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PNNL-ACT-10110

Preliminary Data Aggregation and Analysis of the Effects on Fish, Marine Mammals, and other Marine Organisms, and the Habitats that Support them, from a Proposed Offshore Wind Farm off the Coast of Grays Harbor, Washington

January 2022

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Summary

Background

Grays Harbor Wind LLC (GHW) is proposing to develop a floating offshore wind farm offshore of west Grays Harbor County, Washington (Grays Harbor). The proposed GHW Offshore Wind Project (Project) would entail construction, installation and operation of a 1,000-megawatt (MW) offshore wind farm consisting of approximately 75 floating units, each containing a floating foundation and wind turbine generator (WTG). The Project location is approximately 25 miles (21.7 nautical miles [nmi]) offshore west of Grays Harbor, at waters depths of 360 to 700 feet.

The Pacific Northwest National Laboratory (PNNL) was contracted by Herrera Environmental Consultants, Inc. on behalf of GHW to carry out this preliminary scoping study to evaluate baseline conditions and potential effects on fish and marine mammals from development and operation of a floating offshore wind farm installed within a designated area off the coast of Washington[1].

Floating offshore wind units installed in an ocean environment as part of the Project would interact with marine wildlife. This Study report provides an initial data aggregation and analysis, using publicly available data, of the Project effects, both negative and positive, on the marine environment. The scope of this assessment is limited by the fact that the Project development is presently at the conceptual level. Data on marine organisms were aggregated and evaluated; however seabirds were evaluated by Herrera Environmental Consulting and, along with bats, were not included in the scope of this study. Significant additional work is necessary to characterize ocean, seafloor, and environmental conditions; select appropriate floating offshore wind technologies; identify construction methods and locations; and assess facility locations, including electrical interconnection. Data aggregation and analysis of seabirds and bats is also needed. Evaluation of the full range of potential environmental effects would be conducted following an award of a lease from the Bureau of Ocean Energy Management (BOEM) as part of the leasing, National Environmental Policy Act (NEPA)/State Environmental Policy Act (SEPA) environmental review and permitting processes.

While this initial data aggregation and analysis uses best available public scientific information and current assumptions about the Project configuration, the effects discussed herein are based on the status of review to-date and may change as Project-specific details are developed.

Environmental Effects

This initial data aggregation and analysis of the potential environmental effects on marine wildlife resulting from offshore wind development in the waters off the coast west of Grays Harbor looked at the effects that may occur in the offshore wind farm area, along the electrical cable route back to shore, and within the Grays Harbor Estuary. Species of particular interest included fish, shellfish, marine mammals, benthic organism, sea turtles, seagrasses, and other native plants, and the habitats that support them. The extent of how these species could be affected by the wind farm, especially those of commercial importance or special environmental status, were reviewed to provide an initial assessment of potential environmental effects of the offshore wind development.

[1] This work was not funded, reviewed, or endorsed by the U.S. Department of Energy.

Species abundance and geographic distribution were determined using existing, publicly available data sources based on scientific research by academic groups and state or federal agencies. Potential environmental effects on the species of interest were evaluated using knowledge generated by robust scientific research and observations from interactions between marine wildlife and human-built ocean structures. Environmental effects research from other locations and comparable species were used in the analysis when primary research was unavailable for the exact species located in the Project areas.

Based on the conceptual level of Project design, the initial findings suggest that the environmental effects on marine life would be low to moderate in severity, and there would be potential to reduce them further by employing appropriate construction techniques or mitigation measures. Environmental effects would differ between the wind farm construction and operational periods. Effects during the construction period would occur over a short period of time, from days to weeks for some activities. Some temporary effects could be mitigated by timing the construction activity to minimize effects on the environment. Other effects from construction may cause a physical disturbance, but the impact would be limited to a small geographic area around the installation. Environmental effects on different groups of marine life could include the following:

- No long-term environmental effects on fish populations are expected from construction or operation.
- The greatest effects on fish are likely to occur within the wind farm at the offshore Project site once the wind farm has been constructed, resulting in increased numbers of fish within the wind farm and possibly increases in abundance outside the area.
- Gray whales and humpback whales may migrate near the Project area. Whales can be affected by temporary construction noise. Such effects could be mitigated by carefully considering noise mitigation (including construction timing) when it is applied to marine species as a whole. During operation of the wind farm, cable interactions (either mooring lines or other cables that are draped in the water column) with marine life have a very low probability of occurrence but could result in injury to a sensitive species.
- During construction of the electrical cable that connects the wind farm to the shore, there would be a temporary disturbance of benthic habitats, for example for shellfish. The habitat is expected to recover to natural conditions within months to a few years after cable installation.
- Loss of benthic habitat during the operational lifetime of the wind farm is expected to be limited to small areas around the anchors. The anchors also provide new hard substrate habitat that can be used by benthic organisms. Groundfish populations are unlikely to shift their range in response to the new substrate.
- The overall effects of climate change will increase pressure on marine wildlife in the Project area. Climate change will likely have an impact on marine wildlife in the Project area that is as large as, or greater than, that of an offshore wind development.

Designing and permitting an offshore wind farm in the proposed area requires an extensive environmental review governed by state and federal environmental regulations, which will be conducted in due course and would include detailed environmental analysis and site-specific surveys.

Acronyms and Abbreviations

BOEM	Bureau of Ocean Energy Management
EMF	electromagnetic field
ESA	Endangered Species Act
GHW	Grays Harbor Wind LLC
HAPC	Habitat Areas of Particular Concern
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
OPC	California Ocean Protection Council
PNNL	Pacific Northwest National Laboratory
RCP	Representative Concentration Pathway
QIN	Quinault Indian Nation
SEPA	State Environmental Policy Act
USGS	United States Geologic Survey
WDFW	Washington Department of Fish and Wildlife

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1.0 Introduction

Grays Harbor Wind LLC (GHW) is proposing to develop a floating offshore wind farm west of Grays Harbor. The proposed GHW Offshore Wind Project (Project) would entail construction, installation and operation of a 1,000-megawatt (MW) wind farm consisting of approximately 75 floating offshore wind units, each containing a floating foundation and wind turbine generator (WTG). The Project site is planned to be located 16 mi offshore west of Grays Harbor. The area is approximately 102 square miles (65,000 acres) with a length of about 8.5 miles from north to south and a width of about 16 miles from east to west (Figure 1). The water depths in the Project area range between 300 and 700 feet (100-200 meters).

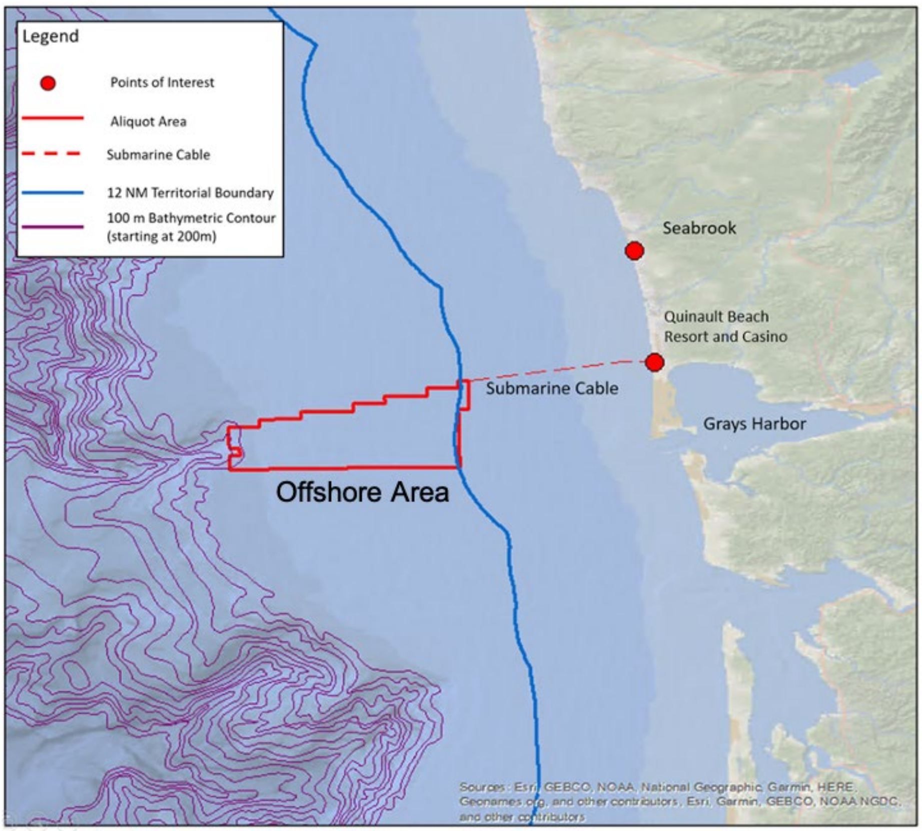

Figure 1. Project site map

The proposed Project would install floating offshore wind units and corresponding export cable(s) to shore in the ocean environment that could interact with marine wildlife. In addition, construction or maintenance activities may occur at the port of Grays Harbor or at other locations on the west coast. During all Project phases (site assessment, construction, operation, and decommissioning) the environmental effects of offshore wind development need to be considered at three locations: the offshore wind farm area (offshore area), along the cable route, and within the Grays Harbor Estuary

Pacific Northwest National Laboratory (PNNL) conducted an initial study of potential environmental effects in the areas of the offshore wind farm. Grays Harbor Wind, LLC contracted with Herrera Environmental Consultants to carry out a preliminary assessment of offshore wind in the area including socioeconomic impacts, port infrastructure, and environmental effects. Herrera Environmental Consultants subcontracted to PNNL to analyze the potential environmental effects, which is reported in the present document[1]. This report is developed to guide decision making around a potential unsolicited lease request to develop offshore wind in the Grays Harbor area. Formal environmental analysis will need to be completed for regulatory purposes if this project decides to move forward.

1.1 Purpose and Scope

This report documents the results of the initial assessment conducted by PNNL to evaluate the environmental effects of the Project on marine species, specifically fish, shellfish, marine mammals, benthic organisms, and sea turtles. PNNL did not evaluate the effects of the Project on seabirds or bats; sea birds were evaluated by Herrera Environmental Consulting. It describes the baseline of existing information on the environmental conditions and possible environmental effects resulting from an offshore wind farm development in the proposed area in the waters west of Grays Harbor. This assessment is also put into the context with effects of future climate change on the species of interest.

The scope of this assessment included environmental effects that may occur in the offshore wind farm area, along the electrical cable route back to shore (which includes the landfall area for the cable), and within the Grays Harbor Estuary. Species abundance information was gathered from existing public data sources with a focus on species of special interest to the Quinault Indian Nation (QIN), and species listed as threatened or endangered under state or federal listings.

1.2 Report Contents and Organization

The ensuing subsections describe the assessment process and the key findings. Section 4.0 presents the expected environmental effects on marine species based on the conceptual level design details to date. Section 0 addresses climate change considerations. Section 4.8 presents conclusions based on the initial findings and identifies future work.

2.0 Assessment Process

Each area of the proposed Project is evaluated separately because (1) each location would experience different types of activities during construction and operation periods and (2) the types of species present at each location differ. The location and characteristics of each area are described below.

- Offshore area: The offshore area is located approximately 25 (21.7 nautical miles [nmi]) to 34 miles (29.5 nmi) west of the Grays Harbor Estuary in Washington State. The area lies on the relatively shallow slope of the continental shelf at a water depth of 360 to 700 feet. Immediately offshore from the proposed project area, the water depth deepens quickly onto the continental slope.
- Cable route: The primary proposed cable route would travel from the northeast corner of the offshore area toward the shoreline on the coast, where the cable would make landfall shoreward of the beach.

[1] This work was not funded, reviewed, or endorsed by the U.S. Department of Energy.

- Grays Harbor Estuary: Port facilities inside Grays Harbor Estuary could be used as a hub for fabrication, operations, or maintenance activities. The entirety of the estuary is considered within the geographical scope of the environmental effects analysis.

Environmental effects were reviewed for the following different groups of marine species, with a focus on endangered, threatened, or commercially important species. Publicly available information was used, and where no data or information exist, the results are noted. There are no studies of the area that explicitly present information on marine food webs or other trophic interactions.

- Fish: Focuses on species of commercial interest, including demersal (groundfish), and anadromous fish (spawning in freshwater and living in ocean). Certain runs of Chinook, chum, coho, and sockeye salmon are protected under the Endangered Species Act (ESA). Steelhead trout and Eulachon smelt in Washington are also listed as threatened under the ESA.
- Shellfish: Focuses on invertebrate species of commercial interest, including crustaceans (e.g., crabs), and mollusks (e.g., clams and mussels).
- Marine mammals: Focuses on threatened and endangered cetaceans (e.g., whales and dolphins) and pinnipeds (e.g., seals and sea lions) that may be present off the Washington coast. There are no mustelids (e.g., sea otters) present on the Washington coast in the vicinity of the project site.
- Benthic habitat and organisms: Focuses on the effects on the benthic environment (i.e., seafloor) including the substrate, benthic and essential fish habitat, and organisms that live on or below the seabed.
- Sea turtles: Includes information for leatherback and loggerhead sea turtles—highly migratory reptiles that live in the ocean and are listed as endangered under the ESA.
- Seagrass and vegetation: Focuses on aquatic vegetation including information about seagrasses, kelp, and other vegetation.

3.0 Data Sources

For the purpose of this study, species abundance and geographic distribution are determined using existing, publicly available data sources created by the scientific research of academic groups and state or federal agencies. Potential environmental effects on these species are evaluated using knowledge generated by scientific research programs and observations of interactions between marine wildlife and structures in the ocean that have been placed by humans that include floating and moored structures such buoys and platforms. Environmental effects research from other locations and related to comparable species are used in this analysis, when primary research is unavailable for species of interest located in the Project area. The main data sources include the following:

- Marine Cadastre – www.marinecadastre.gov

  Marine Cadastre is an online database and mapping service provided in partnership between the US National Oceanic and Atmospheric Administration (NOAA) and the US Department of Interior that provides spatial data sets for environmental, geophysical, and human uses of the ocean.

- NOAA National Marine Fisheries Service: https://www.fisheries.noaa.gov/

  NOAA National Marine Fisheries Service hosts information about marine organisms including regulations applicable to the fishing industry and management plans to recover protected species.

- Washington Department of Fish and Wildlife (WDFW) – https://wdfw.wa.gov/species-habitats/species

  WDFW provides information about plant and animal species that are present in Washington and off the Pacific Coast. They provide information about species habitat, location, and regulations for fishing.

- Tethys – www.tethys.pnnl.gov

  Tethys is an online knowledge based hosted by PNNL that collects scientific literature about the environmental effects of wind and marine renewable energy.

- Washington Marine Spatial Planning – www.msp.wa.gov

  The Washington State Marine Spatial Planning website includes data sources and a mapping application that are used as a basis for marine spatial planning by state natural resource agencies.

- Data Basin – www.databasin.org

  Data Basin is an online mapping and analysis tool built by the Conservation Biology Institute to manage and share scientific data about environmental conservation. Data Basin provides access to primary data that describe the ocean environment and marine species.

Data sets describing the spatial distribution and abundance of fish in the ocean are limited and, in some cases, not available. Catch or landing data from fisheries have limitations as a substitute for species distribution because these data may not comprehensively or accurately reflect the location or size of offshore fish populations. Inaccuracies in landing data arise because of reporting bias, fish may be caught offshore then reported as a landing at a more distant port, and landing data provide information about the fish removed from the ocean, not the abundance and location of the populations. More information about fisheries data and potential impacts is described in the socioeconomic section of this report.

4.0 Offshore Environmental Effects

Offshore wind development may have effects on marine wildlife throughout the life cycle of a floating offshore wind farm, from surveying through construction, operation, and decommissioning. Environmental effects would be different between each region of the wind farm including the offshore area, cable route, and the estuary. The temporal and spatial dimensions of environmental interactions are important to consider when reviewing where wildlife may overlap with offshore wind development, how long the interaction may take place, and if a habitat or individual can recover from any potential impact.

The potential environmental effects are discussed below for marine wildlife of particular interest in the region. This section is organized into six groups of species. For each species, some basic information is provided about their behavior, habitat, and geographic range before discussing the potential environmental effects across all Project areas throughout the life cycle of the Project.

4.1 Fish

The fish present in and around Grays Harbor, Washington, live at all levels of the ocean from demersal fish at the bottom to pelagic fish throughout the water column. Some fish live entirely in the Pacific Ocean, but anadromous—like salmonids—migrate to freshwater in rivers and creeks to spawn juveniles.

The following sections describes the environmental effects on fish with a focus on species of commercial interest near Grays Harbor. Data for fish distribution were collected from publicly available sources, but limited information is available from scientific surveys that have a high degree of resolution. Instead of relying on fisheries landing data, which may not accurately describe the abundance and distribution of overall fish populations, the expected range of fish populations is determined by their typical habitat and behavior patterns.

4.1.1 Anadromous Fish

Key Points:

- Salmonids spend part of their life offshore and may overlap with the offshore Project area.
- Construction noise is the most likely mechanism of harm but is temporary in nature.
- Operation of the wind farm is not expected to change the population abundance or geographic distribution of salmonids in the area.

Description and Status

Chinook salmon (*Oncorhynchus tshawytscha*), chum salmon (*Oncorhynchus keta*), coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), and sockeye salmon (*Oncorhynchus nerka*), Steelhead trout (*Oncorhynchus mykiss*), Eulachon Smelt (*Thaleichthys pacificus*), Pacific lamprey (*Entosphenus tridentatus*), green sturgeon (*Acipenser medirostris*), and coastal cutthroat trout (*Oncorhynchus clarki clarki*) are some of the anadromous fish that spend part of their life cycle off the Washington coast. Within this group, the salmonid species have a variety of characteristics and traits. Lifespans range from 2 to 7 years; adults can grow from 1.5 feet (pink salmon) up to 3 feet (chum salmon); their weights range from 3 to 130 pounds, and the salmonids have a variety of colors including steel blue, silver, and red (Figure 2). All of these species are managed under the Magnuson-Steven Fishery Conservation and Management Act (NOAA 2021a). Certain runs of Chinook, chum, coho, and sockeye salmon are protected under the Endangered Species Act (ESA). Steelhead trout, eulachon smelt, and green sturgeon in Washington are listed as threatened under the ESA.

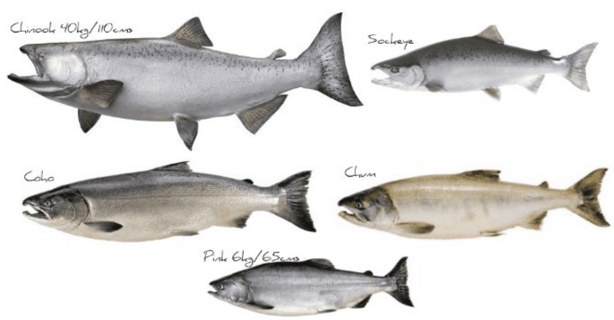

Figure 2. Image of Salmonids (from top right clockwise: Chinook, sockeye, chum, pink, coho) (The Fish Society).

Habitat

Pacific salmonid species and other anadromous species live in the North Pacific waters off the United States and Canadian coast. They have a dynamic life cycle that includes time in fresh and saltwater habitats. These fish are born in freshwater streams and rivers, migrate to coastal estuaries, then enter the ocean where they mature. They usually return as adults to the same streams where they were born to spawn and begin the cycle again. Most salmon runs usually occur between July and October, depending on the species (Pacific Angler, 2021). When in the ocean, salmonids are a pelagic fish that typically swim in the water column at depths between 20 to 200 feet (WDFW, 2021a). Steelhead make two runs from the ocean to freshwater that occur in the winter and summer (WDFW, 2021b). Summer runs tend be longer, ending further upstream compared to winter runs that spawn closer to the ocean (WDFW, 2021b). Eulachon smelt runs occur between December and June (NOAA, 2021b).

The life history of anadromous fish in the Grays Harbor estuary is not the focus of this analysis as the proposed project will not include manufacture or assembly within the estuary, and thus will not affect the estuarine portion of the fishes' life history.

Overlap with Project Area

Salmonids and other anadromous species overlap with the offshore Project area during the portion of their life cycle spent in a saltwater environment. They are expected to be found toward the upper 200 m of the water column within the wind farm offshore area and above the cable route. When migrating to and from freshwater environments, salmonids enter rivers and streams connected to Grays Harbor Estuary. While offshore distribution and abundance data for salmonids are not available, salmon habitat populations rating maps (Figure 3) can be used to develop a general sense of which watersheds are most suitable for specific populations.

Potential Environmental Effects

Potential environmental effects to anadromous species include construction noise, introduction of new habitat where the fish may find shelter, and sensing of electromagnetic fields (EMF) (Table 1). During operation of the wind farm, the floating platforms provide new structures that could provide shelter to in salmonid habitat and food sources offshore. The introduction of these floating platforms does not create a direct mechanism of harm to salmonids.

Along the cable route, EMF would be emitted from the cable. Salmon are one of the few pelagic fish that can sense magnetic fields. However, population-level behavioral changes are not expected in salmon, based on the results from of a study in California (Kimley et al. 2017), that showed salmon migration patterns are unaffected by the presence of a submarine cable.

Table 1. Summary of potential environmental effects on salmonids.

Stressor	Location	Potential Effect	Magnitude of Effect
Construction noise	Offshore area, cable route	Increased noise	Temporary; unlikely to change species abundance or behavior. Construction noise from floating offshore wind platforms is expected to be very low.
Introduction of new floating platforms	Offshore area	Creates new habitat for pelagic fish; possible habitat for non-native species	No mechanism of harm
Electromagnetic fields from electrical export cable	Offshore area, cable route	Possible changes in behavior or direction	Salmon can sense EMF, but studies have shown migration patterns unaffected by EMF

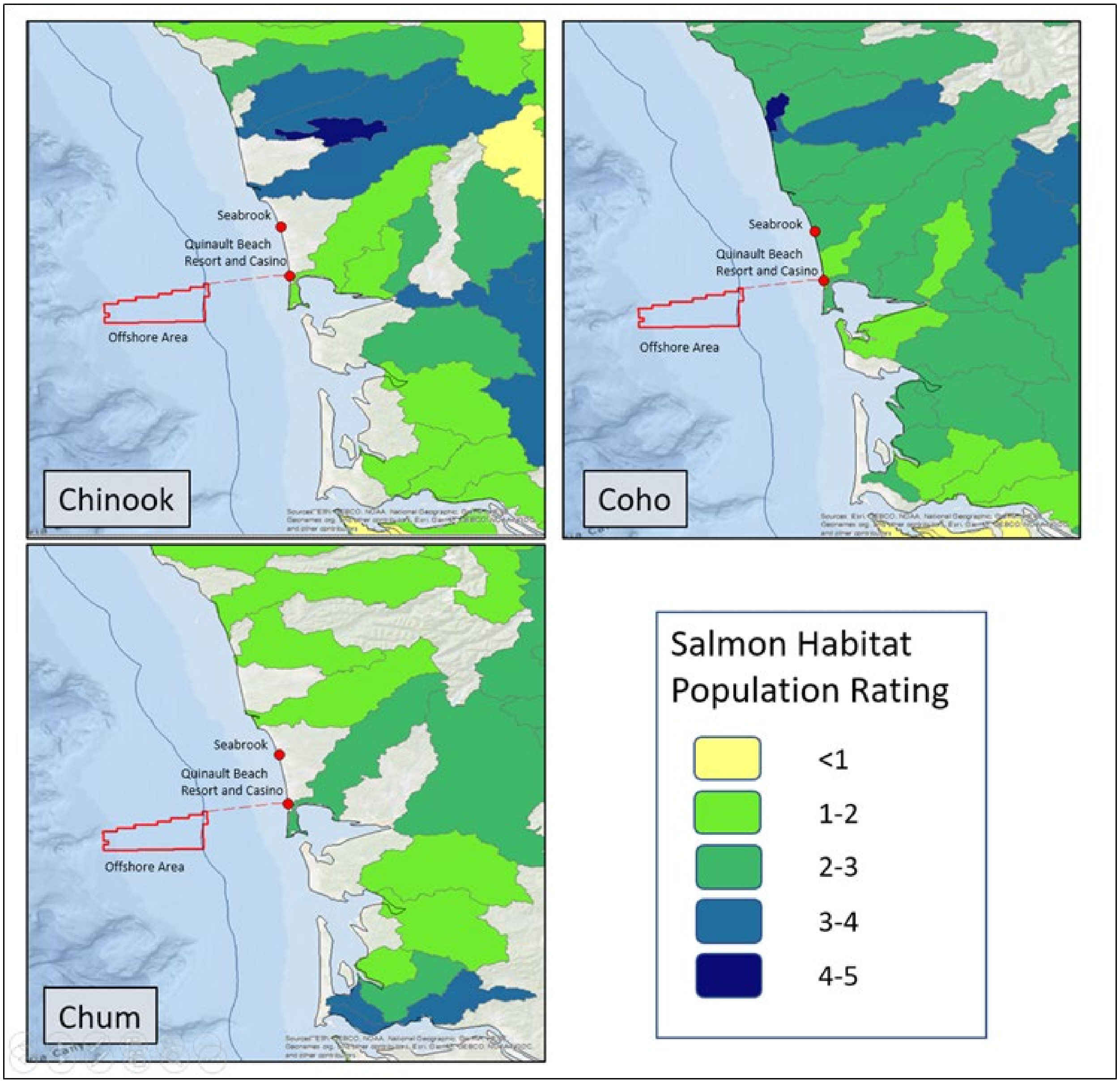

Figure 3. Habitat population rating for chinook, coho, and chum salmon. Higher number values indicate higher potential to support long term survival of salmon species against anthropogenic disturbances (data from Wild Salmon Center, USGS).

4.1.2 Groundfish

Key Points:

- Groundfish abundance is relatively low in the Project areas compared to the surrounding areas to the north and south.
- Noise during construction is the most likely environmental effect and may cause temporary avoidance behavior.
- Long-term changes in population abundance or distribution are unlikely.

Description and Status

Groundfish is a broad category that includes a variety of different fish that live on or just above the seafloor. Flatfish, rockfish, and roundfish are examples of groundfish found on the Pacific coast. Sharks and skates also live off the Pacific Coast. Species tend to gather by depth and geologic features that provide suitable habitat and nutrition. This section covers groundfish as a group, and two particular species of commercial interest—sablefish and Pacific halibut—are described in more detail below.

Habitat

Groundfish may be found in shallow, intertidal waters all the way out to ocean depths of 11,500 feet (NOAA 2021c). Pacific groundfish are dispersed throughout different latitudes and depths along the Washington coast (Figure 4).

Overlap with Project Area

Near the Project areas, groundfish abundance is higher within 14 miles from shore, and lower within the offshore area, compared to areas farther north and south of the offshore Project area. Groundfish abundance is lower along the continental slope to the west of the Project area where the seafloor quickly descends to deeper depths. Overall, the Project area appears to be located in a region with low groundfish abundance compared to areas of similar depth in the surrounding region (Figure 4).

Potential Environmental Effects

Based on the conceptual level of Project design to-date and this preliminary analysis, environmental effects on groundfish are likely to be low, in particular because of their low expected abundance in the Project region. A small portion of groundfish may be affected by changes in the seabed when placing anchors or trenching for the submarine cable because of noise and physical disturbance. The expected response is for the fish to avoid areas of loud noises, although there may be different behaviors depending on the species. These effects are limited to a small area of the seafloor and would be temporary in nature during the construction period. Groundfish populations and long-term spatial distribution are not expected to be adversely affected by the installation and operation of an offshore wind farm and are likely to increase in abundance due to the reserve effect.

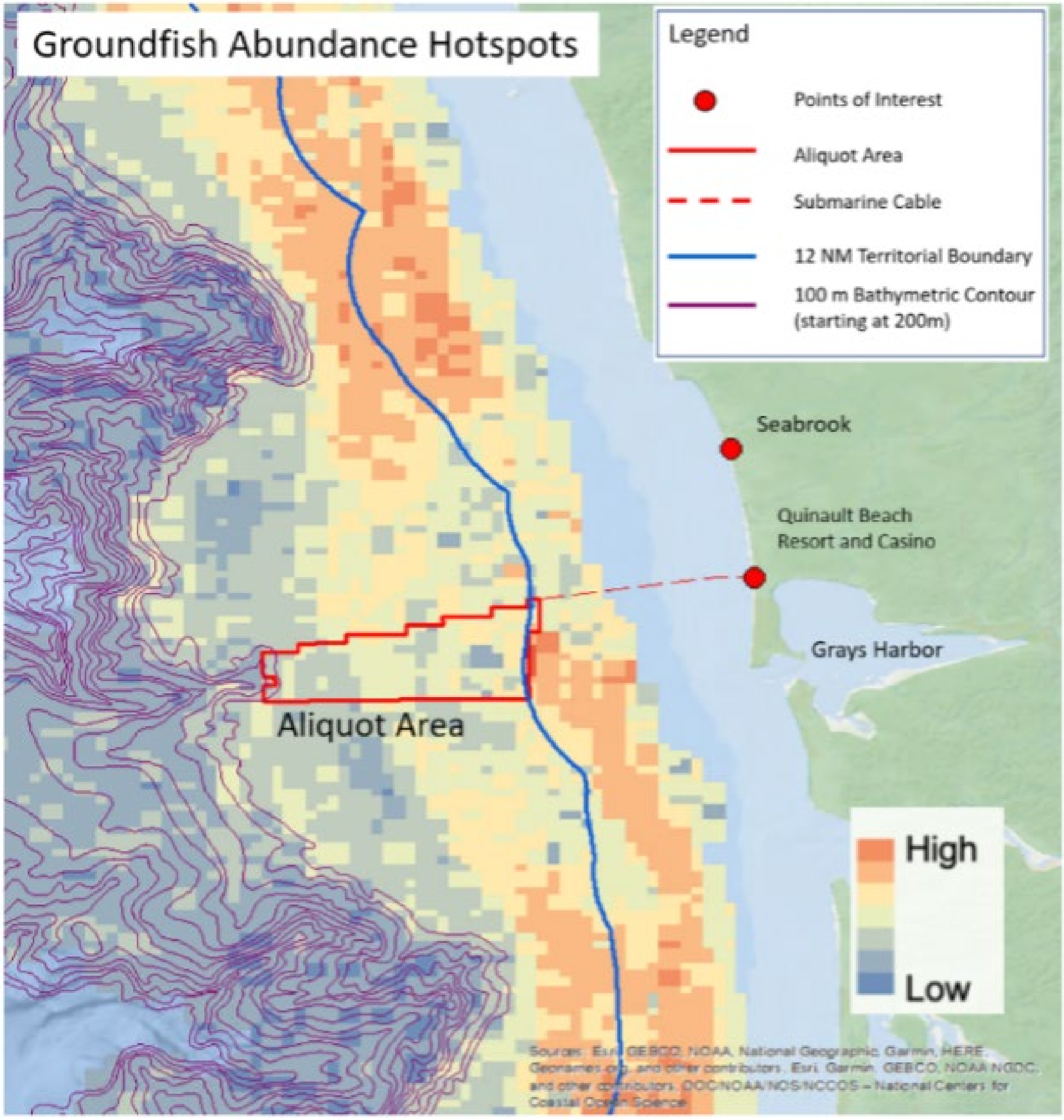

Figure 4. Groundfish abundance hotspots (data from NOAA National Centers for Environmental Information).

4.1.3 Sablefish

Key Point:

- Direct environmental effects on sablefish are not expected because there is limited overlap between their habitat and the wind farm areas.

Description and Status

Sablefish (*Anoplopoma fimbria*), commonly known as black cod, are a commercially harvested groundfish (see preceding section). Sablefish adults are black or greenish gray in color (Figure 5) and can grow up to 30 inches in length. The sablefish is not listed as threatened or endangered, and the West Coast stock is not overfished or subject to being overfished.

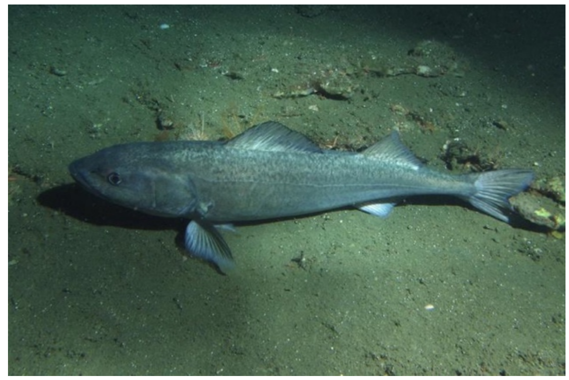

Figure 5. Sablefish (from NOAA 2021).

Habitat

Sablefish live in the northeast Pacific Ocean between northern Mexico and Alaska. Adults primarily inhabit soft or muddy bottom locations at depths between 1,000 and 5,000 feet. Spawning occurs in the winter months in waters deeper than 1,000 feet (OPC 2021). After hatching, juveniles spend most of their time in pelagic inshore waters before moving to deeper locations at an age of 4 to 6 years. A population map specific to sablefish is not available, instead a groundfish abundance map can be used to understand general groundfish distribution (Figure 4).

Overlap with Project Area

Adult sablefish habitat and spawning grounds do not overlap with the Project area. The offshore Project area is in waters less than 650 feet deep, and sablefish habitat is deeper than 1,000 feet. However, juvenile sablefish often spend time in pelagic water less than 1,000 feet deep for the first 4 to 6 years of their life.

Potential Environmental Effects

Direct environmental effects are not expected because the construction or operation of the wind farm does not overlap with the typical geographic range of sablefish populations (Table 2).

Table 2. Summary of potential environmental effects on sablefish.

Stressor	Location	Potential Effect	Magnitude of Effect
No direct effect expected			

4.1.4 Halibut

Key Point:

- Direct environmental effects on halibut populations are not expected

Description and Status

Pacific halibut (*Hippoglossus stenolepis*) is the largest species of flatfish, weighing up to 500 pounds and growing over 8 feet long (NOAA 2021e). Halibut adults can live up to 55 years (but halibuts over the age of 25 are rare). They have flat, diamond-shaped bodies and swim sideways with two eyes on the upper side of their body (Figure 6). They are fished commercially, recreationally, and by subsistence fishers, and are sustainably managed and responsibly harvested under United States and international regulations. Pacific halibut are not overfished, according to the 2018 stock assessment (Stewart and Hicks 2018).

Figure 6. Halibut (from Monterey Bay Fisheries Trust).

Habitat

Pacific halibut are found off the United States and Canadian west coast, with highest abundance found in the Gulf of Alaska. As larvae, they float near the surface feeding on zooplankton, remaining there for 6 months and before they settle down to the bottom. Halibut habitat is 100 to 1,000 feet deep and they have been recorded at depths up to 3,600 feet (O'Fish'ail 2021).

Overlap with Project Area

Pacific halibut habitat overlaps with the Project area. The offshore Project area is in waters less than 650 feet deep, and Pacific halibut generally live in waters between 100 to 1,000 feet deep.

Potential Environmental Effects

Previous studies and monitoring of offshore windfarm effects on other flatfish have shown that footprints of offshore wind farms can increase the average numbers of individuals during the operational life of a wind farm (Krone et al. 2017). Other studies show that flatfish population variability at an offshore wind farm in Rhode Island is not associated with the construction or operation of the wind turbines, and no artificial reef effect was found where flat fish congregate around the turbine structures (Wilber et al. 2018). While the effects of OSW on Pacific halibut has not been monitored, these studies suggest that flatfish may experience either no effect or a positive effect from offshore wind development (Table 2-3).

Table 3. Summary of potential environmental effects on Pacific halibut.

Stressor	Location	Potential Effect	Magnitude of Effect
No direct effect expected			

4.1.5 Pacific Hake

Key Point:

- Direct environmental effects on Pacific hake populations are not expected

Description and Status

Pacific hake (*Merluccius productus*) – commonly known as whiting – is a silver-colored semi-pelagic groundfish (Figure 7). Whiting have elongated bodies that can grow up to three feet in length and typically weight 1.4 pounds.

Figure 7. Pacific hake (WDFW).

Habitat

Pacific hake live in waters up to 3,000 feet deep and most commonly in waters less than 750 feet deep. They are semi-pelagic groundfish, meaning they live near the bottom of the ocean and can also be found in the water column. Pacific hake generally move closer to shore and further north in the spring and feed on the continental slope and shelf. Large schools of whiting form during the summer on the shelf break.

Overlap with Project Area

Pacific hake are abundant on the Pacific Coast. Their range is expected to overlap with the offshore Project area.

Potential Environmental Effects

Abundance of pacific hake in the Project area are not expected to change or may see a small increase as a result of offshore wind development and limitations on fishing in the area (Table 4). Increases in fish abundance and prey have been commonly observed and documented at other offshore wind farms (for example Coates et al., 2016; van Hal et al., 2017; Stenberg et al., 2015; Slavik et al., 2019; Krone et al., 2017; Bergstöm et al., 2013; Raoux et al., 2017).

Table 4. Summary of potential environmental effects on Pacific hake.

Stressor	Location	Potential Effect	Magnitude of Effect
No direct effect expected or slight increase in abundance			

4.1.6 Pacific Sardine

Key Point:

- Direct environmental effects on sardine populations are not expected

Description and Status

Pacific sardines (*Sardinops sagax caerulea*) are small fish with light white and silver sides and a darker blue and green back (Figure 8).

Figure 8. Pacific sardines (WDFW).

Habitat

Pacific sardine are a pelagic species that live along the Pacific Coast from Mexico to Alaska.

Overlap with Project Area

Sardines are expected to overlap with the offshore Project area.

Potential Environmental Effects

Abundance of sardines in the Project area are not expected to change or may see a small increase as a result of offshore wind development and limitations on fishing in the area (Table 5). Increases in fish abundance and prey have been commonly observed and documented at other offshore wind farms (for example Coates et al., 2016; van Hal et al., 2017; Stenberg et al., 2015; Slavik et al., 2019; Krone et al., 2017; Bergstöm et al., 2013; Raoux et al., 2017).

Table 5. Summary of potential environmental effects on Pacific sardine.

Stressor	Location	Potential Effect	Magnitude of Effect
No direct effect expected or slight increase in abundance			

4.2 Non-native Species

Artificial structures, in particular hard substrates such as floating foundations, may provide an opportunity for non-native species to colonize, spread, or expand their range (Bulleri and Airoldi 2005; Glasby et al. 2007). Floating wind platforms could serve as stepping stones for non-native species in a new area. Non-native species can be introduced through operations and maintenance vessels or when bringing turbine components from port facilities – where non-native species may be present – to the offshore wind location (Hemrey 2020). Non-native species have been identified on turbine foundations in the Belgian North Sea, with the majority found on intertidal areas of the structures near the ocean surface (Kerckhof et al. 2011). Non-native species can put additional stress on native threatened species, but results from monitoring at other offshore wind farms show that only negligible impacts to native species could be attributed to new infrastructure (Vattenfall 2005). Importantly, studies have not found that an offshore turbine structure has supported non-native species that were not already present on other hard surfaces in the immediate region. All existing research studies from around the world support the concept that offshore wind infrastructure is not likely to be used by non-native species as a pathway for invasion. Thus, introduction of non-native species is not expected to have a substantial effect on fish populations in the Project area.

4.3 Shellfish

Shellfish are aquatic invertebrates that are used as a food source for humans as well as prey for important finfish species. In Washington State, valued shellfish include crab, shrimp, mussels, clams, and oysters. Limited data are available to identify the precise geographic distribution and abundance of these shellfish, so the analysis focuses on a few species that are well understood from commercial activities and regulations. Near the Project site, the primary shellfish harvested from the wild are Dungeness crabs and razor clams. This section reviews the potential environmental effects on shellfish populations resulting from the development of offshore wind off the coast of Grays Harbors

4.3.1 Dungeness Crabs

Key Points:

- Dungeness crab are found in greatest abundance along the proposed cable route.
- Previous studies found that Dungeness crab populations are not likely to be affected by EMFs from power cables and that offshore wind farms do not negatively impact crab populations.
- Cable installation may provide a short-term disruption of a small area of habitat along the cable route, but the habitat is expected to recover quickly to its natural state.

Description and Status

Dungeness crab (*Metacarcinus magister*) are invertebrates that live on the sea floor. They have eight legs and two large claws (Figure 9). They weigh up to 4.5 pounds, have a lifespan up to 13 years, range in color from yellowish brown to purple, and their main body can reach 10 inches in width. Dungeness crab are a popular and important commercial and recreational fishery that is regulated by the WDFW.

Figure 9. Dungeness Crab (from Jerry Kirkhart/Flickr).

Habitat

Dungeness crab range along the Pacific Coast from Mexico to Alaska (WDFW 2021c). Their habitat includes sandy or muddy substrate and eelgrass beds, primarily within the intertidal zone. They are most abundant in water depths less than 300 feet and are rarely found deeper than 735 feet (PSMFC 2012).

Overlap with Project Area

Locations with Dungeness crabs overlap with the Project area along the cable route and potentially in eelgrass beds within the Grays Harbor Estuary. The offshore Project area is outside the range where Dungeness crab are abundant.

Potential Environmental Effects

Environmental effects on Dungeness crab are expected to be limited to a temporary disruption of benthic habitat during cable installation (Table 6).

Subsea cable installation would create a temporary disturbance of the seafloor in the area within a few meters either side of the cable. Benthic habitat has been observed to recover to its natural state after cable burials, and no long-term effects on crab is expected.

While there is concern about Dungeness crab having a behavioral response to EMFs during operation of a subsea cable, studies have found that these crabs respond to EMF signals, but their response does not appear to create a significant change in their behavior that will affect their feeding, reproductive success, or survival (Woodruff et al. 2012). Further studies have shown that the presence of an energized subsea cable does not reduce the catchability of this species. The subsea cable would be buried below the surface of the seafloor in the areas where crabs are harvested, which would create a physical distance separating the crabs from the cable and attenuate the EMF signal (Love et al. 2017). Based on this information, Dungeness crab are not expected to have a behavioral response to a subsea cable during the operation of the wind farm.

Studies of fixed-bottom offshore wind farms located within shallower waters have found no evidence of a negative impact on crab species (Langhammer et al 2016) and in some cases found numerous crabs near the turbine foundations, which may provide new nursery grounds for crabs (Hutchinson et al. 2020). The design of the Project would have a smaller benthic footprint by using floating platforms and anchors rather than the fixed turbine foundations. Therefore, there is no expectation that the platforms would have any influence on the small numbers of Dungeness crab to be found at the offshore site.

Table 6. Summary of potential environmental effects on Dungeness crab.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable route	Disruption in habitat	Temporary impact: habitat recolonizes cable lay area

4.3.2 Razor Clam

Key Points:

- Razor clams are found along the coastal beaches where the electrical cable would make landfall.
- Direct disturbance would be avoided by using horizontal direct drilling of the cable under the intertidal area.
- The effects of EMFs on clams are largely unknown, but the physical separation of the razor clams from the cable would isolate the animals from any potential effects.

Description and Status

The Pacific razor clam (*Siliqua patula*) has a golden-brown, oval-shaped shell (Figure 10). Razor clams generally are between 2.5 to 6 inches long in Washington but can grow larger in colder climates (WDFW 2021d). Razor clams are a historically important shellfish to the QIN (Weinberg 2021). On beaches in Washington State, this desirable recreational fishery is regulated by the WDFW.

Figure 10. Pacific Razor Clams Harvested from the Beach (from WDFW).

Habitat

Razor clams are found on sandy, intertidal ocean beaches along the Pacific Coast from California to Alaska. Razor clams live just under the surface of the sand located between a minus 2 foot tide and a plus 3 foot tide. Habitat for the Pacific razor clam includes the coastal beaches adjacent to the south and north jetty of Grays Harbor, and the beaches extending north through the QIN Reservation (Figure 11).

Overlap with Project Area

The electrical cable would make landfall through horizontal direct drilling (HDD) underneath a coastal beach that is habitat for Pacific razor clam. However, the cable is expected to be buried several meters below the intertidal zone, where it would not likey expose the razor clams to EMFs.

Potential Environmental Effects

Temporary habitat disturbance may occur on the beach at the submarine cable landfall location as the HDD takes place, but the impact should be minimal to none (Table 7).

Environmental effects resulting from EMF emissions from the electrical cable are largely unknown for razor clams. Clams would be isolated from the cable, which is buried under the beach, so the strength of the EMF would be reduced in razor clam areas.

Table 7. Summary of potential environmental effects on razor clams.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable landfall at beach	Possible disruption of habitat	Depends on construction method; if HDD and construction equipment is located off the beach in a parking lot, then no effect is expected.
Electromagnetic fields from electrical export cable	Cable landfall at beach	Unknown	More study is needed; any effect is likely to be limited to a small area around the cable.

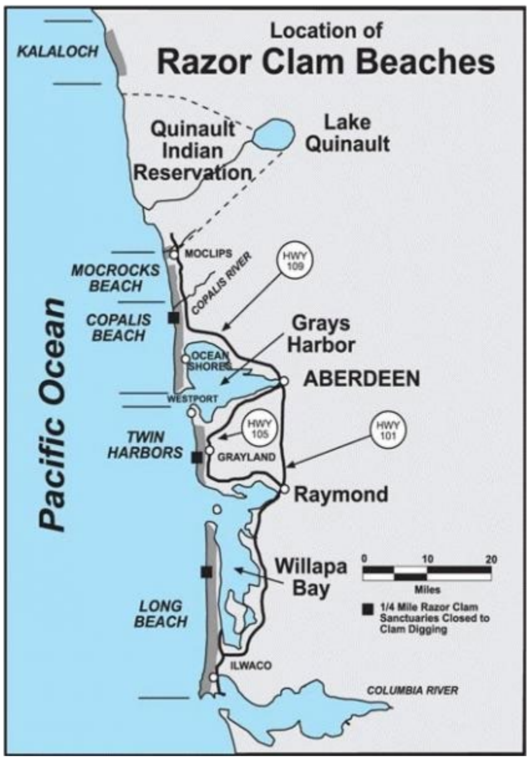

Figure 11. Map of Razor Clam Beaches Regulated by WDFW near Grays Harbor (from WDFW).

4.3.3 Pink Shrimp

Key Point:

- Direct environmental effects on pink shrimp populations are not expected

Description and Status

Pink shrimp (*Pandalus jordani*) are crustaceans that are light pink in color and generally less than 6 inches long.

Habitat

Pink shrimp found in the Pacific Ocean are called ocean pink shrimp – or smooth pink shrimp. They are benthic organisms that inhabit muddy or sandy seafloors in a typical depth range of 360 to 600 feet but can exist at depths between 110 to 1,500 feet.

Overlap with Project Area

Pink shrimp are expected to be found in the offshore Project area and possibly some subtidal areas along the cable route.

Potential Environmental Effects

Abundance of pink shrimp in the Project area are not expected to see long-term changes in the as a result of offshore wind farm development. The potential temporary environmental effects are described in Table 8.

During cable installation, the immediate area around the cable would be physically disrupted. This effect is limited to a small area around the cable installation site and, if the cable is buried, the habitat is expected to recover (HDR, 2018; Kraus and Carter 2018).

Mooring line anchors will take up some space on the sea floor, but the anchor footprint is very small relative to the size of the wind farm and will not create additional habitat competition for pink shrimp.

Sediment suspension and redistribution during anchor installation is expected to be temporary and be limited to a small vicinity around the anchor. Significant sediment plumes have not been observed in OSW farms on the East Coast and in Europe during specific monitoring campaigns during construction (Saunders, 2012; Center for Marine and Coastal Studies, 2008; James et al., 2017; English et al, 2017). Even when hydrodynamic models predicted larger plumes, they were not observed in practice. Construction activities to lay anchors and cables for these floating projects suspend less sediment than the pile driving and drilling activities used during the observational studies. The general conclusion from previous studies is that the majority of resuspended sediment will collect within a few meters of the construction activity and not impact individuals that were not otherwise impacted directly from construction.

Table 8. Summary of potential environmental effects on pink shrimp.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable route	Disruption in habitat	Temporary impact: habitat recolonizes cable lay area
Anchor installation	Offshore area	Disruption in habitat	Temporary impact: habitat recolonizes cable lay area
Mooring line anchors	Offshore area	Seabed scour disrupts habitat	Limited: scour area very small relative to the wind farm size and available surrounding habitat

4.4 Marine Mammals

Key Points:

- Two whale species—gray whale and humpback whales—migrate through the area of the project and may pass near the project site. Other whales including blue, Fin, sperm, and orca, are expected to have limited or no overlap with the Project area.
- Construction noise is one of the primary environmental concerns for marine mammals because it may disrupt their hearing. Construction noise would be temporary, and the effects could be mitigated by scheduling activities during times of low occurrence of whales in the area.
- There is a very low probability of interaction between marine mammals and mooring lines in the water column, but interactions could cause injury.
- Vessel collision is a concern for marine mammals along the entire Pacific Coast. The offshore wind Project would increase the amount of vessel traffic slightly, just barely above that of existing traffic.

Marine mammals are a diverse set of animals, including whales, dolphins, porpoises, seals, sea lions, and others. Their diversity is evident in how marine mammals interact with waters off the Washington coast: some whales pass through the waters during annual migrations, others forage for food off the coast, and seals spend time on beaches and rocky outcroppings during molting or breeding seasons.

Information about the distribution and abundance of marine mammals is readily available from public sources because of the increased scientific rigor and regulatory practices in place to protect these species after hunting practices in the 20th century endangered the survival of some species. Due to the availability of high-quality data, several species are described below, but not all of these species would overlap with the proposed Project area. Of all the species listed below, gray whales and humpback whales are most likely to be found near the Project area.

Possible environmental effects on marine mammals include increased noise during construction or operation, interactions with mooring lines or cables floating in the water column and impacts with vessels during installation or maintenance of the wind farm. These main effects are common between many, but not all, marine mammals. Rather than repeating the potential environmental effects for each species, Table 9 summarizes the information for all marine mammals considered in this study.

Table 9. Summary of potential environmental effects on marine mammals.

Stressor	Location	Potential Effect	Magnitude of Effect	Relevant Species[a]
Construction noise	Offshore area, Cable route	Avoidance of area; masking communication signals; physiological stress	Construction noise from floating offshore wind platforms is expected to be very low.	BW, FW, HW, SW, GW, NES, SSL, HS
Vessel traffic (noise)	Within harbor, Offshore area	Masking communication signals; physiological stress	Low, especially relative to existing vessel traffic	BW, FW, HW, SW, GW, NES, SSL, HS
Vessel traffic (collision)	Within harbor,	Vessel strike can result in injury	Low, especially relative to existing vessel traffic	BW, HW, GW, NES, SSL, HS

	offshore area			
Floating cables	Offshore area	Collision or entanglement	Low probability of encounters and very low probability of entanglement; medium risk of injury	BW, HW, GW, NES, SSL, HS

[a] BW = blue whale FW = Fin whale HW = humpback whale SW = sperm whale GW = gray whale NES = northern elephant seal SSL = Steller sea lion HS = harbor seal.

4.4.1 Blue Whale

Description and Status

Blue whales (*Balaenoptera musculus*) are the largest animals in the world, reaching lengths of over 100 feet and weighing more than 150 tons. They have long slender bodies and deep, blue-colored skin. Their underside can have a yellowish hue due to other smaller organisms that can live on the skin. The average lifespan of blue whales is estimated to be 80 to 90 years. They produce loud sounds to communicate. Blue whales are listed as endangered by the International Union for Conservation of Nature (IUCN) and the ESA throughout their range, but the general population trend is increasing.

Habitat

Blue whales are found in all the oceans except the Arctic Ocean. For feeding, they use regions closer to the poles where they find high concentrations of krill during the summer months. They migrate to warmer waters after winter for mating.

Overlap with Project Area

The migratory routes of blue whales are not well established. Collected sighting data suggest that blue whales have a moderate probability of being seen the along the southern Washington coast, with diminishing likelihood farther north (Figure 12). There is low likelihood that blue whales would encounter the Project area.

Potential Environmental Effects

Potential environmental effects on blue whales include entanglement with floating cables or derelict fishing gears, collision with vessels, and increased underwater noise. The probability of their interaction with floating cables is low because the cables take up a very small amount of space in the ocean (Copping and Grear 2018), and entanglement risk is extremely low because the cables are too taut to create a loop and have no loose ends, but collisions could cause injury to the animal. Marine mammal entanglement risk is increased if derelict fishing gear or ocean debris becomes entangled with mooring lines.

Collisions with vessels are another risk to marine mammals. Vessel traffic is only expected to increase slightly relative to existing vessel traffic in the region, and vessel collision risk is not expected to be a major issue.

Underwater noise generated by construction activity can increase stress for blue whales by disrupting their auditory sense. Noise would be only slightly elevated during the construction phase and noise would not rise to the level of harm for blue whales because offshore wind platforms do not require pile driving or other percussive activities. Construction activities could be timed to reduce the noise and vessel exposure to whales. Marine mammal observers could also be used during construction to help avoid interactions when marine mammals are nearby. During the operational period, underwater noise levels from offshore wind farms are expected to stay well below the threshold levels published by NOAA (NMFS 2018).

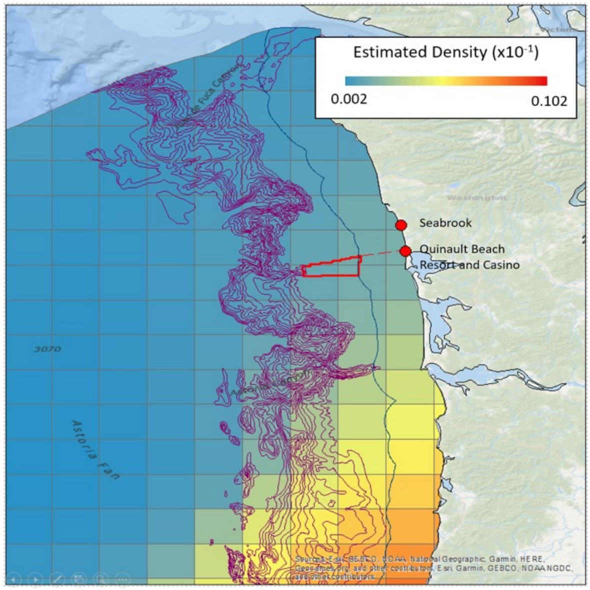

Figure 12. Estimated blue whale population density. Data from Becker et al. 2020; data set available from Marine Cadastre.

4.4.2 Fin Whale

Description and Status

Fin whales (*Balaenoptera physalus*) are the second largest marine mammal, measuring up to 25 m long and weighing up to 80 tons. They have dark coloring on their back and sides and white coloring underneath, and a large upright dorsal fin toward their tail. Their diet consists primarily of krill and small schooling fish. An estimated 14,000 to 18,000 Fin whales live in the North Pacific (down from an estimated 45,000 before commercial whaling (WDFW 2021e)); 3,200 compose the Eastern North Pacific Stock off the coasts of California, Oregon, and Washington (NOAA 2021f). Fin whales are listed as endangered under the ESA and by IUCN. Their population is considered depleted under the Marine Mammal Protection Act (MMPA).

Habitat

Fin whales are found in all major oceans. They are a semi-migratory species generally moving from high latitudes in the summer to temperate or tropical latitudes in the winter for breeding, but some individuals can be found in all locations year-round. Fin whales live in the deep, open ocean or near the continental slope, and are occasionally observed nearshore. Observations of Fin whales occur year-round off the Washington coast, but the majority of the Eastern North Pacific Stock are found in waters off the coast of California.

Overlap with Project Area

Limited overlap is expected in the offshore Project area because Fin whales are generally found in deeper waters, and farther south than the Project area (Figure 13). Sightings in Washington are more common south of Grays Harbor.

Potential Environmental Effects

Physical interactions with vessels or floating cables and increased noise during construction and operation are not expected to have an effect on Fin whales because of their limited expected overlap in the Project area.

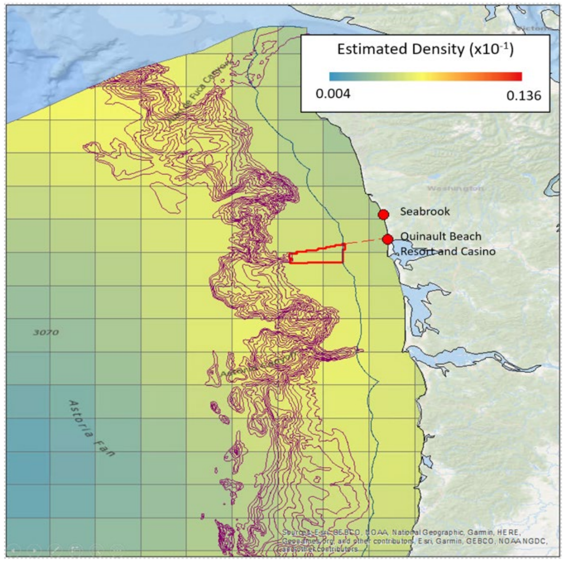

Figure 13. Estimated Fin Whale Population Density. Data from Becker et al. 2020; data set available from Marine Cadastre.

4.4.3 Humpback Whale

Description and Status

The humpback whale (*Megaptera novaeangliae*) is a baleen whale approximately 40 to 50 feet in length and weighing from 25 to 30 tons. This whale species is iconic to whale watchers because they exhibit active behaviors at the surface of the water such as breaching. Their flukes can reach up to 60 feet in length and have patterns and scars distinctive enough to identify individuals. Their life expectancy ranges from 80 to 90 years. This species is listed as Least Concern by the IUCN but as endangered by the ESA in regions including the North Pacific region.

Habitat

Humpback whale habitat range includes all oceans. Their presence is mainly driven by the availability of food such as krill and small fish. They migrate closer to the poles during the summer months to feed, and to the lower latitudes to breed. humpback whales have been recorded to travel up to 3,000 miles between their breeding and foraging grounds regularly.

Overlap with Project Area

Humpback whales are sighted at nearshore areas (Figure 13), and the relative likelihood of their seasonal presence around the Project area is high.

Potential Environmental Effects

Potential environmental effects include entanglement with floating cables or derelict fishing gear, collision with vessels, and increased underwater noise. The probability of humpback whales interacting with floating cables is low because the cables take up a very small amount of space in the ocean (Copping and Grear 2018). Derelict fishing gear or other ocean debris can become caught on floating cables (mooring lines or interarray electrical cables) and create a hazard for marine mammal entanglement. Entanglement risk is extremely low because the cables are too taut to create a loop and have no loose ends, but collisions could cause injury to the animal. The risk of collision with a vessel is expected to increase only slightly above that of existing vessel traffic. Underwater noise generated can cause a behavioral response in humpback whales to increase the level of their vocalizations or change to communicating through non-vocal methods (Dunlop 2016). Noise would be greater during the construction phase but is expected to stay well below the threshold levels published by NOAA (NMFS 2018). Noise during construction is low level noise from vessel operations, cable laying, trenching, and anchoring. The noise generated during construction does not include pile driving or other percussive activities that can cause injury to marine mammals. Construction activities could be timed to reduce exposure to humpback whales. Marine mammal observers could also be used during construction to help avoid interactions when marine mammals are nearby.

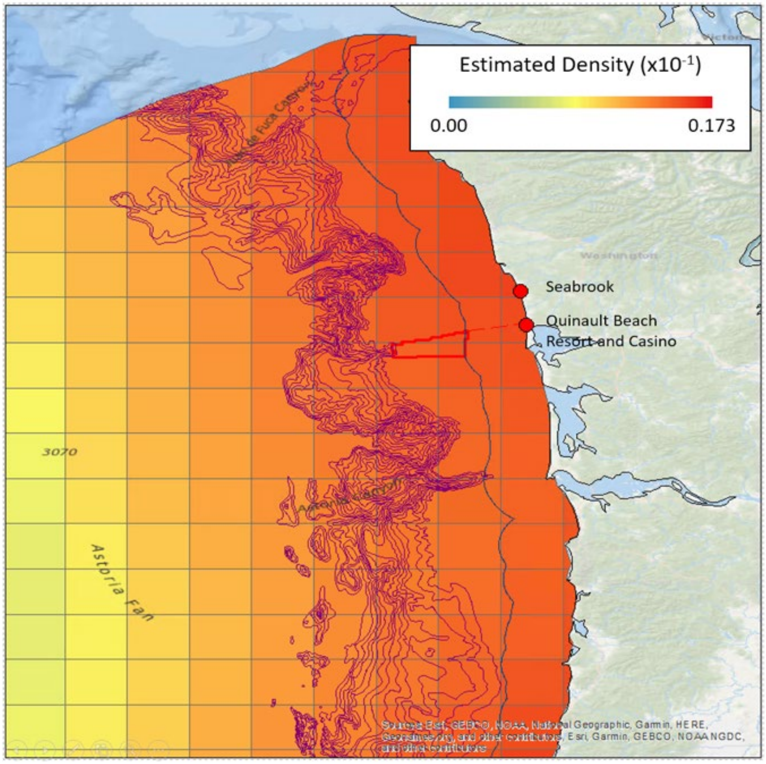

Figure 14. Estimated humpback whale population density. Data from Becker et al. 2020; data set available from Marine Cadastre.

4.4.4 Sperm Whale

Description and Status

Sperm whales are toothed whales that feed on squid, skate, and fish found in deep waters (NOAA 2021g). Their entire body is dark grey. Females can be up to 40 feet long, and males as long as 52 feet. Sperm whales dive deep into the ocean to search for food, commonly reaching depths of 2,000 feet, and they capable of diving as deep as 10,000 feet. They are listed as endangered under the ESA and by IUCN. Their population is considered depleted under the MMPA.

Habitat

Sperm whales live in all oceans and regions from the tropics to high latitudes. They are found in deeper waters from the continental shelf outward (Figure 15), and their greatest density is in productive waters that have steep geologic features. Sperm whales can be found in deep waters off the coast of Washington during spring, summer, and fall.

Overlap with Project Area

Sperm whales live in deeper waters over the continental slope and further offshore. Their normal range does not include shallower, nearshore waters where the Project would be located.

Potential Environmental Effects

Physical interactions with vessels or floating cables are not expected to have an effect on sperm whales because of the low expected overlap in the Project area. Increased noise during construction and operation are also expected to be minimal.

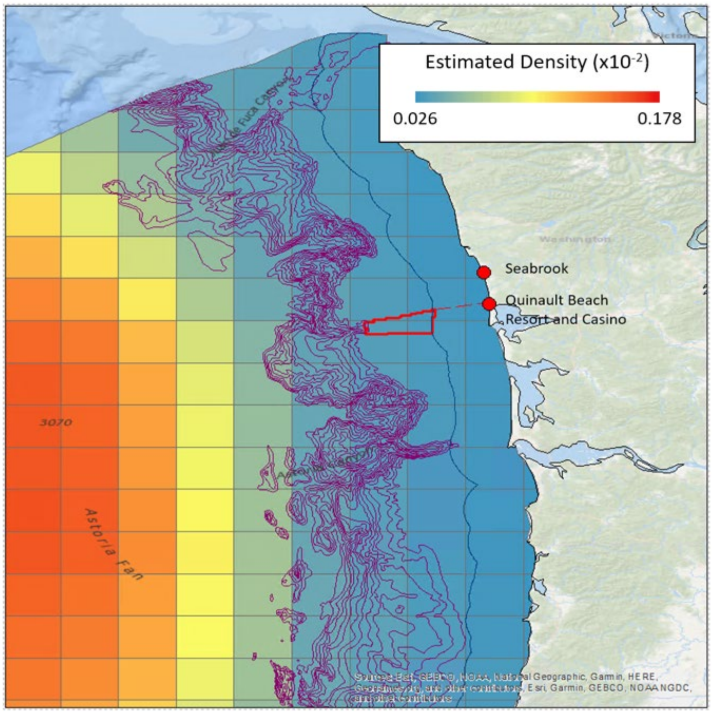

Figure 15. Estimated Sperm Whale Population Density. Data from Becker et al. 2020; data set available from Marine Cadastre.

4.4.5 Gray Whale

Description and Status

Gray whales (*Eschrichtius robustus*) are dark grey and measure approximately 50 feet long. They feed on benthic organisms and invertebrates that live on or just above the seafloor. Gray whales are split into two distinct population segments: the Western North Pacific and the Eastern North Pacific stocks. The Eastern North Pacific stock has recovered from commercial whaling harvest and was removed from the ESA in 1994 but remains protected under the MMPA. The Western North Pacific stock has much lower numbers and is listed as endangered under the ESA and depleted under the MMPA.

Habitat

Gray whales are a highly migratory marine mammal, traveling from Alaska to Mexico. Southbound migration occurs from October to January, northbound from February to June (WDFW 2021f). Whales travel close to shore and feed on the continental shelf and shallow coastal waters close to shore. The southbound migration typically occurs closer to shore than the springtime northern migration. The migration corridor is along the coast of Washington, where the whales feed in areas of higher food concentrations (Figure 15).

Overlap with Project Area

Gray whales migrate near or within the Project area during the spring or fall. A gray whale feeding ground has been identified directly offshore of the mouth of Grays Harbor Estuary.

Potential Environmental Effects

Potential environmental effects include entanglement with floating cables or derelict fishing gears, collision with vessels, and increased underwater noise. The probability of interaction with floating cables is low because the cables take up a very small amount of space in the ocean (Copping and Grear 2018). Derelict fishing gear or other ocean debris can become caught on floating cables (mooring lines or interarray electrical cables) and create a hazard for marine mammal entanglement. Entanglement risk is extremely low because the cables are too taut to create a loop and have no loose ends, but collisions could cause injury to the animal. The risk of collision with a vessel is expected to increase only slightly above that experienced with existing vessel traffic. Lastly, underwater noise generated can cause a behavioral response in gray whales, including a change in the loudness, timing, and structure of their vocalizations. Noise would be greater during the construction phase but is expected to stay well below the threshold levels published by NOAA (NMFS 2018). Noise during construction is low level noise from vessel operations, cable laying, trenching, and anchoring. The noise generated during construction does not include pile driving or other percussive activities that can cause injury to marine mammals. Construction activities could be timed to reduce exposure to gray whales. Marine mammal observers could also be used during construction to help avoid interactions when marine mammals are nearby.

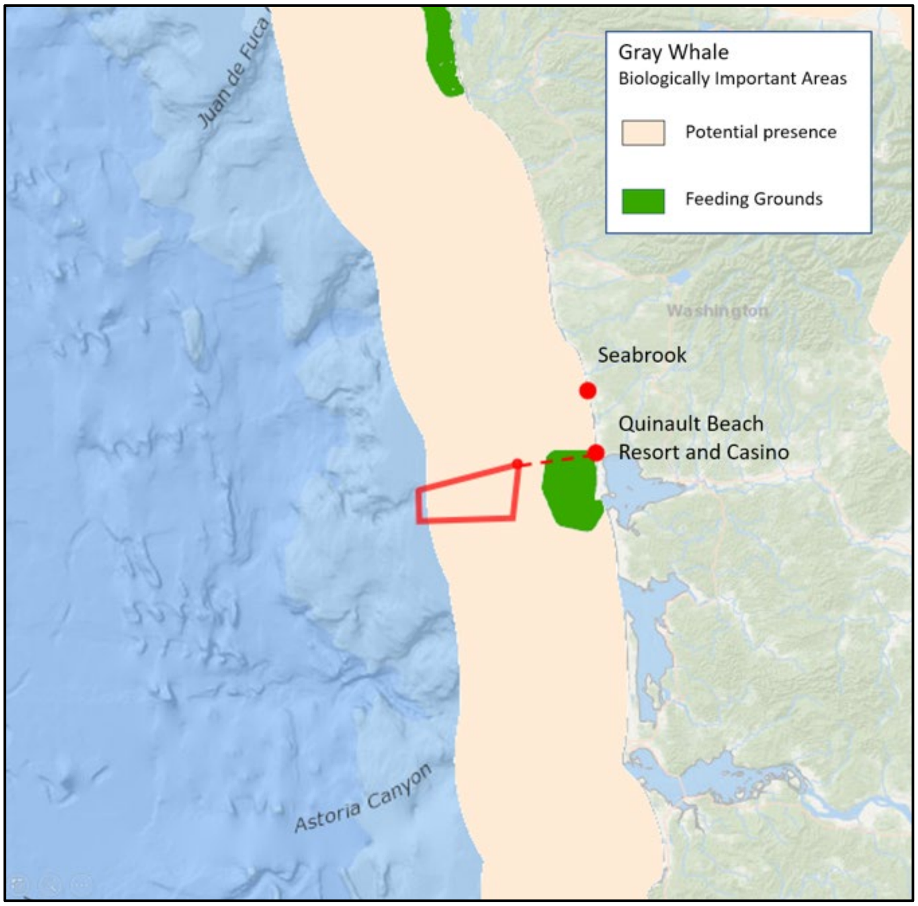

Figure 16. Potential Presence of Gray Whales in Migration Corridor (light orange) and Gray Whale Feeding Grounds (green). Data from Calambokidis et al. 2015.

4.4.6 Orca Whale

Description and Status

Killer whales (*Orcinus ocra*) are black with large white spots around their eyes and on their underside. They measure up to 32 feet long. Three populations of killer whales, the southern residents, transients, and offshores, inhabit waters around Washington. They feed on fish, with the southern resident population mostly eating chinook and chum salmon. All three populations are listed as endangered in the State of Washington and protected under the MMPA. The southern resident are federally listed as endangered under the ESA (WDFW, 2021g).

Habitat

Each population segment occupies a different area. The southern resident population inhabits waters in the Strait of Juan de Fuca and near the San Juan Islands between the spring and fall, then moves to the coast during the winter. The transient population occurs from California to Alaska and California typically within nine miles of the coastline. Offshore killer whales have a population that occurs further from shore between Alaska and California.

Overlap with Project Area

The southern resident killer whale and transient populations typically inhabit waters within nine miles from shore, which overlaps with the cable route but not the wind farm area. Southern resident killer whales only spend a portion of the year in on the Pacific Coast waters, spending most of their time within the Strait of Juan de Fuca or further east. Offshore killer whales may overlap with the project area.

Potential Environmental Effects

Potential environmental effects include entanglement with floating cables or derelict fishing gears, collision with vessels, and increased underwater noise. The probability of interaction with floating cables is low because the cables take up a very small amount of space in the ocean (Copping and Grear 2018). Derelict fishing gear or other ocean debris can become caught on floating cables (mooring lines or interarray electrical cables) and create a hazard for marine mammal entanglement. Entanglement risk is extremely low because the cables are too taut to create a loop and have no loose ends, but collisions could cause injury to the animal. The risk of collision with a vessel is expected to increase only slightly above that experienced with existing vessel traffic.

Lastly, underwater noise generated can interfere with orca's abilities to communicate and find prey through echolocation. Noise during construction is low level noise from vessel operations, cable laying, trenching, and anchoring. The noise generated during construction does not include pile driving or other percussive activities that can cause injury to marine mammals. Construction activities could be timed to reduce exposure to killer whales. Marine mammal observers could also be used during construction to help avoid interactions when marine mammals are nearby.

4.4.7 Northern Elephant Seal

Description and Status

Northern elephant seals (*Mirounga angustirostris*) are short-haired pinnipeds with gray to brown coloring and a large, inflatable proboscis (nose). Females measure up to 12 feet and 1 ton compared to the larger males that can reach 13 feet in length and over 2 tons (The Whale Trail 2021). Their diet consists primarily of fish and squid. There is a large population on the Pacific Coast—more than 100,000 seals. They are protected under the MMPA, but not listed as threatened or endangered under ESA.

Habitat

Northern elephant seals range from Alaska to Mexico, with major colonies and breeding grounds in the Channel Islands and Baja, California. Summer feeding grounds are in the Gulf of Alaska for males and off the coast of Washington and Oregon for females. During the spring and summer season, seals come onshore for an extended time to molt, then return to the water for feeding. During the winter, the seals migrate south to California or Mexico and come ashore for breeding.

Overlap with Project Area

Northern elephant seal utilization of waters off the coast of Grays Harbor are shown in Figure 17. Females forage in the waters off the coast of Washington. There may be limited overlap of feeding grounds with the Project area. Elephant seals are not known to come ashore for molting in the Grays Harbor region.

Potential Environmental Effects

Potential environmental interactions with northern elephant seals are limited to the offshore area. Like other marine mammals, the primary effects may be from noise, interactions with vessels, and interactions with floating cables. Cumulative impacts may be important to consider if fish populations thrive in the offshore area due to potential changes in fishing activity and new habitat, and the offshore area could see increased utilization as seal feeding grounds.

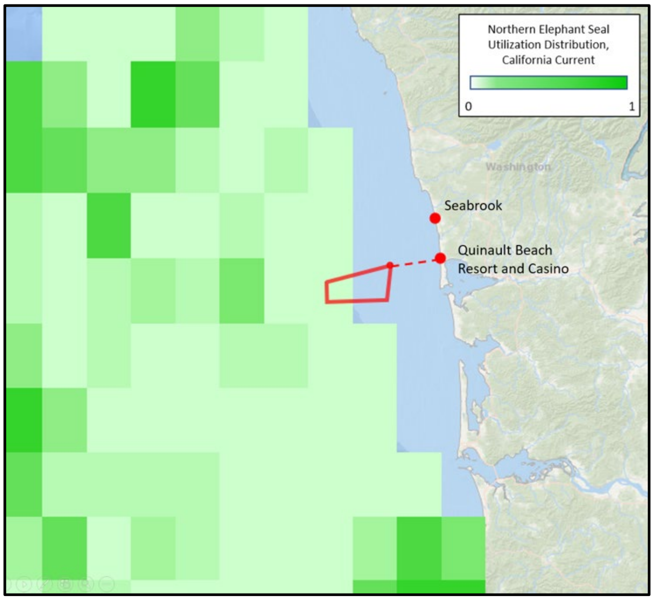

Figure 17. Utilization Distribution of Northern Elephant Seals (darker green indicates higher utilization).

4.4.8 Steller Sea Lion

Description and Status

Steller sea lions (*Eumetopias jubatus*) have light brown coarse hair on their body and light whiskers on their muzzle (Figure 18). Males are larger and more muscular than females. Males measures up to 11 feet and weigh up to 2,400 pounds; females are slightly shorter, measuring up to 9.5 feet and weighing as much as 800 pounds (NOAA 2021h). Steller sea lions search for food at night, eating primarily fish and cephalopods (e.g., squid). They forage in pelagic and benthic zones in areas both nearshore and offshore of the continental shelf. Steller sea lion populations are separated into two distinct population segments, with the Eastern Distinct Population Segment occurring off the Washington coast. The Eastern Distinct Population Segment is protected under the MMPA and is not listed as threatened or endangered under the ESA.

Figure 18. Steller Sea Lion (image from NOAA).

Habitat

The Eastern Distinct Population Segment of Steller sea lions is located near the coasts of California, Oregon, Washington, and British Columbia, and southern Alaska. They do not make large-scale migrations but move based on food availability and weather patterns (Wiles 2015). Steller sea lions are found in the waters off the coast of Washington and use haulout sites on the coast of the Olympic Peninsula.

Overlap with Project Area

Steller sea lions are known to use rocks near Split Rock as a seasonal haulout location (Jeffries et al. 2000). Split Rock is located offshore of the Quinault Indian Nation reservation and approximately 17 mi northwest of Seabrook, Washington. This haulout location does not overlap with any of the Project locations, but its location indicates that Steller sea lions may forage near the areas around the Project site. The floating wind platforms will be 20-40 m above the waterline, depending on the technology chosen, which makes them out of reach for pinniped haulouts.

Potential Environmental Effects

Potential environmental interactions with Stellar sea lions are limited to the offshore area. Like other marine mammals, the primary effects may be from noise, interactions with vessels, and interactions with floating cables.

4.4.9 California Sea Lion

Description and Status

California sea lions (*Zalophus californianus californianus*) are pinnipeds that range in color from blonde and light brown (female) to darker brown and black (male). They live up to be 20 or 30 years old and weigh approximately 240 pounds for a female and 700 pounds for a male. Their diet consists of squid, sardines, and other fish. California sea lions are protected under the MMPA and not listed as threatened or endangered under the ESA.

Habitat

The California sea lion are native to the waters off the coast of California and Mexico. Only since the 1950s have observations of California sea lions been common in Washington. Female California sea lions spend the entire year in warmer waters near breeding rookeries in California and Mexico, but some males will travel north to waters off the coast of Washington in the fall and stay through the spring. California sea lions will haulout on rocks, jetties, docks, and even navigation buoys.

Overlap with Project Area

Small numbers of California sea lions are known to use rocks near Split Rock as a seasonal haulout location (Jeffries et al. 2000). Split Rock is located offshore of the Quinault Indian Nation reservation and approximately 17 mi northwest of Seabrook, Washington. This haulout location does not overlap with any of the Project locations, but its location indicates that California sea lions may forage near the areas around the Project site between the fall and spring. The floating wind platforms will be 20-40 m above the waterline, depending on the technology chosen, which makes them out of reach for pinniped haulouts.

California sea lions are also found seasonally in small numbers foraging in Grays Harbor Estuary or hauled out on docks on intertidal flats (Jeffries et al. 2000).

Potential Environmental Effects

Potential environmental interactions with California sea lions are similar to other pinnipeds and marine mammals, where the primary effects may be from noise, interactions with vessels, and interactions with floating cables.

If construction activities for the Project take place in Grays Harbor, the effect on California sea lion haulout sites should be evaluated in detail to identify any areas of overlap.

4.4.10 Harbor Seal

Description and Status

Harbor seals (*Phoca vitulina richardsi*) are a small grey seal that has black spots, flippers and claws; they weigh up to 265 pounds (Figure 19). Harbor seal populations are stable on the West Coast. They are protected under the MMPA and listed as a priority species by the WDFW.

Figure 19. Harbor Seals at a Sandy Haulout Location (image from NOAA).

Habitat

Harbor seals live in temperate and arctic latitudes in the northern hemisphere. They spend time in offshore waters, in estuaries, and on land along the coast or in estuaries. They use water off the coast of Washington year-round. Harbor seals do not migrate between seasons; their typical home range is within a 15 to 30 mile radius (NOAA 2021i). Harbor seal haulout locations are found in Grays Harbor and along the Washington coast.

Overlap with Project Area

Harbor seals will come on land at haulout locations on the intertidal mud flats and sand bars within Grays Harbor (Jeffries et al. 2000). Along the Pacific Coast, haulout sites include intertidal rocks and reefs, that are used extensively by seals during the summer for pupping and molting.

Potential Environmental Effects

Potential environmental interactions with harbor seals could occur in the offshore area. Like other marine mammals, the primary effects may be from noise, interactions with vessels, and interactions with floating cables.

If construction activities for the Project take place in Grays Harbor, the effect on Harbor Seal haulout sites should be evaluated in detail to identify any areas of overlap.

4.5 Benthic Habitat and Organisms

Key Points:

- The seafloor—or benthic environment—is host to a variety of species and serves as a key foundation of the marine food web.
- Offshore wind may create temporary effects on small areas of the seafloor during installation of the submarine electrical cable. This effect would be temporary, based on observations at other offshore wind farm sites, the sea floor has been shown to recover to its natural state.
- Careful siting and pre-construction surveys to identify and avoid any location of potential impact would avoid direct harm to benthic organisms from anchor installation offshore, such as the recently listed endangered sunflower sea star.

4.5.1 Benthic Habitat

The species composition in an offshore area is largely influenced by the seafloor characteristics. Benthic habitats in the Project area can be identified using the seafloor substrate and type of sediment. Within the offshore area and cable route back to shore, there is a mix of sandy, muddy, and rocky areas. Sandy and muddy areas (soft bottom) allow organisms to burrow into the sediment. Rocky areas (hard bottom) are advantageous to other organisms that can attach to rocks or use the local terrain as shelter. Common assemblages in different substrates identified in Grays Bank, which is located to the northeast of the Project area, are described in Table 10 (Goldfinger et al. 2014).

The proposed project will not include manufacture or assembly within the estuary, and thus will not affect the estuarine habitats.

Table 10. Typical organisms in different substrates.

Substrate	Typical Organisms[a]
Rock	Various sponges, gorgonians (corals), sea anemones, and echinoderms (sea stars, sea cucumbers, sea urchins, sand dollars, sea lilies)
Gravel	Sea anemones and burrowing brittle stars[b]
Mud Muddy Sand Sand Mud	Sea whips and burrowing brittle stars; many species of animals living buried in the sediment, including polychaetes (worms) and mollusks

[a] Sources: Hemery and Henkel 2016 and Dethier 1990.

[b] Epifauna listed for Unconsolidated Rock in the first reference (Hemery and Henkel 2016) corresponds to Gravel and Gravel Mix in this categorization.

The seafloor in the Project area consists of soft and hard bottom habitat (Figure 20). The data shown below are based on surveys and predictive modeling, but site-specific surveys would be needed to identify the geologic and biologic conditions prior to Project development.

Offshore Area

The offshore area consists largely of mud, muddy sand, and sandy mud. There are few areas of rock and gravel mix toward the nearshore side of the Project area. The locations and types of anchors used for the Project would be selected based on the seafloor conditions.

Cable Route

The cable route back to shore would likely cross mostly sandy substrate and pass through some areas of gravel. Depending on the cable installation techniques and the pre-construction survey, the route would likely try to avoid hard bottom substrate.

Potential Environmental Effects

Environmental effects on benthic habitat and associated organisms are possible during cable installation and around the anchors during operation of a floating wind farm (Table 11).

- During cable installation, the immediate area around the cable would be physically disrupted. This effect is limited to a small area around the cable installation site and, if the cable is buried, the habitat is expected to recover.
- Throughout the lifetime of the wind farm, the benthic habitat would be physically disrupted at the anchor sites to install the floating foundations. The effect would be limited to a small area surrounding the anchors.
  - The anchors would provide new hard substrate habitat in the ocean.
  - If a drag embedded anchor and mooring chain are used, the immediate area around the anchor would be continually disrupted by the swaying motion of the chain.
  - Scour, or local erosion, can occur around an anchor that removes soft sediment and habitat near the anchor location.

Table 11. Summary of potential environmental effects on the benthic habitat.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable route	Disruption of habitat	Temporary impact: habitat recolonizes cable lay area
Mooring line anchors	Offshore area	Seabed scour disrupts habitat	Limited: scour area very small relative to the wind farm size and available surrounding habitat
Introduction of new hard substrate	Offshore area	Addition of anchors to the seafloor create a new hard substrate	Limited: anchor area very small relative to the wind farm size and available surrounding habitat

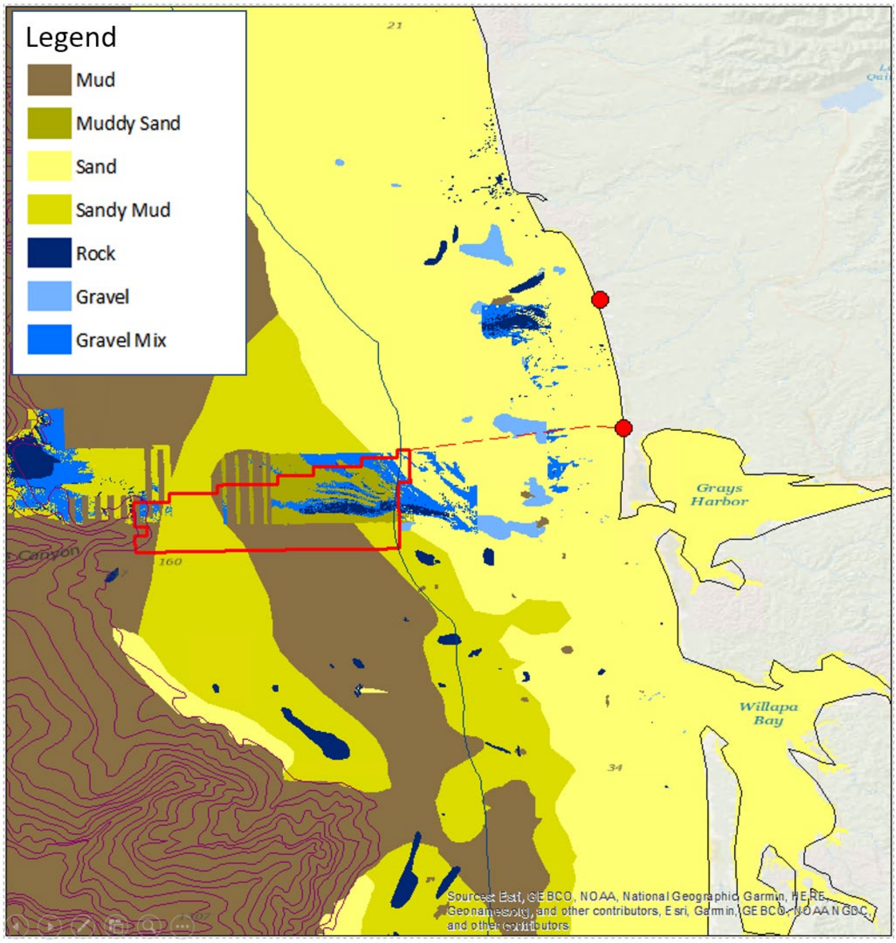

Figure 20. Seafloor Substrate off the Coast of Grays Harbor, Washington (data from Oregon State Active Tectonics Laboratory, West Coast Habitat Map (2021)).

4.5.2 Habitat Areas of Particular Concern, Rocky Reef

The National Marine Fisheries Service delineates Habitat Areas of Particular Concern (HAPC) as areas with particular focus on conservation due to their sensitive habitat that can be stressed by human development or use (NOAA, 2021j). There are several types of HAPC, including Estuaries, Canopy Kelp, Seagrass, Rocky Reefs, and Areas of Interest. Rocky reef HAPC are located in areas with hard substrates on the seafloor that create special habitat for benthic organisms and groundfish. NOAA defines Rocky Reef HAPCs by using substrate data from their groundfish essential fish habitat assessments, then can add or delineate more hard bottom areas by using surveys or observations. The Rocky Reef HAPCs note the presence or possible presence of deep water corals and deep water sponges.

Several Rocky Reef HAPCs occur in the areas surrounding the proposed offshore wind area (Figure 21), but none of them overlap within the Project area. Cable routing and turbine micro-siting would consider hard bottom habitat during their survey and planning phase to avoid disruption of any hard substrate.

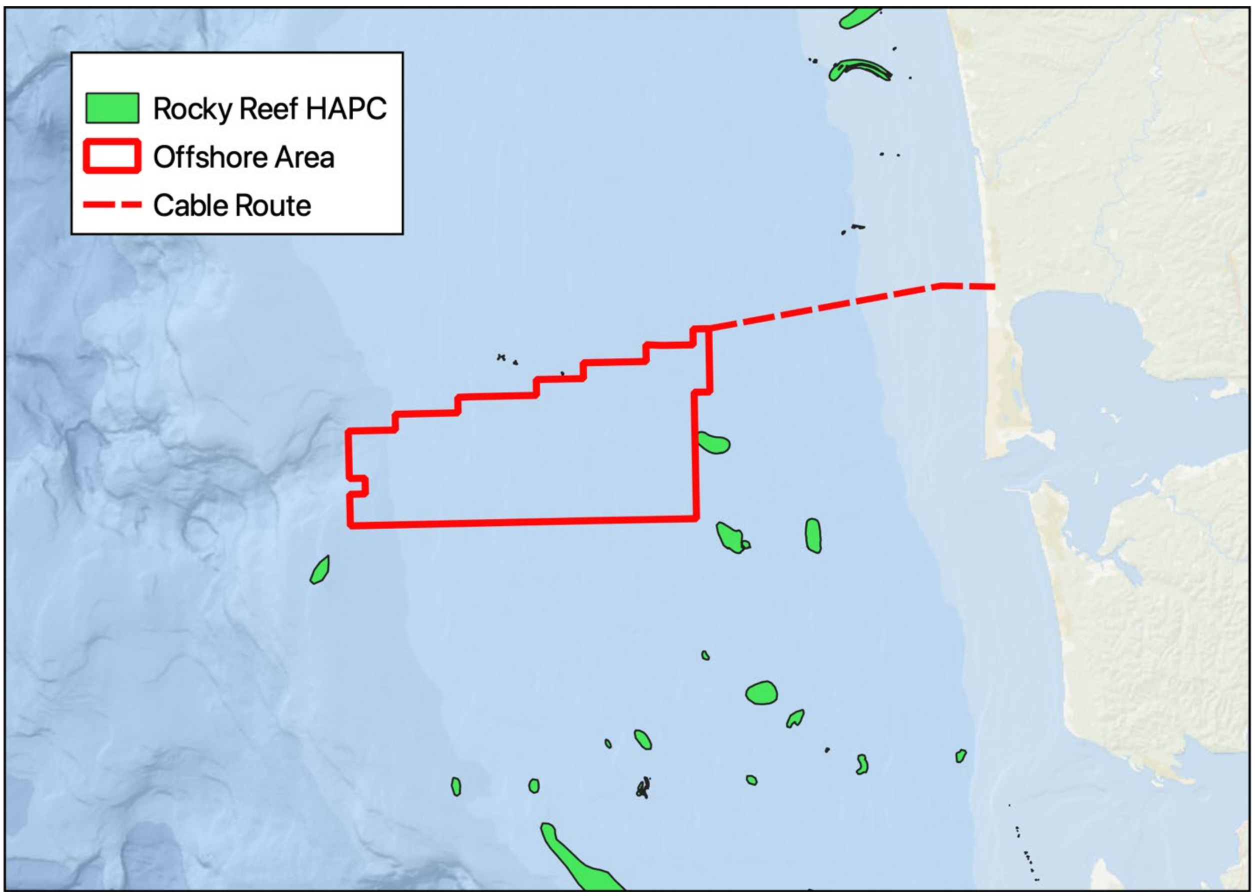

Figure 21. Rocky Reef HAPCs Surrounding the Offshore Area.

4.5.3 Sunflower Sea Star

Description and Status

The sunflower sea star (*Pycnopodia helianthoides*) is the largest sea star in the world; it grows up to 3.2 feet in diameter and has up to 24 arms (Figure 22) (Slater Museum 2021). They can travel at speeds over 3.2 feet per minute (Monterey Bay Aquarium 2021). The sunflower sea star has soft skin with colors of purple or brown. It was listed as a critically endangered species in 2020 (IUCN 2021). The sea star decline is caused by a widespread sea star wasting syndrome and increasing sea temperatures.

Figure 22. Sunflower Sea Star (University of Puget Sound).

Habitat

Sunflower sea stars are found from the subtidal zone out to a depth of 1,500 feet. They are most commonly found below the 80-foot depth and rarely found deeper than the 400 foot depth. Their habitat includes sand, gravel, mud boulders, and rocky substrates.

Their historical range extends from Mexico to the Aleutian Islands in Alaska. Recent research by Oregon State University shows that their current distribution does not extend farther south than Puget Sound in Washington (Figure 23) (Dunagan 2020).

Overlap with Project Area

While the historical range of the sunflower sea star extended to the area offshore Grays Harbor, their range is shrinking, and their current distribution extends northward from the Strait of Juan de Fuca. The depth range of this species overlaps minimally with the offshore area; they are more commonly found in waters shallower than 80 feet. There is a potential for the sunflower sea star to occur along the cable route; however, the current distribution indicates that this will be unlikely.

Potential Environmental Effects

Sea star habitat could be disrupted by the installation of the subsea electrical cable connecting the wind farm to the shore. Cable installation and landfall could cause temporary disruptions to the seafloor, but the seafloor is expected to recover (Table 12).

The mooring chain connected to the anchors for the floating turbine platforms could continually disrupt the small area adjacent to the anchors at the depths of the Project area.

These effects are unlikely to have direct consequence to the sunflower star unless its current geographic range extends to the Project area in future.

Table 12. Summary of potential environmental effects on the sunflower sea star.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable route	Disruption of habitat	Temporary impact: habitat recolonizes cable lay area
Mooring line anchors	Offshore area	Seabed scour disrupts habitat	Limited; scour area very small relative to the wind farm size; possible, but unlikely to be present in offshore area because of depth

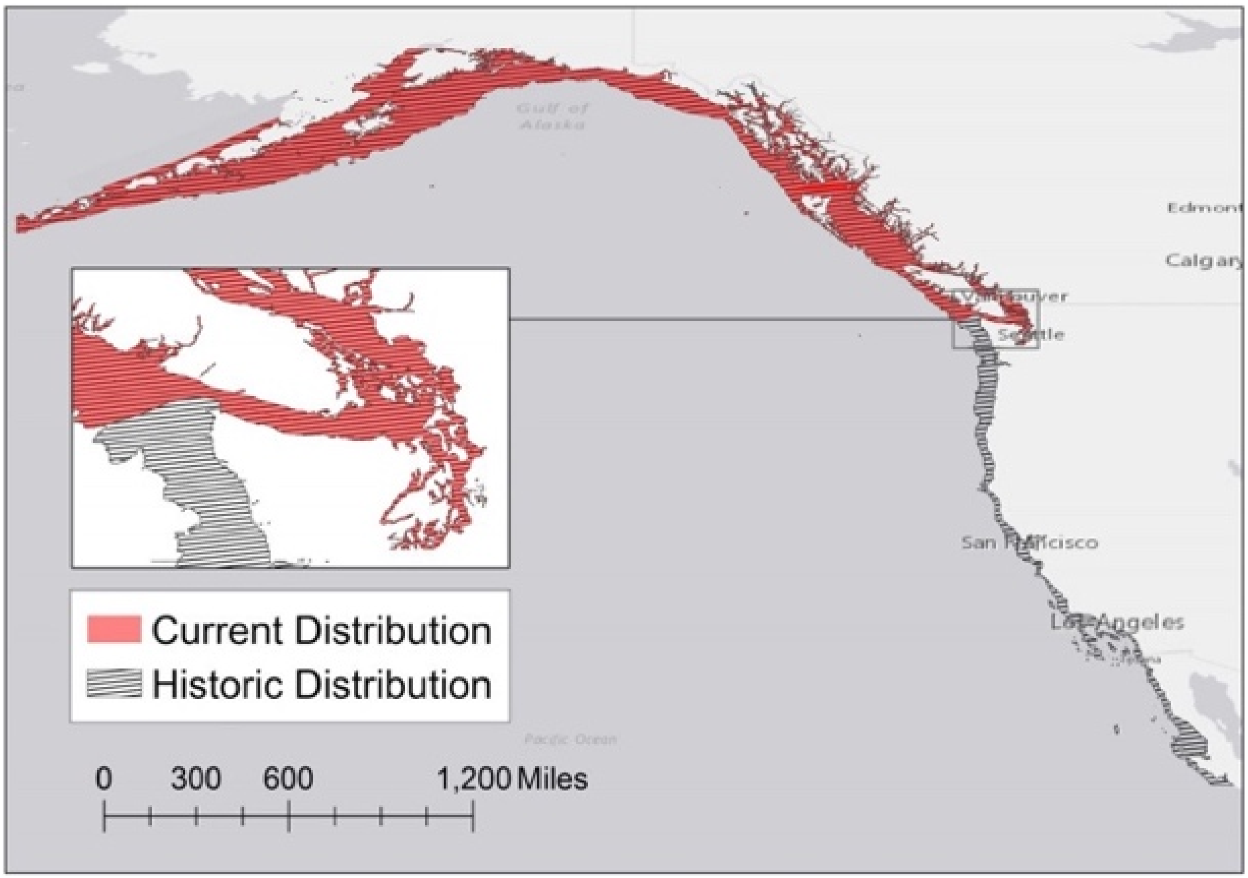

Figure 23. Geographic Range of Sunflower Sea Star (from Sara Hamilton, Oregon State University).

4.6 Sea Turtles

Key Points:

- Six species of sea turtles are found in United States waters. All are listed as threatened or endangered under the ESA.
- Sea turtles are rarely found in waters off the coast of Washington. Small numbers of leatherback sea turtles visit Washington in the summer, but the occurrence of other sea turtle species is very rare.
- Collision with floating cables or mooring lines is a potential environmental effect between the offshore wind farm and individual sea turtles, but interactions are expected to be of extremely low probability due to the low frequency of sea turtle occurrence and the small area of the floating cables in the water column.

Sea turtles are sensitive marine reptiles that live in all of the world's oceans. Six species of sea turtles can be found in United States waters, as described below. All of these sea turtles are listed as endangered or threatened under the ESA. Sea turtles are not common in the waters off the coast of Washington; they prefer warmer waters in lower latitudes. Of the six species in the United States. the leatherback sea turtle is the only one that is commonly found in Washington, although in low numbers. Loggerhead sea turtles may visit waters off the coast of Washington, but their occurrence is expected to be very rare. Other species of sea turtles are not found in Washington waters and no further analysis on these species has been done.

The possible environmental effects on sea turtles are collision with floating cables, sensitivity to marine noise from increased vessel traffic, and collision with a vessel. The possibility of interaction between a wind farm and sea turtles is extremely low in Washington because of the limited overlap between the Project and their range. Rather than repeating the potential environmental effects for each species, Table 13 summarizes the information for all sea turtles.

Table 13. Potential environmental effects on sea turtles.

Stressor	Location	Potential Effect	Magnitude of Effect	Relevant Species[a]
Floating cables in water column, primarily mooring lines	Offshore area	Collision or entanglement	Low probability of encounters, but high risk of injury.	Leatherback, loggerhead
Increased vessel traffic	Within harbor, offshore area	Increased noise Increased risk for vessel strike	Very low, especially relative to existing vessel traffic	Leatherback, loggerhead

[a] No direct effect expected because Project area does not overlap with species ranges.

4.6.1 Leatherback Sea Turtle

Description and Status

The leatherback sea turtle (*Dermochelys coriacea*) is a large, highly migratory sea turtle (Figure 24). They have tough, rubbery skin and a hard shell with primarily black coloring and white underneath (NOAA 2021k). All leatherback populations are listed as endangered under the ESA.

Habitat

Leatherbacks reside in the Pacific, Atlantic, and Indian Oceans. Their nesting grounds are located in tropical latitudes in the eastern and western Pacific. Leatherback sea turtles have feeding grounds on the United States Pacific Coast. The highest abundance occurs off the central California coast and they are occasionally found off the coast of Washington in the summer (WDFW 2021h). They are typically found near the edges of the continental shelf.

Figure 24. Leatherback sea turtle (NOAA Fisheries).

Overlap with Project Area

The Project area falls within the possible leatherback sea turtle range. However, the utilization distribution of this species indicates they are likely to occur in deeper waters farther from the Washington coast (Figure 25) (Benson et al. 2011).

Potential Environmental Effects

To date, no operational wind farms have shown negative effects on sea turtles. The possible environmental effects on leatherback sea turtles are entanglement with floating cables, sensitivity to marine noise from increased vessel traffic (Piniak et al. 2012), and collision with a vessel.

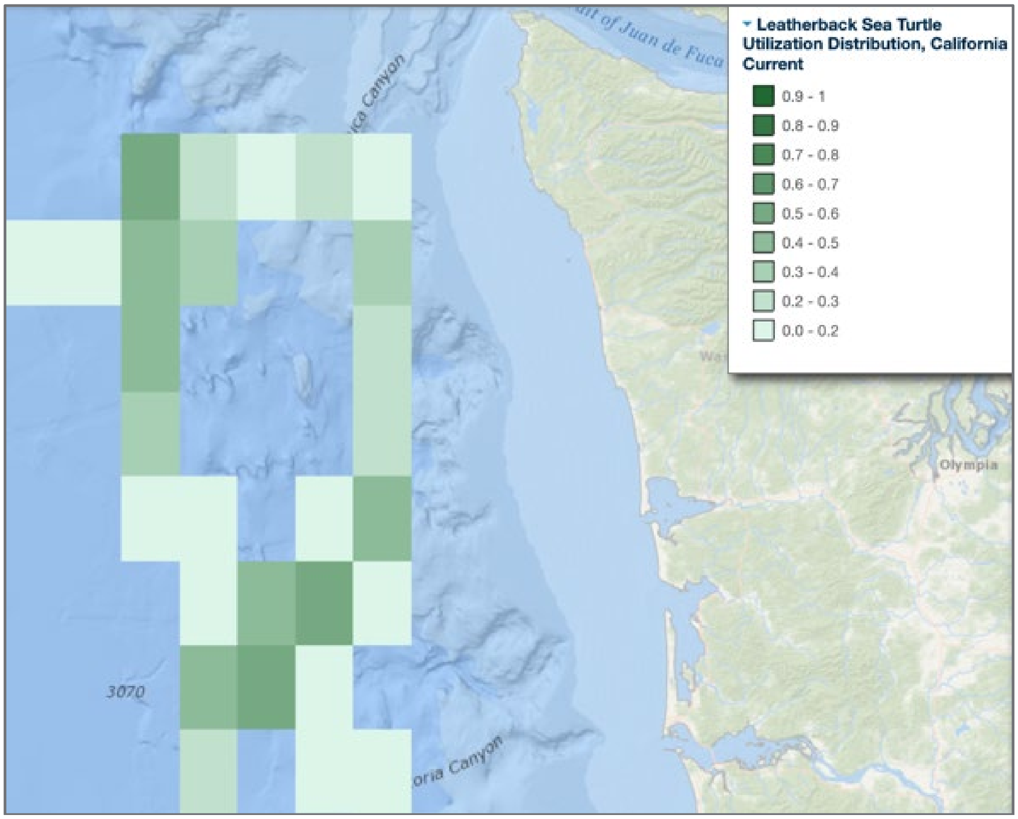

Figure 25. Leatherback Sea Turtle Utilization Distribution (darker green represents greater utilization) (data from Maxwell et al. 2013).

4.6.2 Loggerhead Sea Turtle

Description and Status

The loggerhead sea turtle (*Caretta caretta*) is the most abundant sea turtle found off United States coasts (Figure 26). The North Pacific Distinct Population Segment is listed as endangered under the ESA (NOAA 2021l).

Figure 26. Loggerhead Sea Turtle (National Wildlife Federation).

Habitat

The North Pacific Distinct Population Segment nests in the western Pacific near Japan and migrates across the Pacific to California, Mexico, and South America.

Overlap with Project Area

Loggerhead sea turtles are very rarely located in waters off the coast of Washington (WDFW 2021i). Potential loggerhead range overlaps with the Project area, although low numbers and large distances to any nesting ground indicate a low possibility of interaction (Polovina et al. 2004; Peckham et al. 2007).

Potential Environmental Effects

To date, no operational wind farms have shown negative effects on sea turtles. The possibility of interaction is extremely low because this species is rarely found off the Washington coast. The possible environmental effects are entanglement with floating cables, sensitivity to marine noise from increased vessel traffic, and collision with a vessel.

4.7 Seagrass and Vegetation

4.7.1 Eelgrass

Key Points:

- Eelgrass is located around the perimeter of Grays Harbor.
- If improvements to the port or navigation channel are required to support offshore wind development, eelgrass habitat should be avoided. There does not appear to be any overlap between the location of the navigation channel and terminals within Grays Harbor with eelgrass beds.

Description and Status

Eelgrass (*Zostera marina L.*) is a flowering aquatic plant that grows in soft sediment. Eelgrass grows in wide beds connected by an underground rhizomatic structure. The long leaves of eelgrass provide shelter and foraging ground for invertebrates and young fish, and act as an important food source for the nearshore marine food web.

Habitat

Eelgrass grows in soft sediment in sheltered areas along the shallow perimeter to depths of 4 to 30 feet below mean lower low water of a bay or estuary with access to clear water and sunlight.

Overlap with Project Area

Eelgrass is present around the perimeter of Grays Harbor Estuary (green hatched areas in Figure 30). The locations of eelgrass do not directly overlap with the port facilities or navigation channel that may be used for maintenance and servicing of the offshore wind components.

Potential Environmental Effects

Any improvement or additions to port infrastructure around Grays Harbor could remove or affect eelgrass habitat depending on the specific location of port improvements. Any changes within Grays Harbor are likely to be in the vicinity of the navigation channel and terminals, which are located outside of existing eelgrass habitat areas. Thus, impacts on eelgrass are unlikely. If development was to overlap with eelgrass locations there are two possible environmental effects: (1) creation of new overwater structures would limit the available light for eelgrass, and (2) increased turbidity in the water could reduce the growth of eelgrass (Table 14).

Table 14. Potential environmental effects on eelgrass.

Stressor	Location	Potential Effect	Magnitude of Effect
Port improvements (if needed)	Within harbor	Reduction of habitat	Limited to a small area; unlikely to overlap with eelgrass habitat

4.7.2 Kelp

Key Points:

- Only one small area of kelp has been identified in the Grays Harbor area, located on the bay side near the tip of the southern spit of Grays Harbor.
- Any improvements or activities within Grays Harbor Estuary are not expected to overlap with the location of kelp or cause harm to its habitat.

Description and Status

Kelp are large, brown algae (seaweed) that grow underwater. The name ‘kelp’ is the common term for the order Laminariales, which includes many species. Giant kelp (*Macrocystis pyrifera*) and bull kelp (*Nereocystic luetkeana*) are the most common species on the Pacific Coast. Kelp beds can create a habitat for fish, snails, crabs, and other marine life. Many marine animals feed on kelp as a food source; humans harvest kelp for food.

Habitat

Kelp grows along the coastline in cool, nutrient rich waters (NOAA 2021q). Kelp anchors on rocky or hard substrate and grows vertically through the water column. Kelp favors clear waters, where light can penetrate through the water column.

Overlap with Project Area

Washington surveys for kelp identify areas within Puget Sound, the Strait of Juan de Fuca, and on the northern coastline of the Olympic Peninsula. Kelp was not found on the outer coast near the Project area. There is no overlap of kelp areas with the offshore Project areas. Around Grays Harbor, one kelp bed was identified on the bay side of the southern spit (purple dot in Figure 27).

Potential Environmental Effects

Environmental effects on kelp are not expected to occur within Grays Harbor, because the location of kelp does not overlap with any expected locations proposed for development (Table 15). If the Project requires port or navigation improvements, they would be limited to the area surrounding the navigation channel and terminals, which do not intersect with the area of kelp.

Increased turbidity (suspended sediment) in the water could reduce the amount of light reaching kelp. An increase in vessel traffic or dredging as part of an offshore wind development would likely occur far enough from the kelp that the nearby turbidity would not be affected, nor is kelp likely to be affected by ship propellers.

Table 15. Summary of potential environmental effects on kelp.

Stressor	Location	Potential Effect	Magnitude of Effect
No direct effect expected			

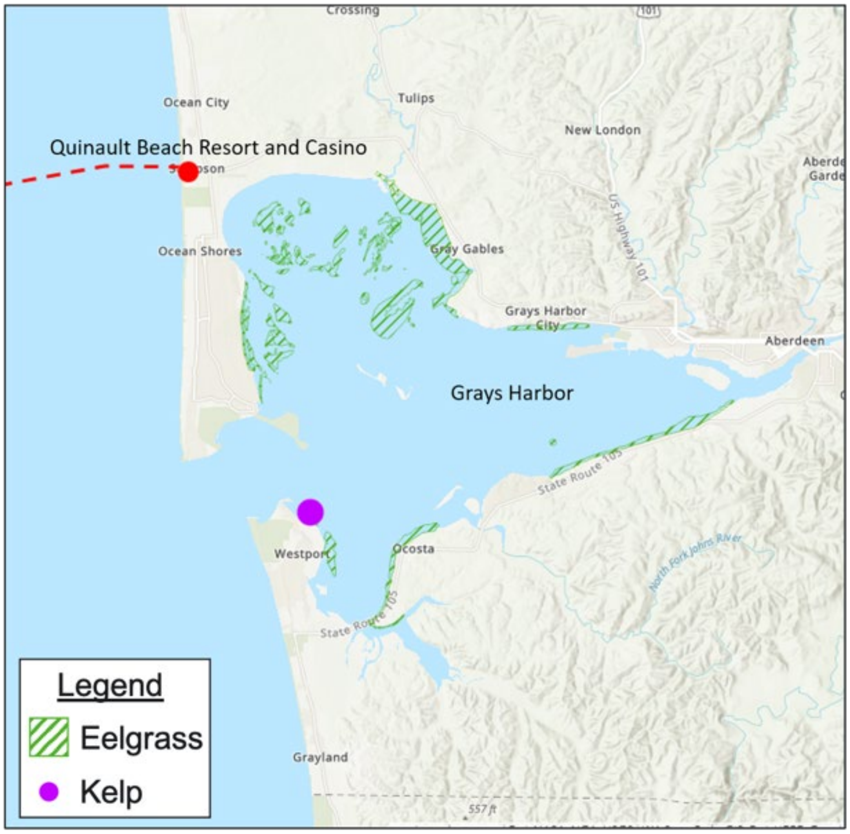

Figure 27. Eelgrass and kelp in and around grays harbor.

4.7.3 American Dunegrass

Key Points:

- American dunegrass is abundant along the coastal beaches north and south of Grays Harbor.
- Dunegrass may be removed during construction at the cable landfall, but is expected to recover quickly or be reintroduced after cable installation.

Description and Status

American dunegrass (*Leymus mollis*) is a native, perennial grass that grows 3 to 6 feet tall along coastal sand dunes and marshes (Figure 28) (Wildflower Center, 2021). Dunegrass helps control erosion on dunes and gravelly beaches. Dunegrass is common, occurring widely along the Washington coast (USDA 2021).

Figure 28. American Dunegrass (Marilee Lovit).

Overlap with Project Area

American dunegrass is present on the beaches north and south of Grays Harbor (Figure 29) and would likely be present at the cable landfall location.

Potential Environmental Effects

Dunegrass may need to be removed to accommodate construction at the cable landfall location, depending on the construction method. Localized removal of dunegrass is not expected to have consequences on its population, and any effect could likely recover back to a natural state or be reintroduced to the affected area (Table 16).

Table 16. Summary of potential environmental effects on American dunegrass.

Stressor	Location	Potential Effect	Magnitude of Effect
Electrical export cable installation	Cable landfall	Disruption or removal	Temporary impact: expected to return to natural state or be replanted after construction

Figure 29. American Dunegrass Locations Around Grays Harbor Shown in Yellow (Washington Marine Spatial Planning).

4.7.4 Beargrass

Key Points:

- Beargrass is a culturally important species used for basket weaving.
- Beargrass is located in a wide range of terrestrial habitat from sea level to the Cascade Mountains.
- The environmental effects of offshore wind development are not expected to overlap with any beargrass habitat locations because the activities would occur offshore or around the navigation channel and terminals at Grays Harbor.

Description and Status

Beargrass (*Xerophyllum tenax*) is a terrestrial, perennial plant that has a white flower that blooms from the center of a long stalk (Figure 33). It grows from 6 to 60 inches tall in bunches Beargrass is a culturally important species that is used for basket weaving.

Figure 30. Beargrass (US Forest Service photo by Barbara Mumblo).

Habitat

Beargrass has a wide-ranging habitat and can be found on dry slopes, ridges, bogs, and wetlands. Beargrass grows throughout mountainous regions Sierra Nevada, Cascades, and Rocky Mountains and also grows in coastal and low lying areas in northern California and at sea level on the Olympic Peninsula.

Overlap with Project Area

There is no expected overlap between beargrass habitat and the offshore wind Project areas.

Potential Environmental Effects

No direct environmental effects are expected because there is no overlap between the Project areas and beargrass habitat and dredging will not occur in Grays Harbor as a result of the project (Table 17).

Table 17. Summary of the environmental effects on beargrass.

Stressor	Location	Potential Effect	Magnitude of Effect
No overlap with Project areas			

4.8 Climate Change Considerations

Key Points:

- Climate change will likely have an impact on populations of marine wildlife in the Project area that is as large or greater than that of the offshore wind development.
- Sea level rise, sea surface temperature increase, and ocean acidification are the primary forces that will put marine species under increased pressure. Anadromous species of fish may also be affected by changes on land including changes in precipitation patterns, and extreme events.
- The main effects will be fish moving north to find colder waters, shifting timing of marine mammal migration, and difficulty for shellfish and invertebrates to build their shells from calcium carbonate.
- The impacts of climate change are not expected to exacerbate environmental effects experienced from offshore wind.

Climate change caused by anthropogenic emissions of greenhouse gases is putting additional stress on coastal and marine ecosystems. The effects of climate change are altering the characteristics of the ocean and the success and behavior of marine life. All marine and estuarine development projects need to consider not only the effects on marine life under existing conditions but also the potential effects on wildlife under future conditions. As CO_2 and other greenhouse gas concentrations have risen in the Earth's atmosphere, changes in the environment have been noted in rising sea levels, higher sea surface temperatures, and acidification of ocean water. The effects of these changes on the marine environment around Grays Harbor are described in the following sections.

4.8.1 Sea Level Rise

Sea level rise is caused by three main factors:

- Increased volume of water in the global oceans caused by melting ice sheets and glaciers; and
- Higher sea water temperature causing the thermal expansion of water, such that the same mass of water occupies more space; and
- Vertical land movement caused by earthquakes and geologic movement creating a relative change between the sea floor and land level, causing the sea level to rise along certain coastlines. This factor is not related to anthropogenic climate change but can exacerbate its effect in geologically active areas.

On the coastline surrounding Grays Harbor, the average sea level is expected to increase (Figure 31), based on an evaluation documented in a 2018 report by the University of Washington (Miller et al. 2018). By 2050, there is a 50 percent chance that the average sea level will rise 0.4 feet and a 1 percent chance that the sea level will rise by 1.1 feet relative to the average sea level between 1991 and 2009, based on two different Intergovernmental Panel on Climate Change (IPCC) scenarios. The lower trajectory of global greenhouse gas emissions (Representative Concentration Pathway [RCP] 4.5) represents a significant halting of existing fossil fuel use, while the higher trajectory of global greenhouse gas emissions (RCP 8.5) indicates a more "business as usual" scenario (IPCC 2014), as represented by the most recent findings of the IPCC. Beyond 2050, the trajectory of global emissions will influence the extent to which sea level rise occurs in Washington State. Note that these estimates do not include the potential for a subduction zone earthquake off the coast of Washington, which could increase sea level by up to 5 feet.

Figure 31. Expected Mean High High Water (MHHW) with 1 Foot of Sea Level Rise in and Around Grays Harbor Estuary (image from NOAA's Sea Level Rise Viewer).

Changes in average sea level are more severe when considering the fluctuations in daily and annual tidal cycles and storm surges, compared to a historical baseline. The highest tides of the year may exceed the projected change in the average sea level rise and cause flooding or inundation in areas not accustomed to seawater.

Sea level rise is not anticipated to have major effects on marine life in the Project area. Most of the impact from sea level rise is expected to be on coastal communities, infrastructure, and habitat within the expanded range of coastal inundation.

4.8.2 Sea Surface Temperature Increase

Global sea surface temperature has been rising throughout the 20th and 21st centuries. Since 1901, the average sea surface temperature off the coast of Washington has increased by more than 1°C (U.S. EPA 2021). Warmer oceans can change the range, breeding grounds, and migration patterns of marine life; threaten vulnerable ecosystems; and cause more frequent or severe algal blooms. Over the long term, increased sea surface temperature may slow the circulation patterns that bring nutrients from the deep ocean toward the surface.

The primary effect of warmer sea surface temperatures in the Project area is the expected shift in population ranges. Fish and marine mammal populations will likely shift north to maintain habitat that had similar temperature profiles to their historical range or expand to follow the location of nutrients and prey, based on studies of fish populations in areas already experiencing effects of climate change. Other potential effects have been postulated including overall marine survival rates for certain species, changes in morphology and phenology, reproductive effects, and adverse reactions to biological changes in the ocean such as increases in harmful algal blooms (HABs), and nearshore hypoxia. To date, there have not been observations made of these changes.

4.8.3 Ocean Acidification

Ocean acidification occurs as CO_2 in the atmosphere is dissolved into seawater. Increased CO_2 concentration in seawater reduces the carbonate ion concentration, which shellfish, corals, and plankton rely on to build their skeletons. The long-term impact of ocean acidification on marine life near the Project area is that shellfish may have reduced survival, growth, and reproduction rates. All other marine life will also experience challenges in their growth and reproduction as the acidity of the oceans change, but shellfish calcification is the most prominent change documented to date. The effects of ocean acidification are not expected to compound any environmental effects of an offshore wind project.

5.0 Conclusion

Based on the conceptual level of Project design, the initial findings of this preliminary study suggest that the environmental effects of the development of an offshore wind farm on marine life, specifically fish, shellfish, marine mammals, benthic organisms, sea turtles, seagrasses, and other native plants, and the habitats that support them, would be low in severity, and there would be potential to reduce any effects by employing appropriate construction techniques or mitigation measures. Environmental effects would differ between the construction and operational periods of the wind farm (Table 2-15). Effects during the construction period would occur over a short period of time, from days to weeks, for some activities. Some temporary effects could be mitigated by timing the construction activity to minimize environmental effects. Other effects from construction may cause a physical disturbance, but the impact would be limited to a small geographic area around the installation, and the areas are likely to be returned to a natural state in a matter of months to years. Operational effects are likely to be quite limited but would continue throughout the duration of the wind farm existence. Environmental effects on different groups of marine life include the following:

- No long-term environmental effects on fish populations are expected from construction or operation.
- The greatest effects on fish are likely to occur within the wind farm at the offshore Project site once the wind farm has been constructed, resulting in increased numbers of fish within the wind farm. In addition, there may be increases in fish abundance outside the wind farm, as has been observed at other offshore wind farms (for example Coates et al., 2016; van Hal et al., 2017; Stenberg et al., 2015; Slavik et al., 2019; Krone et al., 2017; Bergstöm et al., 2013; Raoux et al., 2017).
- Gray whales and humpback whales migrate near the Project area, while other whale species are infrequent visitors to the area. Whales can be affected by temporary construction noise. Such effects could be mitigated by carefully considering noise mitigation (including construction timing) when it is applied to marine species as a whole. During operation of the wind farm, cable interactions (either mooring lines or other cables that are draped in the water column) with marine life have a very low probability of occurrence but could result in injury to a sensitive species. Entanglement risk is extremely low because the cables are too taut to create a loop and have no loose ends.
- During construction of the electrical cable that connects the wind farm to the shore, there would be a temporary disturbance of benthic habitats, for example for shellfish. The habitat is expected to recover to natural conditions within months to a few years after cable installation.
- Loss of benthic habitat during the operational lifetime of the wind farm is expected to be limited to small areas around the anchors. The anchors also provide new hard substrate habitat that can be used by benthic organisms. Groundfish populations are unlikely to shift their range in response to the new substrate.
- The overall effects of climate change will increase pressure on marine wildlife in the Project area. Potential project effects will be much smaller than effects of climate change on marine wildlife in the Project area.

Table 18. Summary of potential environmental effects for construction and operational periods.

Stressor	Receptor	Location	Potential Effect	Magnitude of Effect
Construction Period				
Construction operations	Marine mammals, fish	Offshore area, cable route	Increased noise	Temporary; effect would be reduced by timing construction. Construction noise from floating offshore wind platforms is expected to be very low.
	Marine mammals, fish, benthic organisms		Water quality reduction caused by turbidity, contamination, spills	Increased turbidity is temporary; contamination and spills could be longer lasting, but mitigation measures would reduce the risk.
Increased vessel traffic	Marine mammals, sea turtles	Within harbor, offshore area	Increased noise Increased risk for vessel strike	Low, especially relative to existing vessel traffic.
Electrical export cable installation	Benthic habitat and organisms	Cable route	Disruption of habitat	Temporary effect; habitat recolonizes cable lay area.
			Increased suspended sediment	Temporary effect during installation.
Port improvements[a]	Marine vegetation, fish, invertebrates	Within harbor	Reduction in habitat	Limited to small area.
Operational Period				
Introduction of new floating platforms	Fish	Offshore area	Creates new habitat for fish; possible habitat for non-native species	No mechanism of harm.
Mooring line anchors	Benthic habitat and organisms	Offshore area	Seabed scour disrupts habitat	Limited; scour area very small relative to the total wind farm.
Floating cables in water column, primarily mooring lines	Marine mammals, sea turtles	Offshore area	Collision or entanglement	Low probability of encounters, but high risk of injury.
Electromagnetic fields (EMFs) from electrical cable	Fish, invertebrates	Offshore area, cable route	Changes in behavior of EMF sensing	Limited; only few marine species can sense and react to EMF.
Increased vessel traffic	Marine mammals, sea turtles	Within harbor, offshore area	Increased noise Increased risk for vessel strike	Very low, especially relative to existing vessel traffic.
Port Improvements[a]	Marine vegetation, fish, invertebrates	Within harbor	Reduction in habitat	Limited to small area.

[a] If needed; improvements in the harbor or navigation channel may not be necessary.

5.1 Future Work

The analysis in this report is based on only a preliminary review of environmental baseline conditions and potential environmental effects to marine species that included fish, shellfish, marine mammals, benthic organisms, sea turtles, seagrasses, and other native plants, and the habitats that support them. The analysis is expected to be used as informational material to help guide the understanding of potential interactions between offshore wind and marine life. Designing and permitting an offshore wind farm in this area will require an extensive environmental review governed by the National Environmental Policy Act and Washington's State Environmental Policy Act. Additional detailed studies will be required to fully understand the extent of environmental impacts resulting from an offshore wind project and to determine which mitigation measures can be used to minimize and avoid any significant impact. For example, this study did not assess impacts to sea birds or bats. In many cases, site-specific surveys may be required to collect baseline information before construction can begin. Throughout the life cycle of the project, post-construction monitoring may be required to observe and document how environmental interactions occur in real time.

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