift through the area with limited potential to be present in the direct impact area.

Finfish are expected to move back into the area following the disturbance, but, habitat recovery from the grapnel runs and seafloor leveling may take up to 1 to 3 years to occur, during which habitat quality for benthic/demersal species may be decreased, resulting in a ***minor, long-term, indirect impact*** for species that use those habitats (BERR, 2008; BOEM, 2012; Guarinello et al., 2017). Indirect impacts associated with feeding may also occur; however, this will be dependent upon species. Feeding by some species may be disrupted if they temporarily avoid the area; this will primarily affect benthic species but may also have some impact on pelagic species. Other species may be attracted to the disruption and prey on dislodged benthic species or other species injured or flushed during seafloor preparation. See Table 4.3-12 for common prey species for the identified ecologically and economically important finfish species. This is expected to be a short-term minor indirect impact. Potential presence of the various species and different life stages throughout the year are identified in Table 4.3-10.

Pile Driving/Foundation Installation

Similar to seafloor preparation, installation of the foundations, piles, and associated scour protection are expected to result in ***minor, short-term, direct impacts*** to benthic/demersal early life stages of finfish and ***minor to negligible, short-term, direct impacts*** to benthic/demersal later life stages, including Atlantic sturgeon, that have preferred habitat at the SFWF (Tables 4.3-10 and 4.3-11). Pile driving and foundation installation could crush benthic/demersal species, particularly eggs and larvae, but also less mobile older life stages that do not vacate the area. ***Negligible, short-term, direct impacts*** are expected for pelagic early and later life stages because they are not expected to be at the bottom during work activities or subject to crushing or injury through placement of the materials.

Offshore Substation Platform Installation

Impacts associated with the installation of the OSS platform are expected to be similar to those described for Seafloor Preparation and Pile Driving/Foundation Installation.

SFWF Inter-Array Cable Installation

Direct impacts to the seabed associated with installation of the SFWF Inter-array Cable will take place within the area that had already been disturbed during the PLGRs; those impacts were discussed in the Seafloor Preparation section. Installation of the Inter-array Cable is expected to result in ***minor to negligible, short-term, direct impacts*** to benthic/demersal early and later life stages.

It is also expected to produce ***negligible to minor, short-term, direct impacts*** to early life stages and later life stages of smaller species if using a jet plow because they may become impinged or entrained on the water pumps that will operate the jet plow. Although the circulated seawater is released back into the ocean, it is assumed that all entrained eggs, larvae, and zooplankton will be killed. To assess the potential loss of fish and zooplankton related to this activity, an ichthyoplankton and zooplankton assessment was conducted using data from NOAA's Marine Resource Monitoring, Assessment and Prediction Program and their subsequent Ecosystem Monitoring (EcoMon) plankton sampling programs (Appendix O, Attachment 1). The results indicate that total estimated losses of zooplankton and ichthyoplankton related to entrainment from installation of the Inter-array Cable using a jet plow were less than 0.001 percent of the total zooplankton and ichthyoplankton abundance present in the study region (Appendix O, Attachment 1). Therefore, impacts to early life stages of EFH species from entrainment caused by installation of the Inter-array Cable using a jet plow are expected to be ***negligible to minor and short-term***.

Because of the slow speed of the equipment and limited size of the impact area, it is expected that most mobile benthic/demersal and pelagic finfish will leave the area; however, eggs, larvae, and other slower moving species may be subject to injury or mortality. The Inter-array Cable may also require armoring, and the installation of this armoring is expected to result in ***minor, short-term, direct impacts***.

Similar to seafloor preparation, ***minor, long-term and short-term, indirect impacts*** for benthic/demersal species may include a longer period for prey species to recolonize the impact area resulting in reduced foraging habitat for finfish. ***Minor, short-term, direct impacts*** including a temporary feeding disruption during cable installation may occur; however, some species may also be attracted to the disturbance and increase feeding as Inter-array Cable installation may dislodge benthic prey species.

Vessel Anchoring (Including Spuds)
Impacts associated with vessel anchoring and the use of spuds during construction at the SFWF are expected to be similar to those discussed in the Seafloor Preparation and Pile Driving/ Foundation Installation section. Direct impacts are expected to be ***minor and short-term*** and associated with mortality and or injury of benthic/demersal early life stage species and benthic/demersal later life stage species with limited mobility. Faster moving benthic/demersal species, including Atlantic Sturgeon, and pelagic species are expected to temporarily vacate the impact area associated with the spuds, anchor, or area swept by the anchor chain. The extent of the impacts will vary depending on the vessel type, number of vessels, and duration onsite, and as these numbers increase, the associated impact areas will also increase. ***Long-term, indirect impacts*** will be associated with habitat disturbance and associated recovery time from the areas impacted by the vessel anchors, spuds, and areas swept by anchor chains.

Sediment Suspension and Deposition
Increases in sediment suspension and deposition during construction can result from seafloor disturbance associated with foundation placement and Inter-array Cable installation as well as vessel traffic. Direct impacts associated with increased sediment suspension and deposition are expected to be ***negligible or minor and short-term in nature***. Indirect impacts associated with increased suspended sediment and deposition include changes in habitat and species composition after sediments have settled out. These impacts are expected to result in ***negligible to minor long-term, indirect impacts*** for benthic early and later life stages and ***negligible, short-term indirect impacts*** for pelagic early and later life stages as described in more detail below. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For cable installation activities, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from jet plow installation of the Inter-array Cable, one of three potential types of equipment to be used for cable installation (Appendix I).

Temporary Increase in Total Suspended Solids
In order to estimate the extent of potential impacts from sediment suspension generated by jet plow installation, one of three potential types of equipment to be used for cable installation, a modeling simulation was conducted on a representative section of the Inter-array Cable which indicated that the maximum modeled TSS concentration from SFWF Inter-array Cable installation using a jet plow is 100 mg/L. Water column concentrations of 100 mg/L are predicted to extend up to 131 feet (40 m) from the jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) within 18 minutes (0.3 hour) from the conclusion of jet plow trenching. Modeling also indicates that elevated TSS concentrations are expected to remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the jet plow at any time during the simulation (Appendix I).

Increases in sediment suspension could result in impacts to finfish including abrasion of gill membranes and respiration impairment, impairment of feeding, inhibition of migratory movements, and mortality of early life stages. Juvenile and adult life stages will likely temporarily avoid the area of increased TSS, resulting in behavioral changes such as changes in foraging behavior. However, given the limited extent and duration of the elevated TSS based on the predictive modeling described above, these impacts are expected to be ***negligible to minor*** to benthic/demersal species because they will be ***short-term*** and highly localized. Most marine species have some degree of tolerance to higher concentrations of suspended sediment because storms, currents, and other natural processes regularly result in increases in turbidity (DOI-MMS, 2009). Direct impacts to pelagic species are expected to be ***negligible*** as older life stages will likely leave the area and not be affected by increased suspended sediment and early life stages are expected to have tolerance for short-term increases in suspended sediment.

Sediments are expected to come out of suspension quickly after the impact occurs, returning pelagic habitat to pre-impact conditions in a short-time frame, resulting in a ***negligible, short-term, indirect impact*** for pelagic early and later life stages. Indirect impacts to benthic/demersal species from a potential change in habitat composition are described in the Sediment Deposition section below.

Sediment Deposition

A modeling simulation was also conducted on a representative section of the Inter-array Cable to predict sediment deposition extent and depth resulting from installation of the Inter-array Cable using a jet plow, one of three potential types of equipment to be used for cable installation. The model predicted that sediment deposition resulting from the installation of the Inter-array Cable using a jet plow will be limited to the area immediately adjacent to the burial route, typically, extending no more than 196 feet (60 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.4 inch (10 mm) and limited to within 26 feet (8 m) from the burial route, covering an estimated cumulative area of 0.1 acre (0.04 ha) (Appendix I). Direct sediment deposition impacts to finfish are considered to be ***short-term, localized,*** and ***minor*** because of the limited extent of sedimentation predicted by the model.

In the localized area of impact, these direct impacts could involve mortality through sediment deposition and smothering of early benthic/demersal life stages of finfish and limited injury or mortality of later benthic/demersal life stages. Sediment deposition on eggs or larvae may result in smothering, potentially resulting in mortality (DOI-MMS, 2007). However, most older stages of finfish, including Atlantic sturgeon, are expected to temporarily vacate the area to avoid the increased sedimentation.

Indirect impacts associated with increased sediment deposition include potential changes in habitat composition and species composition after sediments have settled out. This change is similar to what is described in the Seafloor Disturbance section above because habitat quality may be temporarily degraded, and recolonization may take 1 to 3 years, depending upon the extent of the effects (BOEM, 2012). Given the localized extent of sediment deposition predicted by the model, the resulting impacts on benthic communities and habitat quality are expected to be ***negligible to minor*** and ***long-term*** for benthic early and later life stages. Sediment deposition is expected to result in ***no impact*** to pelagic early of later life stages.

Noise

Underwater acoustic modeling was conducted to evaluate various project-related construction sounds including impulsive sounds (pile driving noise) and non-impulsive or continuous sounds (vibratory pile driving, thrusters on DPV). Based on the acoustic modeling, an impact assessment specific to marine protected species was performed (Appendix P) including an evaluation of potential impacts on ESA-listed Atlantic sturgeon. However, the results of these analyses are broadly applicable to fish and are discussed within the context of noise impacts in this section.

Direct impacts associated with noise during construction at the SFWF may occur during pile driving and DPV usage for installation of the Inter-array Cable or associated with vessels and aircraft. Pile driving is expected to cause ***minor to moderate, short-term, direct impacts***, while the other sources of noise are expected to have ***negligible impacts***. Expected impacts from these activities are discussed separately in the following sections.

Hearing among fish vary among species and auditory physiology. Fishes hear sounds using pressure and particle motion and detect the motion of surrounding water (Popper et al., 2008). Fish with swim bladders are generally sensitive to pressure waves, while those that lack swim bladders are more sensitive to particle motion. Generally pelagic species have swim bladders, while benthic/demersal species like halibut, flounders, and soles do not have swim bladders. In addition, different fish species vary greatly in their hearing structures and auditory capabilities, and this may change during different life stages. There is a lack of knowledge about hearing capabilities of most fish species. This applies to sturgeon, which are known to have primitive swim bladders that are not connected to their inner ears. Anatomical and physiological variation makes it difficult to generalize about the impacts of noise on individual species (Thomsen et al., 2006).

The short duration of potential impacts of noise during the construction, operation, and decommissioning of wind farms can be split into the following general categories (Thomsen et al., 2006):

1. Temporary or permanent hearing damage or other physical injury or mortality;
2. Behavioral responses; for example, the triggering of alarm reactions, causing fish to flee from interrupting activities necessary for survival and reproduction, and potentially inducing stress in the fish; or
3. Masking acoustic signals, which may serve as communication among individuals, or may provide information about predators or prey.

There is only limited data on mortality in response to anthropogenic noises and it is not clear whether death or injury only occurs in close proximity to a sound source (Hawkins et al., 2014). Overall, it is more likely that fish will experience sublethal impacts that increase the possibility for delayed mortality (Hawkins et al., 2014). Because most construction sound sources produce low frequency sounds that are within the sensitive hearing range of most fish, the potential for fish to experience temporary threshold shifts (TTS), masking, and behavioral impacts are a higher likelihood.

Behavioral responses (e.g., fleeing or avoidance) to active acoustic sound sources are the most likely direct effects for most fish resources exposed to noise during SFWF construction. Fewtrell and McCauley (2012) found that fish exhibited alarm responses to air gun noise at levels exceeding 147 to 151 dB re 1 micropascal (μP) sound exposure limit (SEL). The potential for masking or behavioral response may exist at a large and variable distance from a sound source, depending on the ambient background noise level and the frequency and amplitude characteristics of the propagated sound.

Pile Driving Noise

Noise generated by pile driving (both impulsive and non-impulsive) has the potential for direct impacts on finfish species, particularly those with swim bladders. While noise generated by both types has the potential to elicit behavioral responses, pile driving has the greatest potential to cause harassment or injury through the generation of intense underwater sound pressure waves and particle motion. For instance, in-water pile driving for bridge construction has resulted in high underwater sound pressures that have proved lethal to fishes, and sturgeon in particular

(Thalheimer et al., 2014, Popper et al., 2016). Noise generated from pile-driving (vibratory and impact hammering) and vessel operations could affect finfish. Laboratory pile driving studies showed swim bladder damage in Chinook salmon and documented barotrauma injuries in other species (Halvorsen et al., 2012).

Direct impacts associated with these intense sound pressure waves and particle motion may include changes in fish behavior and injury or mortality caused by rupturing swim bladders or by internal hemorrhaging. Noise from pile driving can also cause fish to be temporarily stunned, which might make them more susceptible to predation. These noise-generating activities also have the potential to interrupt migration patterns of finfish through the area because they may avoid elevated noise levels. Impacts associated with pile driving noise are expected to be ***short-term and moderate*** with finfish returning to the area after the noise-generating activity has been completed as described in more detail below.

Two accepted sources for defining acoustic impact metrics and thresholds for fish were incorporated into the sound propagation analysis (Appendix J) supporting this COP. A technical report by an American National Standards Institute (ANSI)-registered committee (Popper et al. 2014) reviewed available data and suggested metrics and methods for estimating acoustic impacts for fish and sea turtles. The NOAA Greater Atlantic Regional Fisheries Office (GARFO; 2016) developed a pile driving acoustic tool, which compiled and listed criteria for fish injury from noise including metrics for the potential for injury to fish exposed to pile driving sounds (Stadler and Woodbury 2009). Both of these sources of acoustic metrics and thresholds address injurious noise levels from impulsive sounds but do not completely agree. They also offer different guidance on fish impacts from non-impulsive sounds and behavior impact thresholds from impulsive sounds. Both sources were included based on agency consultations during the development of this COP.

The Popper et al. (2014) report suggests the dual criteria of peak pressure and accumulated sound energy for evaluating potential injury. These acoustic criteria for fish injury from impulsive and non-impulsive sounds are provided in Table 4.3-14. The modeling presented in Appendix J provides the ranges (in meters) to potential injury and temporary threshold shifts for fish groups based on Popper et al. (2014). Appendix J also provides the results of the modeling against the GARFO (2016) criteria for both potential injury *and* behavioral impacts, as presented in Table 4.3-15 and discussed below.

Table 4.3-14. Acoustic Criteria and Thresholds for Injury for Fish

Group	Impulsive Sounds					Non-Impulsive Sounds	
	Mortality or Mortal Injury		*Recoverable Injury*		*TTS*	*Recoverable Injury*	*TTS*
	L_E (dB)	L_{pk} (dB)	L_E (dB)	L_{pk} (dB)	L_E (dB)	$L_{pk, 48h}$ (dB)	$L_{pk, 12h}$ (dB)
Fish without swim bladder	>219	> 213	>216	> 213	>186	--	--
Fish with swim bladder not involved in hearing	210	> 207	203	> 207	>186	--	--
Fish with swim bladder involved in hearing	207	> 207	203	> 207	186	170	158

Source: Popper et al., 2014

L_E = sound exposure level (dB re 1 µPa^2·s); L_{pk} = peak sound pressure (dB re 1 µPa); $L_{p,12h}$ = root mean square sound pressure (dB re 1 µPa) for 12 hours continuous exposure; $L_{p, 48h}$ rms sound pressure (dB re 1 µPa) for 48 hours continuous exposure TTS = temporary threshold shift.

-- = not applicable

Peak levels are the sound levels in dB associated with a single pile strike - defined as the level assessed to cause injury with one strike. Cumulative levels are the total energy received through a pile driving event (generally the energy received over an entire day of pile driving). Of the two sets of criteria considered, the GARFO (2016) metrics are considered more conservative because the acoustic levels are lower than that those included in Popper et al. (2014). If fish are exposed to cumulative (over 12 hours) SEL at or above 187 dB or peak sound pressure at or above 206 dB, they may be injured, killed, or experience a permanent threshold shift (PTS) or TTS, which means that fish lose all or part of their hearing range on a permanent or temporary basis. Popper et al. (2005) found the effects from even substantial TTS to have worn off for fish within 18 hours of exposure. However, hearing loss, even if temporary, could render the fish unable to respond to environmental sounds that indicate the presence of predators or that allow the location of prey or potential mates (Popper and Hastings, 2009).

The acoustic metrics and thresholds for fish published by GARFO (2016) are presented in Table 4.3-15. It is highlighted that criteria for behavioral impacts to fish are included here while they are not in the Popper et al. (2014) metrics, which is an indicator of the ongoing scientific and policy uncertainty pertaining to this issue. According to GARFO (2016), behavioral responses to the construction noise are expected to occur where noise levels exceed the L_p 150 dB re 1 µPa and could affect fish reproduction and population levels if biologically important activities such as migration, feeding, and spawning are interrupted (Thomsen et al., 2006). While studies have generally found that effects on fish decrease the further from the source of the sound, this effect is not straightforward. In some cases, sound levels may be higher at greater distances from the source from propagation through the seabed and sound reflections from objects (Hastings and Popper, 2005).

Table 4.3-15. Acoustic metrics and thresholds for fish (from Stadler and Woodbury (2009) and GARFO (2016)

Fish group	Injury			Behavior
	$L_{E,12h}$ (dB re 1 µPa²·s)	L_{pk} (dB re 1 µPa)	L_p (dB re1 µPa)	L_p (dB re 1 µPa)
Fish	187 [a]	206 [a]	--	150 [b]

Thresholds for fish are for individuals with a total mass of ≥ 2 g

L_{pk} = peak sound pressure; L_p = root mean square of the sound pressure; $L_{E,12hr}$ = cumulative sound exposure level over 12 hours

-- = not applicable

a = Stadler and Woodbury (2009)

b = GARFO (2016)

Elevated noise levels are expected to cause some fish species to temporarily vacate the area, causing a temporary disruption in feeding, mating, and other essential activities. Less mobile species and benthic early life stages are expected to be more susceptible to noise effects than more mobile species as they will not be able to leave the area as quickly (Gill and Kimber, 2005). Atlantic sturgeon, the only endangered finfish species found within the SFWF, have been shown to avoid pile-driving activities in the Hudson River, and based on this, they were not expected to be exposed to the cumulative SEL (Krebs et al., 2016). The same avoidance response is expected if they should be present during pile driving activities at the SFWF because this species is highly mobile.

Fish species also make a variety of sounds, many of which are used for mating or communication purposes, and sounds associated with construction of the SFWF may mask these sounds. As the sounds associated with pile driving may be audible over great distances, the masking of these fish sounds may have implications on mating and other behaviors (Thomsen et al., 2006). This potential for disruption may be influenced by the type of noises that fish make. Species that communicate using only a single sound may experience negligible impacts because pile driving pulses are very short in duration, while species with complex communications may experience more disruption (Thomsen et al., 2006). This masking effect may be magnified if pile driving is occurring at multiple locations at the same time.

Little is known about particle motion effects on finfish, and unlike sound pressure waves, no criteria to assess effects associated with particle motion have been established. It is expected that particle motion associated with pile driving will have similar effects as pressure waves with fish exhibiting behavioral responses such as temporarily vacating the impact area. Excess particle motion may also mask communication and could cause permanent or temporary damage to sensory structures.

Cable Installation Equipment, Vessel, and Aircraft Noise

Sounds created by cable installation equipment, vessels, or aircraft are continuous or nonimpulsive sounds, which have different characteristics underwater and impacts on marine life. Limited research has been conducted on underwater noise from cable installation equipment. Generally, the noise from this equipment is expected to be masked by louder sounds from vessels, especially DP vessels. Also, as most noise generated by these pieces of equipment will be below the sediment surface, noise levels are not expected to result in injury or mortality to finfish but may cause finfish to temporarily vacate the area. The duration of noise at a given location will be short, as the cable lay advance speed is expected to be approximately between 1 mile (1.6 km, 0.86 nm) and 2 miles (3.2 km, 1.73 nm) per day. Noise will occur over a very short period at any given location along the Inter-array Cable route. ***Minor, short-term, direct impacts*** are expected from cable installation equipment noise.

Helicopters will be used to a limited extent for emergency transport and/or limited maintenance activities between the WTGs and shore after an offshore landing pad has been constructed. Underwater noise associated with helicopters is generally brief as compared with the duration of audibility in the air (Richardson et al., 1995). Because of this, ***direct impacts*** to finfish are expected to be ***short-term and negligible***.

Vessel noise may also cause finfish to temporarily vacate the area. However, vessel noise is widely regarded as the predominant anthropogenic noise in the ocean. Research indicates that the direct effects of vessel noise will not cause mortality or body tissue injuries in adult fish (Hawkins et al., 2014). Vessel sound source levels have been shown to cause several different effects in behavior, TTS, auditory masking, and blood chemistry. The most common behavioral responses are avoidance, alteration of swimming speed and direction, and alteration of schooling behavior (Vabø et al., 2002; Handegard and Tjøstheim, 2005; Sarà et al., 2007; Becker et al., 2013). Laboratory and field studies have demonstrated several other behaviors that are influenced by vessel noise. For example, several studies have noted changes in time spent burrowing or using refuge, time spent defending or tending to nests and eggs (Picciulin et al., 2010; Bruintjes and Radford, 2013), intraspecific aggression and territoriality interactions (Sebastianutto et al., 2011; Bruintjes and Radford, 2013), foraging behavior (Purser and Radford, 2011; Bracciali et al., 2012; Voellmy et al., 2014a, 2014b), vocalization patterns (Picciulin et al., 2008, 2012), and overall frequency of movement (Buscaino et al., 2009). These studies also demonstrated that the behavioral changes generally were temporary or that fish habituated to the noises. Some studies noted changes in the blood chemistry of several fish species (e.g., European sea bass, gilthead seabream, red drum, spotted sea trout) in response to vessel noise (Buscaino et al., 2009; Spiga et al., 2012).

Auditory masking and TTS in fish exposed to vessel noise has been demonstrated in a few studies. Auditory thresholds have been shown to increase by as much as 40 dB when fish are exposed to vessel noise playbacks (Wysocki and Ladich, 2005; Vasconcelos et al., 2007; Codarin et al., 2009). The degree of auditory masking or TTS generally depends on the hearing sensitivity of the fish, the frequency, and the noise levels tested (Wysocki and Ladich, 2005). The impact of auditory masking and TTS indicate that vessel noise can lower the ability of fish to detect biologically relevant sounds. However, the effects were found to be temporary and hearing abilities returned to normal. Finfish in the vicinity of SFWF construction vessels may be impacted by vessel noise but the duration of noise at a given location will be short and will occur over a very short period at any given location in the SFWF area or between ports and the SFWF. Therefore, ***minor, short-term direct*** impacts to finfish are expected because of most construction vessel noise.

The dominant vessel noise of concern for fish during SFWF construction will emit from the thrusters on the DPV during Inter-array Cable installation. A DPV will be utilized during both SFWF Inter-array Cable and SFEC lay activities. Popper et al., 2014 published guidance for acoustic thresholds from non-impulsive sounds for injury to fish but there are no adopted acoustic thresholds from non-impulsive sounds for behavioral impacts to fish. Recoverable injury and TTS may occur where peak noise levels exceed 170 and 158 dB respectively. The zone of acoustic influence for injury would be concentrated right at the DPV itself. Fish within this ensonified area over the brief duration of DPV use may experience noise that may temporarily alter their behavior. However, impacts of this magnitude are expected to be ***short-term*** and ***minor.***

Traffic
Impacts associated with vessel traffic during SFWF construction are identified under the Seafloor Disturbance, Noise, Sediment Suspension and Deposition, and Lighting sections.

Lighting
Artificial lighting during construction at the SFWF will be associated with navigational and deck lighting on vessels from dusk to dawn. Reaction of finfish to this artificial light is highly species-dependent and may include attraction and/or avoidance of an area.

Artificial lighting may disrupt the diel vertical migration patterns of fish and this may affect species richness and community composition (Nightingale et al., 2006; Phipps, 2001). It could also increase the risk of predation and disruption of predator/prey interactions and result in the loss of opportunity for dark-adapted behaviors including foraging and migration (Orr et al., 2013). Because of the limited area associated with the artificial lighting used on project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible and short-term*** for benthic early life stages and ***negligible or minor*** for benthic later life stages and pelagic early and later life stages during construction.

Trash and Debris
The release of trash and debris into offshore waters potentially may occur from any on-water activities. Certain types of trash and debris could be accidentally lost overboard during construction, with subsequent effects to finfish. In compliance with existing federal regulations, the amount of trash and debris dumped offshore would be minimal as only accidental loss of trash and debris is anticipated, some of which could sink to the seafloor. Affected fish species

were not fully assessed in the NOAA marine debris summary (2014) but are known to be greatly impacted by derelict fishing gear and are likely affected similarly by other marine debris. It is likely that ingestion and entanglement impacts are not fully realized because of the inaccessibility of affected fish.

Vessel operators, crew, and personnel present on offshore structures are required to comply with the requirements of federal regulations regarding safe disposal of trash and debris. In addition, USCG and EPA regulations require operators to develop waste management plans, post informational placards, manifest trash sent to shore, and use special precautions such as covering outside trash bins to prevent accidental loss of solid materials. Also, BOEM lease stipulations require adherence to Notice to Lessee (NTL) 2015-G03, which instructs operators to exercise caution in the handling and disposal of small items and packaging materials, requires the posting of placards at prominent locations on offshore vessels and structures, and mandates a yearly marine trash and debris awareness training and certification process. The SFWF's compliance with laws and regulations as well as BSEE NTL 2015-G03 will avoid or reduce the potential for impacts from trash and debris on the environment.

Therefore, taking into account the USCG and EPA regulations as well as BOEM guidance, trash and debris from construction and operational activities will not be released into the marine environment. Debris would consist only of isolated items that were accidentally lost overboard. In addition, sturgeon are very sparsely distributed in the SFWF and SFEC areas; therefore, debris ingestion and entanglement impacts on finfish are expected to be ***negligible***.

Operations and Maintenance

Table 4.3-16 summarizes the level of impacts expected to occur to finfish and EFH during the O&M phases of the SFWF. Minor impacts and long-term impacts during O&M are largely associated with the presence of the SFWF. Additional details on potential impacts to finfish and EFH from the various IPFs during O&M are described in the following sections.

Table 4.3-16. IPFs and Potential Levels of Impact on Finfish and EFH for the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact[a]			
		Benthic/Demersal Early Life Stages[b]	Pelagic Early Life Stages [b]	Benthic/Demersal Later Life Stages[b]	Pelagic Later Life Stages [b]
Seafloor Disturbance	Foundation	Minor long-term indirect	Minor long-term indirect	Minor long-term indirect	Minor long-term indirect
	OSS platform	Minor long-term indirect	Minor long-term indirect	Minor long-term indirect	Minor long-term indirect
	SFWF Inter-array Cable	Minor short-term direct Minor long-term indirect	Negligible short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Minor long-term indirect

Table 4.3-16. IPFs and Potential Levels of Impact on Finfish and EFH for the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact[a]			
		Benthic/Demersal Early Life Stages[b]	Pelagic Early Life Stages [b]	Benthic/Demersal Later Life Stages[b]	Pelagic Later Life Stages [b]
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Negligible short-term direct Negligible long-term indirect	Negligible short-term direct Negligible short-term indirect
Noise	Ship Noise and Aircraft Noise,	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct
	WTG Operational Noise	Negligible long-term direct	Negligible long-term direct	Negligible long-term direct	Negligible long-term direct
Electromagnetic Field		Negligible	Negligible	Negligible	Negligible
Traffic		See Seafloor disturbance, noise, sediment suspension and deposition, and lighting IPFs.			
Lighting		Negligible long-term direct	Negligible long-term direct	Negligible long-term direct	Negligible long-term direct
Discharges and Releases [c]		Negligible			
Trash and Debris [c]		Negligible			

[a] Maximum level of impact is the highest impact levels for direct or indirect effects. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Early life stages include eggs and larvae. Later life stages include juveniles and adults.

[c] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Impact producing factors associated with seafloor disturbance during O&M of the SFWF have been split into foundation, OSS platform, SFWF Inter-array Cable, and vessel anchoring (including spuds). See Section 3.1.2.1 for the expected impact areas associated with the monopile foundation that will be used to support the WTGs and OSS and the impact area associated with the Inter-array Cable.

Foundations

The presence of the foundations and associated scour protection is expected to result in ***minor, long-term indirect impacts*** to finfish because of the conversion of existing sand or sand with mobile gravel habitat to hard bottom. This is expected for all life stages of benthic/demersal and pelagic finfish species that are associated with these habitats. This conversion to hard bottom habitat may trigger an effect known as a "reef effect" which could result in both ***minor impacts*** for some species but could also benefit some species. Species such as Atlantic halibut, haddock, monkfish, smooth and spiny dogfish, and windowpane flounder that spawn or lay eggs on, occur on, or feed on species that are present in soft bottom habitat or sand with mobile gravel habitat are expected to have a ***minor impact*** as available habitat in the area will decrease. Those species such as Atlantic cod, black sea bass, red hake, scup, tautog, and wolf fish that prefer harder bottom habitat are expected to ***benefit*** from this activity. For further information on common habitat types by species, see Table 4.3-11. However, this effect is expected to be small based on the expected size of habitat conversion at each WTG relative to the available sand and sand with mobile gravel habitat.

Habitat conversion is expected to cause a ***long-term, minor, indirect impact*** resulting in a shift in species assemblages towards those found in rocky reef/rock outcrop habitat; this is known as the "reef effect" (Wilhelmsson et al., 2006; Reubens et al., 2013). This effect is also well known from other anthropogenic structures in the sea, such as oil platforms, artificial reefs piers, and shipwrecks (Claudet and Pelletier, 2004; Wilhelmsson et al., 2006; Seaman, 2007; Langhamer and Wilhelmsson, 2009). The impact is expected to be minor because both soft and hard bottom habitats are already present in and around the SFWF. Data collected as part of the G&G survey at the SFWF (Appendix H) indicate that sand sheet habitat is not a limiting habitat in the region, and that numerous hard bottom boulder habitats are also present within the area. As a result, the conversion of a small area of sand sheet habitat to hard bottom habitat is unlikely to result in perceptible changes to the benthic community outside of the immediate area impacted.

Species composition and abundance of finfish is expected to be influenced by the foundation for the WTGs and OSS. Wind farms with steel monopile foundations showed a species-dependent effect with some species having higher abundance and some having lower abundance post wind farm installation. At the Horns Rev wind farm, 7 years after construction fish densities decreased at both the wind farm and control sites, indicating inter-annual variation in fish populations more strongly influenced abundances than any attraction effect of the wind farm (Leonhard et al., 2011). This study also revealed that fish aggregated around the wind farm during daylight hours, then migrated to deeper water at night. Fish species diversity was also found to be higher close to the turbines and this diversity was primarily driven by species that prefer hard bottom (Leonhard et al., 2011; Stenberg et al., 2015).

At the offshore wind farm Egmond aan Zee, a tagging study of sole (*Solea vulgaris*) and cod revealed that sole were neither attracted to nor avoided the wind farm turbines (Winter et al., 2010). All sampled cod were juveniles and they were strongly attracted to the monopiles, but individual behavior varied greatly, with some using spatial scales larger than the wind farm, while others stayed within the wind farm for months, moving among the WTGs. In addition, sole, whiting (*Merlangius merlangus*), and striped red mullet (*Mullus surmuletus*) abundances increased and lesser weever (*Echiichthys vipera*) abundances decreased within the wind farm when compared to baseline sampling. Cod were observed on the scour protection rocks 2 years after construction.

Overall, increases in abundance of certain finfish have been observed around WTG foundations at most wind farms that were built in soft-bottom habitat (Bergström et al., 2014). Similar offshore structures like oil and gas platforms have been found to exhibit a reef effect with increased abundance of larval and juvenile fish. This increased abundance may be because the structures extend throughout the water column, making it more likely that juvenile or larval fish encounter and settle on them (RI CRMC, 2010). There may also be less predation on small fish in midwater habitats, so they can safely hide in the vicinity of the structure at a variety of depths (Love et al., 2003). In addition, at these structures, fish can take advantage of the shelter provided while also being exposed to stronger currents created by the structures, which generate increased feeding opportunities and decreased potential for predation (Wilhelmsson et al., 2006). A similar effect is expected for the WTGs. Overall, any adverse or beneficial direct impacts associated with the steel monopile foundations and scour protection will be limited to the immediate vicinity of the individual WTG or foundation, while the vast majority of the SFWF area will not be impacted. In addition, the existing sand and sand with mobile gravel habitat is not expected to be a limiting factor for finfish in the area. Any "reef effect" observed will be limited to the immediate vicinity of that structure and will not cover the entire area where the SFWF is located.

SFWF Inter-Array Cable

Benthic life stages are expected to experience ***minor, short-term, direct impacts*** and pelagic life stages are expected to experience ***negligible, short-term, direct impacts*** if the Inter-array Cable requires maintenance that will expose it. Maintenance of the Inter-array Cable is considered a nonroutine event and is not expected to occur with any regularity. Impacts associated with exposing the Inter-array Cable are expected to be similar but less frequent to those described for the construction/installation phase. The presence of the Inter-array Cable is expected to have ***negligible impacts*** to finfish because the cable will be buried beneath the seabed. However, some areas of the Inter-array Cable may require armoring which may result in ***minor, long-term indirect impacts*** through conversion to hard bottom as described in the Foundation section.

Vessel Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the Inter-array Cable or WTGs require maintenance. Impacts associated with potential vessel anchoring during operation are expected to be similar to those discussed in the Seafloor Preparation and Pile Driving/Foundation Installation section for the construction phase.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M will primarily result from vessel anchoring and any maintenance activities that will require exposing the Inter-array Cable. Both activities are expected to be nonroutine events and not expected to occur with any regularity. Sediment suspension and deposition impacts resulting from vessel activity during SFWF O&M are expected to be similar to vessel-related sediment suspension and deposition impacts described for the construction phase.

Noise

Direct impacts from noise during SFWF O&M may occur associated with vessels, aircraft, and operational noise at the WTGs.

Vessel and Aircraft Noise

Impacts from vessel and aircraft noise during SFWF O&M are expected to be similar to impacts described in the construction phase.

WTG Operational Noise

The underwater noise produced by wind turbines are within the hearing ranges of fish. Depending on the noise intensity, such noises could disturb or displace fish within the surrounding area or cause auditory masking (DOI-MMS, 2007). Noise levels are not expected to result in injury or mortality and finfish may become habituated to the operational noise (Thomsen et al., 2006; Bergström et al., 2014). A recent study also found no difference in the residency times of juvenile cod around monopiles between periods of turbine operation or when turbines were out-of-order. This study also found that sandeels (*Ammodytes marinus* and *Ammodytes tobianus*) did not avoid the wind farm (Lindeboom et al., 2011). In a similar study, the abundance of four of the most commonly occurring species, cod, eel, shorthorn sculpin (*Myoxocephalus scorpius*), and goldsinny wrasse (*Ctenolabrus rupestris*), were found to be higher near WTGs, indicating potential noise effects from operation did not override the "reef effect." Avoidance of WTGs was not observed in this study either (Bergström et al., 2013).

With generally low noise levels generated by the WTGs, fish would be impacted only at close ranges, within approximately 328 feet (100 m) (Thomsen et al., 2006). Thomsen et al (2006) reviewed the findings of observations of fish behaviors in proximity to an operational turbine and found varying results from no perceived changes in swimming behavior (European eels); and both increased and decreased catch rates of cod within 328 feet (100 m) of turbines. As a result, direct impacts associated with long-term noise during WTG operation are expected to be ***negligible***.

Electromagnetic Field

The Inter-array Cable will be shielded. Shielded electrical transmission cables do not directly emit electrical fields into surrounding areas but are surrounded by magnetic fields that can cause induced electrical fields in moving water (Gill et al., 2012).

A modeling analysis of the magnetic fields and induced electric fields anticipated to be produced during operation of the SFWF Inter-array Cable and SFEC was performed and results are included in Appendix K. These modeling results were compared to published studies available in the scientific literature on the sensitivity of marine species to EMF. The modeling results and scientific literature analysis indicates that the EMF associated with the operational buried Inter-array Cable or SFEC will not be detected by bony fish, elasmobranch, or invertebrate species. Given that the calculated values are below the thresholds of detection reported in the scientific literature, behavioral effects impacting regional abundances and distributions of such species are not expected.

Additional field data from 50-Hz submarine cable sites and offshore windfarms support this conclusion, indicating no distributional or behavioral effects on resident fish, elasmobranchs, or invertebrates. It should be noted that these conclusions are in line with the findings of a previous comprehensive review of the ecological impacts of Marine Renewable Energy (MRE) projects, where it was determined that "to date there has been no evidence to show that EMFs at the levels expected from MRE devices will cause an effect (whether negative or positive) on any species" (Copping et al., 2016). Given these findings and the findings presented in Appendix K, impacts from EMF to finfish or EFH are expected to be negligible within the SFWF or SFEC.

Traffic

Impacts associated with vessel traffic during SFWF O&M are identified under the Seafloor Disturbance, Noise, Sediment Suspension and Deposition, and Lighting sections.

Lighting

Artificial lighting during O&M will be associated with O&M vessels, the WTGs, and the OSS. Reaction of finfish to artificial light and potential impacts to finfish from artificial light is described under the Lighting section for the construction phase. Lighting on the WTG foundations and the OSS will be coordinated with the USCG to ensure it meets appropriate safety standards and to minimize potential impacts on marine organisms. Because of the limited area associated with the artificial lighting at each WTG, the OSS, and project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible, long-term*** during operation.

Decommissioning

Decommissioning of the SFWF is expected to have similar impacts as construction of the WTGs, OSS, and Inter-array Cable. After removal, the area is expected to return to pre-project conditions.

South Fork Export Cable

SFEC – OCS and SFEC – NYS

Construction

Table 4.3-17 summarizes the level of impacts expected to occur to finfish and EFH during the construction and decommissioning phases of the SFEC. Decommissioning of the SFEC is included in Table 4.3-17 because the structures are expected to be removed and their removal will be accomplished by similar methods or result in similar impact areas as their installation. Additional details on potential impacts to finfish and EFH from the various IPFs during construction of the SFEC are described in the following sections.

Table 4.3-17. IPFs and Potential Levels of Impact on Finfish and EFH for the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/ Demersal Early Life Stages [b]	Pelagic Early Life Stages [b]	Benthic/ Demersal Later Life Stages [b]	Pelagic Later Life Stages [b]
Seafloor/Land Disturbance	Seafloor Preparation	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
	Pile Driving/ Cofferdam Installation	Minor short-term direct	Negligible short-term direct	Minor short-term direct	Negligible short-term direct
	SFEC installation	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Minor short-term direct Negligible short-term indirect

Table 4.3-17. IPFs and Potential Levels of Impact on Finfish and EFH for the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/ Demersal Early Life Stages [b]	Pelagic Early Life Stages [b]	Benthic/ Demersal Later Life Stages [b]	Pelagic Later Life Stages [b]
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Negligible short-term direct Negligible long-term indirect	Negligible short-term direct Negligible short-term indirect
Noise	Vibratory Pile Driving	Minor short-term direct	Minor short-term direct	Minor short-term direct	Minor short-term direct
	Ship Noise, Trenching Noise, Aircraft Noise	Minor short-term direct	Minor short-term direct	Minor short-term direct	Minor short-term direct
Traffic		Negligible short-term direct	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct
Lighting		Negligible short-term direct	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct
Discharges and Releases [c]		Negligible			
Trash and Debris [c]		Negligible			

[a] Maximum level of impact is the highest impact levels for direct or indirect effects. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Early life stages include eggs and larvae. Later life stages include juveniles and adults.

[c] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

IPFs associated with seafloor disturbance during construction of the SFEC has been split into seafloor preparation, pile driving, SFEC installation, and vessel anchoring (including spuds). In general, seafloor disturbance is expected to produce ***negligible to minor, direct and indirect impacts*** to species depending on the life stages present for each species. Other IPFs that are interrelated with seafloor disturbance such as pile driving noise and sediment suspension and deposition are discussed in subsequent sections. See Section 4.1 for the expected impact areas associated with the SFEC cable and HDD cofferdam.

Similar to the SFWF, the construction and decommissioning of the SFEC is not expected to have major long-term impacts on finfish or designated EFH. Many of the species identified in Table 4.3-10 as possibly present at the SFEC have a completely pelagic lifestyle, and many other species have pelagic early life stages and are not dependent on benthic habitat. As such, modification or disturbance of the substrate is expected to have a negligible impact on the habitat or EFH of pelagic species, if present. There may be some adverse impacts to finfish habitat and EFH of demersal/benthic species resulting from the Project, but because of the small acreage relative to the total area of surrounding finfish habitat and EFH, these are expected to be ***negligible to minor, localized, and short-term*** in nature. See Sections 3.2.2.1 and 4.1 for the expected acreage of benthic habitat that will be affected by construction of the SFEC.

Following completion of construction and during O&M of the SFEC, the substrates at the SFEC are expected to fundamentally remain the same as pre-project conditions. Benthic infauna and epifauna are expected to recolonize the disturbed areas, allowing them to continue to serve as foraging habitat for finfish species, including those with designated EFH. The exception is the conversion of sand and sand with mobile gravel substrate to hard bottom associated with the protective armoring for discrete portions of the SFEC. However, because of the small acreage associated with this conversion relative to the total area of available surrounding finfish habitat and EFH, these impacts to finfish habitat and EFH are expected to be ***minor, short-term and long-term***.

Seafloor Preparation

Seafloor preparation activities at the SFEC during construction include removal of obstructions and installation trials prior to installing the SFEC. A PLGR will be used to clear debris from the area prior to laying the SFEC. Up to five installation trials may be conducted, resulting in a temporary seabed disturbance of up to 9.3 acres (3.75 ha). In addition, boulder relocation may be required within 49 feet (15 m) of each side of the cable centerline where boulders are present. Temporary seabed disturbance from boulder relocation related to preparation for SFEC-OCS installation could include a total temporary disturbance of up to 124.9 acres (50.5 ha). Boulder relocation will not be required along the SFEC-NYS.

Impacts associated with seafloor preparation are expected to be similar to those described for the SFWF.

Pile Driving/Cofferdam Installation

Physical impacts to finfish from SFEC cofferdam installation consisting of sheet pile or gravity cell are expected to be similar to those described for SFWF pile/foundation installation.

SFEC Installation

Impacts associated with installation of the SFEC are expected to be similar to those described for the SFWF Inter-array Cable.

In addition, as described in the SFWF construction section, fish eggs and larvae (ichthyoplankton), as well as zooplankton, are expected to be entrained during installation of the SFEC if using a jet plow. An ichthyoplankton and zooplankton assessment was conducted to analyze the potential loss of fish and zooplankton related to this activity (Appendix O, Attachment 1). The results indicate that total estimated losses of zooplankton and ichthyoplankton related to entrainment from installation of the longest potential SFEC route using a jet plow were less than 0.001 percent of the total zooplankton and ichthyoplankton abundance present in the study region (Appendix O, Attachment 1). Therefore, impacts to early life stages of EFH species from entrainment caused by installation of the SFEC are expected to be negligible to minor and short-term.

Vessel Anchoring (Including Spuds)
Impacts associated with vessel anchoring and the use of spuds during construction of the SFEC are expected to be similar to those described for the SFWF.

Sediment Suspension and Deposition
Increases in sediment suspension and deposition during construction of the SFEC can result from seafloor disturbance caused by vessel anchoring, installation of the SFEC, and limited excavation required at the cofferdam. Direct impacts associated with increased sediment suspension and deposition are expected to be ***negligible or minor and short-term in nature***. Indirect impacts associated with increased suspended sediment and deposition include changes in habitat and species composition after sediments have settled out. These impacts are expected to result in ***negligible to minor, long-term, indirect impacts*** for benthic early and later life stages and ***negligible short-term indirect impacts*** for pelagic early and later life stages as described in more detail below. Vessel mooring or anchoring activity resulting in sediment suspension is expected to be limited to areas of seafloor immediately adjacent to the spuds or anchors. For cable installation at the SFEC - OCS and SFEC - NYS, and excavation at the cofferdam, a sediment transport study was completed that estimated the suspended sediment concentrations, sediment transport, and resulting sediment deposition that may result from jet plow installation, one of three potential types of equipment to be used for cable installation (Appendix I).

Temporary Increase in TSS
In order to estimate the extent of potential impacts from sediment suspension generated by jet plow installation of the SFEC, one of three potential types of equipment to be used for cable installation, a modeling simulation of the burial of the SFEC was conducted. A summary of the modeling results specific to the SFEC - OCS and SFEC - NYS is summarized below.

SFEC – OCS Installation
The modeling results indicate that the maximum modeled TSS concentration from SFEC - OCS installation using a jet plow is 1,347 mg/L. The highest TSS concentrations using this type of cable installation equipment are predicted to occur in locations where the jet plow passes over pockets of finer sediments (e.g., between VC-217 and VC-220, and again between VC-235 and the end of the route –Appendix I), but concentrations above 30 mg/L otherwise remain within approximately 328 feet (100 m) of the source during the simulation. Water column concentrations of 100 mg/L or greater are predicted to extend up to 1,115 feet (340 m) from the jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.4 hours after the conclusion of jet plow trenching. Modeling also indicates that elevated TSS concentrations are expected to remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the jet plow at any time during the simulation (Appendix I).

SFEC – NYS Installation
The modeling results indicate that the maximum modeled TSS concentration from SFEC - NYS installation using a jet plow is 578 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 394 feet (120 m) from the jet plow and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.3 hours after the jet plow crosses into federal waters. Modeling also indicates that elevated TSS concentrations are expected to

remain very close to the seabed and that plumes are not predicted to extend vertically beyond 3 to 9 feet (1 to 3 m) of the jet plow at any time during the simulation (Appendix I).

Cofferdam Installation
A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The maximum predicted TSS concentration from suction dredging at the HDD site is 562 mg/L. Water column concentrations of 100 mg/L or greater are predicted to extend up to 476 feet (145 m) from the source and TSS concentrations are predicted to return to ambient levels (less than 10 mg/L) in 1.1 hours after the conclusion of suction dredging.

Potential impacts to finfish from increases in sediment suspension are similar to those described for the SFWF. Given the limited extent and duration of the elevated TSS based on the predictive modeling described above, these impacts are expected to be ***negligible to minor*** to benthic/demersal species because they will be ***short-term and highly localized***. Direct impacts to pelagic species are expected to be ***negligible*** as older life stages will likely leave the area and not be affected by increased suspended sediment and early life stages are expected to have tolerance for short-term increases in suspended sediment.

Sediments are expected to come out of suspension quickly after the impact occurs, returning pelagic habitat to pre-impact conditions in a short-time frame, resulting in a ***negligible, short-term, indirect impact*** for pelagic early and later life stages. Indirect impacts to benthic/demersal species from a potential change in habitat composition are described in the Sediment Deposition section below.

Sediment Deposition
The model (Appendix I) also predicted sediment deposition extent and depth resulting from installation of the SFEC using a jet plow, one of three potential types of equipment to be used for cable installation. A summary of the modeling results specific to the SFEC - OCS and SFEC - NYS is summarized below.

SFEC – OCS Installation
The model predicted that sediment deposition resulting from installation of the SFEC - OCS using a jet plow will be limited to the area immediately adjacent to the burial route, typically, extending no more than 328 feet (100 m) from the cable-laying track. The maximum predicted deposition thickness is estimated to be 0.45 inches (11.4 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.72 ha) of the seabed (Appendix I).

SFEC – NYS Installation
The model predicted that sediment deposition resulting from installation of the SFEC - NYS using a jet plow will also be limited to the area immediately adjacent to the burial route as described above. The maximum predicted deposition thickness is estimated to be 0.39 inch (9.9 mm). Sedimentation at or above 0.4 inch (10 mm) extends a maximum of 29.5 feet (9 m) from the burial route and covers a cumulative area of 4.3 acres (1.72 ha) of the seabed (Appendix I).

Cofferdam Installation
A modeling simulation of suction dredging and side-casting at the HDD exit point for the sea-to-shore transition was also conducted. The model predicted that sedimentation will be limited to the area immediately adjacent to the exit pit (within 656 feet [200 m] of the source). Unlike previous scenarios where sediment is resuspended along a linear path, the dredge and side-cast operation occurs from a single point within the model domain. For this reason, the deposit is

thicker, but is far more limited in extent. The maximum predicted deposition thickness is 12.5 inches (31.8 cm). Sedimentation at or above 10 mm extends a maximum of 177 feet (54 m) from the side-cast point and covers a cumulative area of only 1.38 acres (0.56 ha) of the seabed (Appendix I).

Potential Impacts to finfish from increases in sediment deposition are similar to those described for the SFWF. Direct impacts from sediment deposition to finfish are considered to be ***short-term, localized,*** and ***minor*** because of the limited extent of sedimentation predicted by the model. Indirect impacts are expected to be ***negligible to minor and long-term*** for benthic early and later life stages. Indirect impacts from sediment deposition are expected to result in ***no impact*** to pelagic early of later life stages.

Noise

The primary sources of underwater sound during SFEC construction that pose risks of impacts to fish are vibratory hammer pile driving for the sheet pile cofferdam and DPV use for SFEC installation. The potential underwater acoustic impacts on fish were addressed in the discussion about the SFWF Inter-array Cable. ***Minor, short-term behavioral impacts*** to fish within the ensonified area of approximately 12 acres (0.05 km^2) around the DPV along the cable route would be expected.

The sheet pile cofferdam installation differs from the main SFWF installation in several ways. The location is close to shore, the duration of the installation is estimated to be short (roughly 12 to 24 hours), and the source type is non-impulsive or continuous, compared to impact pile driving for WTG foundations. According to the acoustical impact analysis provided in Appendix P2, the only quantitative threshold that Popper et al. (2014) give for evaluating the impacts of non-impulsive (shipping) noise is for fish with swim bladders. Popper et al. (2014) does not give quantitative thresholds for other fish categories. The Stadler and Woodbury (2009) criteria were originally developed for impulsive sounds, but they have been used for non-impulsive sounds. The zone of acoustic influence for injury would be concentrated right at the cofferdam and vibratory hammering. Based on the modeling provided in Appendix J1, the radial distance to a 150 dB threshold would be approximately 779 m from the source while the radial distance to a 180 dB threshold would be approximately 31 m. Fish within close proximity to the vibratory hammering are at risk to injury from the noise. However, further away from the hammering, fish within the ensonified area over the brief duration of vibratory hammering may experience noise that may temporarily alter their behavior. Impacts of this magnitude are expected to be ***short-term*** and ***minor*** because fish are likely to swim away and not enter the area once hammering has begun.

Traffic

Impacts associated with vessel traffic during construction of the SFEC are identified under the Seafloor Disturbance, Noise, Sediment Suspension and Deposition, and Lighting sections.

Lighting

Artificial lighting during construction of the SFEC will be associated with navigational and deck lighting on vessels from dusk to dawn. Reaction of finfish to this artificial light is highly species-dependent and may include attraction and/or avoidance of an area. Because of the limited area associated with the artificial lighting used on project vessels relative to the surrounding unlit areas, the effects are expected to be ***negligible and short-term*** for both benthic and pelagic early and later life stages during construction. Additional information on impacts to finfish from artificial lighting are similar to those described for the SFWF.

Operations and Maintenance

Table 4.3-18 summarizes the level of impacts expected to occur to finfish and EFH during the O&M phases of the SFEC. ***Minor and long-term impacts*** during O&M are associated with the presence of the SFEC and associated cable armoring. Additional details on potential impacts to finfish and designated EFH from the various IPFs during O&M are described in the following sections.

Table 4.3-18. IPFs and Potential Levels of Impact on Finfish and EFH for the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/Demersal Early Life Stages [b]	Pelagic Early Life Stages [b]	Benthic/Demersal Later Life Stages [b]	Pelagic Later Life Stages [b]
Seafloor Disturbance	Cofferdam	No impact	No impact	No impact	No impact
	SFEC	Minor short-term direct Minor long-term indirect	Negligible short-term direct Minor long-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Minor long-term indirect
	Vessel anchoring (including spuds)	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect
Sediment Suspension and Deposition		Minor short-term direct Minor long-term indirect	Negligible short-term direct Negligible short-term indirect	Negligible short-term direct Negligible long-term indirect	Negligible short-term direct Negligible short-term indirect
Ship and Aircraft Noise		Negligible short-term direct	Negligible short-term direct	Negligible short-term direct	Negligible short-term direct
Electromagnetic Field		Negligible	Negligible	Negligible	Negligible
Traffic		See Seafloor disturbance, noise, sediment suspension and deposition, and lighting IPFs			
Lighting		Negligible long-term direct	Negligible long-term direct	Negligible long-term direct	Negligible long-term direct
Discharges and Releases [c]		Negligible			

Table 4.3-18. IPFs and Potential Levels of Impact on Finfish and EFH for the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact [a]			
		Benthic/Demersal Early Life Stages [b]	Pelagic Early Life Stages [b]	Benthic/Demersal Later Life Stages [b]	Pelagic Later Life Stages [b]
Trash and Debris [c]		Negligible			

[a] Maximum level of impact is the highest impact levels for direct or indirect effects. Long-term impacts were considered to have a higher potential for impacts than short-term impacts if within the same impact category.

[b] Early life stages include eggs and larvae. Later life stages include juveniles and adults.

[c] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

IPFs associated with seafloor disturbance during O&M of the SFEC has been split into cofferdam, SFEC, and vessel anchoring (including spuds). See Section 3.2.3 for a description of the SFEC construction.

Cofferdam

The cofferdam will be a temporary structure used during construction only. Therefore, no conversion of habitat is expected, and ***no long-term, indirect impacts*** associated with pile driving of the cofferdam is expected.

South Fork Export Cable

Benthic life stages are expected to experience ***minor, short-term, direct impacts*** and pelagic life stages are expected to experience ***negligible, short-term, direct impacts*** if the SFEC requires maintenance that will expose it. Maintenance of the SFEC is considered a nonroutine event and is not expected to occur with any regularity. Impacts associated with exposing the SFEC are expected to be similar but less frequent to those described for the construction/installation phase. The presence of the SFEC is expected to have ***negligible impacts*** to finfish because it will be buried beneath the seabed. However, some areas of the SFEC may require armoring which is expected to result in ***minor, long-term, indirect impacts*** through conversion to hard bottom, as described in the Foundation section for the SFWF.

Vessel Anchoring (Including Spuds)

Vessels are not expected to anchor during O&M activities unless the SFEC requires maintenance. Impacts associated with potential vessel anchoring during O&M of the SFEC are expected to be similar to those described for the SFWF.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M of the SFEC will primarily result from vessel anchoring and any maintenance activities that will require exposing the SFEC. Both activities are expected to be nonroutine events and not expected to occur with any regularity. Sediment suspension and deposition impacts resulting from vessel activity during O&M of the SFEC are expected to be similar to vessel-related sediment suspension and deposition impacts described for the SFEC construction phase, but less frequent and at a smaller scale.

Noise
Direct impacts to finfish associated with noise during O&M of the SFEC may occur associated with vessels and aircraft. Impacts from vessel and aircraft noise during O&M of the SFEC are expected to be similar to those described for the SFWF.

Electromagnetic Field
EMF impacts to finfish from the SFEC are expected to be similar to those described for the Inter-array Cable at the SFWF.

Traffic
Impacts associated with vessel traffic during SFEC O&M are identified under the Seafloor Disturbance, Noise, Sediment Suspension and Deposition, and Lighting sections.

Lighting
Artificial lighting during O&M of the SFEC will be associated with O&M vessels. Reaction of finfish to artificial light and potential impacts to finfish from artificial light is as described under the Lighting section for the SFEC construction phase.

Decommissioning
Decommissioning of the SFEC is expected to have similar impacts as construction. The area is expected to return to pre-project conditions.

Threatened and Endangered Finfish

As described in the Affected Environment section, the endangered Atlantic sturgeon has the potential to occur in the SFWF and SFEC areas. It is extremely unlikely for the endangered shortnose sturgeon to occur in either the SFWF or SFEC area.

Potential impacts on the Atlantic sturgeon would not be materially different from impacts on other fish species described in the previous sections. No spawning habitat will be affected because Atlantic surgeon spawn in hard-bottom, freshwater habitats. Seasonal migratory patterns allow the potential for Atlantic sturgeon to be present in the SFWF construction area; however, they are not expected to be a regular visitor or occupant in large numbers. IPFs for Atlantic sturgeon include seafloor disturbance, sediment suspension and deposition, noise, traffic (i.e., physical disturbance and risk of collisions), and trash and debris (i.e., ingestion and entanglement). Impacts resulting from these IPFs are described again in direct relevance to potential impacts to the Atlantic sturgeon in Appendix P1.

4.3.3.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to finfish and essential fish habitat.

- The SFWF and SFEC - Offshore will minimize impacts to important habitats for finfish species.
- Installation of the SFWF Inter-Array Cable and SFEC - Offshore will occur using equipment such as mechanical cutter, mechanical plow, and/or jet plow. Compared to open cut dredging, this method will minimize sediment disturbance and alteration of demersal finfish habitat.
- The SFWF Inter-Array Cable and SFEC - Offshore will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m).

- Use of DPV for cable installation for the SFWF Inter-array Cable and SFEC - Offshore will minimize impacts to finfish and EFH resources, as compared to use of a vessel relying on multiple-anchors.
- The SFEC sea-to-shore transition will be installed using HDD to avoid impacts to the dunes, beach, and near-shore zone, including finfish and EFH resources.
- Siting of the SFWF and SFEC - Offshore were informed by site-specific benthic habitat assessments and Atlantic cod spawning surveys.
- DWSF is committed to collaborative science with the commercial and recreational fishing industries pre-, during, and post-construction.
- A plan for vessels will be developed prior to construction to identify no-anchor areas inside the MWA to protect sensitive areas or other areas to be avoided.
- DWSF will require all construction and operations vessels to comply with regulatory requirements related to the prevention and control of spills and discharges.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).

4.3.4 Marine Mammals

The description of the affected environment and assessment of potential impacts for marine mammals were developed by reviewing current public data sources related to marine mammals, including state and federal agency-published papers and databases, published journal articles, online data portals and mapping databases, and correspondence and consultation with federal and state agencies. A description of the marine mammals with the potential to occur within the SFWF and SFEC is provided in this section, followed by an evaluation of potential Project-related impacts. In support of this impact evaluation, DWSF has completed a comprehensive underwater acoustic modeling effort (Appendix J1) and a detailed impact assessment for marine mammals, sea turtles, and sturgeon, including animal movement modeling (Appendix P2) as it relates to exposures to project-related underwater noise (Appendix P1).

4.3.4.1 Affected Environment

Thirty-six species of marine mammals inhabit the regional waters upon the Western North Atlantic OCS and may occur in the SFWF and SFEC, including 6 Mysticetes (baleen whales), 25 Odontocetes (toothed whales, dolphins, and porpoise), 4 Pinnipeds (earless or true seals), and 1 species of Sirenia (manatees). All 36 species are protected under the MMPA; 6 species are also protected under the federal ESA. Table 4.3-19 summarizes the marine mammal species potentially present within the Western North Atlantic OCS, including the relative occurrences for each species within the SFWF and SFEC Project areas. The table also includes each species' conservation status, including the designation as a 'strategic stock,' as defined by the MMPA. A species that is a strategic stock meets the following criteria: the population experiences a level of human-caused mortality that exceeds the potential biological removal level; the population is declining and is likely to be listed as a threatened species under the ESA, based on the best available information; or the population is listed as a threatened marine mammal species under the ESA or is designated as depleted under the MMPA. Nonstrategic stock is defined as any marine mammal stock that does not match the strategic stock criteria.

Table 4.3-19. Marine Mammals Possibly Occurring in the SFWF and SFEC Project Areas

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the SFWF and SFEC	Best Estimate[1]
Order Cetacea					
Suborder Mysticeti (baleen whales)					
Minke whale	*Balaenoptera acutorostrata*	Canadian East Coast	Non-strategic	Common	2,591
Sei whale	*Balaenoptera borealis*	Nova Scotia	ESA Endangered/ Depleted and Strategic	Regular	357
Blue whale	*Balaenoptera musculus*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Rare	440
Fin whale	*Balaenoptera physalus*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Common	1,618

Table 4.3-19. Marine Mammals Possibly Occurring in the SFWF and SFEC Project Areas

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the SFWF and SFEC	Best Estimate[1]
North Atlantic right whale	*Eubalaena glacialis*	Western North Atlantic	ESA Endangered/ Depleted and Strategic	Common	451
Humpback whale	*Megaptera novaeangliae*	Gulf of Maine	Non-strategic	Common	896
Suborder Odontoceti (toothed whales, dolphins, and porpoises)					
Sperm whale	*Physeter macrocephalus*	North Atlantic	ESA Endangered/ Depleted and Strategic	Common	2,288
Pygmy sperm whale	*Kogia breviceps*	Western North Atlantic	Non-strategic	Rare	3,785
Dwarf sperm whale	*Kogia sima*	Western North Atlantic	Non-strategic	Rare	3,785
Northern bottlenose whale	*Hyperoodon ampullatus*	Western North Atlantic	Non-strategic	Not Expected	unknown
Cuvier's beaked whale	*Ziphius cavirostris*	Western North Atlantic	Non-strategic	Rare	6,532
Mesoplodont beaked whales	*Mesoplodon spp.*	Western North Atlantic	Depleted	Rare	7,092
Killer whale	*Orcinus orca*	Western North Atlantic	Non-strategic	Rare	unknown
False killer whale	*Pseudorca crassidens*	Western North Atlantic	Strategic	Rare	442
Pygmy killer whale	*Feresa attenuata*	Western North Atlantic	Non-strategic	Not Expected	unknown
Short-finned pilot whale	*Globicephala macrorhynchus*	Western North Atlantic	Strategic	Rare	28,924
Long-finned pilot whale	*Globicephala melas*	Western North Atlantic	Strategic	Common	5,636
Melon-headed whale	*Peponocephala electra*	Western North Atlantic	Non-strategic	Not Expected	unknown
Risso's Dolphin	*Grampus griseus*	Western North Atlantic	Non-strategic	Common	18,250
Common dolphin	*Delphinus delphis*	Western North Atlantic	Non-strategic	Common	70,184
Fraser's dolphin	*Lagenodelphis hosei*	Western North Atlantic	Non-strategic	Rare	unknown

Table 4.3-19. Marine Mammals Possibly Occurring in the SFWF and SFEC Project Areas

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the SFWF and SFEC	Best Estimate[1]
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Western North Atlantic	Non-strategic	Common	48,819
White-beaked dolphin	*Lagenorhynchus albirostris*	Western North Atlantic	Non-strategic	Rare	2,003
Pantropical spotted dolphin	*Stenella attenuata*	Western North Atlantic	Non-strategic	Rare	3,333
Clymene dolphin	*Stenella clymene*	Western North Atlantic	Non-strategic	Not Expected	unknown
Striped dolphin	*Stenella coeruleoalba*	Western North Atlantic	Non-strategic	Rare	54,807
Atlantic spotted dolphin	*Stenella frontalis*	Western North Atlantic	Non-strategic	Uncommon	44,715
Spinner dolphin	*Stenella longirostris*	Western North Atlantic	Non-strategic	Rare	unknown
Rough toothed dolphin	*Steno bredanensis*	Western North Atlantic	Non-strategic	Rare	136
Bottlenose dolphin	*Tursiops truncatus*	Western North Atlantic, offshore	Non-strategic	Common	77,532
		Western North Atlantic, Northern migratory coastal	Depleted and Strategic	Rare	6,639
Harbor porpoise	*Phocoena phocoena*	Gulf of Maine/Bay of Fundy	Non-strategic	Common	79,833
Order Carnivora					
Suborder Pinnipedia					
Hooded seal	*Cystophora cristata*	Western North Atlantic	Non-strategic	Rare	unknown
Gray seal	*Halichoerus grypus*	Western North Atlantic	Non-strategic	Regular	27,131
Harp seal	*Pagophilus groenlandica*	Western North Atlantic	Non-strategic	Rare	unknown
Harbor seal	*Phoca vitulina*	Western North Atlantic	Non-strategic	Regular	75,834

Table 4.3-19. Marine Mammals Possibly Occurring in the SFWF and SFEC Project Areas

Common Name	Scientific Name	Stock	Federal ESA/MMPA Status	Relative Occurrence in the SFWF and SFEC	Best Estimate[1]
Order Sirenia					
Florida manatee[2]	*Trichechus manatus latirostris*	-	ESA Threatened/ Depleted and Strategic	Rare	unknown

ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act.
[1]Best estimate from the most recently updated National Oceanic and Atmospheric Administration Stock Assessment Reports (Waring et al., 2007, 2010, 2014, 2015, 2016; Hayes et al., 2017; NMFS, 2018).
[2]Under management jurisdiction of United States Fish and Wildlife Service rather than National Marine Fisheries Service (USFWS, 2019).

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Definitions:

- Common – Occurring consistently in moderate to large numbers;
- Regular – Occurring in low to moderate numbers on a regular basis or seasonally;
- Uncommon – Occurring in low numbers or on an irregular basis;
- Rare – Records for some years but limited; and
- Not expected – Range includes the Project Area but due to habitat preferences and distribution information species are not expected to occur in the Project Area although records may exist for adjacent waters.

Cetaceans are composed of two separate groups: Mysticetes (baleen whales) and Odontocetes (toothed whales, dolphins, and porpoise). The Odontocetes all possess teeth, and generally feed on fish and invertebrates. The Mysticetes possess large baleen filtration systems instead of teeth, which they use to sieve smaller prey out of the water. Their prey usually consists of zooplankton and small schooling fish. Both groups transit over large distances with Mysticetes migrating seasonally between distinct feeding and breeding areas and Odontocetes following prey species and less distinct migratory behavior. The toothed whales, dolphins, and porpoises are generally found in large, stable pods throughout their lives. Baleen whales are known to maintain small, unstable groups or remain as solitary individuals when not breeding (Wilson and Ruff, 1999). Whales are capable of very deep or prolonged dives while the smaller dolphin and porpoise species generally dive to shallower depths for shorter periods of time. Cetaceans inhabit all the world’s oceans, and can be found in coastal, estuarine, shelf, and pelagic habitats, including the SFWF area (Hayes et al., 2017).

The various seal species (Pinnipeds) inhabit the cooler waters of the northeast and frequent the waters and inland areas around Long Island. Pinnipeds are composed of three families: Odobenidae (the walrus), Otariidae (eared seals, including sea lions and fur seals), and Phocidae (earless seals). Phocidae are the most diverse and widespread pinnipeds and are the only family of seals with the potential to occur within the SFWF and SFEC. Historically, seal species typically included harbor and gray seals, which are still relatively abundant in these waters from late fall until late spring. In recent years, arctic species, such as harp, hooded, and ringed seals, that were once extremely rare for the project area have been sighted (CRESLI, 2017). West Indian manatees (Sirenian) have also been sighted in the region; however, their occurrences are extremely rare. They typically occur in the southeastern United States, which is the northern limit of their range (Lefebvre et al., 2001).

Appendix P provides additional information on the biology, habitat use, abundance, distribution, and the existing threats to the marine mammals that are common to the region and have the potential to occur in the SFWF and SFEC. Furthermore, the potential exposures of marine mammals were investigated through a combination of studies including the underwater sound propagation modeling included in Appendix J1 and the animal exposure modeling included in Appendix P2. The animal exposure modeling quantified the number of marine mammals or percentage of a population within the SFWF and SFEC Project areas. Please refer specifically to Table 4 of Appendix P2 for marine mammal density estimates for the SFWF and SFEC.

4.3.4.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to impact marine mammals, as presented on Figure 4.3-11. The IPFs with potential to result in negligible and greater impacts on marine mammals are evaluated in this section.

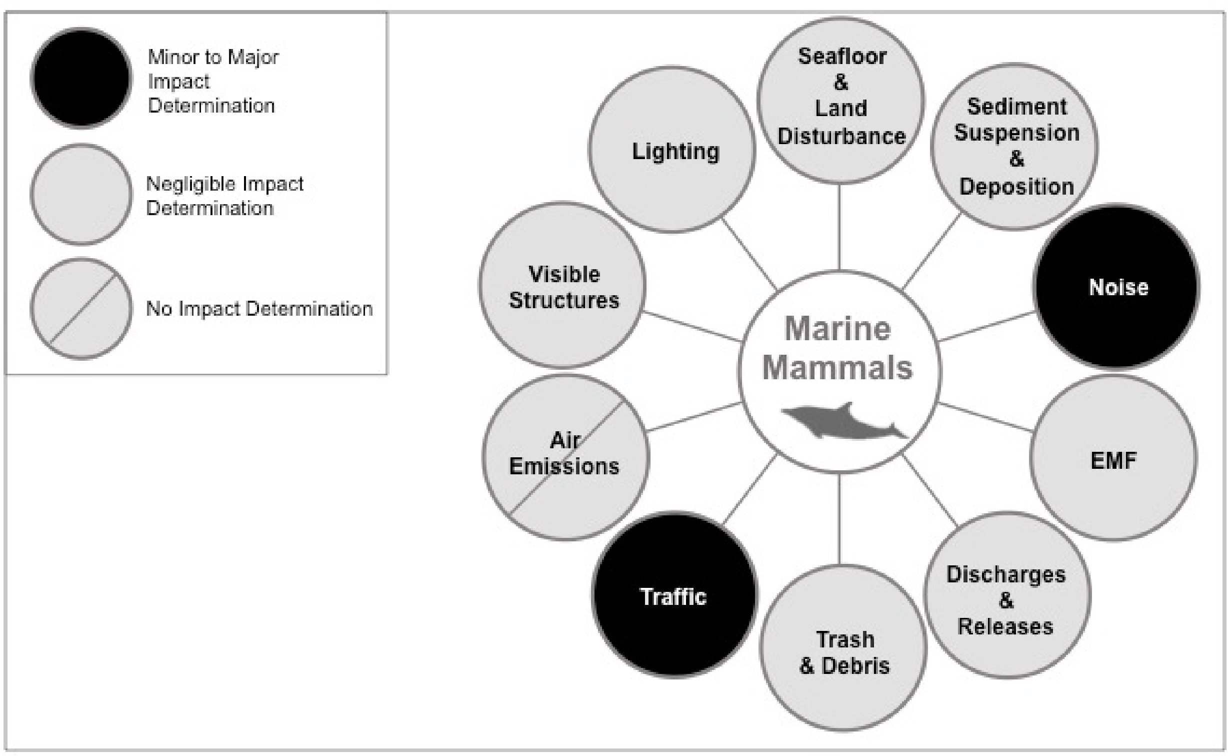

Figure 4.3-11. IPFs on Marine Mammals

Illustration of potential impacts to marine mammals resulting from SFWF and SFEC activities

South Fork Wind Farm

This section summarizes the assessment of potential impacts on 16 species of marine mammals as detailed in Appendix P. The primary IPFs associated with the SFWF that could result in minor to moderate impacts to marine mammals are underwater noise from construction and vessel traffic, in the case of vessel strikes and entanglement in vessel anchor lines. Short-term major impacts to certain species could occur from pile driving noise. Other IPFs considered but anticipated to have negligible impacts to marine mammals are seafloor disturbance, sediment suspension and deposition, EMFs, discharges and releases, trash and debris, visible structures, and lighting. The potential impacts associated with each phase of the SFWF are addressed in the following sections.

Construction

Table 4.3-20 summarizes the level of impacts expected to occur to marine mammals during the construction and decommissioning phases of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-20. IPFs and Potential Levels of Impact on Marine Mammals at the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Seafloor/Land Disturbance	Seafloor Preparation	Negligible short-term localized
	Foundation Installation	Negligible short-term localized
	Vessel Anchoring	Negligible short-term localized
	Inter-array Cable Installation	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized
Noise	Pile driving	Minor to Major short-term
	Equipment Uses	Negligible short-term
	Vessel traffic	Negligible to Minor short-term
Discharges and Releases		Negligible indirect
Trash and Debris		Negligible indirect
Traffic	Increased Vessels	Minor to Moderate short-term
	Entanglement	Negligible short-term
Visible Structures	Physical structure; navigation impediment	Negligible indirect
Lighting	Navigational and Deck Lighting	Negligible short-term localized

Seafloor and Land Disturbance

During construction, seafloor disturbances would be associated with seafloor preparation, foundation installation, vessel anchoring, and cable installation. Some limited benthic habitat conversion will occur, as described in Section 4.3.2. Marine mammals occurring in the SFWF would likely be transiting the area in search of prey species, which would rarely be benthic species except for the sand lance (*Ammodytes* spp.) which is widely distributed throughout the region. In the unlikely event that marine mammals forage on the seafloor in the SFWF and their prey is displaced from those areas because of SFWF construction, the impacts would be ***negligible*** because they are limited to those few impacted individuals and not groups or populations of marine mammals. The conversion of seabed habitat will be relatively minor when compared to the large expanse of similar habitat available in the region so that marine mammals would find comparable benthic habitat for feeding or resting.

Sediment Suspension and Deposition

As discussed in Section 4.1 and again in Section 4.2.2, SFWF inter-array installation will result in short-term, localized increases in sedimentation close to the seafloor and several feet up and outward into the water column (i.e., increased turbidity). Because of the short-term and localized increases in turbidity and decreases in water quality from SFWF Inter-array Cable installation, ***negligible impacts*** would be anticipated to the few marine mammals that may be located near the cable installation activities. As discussed in the next section, underwater construction noise is likely to repel marine mammals from the area before they are impacted by increased turbidity.

Noise

Underwater noise is the primary construction-related IPF that could impact marine mammals if they are present in the area at the time of SFWF construction. Acoustic modeling of construction-related underwater noise was completed to estimate the impacts from construction-related noise-producing activities, such as pile driving, vibratory pile driving, and the use of DP vessel thrusters. Dependent on many factors, as detailed in the underwater acoustic modeling report (Appendix J1) and marine mammal impact assessment (Appendix P), elevated underwater sound pressure levels (SPLs) can cause physiological impacts or behavioral modifications on marine mammals. Noise will be generated during the construction phase of the SFWF from pile driving, trenching and cable lay equipment, and vessel traffic. Pile driving and DP vessel thruster usage are identified as the activities that would likely have the greatest potential for impacts on marine mammals. As discussed in the IPF section (Section 4.1), above water noise during construction would result in ***negligible impacts*** to marine mammals. Therefore, the potential for above water noise impacts to marine mammals is not further discussed in the assessment.

Not all marine mammals have identical hearing capabilities or are equally susceptible to noise-induced hearing loss. Therefore, they have been delineated into five functional hearing groups based on their similarities in hearing sensitivities. The five groups include (1) low-frequency cetaceans (LFCs) (Mysticetes), (2) mid-frequency cetaceans (MFC) (Odontocetes), (3) high-frequency cetaceans (HFC) (true porpoises), (4) Phocid pinnipeds in water (PPW) (true seals), and (5) Otariid pinnipeds (OW) (sea lions and fur seals). Otariid pinnipeds do not occur in the North Atlantic; therefore, they are not further discussed in this assessment. Table 4.3-21 defines the generalized hearing ranges for each hearing group (NMFS, 2016).

Table 4.3-21. Marine Mammal Hearing Groups

Hearing Group	Species or Taxonomic Groups (Relevant Species Examples)	Generalized Hearing Range[a]
LFC	Baleen whales (e.g., fin whale, North Atlantic right whale, sei whale)	7 Hz to 35 kilohertz (kHz)
MFC	Dolphins, toothed whales (e.g., sperm whale), beaked whales, bottlenose dolphins	150 Hz to 160 kHz
HFC	True porpoises (e.g., harbor porpoise)	275 Hz to 160 kHz
PPW	True seals (e.g., harbor seal, gray seal)	50 Hz to 86 kHz
OW [b]	Sea lions and fur seals	60 Hz to 39 kHz

Source: NMFS, 2018.

[a] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on an approximate 65 dB threshold from normalized composite audiogram, with the exception for lower limits for LFC (Southall et al., 2007) and PPW (approximation).
[b] OW do not occur in the North Atlantic or the SFWF and SFEC.

Received sound levels have been developed based on current scientific criteria associated with the onset of a physiological effect (e.g., auditory injury) to or behavioral responses from marine mammals. Acoustic thresholds are used to determine impact levels by providing some quantifiable and spatial context for indicating whether marine mammals could be injured or disturbed by anthropogenic underwater noise. NMFS (2018) defines regulatory criteria for protecting marine mammals by setting potential hearing loss thresholds. These acoustic thresholds for the onset of permanent threshold shift (PTS) from temporary threshold shift (TTS) are used to help assess and quantify exposures from the proposed activities that could result in physiological effects or injury. Table 4.3-22 provides the underwater acoustic thresholds levels for impulsive and nonimpulsive sounds associated with PTS onset (physiological impacts) for marine mammals found in the North Atlantic (NMFS, 2018). The NMFS (2018) guidance recommends dual criteria for assessing potentially injurious exposures, including peak, unweighted sound pressure (SPL_{pk}) and frequency-weighted cumulative sound exposure level (SEL_{cum}). As explained in Appendix P, the SELs are used to assess potential impacts to marine mammals from impact pile driving because they resulted in larger distances from the activity and thus higher potential for animals to be exposed to noise levels resulting in physiological impacts.

Table 4.3-22. Summary of NOAA-NMFS Physiological Impacts Acoustic Thresholds

Hearing Group	Impulsive	Nonimpulsive
LFC	$L_{pk,flat}$: 219 dB $L_{E,LF,24h}$: 183 dB	$L_{E,LF,24h}$: 199 dB
MFC	$L_{pk,flat}$: 230 dB $L_{E,MF,24h}$: 185 dB	$L_{E,MF,24h}$: 198 dB
HFC	$L_{pk,flat}$: 202 dB $L_{E,HF,24h}$: 155 dB	$L_{E,HF,24h}$: 173 dB

Table 4.3-22. Summary of NOAA-NMFS Physiological Impacts Acoustic Thresholds

Hearing Group	Impulsive	Nonimpulsive
PPW	$L_{pk,flat}$: 218 dB $L_{E,PPW,24h}$: 185 dB	$L_{E,PPW,24h}$: 201 dB

Source: NMFS, 2018.

Notes:

Listed are PTS Onset Thresholds (Received Level) with dual metric acoustic thresholds for impulsive sounds. Use whichever results in the largest isopleth for calculating PTS onset. If a nonimpulsive sound has the potential of exceeding the peak SPL thresholds associated with impulsive sounds, these thresholds should also be considered.

Peak sound pressure (L_{pk}) has a reference value of 1 µPa, and cumulative sound expose level (L_E) has a reference value of 1 μPa^2 s.

Agency-adopted behavioral acoustic thresholds are unweighted by hearing group or species. Table 4.3-23 outlines these acoustic threshold limits for marine mammal behavior impacts. These unweighted thresholds were used in the marine mammal impact assessment (Appendix P) because they have a regulatory foundation. While it is acknowledged that weighted thresholds are commonly applied and may be a more appropriate impact metric, the current review status for behavioral acoustic criteria and lack of regulatory basis for weighted values at this time warrant the use of the unweighted metric for this analysis.

Table 4.3-23. Summary of NOAA-NMFS Behavioral Impacts Acoustic Thresholds

Criterion	Acoustic Threshold (SPL_{rms})
Possible Behavioral Disruption (for impulsive noise)	160 dB
Possible Behavioral Disruption (for nonimpulsive, continuous noise)	120 dB

Source: NMFS, 2018.

SPL_{rms} – root-mean-square sound pressure level. Acoustic threshold units (dB) are referenced to 1 µPa.

The determination of how, when, and to what degree marine mammals are exposed to underwater noise that could result in a physiological and/or behavioral impact is very complex. The analysis done in support of this impact evaluation considered many of the factors relevant to the problem including underwater sound propagation based on several operational assumptions, project area-specific marine animal densities, marine animal movements, and the context within which animals may be exposed to project-related noise. In no scenario was the analysis as simple as determining that if any one marine species is likely to occur in the vicinity of the project during noise-generating activity, it would be impacted by the project. Rather, potential physiological and behavioral impacts to marine mammals were assessed based on rational methods using the best available data and modeling applicable to the situation as discussed below.

Impulsive Sounds – Impact Pile-driving

Underwater noise from the impulsive sounds generated by impact pile driving is considered an important IPF in potential physiological and behavioral impacts to marine mammals. The assessment of potential acoustical impacts to marine mammals was completed based on the results of underwater acoustic modeling and animal movement modeling studies specific to proposed SFWF and SFEC construction activities. Appendix J1 provides predicted sound propagation distances based on key construction variables associated with the SFWF and SFEC design envelope, such as: hammer type, pile type, pile schedule (hammer energy/number of strikes/piling duration), season, geographic location, and implementation of noise mitigation (i.e., sound attenuation) measures. Appendix P provides a summary of the animal movement modeling and impact assessments based not only on underwater sound characteristics but the marine environment, autecological characteristics of at-risk species, mitigation factors, and animal behavior.

Based on the results of the underwater noise modeling and animal noise exposure estimates, impacts to marine mammals during pile driving for the SFWF would likely be ***minor*** with a few seasonal exceptions where unmitigated impact pile driving could be ***major*** impact to certain species. For example, the risk of acoustic exposures to North Atlantic right whales is higher during March and April when historical sightings are relatively high; however, outside of spring, the risk of exposure to North Atlantic right whales diminishes. The implementation of noise attenuation systems capable of achieving 6 or 12 dB reductions during pile driving reduces the exposure risk to minimal for most species (Appendix P).

The marine mammal impact assessment determined that seasonality is an important parameter when estimating exposures to potentially harmful underwater noise due to the variable monthly densities of animals in the Project area (Appendix P1). Exposure estimates for impact pile driving (Appendix J1) shows that the potential for physiological-level acoustic exposures are low even with no sound attenuation. With 10 dB noise attenuation, all exposures drop to <1 individual (calculated by rounding up any fraction greater than or equal to 0.5) for all 16 species evaluated in Appendix P1 except for the following species in specific months:

- Fin whales with 1 individual exposed in May, June, July, August, September, or October;
- Minke whales, which had 1 individual exposed in May and June;
- Humpback whales with 1 individual exposed in July, August, November, or December; 2 individuals exposed in May, June, or October, or 4 individuals exposed in September;
- North Atlantic right whale with 1 potential exposure in May or June; and
- Harbor porpoise with 1 individual exposed in May;

The maximum number of modeled physiological-level and behavioral impact-level exposures for the species assessed including ESA-listed marine mammals are presented in Appendix P.

Nonimpulsive Sound – Vessel Noise
The noise from Project-related vessel traffic is expected to be similar to existing vessel-related underwater noise levels in the area. Thus, it is presumed that individual or groups of marine mammals in the area are familiar with various and common vessel-related noises and will not be further impacted by Project-related vessel traffic. The use of DP cable-laying vessels for the SFWF Inter-array Cable and SFEC is an exception. The dominant underwater noise source on the DPV is due to cavitation on the propeller blades of the thrusters (e.g., Leggat et al., 1981). The noise power from the propellers is proportional to the number of blades, the propeller diameter, and the propeller tip speed. The noise from the DPV thrusters is nonimpulsive and typically more dominant than mechanical or hydraulic noises from the cable trenching equipment.

Underwater noise modeling of the nonimpulsive sounds from DPV thruster operations and vibratory hammer (discussed in the following section for SFEC construction) use was conducted for two representative locations: offshore and nearshore. The results of the modeling are presented in Appendix J1. Table 4.3-24 shows the average distances to published physiological and behavioral thresholds for marine mammal functional hearing groups along the SFEC corridor and Inter-array Cable routes.

Table 4.3-24. Maximum Distances to Regulatory Acoustic Thresholds during Operation of Thrusters on a Dynamically Positioned Vessel along the Inter-array Cable Lay Route

Faunal Group	Distances (m) to Physiological Thresholds[1]	Distances (m) to Behavioral Thresholds[2]
LFC	112	14,734
MFC	35	14,734
HFC	103	14,734
PPW	50	14,734

[1]-Physiological thresholds based on cumulative sound exposure accumulated over a 24-hour period ($SEL_{cum, 24\ hr}$)

[2]-Behavioral thresholds based on root-mean-square sound pressure levels (SPL_{rms})

The physiological and behavioral impacts on marine mammals due to underwater continuous noise from the SFWF inter-array installation are expected to be ***short-term*** and ***negligible*** to ***minor***. Injuries to marine mammals from underwater noise from DP thrusters, are unlikely because of short distances from the sound source to physiological thresholds, the relatively low density of mammals expected to occur in the region, and the short duration of the activity. For those few individuals in the vicinity that could be at risk of exposure to noise levels over the behavioral threshold, it is likely that other non-project-related noises from vessel traffic would interfere or interact, making it very uncertain if marine mammals will experience behavioral impacts from DP thruster operations or other sound sources. For those very few individuals that may perceive the continuous noise from the thrusters, they might experience short-term disruption of communication or echolocation from auditory masking; behavior disruptions; or limited, localized, and short-term displacement from ensonfied areas around the vessels.

Discharges and Releases / Trash and Debris

During construction of the SFWF, sanitary and other waste fluids, trash, and miscellaneous debris will be generated but properly managed in accordance with federal and state laws. Accidental discharges, releases, and disposal do represent a risk factor to marine mammals because they could potentially ingest or become entangled in debris, causing lethal or injurious impacts. As explained in Sections 4.1.5. and 4.1.6., the total quantities of hazardous and nonhazardous materials would be small and strictly managed. An OSRP (Appendix D) has been developed describing the procedures to be employed when responding to an oil spill, or the substantial threat of an oil discharge from any SFWF or SFEC component. DWSF and its contractors will also maintain SPCC plans during construction. Therefore, impacts on marine mammals from discharges, releases, trash, and debris are considered ***negligible*** because of the low likelihood of such routine and accidental events.

Vessel Traffic – Strikes

Short-term construction vessel traffic will occur over a 1- to 2-year period. Project-related vessel traffic will slightly increase vessel traffic within the area, but the number of vessels that operate for SFWF construction and decommissioning is expected to be a ***negligible*** addition to the normal traffic in the region (Appendix X, SFWF Navigational Safety Risk Assessment). Vessel collisions with marine mammals is not uncommon, and if they were to occur, would likely result in animal injury or death.

Vessel strikes happen when either whales or vessels fail to detect one another in time to avoid the collision. Variables that contribute to the likelihood of a collision include vessel speed, vessel size and type, and visibility. Marine mammal strikes have been reported at vessel speeds of 2 to 51 knots, and lethal or severe injuries are most likely to occur at speeds of 14 knots or more (DOI-MMS, 2007). Vessel types involved include Navy vessels, container and cargo ships, freighters, cruise ships, and ferries. Generally, the larger the vessel size (262 feet [80 m] or more), the more likely a collision will result in fatal or severe injuries (DOI-MMS, 2007).

Whale species that are most frequently involved in vessel collisions include fin whale, North Atlantic right whale, humpback whale, minke whale, sperm whale, sei whale, gray whale, and blue whale (Dolman et al., 2006). Smaller cetaceans and pinnipeds are also at risk of vessel strikes; however, these species tend to be more agile power simmers and are more capable of avoiding collisions with oncoming vessels (DOI-MMS, 2007).

Construction vessel traffic will result in a relatively ***short-term*** and ***localized impact*** around the SFWF, increasing the volume and movement of vessels in the SFWF. Large work vessels for foundation and WTG installation will generally transit to the work location and remain in the area until installation is complete. These large vessels will move slowly and over a short distance between work locations. Transport vessels will travel between several ports and the SFWF over the course of the construction period. These vessels will range in size from smaller crew transport boats to tug and barge vessels. Dependent on the time of year, the Project-related increase in vessel traffic will be ***negligible*** when compared to other vessel operations within the area.

To mitigate marine mammal vessel strikes, DWSF will abide by vessel strike avoidance measures based on NMFS's *Vessel Strike Avoidance Measures and Reporting for Mariners* (2008). Adherence to these provisions would further reduce the risk of associated vessel strikes or disturbance to marine mammals that might result from the proposed SFWF construction activity. It is not anticipated that the SFWF would cause a significant increase in frequency of vessel collisions to marine mammals; therefore, impacts caused by construction vessels would be considered ***minor***. However, because of low population estimates for threatened and endangered whale species that may occur in the area, vessel collisions could be detrimental to their population; therefore, impacts to ESA-listed species would be considered ***moderate***.

Entanglement of marine mammals can occur from the Project vessel traffic if lines, cables, or other tethered gear are placed in the water. However, since the only lines that will potentially be deployed would be steel anchor lines that will be under significant tension and short-term, it would be highly unlikely that marine mammals would become entangled. Therefore, the expected impact to marine mammals from entanglement would be ***negligible***.

Lighting

Artificial lighting during SFWF construction will be associated with navigational and deck lighting on vessels from dusk to dawn. It is likely that reaction of marine mammals to this artificial light is species-dependent and may include attraction or avoidance of an area. Because of the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for marine mammals during construction.

Visible Structures

Vessels, equipment, and structural elements used during SFWF and SFEC construction will be present for a limited time and only from certain locations on the OCS, Long Island, and the ports to be used during construction. If and how marine mammals perceive the physical presence of these vessels or structures is not well understood. However, the temporary nature of these sources during construction have such a ***negligible*** anticipated impact on resources that they are not considered further in this discussion.

Operations and Maintenance

Table 4.3-25 summarizes the level of impacts expected to occur to marine mammals during the O&M phase of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-25. IPFs and Potential Levels of Impact on Marine Mammals at the SFWF during Operation and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Seafloor Disturbance	Foundations	Negligible long-term indirect
Sediment Suspension and Deposition		Negligible short-term localized
Noise	Continuous Mechanical Noise	Minor to Moderate long-term
EMF		Negligible localized
Traffic	Collision	Negligible short-term localized
Discharges and Releases [a]		Negligible short-term
Trash and Debris [a]		Negligible short-term
Visible Structures	Physical presence; impediment to navigation	Negligible localized
Lighting		Negligible short-term

[a] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

The installation of the foundations and resulting conversion of existing sandy bottom to hard bottom habitat may produce a "reef effect" that will attract benthic and pelagic fish species similar to those found in rocky/reef outcrop habitat (Wilhelmsson et al., 2006; Reubens et al., 2007). This could potentially lead to an increased number of marine mammals using this habitat for foraging. Russel et al (2014) observed harbor and grey seals displaying concentrated foraging efforts around windfarms with site fidelity indicating successful foraging behavior. Impacts from the conversion of habitat to hard bottom would have measurable but not adverse impacts on only a few marine mammal species and are therefore expected to be ***negligible, long-term*** and ***indirect*** based on the pre-defined impact characterizations in Section 4.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M will primarily result from vessel anchoring and any maintenance activities that will require exposing the Inter-array Cable. Both activities are expected to be nonroutine events and not expected to occur with any regularity. Sediment suspension and deposition impacts resulting from vessel activity during SFWF O&M are expected to be similar to vessel-related sediment suspension and deposition impacts described for the construction phase.

Underwater Noise

Operating WTGs produce mechanical noise that transmits underwater through the towers and pilings, resulting in continuous underwater sounds. The frequency and sound level generated from operating WTGs depends on WTG size, wind speed and rotation, foundation type, water depth, seafloor characteristics, and wave conditions (Miller et al., 2010). Underwater noise from turbines has been measured within the hearing frequency of marine mammals; but at the anticipated levels, the impacts would be limited to audibility and perhaps some degree of behavioral response or auditory masking, (DOI-MMS, 2007). Behavioral responses include changes in foraging, socialization, or movement, while auditory masking could impact foraging and predator avoidance. Estimated underwater sound levels are summarized in Section 4.1.3, which reference sources that WTG sounds have been documented to range from 90 to 128 dB re 1 µPa in relative proximity (150 to 350 feet [46 to 107 m]) to operational turbines.

It is presumed that although wind turbine noise during O&M will persist for longer periods of time and potentially expose a higher number of individuals to increased noise levels, compared to noise produced by construction (DOI-MMS, 2007), the impacts to marine mammals during O&M will be smaller than during the construction phase (Scheidat et al., 2011). Studies conducted on the harbor seal indicate that abundance may be reduced during the construction phase, but that population sizes during the operational phase can return to preconstruction levels (Vellejo et al., 2017).

Additionally, Scheidat et al. (2011) indicated that harbor porpoise population sizes can be higher within wind farms compared to reference areas. Reasons for this may be an increased food supply (Vellejo et al., 2017) or habituation to the noise produced from turbines (Teilmann and Carstensen, 2012). Operational wind turbines sampled are only audible to harbor porpoises at distances of 207 feet (63 m) or less (English et al., 2017). Underwater noise during O&M is anticipated to result in ***minor*** impacts to marine mammals, if long-term avoidance behaviors by marine mammals result in potential abandonment of feeding grounds or migratory routes near the SFWF, then ***long-term, minor*** to ***moderate impacts*** could be expected.

Electromagnetic Field

Available evidence for marine mammals does not indicate that these species are capable of detecting the magnetic fields associated with the Project's 60-Hz AC cables. In particular, marine mammal surveys conducted at offshore windfarm sites indicate no adverse long-term impacts to these species. Appendix K has a more detailed discussion about the potential impacts of EMF on marine mammals. EMF is expected to be present near the cable, and marine mammals must surface to breathe. So, such behavior is expected to limit time spent near cables. Furthermore, the broad scale of marine mammal migrations and the generally low density of individuals within a given area are also expected to lower the likelihood that individuals will regularly encounter the cable route and Project-associated EMF. This broad distribution and movement means that the SFWF represents a small portion of the available habitat for migratory marine mammals. ***Negligible impacts*** from EMF during O&M are expected.

Vessel Traffic

The potential impacts of vessel collision during O&M on marine mammals would be less than those identified in the construction phase of the SFWF because the volume of vessel traffic will be much less than traffic experienced during construction, and negligibly contribute to existing vessel traffic in the area. Vessel strike impacts during SFWF O&M are anticipated to be ***negligible***.

Visible Structures
Structural elements of the SFWF will be present for the O&M life of the project. If and how marine mammals perceive or avoid the physical presence of the structures is not well understood. However, only ***negligible*** anticipated impacts on marine mammals due to the physical impediments to their movements is assumed.

Lighting
Artificial lighting during O&M will be associated with O&M vessels, the WTGs, and the OSS. Lighting on the WTG foundations and the OSS will be coordinated with the USCG to ensure it meets appropriate safety standards and to minimize potential impacts on marine organisms. It is likely that reaction of marine mammals to this artificial light is species-dependent and may include attraction or avoidance of an area. Because of the limited area associated with the artificial lighting used on Project vessels, the WTGs, and the OSS relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for marine mammals during O&M.

Decommissioning

During decommissioning activities, marine mammals could be impacted by underwater noise generated by the dismantling of the WTGs and potential collisions with the decommissioning vessels. Decommissioning would conceptually reverse the sequence of construction steps to dismantle or remove the SFWF. Decommissioning activities resulting in underwater noise and vessel traffic are expected to be less intensive than the activities associated with the construction phase of the Project. A more detailed description of decommissioning activities is provided in Section 3.1.6. Impacts to marine mammals would be considered ***negligible***.

South Fork Export Cable

Construction, O&M, and decommissioning activities associated with the SFEC have the potential to impact marine mammals. This section summarizes the potential impacts on marine mammals from activities associated with the SFEC. IPFs that could have more than negligible impacts include underwater noise and vessel traffic. Impacts associated with each phase of the SFEC are addressed in the following sections.

SFEC - OCS and SFEC - NYS

Construction

Table 4.3-26 summarizes the level of impacts expected to occur to marine mammals during the construction and decommissioning phases of the SFEC. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-26. IPFs and Potential Levels of Impact on Marine Mammals at the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Seafloor/Land Disturbance	Cable Installation	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized

Table 4.3-26. IPFs and Potential Levels of Impact on Marine Mammals at the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Noise	Installation of Cable	Negligible to Minor short-term
	Vibratory Hammering of Sheet Piles for Cofferdam	Negligible short-term
Discharges and Releases		Negligible short-term
Trash and Debris		Negligible short-term
Traffic	Increased Vessels	Negligible short-term localized
Lighting		Negligible short-term localized

Seafloor Disturbance

Seafloor disturbance associated with installation of the SFEC may impact marine mammals. Impacts are considered ***short-term*** and ***negligible*** for similar reasons as described for seafloor disturbances from SFWF construction.

Sediment Suspension and Deposition

As previously discussed for SFWF construction, impacts to the few marine mammals that may be located near the cable installation activities that could be exposed to sediment suspension are expected to be ***localized, short-term,*** and ***negligible***.

Underwater Noise

As described for the SFWF Inter-array Cable, the impacts of underwater noise generated from Project construction vessels, including the use of DP thrusters, on marine mammals are expected to be ***short-term*** and ***negligible***. ***Short-term, minor*** behavioral impacts can also occur during SFEC installation if marine mammals are exposed to the nonimpulsive sound generated by the DP thrusters. However, the likelihood of measurable impacts to marine mammals is considered very low because SFEC installation will occur over a relatively short timeframe; along a relatively narrow swath of ocean, and depending on the time of year of installation, few marine mammals would be expected in the region. As the cable-laying operation enters SFEC - NYS waters, the likelihood of impact decreases with the lower occurrence of marine mammals in nearshore waters, with the possible exception of some dolphins, porpoises, and seals, which may be found closer to shore on a seasonal basis.

Construction of a temporary cofferdam will be required for the nearshore SFEC connection and will require vibratory hammering and subsequent vibratory removal of sheet piles. This construction method differs from the pile driving associated with the SFWF foundations in several ways. The location is close to shore, the duration of the installation and removal is estimated to be short (roughly 12 to 24 hours for each activity), and the source type is nonimpulsive, compared to impulsive for the SFWF pile driving. Predicting marine mammal exposure estimates resulting from vibratory pile driving is complicated by the location, short duration of cofferdam installation, large behavioral isopleths created by a low acoustic threshold, and static species density data that are not indicative of animals transiting the near shore environment. No injury-level exposures are expected from vibratory pile driving due to the small isopleths in the case of MFC, HFC, and PPWs and due to the short duration of activity and low densities of LFC indicating that 24-hour duration exposures (required to meet the threshold) would not be achieved.

As detailed in Appendix P, the large behavioral isopleth for marine mammals (~36 km) is the result of a very conservative, and likely outdated, regulatory SPL_{rms} threshold of 120 dB re 1 µPa. This exaggerated isopleth suggests that all species within it will experience behavioral impacts from project-related non-impulsive noise, which is very likely not the case and ignores the complexity of factors involved for a receptor or group of receptors to be exposed to any one sound source in the ocean.

In the event that marine mammals were in the vicinity of the cofferdam installation during the limited construction period, the near-shore setting of the sound source and the masking effects of other non-project-related sounds diminishes the likelihood that marine mammals would be exposed solely to vibratory hammer noises resulting in physiological or behavioral impacts. For those very few individuals that may perceive the continuous noise from the vibratory hammering, they might experience short-term disruption of communication or echolocation from auditory masking; behavior disruptions; or limited, localized, and short-term displacement from ensonfied areas around the nearshore cofferdam. Therefore, marine mammal impacts from vibratory hammering of sheet piles for the SFEC cofferdam are expected to be ***short-term*** and ***negligible***.

Discharges and Releases / Trash and Debris
The potential for marine mammal exposure and impacts from routine and nonroutine discharges, releases, trash, and debris will be similar to those identified in the SFWF.

Traffic
The potential impacts of vessel traffic on marine mammals would be similar to those discussed above for the SFWF; however, the occurrence of impacts would be less likely because fewer vessels are required for SFEC installation. As the SFEC installation activity approaches the landing site in the SFEC - NYS, few marine mammals are expected in the area because of the shallow water.

Lighting
Artificial lighting during construction of the SFEC will be associated with navigational and deck lighting on vessels from dusk to dawn. Because of the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for marine mammals during construction.

Operations and Maintenance

Table 4.3-27 summarizes the level of impacts expected to occur to marine mammals during the O&M phase of the SFEC. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-27. IPFs and Potential Levels of Impact on Marine Mammals at the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Seafloor Disturbance	Potential SFEC Maintenance	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized

Table 4.3-27. IPFs and Potential Levels of Impact on Marine Mammals at the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Noise	Vessel Noise	Negligible short-term localized
EMF		Negligible localized
Traffic	Collision	Negligible short-term localized
Discharges and Releases [a]		Negligible short-term
Trash and Debris [a]		Negligible short-term
Lighting		Negligible short-term localized

[a] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1

Seafloor Disturbance
Maintenance of the SFEC is considered a nonroutine event and is not expected to occur with any regularity. Impacts associated with exposing the SFEC are expected to be similar but less frequent to those described for the construction/installation phase.

Sediment Suspension and Deposition
Increases in sediment suspension and deposition during O&M of the SFEC will primarily result from vessel anchoring and any maintenance activities that will require exposing the SFEC. Both activities are expected to be nonroutine events and not expected to occur with any regularity. Sediment suspension and deposition impacts resulting from vessel activity during O&M of the SFEC are expected to be similar to vessel-related sediment suspension and deposition impacts described for the SFEC construction phase, but less frequent and at a smaller scale.

Noise
Direct impacts to marine mammals associated with noise during O&M of the SFEC may occur associated with vessels. Impacts from vessel noise during O&M of the SFEC are expected to be similar to vessel noise impacts described for the SFWF construction, but at a smaller scale.

Electromagnetic Fields
The potential EMF impacts from the SFEC on marine mammals is similar to that described for the SFWF Inter-array Cable. Impacts to marine mammals relating to the EMF emitted from the SFEC will be ***negligible*** because of the low density of marine mammals in the water, their habit of surfacing for air, and the relatively narrow corridor occupied by the SFEC.

Traffic
The potential impacts of vessel collision will be similar to those identified in the SFWF.

Lighting
Artificial lighting during O&M will be associated with O&M vessels. Because of the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for marine mammals during O&M.

Decommissioning

Impacts expected to marine mammals would be similar to impacts during installation, assuming that similar vessels are used for the removal activity.

4.3.4.3 Potential Environmental Protection Measures

Environmental protection measures will be implemented to minimize impacts on marine mammals to the maximum extent possible, including the use of noise attenuation and ramp-up, soft-start, and shutdown pile-driving procedures. DWSF will consider the use of technically and commercially feasible noise attenuation technology.

Several environmental protection measures will reduce potential impacts to marine mammals.

- Exclusion and monitoring zones for marine mammals will be established for pile driving activities and HRG survey activities.
- Mitigation measures will be implemented for pile driving and HRG survey activities. These measures will include soft-start measures, shut-down procedures, protected species monitoring protocols, use of qualified and NOAA-approved protected species observers, and noise attenuation systems such as bubble curtains, as appropriate.
- Impact pile driving activities will not occur at the SFWF between January 1 and April 30 to minimize potential impacts to the North Atlantic right whale, which will have a protective effect for other marine mammal species.
- Vessels will follow NOAA guidelines for marine mammal strike avoidance measures, including vessel speed restrictions.
- All personnel working offshore will receive training on marine mammal awareness and marine debris awareness.
- DWSF will require all construction and operations vessels to comply with regulatory requirements related to the prevention and control of spills and discharges.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).
- The SFWF Inter-array Cable and SFEC - Offshore will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m).

DWSF intends to comply with federal regulations and guidelines to avoid and minimize impacts to marine mammals and has identified several potential measures based on protocols and procedures that have been successfully implemented for similarly approved offshore projects for marine mammals and other protected marine species.

4.3.5 Sea Turtles

The description of the affected environment of sea turtles, including documentation of regional occurrences and Project-related impact evaluation provided in this section, are based on the most recent literature and studies available that focus on renewable energy sites in the Mid-Atlantic and New England regions, including the Massachusetts Wind Energy Area (WEA), RI-MA WEA, OSAMP area, and the New York Offshore Planning Area. Studies encompassing these areas that were used for this assessment include the NOAA NEFSC's Atlantic Marine Assessment Program for Protected Species (AMAPPS) (Palka, 2010, 2011, 2012, 2013, 2014, and 2015), the *Northeast Large Pelagic Survey Collaborative Aerial and Acoustic Surveys for Large Whales and Sea Turtles* (Kraus et al., 2016), Remote Marine and Onshore Technology surveys for NYSERDA (Normandeau, 2016a, 2016b, 2017a, 2017b, 2017c, and 2018) and a technical report, *Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound, Rhode Island Sound and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Management Area Plan* (Kenney and Vigness-Raposa, 2010). In support of this impact evaluation, DWSF has completed a comprehensive underwater acoustic modeling effort (Appendix J1) and a detailed impact assessment for marine mammals, sea turtles, and sturgeon, including animal movement modeling as it relates to exposures to project-related underwater noise (Appendix P2).

4.3.5.1 Affected Environment

There are four sea turtle species that are commonly found throughout the western North Atlantic Ocean and may occur in the SFWF and SFEC Project areas. These species are the green sea turtle (*Chelonia mydas*), Kemp's ridley (*Lepidochelys kempii*), leatherback sea turtle (*Dermochelys coriacea*), and loggerhead sea turtle (*Caretta caretta*). A fifth species, hawksbill sea turtle (*Eretmochelys imbricata*), may potentially occur within the region. However, it is considered extremely rare because this species is commonly found in tropical waters and coral reef habitats (GARFO, 2017). The four turtle species included in this COP section are listed as endangered or threatened. The USFWS and NMFS share the responsibility for sea turtle recovery under the authority of the ESA.

Table 4.3-28 lists the sea turtles that may occur within the vicinity of the SFWF and SFEC. Appendix P1 provides additional information on the distribution and ecology of listed turtle species relevant to this discussion. The northeast coast, including areas around Long Island, contains a variety of marine habitats that are suitable for these sea turtles, such as shallows, enclosed waters of the Peconic, and the southern bays and the deeper waters of Long Island Sound and the Atlantic Ocean (Burke et al., 1993). In offshore and coastal waters of New York, the four species of sea turtles, loggerhead, green sea turtle, Kemp's ridley, and leatherback, have been recently documented predominantly in the summer and fall by the NYSERDA Digital Aerial Baseline Surveys (Normandeau, 2016a, 2016b, 2017a, 2017b, 2017c, and 2018). Winter turtle strandings have been documented on Long Island, although surveys of the waters north of the SFWF have not recorded turtle observations in the winter (Kraus et al., 2016).

Table 4.3-28. Sea Turtles That Occur within the Regional Waters of the Western North Atlantic OCS and Project Area

Species	Status[a]	Seasonal Presence in SFWF and SFEC[b, c]
Green Sea Turtle (North Atlantic DPS)	Threatened	Summer, fall
Kemp's Ridley Sea Turtle	Endangered	Summer, fall
Leatherback Sea Turtle	Endangered	Summer, fall
Loggerhead Sea Turtle (Northwest Atlantic Ocean DPS)	Threatened	Summer, fall

[a] ESA

[b] GARFO, 2017

[c] Kraus et al., 2016; Palka, 2010, 2011, 2012, 2013, 2014, 2015, and 2016; Palka et al., 2016; and Normandeau, 2016a, 2016b, 2017a, 2017b, 2017c, and 2018

Appendix P2 includes the results of the animal movement modeling completed in support of the impact assessment for marine mammals and sea turtles. The model considered sea turtle density estimates derived from SERDP-SDSS NODE database (http://seamap.env.duke.edu/serdp). Loggerhead, Kemp's ridley, and leatherback turtles are common visitors to the SFWF and SFEC Project area. The loggerhead and leatherback are the species that are expected to occur in higher densities offshore, while Kemp's ridley turtles would be more likely to occur nearshore of the SFEC and not as likely offshore near the SFWF.

4.3.5.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to impact sea turtles depending on when and where impact-producing activities occur. A review of the IPFs for sea turtles associated with the SFWF and SFEC is presented on Figure 4.3-12. The IPFs with potential to result in negligible or greater impacts on sea turtles are discussed in this section and in detail in Appendix P.

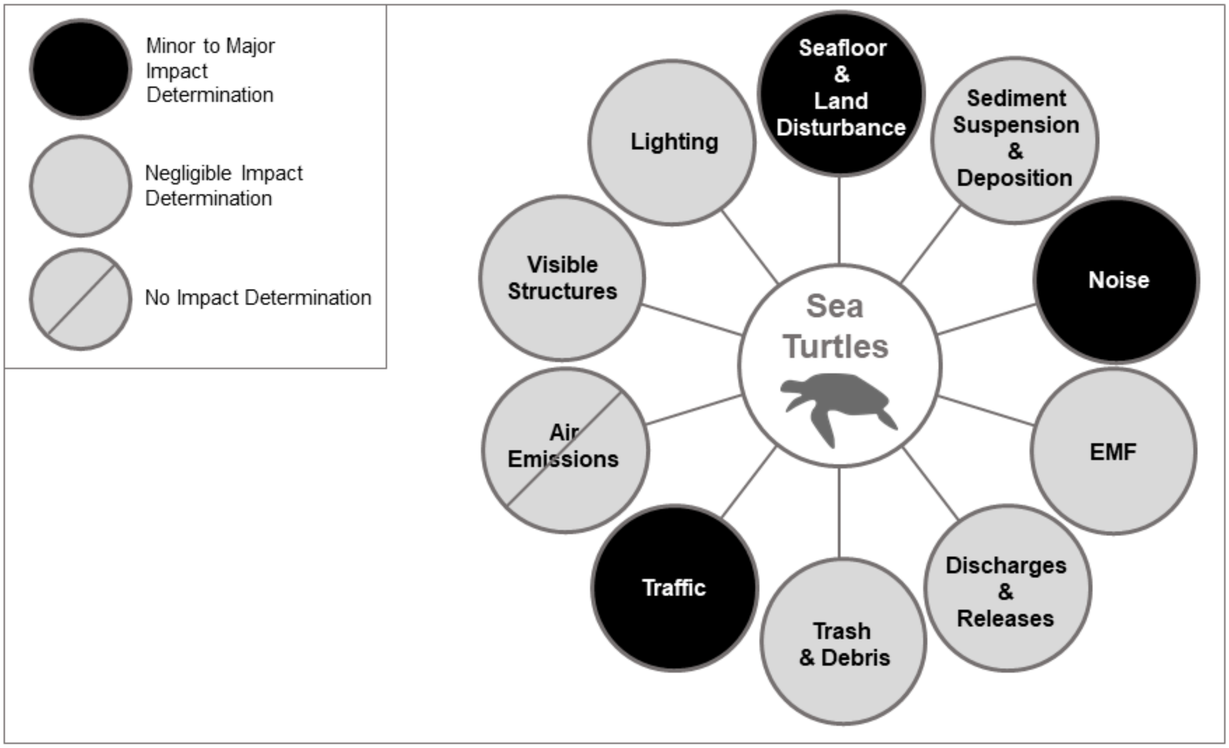

Figure 4.3-12. IPFs on Sea Turtles

Illustration of potential impacts to sea turtles resulting from SFWF and SFEC activities

South Fork Wind Farm

This section provides an overall assessment of potential impacts on sea turtles from the SFWF that is further explored in Appendix P. The primary IPFs associated with the SFWF that will result in minor to moderate impacts to sea turtles are underwater noise from construction, seafloor disturbance and vessel traffic. Other IPFs considered but anticipated to have negligible or no impacts to sea turtles are sediment suspension and deposition, EMFs, discharges and releases, trash and debris, visible structures, and lighting. The potential impacts associated with each phase of the SFWF are addressed separately in the following sections.

Construction

Table 4.3-29 provides a summary of the IPFs and potential levels of impact on Sea Turtles during Construction and Decommissioning.

Table 4.3-29. IPFs and Potential Levels of Impact on Sea Turtles at the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Seafloor/Land Disturbance	Seafloor Preparation	Negligible short-term localized
	Foundation Installation	Negligible short-term localized
	Vessel Anchoring	Negligible short-term localized
	Inter-array Cable Installation	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized

Table 4.3-29. IPFs and Potential Levels of Impact on Sea Turtles at the SFWF during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Noise	Pile Driving	Minor to Moderate short-term
	Equipment Uses	Negligible short-term localized
	Vessel Traffic	Negligible short-term
Discharges and Releases		Negligible indirect
Trash and Debris		Negligible indirect
Traffic	Collision	Minor to Moderate short-term localized
	Entanglement	Negligible short-term localized
Visible Structures	Physical structure; navigation impediment	Negligible indirect localized
Lighting	Navigational and Deck Lighting	Negligible short-term localized

Seafloor Disturbance

During construction, seafloor disturbances will be associated with seafloor preparation, foundation installation, vessel anchoring, and cable installation. Sea turtles occurring in the SFWF will likely be transiting the area in search of prey species, some of which could be benthic species. In the unlikely event that leatherback or loggerhead sea turtles forage on the seafloor in the SFWF and could be displaced from those areas because of SFWF construction, the impacts will be ***negligible*** because they are limited to those few impacted individuals and not groups or populations of turtles.

Sediment Suspension and Deposition

As discussed in Section 4.1 and again in Section 4.2.2, SFWF construction activities will result in short-term, localized increases in sedimentation in the water column (i.e., increased turbidity) and consequent impacts to the quality of the water column. Because of the relatively low anticipated densities of sea turtles in the SFWF, and the momentary and localized increases in turbidity and decreases in water quality from SFWF Inter-array Cable installation, ***negligible impacts*** are anticipated to the few leatherback or loggerhead sea turtles occurring near the cable installation activities.

Noise

Sea turtles may be impacted by underwater sounds produced during the construction of the SFWF with the potential for physiological and behavioral effects. Impacts of sound on sea turtles are largely unknown because of a lack of information on hearing capabilities and behavioral responses to sound. However, the data available suggest that sea turtles can detect and behaviorally respond to acoustic stimuli (Dow Piniak et al., 2012a). A detailed explanation of underwater noise impacts on sea turtles is provided in Appendix P, with an overview of the primary issues provided in this section.

A few experimental studies have been conducted on the hearing capabilities of green sea turtles, loggerhead sea turtles, Kemp’s ridley sea turtles, and leatherback sea turtles; however, the frequency ranges vary per species. Based on Bartol et al. (1999), juvenile loggerheads respond to click stimuli with a mean threshold of -10.8 dB re 1-gram (g) rms ± 2.3 dB standard deviation (SD). The hearing range from tone bursts was 250 to 750 Hz. The lowest frequency tested was 250 Hz, with a mean threshold of -23.3 dB re: 1 g rms ± 2.3 dB SD.

Bartol and Ketten (2006) measured the auditory evoked potentials (AEPs) of two Atlantic green sea turtles and six sub-adult Pacific green turtles. Sub-adults were found to respond to stimuli between 100 and 500 Hz, with a maximum sensitivity of 200 and 400 Hz. Juveniles responded to stimuli between 100 and 800 Hz, with a maximum sensitivity between 600 and 700 Hz.

Martin et al. (2012) recorded the AEPs of one adult loggerhead sea turtle. The loggerhead responded to frequencies between 100 and 1131 Hz, with greatest sensitivity between 200 and 400 Hz. This limited research indicates that sea turtles are capable of hearing LF sounds with some variation depending on size, age, and species.

In two separate studies conducted in 2012, Dow Piniak et al. recorded AEPs of turtles in air and underwater. Dow Piniak et al. (2012b) found that the AEPs of juvenile green turtles were between 50 and 1600 Hz in water, and 50 and 800 Hz in air; with ranges of maximum sensitivity between 50 and 400 Hz in water, and 300 and 400 Hz in air. Sensitivity decreased sharply after 400 Hz in both media. Dow Piniak et al. (2012a) found that hatchling leatherback sea turtles responded to stimuli between 50 and 1200 Hz in water, and 50 and 1600 Hz in air. The maximum sensitivity was between 100 and 400 Hz in water, and 50 and 400 Hz in air. These studies show that turtle hearing is more suited to underwater than in air.

Limited research has been conducted on the physiological impacts of underwater or in-air sound on sea turtles, and very few data are available on the behavioral responses of sea turtles to sound. The few studies that are available only examine the behavioral responses of loggerhead and green sea turtles to underwater sound produced by seismic guns. Behavioral responses observed during seismic surveys included avoiding the source of the sound (O'Hara and Wilcox, 1990), startled reactions (DeRuiter and Doukara, 2012), and increased swimming speed (McCauley et al., 2000). Other possible behavior responses could include increased surfacing time and decreased foraging. McCauley et al. (2000), reported that source levels of 166 dB re 1 µPa rms were required to induce behavioral reactions of sea turtles.

NOAA has not established formal acoustic thresholds for behavioral harassment or injury for sea turtles. As explained in the animal movement modeling report in Appendix P2, BOEM and NOAA have adopted the injury thresholds based on the dual criteria of peak pressure and accumulated sound energy reported by Popper et al. (2014) and the behavior thresholds developed by the GARFO (2016) and U.S. Navy (Blackstock et al., 2017). Table 4.3-30 summarizes the agency-adopted acoustic thresholds for sea turtles, which are used to evaluate noise impacts to sea turtles from impulsive sounds generated by impact pile driving and nonimpulsive sounds generated by DPV thrusters and vibratory hammering.

Table 4.3-30. Physiological and Behavioral Threshold Criteria for Impulsive and Nonimpulsive Sounds for Sea Turtles

Faunal Group	Sound Source Type	Injury Criteria Metric	Physiological Threshold	Behavior Criteria Metric	Behavioral Threshold
Sea Turtles	Impulsive sounds	SPL_{pk}	207 dB re 1 µPa	SPL_{rms}	175 dB re 1 µPa
		$SEL_{cum, 24hr}$	210 dB re 1 µPa^2 s		
	Nonimpulsive sounds	SPL_{rms}	180 dB re 1 µPa	SPL_{rms}	175 dB re 1 µPa

Source: GARFO, 2016; Popper et al., 2014; Blackstock et al., 2017.

Underwater acoustic modeling was conducted to estimate the impacts produced from construction-related, noise-producing activities, such as pile driving, vibratory pile driving, and DPV thrusters. Dependent on many factors as detailed in the underwater acoustic modeling study (Appendix J1) and sea turtle impact assessment (Appendix P1), elevated underwater SPLs may impact sea turtles. Pile driving and DPV thruster usage are identified as the activities that will likely have the greatest potential for impacts on sea turtles. As discussed in the IPF section (Section 4.1), above-water noise impacts on sea turtles during construction will result in negligible impacts because sea turtle exposures to underwater noises are more probable and impact-producing by comparison. Therefore, the potential for above-water noise impacts to sea turtles is not further discussed in this assessment of impacts.

Impulse Sound – Impact Pile-driving

Underwater noise from the impulsive sounds generated by impact pile driving is considered an important IPF in potential physiological and behavioral impacts to sea turtles. The assessment of potential acoustical impacts to sea turtles was completed based on the results of underwater acoustic modeling and animal movement modeling studies specific to proposed SFWF and SFEC construction activities. Appendix J1 provides predicted sound propagation distances based on key construction variables associated with the SFWF and SFEC design envelope, such as: hammer type, pile type, pile schedule (hammer energy/number of strikes/piling duration), season, geographic location, and implementation of noise mitigation (i.e., sound attenuation) measures. Appendix P2 provides a summary of the animal movement modeling and impact assessments based not only on underwater sound characteristics but the marine environment, autecological characteristics of at-risk species, mitigation factors, and animal behavior.

Based on the results of the underwater noise modeling and animal noise exposure estimates, impacts to sea turtles during pile driving for the SFWF would likely be ***minor*** to ***moderate***. Modeled impact pile driving at SFWF resulted in a mean distance of 291 m to the sea turtle physiological threshold, defined as the minimum SEL_{cum} accumulated over a 24-hour period that could potentially induce the onset of a mortal injury. The potential for physiological-level acoustic exposures are low even with no sound attenuation. The sea turtle impact assessment determined that seasonality is an important parameter when estimating exposures to potentially harmful underwater noise due to the variable monthly densities of animals in the Project area (Appendix P). With 10 dB noise attenuation, all exposures drop to <1 or fewer individuals (calculated by rounding up any fraction greater than or equal to 0.5) for all species evaluated in Appendix P2 except for loggerhead sea turtles.

Sea turtles are not expected to linger within the ensonified area around impact pile driving for durations that would result in a physiological impacts. The maximum distance to SPL_{pk} thresholds representing the greatest potential for instantaneous injury to sea turtles was 260 m, which would be reached only at the highest hammer energy near the end of pile installation (Appendix J1). Due to the placement of sound attenuation devices and general construction activities combined with much smaller impact isopleths for most hammer strikes, sea turtles are not expected to encroach any of the SPL_{pk} isopleths and, therefore, no physiological exposures are expected for sea turtles from impact pile driving.

Modeled behavioral thresholds ranged from 4,337 feet (1,322 m) with 12 dB attenuation to 11,457 feet (3,492 m) with no attenuation (Appendix J1). There is a likelihood of behavioral threshold exposure and general activity in the area that could result in sea turtles temporarily vacating the SFWF construction area. Exposures to acoustic thresholds are expected to be temporary and not biologically significant.

Nonimpulsive Sound

Commercial and recreational vessels can have varying SPLs dependent on the overall size, engine, propeller size, and configuration. These vessels can create LF noises that can be detected by turtles (Dow Piniak et al., 2012a). While the SPLs created may not directly damage hearing, the presence of vessels within sea turtle habitat may mask important auditory cues (Dow Piniak et al., 2012a). The additional noise from Project-related vessel traffic above the existing vessel-related underwater noise level is not expected to be significant, and the presumption is that individual sea turtles in the SFWF are familiar with various and common vessel-related noises, particularly within trafficked areas of the SFWF and nearby shipping lanes.

The use of DPV thrusters for laying the SFWF Inter-array Cable and SFEC is the vessel-related underwater noise source of concern to sea turtles. The cavitation on the propeller blades of the thrusters generate a continuous or nonimpulsive noise (e.g., Leggat et al., 1981). The noise power from the propellers is proportional to the number of blades, the propeller diameter, and the propeller tip speed. The noise from the DPV thrusters is expected to be more dominant than mechanical or hydraulic noises from the cable trenching equipment.

The hydroacoustic modeling calculations for DPV thruster operations presented in Appendix J1 include two representative locations, offshore and nearshore, for cable laying operations. Underwater noise from DPV thrusters is not expected to injure sea turtles because of the relatively low sound pressure levels and small estimated distances to behavior thresholds. If impacts occur to sea turtles from Project-related vessel noise then they will not be biologically significant and would be limited to short-term disruption and displacement of individuals from localized areas around the vessels. The impacts of underwater sound generated from most Project construction vessels on sea turtles is expected to be ***short-term*** and ***negligible***.

Discharges and Releases/Trash and Debris

During construction of the SFWF, sanitary and other waste fluids, trash, and miscellaneous debris will be generated but properly managed in accordance with federal and state laws. Accidental discharges, releases, and disposal do represent a risk factor to sea turtles because they could potentially ingest or become entangled in debris, causing lethal or injurious impacts. If sea turtles were to be exposed to an oil spill or a discharge of waste material, studies have indicated that respiration, skin, some aspects of blood chemistry and composition, and salt gland function could be significantly impacted (Vargo et al., 1986).

As explained in Sections 4.1.5. and 4.1.6., the total quantities of hazardous and nonhazardous materials will be small and strictly managed. An OSRP (Appendix D) has been developed describing the procedures to be employed when responding to an oil spill, or the substantial threat of an oil discharge from any SFWF or SFEC component. DWSF and its contractors will also maintain SPCC plans during construction. Therefore, impacts on sea turtles from discharges, releases, trash, and debris are considered ***negligible*** because of the low likelihood of such routine and accidental events.

Vessel Traffic

Sea turtles swimming or feeding at or near the surface of the water can be vulnerable to boat and vessel strikes. Propeller and collision injuries to sea turtles from boats or vessels are not uncommon (NOAA and USFWS, 1991). It is estimated that approximately 50 to 500 turtle mortalities per year in U.S. waters result from boat collisions (Plotkin, 1995). Vessel strikes happen when either turtles or vessels fail to detect one another in time to avoid the collision. Variables that contribute to the likelihood of a collision include vessel speed, vessel size and type, and visibility.

SFWF construction vessels could potentially collide with sea turtles, which could result in turtle injury or death. In the unlikely event that injury or death were to occur to one of the ESA-listed turtle species as a direct result of SFWF construction activities, these impacts will be considered ***moderate*** because of the conservation status of these species. Construction vessel traffic will be relatively short-term and localized around the SFWF where a concentrated increase in the volume and movement of vessels will occur. Large work vessels for foundation and WTG installation will generally transit to the work location and remain in the area until installation is complete. These large vessels will move slowly and over short distances between work locations. Transport vessels will travel between several ports and the SFWF over the course of the construction period. These vessels will range in size from smaller crew transport boats to tug and barge vessels.

Dependent on the time of year, Project-related vessel traffic will slightly increase within the area, but the number of vessels that operate for SFWF construction and decommissioning is expected to represent a negligible addition to the normal traffic in the region.

Entanglement of sea turtles can occur from Project vessels, especially from lines, cables, anchors, or other gear placed in the water. However, because the only lines that will potentially be deployed will be steel cables that will be under significant tension and short-term, it is highly unlikely that sea turtles will become entangled. Therefore, the expected impact to sea turtles from entanglement from SFWF construction activities will be ***negligible***.

Visible Structures

Vessels, equipment and structural elements used during SFWF and SFEC construction will be present for a limited time and only for certain locations on the OCS, Long Island, and the ports to be used during construction. If and how sea turtles perceive the physical presence of these vessels or structures is not well understood; however, the potential beneficial habitat alterations are discussed under "Seafloor Disturbance." The temporary nature of these sources during construction are expected to have a ***negligible*** anticipated impact on resources and they are not considered further in this discussion.

Lighting

Artificial lighting during SFWF construction will be associated with navigational and deck lighting on vessels from dusk to dawn. Reaction of sea turtles to this artificial light is dependent on species-specific and environmental factors that are impossible to predict but likely are to include attraction or avoidance of a lighted area. Because of the low anticipated density of sea turtles in the area and the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for sea turtles during construction.

Operations and Maintenance

Table 4.3-31 summarizes the level of impacts expected to occur to sea turtles during the O&M phase of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-31. IPFs and Potential Levels of Impact on Sea Turtles at the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Seafloor Disturbance	Foundations	Minor long-term indirect

Table 4.3-31. IPFs and Potential Levels of Impact on Sea Turtles at the SFWF during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Sediment Suspension and Deposition		Negligible short-term localized
Noise	Continuous Mechanical Noise	Negligible short-term localized
EMF		Negligible localized
Traffic	Collision	Negligible localized
Discharges and Releases [a]		Negligible short-term
Trash and Debris [a]		Negligible short-term
Visible Structures	Physical presence; impediment to navigation	Negligible localized
Lighting		Negligible short-term

[a] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

The construction of the SFWF will create hard-bottom habitats as discussed in Section 4.3.2 that will benefit sea turtles. Sea turtles have been observed within the vicinity of offshore structures, such as oil platforms (i.e., visible structures). High concentrations of sea turtles have been reported around these oil platforms NRC, 1996). During a surface survey at a platform off the coast of Galveston, Texas, approximately 170 sightings were reported (Gitschlag, 1990). Sea turtles use these offshore structures as areas to rest, seek refuge, and feed (NRC, 1996). It is estimated that offshore petroleum platforms in the Gulf of Mexico, provided an additional 2,000 square miles (5,180 km^2) of hard bottom habitat (Gallaway, 1981). For sea turtles visiting the SFWF mainly in the summer and fall, created habitat could result in a benefit to those individual turtles.

The potential "reef effect" caused by the introduction of a new hard bottom habitat in this area is expected to attract numerous species of algae, shellfish, finfish and sea turtles to this site (Wilhelmsson et al., 2006; Reubens et al., 2013). For sea turtles, artificial reefs can provide multiple benefits including foraging habitats, shelter from predation and strong currents, and methods of removing biological build-up from their carapace (NRC 1996; Barnette 2017). The increased fish activity is also expected to attract commercial and recreational fishing to the area, which could pose an ***indirect*** threat to sea turtles through entanglement or ingestion of fishing gear. Greater fishing effort around this site would increase the amount of equipment in the water increasing the risk of sea turtles ingesting or becoming entangled in this discarded equipment (Barnette 2017). Due to the current status of local sea turtles and the likelihood of increased fishing effort around the windfarm, the potential impacts are anticipated to be ***minor*** and ***long-term.***

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M will primarily result from vessel anchoring and any maintenance activities that will require exposing the Inter-array Cable. Both activities are expected to be nonroutine events and not expected to occur with any regularity.

Sediment suspension and deposition impacts resulting from vessel activity during SFWF O&M are expected to be similar to vessel-related sediment suspension and deposition impacts described for the construction phase.

Noise

Operational WTGs have the potential to produce underwater sound levels of 90 to 115 dB at a distance of 351 feet (110 m) in moderate winds and frequencies of 20 to 1,200 Hz, with peak levels at 50, 160, and 200 Hz (Thomsen et al., 2006). Potential impacts from operational noise produced by the turbines may include avoidance of the SFWF, disorientation, and disruption of feeding behaviors (BOEM, 2007). In contrast to the short-term duration of construction activities, noise generated during normal operation will be long-term over the operational life of the Project (i.e., 25 to 30 years). Adults and juveniles have strong enough swimming abilities to avoid the operational noises of a wind project, but hatchlings passively traveling through a wind project on currents may not be able to actively leave, thus subjecting them to long-term exposure to turbine noise (BOEM, 2007). The impacts of long-term noise exposure on sea turtles is generally unknown; however, because the sound levels produced during operation are less than the behavioral and physiological thresholds for sea turtles impacts to sea turtles are expected to be ***negligible***.

Electromagnetic Field

Sea turtles are highly migratory species and undergo trans-oceanic migrations during certain periods of their lives. Hatchlings swim from beaches into open ocean, juveniles migrate to and from seasonal habitats, and adults will leave feeding grounds to mate and migrate back to their natal beaches (Lohmann et al., 1999). To navigate and orient themselves, sea turtles are known to use the earth's magnetic fields. Sea turtles possess the ability to detect two different features of the geomagnetic field, including inclination angle and intensity (Lohmann and Lohmann, 1994). These fields vary across the earth's surface, and turtles can derive positional information from these fields.

It is theorized that sea turtles use these fields in two different ways (1) as a magnetic compass, for directional sense that enables them to establish a heading and maintain their course; and (2) for positional information, where turtles can approximate their position within the ocean (Lohmann and Lohmann, 1996). Multiple studies have demonstrated magneto-sensitivity and behavioral responses to field intensities ranging from 0.0047 to 4000 microteslas (µT) and 29.3 to 200 µT for loggerheads and green turtles, respectively (Normandeau, 2011).

Despite the potential for sea turtle orientation to be impacted by specific magnetic fields, available evidence for sea turtles does not indicate that these species are capable of detecting the magnetic fields associated with the Project's 60-Hz AC cables. Luschi et al. (1996) placed magnets on the head of sea turtles to mask the earth's magnetic fields from the sea turtles. Results showed that sea turtles with the magnets were still capable of returning home; however, their routes were less direct than the control (Normandeau, 2011; Luschi et al., 1996). Appendix K provides a more detailed discussion about the potential impacts of EMF on sea turtles.

Sea turtles could encounter EMF from the SFWF Inter-array Cable if feeding on benthic organisms in the SFWF at the sediment surface above the cable. Because these species must surface to breathe, such behavior is expected to limit time spent near cables. Furthermore, the broad scale of sea turtle migrations and the generally low density of individuals within a given area are also expected to lower the likelihood that individuals will regularly encounter the cable route and Project-associated EMF. This broad distribution and movement means that the SFWF represents a very small portion of the available habitat for migratory sea turtles. The impact of EMF on sea turtles during O&M is anticipated to be ***negligible***.

Traffic
The potential impacts of vessel collision on sea turtles will be less than those identified in the construction phase of the SFWF because the infrequent vessel traffic that will negligibly contribute to existing vessel traffic in the area. Vessel strike impacts on sea turtles during SFWF O&M are anticipated to be ***negligible***.

Visible Structures
Structural elements of the SFWF will be present for the O&M life of the project. If and how marine mammals perceive or avoid the physical presence of the structures is not well understood. However, only *negligible* anticipated impacts on marine mammals due to the physical impediments to their movements is assumed.

Lighting
Artificial lighting during O&M will be associated with O&M vessels, the WTGs, and the OSS. Lighting on the WTG foundations and the OSS will be coordinated with the USCG to ensure it meets appropriate safety standards and to minimize potential impacts on marine organisms. It is likely that reaction of sea turtles to this artificial light is species-dependent and may include attraction or avoidance of an area. Because of the limited area associated with the artificial lighting used on Project vessels, the WTGs, and the OSS relative to the surrounding unlit areas, the impacts are expected to be negligible and short-term for sea turtles during O&M.

Decommissioning

During decommissioning activities, sea turtles could be impacted by noise generated by the dismantling of the WTGs, collisions with the decommissioning vessels, and exposure to accidental release of hazardous materials or fuel spills. Decommissioning would conceptually reverse the sequence of construction steps to dismantle or remove the SFWF. Decommissioning activities resulting in underwater noise and vessel traffic are expected to be less intensive than the activities associated with the construction phase of the Project. Impacts to sea turtles during decommissioning are expected to be ***negligible***.

South Fork Export Cable

Construction, O&M, and decommissioning activities associated with the SFEC have the potential to impact sea turtles. This section summarizes the potential impacts on sea turtles from activities associated with the SFEC. IPFs that could have more than negligible potential impacts include noise and vessel traffic. Impacts associated with each phase of the SFEC are addressed in the following sections.

SFEC - OCS and SFEC - NYS

Construction

Table 4.3-32 summarizes the level of impacts expected to occur to marine mammals during the construction and decommissioning phases of the SFEC. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-32. IPFs and Potential Levels of Impact on Sea Turtles at the SFEC during Construction and Decommissioning

IPF	Potential Impact	Maximum Level of Impact
Seafloor/Land Disturbance	Cable Installation	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized
Noise	Installation of Cable	Negligible short-term
	Vibratory Hammering of Sheet Piles for the Cofferdam	Negligible short-term
Discharges and Releases		Negligible short-term
Trash and Debris		Negligible short-term
Traffic	Collision	Minor to Moderate short-term localized
	Entanglement	Negligible short-term
Lighting		Negligible short-term localized

Seafloor Disturbance

Seafloor disturbance associated with installation of the SFEC may impact sea turtles. Impacts are considered ***short-term*** and ***negligible*** for similar reasons as described for seafloor disturbances from SFWF construction.

Sediment Suspension and Deposition

As previously discussed for SFWF construction, impacts to the few transiting individual sea turtles in the region that could be exposed to sediment suspension are expected to be ***localized, short-term,*** and ***negligible***.

Noise

As described for the SFWF, the impacts of underwater noise generated from Project construction vessels on sea turtles are expected to be short-term and negligible. ***Short-term, negligible impacts*** may also occur during SFEC installation because of the considerable range of potentially disruptive sound propagation generated by the DPV thrusters during cable laying, and because cable installation will occur over a relatively short time frame. Also, the likelihood decreases for sea turtles occurring in shallow waters as the cable laying operation enters New York State waters. Therefore, the risk of sea turtles exposed to DPV noise is lower close to shore.

Construction of a cofferdam will be required for the nearshore SFEC connection and will require vibratory hammering of sheet piles. This installation differs from the piledriving for SFWF foundations because the location is close to shore, the duration of the installation is estimated to be short (roughly 12 to 24 hours), and the source type is nonimpulsive and continuous. Both the propagation characteristics of the sheet pile vibratory pile driving and the threshold criteria for sea turtles are different than for the pile driving for the foundation.

Vibratory pile driving associated with SFEC construction, while within the estimated hearing range of sea turtles, is expected to produce lower noise levels relative to impact pile driving.

Propagation modeling of vibratory pile driving at the SFEC indicates that isopleth ranges to both physiological and behavioral thresholds are relatively small: 31 m to physiological thresholds and 53 m to behavioral thresholds (Appendix J1). No injury or mortality is expected, and behavioral exposures are unlikely. If behavioral exposures occur, behavioral responses are expected to be temporary, short-term, and would not affect the reproduction, survival, or recovery of threatened or endangered species. Vibratory pile driving is anticipated to have ***negligible*** impacts on sea turtle species and may have no affect depending on the season in which this activity would take place. Winter and spring have very low densities of sea turtles in the area and would have a lower potential for any exposure risk.

Discharges and Releases/Trash and Debris
The potential for sea turtle exposure and impacts from routine and nonroutine discharges, releases, trash, and debris will be similar to those identified in the SFWF.

Traffic
The potential impacts of vessel traffic (collision or entanglement risk) on sea turtles will be less than those discussed for the SFWF because of the fewer anticipated vessels involved in SFEC construction.

Lighting
Artificial lighting during construction of the SFEC will be associated with navigational and deck lighting on vessels from dusk to dawn. Because of the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for sea turtles during construction.

Operations and Maintenance

Table 4.3-33 summarizes the level of impacts expected to occur to sea turtles during the O&M phase of the SFEC. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-33. IPFs and Potential Levels of Impact on Sea Turtles at the SFEC during Operations and Maintenance

IPF	Potential Impact	Maximum Level of Impact
Seafloor Disturbance	Potential SFEC Maintenance	Negligible short-term localized
Sediment Suspension and Deposition		Negligible short-term localized
Noise	Vessel noise	Negligible short-term localized
	Vibratory pile driving of the cofferdam	Negligible short-term localized
EMF		Negligible localized
Traffic	Collision	Negligible short-term localized
Discharges and Releases [a]		Negligible short-term
Trash and Debris [a]		Negligible short-term
Lighting		Negligible short-term

[a] Supporting information on the negligible level of impact for the Discharges and Trash/Debris IPFs is provided in Section 4.1.

Seafloor Disturbance

Maintenance of the SFEC is considered a nonroutine event and is not expected to occur with any regularity. Impacts associated with exposing the SFEC are expected to be similar but less frequent to those described for the construction/installation phase.

Sediment Suspension and Deposition

Increases in sediment suspension and deposition during O&M of the SFEC will primarily result from vessel anchoring and any maintenance activities that will require exposing the SFEC. Both activities are expected to be nonroutine events and not expected to occur with any regularity. Sediment suspension and deposition impacts resulting from vessel activity during O&M of the SFEC are expected to be similar to vessel-related sediment suspension and deposition impacts described for the SFEC construction phase, but less frequent and at a smaller scale.

Noise

Direct impacts to sea turtles associated with noise during O&M of the SFEC may occur associated with vessels. Impacts from vessel noise during O&M of the SFEC are expected to be similar to vessel noise impacts described for the SFWF and SFEC construction, but very limited in occurrence and duration.

Electromagnetic Fields

The potential EMF impacts from the SFEC on sea turtles is similar to that described for the SFWF Inter-array Cable. Impacts to sea turtles relating to the EMF emitted from the SFEC will be ***negligible*** because of the low density of sea turtles in the water, their habit of surfacing for air, and the relatively narrow corridor occupied by the SFEC.

Traffic

The potential impacts of vessel collision will be similar to those identified in the SFWF.

Lighting

Artificial lighting during O&M will be associated with O&M vessels. Because of the limited area associated with the artificial lighting used on Project vessels relative to the surrounding unlit areas, the impacts are expected to be ***negligible*** and ***short-term*** for sea turtles during O&M.

Decommissioning

The impacts expected to sea turtles will be similar to impacts during installation, assuming that similar vessels are used for the activity.

4.3.5.3 Proposed Environmental Protection Measures

Environmental protection measures will be implemented to minimize impacts on sea turtles to the maximum extent possible, including the use of noise attenuation and ramp-up, soft-start, and shutdown pile-driving procedures. DWSF will consider the use of technically and commercially feasible noise attenuation technology.

- Exclusion and monitoring zones will be established for sea turtles during pile driving activities and HRG survey activities.
- Mitigation measures will be implemented for pile driving and HRG survey activities. These measures will include soft-start measures, shut-down procedures, protected species monitoring protocols, use of qualified and NOAA-approved protected species observers, and noise attenuation systems such as bubble curtains, as appropriate.

- Impact pile driving activities will not occur at the SFWF from January 1 to April 30 to minimize potential impacts to the North Atlantic right whale, which will have a protective effect for sea turtles.
- Vessels will follow NOAA guidelines for sea turtle strike avoidance measures, including vessel speed restrictions.
- All personnel working offshore will receive training on sea turtle awareness and marine debris awareness.
- DWSF will require all construction and operations vessels to comply with regulatory requirements related to the prevention and control of spills and discharges.
- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).
- The SFWF Inter-array Cable and SFEC - Offshore will be buried to a target depth of 4 to 6 feet (1.2 to 1.8 m).

4.3.6 Avian Species

The description of the affected environment and assessment of potential impacts to avian species and their habitats was evaluated by reviewing survey results from land-based, ship-based, aerial, and radar surveys; online data modeling and mapping databases; and correspondence and consultation with federal and state agencies. Recent data on listed species include preliminary results of digital very high-frequency (VHF; nanotag) tracking studies funded through BOEM and boat-based bird surveys at the BIWF off the coast of Rhode Island. The BIWF is the first offshore wind farm in the United States and is currently the only regional wind development site with both pre- and post-construction data. These results can help inform potential impacts to birds at the SFWF and other offshore wind projects in the region. Avian species within the potentially affected environment are described below, followed by an evaluation of potential project-related impacts. For more information regarding the avian species at the SFWF, see the SFWF Draft Avian and Bat Risk Assessment and Draft Avian and Bat Resources Technical Report, and the BIWF Post-Construction Avian Ship-based Survey in Appendix Q.

4.3.6.1 Affected Environment

Regional Overview

As described in BOEM's Revised Environmental Assessment (BOEM, 2013), the Atlantic Coast along New York, Rhode Island, and Massachusetts is used by a variety of avian species for foraging, breeding, and migration. Water depth is likely the primary physical feature affecting bird species distribution in the marine environment, as this physical habitat characteristic limits where different species can successfully access food resources. However, other factors such as coastline character, substrate, water temperature, salinity, and currents all affect resource availability throughout the year and, consequently, seasonal bird species distribution and abundance. Major habitat types expected to be found within the SFWF and SFEC are described in Section 4.3.1. The nearshore open waters surrounding Montauk Point, New York, including Montauk Shoals and Endeavor Shoals, provide important seabird and wintering waterfowl habitat. Generally, as the distance from shore increases, bird abundance decreases (Paton et al., 2010; Winiarski et al., 2011; Geo-Marine Inc., 2010; and Menza et al., 2012).

State- and federally listed species documented or potentially present in the SFWF and portions of the SFEC − OCS, SFEC - NYS, and SFEC − Onshore include northern harrier (*Circus cyaneus*) (state threatened), bald eagle (*Haliaeetus leucocephalus*) (state threatened), piping plover (*Charadius melodus*) (federally threatened and state endangered), rufa red knot (*Calidris canutus rufa*) (federally threatened), least tern (*Sternula antillarum*) (state threatened), roseate tern (*Sterna dougallii*) (federally and state endangered), and common tern (*Sterna hirundo*) (state threatened). These species are discussed in the following sections.

For the purposes of this summary, "offshore" is defined as waters beyond a 3-nm (5.6 km) distance from land and 'nearshore' is within the 3-nm (5.6 km) distance from land.

South Fork Wind Farm

Offshore waters provide high-value foraging habitat for seabirds in locations with a varied resource base of forage fish, crustaceans, and mollusks. The SFWF will be located in deep water (approximately 105 to 147 feet (32 to 45 m) where there are no shoals, but fish, crustaceans, and other zooplankton are available at different depths. Benthic resources, including shellfish, and associated habitat types are described in Section 4.3.2.

Table 4.3-34 summarizes species present or potentially present within the SFWF. The table delineates timing, distribution, and status of avian groups expected to occur in the SFWF. Avian groups likely to use deeper offshore waters within the SFWF at least seasonally include loons (*Gavia spp.*), shearwaters (*Procellariidae spp.*), fulmars (*Procellariidae spp.*), storm-petrels (*Hydrobates pelagicus*), gannets (*Morus spp.*), seaducks (*Merginae spp.*), jaegers (*Stercorariidae spp.*), gulls (*Laridae spp.*), kittiwakes (*Rissa spp.*), terns (*Laridae spp.*), alcids (*Alcidae spp.*), and to a lesser extent, migrating shorebirds and land birds. Appendix Q includes additional details about the presence of these species groups. Shorebirds (except for phalaropes) are not expected to occur away from shore unless flying during migratory movements. Species that are state- or federally listed are described in more detail in relation to proposed SFWF activities in the following sections. See Appendix Q for additional information on listed species.

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Table 4.3-34 Timing, Distribution, and Status of Avian Species Groups That Have Potential to Occur in the SFWF

Species Group	Status	Seasonal Use	Peak Season	Primary Location	Status Offshore
Loons (*Gavia spp.*) Common (*Gavia immer*) Red-throated (*Gavia stellate*)	State special concern	Migrant, winter resident	Fall, winter	Nearshore, offshore	 Uncommon Uncommon
Shearwaters (*Procellariidae spp.*) Manx (*Puffinus puffinus*) Great (*Puffinus gravis*) Sooty (*Ardenna grisea*) Cory's (*Calonectris borealis*) Audubon's (*Puffinus iherminieri*)	 -- -- -- --	Summer resident	Summer	Offshore	 Common Abundant Common Abundant Uncommon
Northern fulmars (*Fulmarus glacialis*)	--	Winter resident	Fall, winter	Offshore	Uncommon
Storm-petrels (*Hydrobates pelagicus*) Wilson's (*Oceanites oceanicus*) Leach's (*Oceanodroma leucorha*)	 -- --	Summer resident	Summer	Offshore	 Abundant Uncommon
Northern gannets (*Morus bassanus*)	--	Migrant, winter resident	Spring, fall, winter	Offshore	Common
Seaducks (*Merginae spp.*) Common eider (*Somateria mollissima*) Black scoter (*Melanitta americana*) White-winged scoter (*Melanitta deglandi*) Surf Scoter (*Melanitta perspicillata*) Long-tailed duck (*Clangula hyemalis*)	 -- -- -- --	Migrant, winter resident	Winter	Nearshore, offshore	 Uncommon Uncommon Uncommon Uncommon Uncommon
Jaegers (*Stercorariidae spp.*) Parasitic (*Stercorarius parasiticus*) Pomarine (*Stercorarius pomarinus*)	 -- --	Migrant	Spring, fall	Offshore, nearshore	 Uncommon Rare

Table 4.3-34 Timing, Distribution, and Status of Avian Species Groups That Have Potential to Occur in the SFWF

Species Group	Status	Seasonal Use	Peak Season	Primary Location	Status Offshore
Gulls (*Laridae spp.*) Herring (*Larus argentatus*) Great black-backed (*Larus marinus*) Bonaparte's (*Chroicocephalus philadelphia*) Laughing (*Leucophaeus atricilla*)	 -- -- -- --	Breeder, migrant, winter resident	Year-round	Nearshore, offshore	 Common Uncommon Uncommon Common
Black-legged kittiwakes (*Rissa tridactyla*)	--	Migrant, winter resident	Winter	Offshore	Abundant
Terns (*Laridae spp.*) Common (*Sterna hirundo*) Roseate (*Sterna dougallii*) Least (*Sternula antillarum*)	New York Threatened Federal Endangered New York Endangered New York Threatened	Breeder, migrant	Summer	Nearshore, offshore	 Rare Rare Rare
Alcids (*Alcidae spp.*) Razorbill (*Alca torda*) Common murre (*Uria aalge*) Thick-billed murre (*Uria lomvia*) Atlantic puffin (*Fratercula arctica*) Dovekie (*Alle alle*) Black guillemot (*Cepphus grylie*)	 -- -- -- -- -- --	Migrant, winter resident	Winter	Nearshore, offshore	 Uncommon Uncommon Uncommon Rare Common Uncommon
Land birds*		Migrant	Spring, fall	Migrating	Uncommon

Sources: Paton et al., 2010; Tetra Tech and DeTect, 2012; Winiarski et al., 2012; and Sussman and USGS, 2014.

* Observed land bird species: various swallow species

SFEC – OCS and SFEC - NYS

The following summary focuses on avian groups documented or expected to occur in portions of the SFEC − OCS. The SFEC − OCS is primarily a pelagic environment, and bird species composition, distribution, seasonality, and resource base are likely to be similar to that described for the SFWF. Where the proposed cable route travels south of Montauk Point, the bird community is expected to include more coastal species. In the area where the proposed cable route comes within 10 miles (16 km) of Montauk Point, pelagic species become more uncommon and the composition of birds begins to include species that occur both nearshore and offshore.

Table 4.3-35 summarizes species present or potentially present within the SFEC. Avian groups likely to use deeper offshore waters at least seasonally include loons, shearwaters, fulmars, storm-petrels, gannets, seaducks, jaegers, gulls, kittiwakes, terns, alcids, and to a lesser extent, migrating shorebirds and land birds. Appendix Q provides additional detail about the occurrence on bird species and their status with respect to the SFEC, including additional information on listed species.

The SFEC − NYS will be more than 3 miles (5 km) from the productive shallow waters nearshore, including Montauk Shoals and Endeavor Shoals. Data from local surveys, such as Christmas Bird Counts, indicate a variety of land birds and waterbirds occur onshore in the area. Horseshoe crabs breed on the beaches in large numbers during the spring providing forage for migrant shorebirds, including the rufa red knot. Species known to occur in the New York Bight, the location of the SFEC route, include terns, gulls, cormorants (*Phalacrocoracidae spp.*), and shorebirds during summer and seaducks, bay ducks (*Aythyinae spp.*), fish ducks (*Anatidae spp.*), dabblers (*Anas spp.*), loons, grebes (*Podicipedidae spp.*), and alcids during winter. In the fall, the highest densities of seabirds are observed south and east of Montauk Point and along the south shore of Long Island. Other more pelagic species that could occur around the SFEC − NYS include Cory's shearwater (*Calonectris borealis*), northern gannet (*Morus bassanus*), and black-legged kittiwake (*Rissa tridactyla*). Table 4.3-36 summarizes species present or potentially present within New York State waters. Appendix Q provides additional detail about the occurrence on bird species and their status with respect to the SFEC − NYS nearshore and onshore.

Shorebirds will use intertidal zones of beaches for foraging for invertebrates, small crustaceans, bivalve mollusks, small polychaete worms, insects, and talitrid amphipods (Macwhirter et al., 2002). Terns and related species will forage over shallow waters and sandspits near shore in pursuit of small prey fish (Nisbet et al., 2017). Breeding shorebirds on Long Island include piping plover, American oystercatcher (*Haematopus palliates*), and killdeer (*Charadrius vociferous*). Several species will overwinter on Long Island (sanderling [*Calidris alba*], dunlin [*C. alpine*], purple sandpiper [*C. maritima*]), but most shorebirds occur as migrants. Other species likely to occur on Long Island during migration include black-bellied plover (*Pluvialis squatarola*), semipalmated plover (*Charadrius semipalmatus*), ruddy turnstone (*Arenaria interpres*), semipalmated sandpiper (*Calidris pusilla*), and short-billed dowitcher (*Limnodromus griseus*). During migration, rufa red knots occur on large waterbodies with suitable shoreline habitat. Concentrations of this species can occur on the south shore of Long Island in spring and fall. Preliminary results from BOEM's nanotag study detected birds flying around Long Island's south shore (Loring et al., 2017).

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Table 4.3-35. Timing, Distribution, and Status of Avian Species Groups That Have Potential to Occur in the SFEC − OCS

Avian Group	Seasonal Use	Peak Seasons	Peak/Primary Location	Status Offshore
Loons	Migrant, winter resident	Fall, winter	Offshore, nearshore	Common (more common nearshore)
Shearwaters	Summer resident	Summer	Offshore	Common
Storm-petrels	Summer resident	Summer	Offshore	Common
Gannets	Migrant, winter resident	Winter, spring, fall	Offshore	Common
Seaducks[a]	Migrant, winter resident	Winter, spring, fall	Offshore, nearshore	Uncommon
Jaegers	Migrant	Spring, summer, fall	Offshore	Rare
Gulls[b]	Breeder, migrant, winter resident	Year-round	Offshore, nearshore	Abundant (more abundant nearshore)
Kittiwakes	Migrant, winter resident	Winter	Offshore	Abundant
Terns	Migrant, post-breeding	Summer	Offshore, nearshore	Rare offshore
Alcids	Migrant, winter resident	Winter	Offshore, nearshore	Common (more common nearshore; exc. dovekie, more common offshore)
Land birds[c]	Migrant	Spring, fall	Migrating	Uncommon

Sources: Paton et al., 2010; Tetra Tech and DeTect, 2012; Winiarski et al., 2012; and Sussman and USGS, 2014.

[a] Observed waterfowl species: common eider, surf scoter, black scoter, long-tailed duck, white-winged scoter, red-breasted merganser.
[b] Observed gull species: herring gull, great black-backed gull, laughing gull, ring-billed gull, Bonaparte's gull.
[c] Observed land bird species: various swallow species.

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SFEC – Onshore

A variety of land birds have potential to occur in upland and coastal habitats associated with the onshore portions of the SFEC. A wide variety of passerines and other land birds use Long Island as a potential stopover location along the Atlantic Coast during migration and could fly over the cable route when coming to land. These migrants include species that breed in the surrounding dune, coastal wetland, shrub, forested, and urban habitats near the SFEC − Onshore, as well as species with breeding ranges further to the north and east that only pass through Long Island in spring and fall.

Avian species that may breed in the area primarily include locally nesting marsh and wading birds using nearby coastal wetlands and common swallows, thrushes, corvids, warblers, sparrows, and blackbirds using residential, backyard, and small field habitats proximal to the SFEC − Onshore.

The state threatened northern harrier is known to breed at locations across Long Island, with breeding records near the SFEC − Onshore, including Napeague State Park, Hither Hills State Park, Napeague Harbor (NYSDEC, 2017). Their breeding period extends from April through September, with nesting habitat in marshes, meadows, and grasslands with low, thick vegetation (Smith et al., 2011). Species occurring only in winter are even fewer and may include species such as snow buntings (*Plectrophenax nivalis*), horned larks (*Eremophila alpestris*), and snowy owls (*Bubo scandiacus*) as well as some of the year-round resident land bird species, including corvids, chickadees, and titmice.

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Table 4.3-36. Timing, Distribution, and Status of Avian Species Groups Likely to Occur in the Onshore Cable Route and Landing Sites of the SFEC − NYS

Avian Group	Seasonal Use	Peak/Primary Seasons	Peak/Primary Location	Status in Coastal Waters
Loons	Migrant, winter resident	Fall, winter	Offshore, nearshore	Common
Grebes	Migrant, winter resident	Winter	Nearshore	Occasional
Gannets	Migrant, winter resident	Spring, fall	Offshore	Uncommon
Cormorants	Summer breeder; winter resident	Summer, fall	Nearshore	Common (exc. great cormorant, occasional)
Seaducks[a]	Winter resident	Winter	Offshore, nearshore	Common
Geese, bay ducks, fish ducks, and dabblers[b]	Migrant, winter resident	Fall, winter	Offshore, nearshore	Common
Shorebirds[c]	Breeding, migrant, winter resident	Spring, fall	Nearshore, onshore	Common
Gulls[d]	Breeding, migrant, winter resident	Spring, summer	Offshore, nearshore, onshore	Abundant
Kittiwakes	Winter resident	Winter	Offshore	Occasional
Terns[e]	Breeding, migrant	Summer, fall	Nearshore, onshore	Common
Land birds[f]	Breeding, migrant, winter resident	Spring, summer	Onshore	Common

Sources: Paton et al., 2010; O'Connell et al., 2011; Tetra Tech and DeTect, 2012; Veit et al., 2016; Sussman and USGS, 2014; and land-based surveys and nearshore boat surveys.

[a] Observed seaduck species: black scoter, white-winged scoter.
[b] Observed geese and duck species: Canada goose, brant, common goldeneye, bufflehead, greater scaup, hooded merganser, red-breasted merganser, American black duck, mallard, American widgeon, harlequin duck.
[c] Observed overwintering shorebird species: purple sandpiper, sanderling, dunlin, piping plover.
[d] Observed gull species: herring gull, great black-backed gull, laughing gull, ring-billed gull, Bonaparte's gull.
[e] Observed tern species and allies: common tern, Forster's tern, roseate tern, least tern, black skimmer.
[f] Observed land birds include raptors, herons, doves, and passerines.

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4.3.6.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential to affect avian species through both direct and indirect impacts, including habitat loss/modification, disturbance, and collision risk, and displacement, attraction, barrier effects, and mortality or injury associated with discharges/releases or trash/debris.

The IPFs and anticipated levels of impact to birds associated with the construction, O&M, and decommissioning phases for the SFWF and SFEC are outlined in Tables 4.3-37 through 4.3-39 and Figure 4.3-13, including potential impacts to the federally listed roseate tern, piping plover, and red knot, and state-listed least tern and common tern. Impacts resulting from the SFWF and SFEC are anticipated to range from no impact to minor. The SFWF and SFEC's risk assessment in Appendix Q includes additional details of these impacts which are summarized below.

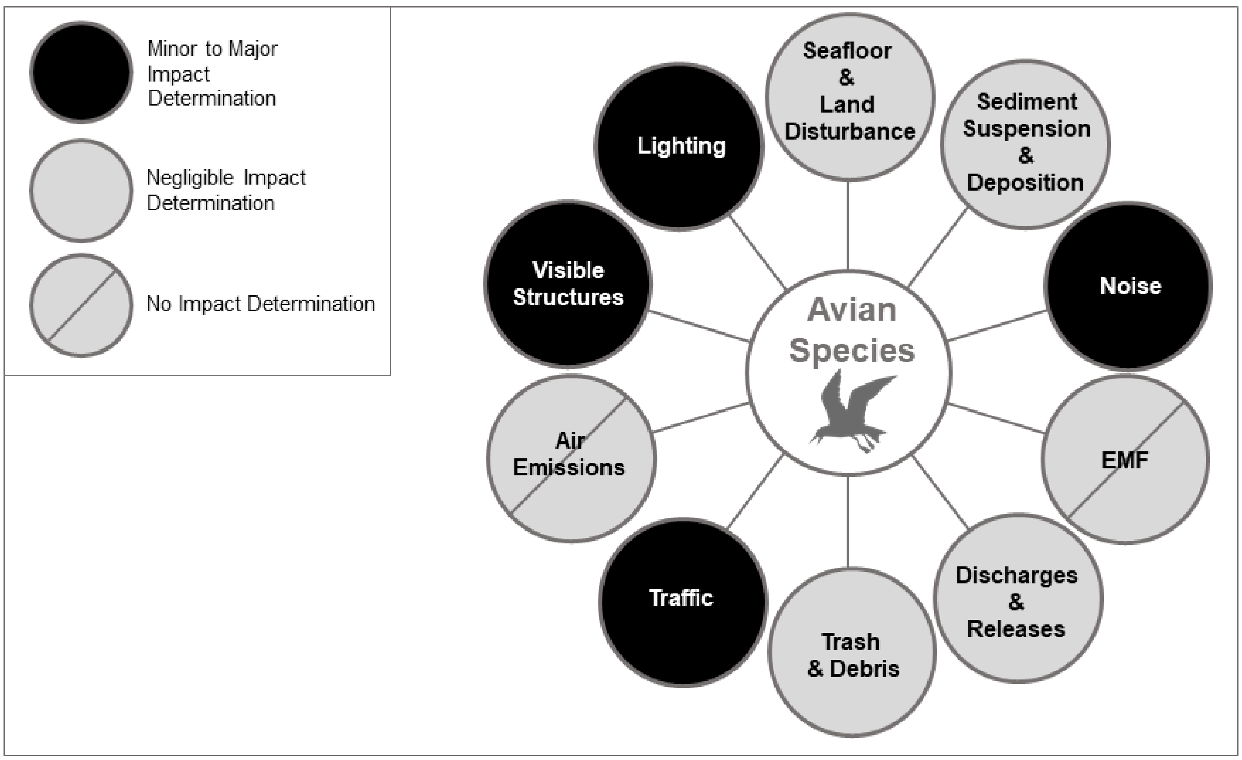

Figure 4.3-13. IPFs on Avian Species

Illustration of potential impacts to avian species, including potential impacts to the federally listed roseate tern, piping plover, and red knot, and state-listed least tern and common tern resulting from SFWF and SFEC activities

South Fork Wind Farm

This section summarizes the assessment of potential impacts on avian species presented in Appendix Q. The primary IPFs associated with the SFWF that could impact avian species include Seafloor or Land Disturbance, Sediment Suspension and Deposition, Noise, Traffic, Visible Structures and Lighting, Discharges and Releases, and Trash and Debris. The potential impacts associated with each phase of the SFWF are addressed separately in the following sections.

Construction

Table 4.3-37 summarizes the level of impacts expected to occur to avian species during the construction and decommissioning phase of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-37. IPFs and Potential Levels of Impact on Avian Species for the SFWF during Construction and Decommissioning

Impact Producing Factor	Project Activity	Potential Impact
Seafloor/Land Disturbance	Habitat loss/modification from WTG foundation and Inter-array Cable installation	Negligible direct
Sediment Suspension and Deposition	Habitat loss/modification from WTG foundation and Inter-array Cable installation	Negligible direct
Noise	Disturbance from pile-driving and Inter-array Cable installation	Negligible or Minor direct
Traffic	Disturbance from vessel activity	Negligible or Minor direct
Visible Structures / Lighting	Collision risk with construction vessels/platforms	Negligible to Minor direct
Discharges/Releases	Mortality/decreased breeding success during construction activities associated with WTG foundation and Inter-array Cable installation	Negligible indirect
Trash/Debris	Mortality/injury from accidental disposals associated with WTG foundation and Inter-array Cable installation	Negligible indirect

Seafloor Disturbance and Sediment Suspension and Deposition

Because of the short-term nature of construction and decommissioning activities, only ***negligible impacts*** associated with the direct effect of habitat loss or modification due to seafloor/land disturbance are anticipated.

Noise and Traffic

Only ***negligible*** to ***minor impacts*** to birds because of disturbances associated with noise and vessel traffic are expected during construction activities. These impacts will be short-term and similar to those observed with normal non-project-related vessel traffic.

Visible Structures and Lighting

Negligible to ***minor impacts*** associated with collision risk with visible structures for birds during construction may occur, depending on the species and number of individuals involved in potential collision events. Birds are susceptible to collision with both moving and stationary man-made structures extending above the surface of the water, particularly at night and/or during other periods of low visibility (e.g., rain or fog). Brightly illuminated structures offshore such as research platforms pose a risk to birds migrating at night particularly during rain or fog when birds can become disoriented by sources of artificial light. While nocturnal migrant passerines are known to be most prone to collision with man-made structures, among those species that may be at risk of collision include federally or state-listed species: roseate tern, rufa red knot, piping plover, least tern, and common tern. While collision risk for these species of concern is considered low, the loss of one or a few individuals to these populations already at risk could represent a ***minor impact***. Other bird groups with relatively stable populations may generally be at risk of ***negligible*** to ***minor impacts*** resulting from collision, depending on the time of year and number of individuals involved. Lighting during construction activities will be limited to the minimum required for safety during construction activities to minimize impacts.

Discharges and Releases
Potential indirect effects such as mortality or injury from contaminant discharges or releases during construction and decommissioning would be expected to result in ***negligible impacts*** because of the preemptive implementation of BMPs to prevent such incidents.

Trash and Debris
Potential indirect effects such as mortality or injury from accidental disposal of trash or debris during construction and decommissioning is expected to result in ***negligible impacts*** because of the preemptive implementation of BMPs to prevent such incidents.

Operations and Maintenance

Table 4.3-38 summarizes the level of impacts expected to occur to avian species during the O&M phase of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-38. IPFs and Potential Levels of Impact on Avian Species for the SFWF during Operations and Maintenance

IPF	Potential Effect from Project Activity	Potential Impact
Noise	Disturbance from WTG operation and maintenance vessel activity	Negligible to Minor direct
Traffic	Disturbance from maintenance vessel activity	Negligible to Minor direct
Visible Structures / Lighting	Collision risk with WTGs or OSS	Negligible to Minor direct
	Displacement, attraction, or barrier effect, based on presence of WTGs or OSS	Negligible to Minor direct
Discharges/Releases	Maintenance vessel activity at WTGs or OSS	Negligible indirect
Trash/Debris	Maintenance vessel activity at WTGs or OSS	Negligible indirect

Traffic and Noise
Direct impacts during O&M could include short-term disturbances associated with traffic or noise during maintenance activities. These disturbances would be ***short-term*** and ***negligible*** to ***minor*** and similar to those observed with normal vessel traffic.

Visible Structures and Lighting

The primary direct impact for birds during O&M is collision risk with WTGs at the SFWF because of visible structures and lighting. Species most at risk of collision are those that more frequently occur in the rotor-swept zone (RSZ) and those that may travel through the SFWF at night or periods of inclement weather. Impacts associated with risk of collision are anticipated to be ***negligible*** to ***minor*** and would be dependent on species and the number of individuals involved. Federally and state-listed species are among birds that may be susceptible to minor impacts associated with collision risk, including roseate tern, rufa red knot, piping plover, least tern, and common tern. While these species are not expected to frequent the SFWF, individuals in general may cross the area at most twice per year during migration. The loss of one or a few individuals, over the life of the SFWF, for a population already at risk would represent an adverse impact; however, it would not represent an impact that that these populations could not recover from. Other avian groups with relatively stable populations may generally be at risk of ***negligible*** to ***minor impacts*** resulting from collision, depending on the time of year and number of individuals involved.

Indirect operational impacts related to visible structures and lighting may pose ***negligible*** to ***minor impacts***, depending on type of impact (displacement, attraction, or barrier effect, or discharge/release). Displacement, attraction, and barrier effects are expected to generally result in ***negligible*** to ***minor impacts*** to most species that seasonally occur in the SFWF.

Discharges and Releases

The level of impact of a contaminant spill or release would be dependent on the type, size, and location of the spill. Federally and state-listed birds are among species that may be impacted after a spill or release. However, any potential spill-related impacts are expected to be mitigated by a series of avoidance and minimization measures and preemptive implementation of BMPs during operations; therefore, discharges and releases during O&M are expected to result in ***negligible impacts***.

Trash and Debris

Potential indirect effects such as mortality or injury from accidental disposal of trash or debris during O&M is expected to result in ***negligible impacts*** because of the preemptive implementation of BMPs to prevent such incidents.

Decommissioning

Decommissioning of the SFWF will have similar impacts as construction.

South Fork Export Cable

This section summarizes the assessment of potential impacts on avian species presented in Appendix Q. The primary IPFs associated with the SFEC that could affect avian species include Seafloor/Land Disturbance, Sediment Suspension and Deposition, Noise, Traffic, Visible Structures and Lighting, Discharges and Releases, and Trash and Debris. The potential impacts associated with each phase of the SFWF are addressed separately in the following sections.

SFEC – OCS and SFEC – NYS

Construction

Table 4.3-39 summarizes the level of impacts expected to occur to avian species during the construction and decommissioning phases of the SFEC. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-39. IPFs and Potential Levels of Impact on Avian Species for the SFEC during Construction and Decommissioning

IPF	Project Activity	Potential Impact
Seafloor/Land Disturbance	Habitat loss/modification from cable and interconnection facility installation	Negligible direct
Sediment Suspension and Deposition	Habitat loss/modification from cable installation	Negligible direct
Noise	Disturbance from cable installation, HDD, and interconnection facility installation	Negligible to Minor direct
Traffic	Disturbance from vessel and vehicle activity during cable and interconnection facility installation	Negligible to Minor direct
Discharges/Releases	Mortality/decreased breeding success during construction activities associated with cable and interconnection facility installation	Negligible indirect
Trash/Debris	Mortality/injury from accidental disposals associated construction activities associated with cable and interconnection facility installation	Negligible indirect

Seafloor Disturbance

Because of the short-term nature of construction and decommissioning activities, only ***negligible impacts*** associated with the direct effect of habitat loss or modification from seafloor disturbance are anticipated.

At the sea-to-shore transition, HDD will mitigate potential construction impacts on the inter-tidal community within the vicinity of the landing site. No long-term changes in inter-tidal habitat structure or prey availability is expected because of cable installation activities. Any increase in turbidity and potential relocation of sandy sediments would be ***short-term, localized,*** and ***negligible***, resulting in no lasting physical changes to coastal areas or beaches.

There will be ***no impacts*** to nesting areas at beaches as installation for the SFEC will occur under the beach. The need for time of year restrictions for beach work at onshore components will be determined in consultation with the agencies.

Noise and Traffic
Only ***negligible*** or ***minor impacts*** to birds from disturbances associated with noise and vessel traffic are expected during construction of the SFEC-OCS and SFEC-NYS. These impacts will be ***short-term*** and similar to those observed with normal non-project-related vessel traffic.

Noise from installation of the cofferdam and from HDD in the sea-to-shore transition and activities at beach work areas could result in ***short-term disturbance impacts*** that will be relatively ***short-term*** and ***localized***; therefore, only ***negligible*** to ***minor impacts*** to shorebirds are expected from construction. Because the construction period is expected to occur largely outside of the breeding period of listed species that breed in the area and use of the shoreline at the proposed landing sites is expected to be minimal for other listed species that may occur in the region, disturbance impacts for listed species are expected to be ***negligible*** to ***minor*.**

Visible Structures and Lighting
Negligible to ***minor impacts*** associated with collision risk with visible structures (e.g., construction vessels or platforms) for birds during construction may occur, as described for the SFWF.

Discharges and Releases
Potential indirect effects such as contaminant discharges or releases during construction and decommissioning would be expected to result in ***negligible impacts*** because of the preemptive implementation of BMPs to prevent such incidents.

Trash and Debris
Potential indirect effects such as mortality or injury from accidental disposal of trash or debris during construction and decommissioning is expected to result in ***negligible impacts*** because of the preemptive implementation of BMPs to prevent such incidents.

Operations and Maintenance

No impacts to avian species are anticipated during routine O&M of the SFEC – OCS and SFEC – NYS.

Decommissioning

Decommissioning of the SFEC – OCS and SFEC – NYS will have similar impacts as construction.

SFEC – Onshore

Construction

Land Disturbance
There will be ***no impacts*** to nesting areas at beaches as installation for the sea-to-shore transition will occur under the beach.

Construction activities along the SFEC – Onshore route have the potential to affect shorebirds and some seabirds (e.g., terns), including potential impacts to listed species including piping plover (federally- and NYS-threatened), red knot (federally threatened) and least tern (NYS-threatened). These species breed, forage, and/or rest in the vicinity of the sea-to-shore transition and SFEC – Onshore. These potential impacts were considered during the siting process and the HDD work area was setback at least 650 feet (198 m) from the MHWL to minimize the potential for impacts. Additional construction activities are scheduled to occur outside of the tern and plover breeding period; red knots may be present during migration only briefly, if at all. DWSF will develop a plan to manage listed species in consultation with regulatory agencies to address residual risk to these species; therefore, ***no impacts*** to listed species are expected.

A variety of land birds including passerines and raptors use terrestrial habitats on Long Island in the East Hampton area. Except for construction of the new SFEC – Interconnection Facility to be located adjacent to the existing East Hampton substation, all components of the SFEC – Onshore will be set within a new underground duct bank in developed areas along existing ROWs, thus avoiding disturbances to land birds. Woodland habitat will be cleared for construction of the new SFEC – Interconnection Facility, and there may be a small amount of additional clearing along railroad ROWs for the SFEC − Onshore. During the breeding season, clearing of trees or vegetation that may contain nests of land birds could result in destruction of nests, causing impacts to some individuals; however, significant impacts to local breeding populations are not anticipated. No listed land bird species are expected to occur at the new SFEC – Interconnection Facility location; therefore**, *no impacts*** are expected.

Noise and Traffic

HDD activities will generate noise and vibration that could temporarily flush birds, if present, during migration or winter. Certain activities may require limited equipment and vehicle activity on the beach (e.g., rollout of the conduit pipe to support HDD). DWSF will develop a plan to manage listed species in consultation with regulatory agencies to address risk to these species.

There will be noise and traffic associated with construction of the SFEC - Onshore and the SFEC – Interconnection Facility. These activities could affect shorebirds, some seabirds, and land birds that use the beach and terrestrial habitats of eastern Long Island in the immediate vicinity of installation activities. Noise- and traffic-related impacts are expected to have ***short-term*** to ***minor impacts*** on these birds because construction will occur in already developed areas, and impacts associated with construction will be similar to existing sources of noise and traffic in the local area.

Operations

No impacts to avian species are anticipated during routine operations of the SFEC – Onshore.

Decommissioning

Decommissioning of the SFEC – Onshore will have similar impacts as construction.

4.3.6.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to avian species.

- The SFWF WTGs will be widely spaced allowing avian species to avoid individual WTGs and minimize risk of potential collision.
- The location of the SFWF, more than 18 miles (30 km, 16.6 nm) offshore, avoids the coastal areas, which are known to attract birds, particularly shorebirds and seaducks.
- Lighting during operations will be limited to the minimum required by regulation and for safety, therefore minimizing the potential for attraction or disorientation.
- DWSF will require all construction and operations vessels to comply with regulatory requirements related to the prevention and control of spills and discharges.

- Accidental spill or release of oils or other hazardous materials will be managed through the OSRP (Appendix D).
- The SFEC sea-to-shore transition will be installed via HDD to avoid impacts to the dunes, beach, and near-shore zone.
- An avian management plan for listed species will be prepared for the SFEC - Onshore.
- The SFEC - Onshore cable will be buried; therefore, avoiding the risk to birds associated with overhead lines.

4.3.7 Bat Species

The description of the affected environment and assessment of potential impacts to bat species and their habitats were evaluated by reviewing a compilation of published and unpublished environmental and technological literature, anecdotal records, records incidental to other scientific research, and studies that targeted bats offshore, including acoustic bat monitoring at the BIWF and vessel-based acoustic monitoring at the SFWF. Bat species that may occur within the SFWF and SFEC are described in this section, followed by an evaluation of potential project-related impacts. For more information regarding the bat species that may occur at the SFWF, see Vessel-based Acoustic Bat Monitoring, Draft Avian and Bat Risk Assessment, and Draft Avian and Bat Resources Technical Report in Appendix Q.

4.3.7.1 Affected Environment

For bats, relating occurrence to certain physical and biological features in the offshore environment is more difficult to estimate than for birds. While known to be present, the circumstances of when and where bats occur offshore is only beginning to be understood.

For the purposes of this summary, "offshore" is defined as waters beyond a 3-nautical-mile (5.6 km) distance from land, and "nearshore" is within the 3-nautical-mile (5.6 km) distance from land.

Regional Overview

The extent of scientific knowledge regarding the presence and behavior of bats in the offshore environment is limited. Historical observations and a few scientific studies indicate that bats migrate and possibly forage offshore. They will use islands, vessels, and other offshore structures as opportunistic or deliberate stopover sites (Pelletier et al., 2013). Bats may forage offshore during migration, perhaps to avoid competition or to exploit certain food sources (Ahlén et al., 2009). Detections of bats anecdotally in the offshore environment have been reported most often during the migratory periods, particularly in the fall (Nichols, 1920; Thomas, 1921; Norton, 1930; Griffin, 1940; Carter, 1950; Mackiewicz and Backus, 1956; Pelletier et al., 2013).

Historical observations of bats offshore have been predominately of the migratory tree-roosting species, which include eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*) (Pelletier et al., 2013). However, focused surveys documented offshore detections of species considered to be nonmigratory (Ahlén, 2006; Ahlén et al., 2007, 2009; Stantec, 2016; Pelletier et al., 2013), some of which are subject to population declines because of white-nose syndrome. The northern long-eared bat (*Myotis septentrionalis*) is the only bat species with potential to occur in the SFWF and SFEC that is afforded protection under the federal ESA and New York's Fish and Wildlife Law. See Appendix Q for additional information on listed species.

Bats were detected from 10 to 43 miles (16 to 70 km) offshore during either boat-based or high-definition video aerial surveys in the mid-Atlantic (Hatch et al., 2013). During acoustic studies conducted in the northeast, mid-Atlantic, and Great Lakes regions, Stantec Consulting Services Inc. (2016) found relative bat activity (mean number of bat passes per night) on coastal and offshore sites to be comparable to onshore sites. Prior statistical analyses also failed to detect significant differences in bat activity levels at island versus mainland sites (Pelletier et al., 2013).

Bats are regularly detected at remote islands and offshore structures, but primarily on a seasonal basis, with declining activity as the distance from shore increases.

Bat acoustic detector surveys were conducted at BIWF during preconstruction, construction, and postconstruction phases. During postconstruction surveys, bat detection rates at BIWF were highest in the months of August and September. No bat passes were recorded from November through January, as described in Draft Avian and Bat Risk Assessment and Draft Avian and Bat Resources Technical Report in Appendix Q.

Available regional data suggest bats could occur anywhere in the SFWF or SFEC, particularly during the fall migratory period, but also potentially during spring migration and early summer. Table 4.3-40 provides a summary of probable occurrence of bat species in the SFWF or SFEC.

Table 4.3-40. Timing, Distribution, and Relative Frequency of Occurrence of Bat Species and Species Groups in the SFWF and SFEC

Species/Species Group	Scientific Name	Occurrence	Peak Occurrence	Relative Frequency of Occurrence		
				Onshore	Nearshore	Offshore
eastern red bat	*Lasiurus borealis*	May to October	August	Seasonally common	Uncommon	Uncommon
hoary bat	*Lasiurus cinereus*	July to October	August	Seasonally common	Uncommon	Uncommon
silver-haired bat	*Lasionycteris noctivagans*	May, July, August	August	Seasonally common	Uncommon	Uncommon
little brown bat	*Myotis lucifugus*	May to October	August	Seasonally common to abundant	Uncommon	Uncommon
northern long-eared bat	*Myotis septentrionalis*	May to October	August	Seasonally common to abundant	Uncommon	Uncommon
eastern small-footed bat	*Myotis leibii*	May to October	August	Seasonally common to abundant	Uncommon	Uncommon
big brown bat	*Eptesicus fuscus*	May to October	August	Seasonally common to abundant	Uncommon	Uncommon
tri-colored bat	*Perimyotis subflavus*	May to October	August	Seasonally common to abundant	Uncommon	Uncommon

SFWF, SFEC − OCS, and SFEC − NYS

Bat acoustic detector surveys were conducted during G&G surveys from mid-July to mid-November 2017. Vessel-mounted detectors recorded bat passes from July through November, with most calls recorded in the August – September period. Species identified within the SFWF included silver-haired bat, hoary bat, eastern red bat, tri-colored bat (*Perimyotis subflavus*), and little brown bat (*Myotis lucifugus*). A northern long-eared bat call was detected at the southeastern edge of the SFWF, and multiple northern long-eared bat calls were detected along the SFEC route (as described in Vessel-based Acoustic Bat Monitoring, Appendix Q). For the entire study area, northern long-eared bat calls represented 4 percent of all recorded calls (however, there are limitations to positive identification of northern long-eared bat calls due to overlaps with species that have similar call signatures). Most northern long-eared bat activity was detected in the month of August; however, it should be noted that the survey was conducted for only a portion of the year (mid-July through mid-November).

Available data suggest bats are more likely to occur at nearshore locations compared to offshore. Field surveys on Block Island documented resident populations of bats and indicated the island may act as a migration stopover point for migratory tree roosting species (Tetra Tech and DeTect, 2012; Stantec, 2016). The surveys demonstrated that Block Island, and to a lesser extent, nearshore waters immediately surrounding the island, provide habitat for at least five species of bat, including big brown bat (*Eptesicus fuscus*), little brown bat, eastern red bat, silver-haired bat, and hoary bat. Passive and active acoustic monitoring data showed detections were predominately limited to the island and nearshore waters, with a low rate of detection offshore.

SFEC − Onshore

Anecdotal and survey-focused evidence includes bat detections on the coast of Long Island in fall (Merriam, 1887). Mist-netting surveys and acoustic monitoring documented all eight species likely to occur on Long Island, based on these species' known ranges (Cane, 2011; Fishman, 2013). NYSDEC 2017 acoustic surveys did not identify northern long-eared bat within 1.5 miles (2.4 km) of the Beach Lane landing site; there have, however, been positive identifications for this species within 1.5 miles (2.4 km) of the Hither Hills landing site (Jennings and Gaidasz, 2018, pers. comm.).

4.3.7.2 Potential Impacts

Construction, O&M, and decommissioning activities associated with the SFWF and SFEC have the potential for both direct and indirect impacts to bat species, including habitat loss or modification, disturbance, collision risk, displacement, attraction, and barrier impacts.

The IPFs and anticipated levels of impact to bats associated with the construction, O&M, and decommissioning phases for the SFWF and SFEC are outlined on Figure 4.3-14 and in Tables 4.3-41 and 4.3-42, including potential impacts to the federally listed northern long-eared bat. Impacts resulting from the SFWF and SFEC are anticipated to range from no impact to minor. The SFWF and SFEC's risk assessment in Appendix Q includes additional details of these impacts, which are summarized in the rest of this section.

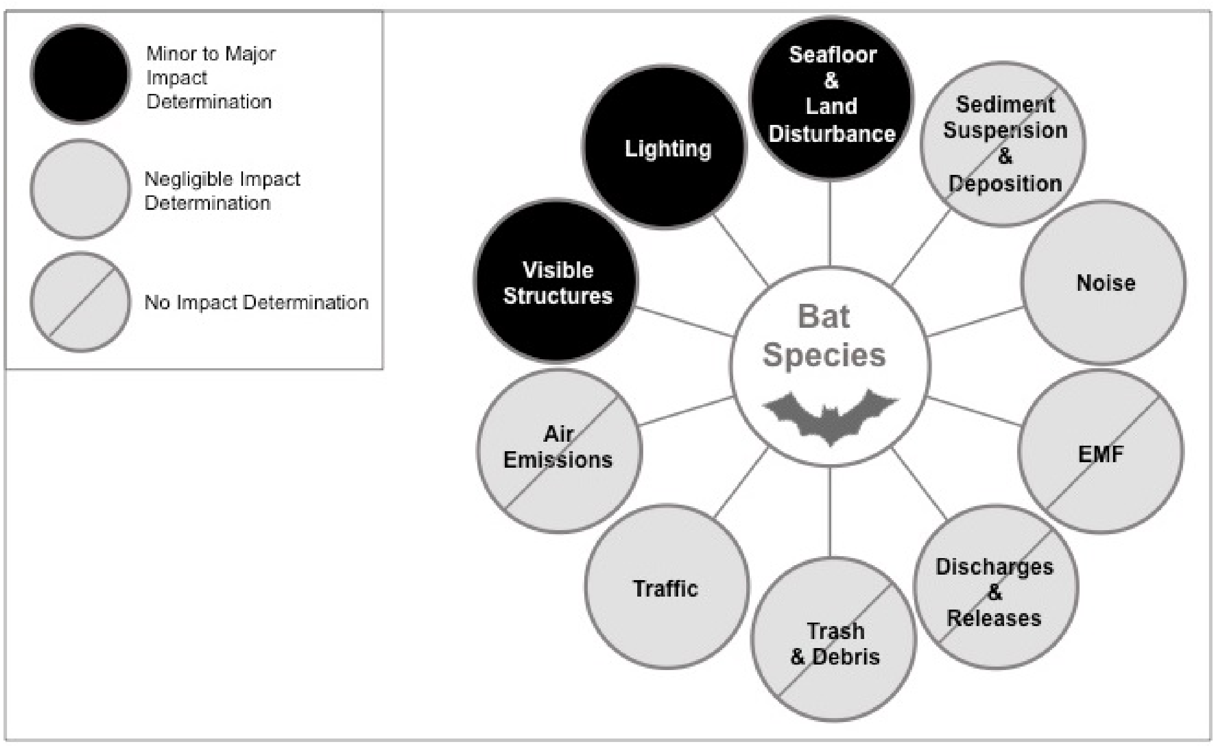

Figure 4.3-14. IPFs on Bat Species

Illustration of potential impacts to bat species, including the federally listed Northern Long-eared bat resulting from SFWF and SFEC activities

South Fork Wind Farm

This section summarizes the assessment of potential impacts on bat species presented in Appendix Q. The primary IPFs associated with the SFWF that could impact bat species include Visible Structures and Lighting. The potential impacts associated with each phase of the SFWF are addressed separately in the following sections.

Construction

No impacts are expected during construction of the SFWF. Bats are expected to seasonally occur in the SFWF while migrating, commuting, or foraging but will be unimpacted by seafloor disturbances during construction of the SFWF due to a lack of roosting habitat in these areas. There are ***no collision-related impacts*** to bats anticipated during construction because bats are expected to detect stationary structures. As bats are only anticipated to occur occasionally in the airspace of the SFWF during migration, impacts associated with traffic and noise during construction are anticipated to have ***no impact*** to bats. Bats are typically expected to forage for insects in flight (but may rarely take prey from the surface of the water); therefore, ***no impacts*** to bats from discharges or releases at the SFWF are expected.

Operations and Maintenance

Table 4.3-41 summarizes the level of impacts expected to occur to bat species during the O&M phases of the SFWF. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-41. IPFs and Potential Levels of Impact on Bats for the SFWF during Operations and Maintenance

IPF	Project Activity	Potential Impact
Visible Structures / Lighting	Collision risk with WTGs or OSS	Negligible to Minor direct
	Displacement, attraction, or barrier effect, based on presence of WTGs or OSS	Negligible to Minor direct

Visible Structures and Lighting

While bats are presumably less abundant in offshore environments than onshore, the possible attraction of bats to tall structures on an otherwise flat landscape may influence bat activity and risk of collision at offshore WTGs. The actual number of bats that may collide with offshore turbines is presently unknown, and methods for monitoring are limited. Further, the level of mortality observed at onshore turbines is not necessarily transferable to offshore turbines due to the different use of habitats and behaviors offshore. A lack of bat carcasses reported during large-scale, bird-related fatality events at illuminated lighthouses, lightships, and oil or research platforms indicates bats do not appear to be susceptible to the same large-scale collision events that birds are vulnerable to with lit structures (Appendix Q).

However, light sources on the SFWF, WTG decks, and OSS may serve as an attractant to bats as they navigate, or bats may potentially be indirectly attracted if insect prey are drawn to the lighting. Specific WTGs may also be lit with aviation lighting; however, aviation lighting has not been found to influence bat collision risk at onshore facilities in North America (Arnett et al., 2008).

Bat collision-related impacts may result in ***minor impacts*** at the SFWF, with long-distance migratory bats considered to be most at risk. Additionally, several North American nonmigratory bat species populations are in decline (notably the federally threatened northern long-eared bat). Given bats have low reproductive rates and require a high adult survivorship, those populations in decline are potentially vulnerable to impacts (Arnett et al., 2013). Despite an anticipated low collision risk, the level of impact to the listed northern long-eared bat is also considered ***minor*** (because they are a population already at risk).

Based on available information, bats may more likely be attracted to the wind farm rather than displaced due to the presence of the WTGs, as they may investigate WTGs for potential roosting opportunities or use the structures for navigational purposes while migrating. While these behaviors may increase their risk of collision, there are ***no impacts*** or ***negligible impacts*** associated with displacement or barrier impact anticipated during SFWF operations.

Noise and Traffic

Boat activity and noise already occur to some extent within and adjacent to the SFWF area due to existing levels of vessel traffic. Short-term increase of activity and associated disturbances during maintenance activities is expected to have ***no impact*** on bats in SFWF.

Discharges and Releases

There are also ***no impacts*** to bats anticipated with discharges and releases during operation at the SFWF, since these components will be buried beneath the seabed, and there will be no routine maintenance at these components.

Decommissioning

Decommissioning of the SFWF will have similar impacts as construction.

South Fork Export Cable

This section summarizes the assessment of potential impacts on bat species presented in Appendix Q. The primary IPFs associated with the SFEC that could impact bat species include seafloor and land disturbance, noise, traffic, visible structures, and lighting. The potential impacts associated with each phase of the SFEC are addressed separately in the following sections.

Construction

Similar to SFWF, no impacts to bat species are anticipated during construction of the SFEC – OCS and SFEC – NYS.

Operations and Maintenance

No impacts to bat species are anticipated during routine operations of the SFEC – OCS and SFEC – NYS.

Decommissioning

Decommissioning of the SFEC – OCS and SFEC – NYS will have similar impacts as construction.

SFEC – Onshore

Construction

Table 4.3-42 summarizes the level of impacts expected to occur to bat species during the construction and decommissioning phases of the SFEC-Onshore. Additional details on potential impacts from the various IPFs are described in the following sections.

Table 4.3-42. IPFs and Potential Levels of Impact on Bats for the SFEC - Onshore during Construction and Decommissioning

IPF	Project Activity	Potential Impact
Seafloor/ Land Disturbance	Habitat loss/modification from cable installation and interconnection facility installation	Negligible or Minor direct
Noise	Disturbance from cable installation, HDD, and interconnection facility installation	Negligible direct
Traffic	Disturbance from vessel and vehicle activity during cable and interconnection facility installation	Negligible direct

Land Disturbance

Installation of the SFEC – Onshore and construction of the SFEC – Interconnection Facility will result in ***short-term*** and ***minor*** land disturbances. Since the SFEC – Onshore is within existing ROWs (primarily existing roads), ***no impacts*** to bats are expected from installation of the SFEC – Onshore, and ***minor impacts*** are expected from construction of the SFEC – Interconnection Facility. Only ***minor impacts*** to bats are expected, given these activities will occur in already developed areas; and only a relatively small area will be cleared for the SFEC – Interconnection Facility, with minimal additional vegetation clearing along railroad ROWs for the SFEC – Onshore.

Noise and Traffic

There will be noise and traffic associated with construction of the SFEC – Onshore and SFEC – Interconnection Facility. Since these activities will occur in already developed areas, there are ***negligible impacts*** to bats expected.

Operations and Maintenance

No impacts to bat species are anticipated during routine operations of the SFEC – Onshore.

Decommissioning

Decommissioning of the SFEC – Onshore will have similar impacts as construction.

4.3.7.3 Proposed Environmental Protection Measures

Several environmental protection measures will reduce potential impacts to bat species.

- Lighting during operations will be limited to the minimum required by regulation and for safety, therefore minimizing the potential for attraction (or attraction of insect prey) and possibly collision of bats at night.
- SFEC - Onshore will be located underground in previously disturbed areas, such as roadways and railroad ROW, therefore, minimizing potential impacts from clearing.

DWSF will also consult with the agencies regarding the need for time-of-year restrictions for tree-clearing at onshore project components to mitigate potential impacts to tree-roosting bats.