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Volume II: Appendices

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Appendix A: Representative Project Design Envelope for Floating Offshore Wind Energy in California

Representative Project Design Envelope for Floating Offshore Wind Energy: A Focus on the California 2023 Federal Leases

Aubryn Cooperman, Michael Biglu, Matt Hall, Daniel Mulas Hernando, and Stein Housner

National Renewable Energy Laboratory

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC

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Disclaimers

List of Acronyms

ACP	American Clean Power
AHTS	anchor-handling tug supply (vessel)
BOEM	Bureau of Ocean Energy Management
CAISO	California Independent System Operator
cm	centimeter
COP	Construction and Operations Plan
in.	inch
ft	foot
GW	gigawatt
HDD	horizontal directional drilling
HVAC	high-voltage alternating current
HVDC	high-voltage direct current
km	kilometer
kV	kilovolt
m	meter
MW	megawatt
nmi	nautical mile
NREL	National Renewable Energy Laboratory
PDE	project design envelope
ROV	remotely operated vessel
RPDE	representative project design envelope
TLP	tension-leg platform

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1 Introduction

Offshore wind energy development in the United States has to date consisted of fixed-bottom wind turbines in the Atlantic Ocean off the east coast. Planned areas for future offshore wind development include deeper waters offshore Maine, Oregon, and California. In these areas where water depths drop off much more steeply, projects cannot use fixed-bottom technology. The use of floating technologies with buoyant substructures in deeper waters will result in a different physical footprint that could impact offshore wind plant design, installation, and operations.

The Bureau of Ocean Energy Management (BOEM) is the lead federal agency for planning and leasing areas for offshore wind on the United States Outer Continental Shelf. Once an area is leased, the company then develops and submits to BOEM a Construction and Operations Plan (COP). This plan contains the proposed design specifications that all permitting agencies use to evaluate a project. A project design envelope (PDE) approach is a project plan that adheres to a reasonable range of project design parameters. BOEM gives offshore renewable energy lessees the option to use a PDE approach when submitting a COP and issued draft guidance to this effect in 2018 (BOEM 2018). There are benefits to allowing lessees to describe a reasonable range of project designs in a COP given project complexity, the unpredictability of the environment in which it will be constructed, and/or the rapid pace of technological development within the industry. Many leaseholders off the U.S. east coast have utilized the PDE approach in their COPs. No COPs exist for floating offshore wind projects in United States federal waters.

A representative project design envelope (RPDE) provides estimates of the scale and number of components in a floating offshore wind facility when there is a need to describe impacts but there is not yet a PDE to evaluate. This report describes RPDE recommendations developed by the National Renewable Energy Laboratory (NREL) for floating offshore wind energy projects. In the development of these recommendations, we considered industry feedback from offshore wind farm developers in the California lease areas and a practical range of technology options that may be deployed, accounting for major physical constraints and technical readiness.

Section 2 of this report presents the RPDE, and Sections 3 and 4 present four scenarios that illustrate some of the differences between technologies that could be used offshore California, as well as descriptions of the typical installation processes that are expected to be used for floating offshore wind farms. These two sections are intended to provide greater depth and context for the information presented in the RPDE, but do not represent a comprehensive analysis of the design space and possible installation methods. This report does not represent real or proposed projects. It is an attempt to capture a realistic range of technical specifications and layouts of floating wind facilities given the water depths, wind characteristics, and distance from shore of the lease areas offshore California.

2 Representative Project Design Envelope

BOEM issued five leases for offshore wind energy development on the Outer Continental Shelf of California (U.S. Department of the Interior 2022). The water depths between 500 and 1,300 meters (m) (1,800–4,200 feet [ft]) in these lease areas make fixed-bottom technology infeasible, so projects on the California coast will use floating technology. Floating offshore wind is an emerging technology deployed in demonstration and pilot projects. Global deployment of floating projects was just over 120 megawatts (MW) in 2022, compared with 59,000 MW of fixed-bottom offshore wind (Musial et al. 2023). Operational floating wind energy projects use several different substructure designs, and more varied designs have been proposed.

The purpose of this section is to assess the likely range of values for the physical design elements of floating offshore wind development in the California lease areas. An RPDE provides estimates of minimum and maximum values for project design parameters that are relevant for assessing environmental impacts. Table 1 presents the RPDE for the California offshore wind lease areas. The representative project is an offshore wind power plant comprising multiple wind turbines, one or more electric substations, support structures, moorings, and power cables, installed within an area of up to 325 square kilometers (km^2) (80,418 acres) with water depths between 540 and 1,300 m (1,760–4,300 ft) off the coast of California. We provide more detailed information about each of the design elements and define terms in Subsections 2.1 through 2.6 following Table 1.

Table 1. Representative Project Design Envelope

Element	Project Design Element	Typical Range
Plant Layout	Plant capacity	750–3,000 MW
	Number of wind turbines	30–200
	Turbine spacing	920 m–3 km (0.5–1.6 nautical miles [nmi])
	Watch circle radius	Up to 350 m (1,150 ft)
	Capacity density	3–9 MW/km^2
Wind Turbines and Substructures	Turbine rating	15–25 MW
	Turbine rotor diameter	230–305 m (750–1,000 ft)
	Total turbine height	260–335 m (850–1,100 ft)
	Turbine installation method	A floating substructure, with turbine preinstalled at port or sheltered location, towed out to site by a towing vessel group/a floating substructure towed to site, with turbine installed at site by a wind turbine installation vessel or heavy-lift vessel.
	Substructure type	Semisubmersible, barge, or tension-leg platform (TLP); conventional spar may not be feasible but other ballast-stabilized designs may be considered.
Moorings	Mooring line configuration	Taut, semi-taut, or tension leg; catenary moorings are possible but less likely.
	Mooring arrangements	3–12 mooring lines per turbine or substation; shared-anchor arrangements are possible, shared-mooring arrangements are possible but less likely.
	Mooring line materials	Synthetic fiber rope (polyester, high-modulus polyethylene, nylon), steel chain, steel wire rope, steel or fiber tendons

		(e.g., carbon fiber). May also include buoyancy modules, clump weights, load reduction devices, and other accessories.
	Anchor type	Depending on soil type and mooring configuration: suction caisson, helical anchor, plate anchor (vertical load anchor or suction-embedded plate anchor), dynamically embedded (torpedo) anchor, driven pile, drilled pile, micropile, gravity anchor; drag embedment anchor is possible but less likely.
	Anchor material	Steel or concrete; drilled piles and micropiles may use grout.
	Seabed footprint radius	50–2,600 m (160–8,500 ft)
	Seabed contact area	200–300,000 m^2 (0.05–75 acres)
Array Cables	Total array cable length	1–5 km (0.5–2.7 nmi) average per turbine; individual cables may be up to 20–30 km (10.8–16.2 nmi) in some circumstances.
	Array cable diameter	14–25 cm (5.5–9.8 inches [in.])
	Target array cable depth	At least 60 m (200 ft) below water surface.
	Array cable configurations	Cables and mooring lines may be suspended in the water column, laid on the seabed, or buried. Suspended cable configurations can include but are not limited to lazy wave, catenary, steep wave, or suspended U.
	Array cable installation methods	Cable-lay vessel, possibly assisted by a remotely operated vessel (ROV) and/or construction support vessel.
	Cable protection types	Dynamic cables: accessories for cable protection may include bend stiffeners, dynamic bend restrictors, buoyancy modules, sleeves, seabed tethers, anchors or any other combination of protection means as determined by the site-specific design. Seabed: protection could include burial, rock dumping or mattresses.
Export Cables	Number of export cables	2–8
	Total export cable route length	35–400 km (19–270 nmi) per cable (offshore)
	Export cable voltage	Up to 525 kilovolts (kV) (DC) or 420 kV (AC)
	Export cable diameter	12–36 centimeters (cm) (4.7–14 in.)
	Export cable configuration	Dynamic cable between a floating substation and the seabed, with a transition joint to static cable for remaining length/static cable between a subsea substation and cable landfall.
	Export cable seabed disturbance (width)	Up to 13 m (43 ft) per cable, or cable diameter if not buried
	Export cable spacing	2–3 times the water depth on at least one side of a cable to provide repair access, minimum 50–200 m (160–660 ft) between adjacent cables.
	Target export cable burial depth	1–3 m (3–10 ft). Burial may not be required along full cable route depending on water depth, seabed conditions, vessel traffic and other factors considered in a cable burial risk assessment.
	Export cable installation methods	Trenchless: horizontal directional drilling (HDD), direct pipe, micro-tunnel, jack and bore.

		Trenched: open cut, direct burial. Tools and vessels: cable-lay vessel, ROV, cable plow, hydro plow, jetting sled, vertical injector, tracked trencher.
	Cable protection types	Dynamic cables: accessories for cable protection may include bend stiffeners, dynamic bend restrictors, buoyancy modules, sleeves, seabed tethers, anchors, or any other combination of protection means as determined by the site-specific design. Seabed: burial, rock, concrete mattress (at crossings).
Offshore Substations	Number of offshore substations	1–6
	Offshore substation substructure type	Floating: semisubmersible, barge, TLP, spar Emerging technology: subsea substation
	Offshore substation seabed footprint radius	50–2,600 m (160–8,500 ft)
	Offshore substation seabed contact area	200–300,000 m^2 (0.05–75 acres)
Onshore Facilities	Transmission points of interconnection	Various potential points of interconnection may be considered.
	Ports	Potential staging and integration ports: Port of Humboldt, Port of Long Beach, Port of Los Angeles. Additional ports in California that could support component storage, laydown, fabrication, or operations and maintenance: Crescent City Harbor District, Port of Stockton, Port of Benicia, Port of Richmond, Port of Oakland, Port of San Francisco, City of Alameda, Port of Redwood City, Antioch, City of Pittsburg, Pillar Point Harbor, City of Morro Bay, Diablo Canyon Power Plant, Port San Luis, Ellwood Pier, Port of Hueneme, and Port of San Diego. Ports outside of California may also support component manufacturing, storage, or installation.
Vessels	Construction vessel types	Vessel types used during construction may include survey vessels, heavy-lift vessels, wind turbine installation vessels, cable-lay vessels, anchor-handling tug supply vessels, offshore construction vessels, feeders, crew transfer vessels, and service operation vessels. See Section 4.1 for descriptions of these vessel types.
	Transit locations	Construction vessels most often transit to the area from Texas and Louisiana through the Panama Canal or from across the Pacific Ocean if outside the United States.

2.1 Plant Layout

2.1.1 Plant Capacity and Capacity Density

The capacity of an offshore wind project, or plant, is derived from the combined nameplate capacity of multiple wind turbines installed in a designated area. The main elements of an offshore wind plant are illustrated in Figure 1. The plant capacity represents the maximum power output (in megawatts or gigawatts) of the power plant. The plant capacity is influenced by several factors that have not yet been determined in the California lease areas, such as offtake agreements, wind turbine rating, layout and density of turbines, and site-specific obstacles to turbine placement. To estimate total plant capacity without these inputs, we use capacity density, which measures the power-generating capacity installed within a specified area.

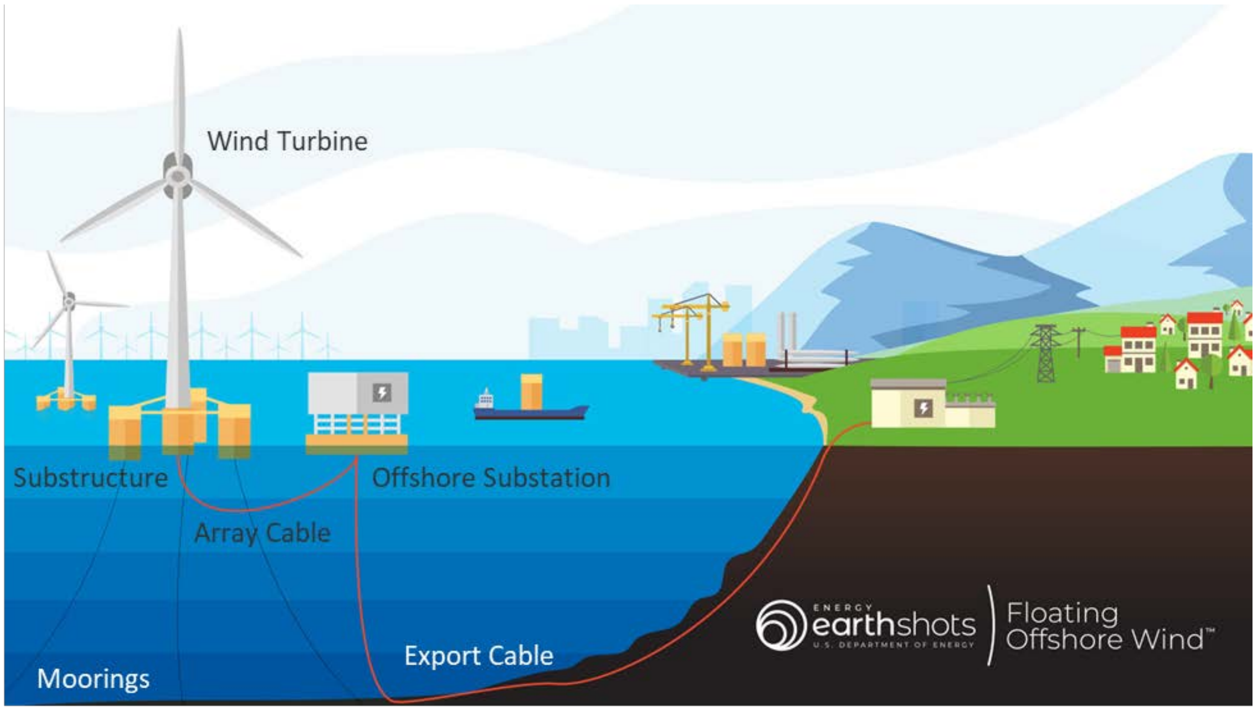

Figure 1. Floating offshore wind plant

Image from U.S. Department of Energy, with labels added by authors

We considered a range of possible capacity densities based on planned offshore wind projects on the U.S. Atlantic coast. A comparison of 17 fixed-bottom projects found capacity densities between 2 and 9 MW/km^2; however, densities close to the lower bound of 2 MW/km^2 were only observed in areas where a fixed turbine spacing was prescribed (Mulas Hernando et al. 2023). We consider 3 MW/km^2 to be a reasonable lower bound of capacity density because BOEM and NREL estimated 3 MW/km^2 in the delineation of the California leases (Cooperman et al. 2022). The planning process for offshore wind leasing areas, such as offshore Oregon (BOEM 2024), now considers an updated capacity density of 4 MW/km^2 (Musial et al. 2023). The maximum plant capacity considered in this report is 9 MW/km^2. This is consistent with the upper bound reported by Mulas Hernando et al. (2023) based on public announcements of offshore wind plant capacity and development area. Among projects with approved COPs, the maximum capacity density is closer to 8 MW/km^2.

To determine the plant capacity, the capacity density (3–9 MW/km^2) is multiplied by the total lease area. The California lease areas range from 256 km^2, for the smallest of the five leases, to 325 km^2, which represents the largest California lease. The resulting estimated total plant capacity of a California offshore lease used in this report is between 750 MW and 2,925 MW. In Table 1, we round the maximum value to 3,000 MW to avoid an appearance of false precision resulting from these approximations.

2.1.2 Wind Turbine Spacing and Number

Wind turbine spacing will need to incorporate many considerations, including energy production, navigation, and array layout. Agreements regarding the utilization of the area for other ocean activities (e.g., fishing) may influence the design, but the parties involved have not yet reached a consensus that could be used to inform this report. Based on the wind distribution in the California lease areas, which is highly unidirectional, spacing may be wider along the prevailing northerly wind direction with tighter spacing along the opposite axis. Spacing wind turbines between 4 and 10 rotor diameters apart (Cooperman et al. 2022) would result in a minimum distance of approximately 0.9 km (0.5 nmi) and a maximum distance of 3 km (1.6 nmi). The number of wind turbines was estimated by dividing the total plant capacity by the maximum and minimum turbine ratings, discussed in Section 2.2, resulting in a range of 30 to 200 wind turbines per lease area.

2.1.3 Watch Circle Radius

An additional consideration for the layout of floating wind turbines is their range of motion at the water surface. This range of motion—known as the watch circle—is determined by the mooring system's resistance to platform offsets caused by wind, waves, and currents (Figure 2). The radius of the watch circle corresponds to the maximum horizontal displacement of the floating platform. Depending on the mooring system design, the distance between the central position and the maximum displaced position may not be the same in all directions (in other words, the watch circle may have a noncircular shape). Floating offshore wind turbine arrays have not been deployed in depths equivalent to the California lease areas anywhere in the world. We therefore used internal engineering design studies as the primary source of estimates of the watch circle dimensions. Based on watch circle sizes reported in these studies, an upper bound on expected watch circle radii is 350 m, whereas smaller watch circle radii on the order of 100 m are likely in many cases. Watch circle size is expected to roughly scale with depth for a given type of mooring system. The 350-m-radius watch circle upper bound would be for the greatest depths of 1,300 m in the California leases. These watch circle radii describe the extreme offsets in an intact condition. Failure of a mooring line could result in a much larger offset, especially for nonredundant mooring designs. Floating offshore wind array design is an active area of research, and site-specific designs for projects in California may arrive at new solutions that balance mooring system footprint, redundancy, and platform displacement.

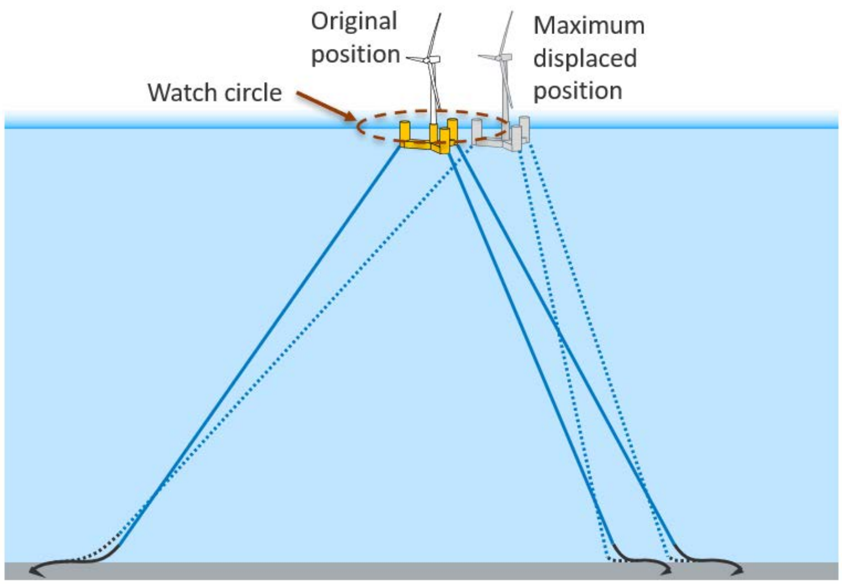

Figure 2. Watch circle for a generic semi-taut mooring system

2.2 Wind Turbine Generators

2.2.1 Turbine Rating, Rotor Diameter, and Height

The size and rating of offshore wind turbines have increased noticeably over the last two decades, and even larger models are under development (Figure 3). Constraints in the supply chain, vessel capabilities, and port infrastructure are a current challenge and may limit continued upscaling (Musial et al. 2023). Offshore wind turbines installed in 2022 had an average rating of 7.7 MW, but manufacturers announced the development of turbines with ratings up to 22 MW. Turbines with ratings of 13 MW were installed in commercial-scale U.S. Atlantic offshore wind farms in 2023 (Vineyard Wind 2023; GE Vernova 2023). Leaseholders in the California offshore wind lease areas are considering a range of turbine ratings between 15 and 25 MW. Assuming that the specific power (rated capacity per rotor-swept area) remains similar to current offshore wind turbine models, rotor diameters for these turbines would be approximately 230–305 m (750–1,000 ft). With a tip clearance of approximately 30 m from the mean sea level, this results in a total turbine height of 260–335 m (850–1,100 ft) above the still water level.

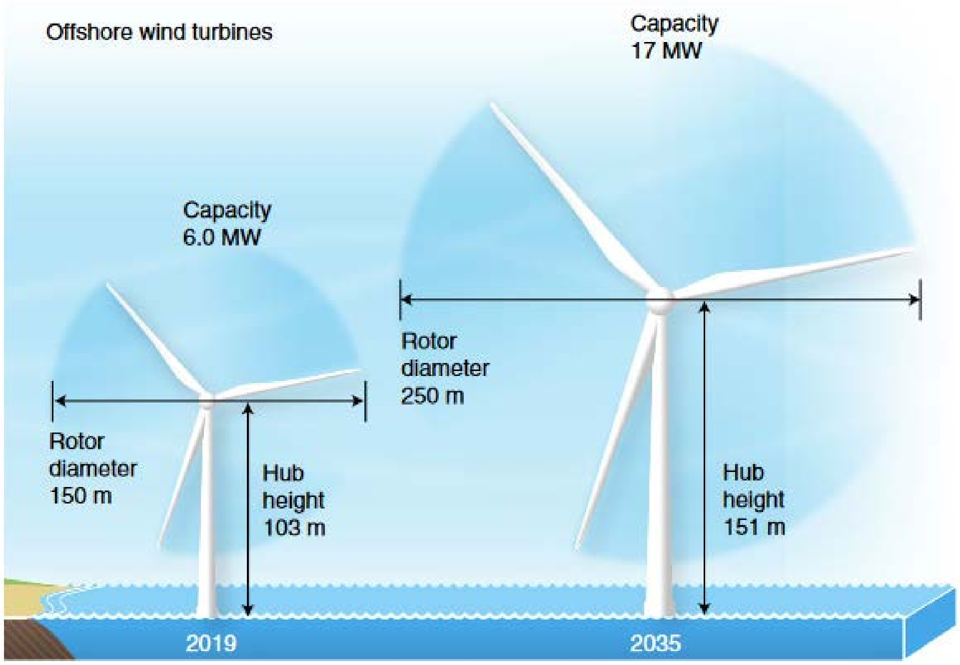

Figure 3. Evolution of wind turbine rating and size over time.

Source: Wiser et al. (2021)

2.2.2 Substructure Type and Installation Method

In the California lease areas, water depths are more than 500 m (1,640 ft), and offshore wind plants will require floating substructures. Floating substructure designs rely on a combination of three stability types: ballast, buoyancy, or moorings. Figure 4 illustrates three conventional substructure types: spar, semisubmersible, and TLP. Floating substructures are in use for commercial oil and gas operations but are considered an emerging technology (Horwath et al. 2020; Edwards et al. 2023) for commercial-scale floating offshore wind. In 2022, there were approximately 86 MW of operational offshore wind projects using semisubmersible or barge substructures and 38 MW using spars (Musial et al. 2023). There were no operational offshore wind TLPs in 2022. TLP and semisubmersible substructures appear feasible in California; however, the California coast does not have sheltered deep waters (such as fjords) suitable for assembling traditional spar designs in the way that has been demonstrated in Europe.

Figure 4. Examples of floating substructure types (left to right): spar, semisubmersible, TLP.

Illustration by Joshua Bauer, NREL

The floating substructures shown in Figure 4 are not the only options. Newer technologies that are variations of the conventional substructure types or combinations of the three stability types may be suitable and utilized in California. More than 20 different types of floating substructures have been demonstrated (Edwards et al. 2023), and many more designs have been proposed. Some designs have a shallower draft in port and then tilt or deploy ballast to reach a deeper draft during installation. Other proposed designs combine the buoyancy of semisubmersibles with the mooring tension of TLPs to achieve faster deployment. Steel and/or concrete are typically the primary structural materials for floating substructures. The choice of substructures for California wind farms will be influenced by many factors, including site conditions, port and manufacturing facilities, cost, and installability.

The method for installing floating substructures differs depending on the substructure design. One typical method is to assemble the substructure and integrate the wind turbine onto the substructure within a port or sheltered harbor before towing the wind turbine and substructure to the wind plant site, where they are hooked up to moorings and intra-array cables. Alternatively, floating-to-floating assembly could take place at sea; however, this would require a vessel with sufficient crane capacity as well as advanced motion compensation to carry out the installation process.

The draft—or distance from the water surface to the bottom of the substructure—of a floating substructure that is towed from a port must be compatible with the harbor channel depth (11–15 m or 38–50 ft at California ports considered for staging and integration) (Trowbridge et al. 2023). During installation, the draft may be increased to enhance stability by various means, including mooring system tension or by adding ballast (e.g., seawater, sand, rock, or iron ore). Operational drafts vary with the specific design, but indicative values for conventional designs are 80 m (260 ft) for a spar, 20 m (65 ft) for a semisubmersible, or 30 m (100 ft) for a TLP (Porter and Phillips 2016; Edwards et al. 2023).

2.3 Moorings

2.3.1 Mooring Line Configuration, Arrangement, and Materials

Floating offshore platforms are anchored to their positions within the offshore wind lease area through mooring systems. Mooring lines can consist of steel chain, synthetic fiber rope, steel wire rope, or tendons made from steel or synthetic fibers. Tendons—tensioned, vertical mooring lines—are used for TLPs, whereas the other floating platform types use rope and/or chain in a taut, semi-taut, or catenary configuration. Although catenary moorings have been demonstrated in floating offshore wind projects at water depths of 60–300 m, these configurations are less likely to be used in the California lease areas because they would entail very long lengths of large-diameter chain, making them prohibitively heavy for the floating platforms and requiring a large seabed area to accommodate an anchor circle radius that could be several times the water depth. The size and quantity of chain required would approach the limits of current manufacturing capacities. The number of mooring lines depends on the level of redundancy desired in the mooring system and the selected trade-off between component sizes and quantities. Existing examples of floating wind turbine platforms have included between three and eight mooring lines (Edwards et al. 2023); platforms for floating substations could potentially use up to 12 lines for additional stability and redundancy. Mooring lines for multiple wind turbines may connect to a single anchor in a shared-anchor configuration. Shared-mooring configurations, in which mooring lines run directly between adjacent wind turbines, are also possible but less likely because these concepts have not yet been demonstrated.

2.3.2 Seabed Footprint Radius and Contact Area of Mooring Systems

The mooring system seabed footprint radius and seabed contact area are important metrics in Table 1. The seabed footprint radius varies widely between mooring configurations, as illustrated in Figure 5. The distance on the seafloor from a TLP anchor to the center of the turbine position can, at a minimum, be approximately 50 m (160 ft). The radius of taut, semi-taut, and catenary moorings depends on the water depth, the angle of the mooring line, and the physical properties of the mooring line or chain. For the water depths in the California lease areas, we consider 2,600 m (8,500 ft) to represent a reasonable upper bound on the horizontal extent of the mooring footprint.

The choice of mooring configurations also affects the seabed contact area. Taut mooring lines and TLP tendons do not contact the seabed, so the contact area is only as large as the anchor footprint. We estimated the minimum area of seabed contact in this scenario to be approximately 200 m^2 in total based on three suction pile anchors each contacting the seabed within a circle 10 m in diameter. Semi-taut and catenary moorings include a horizontally oriented segment that lies on the seabed and moves in response to floating platform motions and currents acting on the moorings. We estimated the maximum seabed contact area in this scenario to be 300,000 m^2. This maximum value assumes 12 mooring lines, each with 1,000 m of chain on the seabed that has a lateral range of motion of 50 m at the touchdown point and is fixed at the anchor. The seabed contact area and mooring footprint radius are shown in Figure 5 for a semi-taut mooring configuration (illustrating maximum values) and a TLP configuration (illustrating minimum values).

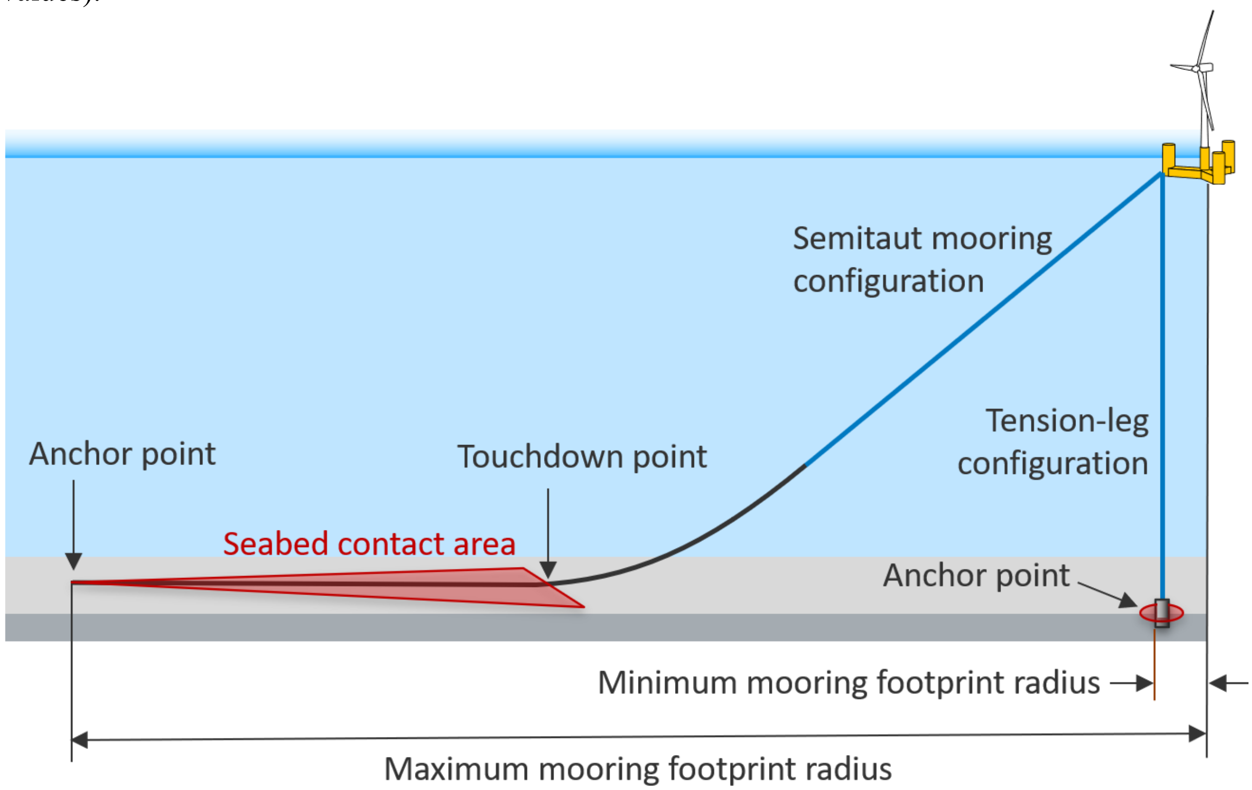

Figure 5. Seabed contact area and footprint radius illustrations for a single anchor and mooring line in a semi-taut configuration and a TLP configuration. Blue lines indicate synthetic rope and black lines indicate chain segments.

2.3.3 Anchors

Anchors fix the mooring lines to the seabed. Multiple types of anchors will be feasible for most projects. Common anchor types include drag embedment anchors, suction caissons or piles, vertical load anchors, drilled piles, and gravity or deadweight anchors (Figure 6). These are typically made of steel, but concrete could be a viable option as well. Although drag embedment anchors have been used in floating wind energy demonstration projects, the use of drag embedment anchors in the water depths in the California lease areas would require seabed footprint radii of multiple kilometers due to the method of seabed resistance that drag embedment anchors use. In addition to water depth, the choice of anchor will be influenced by local soil type, seismic risk, mooring configuration, cost, and installation logistics. Anchoring needs for floating wind turbines in areas with seismic activity are ongoing research topics. Depending on the anchor type selected, anchors would be embedded on the order of tens of meters but may require deeper embedment to be below near-surface sediment layers that are susceptible to liquefaction or slumping.

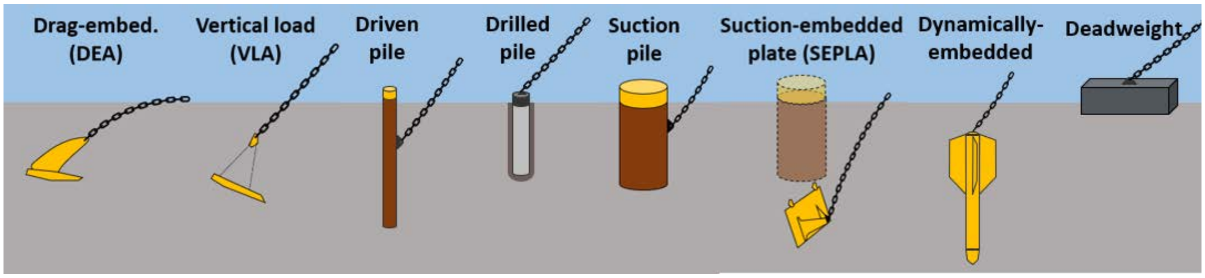

Figure 6. Types of anchors

New anchor technologies have the potential to reduce cost and risk. Shared anchors are anchors with multiple mooring line attachments that connect to multiple floating offshore wind platforms that would reduce the total number of anchors in a wind farm and reduce cost. Helical anchors use multiple long, slender pile anchors with helices attached that are relatively easy to install, are low weight, and provide high load capacity. The effects that these anchors have on the seabed are not expected to vary significantly from conventional anchor types.

2.4 Array and Export Cables

Offshore wind plants require array (collector) cables between individual wind turbines and the offshore substation(s), and one or more export cables to connect the offshore substation(s) to the electric grid. Cable segments that run between a floating platform and the seabed or another floating platform must be designed to withstand the loads and motions associated with being suspended in the water column; these are called "dynamic" cables. Static cables can be used for segments that lie at or under the seabed, connected to the dynamic segment via a transition joint. Dynamic cables are typically double-armored to have greater fatigue resistance, tensile strength, and bending stiffness than equivalent static cables and have correspondingly higher cost. Dynamic cable systems also include ancillary equipment to protect the cable and maintain the desired profile through the water column (Figure 7). Dynamic cables can have a variety of profiles, depending on the application, the most common of which is the lazy wave shape shown in Figure 7. The water depths in California are much deeper than existing floating wind farms and may prompt the use of more compact "steep wave" profiles, catenary profiles, or array cables that are fully suspended between turbines, without any static portion touching the seabed (Figure 8). In these cases, different cable profiles would be used, likely following a U or W shape. Although dynamic cables have been used for oil and gas platforms and offshore wind pilot projects, the technology has not yet been demonstrated at the voltage level that would be required for a commercial-scale offshore wind plant export cable (Corewind 2020; Huang, Busse, and Baker 2023).

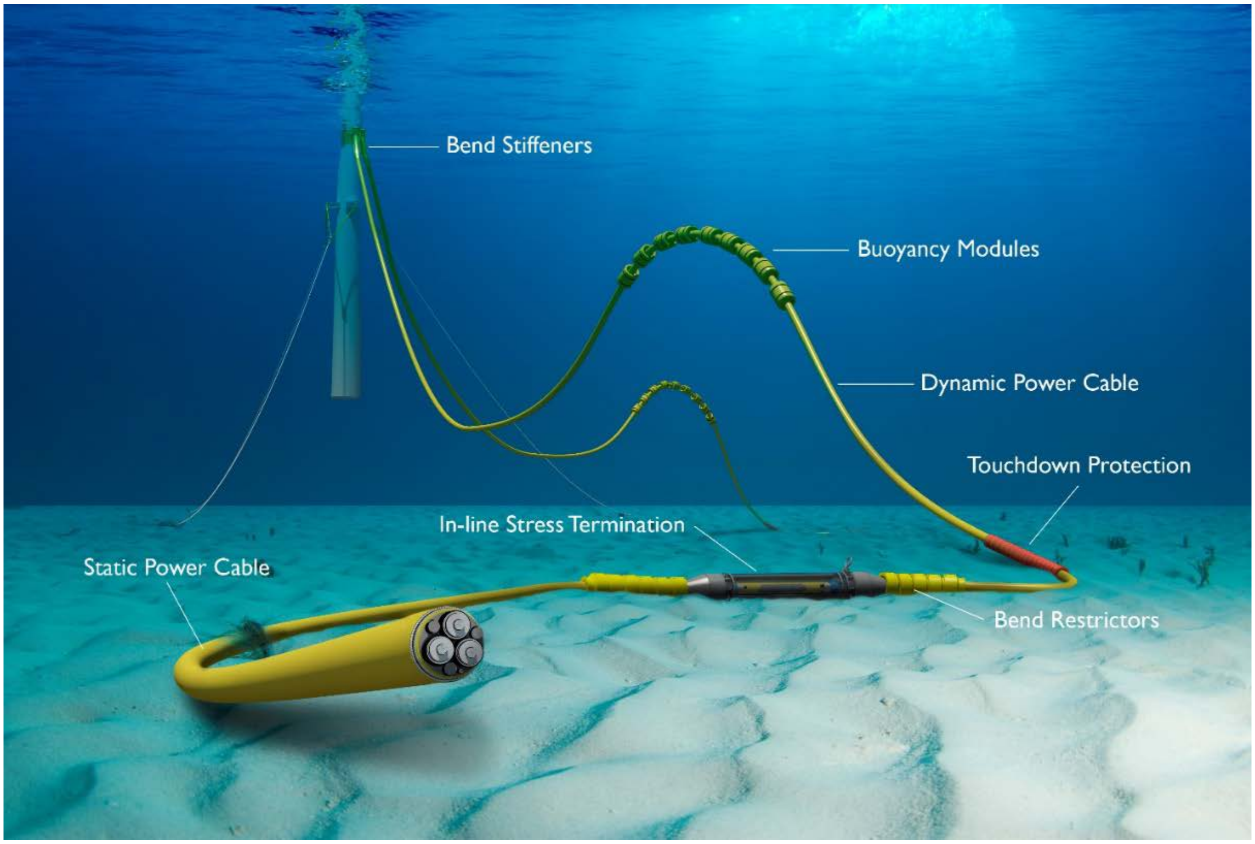

Figure 7. Dynamic subsea cable system components

Illustration by Joshua Bauer, NREL

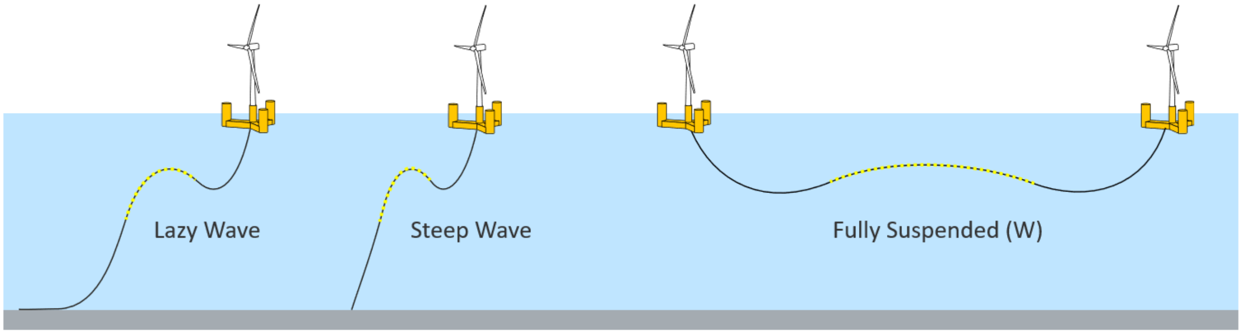

Figure 8. Three common dynamic cable profile shapes

2.4.1 Array Cable Configurations and Depth

Array cables are the cables that carry power from each turbine to the point where energy is collected for export. Array cables connect individual turbines to each other in strings and connect the strings to an offshore substation. A typical configuration is a radial—or daisy chain—arrangement, in which each turbine is connected to two adjacent turbines in series with one end at the substation. Although this often results in a cost-effective design, a cable failure can lead to several turbines no longer being supplied with power (American Clean Power [ACP] 2024).

Another option is to connect the turbines in a ring, which has the advantage of diverting the power in the other direction if one cable fails. Alternative configurations could also be considered to increase redundancy or reduce material use (Marcollo and Efthimiou 2024).

In fixed-bottom offshore wind plants and floating offshore wind demonstrations to date, array cables were laid on the seabed or buried. This configuration is well-tested and suitable for situations in which the horizontal distance spanned by the cable is much larger than the water depth. In the California lease areas, the water depth can be approximately the same as the distance between adjacent wind turbines, and in some cases may be greater. Suspending array cables in the water column using buoyancy modules or other cable accessories may be considered as a method to reduce the total length of cable required and minimize electrical losses. The depth at which cables may be suspended is yet to be determined, and it would depend on factors such as mechanical properties of the cable, the layout design, protection of the cable from wave action, and navigation considerations. Seabed lay of array cables is also possible.

2.4.2 Array Cable Length and Diameter

The length of cable required for each turbine depends on the array configuration. With turbine spacings of 900 m (0.5 nmi) or more, at least 1 km (0.5 nmi) of cable per turbine will be needed to allow for the cable depth and relative motion between turbines. An upper bound on the average cable length of approximately 5 km (2.7 nmi) per turbine accounts for wide turbine spacing, watch circles, and seabed cable lay at the maximum water depth of 1,300 m. Individual cable segments may be longer or shorter than this average length, depending on the site-specific layout. For instance, the connection between a string of turbines and the offshore substation could be up to 30 km (16 nmi) depending on the array layout. The cable size for each section depends on the rating and number of upstream turbines feeding into the specific cable (ACP 2024). The latest standard for array cables in Europe is a 3-core design in the 72.5-kV class, which complies with IEC 63026 (ACP 2024). Dynamic 66-kV cables in use today have diameters of 14–20 cm (5.5–8 in.); 132-kV dynamic cables will likely be available by the 2030s and could have diameters up to 25 cm (9.8 in.) (Carbon Trust 2022).

2.4.3 Array Cable Installation and Protection

Specialized cable-lay vessels will be required for array cable installation, with support from other vessels that may include tugs, construction support vessels, or ROVs. If array cables are buried, the route will need to be cleared before cable lay begins. The potential for interaction between cable-lay activities and mooring installation should also be considered. Protection methods for cables on the seabed include burial, mattresses, and rock dumping. Seabed tethers and anchors may be used near the point of touchdown. If array cables are suspended in the water column, options for protection include bend stiffeners, dynamic bend restrictors, and protective sleeves (Offshore Wind Scotland 2024). When developing the wind plant layout, the relative motion of turbines within their watch circles must be considered to ensure that the array cables do not incur displacements beyond their design capabilities. Another design consideration to reduce risk is to avoid placing array cable hang-offs near boat landings (ACP 2024).

2.4.4 Export Cable Configuration, Voltage, and Diameter

Both high-voltage alternating current (HVAC) and direct current (HVDC) technologies could be considered for offshore export systems. HVAC export cables are typically three-core cables, with voltage between 220 kV and 420 kV for a 1-gigawatt (GW) wind plant. HVDC export cables are currently available at 320 kV, and 525-kV cables are being developed (ENTSO-E 2024). Configuration options for HVDC circuits include:

- Asymmetric monopole: one HVDC cable with a metallic return and a converter at each end of the cable
- Symmetric monopole: two HVDC cables and a converter at each end of the circuit
- Bipole: two HVDC cables and an optional metallic return with two converters in series at each end of the circuit.

The selection of HVAC or HVDC cable also affects the cable diameter. Three-core HVAC cables have larger diameters, up to 36 cm (14 in.), whereas single-core HVDC cables with cross-linked polyethylene insulation can have a smaller diameter of 12 cm (4.7 in.). The distance to shore, the related costs and electrical losses and the plant capacity are the most important factors for choosing an HVAC or HVDC system. An HVDC system is more likely to be suitable for longer export cable distances (more than 70–100 km) and larger plant capacities (more than 800–1,000 MW).

2.4.5 Export Cable Route Length, Number, Spacing, Seabed Disturbance, and Burial Depth

The minimum distance for a cable route is the straight-line distance from the eastern edge of the Humboldt lease areas to the closest potential landfall point, approximately 35 km (19 nmi). The minimum distance from Morro Bay is approximately 60 km (32 nmi). Actual cable routes will deviate from the straight-line distance to landfall for many reasons, including locations to the grid connection, subsea topography, seabed conditions, and to avoid conflicts with other ocean users. Export cables will likely cross active faults, and additional length may be required to provide slack in case of fault rupture and displacement. Accounting for more distant potential points of interconnection and less direct cable routing to avoid obstacles gives an estimated maximum route length of 400 km (270 nmi).

The number of export cables is influenced by the total plant capacity, cable capacity, reliability considerations, and permitting. California Independent System Operator (CAISO) planning standards regulate the amount of generation that would be forced offline by a single contingency (e.g., an export cable failure); the maximum is currently 1.15 GW (CAISO 2023). Although it would be possible for an offshore wind plant with a capacity of 1 GW or less to export power via a single cable, a second cable would likely be used to provide redundancy in case of damage or failure. Typical HVAC export cables that are currently in use have a capacity of approximately 400 MW, which would result in a maximum of 8 cables for a plant capacity close to 3 GW. Fewer circuits could be used in an HVDC system, with cable capacities up to 2 GW; however, symmetric monopole or bipole configurations require two cables per circuit. In this report we assume each plant could use a total of 2 to 8 export cables. Assuming that export cables are developed independently by each leaseholder, this results in a total of 4 to 12 cables in the Humboldt region and 6 to 24 cables in the Morro Bay region.

The cable corridor width is the space required for installing and maintaining cables. In general, cable corridor widths are determined based on the number of cables, water depth, and anticipated repair methods. European guidelines for cable spacing recommend at least 50–100 m (160–330 ft) between cables (New York State Energy Research and Development Authority 2023). In deeper water depths, the primary factor affecting cable spacing is often the gap required to facilitate cable repair. The sizing of this gap is determined by the anticipated length of a cable repair bight plus a safety margin, resulting in spacing between 2 and 3 times the water depth. The repair bight is a double catenary (omega shape) in the cable profile, which is created when the two segments of cable on either side of the damaged location are recovered to a vessel where a new segment is inserted, then re-laid to one side of the original cable centerline on the seabed (ACP 2024). Offshore wind submarine cable spacing guidelines propose the possibility of laying a repair bight over an adjacent cable; however, such an approach requires the evaluation of the associated commercial and technical risks (Bureau of Safety and Environmental Enforcement 2014).

The amount of seabed disturbance associated with a cable differs between buried cables and surface-laid cables. The determination of whether to bury a cable, and the depth at which to bury it, should follow a cable burial risk assessment that considers seabed conditions, seismic risk, vessel traffic, fishing activities, permitting, and other factors. The California State Lands Commission targets a burial depth of at least 1 m (3 ft) within its jurisdiction. Cable burial depths between 2 and 2.5 m (7–8 ft) are likely to be sufficient for even the largest ships (COWI 2022). The width of seabed disturbance associated with cable burial depends on the width of the burial tool, which can be up to 13 m (43 ft) (New York State Energy Research and Development Authority 2023). Burial becomes more difficult in deep water depths and may not be feasible in some areas. Existing submarine power cables have been laid on the seabed rather than buried below water depths of 400–600 m (1,300–2,000 ft) (Ardelean and Minnebo 2015). Some power cables laid for oil and gas or transmission along the U.S. West Coast were not buried in depths of less than 400 m (1,300 ft). If the cable is not buried, the cable itself is the only cause of seabed disturbance. Like mooring lines, dynamic export cables will have a range of motion near the point where they touch the seabed, leading to a wider disturbed area in that region. A tether and anchor may be used to limit motion at the cable touchdown point.

2.4.6 Export Cable Installation and Protection

The process for installing export cable far offshore is similar to the array cable installation process and involves the same type of equipment. Near shore, additional types of equipment are used for the cable landfall, such as a flat-bottom barge, cable plow, or vertical injector. HDD to bring the power cable under the seafloor to the point of landfall is subject to the California State Land Commission’s burial depth requirement, which specifies a minimum of 5 ft (1.5 m) of cover in areas with water depth between 0 and 15 ft (4.6 m). HDD of four subsea power cables offshore Newport, Oregon, reached a maximum depth of 120 ft (36 m) (PacWave 2022).

Protection methods for cables on the seabed include burial and rock dumping. If it is necessary to cross existing infrastructure, such as other power or telecommunication cables or oil/gas pipelines, the crossing should be designed carefully, considering applicable rules and guidelines and in close alignment with the owners. Typical cable crossings consist of two layers, which could be made of rock berms or concrete mattresses. The bottom layer is installed directly between the infrastructure to be crossed and the power cable, ensuring that a minimum distance—usually 12 in. (30 cm) or more, as required for heat dissipation—is maintained (Sharples 2011). The top layer is placed above the cable to keep it in position and protect it from external impacts.

For dynamic cable sections between a floating offshore substation and the seabed, options for protection include bend stiffeners, dynamic bend restrictors, and protective sleeves (Offshore Wind Scotland 2024). Seabed tethers and anchors may be used near the point of touchdown.

2.5 Offshore Substations

2.5.1 Substructure Types and Seabed Footprint

Conventional fixed-bottom foundations are most feasible for offshore substations in waters up to 60 m depth. The options for floating substructure types are similar to those for wind turbines, including semisubmersible, TLP, barge, spar, and hybrid designs. Although HVAC substations and HVDC converter platforms are established technologies for fixed-bottom offshore wind, floating versions of these platforms are still being developed. Current HVAC substations have a maximum capacity of 700–800 MW with a topside weight close to 4,000 tons and an average area of 1,000 m^2 (0.25 acres). HVDC converter station capacity can reach 2 GW, with topside weights more than 8,000 tons and an area of 8,000 m^2 (2 acres). An emerging concept for offshore substations would place the substation on the seabed, eliminating weight and motion concerns but introducing new challenges related to underwater operation (Huang, Busse, and Baker 2023).

The seabed footprint radius and contact area depend on the substructure type. We assumed the same range of potential values as for wind turbine moorings; however, substation mooring footprints will generally be larger than those of similar wind turbine moorings. The footprint of a subsea substation includes the substation equipment and cable connections, and the total area would likely fall between the minimum and maximum values for floating platforms.

2.5.2 Number of Offshore Substations

An offshore wind plant with a capacity near 750 MW could operate with a single offshore substation. Leaseholders consider up to six offshore substations to be a maximum within the existing lease areas. In the Morro Bay area where there are three leases, and we estimate a capacity range of 2 to 9 GW for those 3 leases, we estimate between 3 and 18 substations in that area. In the Humboldt area where there are two leases and we estimate a capacity range of 1.5 to 6 GW, we estimate between 2 and 12 substations.

2.6 Onshore Facilities

2.6.1 Points of Interconnection

The points of interconnection for all the California leases have not been finalized or approved. Several potential points of interconnection were identified in previous studies, including Eureka for the leases offshore Humboldt Bay and Diablo Canyon for the leases offshore Morro Bay (Zoellick et al. 2023; Cooperman et al. 2022); however, other alternatives remain under consideration. Beyond the points of interconnection, CAISO identified substantial upgrades to the land-based electrical grid that will be needed to carry power from offshore wind plants to load centers (CAISO 2024).

2.6.2 Ports

There are many different ports that could become involved in offshore wind deployment. More than 80 locations have been identified on the west coast alone (Shields et al. 2023), and ports in other regions could also supply vessels or materials. Because this RPDE focuses on California, the list of ports in Table 1 is limited to California locations; however, ports in other states may also be considered. Port facilities in California that could potentially support offshore wind activities were identified by the California Energy Commission, as required by Assembly Bill 525 (Lim and Trowbridge 2023). The ports identified in that assessment could play various roles including staging and integration, manufacturing, mooring and cable staging, and operations and maintenance. The ports of Humboldt, Long Beach, and Los Angeles were identified as potential staging and integration ports for wind turbines and floating platforms. Other California ports could support flexible laydown, manufacturing, operations, and maintenance. Additional ports outside California may also contribute to the offshore wind supply chain for projects in the California lease areas. Potential port facilities in Oregon and Washington were identified in Shields et al. (2023).

3 Scenario Analysis of Offshore Wind Plant Layout

This section introduces four scenarios to explore the range of possible impacts resulting from different plant layouts and other design options described in the RPDE. The scenarios are illustrative but not prescriptive and are categorized based on smallest and largest lease area sizes (250 km^2 or 325 km^2) and multiplied by capacity densities of approximately 3 MW/km^2 or 7 MW/km^2 to compare four plant capacities. Although 9 MW/km^2 is the maximum capacity density in the RPDE, in this section, we use 7 MW/km^2—a more moderate estimate for a commercial-scale wind farm. Different capacity densities of a plant could result from project design factors such as array layouts, turbine size, and mooring technology type, as well as the seabed characteristics and bathymetry of the lease area. The combination of two lease area sizes (250 or 325 km^2) and four capacity densities yields four scenarios detailed in Table 2.

Table 2. Offshore Wind Plant Layout Area and Plant Capacity Ranges Considered in Scenarios

	3 MW/km^2	7 MW/km^2
Small Area	(1) 250 km^2 750 MW	(2) 250 km^2 1.75 GW
Large Area	(3) 325 km^2 975 MW	(4) 325 km^2 2.275 GW

For each scenario, we created a rectangular grid layout corresponding to the prescribed area and capacity density and calculated the plant capacity and generating potential. Section 3.1 provides a detailed description of the potential scenario layouts. The results in Section 3.2 illustrate potential implications from the selection of different wind farm design options. These four scenarios are illustrative and not a proposed project. However, they do not represent all of the possible design choices within the RPDE. Offshore wind projects developed within the California lease areas will implement different designs than those illustrated here. Although we chose a rectangular layout due to its simplicity, other layout arrangements could be considered. The intent of this section is to picture and describe a range of plant layout options for the California leases without focusing on a specific site.

3.1 Scenario Layouts

Small areas are defined as individual projects within a rectangular lease area measuring 10 km in width and 25 km in length, totaling 250 km^2. Large areas maintain the same length as the small areas but extend to 13 km in width, resulting in a total area of 325 km^2.

We considered two turbine rating options for scenario development. The first option was a 15-MW turbine, aligning with near-term product offerings from turbine manufacturers including Vestas and GE Vernova (U.S. Securities and Exchange Commission 2024; Vestas 2024). The second option introduced a hypothetical 20-MW turbine representative of potential future designs. A 25-MW turbine rating is mentioned in Section 2.2 and Table 1 (maximum range in the RPDE) to avoid constraining potential turbine technology development. However, 25 MW is not considered in this scenario analysis, as this analysis is not intended to necessarily use the limit cases of the RPDE. Scenarios 1 and 4 used the 15-MW turbine, whereas Scenarios 2 and 3 used the 20-MW turbine. For each scenario, we arranged turbines on a rectangular grid with constant north-south and east-west spacings between 0.6 and 1.6 nmi. Actual layouts may use different spacings that incorporate additional considerations such as fishing or navigation corridors. The scenarios in this report are intended to illustrate the spectrum of turbine positions achievable within a high-density and a low-density lease area. However, they do not explore the limits of every parameter within the design envelope.

The scenario layout is affected by the mooring system type. The radius of the mooring system footprint determines the minimum distance a floating wind turbine can be placed from the lease area boundary (Figure 9). This decreases the developable area and may decrease the total plant capacity. For this analysis, we held the spacing fixed within each scenario to isolate the effects of mooring footprint on the turbine layout.[1] Estimates of the distances from turbine to lease area boundary as a function of water depth for different mooring types are provided in Cooperman et al. (2022) and shown in Table 3. The minimum turbine-to-boundary distance equations and values at 537 m and 1,284 m (minimum and maximum depths across the California lease areas) are shown in Table 3 and range from 100 m to almost 1,000 m. For the scenarios, we assume a constant water depth of 1,284 m. This approach highlights the maximum impact of the minimum turbine-to-boundary distance on the amount of developable area, depending on the type of mooring system used.

[1] Mooring system footprints could affect the turbine spacing. In this analysis, we assume a fixed spacing, omitting the potential impact of mooring system footprints on the turbine layout.

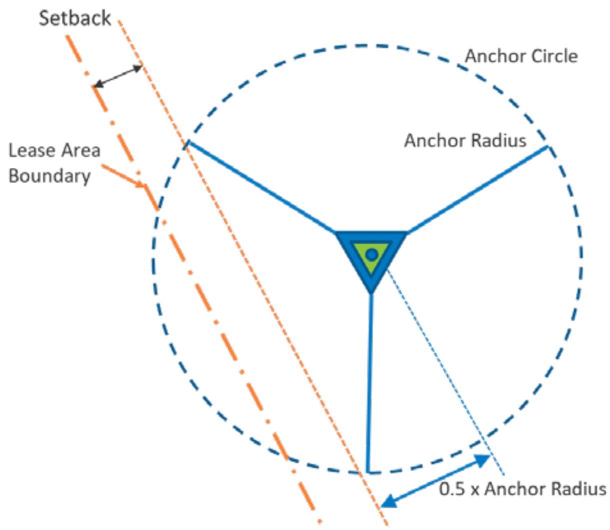

Figure 9. Schematic representation of layout constraints near the lease area boundary.

Image from Cooperman et al. (2022)

Table 3. Minimum Turbine-to-Boundary Distance for Tension-Leg Platform, Taut, and Semi-Taut Mooring Systems

Mooring Type	Minimum Turbine-to-Boundary Distance (m)	Value at 537 m Water Depth (m)	Value at 1,284 m Water Depth (m)
TLP	100	100	100
Taut (55° incline)	0.35 × water depth	188	450
Semi-taut	0.35 × water depth + 500	688	950

This results in the analysis of the plant capacity and generating performance of a total of 12 scenarios depending on area size, turbine spacing, turbine rating, and mooring system type. The layouts of these scenarios are shown in Figures 8, 9, 10, and 11.

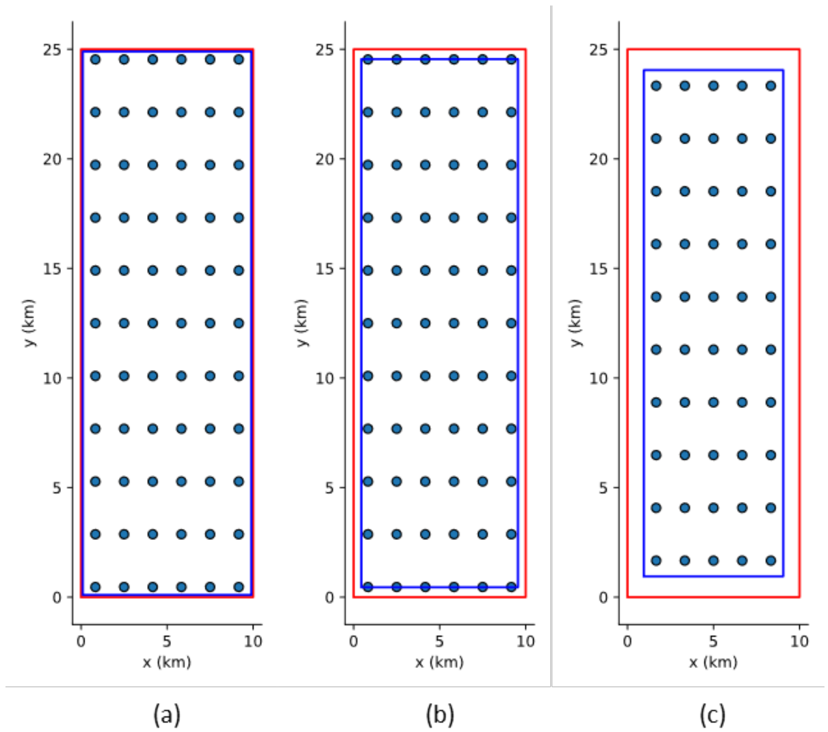

Figure 10. Scenario 1: low density, small area, 0.90 × 1.30 nmi, (a) TLP, (b) taut, (c) semi-taut

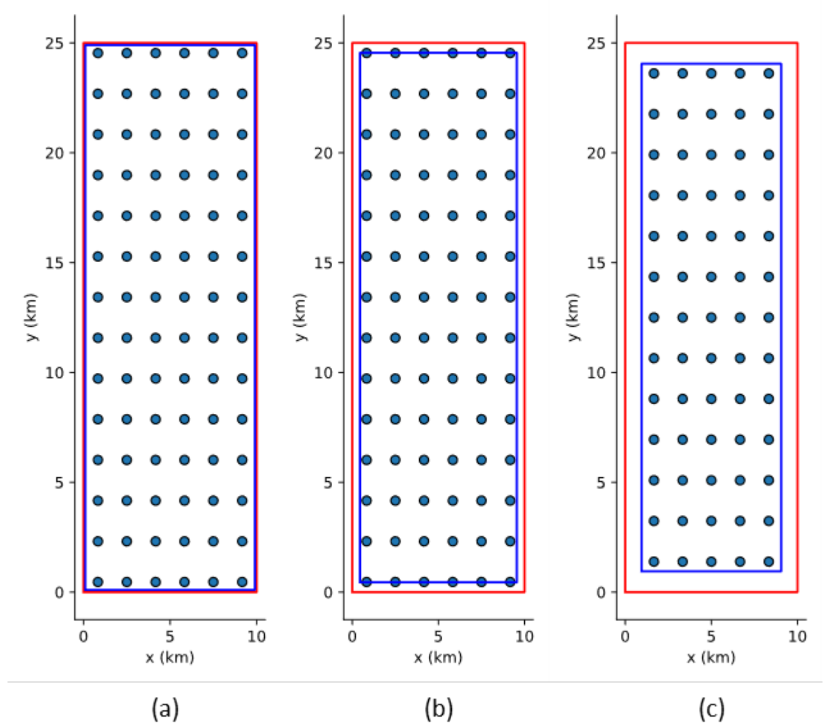

Figure 11. Scenario 2: high density, small area, 0.90 × 1.00 nmi, (a) TLP, (b) taut, (c) semi-taut

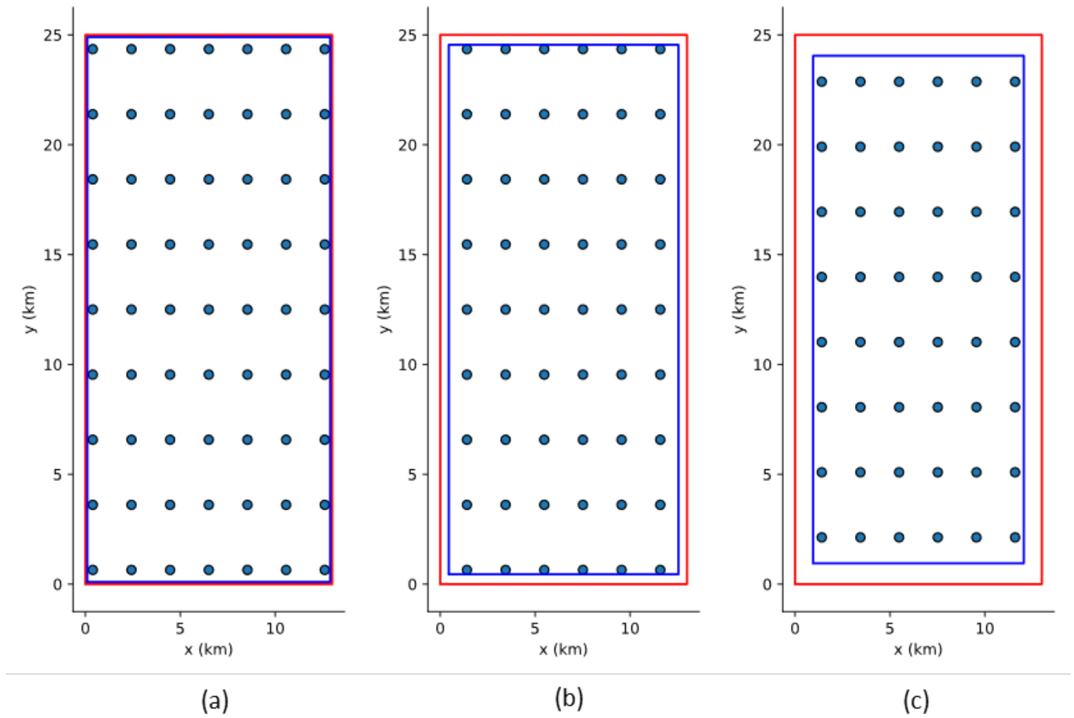

Figure 12. Scenario 3: low density, large area, 1.10 × 1.60 nmi, (a) TLP, (b) taut, (c) semi-taut

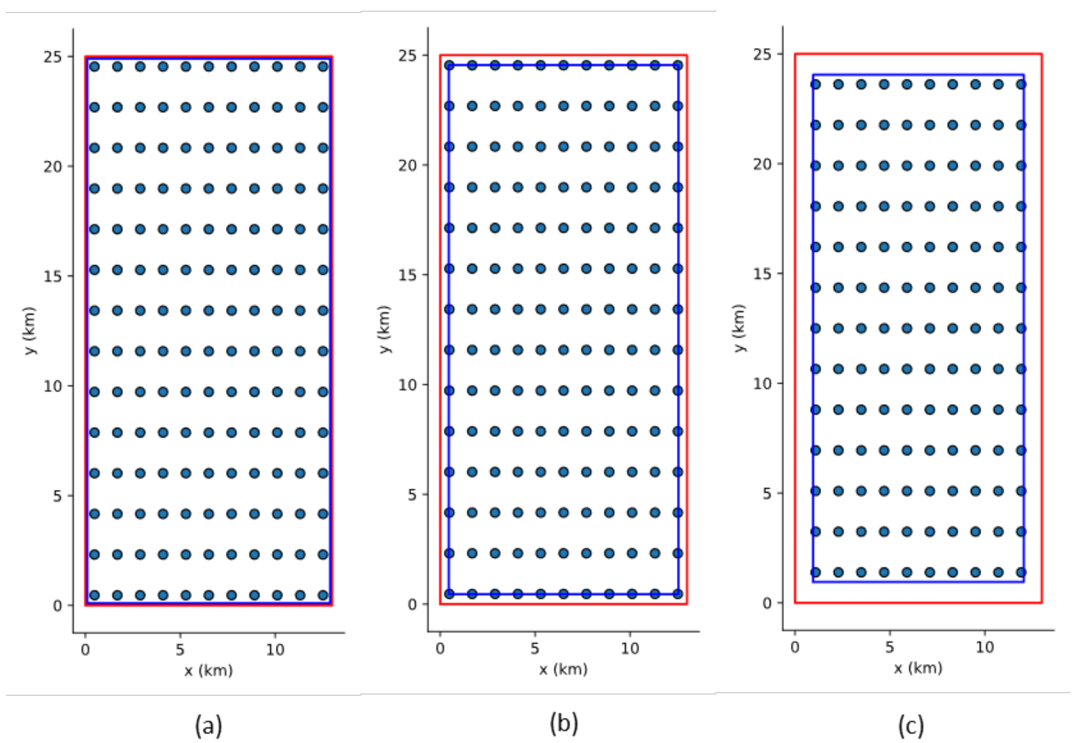

Figure 13. Scenario 4: high density, large area, 0.65 × 1.00 nmi, (a) TLP, (b) taut, (c) semi-taut

Additional variables, such as the array system configuration (suspended or buried) and the export system type (HVAC or HVDC), are also relevant for assessing impacts of a proposed layout. It is important to note that while the cable length and seabed disturbance may differ based on the array system type, and the cable corridor and platform requirements could be subject to variation based on the export system type, these factors do not impact the plant capacity of each scenario layout. Therefore, we only investigated sensitivities for these variables in Scenario 4, the high-density large area scenario, for the case of TLP moorings, which allow for the highest density.

3.2 Analysis Results

The following section provides an analysis of capacity density, plant capacity, and generating potential for the scenarios presented in the previous subsection. Net annual energy production was calculated using net capacity factors for high and low densities from Cooperman et al. (2022). The net capacity factor is the ratio of electricity output of an offshore wind plant over a specified period to its maximum possible output if the farm operated at full capacity for the same period. The results of this analysis are presented in Table 4.

Table 4. Scenario Capacity Densities and Generating Potential

Density Type	Low Density						High Density					
Area Size	Small Area			Large Area			Small Area			Large Area		
Area (km^2)	250			325			250			325		
Mooring Type	TLP	Taut	Semi taut	TLP	Taut	Semi taut	TLP	Taut	Semi taut	TLP	Taut	Semi taut
Turbine Spacing (nm)	0.90 x 1.30			1.10 x 1.60			0.90 x 1.00			0.65 x 1.00		
No. of Turbines	66	66	50	63	54	48	84	84	65	154	154	130
Turbine Rating (MW)	15			20			20			15		
Total Plant Capacity (GW)	1.0	1.0	0.8	1.3	1.1	1.0	1.7	1.7	1.3	2.3	2.3	2.0
Capacity Density (MW/km^2)	3.96	3.96	3.00	3.88	3.32	3.95	6.72	6.72	5.20	7.11	7.11	6.00
Net Capacity Factor (%)	47.7–50.2						46.5–49.4					
Net Annual Energy Production (TWh)*	4.1–4.4	4.1–4.4	3.1–3.3	5.5–5.3	4.7–4.5	4.2–4.0	6.8–7.3	6.8–7.3	5.3–5.6	9.4–10.0	9.4–10.0	7.9–8.4

*TWh = terawatt-hours

Capacity densities fall within the targeted range of 3 to 7 MW/km^2. The taut and TLP layouts have the same total capacity in each scenario. In low-density scenarios, total plant capacity ranges from 0.8 to 1.3 GW and is 100–300 MW higher for TLP and taut layouts than semi-taut layouts. The difference between TLP and semi-taut layouts is 300–400 MW in the high-density scenarios span. Capacity densities are also close to 1 MW/km^2 higher for TLP and taut layouts as compared with semi-taut mooring types in the high-density scenarios. These findings highlight the impact of mooring type choices on the number of turbine positions in each scenario and the associated variation in potential annual energy production across small and large areas under distinct spacing and turbine size selections.

We conducted an additional analysis within a high-density large area with TLP to examine the sensitivities related to the total cable length and seabed disturbance for suspended and buried cables, and the cable corridor width and platform weight requirements for an HVAC and HVDC export system. To facilitate this evaluation, we conducted a comparative analysis of two wind farms with different characteristics (Table 5).

Table 5. Characteristics of Two Wind Farms for the Comparative Analysis

Wind Farm Characteristics	Buried Array + HVAC Export Farm	Fully Suspended Array + HVDC Export Farm
Lease Area (km^2)	325	325
Water Depth (m)	1,284	1,284
Mooring Type	TLP	TLP
Turbine Spacing (nmi)	0.65 x 1.00	0.65 x 1.00
Turbine Positions	154	154
Turbine Rating (MW)	15	15
Project Capacity (MW)	2,310	2,310
Array Cable		
Cable Type	132 kV HVAC, three-core	132 kV HVAC, three-core
Cable Diameter (millimeter [mm])	500	500
Buried or Suspended	Buried	Fully suspended 100 m below the water line
Cable Capacity (MW)	142	142
Max. Number of Turbines in Series	9	9
Export Cable		
Cable Type	220 kV HVAC, three-core	± 320 kV HVDC, dual-core
Cable Diameter (mm)	800	2,000
Cable Capacity (MW)	295	1,216
Number of Cables Required in Parallel	9	2
Offshore Substations		
Capacity per Substation (MW)	800	1,200
Number of Substations Required	3	2

The array cable lengths determined in this analysis—buried, suspended, and total—are calculated using the Offshore Renewables Balance-of-System and Installation Tool (ORBIT; Nunemaker et al. 2020), a process-based bottom-up tool for modeling offshore wind balance-of-system installation and costs. To calculate the total disturbed seabed area, we assumed that the seabed disturbance resulting from the burial of a 132-kV cable extended over a width of 20 m.

This assumption, along with the total length of buried cable (in Table 6), provided the basis for estimating the extent of seabed disturbance associated with buried array cables.

As described in Section 2.4, common guidance for cable spacing is between 2 and 3 times the water depth, to allow space for cable repairs. In this scenario assessment, we assumed that pairs of cables could be laid 100 m apart, with adjacent pairs separated by twice the water depth.

Representative substation topside weights for floating HVAC and HVDC platforms were taken from a joint industry design exercise (DNV 2023).

The results associated with the comparative analysis of the wind farms characterized in Table 5 are shown in Table 6.

Table 6. Comparative Analysis Results

Parameters		Buried Array + HVAC Export Farm	Fully Suspended Array + HVDC Export Farm
Total Array Cable Length (km)		629	322
Suspended Length (km)		431	322
Buried Length (km)		198	0
Seabed Disturbance due to Cables (km^2)		3.96	0
Total Export Cable Length (km)		800	200
Export Cable Corridor Width (km)	at 1,284 m	15.8	5.2
	at 1,000 m	12.4	4.1
	at 500 m	6.4	2.1
	at 250 m	3.4	1.1
	at 50 m	1.0	0.3
Weight per Substation (metric tons)		3,000	10,000

The results indicate that buried cables exhibit greater total cable length and seabed disturbance when compared to fully suspended cables, where seabed disturbance is negligible (a suspended cable is not in contact with the seabed, so it does not disturb the seabed). While fully suspended cables do not contribute to seabed disturbance, determining the appropriate depth for their suspension requires consideration of various factors such as cable mechanical properties, layout design, wave protection measures, and navigation concerns. Additionally, the selection of lower-voltage HVAC cables requires more cables and a wider cable corridor than the higher-voltage HVDC cables. In contrast, HVDC converter stations tend to have larger dimensions and greater tonnages than HVAC substations.

4 Construction Methodology

The preparation and construction of a floating wind farm may use various equipment and processes depending on the specific designs of wind farm components and how they interact with the limitations and capabilities of available ports, vessels, and the supply chain. In this section, we outline typical construction processes and some of the possible alternatives under different circumstances. We focus on activities occurring at the wind project site or the staging and integration port. We do not consider activities such as component manufacturing that may occur at other ports or in other regions.

This section covers vessel requirements, staging and integration port facilities, and construction activities for floating wind development in California offshore wind lease areas. We discuss installation of the following major components:

- Moorings and anchors
- Export and array cables
- Floating platforms.

4.1 Vessels

Many different specialized vessel types are involved in the offshore construction and installation of a floating offshore wind farm.

4.1.1 Vessel Types

The number and types of vessels deployed to install a floating offshore wind farm are similar to those used for the construction of a fixed-bottom wind farm. However, there are some significant differences in installation processes that are unique to floating wind farms—for instance, mooring installation and floating platform tow out. An overview of various vessel types deployed during different development phases is shown in Table 7. In general, for each vessel type, there are different vessel sizes that may be more appropriate for installation activities near shore or farther offshore. Other vessels that may be used throughout the construction phase are accommodation vessels—which provide personnel accommodation at the offshore wind plant site—and safety/scout or guard vessels that ensure the safety of marine traffic near the construction area (ACP 2023).

Table 7. Overview of Deployed Vessel Types per Development Phase

Development Phase	Survey Vessel	Heavy-Lift Vessel, Wind Turbine Installation Vessel	Cable-lay Vessel	Anchor-Handling Tug Supply Vessel	Offshore Construction Vessel	Feeder	Crew Transfer Vessel, Service Operation Vessel
Component Staging					X	X	X
Seabed Preparation	X			X	X		
Mooring System Installation	X			X	X	X	X
Turbine Integration		(X)		X			
Platform Tow-Out and Installation				X	X		X
Offshore Substation Installation		(X)		X	X		X
Array Cable Installation	X		X		X		X
Export Cable Installation	X		X	(X)	X		X

(X) means that vessel type is not always used, dependent on the specific project.

Survey vessels are used throughout many different construction phases and equipped with different survey equipment to collect various types of data. In the early phases, survey vessels collect environmental, geotechnical, geophysical, and—if present—unexploded ordnance data. Then, for instance during and after cable installation and dredging activities, the progress is monitored with geophysical surveys. Geotechnical survey vessels collect and test physical seabed samples and geophysical survey vessels can be equipped with different acoustic sensors to map seabed features at wind turbine locations and along the cable routes.

In contrast to their key role in the construction of fixed-bottom offshore wind farms, wind turbine installation vessels and heavy-lift vessels may not be used for floating offshore wind turbine installation. Wind turbines can be integrated with floating platforms in port—using port-based infrastructure such as cranes, self-propelled modular transporters, a drydock, or semisubmersible barges—before being towed the full assembly to the offshore wind site. This approach would not require wind turbine installation vessels or heavy-lift vessels. Alternatively, a wind turbine installation vessel or heavy-lift vessel could be used to integrate the wind turbine and substructure in a protected location. For offshore floating-to-floating assembly in deep waters, vessels equipped with advanced motion compensation would be required, because jack-up operations are not possible in deep water.

Anchor-handling tug supply (AHTS) vessels are built to operate in difficult conditions, equipped with powerful engines and a high bollard pull. AHTS vessels are used to transport, set, install, and recover mooring system components for floating offshore structures. Figure 14 shows an image of the general size and layout of these vessels from a stern view.

Figure 14. Anchor-handling tug supply vessel used for mooring and anchor installation activities.

Photo from Maksim Safiullin, licensed under the Creative Commons Attribution 3.0 Unported license.

Offshore construction vessels can be used for a variety of offshore construction activities, such as installing concrete mattresses, performing post-excavation work or transporting materials. Individual offshore construction vessels may be used for different tasks depending on their equipment, such as cranes or ROVs and available deck space.

There are several different types of cable-lay vessels that could be selected for specific operations based on cable turntable size, burial method, or water depths. When laying cables in deep waters, the vessel must be able to maintain its position in the rough seas, and the equipment used to lay the cables must be able to operate at such depths. For (nearshore) shallow-water cable installation, additional vessel types include shallow-water cable installation flat-bottom barges (ACP 2024) and specialized equipment such as a vertical injector—an “L”-shaped, simultaneous lay and burial jetting tool with high-pressure jet nozzles to fluidize soft soils. If dredging operations are required, for instance at cable landfall, there is a variety of different dredger vessels, either hydraulic or mechanical. Fall-pipe vessels can be used to dump rocks or to install scour protection. Alternatively, rocks can also be placed using grab solutions.

For larger equipment and wind plant components, feeder and transport vessels carry construction materials to the construction site, optimizing the utilization of the main vessel so that more time is available for the actual construction work. Feeder vessels, which can be of various types, could be used to supply the main construction and installation vessels on site to optimize logistics and vessel utilization.

Both crew transfer vessels and service operation vessels can be used to transport crew and light equipment during the construction and operation of a wind farm. Crew transfer vessels are more limited in their ability to operate in high sea states and are typically used for projects located less than 2 hours travel—40 nautical miles (75 km)—from port. Service operation vessels are larger vessels that can operate in higher sea states and remain at sea for 1–2 weeks. Especially for floating offshore wind projects, which tend to be further away from the coast with relatively high sea states, service operation vessels might be better suited to ensure safe operations. “Walk to work” vessels have a motion compensated gangway that allows turbine technicians safe access to the wind turbine platform, whereas transfers from a crew transfer vessel to a floating structure may entail additional risks.

4.1.2 Vessel Considerations for California Offshore Wind Leases

4.1.3 Environmental Conditions

The Pacific Ocean has long open distances, with higher, longer waves and longer wave periods compared to other oceans (National Oceanic and Atmospheric Administration 2023). The vessels must be able to operate and carry out offshore installation activities efficiently in these conditions. In addition, due to the water depths of several hundred meters it is not possible to use jack-up vessels. Certain operations such as platform hookup and cable installation will require dynamic positioning and heave compensation to ensure safe and accurate installation of wind plant components.

4.1.4 Jones Act

The Jones Act (46 U.S.C. § 55102) is part of the Merchant Shipping Act of 1920 that applies to goods transported by water within the United States, not only in California. It requires that cargo be carried between two destinations in U.S. water only on vessels that are coastwise qualified: built in the United States, owned and crewed by U.S. citizens, and registered in the United States (U.S. Maritime Administration 2023). Vessels that are coastwise qualified can be used to transport cargo and material between U.S. ports and an offshore wind site. In some cases, coastwise qualified feeder vessels may be used to transport materials from the harbor (Shields et al. 2022).

4.1.5 Ocean-Going Vessel Fuel Regulation

The California Air Resource Board adopted Cal. Code Regs. Tit. 13, § 2299.2 – Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline and Cal. Code Regs. Tit. 17, § 93118.2 – Airborne Toxic Control Measure for Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline. The aim is to reduce sulfur oxide, oxides of nitrogen, and particulate matter emission from vessels to improve the air quality in the state of California (California Air Resources Board 2023; State of California 2011a, 2011b). Compliance with these regulations is another significant consideration for vessels used for offshore wind projects in California.

4.2 Installation Activities

4.2.1 Port Facilities

Construction of offshore wind projects will require port facilities that can support component staging and integration as well as provide berths for installation vessels. Table 8 gives an overview of physical parameters that are relevant for staging and integration port facilities. An additional consideration for fully integrated turbine and platform assemblies is the air draft or clearance above the waterline. Once a wind turbine has been integrated onto a floating platform, it will require an air draft beyond its total height, which may be up to 335 m.

Table 8. Port Infrastructure Parameters

Adapted from Shields et al. (2023)

Port Infrastructure	Approximate Range for Staging and Integration
Acreage (minimum)	30 to 100 acres
Wharf Length (minimum)	1,500 ft
Minimum Draft at Berth	38 ft
Draft at Sinking Basin*	40 to 100 ft
Wharf Loading	>6,000 pounds per square foot (psf)
Uplands/Yard Loading	>2,000 to 3,300 psf

*A sinking basin may be used with a semisubmersible barge to transfer a floating platform into the water; other methods could utilize a ramp or crane.

Outside of staging and integration, ports will be needed to support operations and maintenance, component manufacturing, fabrication, and assembly (Trowbridge et al. 2023; Lim and Trowbridge 2023; Shields et al. 2023).

4.2.2 Mooring and Anchor Installation

After the necessary site surveys and mooring system design processes have been completed, the mooring and anchor installation process for a floating wind farm can begin. Anchors and other mooring system components are loaded onto vessels at port (or transported to the wind farm site via feeder vessels) before the components are installed on-site. Complete mooring systems can be preinstalled prior to the installation of the wind turbine platforms.

Anchor and mooring line installation can be done in one of three primary installation methods: drag embedment, direct embedment, or dynamic embedment. The vessel used depends on the anchor type and installation method. The drag embedment process involves lowering the anchor into the water from the stern of an AHTS (Figure 14), with the mooring line attached, and embedded into the seabed by the thrust of the AHTS and the shape of the anchor. This would apply to drag embedment anchors and vertical load anchors. The direct embedment process typically involves a powerful crane attached to an offshore construction vessel that lifts an anchor from the deck and lowers it into the water and then to the seabed. Additional equipment is used to embed the anchor into the seabed. For example, ROVs can pump water out of the inside of a suction pile to create suction, whereas drilling equipment is lowered to the seabed with drilled piles, which are grouted into place, and then the drilling equipment is brought back to the surface. Other direct embedment anchor types include driven piles, suction-embedded plate anchors, or helical (screw) piles. The dynamic embedment process reduces installation time significantly by allowing the gravitational weight of the anchor to provide the necessary force to embed the anchor into the seabed. Anchors that are dynamically embedded can also be called torpedo anchors. Deadweight anchors can be lowered and set on the seabed by crane with little to no seabed disturbance. Each anchor type will have its own specific installation method, but these are the general approaches.

Mooring lines are typically attached to the anchor during anchor installation and either laid along the seabed or attached to a buoy, ready for connection to a floating offshore wind turbine. These buoys may be set near the seabed to minimize the risk to marine mammals, vessel navigation, and potential damage to the buoy itself.

4.2.3 Array and Export Cable Installation

Installing submarine offshore power cables is a complex endeavor requiring detailed planning and specialized cable installation vessels. Cable installation includes but is not limited to the following steps:

- Route preparation activities
- Cable installation
- Post burial activities.

Design of a cable route takes into account detailed knowledge about the geophysical and geotechnical data, metocean conditions, vessel traffic, and fishing activities. Before laying and burying the cables, the cable routes must be prepared. Route preparation activities may include a pre-lay survey, removal of debris (such as boulders, unexploded ordnance, or out-of-service cables), a pre-lay grapnel run, pre-trenching, and seabed leveling.

The export cable landfall is typically prepared using HDD in advance of the export cable installation. The subsea export cable is connected to onshore grid infrastructure through the HDD pipe, which may be up to 1.5 km (~5,000 feet) long. The California State Lands Commission regulates HDD installation, including burial depth. Considerations for HDD installation include the configuration of the excavation, the potential applicability of a cofferdam, noise levels during installation, and disposal of the dredged material.

Different vessels may be selected for cable installation depending on the site conditions. Cable plows, for example, can bury cables in stiffer soils such as sand or stiff clay. For mud, on the other hand, jetting systems may be more appropriate. Mechanical trenchers can bridge the gap between softer jet-trenchable soils and stiffer soils.

Cables suspended in the water column require buoyancy modules along the cable and tethering to the seabed to protect the cable and keep it in situ. The buoyancy modules are clamped around the cable on the deck of the cable-lay vessel before being installed below the water surface.

The cable segments are connected with offshore joints. The length of the cable segments determines the number of offshore joints required per cable along the cable route. In most cases, no offshore joints are required for an array cable. However, a transition joint will be needed if a cable includes both static and dynamic segments. There are two different types of offshore cable joints, in-line joints and omega joints. In-line joints, as the name implies, are installed in line with the cable route when the cable is laid. For omega joints, the cable segments are preinstalled with an excess length to allow both cable ends to be pulled to the water surface. The cable segments are retrieved from a jointing vessel and joined together on deck. The offshore joint is then lowered into the water and laid on the seabed in the shape of an omega. The advantage of an omega joint is that it decouples the jointing operation from the cable-laying operation; on the other hand, it results in additional cable lengths and disturbance of the seabed, especially in deeper waters.

Crossings of third-party infrastructure (e.g., other power cables, pipelines, or telecommunication cables) are subject to crossing agreements between the parties and typically include protection methods such as concrete mattresses or rock berms to maintain a fixed separation between the cable(s) and/or pipeline. Other crossing solutions are also possible.

The cables can be preinstalled and stored wet, which can be beneficial for the critical path of offshore wind farm installation. Once the floating wind turbines are securely anchored on-site, the field cables can be pulled into each wind turbine, and some can be pulled into the offshore substation or converter station. The same applies to the export cable connecting the offshore substation to the onshore substation (or converter station).

The installation process for array and export cables is similar; however, there are also some important differences between these cable types from the installation point of view:

- Cable length: Export cable length can vary depending on the cable type and design. Typical segment lengths for three-core HVAC export cables are between 20 and 30 km. For HVDC cables, on the other hand, a single cable length can be up to 150 km. Individual cable segments are made as long as possible to avoid offshore joints (ACP 2024). An HVDC circuit includes two cables (+ and -) that can be bundled or separate. The cable lengths are typically limited by the cable manufacturing capacity and the turntable capacity of the cable-lay vessels. For array cables, the segment length is based on the distance between wind turbines.
- Depth of burial: The primary reason for specifying a burial depth is to protect the cable from external damage, such as from a ship's anchor or fishing gear. Depth of burial can be determined by conducting a cable burial risk assessment, which quantifies the risk of external damage to the cable as a function of vessel traffic in the vicinity of the cable route and ground conditions (Ehlers et al. 2023; Carbon Trust 2015; ACP 2024). Because array cables are installed within an offshore wind farm and export cables connect the offshore wind farm to shore over long distances, often crossing shipping lanes, the associated risks are different. Floating offshore wind farms present new challenges in terms of cable risk assessment, as cable segments (or entire array cables) may be suspended in the water column or be laid on the seabed without burial, depending on water depth.
- Cable vessel requirements may also vary, as larger cables require larger turntables, and jointing requires additional deck space (and cable chutes). In addition, different cable-laying tools have different specific handling requirements. For instance, for the landfall cable pull-in, the vessel may be positioned with anchors for better control or be assisted by a jack-up/barge in shallow waters.

4.2.4 Floating Platform Tow-Out and Commissioning

With multiple types of floating platform under consideration, the details of the installation process vary depending on the specific technology. There are also variations in sequencing; for example, array cables may be laid before the platforms are in position or connected afterward. The key element of this installation phase is that the floating platforms are towed from a staging and integration port to their locations at sea where they are connected to their mooring systems. Different vessel types may be used for the towing operation, including AHTS vessels, oceangoing tugs, or a more specialized vessel for a specific platform architecture. Mooring hookup may also require support from an offshore construction vessel, AHTS, or ROV. If wind turbine integration is to be accomplished at the wind farm site using floating-to-floating operations, these would occur after the platforms are moored. Cable hookup can occur at any point after the integrated turbine and platform are securely moored.

Final commissioning is the last stage of the installation process. It involves inspecting and testing key components and subsystems, both mechanical and electrical, before the wind plant begins delivering power to the grid.

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Appendix B: Scoping Report

Contents

Abbreviations and Acronyms

Acronym	Definition
AB	Assembly Bill
AMMM	avoidance, minimization, mitigation, and monitoring
BOEM	Bureau of Ocean Energy Management
CFR	Code of Federal Regulations
CO_2	carbon dioxide
COP	Construction and Operation Plan
dB	decibels
EFH	essential fish habitat
NEPA	National Environmental Policy Act
NOI	Notice of Intent
PEIS	Programmatic Environmental Impact Statement
WEA	Wind Energy Area

B.1 Introduction

On December 19, 2023, the Bureau of Ocean Energy Management (BOEM) published a Notice of Intent (NOI) to prepare a Programmatic Environmental Impact Statement (PEIS) to analyze potential impacts of offshore wind energy development activities on five offshore wind lease areas off California's north and central coasts. The 60-day public scoping comment period was open from December 20, 2023 through February 20, 2024. BOEM received a total of 198 comments, 187 of which were unique, through regulations.gov (docket BOEM-2023-0061) and through email and U.S. mail.

Comments came from a variety of stakeholders including federal, state, and non-governmental agencies, as well as individual commenters. This report uses footnotes, including the names of individuals and organizations, to indicate the commenters that made particular arguments. However, the footnotes are not meant to be exhaustive of each commenter providing a similar argument.

BOEM summarized comments by key issue as presented in this report. BOEM reviewed each comment letter, identified the substantive excerpts within each submission ("bracketing"), and used the issue outline to associate each excerpt to the issue(s) to which it applies ("coding"). The full text of all public scoping comments received can be viewed online at http://www.regulations.gov by typing "BOEM-2023-0061" in the search field.

Table B-1 lists the commenters.

Table B-1. Index of comment submissions sorted by submission number

Commenter	Commenter Type	Submission ID
Altman, Rochelle	Individual	0089
Alward, Alan	Individual	0160
American Albacore Fishing Assn	Business/Trade Association	0181
American Clean Power Association	Business/Trade Association	0140
American Waterways Operators	Business/Trade Association	0071
Anonymous	Unknown	0179
Anonymous	Unknown	0154
Anonymous	Unknown	0148
Anonymous	Unknown	0062
Anonymous	Unknown	0042
Anonymous	Unknown	0039
Anonymous	Unknown	0038
Anonymous	Unknown	0026
Anonymous	Unknown	0025

Commenter	Commenter Type	Submission ID
Armstrong, Wendy	Individual	0119
Avery, Paulina	Individual	0018
Bat Conservation International	Advocacy Group	0171
Bettenhausen, Elizabeth	Individual	0164
Blaney, Carol	Individual	0147
BlueGreen Alliance	Advocacy Group	0134
Borden, Lanee	Individual	0159
Bradford, John	Individual	0091
Breen, K	Individual	0116
Brightline Defense	Advocacy Group	0156
Bruce-Hostler, Deborah	Individual	0070
Bureau of Safety and Environmental Enforcement (BSEE)	Federal Agency	0187
Buchanan, Catherine	Individual	0028
Buchanan, Catherine	Individual	0027
Cable, Diane	Individual	0153
Cannon, Kelly	Individual	0054
Channel Wind	Industry	0136
Climate Action California	Advocacy Group	0069
Oregon Conservation Coalition: Bird Alliance of Oregon, American Bird Conservancy, Oceana Kalmiopsis Audubon Society, Cape Arago Audubon Society, Audubon Society of Lincoln City, Lane County Audubon Society, Umpqua Valley Audubon Society, Salem Audubon Society, Audubon Society of Corvallis, Rogue Valley Audubon Society, East Cascades Audubon Society, Redwood Region Audubon Society, Native Fish Society, Ten Mile Creek Sanctuary, Oregon Chapter of the American Cetacean Society, Oregon Shores Conservation Coalition, Rogue Climate (Coalition of Oregon ENGOs)	Advocacy Group	0130
Coastal Coordination Program, The Ocean Foundation	Advocacy Group	0111
Cole, M	Individual	0095
Cole, Marcie	Individual	0032
Cole, Mike	Individual	0036
Continuum Industries	Industry	0123
Crocco, Bob	Individual	0075
Croyle, Linda	Individual	0074
D, Tom	Individual	0081
Dallmann, Allyson	Individual	0157

Commenter	Commenter Type	Submission ID
Dorfman, K.	Individual	0047
Dorfman, Nicole	Individual	0065
ECOncrete	Industry	0048
Elk Valley Rancheria, California	Tribal Government	0031
EPA Region 9	Federal Agency	0188
Equinor Wind US LLC	Industry	0155
Eriksen, Linda	Individual	0122
Farris, Judy	Individual	0110
Fawcett, Harry	Individual	0045
Fern, Karah	Individual	0014
Flaherty, John	Individual	0052
Flaherty, John	Individual	0050
Frank, Jewel	Individual	0165
Franklin, Katie	Individual	0034
Gaede, Don	Individual	0040
Gallo, Paul	Individual	0064
Ginkel, Marcy	Individual	0128
Glosten	Industry	0108
Goetz, Gary	Individual	0086
Golden State Wind LLC	Industry	0127
Gorham, Bill	Individual	0068
Graugnard, Craig	Individual	0051
GREENSPACE - the Cambria Land Trust	Advocacy Group	0150
Grijalva, Cynthia	Individual	0166
Hafer, Sheri	Individual	0006
Hafer, Sheri	Individual	0005
Hafer, Sheri	Individual	0004
Hall, PhD, Dr. Douglas	Individual	0145
Hearst Corporation	Industry	0105
Hellliwell, David	Individual	0129
Hensher, Holly	Individual	0180
HiDef Aerial Surveying LTD	Industry	0009
Holtam, Mary	Individual	0057
Horvath, Doug	Individual	0022

Commenter	Commenter Type	Submission ID
Howard, Dolores	Individual	0126
Hunt-Pierson, Lucy	Individual	0041
Invenergy California Offshore LLC	Industry	0152
Johnson, Gail	Individual	0096
Johnston, Peggy	Individual	0012
Kazazian, Kaspar	Individual	0058
Krop, Nancy	Individual	0044
Krueger, Carolyn	Individual	0143
Leatherwood, Morgan	Individual	0013
Leicester-Cadaret, Michelle	Individual	0100
Leicester-Cadaret, Michelle	Individual	0035
Los Cerritos Wetlands Land Trust	Advocacy Group	0114
Lucas, Michael	Individual	0055
Ludwig, Art	Individual	0079
Ludwig, Arthur	Individual	0043
Lueker, Andrea	Individual	0174
M, Melissa	Individual	0118
Machine-Free Trails Association	Advocacy Group	0067
Mahoney, Tim	Individual	0073
Martinez, Sherry	Individual	0102
Maruska, Don	Individual	0183
McManus, Collette	Individual	0101
McQuillen, Mary	Individual	0135
Mecklin, John	Individual	0076
Meyer, Nina	Individual	0142
Monterey Audubon Society	Advocacy Group	0117
Montgomery, Catherine	Individual	0144
Morro Bay Commercial Fishermen's Organization	Business/Trade Association	0002
Morro Bay Commercial Fishermen's Organization	Business/Trade Association	0020
Morro Bay Commercial Fishermen's Organization	Business/Trade Association	0056
Morro Bay Commercial Fishermen's Organization	Business/Trade Association	0007
Morro Bay Commercial Fishermen's Organization	Business/Trade Association	0003
Moser, Rich	Individual	0087
Murphy, Lisa	Individual	0133

Commenter	Commenter Type	Submission ID
Murtaugh, Brian	Individual	0029
Natural Resources Defense Council et al.	Advocacy Group	0161
Nelson, David	Individual	0125
Nicholson, Dani	Individual	0106
National Oceanic Atmospheric Administration (NOAA)	Federal Agency	0084
North County Watch	Advocacy Group	0109
Offshore Wind Coalition	Advocacy Group	0162
Olson, Ava	Individual	0066
Oregon Trawl Commission	Business/Trade Association	0186
Pacific Coast Federation of Fishermen's Associations (PCFFA) and Institute for Fisheries Resources (IFR)	Business/Trade Association	0173
Pacific Fishery Management Council	State Government	0138
Padalino, Hope	Individual	0151
Padalino, Lawrence	Individual	0158
Palley, Ken	Individual	0082
Peninsula Community Collaborative (PCC)	Advocacy Group	0176
Plaister, Deane	Individual	0113
Porco, Carolyn	Individual	0115
Pressley, Roe	Individual	0011
Prinz, Ron	Individual	0092
Puntillo, Rose	Individual	0063
Pusateri, Rich	Individual	0021
Quinault Indian Nation	Tribal Government	0149
Quinn, John	Individual	0010
Raichart, David	Individual	0093
REACH	Advocacy Group	0146
REACT ALLIANCE	Advocacy Group	0098
REACT Alliance	Advocacy Group	0061
Redwood Region Climate & Community Resilience Hub and Partners	Advocacy Group	0172
Reece, Wendy	Individual	0015
Responsible Offshore Development Alliance	Advocacy Group	0137
Riker, Jennifer	Individual	0017
Riker, Reed	Individual	0016
Rochte, Tim	Individual	0019
Rosser, Nathan	Individual	0030

Commenter	Commenter Type	Submission ID
RWE Offshore Wind Holdings, LLC	Industry	0141
Sadler, Sue	Individual	0053
Sadowski, Richard E.T.	Individual	0097
Sadowski, Richard E.T.	Individual	0033
Sahn, Jennifer	Individual	0094
San Luis Obispo County	Local Government	0168
San Luis Obispo County Air Pollution Control District	Local Government	0163
Shelton, Mark	Individual	0049
Shevitz, Mark	Individual	0077
Sierra Club	Advocacy Group	0175
Sierra Club CA	Advocacy Group	0177
Simon, Paula	Individual	0024
SLO Climate Coalition	Advocacy Group	0112
Smith, Katrina	Individual	0167
Smith, Marie	Individual	0104
Spotts, Richard	Individual	0184
State Lands Commission, Dept. of Fish and Wildlife, Ocean Protection Council, Coastal Commission, Energy Commission (California State Lands Commission et al.)	State Government	0139
Stevens, Mara	Individual	0121
Sullivan, Sylvia	Individual	0072
Surfrider Foundation	Advocacy Group	0132
Tang, Joanna	Individual	0085
Thielker, Nicholas	Individual	0083
Thielker, Nicholas	Individual	0080
Thomas, Dean	Individual	0060
THPO, Bear River Band	Tribal Government	0185
Trappler, Thomas	Individual	0078
Truesdale, Carole	Individual	0107
U.S. Army Corps of Engineers	Federal Agency	0008
Watershed Regenerative Ventures	Other	0120
Webb, Mary	Individual	0090
West Coast Pelagic Conservation Group (WCP)	Advocacy Group	0182
WhoPoo App	Industry	0124
Winholtz, Betty	Individual	0103

Commenter	Commenter Type	Submission ID
Winholtz, Betty	Individual	0037
Wiyot Natural Resources Department	Tribal Government	0178
Woodbridge, Bill	Individual	0088
Woodbridge, Bill	Individual	0046
World Shipping Council	Business/Trade Association	0131
Xolon Salinan Tribe	Tribal Government	0170
Yohe, David	Individual	0099
Younger, Lauren	Individual	0023
Yurok Tribe	Tribal Government	0169
ZamEk, Jill	Individual	0059

B.1.1 General Comments

This section provides a discussion of general comments.

B.1.1.1 General Support

Thirty-six commenters conveyed general support for future offshore wind development.[1]

Many commenters expressed that they thought the wind industry would bring sustainable economic benefits to coastal communities, despite the potential for impacts, such as on fisheries.[2]

Many commenters stressed the need for renewable energy to move away from dependence on fossil fuel infrastructure, decarbonize the economy, and combat the impacts of climate change.[3]

Several commenters stressed the importance of balancing the protection of biodiversity and community and cultural resources with the need for renewable energy resources and noted that the PEIS would be a good first step to ensuring a thoughtful and comprehensive installation of offshore wind.[4]

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[1] T. Rochte, R. Sadowski, Anonymous, D. Gaede, A. Ludwig, B. Woodbridge, M. Shelton, C. Graugnard, M Lucas, J. ZaMek, Climate Action California, S. Sullivan, B. Crocco, T. Trappler, N. Thielker, J. Sahn, North County Watch, Monterey Audubon Society, Golden State Wind LLC, Surfrider Foundation, BlueGreen Alliance, Equinor Wind US LLC, Natural Resources Defense Council, Andy Mutziger, Sierra Club, Anonymous, D. Maruska, R. Spotts, Redwood Region Climate & Community Resilience Hub and Partners.

[2] T. Rochte, R. Sadowski, Anonymous, D. Gaede, A. Ludwig, B. Woodbridge, M. Shelton, C. Graugnard, M. Lucas, B. Crocco, N. Thielker, J. Sahn, North County Watch, Surfrider Foundation, BlueGreen Alliance, Sierra Club, D. Maruska.

[3] T. Rochte, R. Sadowski, D. Gaede, C. Graugnard, M. Lucas, J. ZamEk, Climate Action California, S. Sullivan, B. Crocco, T. Trappler, North County Watch, Monterey Audubon Society, Surfrider Foundation, Natural Resources Defense Council, Sierra Club, D. Maruska, R. Spotts, M. Lucas, D. Thomas.

[4] North County Watch, Monterey Audubon Society, D. Maruska, Surfrider Foundation, R. Spotts, Sierra Club, M. Shelton, Redwood Region Climate & Community Resilience Hub and Partners.

Four commenters noted how offshore wind development supports both California and national renewable energy goals.[5]

A commenter indicated support for slowing proposed offshore wind development to incorporate lessons learned from earlier projects.[6]

B.1.1.2 General Opposition

Sixty-nine commenters conveyed general opposition to offshore wind development, primarily due to its potential to affect the marine environments and aquatic species.[7]

Many commenters objected to offshore wind development due to their belief that not enough time or effort has been made to understand the impacts on the ocean and marine life, benthic habitat, marine-protected areas, coastal communities, and the economy.[8] Several commenters opposed offshore wind development because of potential fuel spills and uncertainty about noise pollution on surrounding communities and species sensitive to noise.[9] One commenter opposed offshore wind development because of the development's proposed location and instead requested the location be moved to more developed areas.[10] Multiple commenters referred to outside research and impacts from other offshore wind projects to back up their opposition.[11]

One commenter expressed disapproval of offshore wind development based on the precautionary principle and stressed looking at cumulative climate change and pollution impacts in the region.[12] One commenter expressed that they opposed offshore wind development because they believe it is a speculative process.[13] Additionally, a commenter expressed that they will seek legal counsel after implementation of the offshore wind development in the Humboldt or Morro Bay WEAs.[14] One commenter stated that they would move away if the offshore wind development were to be built.[15]

Some commenters acknowledged potential benefits of renewable energy projects in light of climate change; however, they also warned of the potential for negative environmental impacts offshore wind development may cause.[16] Other commenters stated that regardless of any mitigation measures

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[5] C. Graugnard, Golden State Wind LLC, Equinor Wind LLC, San Luis Obispo County Air Pollution Control District.
[6] J. Flaherty.
[7] W. Reece, P. Avery, D. Horvath, T. Mahoney, L. Croyle, R Moser, REACT Alliance, M. Leicester-Cadaret, S. Martinez, M. Smith, D. Nicholson, J. Farris, D. Plaister, C. Porco, M. Stevens, R. Riker, L. Borden, P. Johnston.
[8] J. Quinn, P. Johnston, L. Younger, P. Simon, C. Buchanan, N. Rosser, K. Franklin, H. Fawcett, J. Flaherty, K. Cannon, REACT Alliance, Anonymous, Machine-Free Trails Assoc., M. Cole, G. Johnson, D. Yohe, B. Winholtz, C. Truesdale, C. Porco, W. Armstrong, C. Blaney, Anonymous, C. Grijalva, A. Lueker, A. Dallmann.
[9] Anonymous, C. McManus, K. Breen.
[10] D. Bruce-Hostler.
[11] K. Fern, M. Shevitz, J. Bradford, R. Prinz, A. Dallmann.
[12] D. Bruce-Hostler.
[13] P. Gallo.
[14] REACT Alliance.
[15] R. Pressley.
[16] J. Flaherty

implemented, nothing can mimic the environmental services naturally provided by the Humboldt and Morro Bay WEAs in the face of climate change; therefore, they expressed seeking rejection of offshore wind development.[17]

For these reasons, alongside others listed throughout this section, many commenters opposed offshore wind development in favor of alternative energy sources.[18]

B.1.1.3 Other General Topics

One commenter mentioned Assembly Bill (AB) 205, AB 1373, AB 286 and emphasized the need to listen to those that would be affected by offshore wind, better understand what the impacts on the environment would be, and consider if the benefits outweigh the costs.[19]

Commenters generally recognized that there are many unknowns about renewable ocean energy.[20] Commenters expressed support for using the best available science regarding impacts, benefits, and costs of offshore wind development on ecosystems and that additional studies may be needed.[21] A commenter identified potential gaps in scientific research, including missing information on seabird population and distribution, impacts of offshore wind infrastructure on seabirds and marine mammals, cetacean migratory patterns, distribution of commercial and Indigenous fishing activity, fish aggregation characteristics, and impacts on kelp forests.[22] Another commenter indicated that the PEIS should discuss information gaps and methods to address them.[23]

Commenters emphasized the need for offshore wind to be developed responsibly by thoroughly evaluating potential environmental impacts and incorporating comprehensive mitigation measures.[24] A commenter appreciated work already completed by BOEM, federal and state agencies, and other stakeholders in developing offshore wind responsibly.[25]

A commenter requested that a harm-benefit analysis be completed to weight the benefit of offshore wind development to the Earth's environment as a whole against the harm done to vulnerable species and environments.[26] A commenter recommended that BOEM stop offshore wind development if negative impacts reach destructive levels.[27] One commenter noted that direct or indirect impacts may

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[17] D. Bruce-Hostler.
[18] L. Hunt-Pierson, L. Murphy.
[19] S. Hafer.
[20] Surfrider Foundation, Coastal Coordination Program & The Ocean Foundation.
[21] J. Tang, C. Blaney, Anonymous, N. Meyer, Natural Resources Defense Council, American Clean Power Association.
[22] Coastal Coordination Program & The Ocean Foundation
[23] Natural Resources Defense Council et al.
[24] Natural Resources Defense Council et al., Sierra Club, D. Thomas, Redwood Region Climate & Community Resilience Hub and Partners.
[25] REACH.
[26] C. Blaney
[27] C. Blaney.

occur from subsequent projects that tier from the PEIS, including natural resources such as marine mammals, fish, and seabirds that travel between state and federal jurisdictions.[28]

One commenter recommended that an annual mitigation fund be built into future offshore wind development to allow for adaptive management.[29] Additionally, a commenter recommended that funding for climate science research be a permit condition for future offshore wind development.[30]

A commenter questioned if BOEM had completed studies on floating offshore wind technology and installation techniques.[31] Another commenter expressed concerns about how offshore wind technology would be delivered and impacts of general maintenance on ocean life and the scenic California coast.[32] A commenter provided questions about the conditions under which offshore wind turbines would shut down.[33] A commenter expressed concern about the size of the undertaking noting it is not scalable for the North Coast region and does not allow for adaptation if issues arise during construction.[34]

A commenter expressed interest in seeing how offshore wind would affect Morro Bay through new workforce housing and harbor improvements.[35]

A commenter expressed that environmental regulation associated with offshore wind should be no more stringent than what is applied to oil and gas development in federally leased offshore areas.[36]

B.2 Purpose and Need

B.2.1 Purpose and Need for Action

A commenter expressed that because the Purpose and Need is the same as the New York Bight PEIS, lessons learned should be incorporated into the California Offshore Wind PEIS including selecting mitigation measures that add value and are technically and economically feasible for implementation. [37]

Multiple commenters indicated that because the Purpose and Need includes meeting federal and state renewable energy goals, the PEIS should include a robust analysis of climate change and air quality benefits from offshore wind across all resource areas and alternatives analysis.[38]

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[28] California State Lands Commission et al.
[29] GREENSPACE – the Cambria Land Trust.
[30] R. Sadowski.
[31] Channel Wind.
[32] L. Murphy.
[33] Pacific Coast Federation of Fishermen's Associations (PCFFA) and Institute for Fisheries Resources (IFR).
[34] Watershed Regenerative Ventures.
[35] M. Lucas.
[36] J. Mecklin.
[37] Golden State Wind LLC.
[38] Golden State Wind LLC, BlueGreen Alliance, RWE Offshore Wind Holdings LLC.

B.2.2 Regulatory Jurisdiction/Statutory Authority

Four commenters underscored the importance of compliance with the Outer Continental Shelf Lands Act (OCSLA) regarding offshore wind.[39]

One commenter highlighted a requirement to include the protection of the environment, conservation of natural resources, reasonable uses of the Exclusive Economic Zone, safety, and fisheries. The same commenter noted that under OCSLA, the policy requires projects "be construed in such a manner that the character of the waters above the outer Continental Shelf as high seas and the right to navigation and fishing therein shall not be affected."[40]

One commenter included an excerpt from BOEM's 2022 *Draft Guidelines for Mitigating Impacts to Commercial and Recreational Fisheries on the Outer Continental Shelf Pursuant to 30 CFR Part 58* that notes BOEM's obligations under the OCSLA to ensure that activities are carried out in a manner that provides for protection of the environment, conservation of natural resources, and prevention of interference with reasonable uses, including fishing, and BOEM's obligations under the National Environmental Policy Act (NEPA) to evaluate social and economic impacts of offshore wind development.[41] The same commenter also listed six requirements for lessees from 30 Code of Federal Regulations (CFR) part 585 subpart F that are relevant to fisheries.

B.2.3 Scope of the Programmatic Environmental Impact Statement

Several commenters provided comments on the geographic scope of analysis for the PEIS. Multiple commenters called for a comprehensive site assessment for all Wind Energy Areas (WEAs), including those in Oregon and Washington.[42] However, another commenter indicated that the PEIS should not be used for future call areas as new scientific studies may become available that change mitigation measures.[43]

Several commenters recommended the PEIS evaluate impacts on the California Current Ecosystem, as well as regions off Northern California/southern Oregon and central California.[44] Several commenters urged BOEM to evaluate offshore wind in its entirety, including ocean, coastal, and terrestrial components.[45] A commenter highlighted that the Humboldt and Morro Bay WEAs are almost 400 miles apart and have unique environmental settings that may result in distinct impacts between the WEAs.[46]

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[39] Morro Bay Commercial Fishermen's Organization, Pacific Fishery Management Council, RWE Offshore Wind Holdings LLC., Natural Resources Defense Council et al.
[40] Pacific Fishery Management Council.
[41] Morro Bay Commercial Fishermen's Organization.
[42] Elk Valley Rancheria, California; B. Gorham; Coalition of Oregon ENGOs.
[43] Anonymous.
[44] NOAA, Redwood Region Climate & Community Resilience Hub and Partners, West Coast Pelagic Conservation Group (WCP).
[45] Surfrider Foundation, Peninsula Community Collaborative (PCC).
[46] California State Lands Commission et al.

Commenters noted the need for the PEIS to analyze all potential impacts from future offshore wind development, including onshore and nearshore areas, and not limit the analysis to just the footprint of the lease areas.[47]

Commenters requested that all potential impacts, including beneficial impacts, be evaluated in the PEIS.[48] A commenter cited *Kern v. U.S. Bureau of Land Management* (2002), which found an agency may not avoid analyzing these reasonably foreseeable environmental consequences in a PEIS "by saying that the consequences are unclear or will be analyzed later."[49] One commenter called for evaluation of impacts on biodiversity and marine megafauna using sound science and robust datasets and inclusion of mitigation measures to reduce these impacts.[50]

One commenter asked for more discussion on the impact on local consumers of electricity and how consumers would be protected from outages or brownouts due to electricity loss over the long transmission lines. The same commenter also asked for a discussion on the impacts of heat from powerlines in shallow water.[51]

A commenter expressed concern that the NOI indicated the PEIS would focus on negligible and minor impacts so site-specific reviews can focus on moderate and major impacts.[52] The commenter requested that the PEIS adequately evaluate the full range of impacts.

Commenters called on the PEIS to include all reasonably foreseeable activities, including those activities outside the WEAs.[53] A commenter indicated that the PEIS should analyze impacts on sites used to assemble and transport offshore wind components and the transmission infrastructure to move electricity to the service areas.[54]

Several commenters requested analysis of transmission alternatives for the region.[55] A commenter noted that there is limited transmission infrastructure in Northern California and such systems would need to be upgraded to export wind energy from the Humboldt WEA.[56] A separate commenter requested that the PEIS analyze the impacts of these transmission infrastructure enhancements.[57] A commenter called for a discussion of cables including how they would be buried and impacts related to electromagnetic fields (EMFs), cable heat, cables breaking, and electrocution risk.[58]

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[47] C. Buchanan, California State Lands Commission et al., H. Hensher.
[48] M. Webb, Surfrider Foundation, Responsible Offshore Development Alliance, Natural Resources Defense Council et al., Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative (PCC), Sierra Club CA, H. Hensher, Oregon Trawl Commission, D. Howard, Wiyot Natural Resources Department.
[49] Natural Resources Defense Council et al.
[50] HiDef Aerial Surveying LTD.
[51] C. Buchanan.
[52] Pacific Fishery Management Council
[53] L. Eriksen, G. Goetz.
[54] Los Cerritos Wetlands Land Trust.
[55] Elk Valley Rancheria, California, Yurok Tribe.
[56] California State Lands Commission et al.
[57] Redwood Region Climate & Community Resilience Hub and Partners
[58] B. Winholtz and Elk Valley Rancheria, California.

A commenter requested the PEIS include an analysis of cumulative impacts as a result of onshore and offshore development of the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal, because the commenter believed the two projects are interwoven.[59] A commenter recommended that the PEIS incorporate the decommissioning included in the *Draft Environmental Impact Report for the Diablo Canyon Power Plan*.[60] Another commenter echoed the request that the PEIS analyze all infrastructure enhancements that would be driven by offshore wind facilities.[61]

Additionally, commenters requested that the following issues be considered in the PEIS.

- Potential environmental and socioeconomic benefits to requiring uniform turbine design within the Humboldt and Morro Bay WEAs.[62]
- Evaluation of the "dual uses" of offshore wind infrastructure, such as the possible production of hydrogen or aquaculture development.[63]
- Future offshore wind infrastructure be sited to minimize impacts on the coastal and marine environment.[64]
- Potential for current and wind to change as a result of future offshore wind development and associated impacts.[65]
- An analysis of potential impacts on sensitive areas, such as marine protected areas (MPAs), critical habitats, and areas of historical or cultural significance.[66]
- Adaptive management actions and triggers that allow for flexibility with offshore wind development and are developed in consultation with stakeholders.[67]
- Analysis of mitigation measures through a range of potential energy productions as energy procurement contracts for the lease areas are not executed.[68]
- The PEIS to inform COP development and ongoing coordination with lessees to determine the feasibility of the Representative Project Design Envelope (RPDE) and mitigation measures.[69]
- Evaluation of unique challenges that may arise from floating offshore wind technology.[70]
- Impacts from decommissioning.[71]

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[59] Redwood Region Climate & Community Resilience Hub and Partners.
[60] San Luis Obispo County.
[61] H. Hensher.
[62] Redwood Region Climate & Community Resilience Hub and Partners.
[63] California State Lands Commission et al.
[64] N. Krop.
[65] B. Winholtz.
[66] Elk Valley Rancheria, California.
[67] Elk Valley Rancheria, California.
[68] Responsible Offshore Development Alliance.
[69] Golden State Wind LLC
[70] American Waterways Operators
[71] Brightline Defense

- An analysis of the lifespan of offshore wind including ongoing operational impacts in addition to construction impacts.[72]

B.2.4 Other Comments on the Purpose and Need for the Proposed Action

One commenter questioned the need for offshore wind development and whether the supporting infrastructure needed to deliver this energy onshore even exists. This commenter noted that offshore wind development could generate anywhere between 25 gigawatts to 45 gigawatts at full build-out, which makes the amount of onshore infrastructure needed for transmission to a variety of local service areas uncertain. [73]

One commenter stated that the PEIS should focus on lessee's project development goals and guide environmental review and authorization of Construction and Operation Plans (COPs) and avoid considering adjustments to lease decisions and boundaries since awards have already been granted. The commenter stated that BOEM needs to collaborate with lessees, agencies, and those who have jurisdiction or special expertise to ensure original leases and development goals are upheld.[74]

B.3 Proposed Action and Alternatives

B.3.1 Proposed Action's Adoption of Mitigation Measures for the Lease Areas

Several comments, representing a total of fourteen organizations, noted the need for the PEIS to include avoidance, minimization, mitigation, and monitoring measures[75] that BOEM will require as a condition of approval for the COPs.[76] Two of these commenters noted the specific importance of robust, regional, and comprehensive mitigation measures especially for the protection of the fishing industry and opposed any deferred mitigation that would not be approved until after any survey impacts.[77]

One commenter stressed the importance of mitigation measures specifically for air quality impacts, because of the large nature of offshore wind development both at sea and within coastal communities. This commenter noted specifically that the lease areas off Morro Bay are likely to result in annual ozone precursor thresholds and will require additional permits.[78]

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[72] Redwood Region Climate & Community Resilience Hub and Partners, H. Hensher
[73] Los Cerritos Wetlands Land Trust.
[74] Invenergy California Offshore LLC.
[75] Within the PEIS, BOEM anticipates using the term "mitigation measures" in favor of "AMMM measures."
[76] Elk Valley Rancheria- California, REACT Alliance, North County Watch, Monterey Audubon Society, Responsible Offshore Development Alliance, California State Lands Commission et al., Wiyot Natural Resources Department, Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources, San Luis Obispo County Air Pollution Control District.
[77] Responsible Offshore Development Alliance, Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources.
[78] San Luis Obispo Air Pollution Control District.

Some commenters made suggestions for potential mitigation measures, such as ones that would provide extra protection for birds, marine mammals, fish, and special environmental resources.[79]

One commenter noted the importance of incorporating Traditional Ecological Knowledge (TEK) to ensure that mitigation measures are relevant and informed by true local experts in the region that they will ultimately affect.[80]

Alternatively, several commenters were opposed to mitigation measures as part of the PEIS process, especially if they put the burden of proving feasibility and necessity on the developers.[81] One commenter claimed that BOEM should wait to adopt mitigation measures prior to COP review to prevent additional delays to the PEIS process and focus on creating mitigation measures that are flexible and apply to project-specific impacts instead of overall and broad environmental impacts at the early stages of offshore wind development.[82] Some of these commenters stated that BOEM lacks the authority to approve mitigation measures during the PEIS stage.[83] A comment from an offshore wind developer specifically mentioned their opposition to the inclusion of curtailment as a mitigation measure, because this would jeopardize potential financing and payback of offshore wind projects.[84]

B.3.2 Alternatives Proposed by Commenters

Several commenters made requests for the PEIS to include a reasonable range of alternatives to demonstrate impacts and comply with NEPA to the highest degree.[85] Some commenters made specific recommendations about finding the balance of economic benefits and ecological impacts, with a prioritization on reducing environmental impacts first, and to not take a lack of evidence as a lack of impact.[86]

One commenter noted that the alternatives analysis must include a detailed analysis of the varied effects on fisheries between the alternatives and pointed out their concern that the No Action Alternative be conflated with a cumulative effects analysis.[87]

One commenter focused on curtailment alternatives and suggested that any impact on electrical generation at proposed cut-in speeds be evaluated using energy production curves and historical wind speed data.[88]

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[79] North County Watch, Monterey Audubon Society.
[80] Wiyot Natural Resources Department.
[81] Golden State Wind LLC, American Clean Power Association, RWE Offshore Wind Holdings LLC.
[82] Golden State Wind LLC.
[83] American Clean Power Association, RWE Offshore Wind Holdings LLC.
[84] Golden State Wind LLC.
[85] N. Krop, S. Sadler, M. Holtam, B. Crocco, T. Trappler, Tom D, K. Palley, J. Tang, G. Goetz, R. Altman, D. Howard, BlueGreen Alliance, Responsible Offshore Development Alliance, D. Howard, Continuum Industries, Makah Tribe.
[86] Redwood Region Climate and Community Resilience Hub and Partners, EPA Region 9, BlueGreen Alliance, Bat Conservation International, Natural Resources Defense Council.
[87] Responsible Offshore Development Alliance
[88] Bat Conservation International

A few commenters asked for alternatives to consider onshore energy options to reach federal and state federal energy goals.[89] One commenter stated that a requirement of NEPA is to research multiple alternatives and recommended that clean incinerators be considered as an energy-producing, prospectively less-impactful alternative to offshore wind.[90] Other commenters were interested in scaling up existing onshore technologies, such as rooftop solar, demand response, batteries.[91]

Five comments, representing eight organizations, expressed a desire for project design to incorporate minimization of impacts and for alternates to be a part of comparing the options for project design.[92] Two commenters suggested that this should include mapping of potential transmission lines and options.[93]

Two commenters recommended analysis of a range of commitments to mitigation measures to address unavoidable impacts.[94] One commenter proposed three alternatives: (1) analyze potential impacts resulting from the application of mitigation measures to the RPDE, (2) analyze the impacts of not adopting the programmatic mitigation measures for the RPDE, and (3) analyze a No Action Alternative.[95] Part of these recommendations includes that the PEIS should assess the full build-out of the five leases together with a holistic consideration of geographies, natural resources, and co-use issues especially to understand which avoidance, minimization, mitigation, and monitoring measures that address regional scale and ecosystem impacts will be needed.[96] One of these commenters also noted that an alternatives analysis should evaluate the impacts of deferring adoption of mitigation measures to the COP stage.[97]

One commenter recommended two alternatives: the first being a "demonstration wind farm" to set an example of what other farms will or can look like, and the second being a minimum footprint alternative based on the number of turbines necessary to achieve the state's clean energy goals.[98]

Alternatively, some comments came from the industry and expressed opposition to other comments regarding project alternatives.[99] Two commenters noted that BOEM will fail to advance the goals of the PEIS by comparing extreme scenarios in its alternatives, such as scenarios where there is no adoption of mitigation measures and where adoption of mitigation measures is economically and technically

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[89] Los Cerritos Wetland Trust, Pacific Coast Federation of Fishermen's Associations and Institute of Fisheries Resources, H. Hensher, C. Buchanan.
[90] C. Buchanan.
[91] Los Cerritos Wetland Trust, Pacific Coast Federation of Fishermen's Associations and Institute of Fisheries Resources, H. Hensher.
[92] California State Lands Commission et al., M. Holtam, Brightline Defense, EPA Region 9.
[93] Brightline Defense, EPA Region 9.
[94] North County Watch, Natural Resources Defense Council, NOAA.
[95] NOAA.
[96] Natural Resources Defense Council, NOAA
[97] Natural Resources Defense Council et al.
[98] Pacific Fishery Management Council.
[99] American Clean Power Association, RWE Offshore Wind Holdings LLC.

infeasible.[100] One commenter noted that alternatives that would substantially reduce project size and make the large investment into wind energy infeasible should not be analyzed[101]

B.3.3 No Action Alternative

Eight commenters stressed the importance of a relevant No Action Alternative analysis, although many differed on the definition of what would qualify as such.[102]

Some commenters wanted a No Action Alternative to demonstrate the risks of not implementing steps toward renewable energy, like offshore wind, to demonstrate what climate-related impacts are at stake by not moving forward with development.[103] One of these commenters suggested that a No Action Alternative analysis could include an investigation into how much land would need to be dedicated to match the energy that could be produced by offshore wind and the environmental and economic costs of continuing to rely on gas-powered energy resources.[104]

One commenter noted that a No Action Alternative should consider environmental impacts that may result from updates to the major harbors that are being considered for offshore wind staging.[105]

One commenter desired a No Action Alternative analysis that included an analysis about existing jobs, industry, community culture, and alternative on-land energy sources that could be enhanced to serve the needs of the population.[106]

One commenter did not want the No Action Alternative to be an analysis of no development in the WEAs, because this would not provide a helpful baseline to compare against for the impact of projects with mitigation measures.[107]

B.4 Resource and Stressor Topics

B.4.1 Air Quality

Nine commenters mentioned concerns over increased air pollution due to offshore wind and related infrastructure.[108]

[100] American Clean Power Association, RWE Offshore Wind Holdings LLC.
[101] Invenergy California Offshore LLC.
[102] Climate Action California, RWE Offshore Wind Holdings LLC, Dr. D. Hall PhD, Anonymous, Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources, A. Lueker, Sierra Club, D. Maruska.
[103] Climate Action California, Dr. D. Hall PhD, Anonymous, Sierra Club.
[104] Sierra Club.
[105] D. Maruska.
[106] Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources.
[107] RWE Offshore Wind Holdings LLC,
[108] R. Pusateri, C. Buchanan, K. Franklin, A. Olson, M. Leicester-Cadaret, Natural Resources Defense Council, San Luis Obispo County Air Pollution Control District, Redwood Region Climate & Community Resilience Hub and Partners.

One commenter noted how offshore wind will reduce reliance on gas-fired power plants, 75 percent of which is in or near disadvantaged communities and will provide air quality and affordability benefits to communities across California over time.[109]

Commenters recommended that the PEIS analyze air quality and greenhouse gas (GHG) impacts from constructing, operating, and maintaining offshore wind facilities.[110] Five commenters stated that the carbon dioxide (CO_2) emissions produced by the installation, maintenance, and manufacturing of offshore wind development have the potential to prevent offshore wind from being an example of green energy that would reduce carbon emissions.[111] Three comments noted transit will increase due to offshore wind development, and conveyed a need to assess the impacts from increased heavy-duty diesel trucks, and to consider the incorporation of ports and transit electrification to avoid additional impacts on local communities near onshore development sites.[112] Several commenters noted that worsened air quality near ports will increase health concerns, such as asthma and cardiovascular disease, among low-income and other disproportionately impacted communities.[113]

One commenter emphasized the need to create impact assessments for onshore and offshore survey and construction activities, and modifications to existing onshore infrastructure, and incorporate efforts to reduce GHG emissions and impacts on air quality. This commenter noted that the PEIS will need to determine whether these pre-construction air quality impacts will need to be evaluated holistically or by individual lessees.[114]

Commenters provided specific recommendations on guidance and tools that should be used to evaluate potential impacts. One commenter provided detailed recommendations for BOEM to provide standardized guidance for lessees to be compliant under the Clean Air Act, and with ways to streamline relevant information sharing to benefit prospective lessees.[115] One commenter pointed out guidance from Council on Environmental Quality (CEQ) that recommends including an assessment of the "social cost of carbon" within BOEM's GHG assessment.[116] One commenter highlighted that offshore wind development in the Morro Bay WEAs needs to apply mitigation measures if air quality and GHG impacts are above the San Luis Obispo County Air Pollution Control District's significance thresholds.[117] One commenter recommended BOEM use the U.S. Environmental Protection Agency's (USEPA's) CO-Benefits Risk Assessment Health Impacts Screening and Mapping tool to quantify human health benefits.[118]

[109] Sierra Club.
[110] Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative (PCC).
[111] R. Pusateri, C. Buchanan, A. Olson, Surfrider Foundation, Natural Resource Defense Council.
[112] Natural Resources Defense Council, Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative (PCC).
[113] Redwood Region Climate & Community Resilience Hub and Partners, Natural Resources Defense Council, Sierra Club.
[114] San Luis Obispo Air Pollution Control District
[115] USEPA Region 9.
[116] USEPA Region 9.
[117] San Luis Obispo County Air Pollution Control District.
[118] American Clean Power Association.

B.4.2 Areas of Special Concern

Nineteen commenters expressed concern regarding how offshore wind development may affect areas of special concern, including the Chumash Heritage National Marine Sanctuary and Morro Bay National Marine Sanctuary.

Several commenters question the potential negative impacts of offshore wind development on birds, marine life, and other ecosystem services of the Chumash Heritage National Marine Sanctuary and request the PEIS assess all opportunities to reduce and mitigate impacts, such as further collaboration between leaseholders and stakeholders.[119] One commenter emphasized the importance of Tribal engagement and incorporating traditional Indigenous knowledge in balancing offshore wind development and the Chumash Heritage National Marine Sanctuary.[120] Similarly, one commenter requested that the National Oceanic Atmospheric Administration's (NOAA's) Office of National Marine Sanctuaries be a cooperating agency on the PEIS, and that BOEM and NOAA enter into a memorandum of understanding, with respect to the potential impacts on the Chumash Heritage National Marine Sanctuary.[121] A commenter indicated that offshore wind development in the Morro Bay WEA would affect the Chumash Heritage National Marine Sanctuary as originally proposed.[122] One commenter expressed support for offshore wind development; however, they requested minimal cables prevent impacts on marine mammals and that any cables placed avoid the Chumash Heritage National Marine Sanctuary.[123]

One commenter expressed concern for the overall welfare of the Morro Bay National Marine Sanctuary because it is adjacent to potential offshore wind development and requested any wind development be done in a different, more industrial, location.[124]

One commenter requested mitigation measures be adopted to reduce major impacts on sanctuary resources as a result of laying subsea energy transmission cables, floating substations, and vessel operations, in addition to other sources caused by offshore wind development. [125]

One commenter requested that no activities be approved in the National Marine Sanctuaries, without analysis of long-term effects and mitigation measures to address ecosystem impacts.[126] Other commenters requested BOEM analyze potential impacts on all MPAs from offshore wind development,

[119] J. ZamEk, E. Veium.
[120] J. Eckerle, A. Dallmann.
[121] T. Studds.
[122] Sierra Club CA.
[123] B. Woodbridge.
[124] Anonymous
[125] NOAA
[126] R. Charter.

including any MPAs listed in the California Marine Life Protection Act.[127] Another commenter expressed that further surveying should be completed to ensure adequate monitoring and protection of MPAs.[128]

Commenters expressed concern relating to how offshore wind development may cause habitat closures, spawning closures, and other impacts on special management areas.[129]

B.4.3 Bats

Several commenters noted that even though there is less information readily available about bat species and their migration patterns, they have been observed flying offshore and should be protected within the PEIS.[130] Seven commenters expressed concern relating to collisions and increased mortality rates for bat populations because of offshore wind development.[131] Two commenters pointed out that bats tend to be attracted to lighting systems, increasing their likelihood of collision with wind infrastructure and, thus, recommended using "on demand" lighting systems.[132]

Several commenters mentioned a variety of methodologies to deter bats from wind turbines and related offshore wind infrastructure, and in some cases, just track their presence.[133] One commenter suggested implementing the Pacific Northwest National Laboratory Thermal Tracker 3D on buoys to better monitor birds and bats near the turbines.[134] Some commenters mentioned using acoustic monitoring to determine bat activity levels as a proxy for mortality risk, since carcasses cannot be collected offshore. Commenters also mentioned using strike detectors, thermal cameras, and ultrasonic devices to track bat population presence near offshore wind facilities.[135] One commenter pointed out that while these tools can be helpful for tracking bat species near wind infrastructure, they should not be used as a mitigation tool because they have had mixed effects, and in some cases acted as an attractant and increased bat mortality. This commenter recommended careful study of acoustic deterrents that could work over the entirety of the rotor swept area, but that current technology has not proved to be sufficient toward this end.[136] Three commenters also mentioned how adaptive management strategies will be especially important for protecting bat species, as further research is being done about their conservation.[137]

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[127] Surfrider Foundation.
[128] L. Murphy.
[129] Morro Bay Commercial Fishermen's Organization.
[130] Natural Resources Defense Council, Bat Conservation International.
[131] Anonymous, K. Franklin, R. Puntillo, L. Murphy, C. Blaney, Natural Resources Defense Council, Bat Conservation International.
[132] Natural Resources Defense Council, Bat Conservation International.
[133] Natural Resources Defense Council, Bat Conservation International.
[134] Anonymous.
[135] K. Smith.
[136] Bat Conservation International.
[137] Natural Resources Defense Council, Bat Conservation International, K. Smith.

Three commenters recommended the practice of feathering turbine blades below the manufacturer's cut-in speed in order to reduce bat fatalities, demonstrated to be approximately 30 percent effective at land-based wind energy facilities.[138]

One commenter recommended using curtailment as a mitigation measure to reduce bat mortality, claiming that this strategy has demonstrated to be 33 percent effective at land-based wind energy facilities. This commenter also mentioned that curtailment schedules can be refined to reduce impacts on wind energy production and maximize benefits to nearby bats.[139]

One commenter recommended identifying an acceptable level of mortality levels that would still allow for viable populations, and the adoption of a mitigation strategy that was proven to reduce mortality below this accepted level.[140]

B.4.4 Benthic Resources

Seventeen commenters were concerned with how offshore wind development may affect benthic resources.

Some commenters expressed concern regarding how dredging and burying cables may permanently disrupt reefs, the sea floor, and deep-sea dwellers, including kelp forests, which could hold sensitive or endemic species.[141] One commenter further explained the biodiversity benefits of benthic habitat and requested that the environmental review of the next phases of offshore wind development consider potential impacts on fish and benthic habitat.[142]

One commenter warned that attachment to the ocean floor would be difficult because of extreme weather events and sea level rise making the sea floor more fragile, in addition to the risks of pollutant leakage.[143]

One commenter requested that the PEIS include a mitigation measure requiring detailed, pre-development seafloor habitat mapping of lease areas overlapping with essential fish habitat (EFH) and for placement of cables to not occur on sensitive habitat or near sensitive species. The commenter also recommended export cables be buried.[144]

One commenter provided the following recommendations to protect benthic habitat.

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[138] Bat Conservation International, Natural Resources Defense Council, K. Smith.
[139] Bat Conservation International.
[140] K. Smith.
[141] K. Franklin, R. Puntillo, M. Webb, REACT Alliance, M. Leicester-Cadaret, L. Murphy, C. Blaney, I. Gutierrez, Peninsula Community Collaborative (PCC), Anonymous, Redwood Region Climate & Community Resilience Hub and Partners.
[142] S. Harvey, West Coast Pelagic Conservation Group (WCP).
[143] L. Murphy.
[144] J. Eckerle.

- Require the lessee to implement management practices to first avoid, then minimize and mitigate adverse impacts from all stages of development and types of offshore wind infrastructure that would destroy benthic habitat.
- Avoid development in areas with known benthic habitat.
- Require lessees to follow the conditions adopted by the California Coastal Commission in its conditional concurrence for the Humboldt and Morro Bay WEAs, including conditions to protect benthic habitat.
- Avoid intentional contact within hard substrate, rock outcroppings, seamounts, or deep-sea coral/sponge habitat during site assessment, construction, and operations.
- Develop an anchoring plan and the requirement that anchoring sites include a buffer of sufficient distance to fully protect sensitive habitat from anchors and related infrastructure, as well as accounts for the possible movements of anchors and cables over time.
- Require the lessee to submit a mitigation plan to the responsible agencies for their approval prior to advancing development.
- Consider the impacts of interarray, mooring, and transmission cables on benthic habitat and whether measures can be used to avoid or minimize their effects.
- Adequately assess the impacts from increased turbidity and sediment deposition on benthic resources, fishes, EFH, and invertebrates during cable installation and require project developers undertake measures to avoid, minimize, and mitigate these impacts.
- Work with local and regional fishery managers and the National Marine Fisheries Service (NMFS) to consider and implement appropriate mitigation measures to avoid, minimize, and mitigate potential adverse impacts on EFH, fishes, benthic resources, and invertebrate populations, which may be affected by construction activities, particularly during vulnerable times of spawning, larval settlement, and juvenile development, and may be affected by operations.[145]

One commenter warned about the impacts dredging may have on larval nurseries by creating sediment plumes, which could in turn also affect the feeding patterns of birds and oyster businesses. For these reasons, the commenter requested the impacts of power dredging be further analyzed.[146]

B.4.5 Birds

Commenters expressed concerns about impacts on birds, specifically increased deaths from wind turbines[147] and changes to migratory patterns.[148] Three commenters mentioned that certain seabird

[145] I. Gutierrez.
[146] V. Helliwell.
[147] S. Hafer, R. Pressley, K. Franklin, Anonymous, R. Puntillo, Machine-Free Trails Association, Climate Action California, REACT Alliance, M. Leicester-Cadaret, North County Watch, Coastal Coordination Program & The Ocean Foundation, Monterey Audubon Society, M. Stevens, M. Ginkel, L. Murphy, C. Blaney, Natural Resources Defense Council, Sierra Club CA.
[148] Anonymous, C. Buchanan, Anonymous, North County Watch, C. Porco, Monterey Audubon Society, M. Stevens, L. Murphy, Natural Resources Defense Council.

populations are attracted to nighttime artificial lighting on offshore industrial structures leading to fatalities and recommended using alternative lighting.[149] One commenter claimed that in France, wind companies have been held liable for killing too many eagles, leading to the dismantling of several wind farms.[150] One commenter suggested that offshore wind turbines would create electromagnetic noise to the degree that migratory birds would be unable to use their magnetic compasses to reach their destinations.[151]

One commenter pointed out that the spacing of the turbines would need to be studied extensively to ensure that they do not simultaneously increase collisions and increase displacement impacts for seabird species.[152] Two commenters recommended comparing wind turbine designs to find an option that has lower impacts on seabird species.[153]

Several commenters mentioned a desire for curtailment, monitoring, and up-to-date study and conservation strategies to be used to prevent excess bird collisions and deaths.[154] One commenter suggested implementing the Pacific Northwest National Laboratory Thermal Tracker 3D on buoys to better monitor birds and bats near the turbines.[155] Another commenter believed artificial intelligence (AI) sensors that can identify bird species would be effective in creating curtailment strategies to prevent bird collisions with moving turbine blades.[156] Another commenter recommended using a range of tools, including marine radar, acoustic detectors, and collision-detection technologies to evaluate risks and document any impacts.[157] Due to the wide variability of certain avian species, many commenters suggested having specific mitigation measures for seabird species.[158] One commenter recommended establishing post-construction monitoring commitments, including radio tagging and deployment and maintenance of Motus Towers in collaboration with the U.S. Fish and Wildlife Service (USFWS) for an appropriate duration of monitoring after installation of turbines.[159]

One commenter detailed how climate change and ocean warming are causing drastic population decreases in a variety of seabird species and recommended compensatory mitigation measures to account for any additional warming that offshore wind development creates to help these bird species thrive once again.[160]

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[149] Coastal Coordination Program & The Ocean Foundation, Natural Resources Defense Council, Bat Conservation International.
[150] S. Hafer.
[151] C. Buchanan.
[152] Natural Resources Defense Council.
[153] Natural Resources Defense Council, Sierra Club CA.
[154] R. Puntillo, K. Franklin, J. Flaherty, C. Blaney, Monterey Audubon Society, Natural Resources Defense Council,
[155] K. Franklin.
[156] J. Flaherty.
[157] Natural Resources Defense Council.
[158] Monterey Audubon Society, Natural Resources Defense Council, Coastal Coordination Program & The Ocean Foundation.
[159] Natural Resources Defense Council.
[160] Climate Action California.

One commenter mentioned that the Anticipated Authorizations and Consultations section of the NOI should mention the Federal Migratory Bird Treaty Act.[161]

B.4.6 Climate Change

Several commenters expressed that this project aligns with state, federal, and international renewable goals, and will help reduce emissions created by electricity generation, reduce sea level damage, and positively benefit local communities.[162]

Two commenters suggested integrating climate change resilience considerations into the programmatic analysis to account for potential changes in sea levels, storm frequency, and ocean conditions.[163] Numerous commenters suggested the PEIS scope expand to conduct long-term climate studies and assess the potential impacts of offshore wind development on the sea surface, nutrient cycling, and upwelling.[164] Two commenters expressed the need for economic and social costs to be evaluated and that the net carbon reduction of offshore wind leasing be weighed for each lease area in the PEIS.[165] Additionally, two commenters suggested that BOEM incorporate the quantifiable and qualitative impacts that would likely be produced from the offshore wind development in the PEIS.[166]

Many commenters were concerned with impacts on coastlines, food systems, marine ecosystems, and marine species derived from climate change.[167] A commenter noted that climate change may contribute to compounding impacts on species from offshore wind development.[168] Another commenter indicated that renewable energy development cannot occur at the expense of Tribal treaty rights, resources, and cultural practices.[169]

One commenter questioned if carbon emissions saved from offshore wind energy generation would cancel out the carbon footprint of offshore wind development.[170] Another commenter asserted that offshore wind development will fail to reduce greenhouse gas emissions and produce no collective impacts on global warming.[171]

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[161] Monterey Audubon Society.
[162] A. Olson, D. Chandler, NOAA, T. Studds, Brightline Defense, Sierra Club, Redwood Region Climate & Community Resilience Hub and Partners.
[163] Elk Valley Rancheria, California, EPA Region 9.
[164] J. Eckerle, C. Blaney, Xolon Salinan Tribe, EPA Region 9.
[165] R. Charter, Surfrider Foundation.
[166] Sierra Club, Peninsula Community Collaborative.
[167] D. Chandler, S. Sadowski, R. Charter, C. Blaney, E. Bettenhausen, Redwood Region Climate & Community Resilience Hub and Partners, H. Hensher.
[168] Redwood Region Climate & Community Resilience Hub and Partners.
[169] Makah Tribe.
[170] V. Helliwell.
[171] N. Dorfman.

B.4.7 Coastal Habitat and Fauna

Many commenters stated general concerns about the potential for offshore wind development to negatively affect coastal habitat and fauna.[172] A commenter argued that offshore wind development could become the largest threat to the marine and coastal environment.[173] The same commenter noted that the California Current Ecosystem is a very important and relatively untouched ecological area. A commenter stated the important role estuaries play in the ecosystem and urged BOEM to protect coastal ecosystems.[174]

Two commenters expressed concerns related to disturbance of upwelling and alteration of ocean and terrestrial microclimates.[175] Another commenter noted that offshore wind development could focus tsunami swells at certain locations, which would result in greater impacts on coastal communities and harbors.[176]

Two commenters expressed concerns about potential impacts on rare moss and lichen species on the Samoa Peninsula.[177] A commenter noted the potential for an increase in invasive species as a result of offshore wind development and recommended a requirement for lessees to provide a plan to reduce the likelihood of introduction.[178]

A commenter stated that baseline studies must be conducted to understand impacts on wildlife from offshore wind development.[179]

A commenter stressed the value that the Central and North Coasts of California provide to residents and visitors and noted the importance of protecting these resources from industrialization.[180] A commenter indicated the PEIS should consider impacts on coastal access and recreation from onshore infrastructure related to offshore wind development and increased vessel traffic.[181] Another commenter stated that the PEIS should analyze potential coastal, onshore, and socioeconomic impacts of offshore wind development and its coastal components.[182]

B.4.8 Commercial and For-Hire Recreational Fishing

Three commenters noted that the local fishing industry is concerned about installation of the wind turbine generators (WTGs) disrupting fishing patterns in the area and stressed the importance of

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[172] Climate Action California, Watershed Regenerative Ventures, L. Murphy, C. Blaney, Brightline Defense, L. Padalino, Peninsula Community Collaborative, Oregon Trawl Commission, GREENSPACE – the Cambria Land Trust.
[173] Oregon Trawl Commission.
[174] A. Dallmann.
[175] R. Puntillo, C. Blaney.
[176] Anonymous.
[177] Peninsula Community Collaborative, Redwood Region Climate & Community Resilience Hub and Partners.
[178] North County Watch.
[179] Sierra Club CA.
[180] C. Blaney.
[181] Natural Resources Defense Council et al.
[182] Natural Resources Defense Council et al.

evaluating how impacts would limit local fishing industry profits.[183] Several commenters expressed concern over negative impacts on the fishing industry's contributions to California's economy and the seafood industry, such as the loss of jobs, ultimately affecting the community as a whole.[184] Additionally, one commenter noted that reduced harvest quotas combined with less area for fishing opportunity will reduce the value of limited entry permits, which could result in a large economic impact for fishermen.[185] A commenter indicated that wind turbines would act as fish-aggregating devices, which could negatively affect fisheries by making those fish unavailable to harvesters.[186]

Several commenters stressed the close connection between fresh fish being landed, the visibility of working commercial fishing vessels, and tourism and that removing fishing would have negative economic impacts on tourism.[187]

Multiple commenters expressed their concern that offshore wind development would compromise fishing opportunities for future generations, affect catch quality, and impose difficulties adapting to climate change.[188] Three commenters noted that increased competition for limited harbor and port space could price out fishing vessels and subsequently affect local businesses that rely on business derived from fishing.[189]

Two commenters noted that upgrading California's ports and harbors to support the nascent offshore wind industry would result in impacts on commercial fishing through interruptions to operations, displacement of fishing vessels, and competition for good weather windows with fishermen's utilization of fishing grounds, or tending to their gear.[190] Multiple commenters expressed concern over site surveys negatively affecting fishing activity, which would displace fisherman.[191]

One commenter stressed the impacts of fishing gear loss or interaction with vessel traffic during construction and operational phases.[192] Additionally, many commenters stated fisherman would experience loss of fishable areas and limited use of gear due to vessel traffic and project design and recommended a compensation or damage claim be established.[193]

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[183] A. Olson, M. Stevens, Sierra Club CA.
[184] Morro Bay Commercial Fishermen's Organization, Climate Action California, Coastal Coordination Program, The Ocean Foundation, West Coast Pelagic Conservation Group (WCP).
[185] Morro Bay Commercial Fishermen's Organization.
[186] American Albacore Fishing Assn.
[187] Morro Bay Commercial Fishermen's Organization, J. Riker, C. Buchanan, Elk Valley Rancheria, California, K. Franklin, C. Blaney, Redwood Region Climate & Community Resilience Hub and Partners.
[188] Morro Bay Commercial Fishermen's Organization, K. Kazazian, M. Webb, REACT ALLIANCE, M. Leicester-Cadaret, M. Ginkel, C. Blaney, Oregon Trawl Commission.
[189] Morro Bay Commercial Fishermen's Organization, Pacific Coast Federation of Fishermen's Associations (PCFFA) and Institute for Fisheries Resources (IFR).
[190] Morro Bay Commercial Fishermen's Organization, N. Rosser.
[191] Morro Bay Commercial Fishermen's Organization, A. Alward.
[192] Morro Bay Commercial Fishermen's Organization.
[193] Morro Bay Commercial Fishermen's Organization, NOAA, Pacific Fishery Management Council, Pacific Fishery Management Council, West Coast Pelagic Conservation Group (WCP).

Two commenters believed BOEM could improve its communication and consulting with fishery managers, fisherman, and other stakeholders.[194] One commenter suggested that a well-funded climate science program, local commercial fishermen, citizen science groups, and academia could fill climate science data gaps and help educate the public.[195] In addition, four commenters emphasized the importance of improving environmental review and decision-making through various methods of detailed analysis, including incorporating local stakeholder knowledge into decisions, and implementing guidelines and restrictions to protect fishery resources.[196]

One commenter stressed that the PEIS needs to fully evaluate interactions among all impact-producing factors and associated responses by marine trust resources, oceanographic and atmospheric processes, and fishing activities across all lease areas within the five lease areas to help inform the development of the WEAs in a holistic manner.[197] Another commenter indicated that the PEIS must include an analysis of impacts, including increased vessel traffic, to the existing maritime and fishing industries, including Tribal fisheries in the bays and rivers within Indigenous and Tribal lands in the greater region.[198] A commenter recommended the PEIS evaluate the economic changes to the fishing industry as a result of offshore wind development.[199]

One commenter noted that fishermen recommended a greater use of concrete mattresses, rather than rock armoring to protect cables. The commenter also stated a fisherman said more accurate seabed maps of cables, cable crossing points, rock armoring, seabed debris, etc. may encourage fishing closer to the turbines and within the wind farm. Ultimately, the commenter believed more information about potential seabed hazards within offshore wind farms may improve confidence to fish inside the farms.[200]

Commenters questioned how negative impacts on fishing from offshore wind would be quantified.[201] Additionally, a couple commenters questioned how the companies would compensate fishermen for loss of jobs.[202]

One commenter stressed the need to support seafood business and community longevity. The commenter emphasized that the federal offshore wind leasing program needs substantially more attention devoted toward developing and incorporating fisheries and ecosystem data. The commenter suggested assessing the impacts on fishing from offshore wind development, allocating funding to fisheries research and resource enhancement, employing mitigation measures, and developing compensation programs.[203]

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[194] Morro Bay Commercial Fishermen’s Organization, C. Blaney, American Albacore Fishing Assn.
[195] R. Sadowski.
[196] L. Johnston, D. Maruska, J. Eckerle, A. Reynolds.
[197] NOAA.
[198] Redwood Region Climate & Community Resilience Hub and Partners
[199] D. Hall.
[200] Morro Bay Commercial Fishermen's Organization.
[201] N. Rosser, West Coast Pelagic Conservation Group (WCP).
[202] B. Winholtz, J. Flaherty.
[203] L. Johnston.

One commenter noted BOEM needs to differentiate and appreciate the nuances of each individual fishery and gear type when considering impacts on commercial fisheries and recreational fisheries and stated a blanket approach will fail to adequately identify impacts and not tailor mitigation measures to be effective.[204]

B.4.9 Cultural Resources

Three commenters indicated that offshore wind development should not affect cultural resources, including California Coastal National Monuments such as Piedras Blancas and White Rock.[205] A commenter recommended that BOEM coordinate with the California State Lands Commission on known and potential shipwreck locations and submerged archaeological sites.[206]

Commenters indicated that the PEIS should disclose if offshore wind development would affect water levels in Humboldt Bay and if that would result in impacts on buried cultural resources and human remains.[207] A commenter encouraged robust marine archaeological measures to ensure ocean floor activities do not disturb Tribal cultural and historic landscapes.[208]

Two commenters emphasized the need for mitigation measures to protect Tuluwat Island from new industrial contaminants.[209]

B.4.10 Cumulative Impacts

Commenters stated that cumulative impacts on fisheries would be greater than any individual impacts from offshore wind development due to the coast-wide nature of fisheries and should, thus, be analyzed further.[210] Other commenters expressed concern that the analysis would be far too narrow to fully capture resource impacts, so the PEIS should include cumulative impacts resulting from other offshore wind development and use outside research.[211] One commenter expressed support for the PEIS on the grounds of its cumulative impact analysis.[212]

One commenter claimed they were told BOEM would not analyze cumulative impacts.[213]

Several commenters made recommendations to conduct a robust analysis of cumulative impacts between offshore wind projects in different regions, and to consider potential synergies or conflicts

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[204] Pacific Fishery Management Council
[205] Xolon Salinan Tribe, H. Hensher, California State Lands Commission et al.
[206] California State Lands Commission et al.
[207] H. Hensher, Redwood Region Climate & Community Resilience Hub and Partners.
[208] Redwood Region Climate & Community Resilience Hub and Partners.
[209] H. Hensher, Redwood Region Climate & Community Resilience Hub and Partners.
[210] Morro Bay Commercial Fishermen's Organization, K. Palley, Offshore Wind Coalition, J. L. James, V. Helliwell, Oregon Trawl Commission, E. Lambe.
[211] B. Gorham, NOAA, E. Lambe, D. Howard, C. Blaney, A. Dallmann, A. Canter, H. Hensher.
[212] L. Johnston.
[213] West Coast Pelagic Conservation Group (WCP).

between various projects to better address ecosystems, wildlife, and local communities.[214] One commenter requested the cumulative analysis include impacts on commercial fisheries and port activities, recreational fisheries, and Tribal fishing activities, including all economic impacts.[215] Another commenter emphasized that the cumulative impact analysis would need to include fisheries, Tribal treaty rights, the regional economy and evaluated in coordination with Tribal participation.[216]

Commenters requested that the analysis of impacts include all reasonably foreseeable activities during construction and operation.[217] One commenter request BOEM coordinate with California State in the development of the Draft PEIS on characterizing the planning process and timelines for identifying future WEAs to ensure that the PEIS clearly describes reasonably foreseeable activities for offshore wind development.[218] One commenter requested that the PEIS consider the two draft Oregon WEAs, the Port of Long Beach and Humboldt Bay Harbor Recreation and Conservation District wind development activities, an additional planned 20 gigawatts (GW) of floating offshore wind development, the potential designation of the National Marine Sanctuary adjacent to the Humboldt and Morro Bay WEAs, wave energy–powered desalination pilot off Fort Bragg, a proposed demonstration project for offshore wind off Point Arguello, all offshore aquaculture and mariculture projects, state and federal initiatives, and oil and gas decommissioning activities off Southern California.[219] Another commenter requested consideration of the RTI Infrastructure, Inc. Eureka Subsea Fiber Optic Cables Project.[220] One commenter requested the cumulative impact analysis included in the PEIS also include offshore wind development off Oregon and the Gorda Ridge Polymetallic subsea mining target area.[221]

One commenter expressed concern regarding planned port development and related commercial fishing and the potential subsequent impacts on marine ecosystems.[222] One commenter requested studies be completed regarding these impacts and that the findings be made public.[223]

One commenter expressed concern regarding future poorly planned offshore wind projects and the risk to MPAs and species and, therefore, urge careful analysis of cumulative impacts.[224]

One commenter expressed concern regarding how future projects will affect air quality.[225]

[214] Elk Valley Rancheria, California.
[215] J. Eckerle, V. Helliwell, Sierra Club, D. Maruska.
[216] Makah Tribe.
[217] N. Krop, B. Crocco, T. Trappler, T. D., J. Tang, R. Altman, S. Harvey, A. Vileisis, Pacific Fishery Management Council, A. Reynolds, I. Gutierrez, Sierra Club, Oregon Trawl Commission, EPA Region 9.
[218] J. Eckerle.
[219] Pacific Fishery Management Council.
[220] J. Eckerle.
[221] R. Charter, A. Vileisis.
[222] Brightline Defense, A. Dallmann.
[223] A. Dallmann.
[224] R. Charter
[225] Surfrider Foundation

One commenter asked for clarity on whether the RPDE represents a full build-out of all five lease areas offshore of California, and instead request that for each lease area, a specific project design envelope be developed appropriate in and for that specific area to better understand cumulative impacts.[226]

One commenter requested that the PEIS mimic the level of detail and analysis of the ongoing and planned activities and environmental stressors that were covered in the New York Bight PEIS.[227]

B.4.11 Demographics, Employment, and Economics

Several commenters opposed offshore wind development as they believed it will hurt the economy, reduce home values, increase the cost of energy for consumers, destroy tourism and the beauty of small towns, and have no impact on climate change.[228] In addition, two commenters asserted that there is not enough equitable long-term benefit for local and regional small businesses and fisherman.[229]

One commenter was concerned that taxpayers would be responsible for paying capital costs but may never see a return nor reduction in energy costs[230] while two commenters predicted there would be a significant increase in energy costs.[231]

Many commenters asserted that offshore wind development should prioritize providing jobs to locals, benefiting the local economy and community, and reducing energy prices for local communities.[232] Three commenters supported offshore wind focusing on supporting the seafood business, demographics of affected fishing communities, and implementing methods to ensure community longevity.[233] Several commenters requested that robust studies of local and regional economies and employment be conducted.[234] In turn, another commenter supported hiring consultants to evaluate the best financial decisions for local communities.[235]

One commenter was concerned about how to quantify tourism gains and losses derived from offshore wind development.[236]

A few commenters were concerned that this strategy does not include the different Tribal workforce opportunities. Commenters noted that Tribal regions have created persistent gaps in the social and economic infrastructure on the North Coast. Commenters asserted that the clean energy coming from

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[226] Pacific Fishery Management Council
[227] I. Gutierrez
[228] D. Raichart, REACT ALLIANCE, M. Leicester-Cadaret, M. Ginkel, Surfrider Foundation, A. Lueker, West Coast Pelagic Conservation Group.
[229] I. Kinney, West Coast Pelagic Conservation Group.
[230] C. Buchanan.
[231] K. Franklin, M. Ginkel.
[232] A. Olson, M. Shevitz, M. Webb, J. Walsh, C. Blaney, Sierra Club, A. Olson.
[233] L. Johnston, Pacific Fishery Management Council, J. Eckerle.
[234] SLO Climate Coalition, J. Walsh, C. Blaney, Anonymous.
[235] B. Winholtz.
[236] J. Flaherty.

the future offshore wind facilities elevates local energy resilience, reliability, for the delivery of clean, affordable energy throughout the North Coast.[237]

Commenters believed offshore wind has the capability of bringing economic benefits through job creation and activities, but the new industry can also pose a threat to housing and community services, leading to displacement of the local communities and putting strains on communities.[238] Two commenters noted that disadvantaged communities in California are already experiencing higher rates of racial and economic inequality and a lack of high-quality job opportunities, particularly for working-class residents and people of color. In more rural and isolated areas, increased activities related to offshore wind can put stress on community resources such as access to healthcare services, roads, and other aging public infrastructure.[239]

Another commenter believed whatever the U.S socioeconomic benefits from floating offshore wind are calculated to be, the losses of income, jobs, asset value, and stranded capital in the fishing industry, as calculated and accounted for in the Gross National Product, needs to be deducted on an annual basis.[240]

B.4.12 Environmental Justice

One commenter stated that the environmental justice analysis must address impacts on Native American Tribes and Indigenous people and noted that impacts on Indian Tribes may be different from impacts on the general population due to a community's distinct cultural practices.[241]

Seven comments noted that input from environmental justice communities, especially Tribal Governments, is crucial toward ensuring offshore wind development does not create further harm.[242] One of these comments specifically pointed out how environmental justice concerns are a highly localized issue and, thus, each area that would be affected by offshore wind development should have a separate, distinct, early, meaningful, and extensive community engagement process.[243] One commenter specifically pointed out that BOEM should be prepared to translate documents and do outreach in linguistically isolated communities.[244] A commenter urged BOEM to proactively outreach to community-based organizations and environmental justice advocates to collaboratively develop alternatives and identify potential impacts.[245]

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[237] I. Kinney, Redwood Region Climate & Community Resilience Hub and Partners.
[238] Brightline Defense, Redwood Region Climate & Community Resilience Hub and Partners.
[239] Brightline Defense, H. Hensher.
[240] West Coast Pelagic Conservation Group.
[241] Elk Valley Rancheria, California.
[242] Surfrider Foundation, Blue Green Alliance, Brightline Defense, Offshore Wind Coalition, Sierra Club, California State Lands Commission et al, EPA Region 9, Makah Tribe.
[243] Brightline Defense, Sierra Club, EPA Region 9, California State Lands Commission et al,
[244] EPA Region 9
[245] Sierra Club.

Two commenters noted that increased costs of living, rising energy costs, and increased burdens on healthcare and other community resources could be associated with offshore wind development and affect communities in proximity to development areas.[246]

One commenter noted how air quality and other related impacts due to construction can have disproportionate impacts on low-income and environmental justice communities, and how any disparate health effects or risks will be disclosed and minimized or mitigated.[247] Another commenter mentioned how construction monitoring programs would be necessary to effectively be able to address impacts from construction near environmental justice communities.[248]

One commenter recommended that local Tribal, minority, and locally owned businesses should be prioritized in contracting, employment, materials and procurement in an effort to retain wealth within the region.[249] Another commenter asked that BOEM describe local job training programs and how local employment would be integrated into project development.[250]

Several commenters mentioned how offshore wind development is considered a Justice40 initiative, because it addresses covered activities such as climate change, clean energy, training and workforce development, legacy pollution, and other indirect covered areas within Justice40.[251] Furthermore, these comments included recommendations to use multiple mapping tools, including the Justice40 tools such as EJScreen, to ensure the accuracy of environmental justice data and to focus on blocks, instead of counties or cities, to provide the greatest level of detail about the presence of minority populations.[252]

One commenter recommended that offshore wind development on the West Coast adopt a similar group to the New York and New Jersey Offshore Wind Environmental Justice Forum.[253]

One commenter recommended that BOEM consult and implement items from the *Promising Practices for Environmental Justice Methodologies in NEPA*, created by the Federal Interagency Working Group on Environmental Justice & NEPA Committee.[254]

One commenter recommended that BOEM use 200 percent of the federal poverty level as a low-income population measurement related to health and economic impacts from offshore wind, based on recommendations from the California Department of Public Health.[255]

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[246] Offshore Wind Coalition, California State Lands Commission et al.
[247] EPA Region 9, California State Lands Commission et al.
[248] California State Lands Commission et al.
[249] Redwood Region Climate & Community Resilience Hub and Partners.
[250] EPA Region 9.
[251] BlueGreen Alliance, Brightline Defense, EPA Region 9.
[252] Brightline Defense, EPA Region 9.
[253] Pacific Fishery Management Council.
[254] EPA Region 9. California State Lands Commission et al.
[255] EPA Region 9.

B.4.13 Endangered Species Act-Listed Species

Several commenters expressed concern in Humboldt Bay over various fish, bird, plants, insects, and, more specifically, the spawning and larval stages of myriad ocean species, a foraging and resting place, and transit, for threatened and endangered salmon and steelhead as the juveniles change from fresh water to saltwater metabolism on their way to the ocean and when the adults return to spawn in local rivers.[256]

One commenter suggested mitigation measures to minimize impacts on special status species, describing the effectiveness of such measures to protect wildlife and indicating how they would be implemented and enforced is essential.[257]

One commenter was concerned with rapidly declining populations of Chinook salmon in response to increasing sea surface temperatures and other factors across diverse model assumptions and climate scenarios.[258] Another commenter suggested potential irreversible destruction of threatened California salmon populations.[259]

A single commenter stated that brown pelican, sea otter, northern elephant seal, and peregrine falcon are among the species that have come back from the brink of extinction. The commenter also noted that eel grass, abalone, and hoary bat are still on the decline. The same commenter noted an increase in boat strikes of marine mammals, sharks, and MolaMola (vulnerable species IUCN Redlist).[260]

A commenter pointed out canopy forming kelp (giant kelp [*Macrocystis pyrifera*] and bull kelp [*Nereocystis luetkeana*]) in California have been negatively affected by climate change, resulting in kelp loss in several areas along the coastline with the most severe losses in the northern region of the state, and localized areas in central and southern California. The commenter recommended the PEIS analysis include the historical and future modeled distribution of kelp, as well as impacts on potential restoration areas, harvest, and other uses for kelp ecosystems.[261]

One commenter listed the following groups of organisms that they believe must be studied and monitored in an integrated way, with endangered and threatened species receiving focused attention.

a. Ocean-going mammals, including whales and other cetaceans; sea otters; seals and sea lions
b. Bats (in marine and terrestrial areas)
c. Birds (in marine and terrestrial areas)
d. Sea turtles
e. Fish
f. Marine algae
g. Plankton and other organisms at the lowest trophic levels

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[256] V. Helliwell, A. Canter, Anonymous.
[257] EPA Region 9.
[258] D. Chandler.
[259] I. Kinney.
[260] L. Murphy.
[261] J. Eckerle.

h. Terrestrial mammals, amphibians, and reptiles
i. Terrestrial plants[262]

One commenter noted gray whales continue to face an array of other threats, including entanglement in fishing gear, collisions with ships, and disturbance from underwater ocean noise. The commenter also stated that due to overfishing, habitat loss and degradation, pollution, as well as climate change, at least 37 percent of the world's sharks and rays, 33 percent of reef corals, 26 percent of mammals (including marine), and 21 percent of reptiles are threatened with extinction.[263]

One commenter stressed the Yurok Tribe's concern of offshore wind development affecting Prey-go-neesh (California condor) ecology in the North Coast. The commenter also emphasized the importance of analyzing the impacts not only on sea birds whose migratory flightpaths may be directly occluded by turbines and related infrastructure, but other bird species, especially those that are endangered or threatened of reasonably foreseeable indirect impacts resulting from offshore wind development, including but not limited to, impacts on prey availability and physical harm from new or upgraded transmission lines. The same commenter predicted impacts on salmon populations and viewsheds are just two reasonably foreseeable impacts of offshore wind development on the Tribal cultural resources of the Yurok Tribe, the environment within the Yurok Ancestral Territory, and on the health and well-being of the Yurok people.[264]

B.4.14 Fishes, Invertebrates, and Essential Fish Habitat

Several commenters expressed concern about noise impacts on marine life and EFH, particularly with EMFs, sonar testing, and high-decibel mapping.[265] Two commenters stated that equipment planned to be used for offshore wind site surveys would have noise levels of 228 decibels (dB), a level that the commenters asserted would result in hearing damage, masking, and stress reactions for many fish or would result in death from internal bleeding and gas emboli.[266] Two commenters stated that a permit was previously denied to the U.S. Navy to conduct sonar testing at only 154 dB.[267]

Commenters expressed concern regarding potential impacts on EFH and critical habitat within marine protect areas from cables and shoreside infrastructure, including EMFs.[268] One commenter requested an EFH assessment be summarized, along with any and all coordination with NMFS.[269] A commenter requested the PEIS address fish aggregation, shell mounds, EMFs and heat, and eelgrass areas.[270] One commenter requested the PEIS evaluate impacts on aquatic resource in terms of the areal (acreage for

[262] C. Blaney.
[263] A. Dallmann.
[264] J. James.
[265] Morro Bay Commercial Fishermen's Organization, C. Buchanan, R. Pusateri, S. Hafer, D. Howard, M. McQuillen, Sierra Club, Anonymous, West Coast Pelagic Conservation Group (WCP).
[266] R. Pusateri, S. Hafer.
[267] R. Pusateri, C. Porco.
[268] NOAA, J. Eckerle.
[269] EPA Region 9.
[270] J. Eckerle.

wetlands) or linear extend (for streams).[271] One commenter discussed the potential impacts artificial reefs may have on aquatic populations as they relate to offshore wind development.[272]

One commenter referenced the Magnuson-Stevens Fishery Conservation and Management Act, which requires fishery management councils to describe and identify EFH for council-managed fisheries based on the guidelines established by the secretary under Section 305(b)(1)(A) of the act, to minimize to the extent practicable adverse effects on such habitat caused by fishing and identify other actions to encourage the conservation and enhancement of such habitat.[273] The commenter continued to express concern regarding the potential impacts on habitat resources in the lease areas, which overlap with designated Essential Fish Habitat Conservation Areas and Habitat Areas of Particular Concern. [274] The same commenter also warned of the potential increase in predation that artificial habitat may attract.[275] The commenter recommended the PEIS also analyze cumulative impacts on fisheries and the fishing communities from prospective offshore wind developments in the draft WEAs off Oregon and the California Coast that are needed to meet California's long-term planning goals. [276]

One commenter requested site assessment plans be developed as a component of the adaptive management approach to better predict potential offshore wind impacts on marine species and their habitats. The commenter also expressed that passive acoustic monitoring is a valuable tool for recording species presence. The commenter requested long-term data collection beginning 3 to 5 years prior to any construction, and post-project implementation monitoring be done to ensure the Chumash Heritage National Marine Sanctuary remains ecologically diverse. [277]

Additionally, commenters emphasized potential impacts of EMFs and called for exclusion zones around cables and transmission lines.[278] The commenters noted that there are several animals who are highly susceptible to EMF changes, such as sharks, bat rays, lobster larvae, sturgeon, lampreys, zooplankton and larvae, dolphins, and whales—all of which would be affected by the increases in EMFs anticipated from offshore wind.[279] A commenter highlighted a potential data gap in research on impacts of EMFs on North Pacific albacore and other highly migratory species.[280] Similarly, a commenter recommended that changes to migration routes of highly migratory species as a result of EMFs be evaluated.[281] A commenter asked that the PEIS analyze the potential impacts from the cumulative effects of EMFs from existing cables and proposed offshore export cables.[282]

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[271] EPA Region 9.
[272] J. Flaherty.
[273] Pacific Fishery Management Council.
[274] Pacific Fishery Management Council.
[275] Pacific Fishery Management Council.
[276] Pacific Fishery Management Council.
[277] I. Gutierrez.
[278] C. Buchanan, S. Hafer.
[279] C. Buchanan, S. Hafer, L. Murphy.
[280] American Albacore Fishing Assn.
[281] Redwood Region Climate & Community Resilience Hub and Partners.
[282] Pacific Fishery Management Council.

One commenter also noted the potential for marine wildlife to become tangled in deep-sea cables and wires or large plastics and fishing nets caught around offshore wind infrastructure, resulting in injury or death.[283] One commenter noted that if the offshore substations use open once-through cooling systems, they could entrap thousands of gallons of larvae and juvenile fish and release chemically treated heated water into the ocean.[284]

Many commenters stated that there would be adverse impacts on fish stocks, migratory patterns (including aquatic and flying species), and fish distribution over the entirety of the West Coast as a result of offshore wind development and, therefore, would threaten the seafood economy as a whole, especially in reference to the California Coastal Act.[285] One commenter questioned if wind farms would result in changes to atmospheric flow and ocean mixing (reduced wind speed and upwelling) needed to be studied because wind farms would undoubtedly affect fishing and referenced a recent study that investigated deep-water deoxygenation due to wind farm development.[286] Another commenter expressed concern about even slight ocean temperature increases, which could affect important species like salmon and abalone.[287] Another commenter emphasized potential impacts on salmon population and urged the PEIS to include spatial and temporal variations in spawning migration, prey availability and distribution, physiology, behavior, and reproductive ecology resulting from turbine size, quantity, placement and spacing, anchor type, quantity, placement and spacing, transmission cable size, placement, quantity, configuration, technology, and materials, substations size, quantity, placement, and spacing, and other infrastructure, in its analysis.[288] A commenter urged BOEM to conduct monitoring and surveys to establish a baseline for fish stocks and fishing to compare with impacts from offshore wind development.[289] One commenter expressed concern regarding how light usage may affect predation rates and interfere with migration patterns of fish.[290]

One commenter listed the following fishery-related recommendations.

- Perform science-based cumulative effects reviews of safe transit areas incorporating fisherman knowledge.
- Analyze alternative spacing patterns.
- Conduct a fishing navigation and operations study with NMFS and the U.S. Coast Guard (USCG).
- Improve procedures for evaluating and regulating safety at sea by adjusting the port access route study process.

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[283] C. Buchanan, L. Murphy.
[284] S. Hafer.
[285] Morro Bay Commercial Fishermen’s Organization, S. Hafer, C. Buchanan, N. Rosser, Anonymous, S. Harvey, I. Gutierrez, Xolon Salinan Tribe, West Coast Pelagic Conservation Group (WCP).
[286] Morro Bay Commercial Fishermen’s Organization.
[287] C. Buchanan.
[288] J. L. James
[289] Pacific Coast Federation of Fishermen's Associations and Institute for Fisheries Resources.
[290] V. Helliwell

- Develop a study to recommend safety measures.
- Evaluate mitigation measures for radar interference and incorporate all current knowledge on the topic.
- Analyze the impacts on high frequency radar.
- Include fishermen in developing navigational aids, minimize conflicts with potential fishing operators near project areas.
- Mandate sufficient export cable burial depths.
- Require real-time cable-monitoring technology.
- Perform micrositing of turbines and cables.
- Coordinate transmission.
- Develop environmental monitoring plans.
- Monitor fishery impacts throughout the life of the project.
- Assess cumulative impacts on whales and other protected resources.
- Provide independent protected species observers.
- Analyze impacts of impingement and entrainment.
- Analyze impacts of increased water temperature.
- Analyze impacts of larval and juvenile fish mortality.
- Increase cooperative research funding.
- Require offshore wind environmental monitoring data be made publicly available.
- Develop studies and monitor socioeconomic impacts.
- Expand NMFS involvement in project monitoring.
- Require baseline data collection and monitoring plans.
- Require developers to partner with the fishing industry and credible independent scientists to co-develop cooperative monitoring and research plans.[291]

B.4.15 Land Use and Coastal Infrastructure

Two commenters asserted that the PEIS must address impacts from onshore development on coastal areas and public access and ensure compliance with relevant laws governing the coastal zone.[292] A commenter noted that offshore wind structures could affect properties of traditional religious and cultural significant and recreational areas, as well as pose an allision hazard for vessels.[293]

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[291] L. Johnston.
[292] North County Watch, Surfrider Foundation, Natural Resources Defense Council et al.
[293] M. Webb.

A commenter stated that any onshore infrastructure resulting from the Humboldt and Morro Bay WEAs would be subject to local land use policies and would require careful planning in concert with local governments and the California Coastal Commission.[294] The same commenter added that two federal consistency determinations by the California Coastal Commission would be required for any lease sale activities or subsequent development for California offshore wind. The same commenter also asserted that the proposed offshore wind development and supporting infrastructure would undoubtedly industrialize portions of the California coast, and that BOEM must avoid impacts where possible and require mitigation, including compensatory mitigation, when impacts cannot be avoided.

Commenters stated that the PEIS should analyze and mitigate impacts from both offshore and onshore wind transmission lines and cable landfalls.[295] A commenter expressed concern that cables and high-voltage wires could negatively affect wildlife and estuaries.[296] A commenter recommended opportunities to improve resiliency of transmission lines in light climate change impacts.[297] Another commenter recommended electrification of local infrastructure and a "dig once" policy to ensure new infrastructure and upgrade efforts are coordinated.[298] A commenter expressed concern that offshore wind development would add additional stress to transmission infrastructure in the Humboldt region.[299]

A commenter recommended that the PEIS should analyze new port infrastructure needed to support the offshore wind projects.[300] A commenter stated that the PEIS should address port usage including the use of Crescent City Harbor and other harbors north of the lease areas.[301] A commenter argued that the San Simeon Harbor cannot be used to support offshore wind given potential environmental impacts.[302] Commenters expressed concern regarding potential environmental and fishing impacts that could result from port development and operations to support offshore wind projects.[303]

A commenter recommended the PEIS include an analysis of local traffic and road congestion as a result of offshore wind development and include traffic reduction and calming measures to increase safety for all road users.[304]

B.4.16 Marine Mammals

Several commenters expressed concerns about the potential for offshore wind construction and infrastructure to harm marine mammals, including whales, dolphins, otters, orcas, seals, and sea lions.[305]

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[294] The Ocean Foundation.
[295] Natural Resources Defense Council et al., H. Hensher.
[296] L. Murphy.
[297] Brightline Defense.
[298] Peninsula Community Collaborative.
[299] Redwood Region Climate & Community Resilience Hub and Partners.
[300] Natural Resources Defense Council et al., Offshore Wind Coalition.
[301] Elk Valley Rancheria, California.
[302] L. Murphy.
[303] Surfrider Foundation, L. Murphy, Pacific Fishery Management Council.
[304] Peninsula Community Collaborative (PCC).
[305] R. Pressley, J. Flaherty, I. Kinney, D. Howard, M. Ginkel, A. Vileisis, L. Murphy, R. Charter.

Commenters stated that offshore wind developments off the West Coast, just south of the Monterey Bay National Marine Sanctuary, and related infrastructure would be in the direct migration path of endangered whale populations, further putting such populations at risk and disrupting marine productivity.[306] There were other mentions of impacts of infrastructure on the behavior of various species, one claiming that dolphins were witnessed to be swimming erratically near wind farms.[307] One commenter requested the analysis clearly identify all reasonably foreseeable activities during construction and operation of any offshore wind development.[308] One commenter asked that consideration be given to alternative platform solutions and more systems to enable more productive stakeholder input, such as the use of tension leg platforms.[309]

Several commenters expressed concern that offshore wind would harm or kill whales, citing increased whale and other mammalian deaths related to East Coast offshore wind development.[310] Commenters stated that whales and other marine mammals could be harmed or killed by increased boat traffic, drifting lines, anchor collisions, vessel strike, EMFs from high-voltage lines, noise from offshore wind development and activities, habitat displacement, and high-decibel mapping.[311] Some of those commenters further requested appropriate mitigation measures to mitigate these impacts, such as increased monitoring, platforms that minimize entanglement risk, baseline assessments, and routine inspections.[312]

One commenter recommended multiple alternatives be developed for the electrical and mooring cable water depths and configurations to minimize potential interactions with marine wildlife.[313]

One commenter expressed concerns regarding the Elkhorn Slough and how offshore wind development may affect this habitat, which is crucial for otters, among other species. They supported their concerns by detailing how recent declines in otter and sea star populations have increased the population of sea urchins, which results in the overgrazing of kelp forests. [314] Other commenters, in a similar fashion, expressed concerns about how shifts in plankton species and availability of forage species may affect higher trophic levels.[315]

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[306] Anonymous, P. Simon, C. Buchanan, K. Franklin, B. Winholtz, REACT Alliance, R. Puntillo, C. Porco, L. Murphy, I. Gutierrez, A. Lueker, R. Spotts, M. Ginkel.
[307] C. Buchanan.
[308] J. Sahn.
[309] Glosten.
[310] R. Pressley, C. Buchanan, K. Franklin, A. Lueker
[311] Redwood Region Climate & Community Resilience Hub and Partners.
[312] C. Buchanan, K. Franklin, B. Winholtz, R. Puntillo, K. Palley, NOAA, M. Webb, J. Sahn, M. Leicester-Cadaret, R. Charter, D. Plaister, M. Stevens, WhoPoo App, M. Ginkel, D. Helliwell, Pacific Fishery Management Council, J. Eckerle, A. Reynolds, C. Blaney, S. Anderson, A. Dallmann, I. Gutierrez, E. Bettenhausen, A. Lueker, Sierra Club CA, Wiyott Natural Resources Department, West Coast Pelagic Conservation Group (WCP), REACT Alliance, M. Leicester-Cadaret, C. Blaney
[313] J. Eckerle
[314] A. Dallmann
[315] West Coast Pelagic Conservation Group (WCP), Natural Resources Defense Council.

One commenter listed the following recommendations.

- Perform science-based cumulative effects reviews of safe transit areas incorporating fisherman knowledge.
- Analyze alternative spacing patterns.
- Conduct a fishing navigation and operations study with NMFS and USCG.
- Improve procedures for evaluating and regulating safety at sea by adjusting the Pacific Coast Port Access Route Study (PAC-PARS) process.
- Develop a study to recommend safety measures.
- Evaluate mitigation measures for radar interference and incorporate all current knowledge on the topic.
- Analyze the impacts on high frequency radar.
- Include fishermen in developing navigational aids.
- Minimize conflicts with potential fishing operators near project areas.
- Mandate sufficient export cable burial depths.
- Require real-time cable-monitoring technology.
- Perform micrositing of turbines and cables.
- Coordinate transmission.
- Develop environmental monitoring plans.
- Monitor fishery impacts throughout the life of the project.
- Assess cumulative impacts on whales and other protected resources.
- Provide independent protected species observers.
- Analyze impacts of impingement and entrainment.
- Analyze impacts of increased water temperature.
- Analyze impacts of larval and juvenile fish mortality.
- Increase cooperative research funding.
- Require offshore wind environmental monitoring data be made publicly available.
- Develop studies and monitor socioeconomic impacts.
- Expand NMFS involvement in project monitoring.
- Require baseline data collection and monitoring plans.

- Require developers to partner with the fishing industry and credible independent scientists to co-develop cooperative monitoring and research plans.[316]

Commenters recommended further analysis of these impacts to have more accurate forecasts of changes to marine ecosystems, and more comprehensive ways to address impacts.[317]

Multiple commenters recommend the PEIS include existing stressors and the potential overlap with, or magnification by, offshore wind development.[318]

B.4.17 Mitigation Measures Proposed by Commenters

Many commenters recommended an adaptive management approach.[319] One commenter suggested that after the initial round of offshore wind leases on the West Coast, new leases would be halted for a minimum of 3 years to allow for time to study any economic, environmental, and socioeconomic impacts related to the initial installations.

Many commenters specifically recommended strong coordination between agencies and stakeholders and incorporation of TEK to ensure that mitigation measures are appropriately incorporated in ways that make a difference to local communities.[320] Another commenter was concerned about who would be monitoring the offshore wind companies to ensure that the agreed-upon rules are followed and implemented.[321]

One commenter recommended that the PEIS create mitigation measures that address impacts at a regional level to set a solid foundation for future lease area impacts in Oregon.[322]

There were several commenters who wanted the PEIS to clarify procedures and how mitigation measures would be analyzed to make the process clear and understandable to the public.[323] One commenter expressed a desire for mitigation measures to be analyzed separately, either as alternatives or sub alternatives, in addition to understanding their cumulative impact to allow the public to better understand their individual influence in addressing impacts.[324] Another commenter expressed a desire for the PEIS procedure to clarify what mitigation measures will likely be required for each lease areas, and to provide an analysis of tradeoffs that are being made.[325] Another commenter requested that there be a clear procedure for keeping the public informed of any construction timelines, and providing local

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[316] L. Johnston.
[317] C. Buchanan, K. Franklin.
[318] I. Gutierrez, Redwood Region Climate & Community Resilience Hub and Partners
[319] Morro Bay Commercial Fishermen's Organization, SLO Climate Coalition, Coalition of Oregon ENGOs, NOAA, Equinor Wind US LLC, Natural Resources Defense Council et al.
[320] Peninsula Community Collaborative, Redwood Region Climate & Community Resilience Hub and Partners, H. Hensher, Natural Resources Defense Council, Brightline Defense.
[321] B. Winholtz.
[322] Coalition of Oregon ENGOs.
[323] NOAA, Responsible Offshore Development Association, Brightline Defense.
[324] Responsible Offshore Development Association.
[325] NOAA.

communities with air filters to protect themselves from related harmful air quality.[326] Six commenters conveyed specific concern over the adoption of mitigation measures that would protect the fishing industry from unnecessary harm or challenges.[327] One commenter recommended consultation with the California Offshore Wind Energy Fisheries Working Group.[328] Two commenters mentioned a focus on project designs that lessen impacts on access and fishing grounds.[329] The first commenter advocated for project design that can accommodate a greater degree of fishing access, such as increased distance between turbines to allow for vessel navigation.[330] The other commenter recommended that underwater infrastructure are not placed within or near areas of high fishery resource or fishing activity concentration, and to use a consistent grid to facilitate easy navigation.[331] Another commenter recommended the adoption of a mitigation measure to ensure that there is sufficient space, dockage and land for fishing communities, including transient vessels participating in seasonal fisheries.[332]

One commenter recommended that offshore wind projects be built with nature-based solutions and ecologically compatible materials, like more porous concrete that could be better suited for flora and fauna to attach to underwater.[333] Similarly, one commenter recommended that BOEM require future offshore wind development use the best available technology to avoid adverse impacts and require lessees to conduct a periodic review to update systems if better technology is available.[334]

Many commenters noted that there should be benthic habitat protection measures that reduce intensive benthic footprints, mooring in sensitive benthic habitats, and protections that prevent the introduction of invasive species.[335] Two commenters noted the importance of including buffers for sensitive habitats that may be close to offshore wind development.[336] Another commenter focused specifically on the need for high-resolution seafloor mapping using the California State Lands Commission's low-energy geophysical survey mapping, and to make this data available to the public.[337]

One commenter pointed out that USCG's rulemaking process about fairways has not been completed yet and recommended that any mitigation measures be adaptable to accommodate the final decision.[338]

One commenter recommended the adoption of mitigation measures around times of year that construction can take place, to reduce impacts on migrating marine mammals.[339]

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[326] Brightline Defense.
[327] NOAA, Pacific Fishery Management Council, Responsible Offshore Development Alliance, N. Rosser.
[328] Pacific Fishery Management Council.
[329] NOAA, Responsible Offshore Development Alliance.
[330] Responsible Offshore Development Alliance.
[331] NOAA.
[332] Pacific Fishery Management Council.
[333] ECOncrete, THPO (Bear River Band).
[334] C. Blaney, Natural Resources Defense Council et al.
[335] Coalition of Oregon ENGOs, NOAA, Pacific Fishery Management Council.
[336] NOAA, Natural Resources Defense Council.
[337] Pacific Fishery Management Council.
[338] American Waterways Operators.
[339] Pacific Fishery Management Council.

One commenter mentioned mitigation measures that reduce collision or attraction of avian species like bats and birds.[340]

Three commenters mentioned mitigation measures in relation to oceanographic and upwelling impacts by offshore wind turbines.[341] One commenter indicated a need for mitigation measures that account for any local and regional oceanographic or hydrodynamic changes as a result of offshore wind, particularly regarding upwelling.[342] One commenter recommended that lessees be required to analyze wind wake effects for each project alternative and identify site designs and characteristics that would generate the least amount of changes to upwelling and other oceanographic processes.[343]

Two commenters recommended the adoption of zero-emissions technology when possible, to reduce air quality impacts.[344] Additionally, a commenter recommended that mitigation measures not be so prescriptive as to not allow for technological advancements.[345]

One commenter mentioned the adoption of mitigation measures that create an oil spill response plan in the chance of a spill due to offshore wind construction.[346]

Two commenters recommended mitigation measures to reduce vessel speeds to reduce vessel strikes.[347]

Many commenters recommended mitigation measures specifically for impacts related to noise, for both onshore and underwater work during survey work and construction.[348]

Two commenters mentioned the importance of establishing mitigation measures to address community level economic concerns through the creation of Project Labor Agreements and Community Benefits Agreements.[349]

Six commenters recommended the creation of compensatory mitigation toward programs that directly benefit the resource being impacted by lessees' project activities.[350] There was a concern from several commenters about impacts on EFH and avian species, and in relation to financial detriments to fishermen.[351] One commenter expressed a desire for compensation procedures for lost or damaged

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[340] Coalition of Oregon ENGOs.
[341] Coalition of Oregon ENGOs, Pacific Fishery Management Council, NOAA.
[342] Coalition of Oregon ENGOs.
[343] Pacific Fishery Management Council.
[344] EPA Region 9, Brightline Defense.
[345] Invenergy California Offshore LLC.
[346] Pacific Fishery Management Council.
[347] NOAA, Coalition of Oregon ENGOs.
[348] Pacific Fishery Management Council, A. Alward, Peninsula Community Collaborative, Coalition of Oregon ENGOs, California State Land Commission et al.
[349] Offshore Wind Coalition, Brightline Defense.
[350] California State Lands Commission et al, Natural Resources Defense Council, NOAA, Coalition of Oregon ENGOs, Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources, N. Rosser.
[351] Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources, N Rosser, NOAA, Coalition of Oregon ENGOs, K. Smith

fishing gear due to conflict with offshore wind infrastructure be put in place before construction is complete.[352] One commenter additionally recommended that a method of compensating fishermen for loss of business be established before any offshore wind projects are approved. This commenter recommended that every several years, if wind farms are still operational, offshore wind developers should meet with NOAA to compensate fishermen for a loss of business based on the most recent science about the effects of wind farms. This recommendation is based on a similar practice by offshore oil companies.[353] One commenter mentioned that compensatory mitigation can often be uncertain, and for BOEM to be aware that compensatory mitigation measures may require higher levels of compensation to offset documented impacts.[354]

Several commenters noted the importance of mitigation measures that create a requirement for developers to contribute to effective, long-term monitoring at a programmatic level and prevent impacts, and even contribute, to local scientific studies and existing monitoring in the area. The specific types of monitoring that were mentioned include atmospheric and oceanic impacts to inform future offshore wind development, for debris related to construction of offshore wind, air quality at ports, and of fish and other marine species population levels in proximity to the offshore wind development areas.[355]

One commenter, a wind developer, requested that mitigation measures and monitoring requirements be built off existing datasets rather than requiring new study methodologies be created.[356]

One commenter recommended that offshore wind development on the West Coast undergo studies by the Government Office of Accountability, like those being conducted on the East Coast, to have an in-depth understanding of impacts related to infrastructure, safety, and vessel navigation.[357]

One commenter recommended that post-construction monitoring be conducted throughout the life of the project to assess performance, determine if corrective action is needed, and implement changes to support adaptive management.[358]

B.4.18 Navigation and Vessel Traffic

Multiple commenters warned that offshore wind development would increase vessel traffic, which could negatively affect marine wildlife, habitat, and air quality.[359] A commenter added that increased vessel traffic could result in the introduction of invasive species and pathogens.[360] Several commenters

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[352] Pacific Coast Federation of Fishermen's Associations & Institute for Fisheries Resources
[353] N. Rosser
[354] NOAA
[355] NOAA, Natural Resources Defense Council, Pacific Fishery Management Council, Coalition of Oregon ENGOs, Brightline Defense, K. Smith
[356] Equinor Wind US LLC
[357] N. Meyer
[358] Natural Resources Defense Council et al.
[359] M. Shevitz, K. Palley, REACT ALLIANCE, D. Howard, M. Ginkel, Sierra Club CA, Peninsula Community Collaborative, Surfrider Foundation, Pacific Fishery Management Council, Natural Resources Defense Council et al.
[360] Peninsula Community Collaborative.

recommended that BOEM require vessel speed reductions and avoidance of sensitive marine areas to reduce impacts on marine wildlife and reduce GHG emissions.[361] A commenter added that vessel speeds should not exceed 10 knots and urged BOEM to develop plans for monitoring and enforcing speed restrictions (e.g., through the use of Automatic Identification System [AIS] or other tracking systems).[362]

A commenter noted that maritime transportation routes are already congested in Humboldt Bay and that additional vessel traffic from offshore wind development could affect commercial fisheries, aquaculture, and recreational users.[363] Another commenter expressed concerns for fishermen safety with the increase of vessel traffic, especially at the narrow entrance of Humboldt Bay.[364] The same commenter questioned how long port access would be closed for passage of offshore wind vessels and recommended a dedicated small boat channel for boats 65 feet of less.[365] Another commenter recommended minimizing port closures during deployment and turbine retrieval.[366]

Several commenters warned that offshore wind development could disrupt traditional navigation routes and affect mariner safety, fishing, and the environment.[367] One commenter noted the importance of ensuring the fishing industry has safe access to and from ports in prevailing weather conditions.[368] A commenter suggested implementing navigational safety measures and following USCG regulations to reduce environmental and safety impacts and ensure that offshore wind can safely coexist with traditional marine traffic.[369] Two commenters recommended several routing measures from the USCG PAC-PARS including a voluntary fairway system that runs west of the Humboldt lease areas, two angled approach or departure fairways on the northern and southern sides of the Humboldt lease areas, and a reduction in lease area if it encroaches on the proposed routing measures.[370] The commenter noted that buffer zones are required around vessel traffic separation schemes, navigational safety corridors, and safety fairways.[371]

Three commenters expressed concern that radar interference from WTGs could lead to collisions or allisions.[372] A commenter recommended that mariners on vessels with radars rendered inoperable from

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[361] N. Krop, B. Woodbridge, S. Sadler, M. Holtam, B Crocco, T. Trappler, T. D., J. Tang, G. Goetz, L. Eriksen, Natural Resources Defense Council et al.
[362] Natural Resources Defense Council et al.
[363] Redwood Region Climate & Community Resilience Hub and Partners.
[364] Pacific Coast Federation of Fishermen's Associations and Institute for Fisheries Resources.
[365] Pacific Coast Federation of Fishermen's Associations and Institute for Fisheries Resources.
[366] Pacific Fishery Management Council.
[367] American Waterways Operators, World Shipping Council, Anonymous.
[368] American Albacore Fishing Association.
[369] World Shipping Council.
[370] World Shipping Council, American Waterways Operators.
[371] World Shipping Council.
[372] Pacific Coast Federation of Fishermen's Associations and Institute for Fisheries Resources, Pacific Fishery Management Council, Anonymous.

WTG interference should be provided operational radars at no cost.[373] A commenter indicated that the PEIS should analyze impacts of subsea export cables on safe navigation.[374]

A commenter expressed concern about increased time at sea due to wind farm avoidance since increased time at sea adds risk to a vessel's voyage and linked increased time at sea to greater fuel costs.[375] The commenter asked that BOEM provide information about the proposed traffic lanes through the WEAs. The commenter also noted that the USCG search and rescue assets may take longer to reach vessels in distress due to WTG location and the effect of WTGs on marine radar.

B.4.19 Oceanography

Eleven commenters were concerned that the proposed wind farms would block wind and thereby alter ocean patterns, including upwelling that brings important nutrients to the coast and are responsible for a majority of the biodiversity.[376] One commenter pointed out how upwelling is particularly crucial to the four National Marine Sanctuaries on the West Coast.[377] A commenter provided several sources modeling changes in upwelling as a result of offshore wind development.[378] Several commenters called for further research about the relationship between wind farms and oceanographic processes to better understand the local and regional effects that offshore wind development would have on the West Coast.[379] A commenter indicated that BOEM should conduct habitat mapping and data collection in coordination with the Makah Tribe and NOAA-NMFS.[380]

Five commenters demonstrated concern that WTG mechanics would warm ocean surface temperatures, leading to range displacement for a variety of species, an increased abundance of toxic algal blooms, lower reproductive success within the ecosystem, threatened fish stocks, and more—ultimately causing irreversible damage to the marine ecosystem functionality and stability.[381]

Two commenters suggested that BOEM use the white papers created by American Clean Power Association and the study by the National Academy of Sciences about the potential hydrodynamic and ecological impacts of wind farms based on local oceanography and wind farm characteristics.[382] One of these commenters stated that while wind farms will have an impact on oceanography, "it will likely be

[373] Pacific Fishery Management Council.
[374] American Waterways Operators.
[375] Morro Bay Commercial Fishermen's Organization.
[376] S. Hafer, K. Franklin, Coastal Coordination Program & The Ocean Foundation, M. Ginkel, L. Murphy, Natural Resources Defense Council et al, Yurok Tribe, Wiyot Natural Resources Department, Anonymous, NOAA, Pacific Fishery Management Council, Redwood Region Climate & Community Resilience Hub and Partners.
[377] Coastal Coordination Program & The Ocean Foundation.
[378] Pacific Fishery Management Council.
[379] Natural Resources Defense Council, Wiyot Natural Resources Department, Yurok Tribe, Makah Tribe.
[380] Makah Tribe.
[381] K. Franklin, Climate Action California, REACT Alliance, Michelle Leicester-Cadaret, Coastal Coordination Program & The Ocean Foundation.
[382] American Clean Power Association, Natural Resources Defense Council.

difficult to distinguish from the significant impacts of climate change and other influences on the ecosystems."[383]

One commenter stated that offshore wind development will affect the ways that fisheries management processes are able to monitor fish stock assessments and create scientific uncertainty and reduced harvest quotas.[384]

One commenter conveyed concern that large swells in the ocean would result in turbines shutting down and result in frequent malfunctions and repairs.[385]

B.4.20 Other Uses (Marine Minerals, Military Use, Aviation, Scientific Research and Surveys)

Several commenters noted that offshore wind development would affect NOAA-NMFS scientific surveys including long-running datasets that inform stock assessments or other aspects of the fisheries management processes, creating uncertainty about stock status and reduced harvest quotas.[386] A commenter specified that the close proximity of offshore wind infrastructure would directly affect National Data Buoy Center Station 46028.[387]

Another commenter predicted many obstacles that would prevent consistent and justifiable energy generation such as large ocean swells, equipment unreliability, U.S. Department of Defense-mandated shutdowns for training, and undependable wind velocities.[388] A commenter noted that offshore wind development would pose a national security risk by interfering with military and national security activities.[389]

One commenter noted that offshore wind in the Humboldt and Morro Bay WEAs would lead to wind turbine interference to the oceanographic high-frequency radars, which provide measurement coverage of the region, necessary for maritime safety, navigation, USCG search and rescue, and more.[390]

A commenter highlighted that coordination between USEPA and BOEM would help avoid potential conflicts between offshore wind development in the Humboldt WEA with the Humboldt Open Ocean Disposal Site expansion.[391]

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[383] American Clean Power Association.
[384] Morro Bay Commercial Fishermen's Organization.
[385] S. Hafer.
[386] Morro Bay Commercial Fishermen's Organization, NOAA, M. Webb, Pacific Fishery Management Council.
[387] NOAA.
[388] S. Hafer.
[389] D. Raichart.
[390] NOAA, M. Webb.
[391] EPA Region 9.

B.4.21 Recreation and Tourism

Many commenters asserted that there would be impacts on coastal tourism such as a loss of community identity, accessibility to recreation activities (fishing, boating, surfing, etc.), and beauty of small towns in favor of large industrial offshore wind vessels and other infrastructure. These commenters noted fishing is a prominent allure to California; therefore, impacts on tourism should be heavily considered in decision-making.[392] A commenter requested the PEIS include robust analysis of water-based recreation and the creation of community safety plans to minimize impacts.[393]

One commenter stressed concern over the lack of communication to businesses and communities that depend on ecotourism who will be most impacted by offshore wind development.[394] Another commenter questioned how the offshore wind companies would compensate communities for loss of tourism.[395]

A few commenters stressed a critical need for high-quality geospatial data on ocean and coastal uses, economic values, and participant demographics to evaluate the potential impacts on recreational areas and human uses.[396]

One commenter believed transforming Highway 1 and Highway 46 to accommodate the size and volume of trucks needed for offshore wind development would be detrimental to tourism.[397]

B.4.22 Scenic and Visual Resources

One commenter asserted that no offshore wind development should be advanced that is visible from any point and any elevation along California's coast. The commenter suggested conducting detailed viewshed studies clearly defining where offshore wind developments would be visible.[398] Many commenters urged that new visual simulations be developed that create a visual depiction of offshore wind development from various distance, directions, weather, and times of day.[399] Additionally, one commenter recommended the PEIS analyze nighttime lighting conditions.[400]

Another commenter expressed concern that offshore wind would impose negative impacts on Highway 1, which was designated a Scenic Highway by California State and a National Scenic Byway.[401]

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[392] Morro Bay Commercial Fishermen's Organization, J. Riker, K. Franklin, REACT ALLIANCE, M. Leicester-Cadaret, C. Porco, Surfrider Foundation, Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative (PCC).
[393] Redwood Region Climate & Community Resilience Hub and Partners
[394] C. Buchanan.
[395] B. Winholtz.
[396] Surfrider Foundation, Peninsula Community Collaborative (PCC).
[397] L. Murphy.
[398] B. Higgins.
[399] T. Studds, Pacific Fishery Management Council, Xolon Salinan Tribe, Redwood Region Climate & Community Resilience Hub and Partners.
[400] Redwood Region Climate & Community Resilience Hub and Partners.
[401] S. Anderson.

Several commenters expressed that offshore wind development would create negative impacts on California's Tribal resources and cultural practices, aesthetics, natural scenery, and tourism and impose health issues from light pollution.[402]

B.4.23 Sea Turtles

Five commenters expressed concern for the well-being of sea turtles in response to planned offshore wind development.

Commenters shared research detailing that sea turtles may become entangled in the drifting lines and nets due to their inability to anticipate the line, resulting in harm. Commenters also noted that sea turtles face risks associated with vessel strikes.[403] Other commenters were concerned with how offshore wind development and associated activities may affect marine animal sensory systems and natural movements.[404] As a result, one commenter requested that additional research be conducted on the population structure, distribution and habitat, and foraging behaviors of sea turtles during the next phases of permitting to better inform decision-making.[405]

B.4.24 Tribal Values and Concerns

Twelve commenters urged BOEM to engage in thorough and thoughtful Tribal consultation, with both federally recognized and non-federally recognized Tribes, and to go beyond archaeological resources to include all potential impacts on Tribal natural resources, cultural resources, and human rights in design, review, construction, operations, monitoring, mitigation, repowering and decommissioning plans.[406] One commenter especially noted that inadvertent discovery protocols must be established at every stage of ground disturbance, including a protocol for communication directly with Tribes.[407]

One commenter provided the following list of Tribal lands that would be affected by offshore wind development activities: Bear River Band of the Rohnerville Rancheria, Big Lagoon Rancheria, Blue Lake Rancheria, Cher-Ae Heights Indian Community of the Trinidad Rancheria, Elk Valley Rancheria, Hoopa Valley Tribe, Karuk Tribe, Nor Rel Muk Wintu Nation, Pulikla Tribe of Yurok People (formerly Resighini Rancheria), Tolowa Dee-ni' Nation, Tsnungwe Tribe, Wiyot Tribe, and Yurok Tribe and Public Domain Allotments not associated to a particular Tribal government.[408] Another commenter noted how the PEIS must address the existence and planned protections and mitigations of any Indian Sacred Sites within the project area.[409]

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[402] M. Stevens, M. Ginkel, Redwood Region Climate & Community Resilience Hub and Partners, V. Helliwell, Peninsula Community Collaborative (PCC), A. Olson.
[403] C. Buchanan, NOAA.
[404] NOAA, I. Gutierrez.
[405] North County Watch.
[406] California State Lands Commission et al, C. Blaney, Natural Resources Defense Council, Yurok Tribe, Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative, Sierra Club CA, Quinault Indian Nation, H. Hensher, D. Bruce-Hostler, Brightline Defense, Makah Tribe.
[407] Redwood Region Climate & Community Resilience Hub and Partners.
[408] H. Hensher.
[409] EPA Region 9.

To encourage greater consultation and meaningful engagement with Tribes, commenters made suggestions of ways to improve communication and collaboration. One suggested BOEM consult the joint document from CEQ and the Office of Science and Technology on how to engage policy, research, and decision-making with Indigenous TEK.[410] Another commenter recommended the creation of local regional science and adaptive management committees that center local science, lived experience, and TEK and compensate representatives for their involvement.[411] Another commenter urged BOEM to recognize the inherent authority of Tribes to regulate Tribal ancestral territory within the WEAs.[412] A commenter encouraged BOEM to apply its Tribal Cultural Landscapes framework and guidance developed in 2015 to assess impacts with Indigenous communities.[413]

One commenter stated that the Chumash Tribe continues to demand for the originally proposed boundary for the Chumash Heritage National Marine Sanctuary and has not consented to reducing its size to accommodate BOEM's offshore wind projects.[414]

Commenters have asked that the PEIS address how offshore wind development would have direct and indirect impacts on Tribal communities through increased electricity costs and with transmission lines that would be built to convey energy to Central and Southern California.[415]

Seven commenters expressed concerns that offshore wind would pose a threat to Tribal fisheries through harm to fish stocks and asked that the PEIS address any potential impacts on federally reserved fishing rights or subsistence fisheries.[416] Commenters noted that local Tribes have just been able to take action to restore salmon populations through dam removal along the Klamath River, and offshore wind development in Humboldt Bay could undo this progress.[417]

One commenter stressed that offshore wind development would infringe on Indigenous religious freedom, access to cultural resource management, and disrupt inter-Tribal trading routes and commerce.[418] Additional commenters noted that breaks in construction, operations, and decommissioning must be flexible to the accommodate Indigenous ceremonies and not prevent access to any Indian Sacred Sites.[419]

Seven commenters stated concerns about impacts on the Pacific Coast viewshed, with turbines or turbine lighting being visible from shore, new buildings and development onshore, cranes, high mast

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410 Brightline Defense.
411 Redwood Region Climate & Community Resilience Hub and Partners.
412 Yurok Tribe.
413 Yurok Tribe.
414 Sierra Club CA.
415 Elk Valley Rancheria - California, Watershed Regenerative Ventures.
416 Pacific Fishery Management Council, Natural Resources Defense Council, Yurok Tribe, Redwood Region Climate & Community Resilience Hub and Partners, Sierra Club CA, Quinault Indian Nation, D. Bruce-Hostler.
417 Sierra Club CA, D. Bruce-Hostler.
418 Watershed Regenerative Ventures.
419 H. Hensher, EPA Region 9, Wiyot Natural Resources Department, D. Bruce-Hostler, Redwood Region Climate & Community Resilience Hub and Partners.

light poles, and other heavy industrial equipment and facilities. Commenters indicated that this would be disruptive to Tribal ceremonies and rituals that focus on a connection to the ocean's horizon and on coastal landscape features like Wigi (Humboldt Bay).[420]

Other commenters noted the cultural and ceremonial importance of Tuluwat, also known as Indian Island, regarding any visual, noise, glare, air and water quality, and any other potential environmental degradation.[421]

Seven commenters expressed concerns that offshore wind development would contribute to and worsen the crisis of murdered and missing Indigenous people with the influx of men from out of the area for construction and development activities, as has been seen with previous development booms like mining, logging, dams, and cannabis.[422] In addition to this threat, a commenter expressed concern over the growing fentanyl and opioid crisis in Indigenous communities in Northern California, and how the rapid economy growth could worsen this crisis.[423]

Five commenters also mentioned how previous extractive development cycles in the region often benefited people outside of the region the most, and left significant and long-lasting environmental damage, legacies of underinvestment, and unfulfilled promises of restoration.[424] These commenters stated that federal and state processes, to this point, have not prioritized Tribal sovereignty, nor sought Tribal consent. This group of commenters indicated that offshore wind should be an opportunity to disrupt this pattern through increased collaboration with Tribes and community members to ensure these actions achieve the greatest benefits to the region, including social and built infrastructure and reliable affordable electricity, healthcare, and broadband and to combat climate change.

Two commenters also noted that offshore wind would result in increased traffic and safety concerns at onshore infrastructure related to fishing, and these impacts would need to be analyzed as they relate to Tribal uses of port infrastructure.[425]

One commenter noted that should minimization or mitigation measures fail to adequately address impacts for viewsheds or coastal areas, BOEM should consider compensation in the form of land purchase, land trusts, or land access agreements.[426]

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[420] California State Lands Commission et al, C. Blaney, Yurok Tribe, Redwood Region Climate & Community Resilience Hub and Partners, Wiyot Natural Resources Department, Brightline Defense, H. Hensher.

[421] Wiyot Natural Resources Department, Redwood Region Climate & Community Resilience Hub and Partners.

[422] J. Frank, Yurok Tribe, Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative, D. Bruce-Hostler, Brightline Defense, H. Hensher.

[423] Yurok Tribe.

[424] Redwood Region Climate & Community Resilience Hub and Partners, H. Hensher, D. Bruce-Hostler, California State Lands Commission et al., Yurok Tribe.

[425] Redwood Region Climate & Community Resilience Hub and Partners, EPA Region 9.

[426] THPO – Bear River Band.

B.4.25 Water Quality

Eleven commenters expressed concern regarding how offshore wind development may affect the water quality of marine environments along the California coast. [427]

Two commenters expressed concern regarding potential spills in the ocean from coolants, fuel, lubricating oils, and other petroleum compounds used for turbines.[428] Commenters recommended the PEIS include a mitigation measure requiring a project-specific spill prevention and response plan coordinated with the California Department of Fish and Wildlife Office of Spill Prevention and Response, as well as other applicable agencies.[429]

One commenter worried how offshore wind development could warm ocean temperatures and reduce the ocean's capacity for CO_2 capture.[430] One commenter was concerned about how marine habitats would be affected by potential debris from offshore wind development.[431]

B.4.26 Wetlands and Other Waters of the United States

One commenter discussed California policies related to wetlands specifically Executive Order W-59-93 and the California Wetland Program Plan.[432] The commenter indicated that cable emplacement, port development, and other actions associated with offshore wind may affect wetlands and wished to see this analysis in the PEIS.

A commenter expressed concern that California's coastal ecosystem has already lost 90 percent of its wetlands mostly due to development.[433]

B.4.27 Other Resource or Stressor Topics

Many commenters stated concerns about the potential for offshore wind development to cause noise pollution, light pollution, and other hard-to-predict impacts on human and ecological environments.[434] Commenters cited the potential for impacts associated with electromagnetic disturbance to sea life, uncertain levels of surface and subsurface noise, and concern about how noise can be reduced or mitigated.

Several commenters stated concerns about noise impacts related to offshore wind construction and operation. These commenters urged BOEM to require offshore wind developers demonstrate how noise

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[427] Redwood Region Climate & Community Resilience Hub and Partners.
[428] C. Buchanan, M. Shevitz, Pacific Management Council, NOAA.
[429] J. Eckerle, Redwood Region Climate & Community Resilience Hub and Partners.
[430] M. Ginkel, West Coast Pelagic Conservation Group (WCP).
[431] Pacific Fishery Management Council.
[432] California State Lands Commission et al.
[433] A. Dallmann.
[434] Morro Bay Commercial Fishermen's Organization, B. Winholtz, R. Riker, N. Krop, R. Puntillo, L. Hunt-Pierson, L. Murphy.

impacts would be avoided, minimized, and mitigated.[435] A commenter provided an acoustic report showing that noise estimates were underestimated for vessels used for offshore wind survey activities on the East Coast and indicated this could be an issue with vessels considered in the PEIS.[436] One commenter asked if vibration and sound studies have been conducted.[437]

Multiple commenters indicated that elevated noise levels from offshore wind development would cause long-term impacts.[438] A commenter asserted that the sound would cause commercially harvested species to avoid a large area in and around the wind farms, and subsequently impact fishermen's harvests.[439] Another commenter indicated that noise impacts could change the abundance, distribution, or migration patterns of living marine resources.[440] One commenter noted that local food security would be affected and increase reliance on imported seafood.[441]

Multiple commenters requested that potential impacts of introduced invasive species as a result of infrastructure and increased vessel traffic be considered.[442] One commenter specified that new offshore wind infrastructure has the potential to create new habitat that could serve as stepping stones in the spread and establishment of non-native species.[443] Two commenters noted that Humboldt Bay is the only waterbody in California free of oyster diseases.[444] One commenter requested the PEIS provide a plan to reduce the likelihood of introducing invasive pathogens during offshore wind activities.[445]

One commenter expressed concern that there are uncertainties about whether wind farms could withstand tsunamis or other increased water movements during storms. The commenter noted that since floating wind farms rely on cables, anchors, and power lines, any changes in ocean level, currents, and even excessive winds could topple the turbines or cause the subsurface infrastructure to snap or drag along the ocean floor.[446]

One commenter requested offshore wind development include an upfront bond to cover the costs of reclamation when the wind turbines reach their end of their life.[447]

A commenter requested that prospective offshore wind developers document a maximum use of recycled materials throughout the operations and to show that materials are able to be recycled from all

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[435] N. Krop, J. Flaherty, S. Sadler, M. Holtam, B. Crocco, T. Trappler, Tom D., J. Tang, G. Goetz, R. Altman, L. Eriksen.
[436] Morro Bay Commercial Fishermen's Organization.
[437] Xolon Salinan Tribe.
[438] Natural Resources Defense Council, Redwood Region Climate & Community Resilience Hub and Partners.
[439] Morro Bay Commercial Fishermen's Organization.
[440] NOAA.
[441] Morro Bay Commercial Fishermen's Organization.
[442] D. Howard, California State Lands Commission et al., Natural Resources Defense Council, Redwood Region Climate & Community Resilience Hub and Partners.
[443] California State Lands Commission et al.
[444] Natural Resources Defense Council, Redwood Region Climate & Community Resilience Hub and Partners.
[445] Natural Resources Defense Council et al.
[446] C. Buchanan.
[447] B. Winholtz.

phases of their operations.[448] Another commenter asked that the PEIS assess the impacts of all toxins being used in offshore wind development and their purpose.[449]

A commenter requested that full decommissioning plans for offshore wind infrastructure be included as a condition for the lease.[450]

A commenter requested that the PEIS consider potential impacts from offshore wind development on the Canada and United States international treaty on Pacific Albacore Tuna Vessels and Port Privileges of 1981.[451]

A commenter indicated that offshore wind development would result in increases in air, noise, and light pollution from industrialized ports.[452] A commenter requested that the PEIS analyze the port infrastructure and transmission upgrades that would be required to facilitate the full build-out of the Morro Bay and Humboldt WEAs.[453]

B.5 National Historic Preservation Act/Section 106 and Programmatic Agreement

B.5.1 Programmatic Agreement

Two commenters recommended the PEIS include an analysis of and recommendation for formal agreements between offshore wind developers, regulatory agencies, and Tribal Nations.[454]

B.5.2 Impacts on Historic Properties

One commenter recommended that BOEM avoid or minimize adverse effects on the physical integrity, accessibility, or use of cultural resources or archaeological sites and discuss any mitigation measures for these sites in a clear manner. The commenter also recommended adding a memorandum of agreement to the Draft PEIS, while following all anonymity protocol required by the National Historic Preservation Act. They also requested a summary of all Tribal coordination, including National Register of Historic Properties eligible site identification and the development of a cultural resource management plan. [455]

B.5.3 Identification of Historic Properties under the National Historic Preservation Act

One commenter requested that the PEIS address potential impacts on onshore historic properties, cultural resources, and Tribal Cultural Landscapes while it addresses Section 106 of the National Historic

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[448] Coastal Coordination Program & The Ocean Foundation.
[449] Redwood Region Climate & Community Resilience Hub and Partners.
[450] Coastal Coordination Program & The Ocean Foundation.
[451] American Albacore Fishing Assn.
[452] REACT Alliance.
[453] EPA Region 9.
[454] H. Hensher, Redwood Region Climate & Community Resilience Hub and Partners.
[455] EPA Region 9.

Preservation Act requirements. The commenter stated that offshore wind development could affect cultural and Tribal cultural resources through noise, light pollution, interference with religious practices, and limit viewsheds.[456]

B.6 Consultations

B.6.1 Endangered Species Act

Five commenters provided comments on Endangered Species Act (ESA) consultations.

A commenter noted the requirements of the California Endangered Species Act and recommended early consultation with the California Department of Fish and Wildlife if a project may affect CESA-listed species.[457] Another commenter noted the requirements of the ESA.[458] A commenter requested that lessees be included throughout the consultation process including ESA consultations.[459] A commenter noted that construction and operation activities for a representative project may result in noise and disturbance to species habitat.[460] A commenter recommended BOEM coordinate with state and federal agencies to determine potential impacts on federal or state rare, threatened, or endangered listed species.[461]

A commenter recommended that the PEIS include offshore wind development's consistency with federal or state ESA, as well as a detailed analysis and comprehensive mitigation for ESA-listed species.[462]

B.6.2 Other Consultations

B.6.2.1 Clean Water Act

A commenter requested that if the proposed activities described in the PEIS would result in discharge of dredged or fill materials into surface waters of the United States, the Draft PEIS should describe the permit application process, recommended measures to protect aquatic resources, and disclose any floodplain impacts.[463]

B.6.2.2 Coastal Zone Management Act

One commenter emphasized the importance of the Coastal Zone Management Act (CZMA) and noted that offshore wind development must be consistent with California's coastal protection policies,

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[456] J. L. James.
[457] California State Lands Commission et al.
[458] WhoPoo App.
[459] RWE Offshore Wind Holdings, LLC.
[460] EPA Region 9.
[461] EPA Region 9.
[462] EPA Region 9.
[463] EPA Region 9.

including the California Coastal Act.[464] A separate commenter noted the requirements of the CZMA consistency determination.[465] Another commenter indicated that BOEM should acknowledge acceptance of Conditions 1 through 7 imposed by the California Coastal Commission's Consistency Determination CD-0001-22,[466] with another commenter highlighting Condition 5, *Engagement with Environmental Justice and Local Communities* and Condition 6, *Engagement with California Native American Tribes*.[467] A commenter indicated that the California Coastal Commission Consistency Determination currently allows noise levels that are lethal to fish and larvae and expressed that vessels that exceed harmful levels should not be permitted to operate.[468]

A commenter flagged that a CZMA consistency determination may be premature at this stage, because the PEIS would not include a full disclosure of the total scale and character of offshore wind development impacts.[469] The same commenter noted that CZMA consistency determinations provide a critical opportunity for public participation.[470] A commenter noted that BOEM's proposal to conduct two separate CZMA consistency determinations, one for Morro Bay WEA and one for the Humboldt WEA, limits the California Coastal Commission's ability to properly assess combined impacts of the two WEAs.[471] A commenter noted that because the CZMA consistency determination would occur after the leases have been sold and the offshore wind projects have gained momentum, there would be significant pressure on the state of California to approve the determination.[472]

B.6.2.3 General Comments on Governmental Consultations

A commenter noted that at the programmatic stage the basis for consultations could be unclear; however, any consultation conducted should include leaseholder participation.[473] NOAA recommended that BOEM and NMFS engage further about the consultations and which would be better suited for COP-specific analysis rather than at the programmatic level.[474]

A commenter requested BOEM coordinate with the U.S. Army Corps of Engineers on their *Port of Long Beach Pier Wind Terminal Development Project Environmental Impact Statement* to rely on consistent data sources, analysis tools, modeling, methodology, and assumptions, where applicable.[475] The same commenter requested that the PEIS include a discussion on how BOEM considered and incorporated information from USACE into the port analysis included in the PEIS.

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464 Surfrider Foundation.
465 GREENSPACE – the Cambria Land Trust.
466 Redwood Region Climate & Community Resilience Hub and Partners.
467 Brightline Defense.
468 Pacific Coast Federation of Fishermen's Associations (PCFFA) and Institute for Fisheries Resources (IFR).
469 Coastal Coordination Program & The Ocean Foundation.
470 Coastal Coordination Program & The Ocean Foundation
471 Coastal Coordination Program & The Ocean Foundation.
472 Coastal Coordination Program & The Ocean Foundation.
473 RWE Offshore Wind Holdings LLC.
474 NOAA.
475 EPA Region 9.

B.7 Scoping/National Environmental Policy Act Process

B.7.1 Scoping Process

One commenter indicated that BOEM's scoping efforts for the PEIS present a unique opportunity to learn from past industries that exploited the North Coast region by engaging with Tribal Nations, local leadership, and communities.[476]

A commenter noted that BOEM as the lead agency should carefully follow NEPA's procedural requirements and analyze the "whole of the action," which includes all actions associated with offshore wind development including development of a wind terminal in Wigi and the proposed Oregon WEAs.[477]

B.7.2 National Environmental Policy Act Cooperating Tribal Government and Cooperating or Participating Agencies

The U.S. Army Corps of Engineers accepted cooperating agency status under NEPA for the PEIS and outlined ways it expects to participate in the NEPA process.[478] NOAA accepted cooperating agency status under NEPA for the PEIS.[479] The Bureau of Safety and Environmental Enforcement requested to participate as a cooperating agency for preparation of the PEIS.[480] The California State Lands Commission, California Coastal Commission, and California Energy Commission formally requested to participate as a cooperating agency for the preparation of the PEIS.[481] The San Luis Obispo County Air Pollution Control District requested additional information on how to become a cooperating agency.[482]

A commenter emphasized the importance of beginning government-to-government consultation early in PEIS development and recommended face-to-face meetings or on-site visits to conduct consultation.[483] One commenter requested that BOEM engage in consultation with the Elk Valley Rancheria, a Tribal Government in Northern California.[484] Commenters requested that BOEM engage with the Northern Chumash Tribal Council, other Indigenous organizations, and non-federally recognized Tribes with an interest in the stewardship of this region.[485] A commenter indicated that each Tribes' Exclusive Economic Zone, which extends Tribal jurisdiction 200 miles off California's coastline need to be formally recognized.[486] A commenter encouraged BOEM to work proactively with non-

[476] Redwood Region Climate & Community Resilience Hub and Partners
[477] Wiyot Natural Resources Department.
[478] U.S. Army Corps of Engineers.
[479] NOAA.
[480] BSEE.
[481] California State Lands Commission et al.
[482] San Luis Obispo County Air Pollution Control District.
[483] EPA Region 9.
[484] Elk Valley Rancheria, California.
[485] Tom D., California State Lands Commission et al., Sierra Club, EPA Region 9, J. Sahn.
[486] Watershed Regenerative Ventures.

federally recognized Tribes to ensure that the concerns of community members are considered as part of the PEIS development.[487]

Several commenters emphasized the importance of interagency coordination.[488] Multiple commenters supported BOEM's invitation to federal agencies, Tribes, and state and local governments to become cooperating agencies and encouraged ongoing and close coordination with these entities.[489] One commenter suggested using environmental review checklists to facilitate the permitting process.[490]

B.7.3 Timeline for the Notice of Availability of the Draft Programmatic Environmental Impact Statement

A commenter expressed concern about errors as a result of the expedited timeline.[491]

A commenter indicated that keeping to the proposed PEIS schedule is important for the PEIS to be useful during the COP development process.[492]

B.7.4 Public Comment Process/Engagement

Commenters noted the need for a transparent and inclusive public engagement process and to communicate details, including potential impacts and mitigation measures, to the public.[493]

Three commenters demonstrated appreciation for the communication and stakeholder engagement plans that have been released to the public so far and are interested in more detail about the methods that would be used. Commenters expressed interest in maximizing advance notice (through media channels, etc.) to increase the likelihood of participation in the engagement process. [494] One commenter recommended that in the future, public agencies should be provided funding to support the time and effort to provide constituents with adequate information to make informed decisions about projects of similar magnitude to offshore wind development.[495]

One commenter noted that very few substantive public comments had been submitted, suggesting that there was inadequate outreach done prior to the scoping period, and potentially that more time is needed for effective outreach to a broader group of stakeholders.[496] One commenter noted that despite

[487] Sierra Club.
[488] G. Johnson, North County Watch, Invenergy California Offshore LLC, Equinor Wind US LLC.
[489] American Clean Power Association, Redwood Region Climate & Community Resilience Hub and Partners.
[490] North County Watch.
[491] Watershed Regenerative Ventures.
[492] Golden State Wind LLC.
[493] Elk Valley Rancheria- California, Climate Action California, Surfrider Foundation, C. Blaney, Brightline Defense, Natural Resources Defense Council, EPA Region 9, Redwood Region Climate & Community Resilience Hub and Partners, Peninsula Community Collaborative, Watershed Regenerative Ventures.
[494] North County Watch, EPA Region 9, Anonymous.
[495] Anonymous
[496] C. Blaney.

submitting several comments to BOEM both in writing and verbally over the years, they have never received a response.[497]

One commenter demonstrated interest in more visual information that helps to describe the PEIS and permitting process for offshore wind projects, and provide a sort of visual "one-stop-shop" for understanding the offshore wind timeline.[498] An additional commenter also indicated a desire for all studies and monitoring to be made publicly available.[499] Two commenters requested that public engagement materials be made available online in more languages than just English, and are written with accessibility in mind for those with Limited English Proficiency.[500]

One commenter noted the importance of BOEM being the primary issuer of Request for Proposals about the scientific studies conducted for offshore wind, to ensure the highest level of objectivity.[501]

Two commenters encouraged BOEM to maintain close coordination with the California Energy Commission, California Coastal Commission, California State Lands Commission, and other relevant state and federal agencies to ensure timely, collaborative, and comprehensive review and agreement on technically and economically feasible mitigation measures that would not result in duplicative environmental review.[502] Two commenters encouraged BOEM to create collaborative and productive relationships with developers to ensure that offshore wind technology can be installed on the West Coast in an economical manner.[503]

Five commenters noted the importance to local communities affected by the offshore wind industry to receive significant and tangible benefits and are aware of plans to mitigate any negative impacts.[504]

B.7.5 Programmatic Approach

Several commenters expressed support for the programmatic approach because it can provide efficiencies for future NEPA reviews, reduce uncertainties, and create predictability for planning by applicants and stakeholders.[505] Three commenters, however, noted the importance of site-specific analysis and emphasized that this PEIS should not replace the need for project-level EISs.[506] Additionally,

[497] West Coast Pelagic Conservation Group.
[498] North County Watch.
[499] Natural Resources Defense Council.
[500] North County Watch, EPA Region 9.
[501] Coastal Coordination Program & The Ocean Foundation.
[502] Golden State Wind LLC, California State Lands Commission et al.
[503] Golden State Wind LLC, Channel Wind.
[504] Climate Action California, C. Blaney, Brightline Defense, EPA Region 9, Redwood Region Climate & Community Resilience Hub and Partners.
[505] NOAA, Redwood Region Climate & Community Resilience Hub and Partners, Natural Resources Defense Council et al.
[506] Redwood Region Climate & Community Resilience Hub and Partners, Responsible Offshore Development Alliance, Yurok Tribe.

a commenter recommended that the project-level reviews compare actual planned development against the hypothetical development impacts.[507]

A commenter noted that the PEIS should include region-specific programmatic mitigation measures to allow individual project NEPA documents to tier off the PEIS.[508] Commenters recommended that BOEM provide tiering guidelines in the PEIS and explain how future activities can tier from the PEIS.[509] Commenters indicated that separating analysis of the initial site characterization and lease sale from the impacts of installation and operation of offshore wind mischaracterizes the entire impacts of offshore wind projects.[510]

A commenter suggested that mitigation measures serve as a baseline for the minimal level of mitigation expected by a lessee.[511] Another commenter recommended that a cumulative impact analysis occur within both the programmatic and individual EISs.[512]

Several commenters provided comments on the timing and schedule for the PEIS. Two commenters expressed concern that potential delays to the PEIS timeline would create delays in initiating project-specific NEPA reviews.[513] A commenter expressed concern that the process was moving forward despite NEPA and California Environmental Quality Act (CEQA) reviews not being complete.[514] Another commenter requested that future PEIS analysis be conducted prior to lease auctions to provide sufficient time to identify and implement mitigation measures.[515]

One commenter expressed concern that the incorporation of PEIS findings into the COPs could be used to avoid additional analysis and avoid addressing Tribal concerns.[516] The same commenter emphasized the programmatic approach needs to be adaptable to incorporate advancements that arise during the process.

A commenter suggested that the PEIS consider a programmatic approach to quantify air quality and GHG impacts and proposed applicable mitigation measures.[517] Similarly, one commenter indicated that the PEIS should assess programmatic-level beneficial impacts such as climate change mitigation, reduced air pollution from fossil fuel-based electric generation and job creation.[518]

Several commenters noted that the previously prepared 2007 *Final Programmatic EIS for Alternative Energy Development and Production and Alternative Use of Facilities on the Outer Continental Shelf* was

[507] Yurok Tribe.
[508] American Clean Power Association.
[509] American Clean Power Association, Yurok Tribe.
[510] Coastal Coordination Program & The Ocean Foundation, Pacific Fishery Management Council.
[511] Responsible Offshore Development Alliance.
[512] Pacific Fishery Management Council.
[513] American Clean Power Association, Invenergy California Offshore LLC.
[514] H. Hensher.
[515] Responsible Offshore Development Alliance.
[516] Elk Valley Rancheria, California.
[517] San Luis Obispo County Air Pollution Control District.
[518] American Clean Power Association.

out of date.[519] A commenter noted that limiting the programmatic review to the five offshore lease areas is not appropriate, because the offshore wind industry is more mature than when the 2007 PEIS was developed.[520]

B.7.6 Representative Project Design Envelope

Nineteen commenters provided comments on the RDPE. Multiple commenters expressed concern that BOEM's approach of using a single RDPE may not be representative of the actual five projects and would not capture the differences between the two geographically distinct regions.[521] Commenters noted the RDPE should accommodate a range of alternative offshore wind technologies that could be used in the five lease areas to provide flexibility and account for rapidly advancing technology.[522] Commenters encouraged BOEM to continue to seek input from lessees, equipment manufacturers, Tribes, and other stakeholders to develop a realistic RDPE.[523] Another commenter asked BOEM to disclose the key assumptions that formed the basis of the RDPE.[524] One commenter noted that some project parameters (e.g., foundation type) do not lend themselves to a range or maximum case scenario.[525]

Commenters indicated that the RDPE should include multiple export cable routes and onshore parameters, such as points of interconnection, substations, operation and maintenance areas.[526] A commenter noted that the RDPE should include subsea offshore substations in addition to floating substations.[527] The same commenter stated that the RDPE should reflect that lessees may use jack-up barges for horizontal directional drilling related to cable landfalls, and these impacts should be analyzed in the PEIS.[528] One commenter provided additional specifics for the RDPE to incorporate, including a turbine layout that allows for mariner safer passage even during inclement weather, cable routes and substations that avoid sensitive habitat, cables that are buried to avoid conflicts with bottom fishing, turbine sizes that account for winter weather, and weak links on interarray cables.[529] The same commenter also stated that ports should be selected that have adequate dock and land space and offshore wind activities should be scheduled to minimally disrupt fishing seasons.[530] Another commenter noted the importance for embracing digital tools and AI to address challenges for offshore corridor

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[519] B. Gorham, Oregon Trawl Commission.
[520] B. Gorham.
[521] Elk Valley Rancheria, California; NOAA; Pacific Fishery Management Council; California State Lands Commission et al., Anonymous.
[522] California State Lands Commission et al.; American Clean Power Association; Natural Resources Defense Council et al; Redwood Region Climate & Community Resilience Hub and Partners; Equinor Wind US, LLC.; Responsible Offshore Development Alliance.
[523] Golden State Wind LLC, American Clean Power Association, RWE Offshore Wind Holdings, LLC; Yurok Tribe; Equinor Wind US, LLC., Invenergy California Offshore LLC.
[524] Natural Resources Defense Council et al
[525] Invenergy California Offshore, LLC.
[526] Elk Valley Rancheria, California, Equinor Wind US, LLC.
[527] Equinor Wind US, LLC.
[528] Equinor Wind US, LLC.
[529] Pacific Fishery Management Council.
[530] Pacific Fishery Management Council

routing.[531] A commenter recommended that offshore export cables go to the Diablo Canyon Power Plant.[532]

Commenters expressed concern related to transmission lines and electromagnetic cables including presence of toxic chemicals, general safety, their potential to fail, and impacts on the marine environment and marine life.[533] A commenter expressed concern with cables being routed through the Point Bouchon MPAs, construction and maintenance vessels being too large for Morro Bay, and the cost for port improvements.[534] Another commenter expressed concern about being able to anchor the large turbines to the ocean floor.[535] A commenter requested a joint network planning approach be used for transmission cable development to ensure optimal routes and substation locations are used for the multiple lease areas.[536] A commenter requested that the PEIS include a discussion of transmission landfall impacts.[537]

A commenter requested that onshore facilities, including cable landings, be resilient to sea level rise.[538] A commenter expressed concern about the potential for offshore wind development in the Morro Bay WEA to be supported by an onshore battery facility in Morro Bay.[539]

B.7.7 Other Comments

A commenter recommended that BOEM draw on lessons learned from the offshore wind industry in Europe, especially as it relates to considering the impact on marine wildlife.[540] Commenters argued that objective science prepared by independent entities and coordinated across diverse stakeholders from various fields needs to be used in the PEIS to provide adequate baseline information.[541] Another commenter noted the need for additional surveys and data collection to provide baseline data for species and habitat.[542]

One commenter recommended that BOEM establish monthly meetings with lessees to exchange information and expertise during development of the PEIS.[543]

A commenter recommended that BOEM require adaptive management for each of the projects and develop a regional adaptive management plan to mitigate regional-level impacts.[544] Another

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531 Continuum Industries.
532 D. Nelson.
533 S. Hafer, R. Puntillo, M. Ginkel, Sierra Club CA; Anonymous.
534 S. Hafer.
535 R. Puntillo.
536 Continuum Industries
537 Brightline Defense.
538 GREENSPACE – the Cambria Land Trust.
539 C. Porco.
540 HiDef Aerial Surveying LTD.
541 Coastal Coordination Program, The Ocean Foundation, North County Watch.
542 Natural Resources Defense Council et al.
543 American Clean Power Association.
544 Yurok Tribe.

commenter echoed the need for adaptive management so that needed adjustments can be made throughout the life of the PEIS.[545] A commenter suggested that continuous monitoring to support adaptive management be included as a permit condition.[546]

One commenter noted that new information has come out related to deferred mitigation and allowable decibels of noise that necessitates portions of the Morro Bay WEA to be updated and redistributed to the public.[547] Another comment notes that BOEM uses the NEPA process to expedite the offshore wind process.[548]

B.8 Out of Scope

One commenter expressed concern about impacts on commercial fishing resulting from high-resolution geographical surveys previously conducted.[549] The same commenter also indicated that there has been a lack of transparency in the California state agency permitting process for offshore wind development. Another commenter expressed concern that site surveys would be authorized before enforceable mitigation measures are adopted, and that Morro Bay lease developers are failing to implement comprehensive mitigation measure to reduce potential impacts on commercial fishing.[550]

A commenter expressed concern that the Humboldt Harbor District must complete a CEQA review prior to entering into an Option Agreement and Lease.[551] Another commenter recommended the Humboldt Bay Offshore Wind Heavy Lift Marine Terminal be a zero-emission terminal.[552]

One commenter recommended that BOEM should commission new studies, as well as an independent analysis with lessons learned from other offshore wind development.[553] The same commenter suggested that BOEM prepare for impacts from all stages of development including unexpected disasters and bankruptcies and suggesting requiring lessees to put down a substantial security deposit.

A commenter recommended that a website with an emergency hotline be created for citizens to report any unusual activity related to offshore wind development.[554] Another commenter suggested that BOEM and other relevant federal agencies support the establishment of a West Coast Offshore Wind and Ecosystem Science Entity.[555]

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[545] EPA Region 9.
[546] North County Watch.
[547] Pacific Coast Federation of Fishermen's Associations (PCFFA) and Institute for Fisheries Resources (IFR).
[548] West Coast Pelagic Conservation Group (WCP).
[549] S. Hafer.
[550] Morro Bay Commercial Fishermen's Organization
[551] Surfrider Foundation.
[552] Redwood Region Climate & Community Resilience Hub and Partners.
[553] C. Blaney.
[554] Greenspace – the Cambria Land Trust.
[555] Natural Resources Defense Council et al.

A commenter questioned how offshore wind energy generation would work in combination with existing solar facilities.[556]

A commenter requested all permits related to seismic ocean floor mapping and dredging for the Morro Bay lease areas be rescinded.[557]

A commenter asserted that provisions in any lease granted for offshore wind energy would need to carefully delineate limits on types of activities granted access within each leasehold.[558]

[556] Los Cerritos Wetlands Trust Group.
[557] M. Stevens.
[558] The Ocean Foundation.

Appendix C: Planned Activities Scenario

Contents

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Abbreviations and Acronyms

Term	Definition
BOEM	Bureau of Ocean Energy Management
CADEMO project	CADEMO Floating Wind Energy Demonstration Project
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CSLC	California State Lands Commission
CO_2	carbon dioxide
COP	Construction and Operations Plan
DOD	Department of Defense
EA	Environmental Assessment
ESA	Endangered Species Act
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
FMP	fishery management plan
GHG	greenhouse gas
IS/MND	Initial Study/Mitigated Negative Declaration
MF	manufacturing/fabrication
MLLW	mean lower low water
MOTEMS	Marine Oil Terminal Engineering and Maintenance Standards
MW	megawatt
CH_4	methane
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Association
nautical mile	nm
N_2O	nitrous oxide
O&M	operations and maintenance
OCS	outer continental shelf
PFMC	Pacific Fishery Management Council
POLA	Port of Los Angeles
POLB	Port of Long Beach
PEIS	Programmatic Environmental Impact Statement
SAP	site assessment plan
S&I	staging and integration

Term	Definition
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
USCG	U.S. Coast Guard
WEA	wind energy area
WTG	wind turbine generator

C.1 Introduction

This appendix describes ongoing and planned activities that could occur in the Affected Environment, thereby contributing to baseline conditions and trends for resources considered in this Draft Programmatic Environmental Impact Statement (PEIS). The PEIS's Proposed Action is the prospective adoption of programmatic mitigation measures that the Bureau of Ocean Energy Management (BOEM) may require as conditions of approval for activities proposed by lessees in Construction and Operations Plans (COP) submitted for the Humboldt and Morro Bay leases (outer continental shelf [OCS] P 0561, 0562, 0563, 0564, and 0565, hereafter referred to as the lease areas). Figure C-1 identifies California wind energy areas (WEAs).

This appendix addresses ongoing and planned actions that may occur in the same space and time as prospective wind energy development (between construction and decommissioning phases).[1] The purpose is to capture the cumulative impacts on each of those resources, combining the effects of wind energy development with those of ongoing and planned activities.

This appendix expresses distances in *statute miles* (miles used in the traditional sense) or *nautical miles* (nm) (miles used specifically for marine navigation). This appendix uses statute miles more commonly and refers to them simply as miles, whereas nautical miles are referred to by name.

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[1] BOEM anticipates that site characterization and site assessment activities for potential offshore projects could commence prior to 2030; however, the schedule for site assessment and site characterization activities would depend on the submittal of COPs by the lease holders and the reviews/approvals of same by BOEM. The decommissioning phase for potential offshore projects is anticipated to be around 35 years after construction is completed.

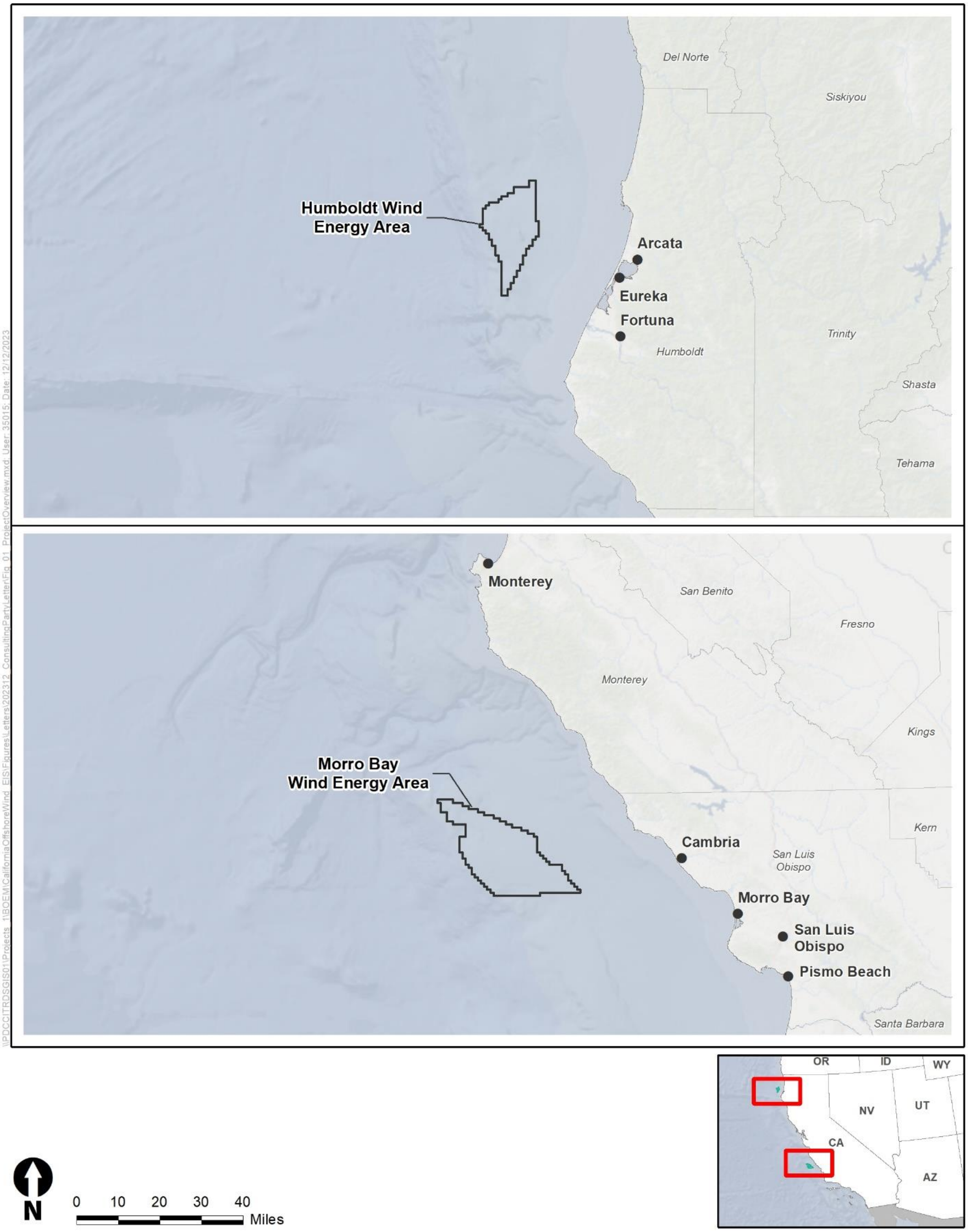

Figure C-1. Humboldt and Morro Bay wind energy areas

C.2 Ongoing and Planned Activities

This section includes a list and description of ongoing and planned activities that could contribute to baseline conditions and trends in the Affected Environment for each resource topic analyzed in this Draft PEIS.

BOEM has completed a study of impact-producing factors on the Atlantic OCS to consider in an offshore wind development cumulative impacts scenario (BOEM 2019). This document incorporates this study by reference. The study notes that other both offshore and non-offshore wind projects may affect the same resources as those associated with offshore wind projects under consideration. To this end, the following subsections discuss ongoing and planned activities, which would be considered in the cumulative impact analyses in Chapter 3, *Affected Environment and Environmental Consequences*. However, projects or actions that are considered speculative per the definition provided in 43 Code of Federal Regulations (CFR) 46.30[2] are excluded from the cumulative impact analysis in Chapter 3.

C.2.1 Offshore Wind Energy Development Activities

As of 2024, there are no operating offshore wind projects off the Pacific Coast. The Humboldt and Morro Bay lease areas represent BOEM's first wind energy OCS leasing activity on the West Coast. Figure C-2 shows other areas along the Pacific Coast being considered for prospective offshore wind development.

[2] 43 CFR 46.30 – Reasonably foreseeable future actions include those federal and nonfederal activities not yet undertaken, but sufficiently likely to occur, that a responsible official of ordinary prudence would take such activities into account in reaching a decision. The federal and nonfederal activities that BOEM must consider in the analysis of cumulative impacts include, but are not limited to, activities for which there are existing decisions, funding, or proposals identified by BOEM. Reasonably foreseeable future actions do not include those actions that are highly speculative or indefinite.

Figure C-2. Prospective offshore renewable energy areas

Two areas offshore Oregon are being considered for offshore wind leasing as a first step toward prospective offshore wind development. The Brookings WEA consists of 133,792 acres and is located approximately 18 miles from shore. The Coos Bay WEA consists of 61,203 acres and is located approximately 32 miles from shore (BOEM 2024a). Figure C-3 and Figure C-4 show locations of prospective lease areas OCS-P-0566 and OCS-P-0567 in these WEAs (BOEM 2024c, 2024d).

On April 30, 2024, BOEM published a draft Environmental Assessment (EA) associated with the prospective leasing of two WEAs offshore of Brookings and Coos Bay and announced proposed auction details and lease terms for the designated WEAs. The WEAs cover approximately 194,995 acres offshore southern Oregon with their closest points ranging from approximately 18–32 miles off the coast. The draft EA, incorporated by reference, focuses on potential environmental effects of site characterization and site assessment activities expected to take place after BOEM’s possible future issuance of commercial wind energy leases offshore Oregon.

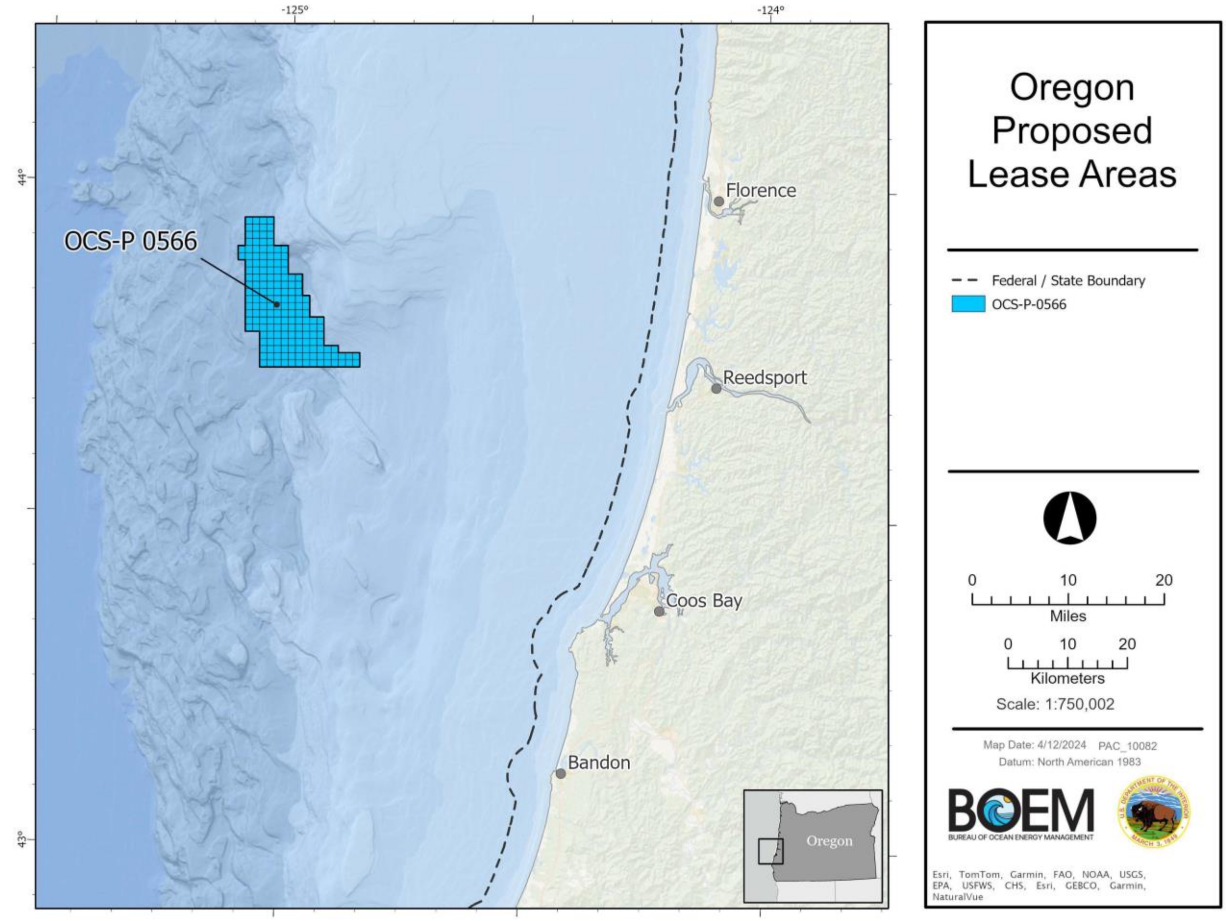

Figure C-3. Proposed Coos Bay Oregon Lease Area (OCS-P 0566)
Source: BOEM 2024c.

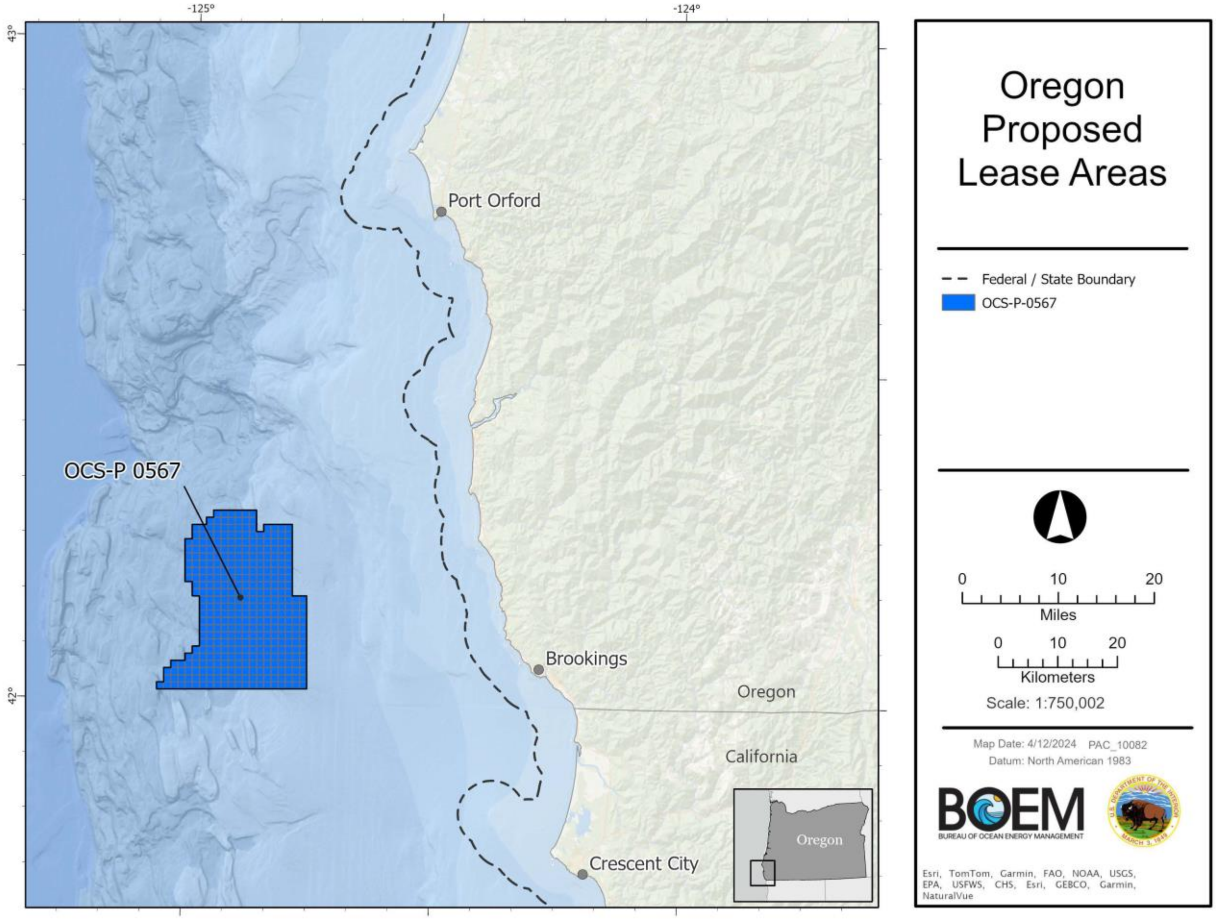

Figure C-4. Proposed Brookings Oregon Lease Area (OCS-P 0567)
Source: BOEM 2024d.

As of September 2024, there are no call areas or wind energy areas off the coast of the state of Washington, but two unsolicited lease requests for waters approximately 40 miles west of Grays Harbor were submitted to BOEM in 2022 (Trident Winds 2023; Hecate Energy 2023). These are not considered reasonably foreseeable for the purposes of being included in this PEIS's cumulative analyses.

C.2.1.1 Site Characterization Studies

A lessee is required to provide the results of site characterization activities with its site assessment plan (SAP) and COP. Lessees have up to 5 years to perform site characterization activities before they must submit a COP (30 CFR 585.235(a)(2)). At this time, BOEM expects site characterization studies for the West Coast to take place if a lessee submits an SAP for any of the offshore lease areas, or if new call/lease areas were identified.

For the purposes of the cumulative effects analysis, BOEM makes the following assumptions for survey and sampling activities.

- Site characterization would occur on all existing leases and potential export cable routes.
- Site characterization would likely take place in the first 3 years following execution of a lease, based on the fact that a lessee would likely want to generate data for its COP at the earliest possible opportunity.
- Lessees would likely survey most or all of the proposed lease area during the 5-year site assessment term to collect required geophysical information for siting of a meteorological tower, two buoys, and commercial facilities (wind turbines). The surveys may be completed in phases, with the meteorological tower and buoy areas likely to be surveyed first.
- Lessees would not use air guns, which are typically used for deep penetration two-dimensional or three-dimensional exploratory seismic surveys to determine the location, extent, and properties of oil and gas resources (BOEM 2016).

Table C-1 describes the typical site characterization surveys, the types of equipment and method used, and which resources the survey information would inform.

Table C-1. Site characterization survey assumptions

Survey Type	Survey Equipment and Method	Resource Surveyed or Information Used to Inform
High-resolution geophysical surveys	Side-scan sonar, sub-bottom profiler, magnetometer, multi-beam echosounder	Shallow hazards, archaeological, bathymetric charting, benthic habitat
Geotechnical/sub-bottom sampling	Vibracores, deep borings, cone penetration tests	Geological
Biological	Grab sampling, benthic sled, underwater imagery/sediment profile imaging	Benthic habitat
	Aerial digital imaging; visual observation from boat or airplane	Birds, marine mammals, sea turtles
	Ultrasonic detectors installed on survey vessels used for other surveys	Bats
	Visual observation from boat or airplane	Marine fauna (marine mammals and sea turtles)
	Direct sampling of fish and invertebrates	Fish and invertebrates

C.2.1.2 Site Characterization Activities

After SAP approval, a lessee can evaluate the meteorological conditions, such as wind resources, with the approved installation of meteorological towers and buoys. Meteorological buoys have become the preferred meteorological and oceanographic data collection platform for lessees, and BOEM expects that most future site assessments would use buoys instead of towers (BOEM 2021a). Installation and operation of meteorological buoys involves substantially less activity and a much smaller footprint than construction and operation of a meteorological tower. There are no proposed or approved site assessment activities for any of the offshore California lease areas. Site assessment would likely take place starting within 1 to 2 years of lease execution, because preparation of an SAP (and subsequent BOEM review) takes time.

C.2.1.3 State Waters Projects

CADEMO Corporation (formerly Cierco), a renewable energy development company, has applied to the California State Lands Commission (CSLC) for a General Lease – Industrial Use of State Sovereign Land to develop an offshore wind demonstration project known as the CADEMO Floating Wind Energy Demonstration Project (CADEMO project). As shown in Figure C-5, the proposed CADEMO project would be located in state waters approximately 2.5 nm off the coast of Vandenberg Space Force Base, Santa Barbara County. The CADEMO project would install four floating wind turbines with individual capability of generating 12 to 15 megawatts (MW) of renewable electricity. The proposed offshore wind platforms are expected to include two different floating foundation designs to help evaluate the performance of each design (CSLC 2023a). As of 2024, the CADEMO project is considered too speculative to be included in this PEIS's cumulative analyses.

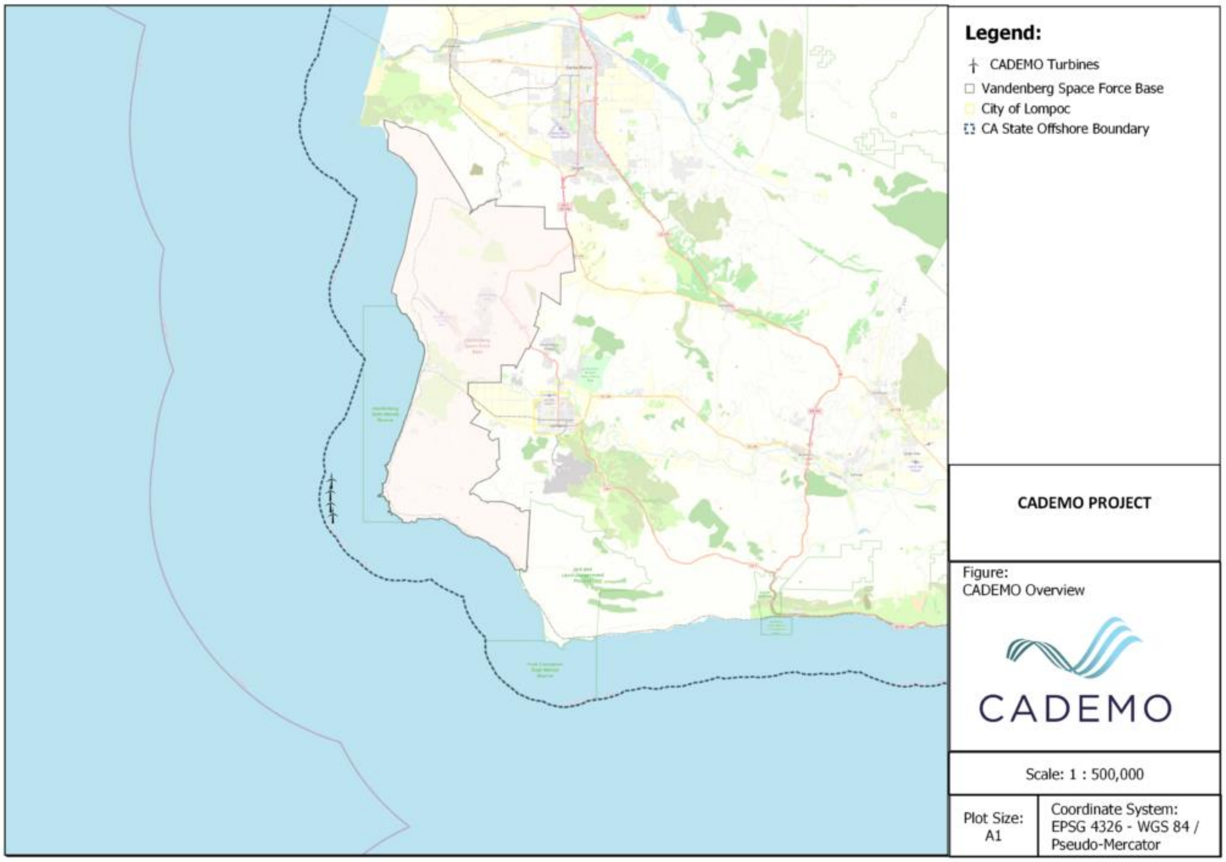

Figure C-5. Proposed CADEMO Project
Source: CADEMO 2024.

C.2.2 National Marine Sanctuary

The National Oceanic and Atmospheric Association (NOAA) is in the process of designating a Chumash Heritage National Marine Sanctuary off the central California coast. In September 2024, NOAA published a final Environmental Impact Statement (EIS) identifying the preferred alternative for the proposed sanctuary's boundary. Figure C-6 shows the agency-preferred alternative off the coast of San Luis Obispo and Santa Barbara Counties.

Following the final decision on designation, NOAA would release the final regulations and final management plan. Designation of a marine sanctuary would alter management and use of the area, although commercial fishing and vessel routing would not change. New exploration/development of oil, gas, and minerals would be prohibited; disposal would be more tightly regulated. The sanctuary may allow (with permits) activities that would disturb the seabed, including placement of submarine cables.

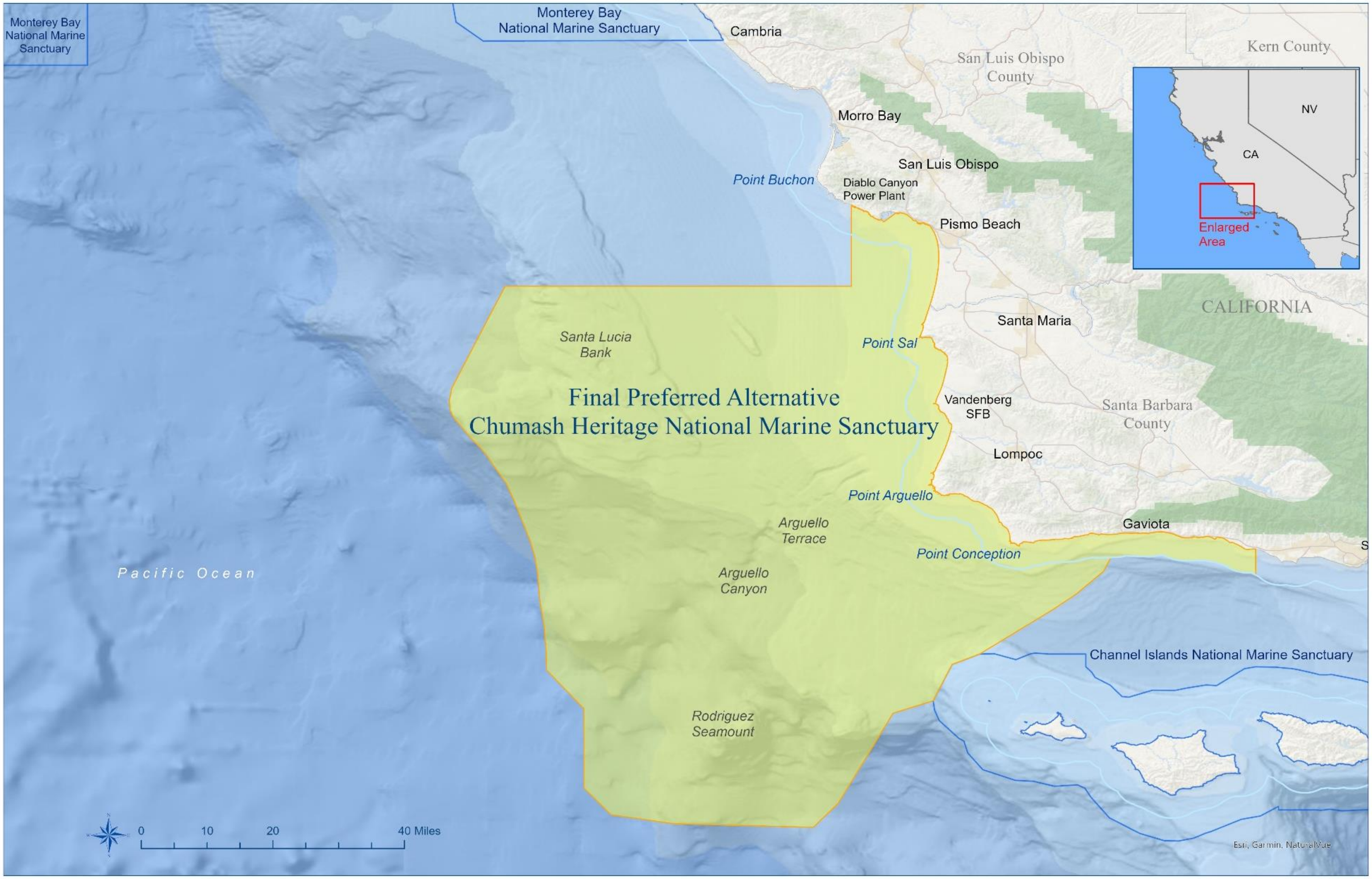

Figure C-6. Agency-preferred alternative for the Chumash Heritage National Marine Sanctuary
Source: NOAA 2024b.

C.2.3 Undersea Transmission Lines, Gas Pipelines, and Other Submarine Cables

Submarine cables, including fiber-optic cables, telecommunication, and trans-Pacific cables, exist with landings along the California coastline. Figure C-7 shows the offshore infrastructure near the Humboldt and Morro Bay WEAs.

Two telecommunication cables currently run through the southern portion of the Humboldt WEA. No known construction or repair is currently planned on those cables (BOEM 2022a). Near Humboldt Bay, the planned Echo Cable System would install a fiber-optic submarine cable system connecting the United States, Singapore, and Indonesia. Locally, the system would land near Eureka (on the Samoa Peninsula). Other cable landings would be on Guam, and in Indonesia and Singapore (Submarine Cable Networks 2021). Three landing pipes have been installed. The Echo cable installation into bore pipe was started in 2021 and was completed by August/September 2022. The TPU cable was to be installed in 2022 and the third bore pipe is to remain vacant awaiting future cable. The U.S. mainland–Guam segment is scheduled to commence operation in 2024. Telstra and TPN would operate the system (PR Newswire 2024).

The ongoing RTI Infrastructure, Inc. Grover Beach Subsea Fiber-Optic Cables Project has landings in the City of Grover Beach, San Luis Obispo County. The project involves up to six 2-inch-diameter subsea fiber-optic cables; two underground landing systems under Grover Beach surface streets; and other related infrastructure needed to support these structures. The first cable was installed in 2020 and two other bore pipes are to be installed in 2024. One pipe is to remain vacant awaiting a future cable (CSLC 2022).

Multiple submarine cables include fiber-optic cables and trans-Pacific cables exist with landings to the south of the Morro Bay WEA near Port San Luis. As of 2022, planning is currently underway for a new cable to be installed along the southern border of the Morro Bay WEA; the installation timeframe for this project is still under consideration (BOEM 2022b).

C.2.4 Hydrokinetic Energy Projects

The gravitational pull of the moon and sun along with the rotation of the Earth create tides in the oceans and, in some places, tides cause water levels near the shore to rise and fall up to 40 feet. Producing tidal energy economically requires a tidal range of at least 10 feet. The United States does not have any commercially operating tidal energy power plants although several demonstrations projects are in various stages of development. PacWave South is a planned open-ocean, wave-energy testing facility at Oregon State University. It consists of two sites, each within several miles of the deep-water commercial port of Newport, Oregon. PacWave South is being developed in partnership with the U.S. Department of Energy, the State of Oregon, and local interested parties. Construction started in 2021 and is expected to be completed in late 2024, with testing starting in 2025 (PacWave 2023, 2024). Figure C-8 is a schematic diagram of the PacWave Project.

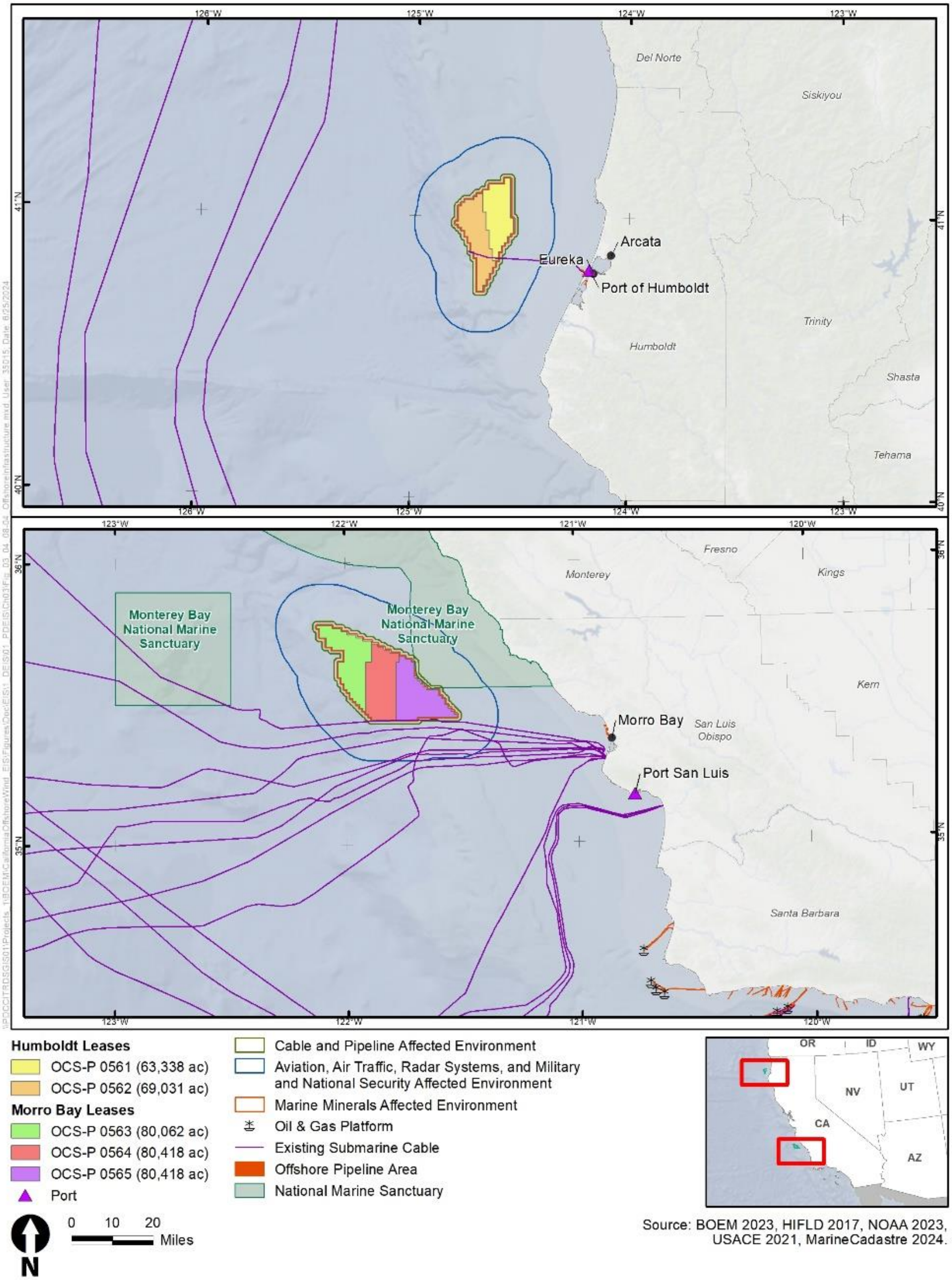

Figure C-7. Existing Offshore infrastructure near Humboldt and Morro Bay WEAs

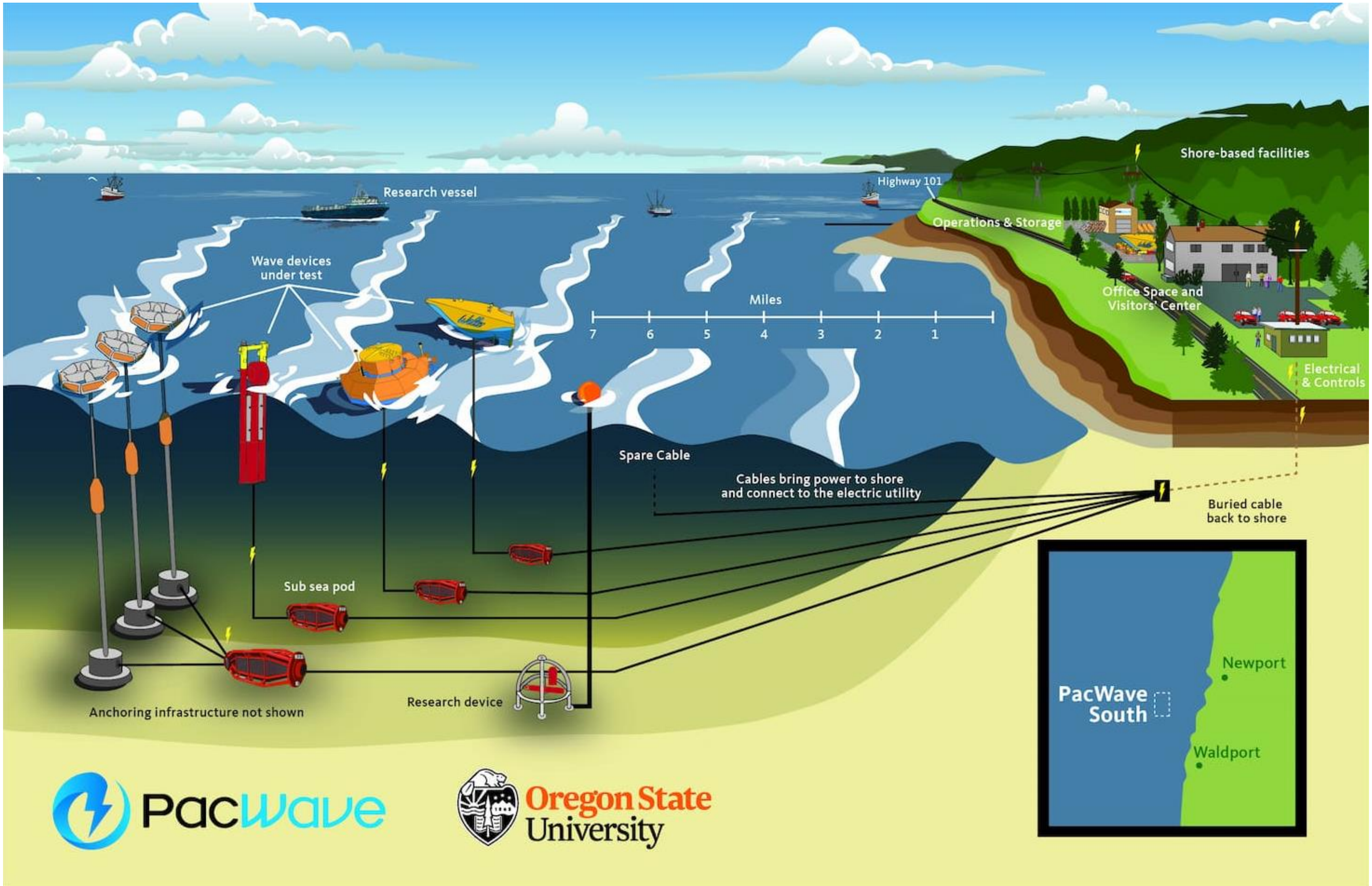

Figure C-8. Schematic Diagram of PacWave Project
Source: PacWave 2023.

C.2.5 Port Improvement and Dredging Projects

The State of California has established goals of deploying 5 gigawatts of offshore wind energy by 2030 and 25 gigawatts by 2045. Studies by BOEM, the National Renewable Energy Laboratory, and CSLC have indicated that major port development will be required throughout California for the federal/state goals to be realized (CSLC 2023b, 2023c). This PEIS identifies 5 of California's 12 major ports that are most expected to facilitate offshore wind development of the Humboldt and Morro Bay WEAs (the Ports of Humboldt, San Luis, Hueneme, Long Beach [POLB], and Los Angeles [POLA]). As indicated in the RPDE, lessees may choose to involve other ports or piers in various stages of project development. Lessees would identify any such intentions in their COPs; project-level National Environmental Policy Act and California Environmental Quality Act documents would analyze such plans accordingly. To this end, the following subsections identify prospective improvement projects at 15 California ports, with a particular focus on the 5 major ports.

C.2.5.1.1 Crescent City Harbor District

Crescent City Harbor was identified as a potential offshore wind operations and maintenance (O&M) site in the *California Floating Offshore Wind Regional Ports Feasibility Analysis* (BOEM 2023a).

The Crescent City Harbor District is proposing to undertake several port improvement projects for which construction contractor bids have been accepted (Port of Crescent City 2024). These include a solicitation to prepare an engineering design of a segment of a vertical breakwater in the Crescent City Harbor District's inner boat basin and a solicitation of proposals from lessees interested in partnering with the Harbor District in generating development proposals (Crescent City Harbor District 2024a). The project area for the vertical breakwater would extend from the seawall to the former Crescent City Coast Guard Station. Developer-proposed projects could include enhancements to harbor access, security, use and safety; support of commercial fishing and recreational uses; green building, energy efficiency, and innovative design; and other proposed projects including revenue-generating projects. The Harbor District is also initiating initial design and National Environmental Policy Act and California Environmental Quality Act process for the construction of a new seawall and a new citizens' dock in the Crescent City Harbor District (Crescent City Harbor District 2023, 2024b).

C.2.5.1.2 Port of Humboldt Bay

The Port of Humboldt Bay was identified as a potential offshore wind staging and integration (S&I) site, O&M site, and manufacturing/fabrication (MF) site in the *BOEM Feasibility Analysis* (BOEM 2023a).

The Humboldt Bay Harbor Recreation and Conservation District is proposing to redevelop the approximately 180-acre site on the Samoa Peninsula to provide a new multipurpose, heavy-lift marine terminal facility to support the offshore wind energy industry and other coastal-dependent industry (Humboldt Bay Harbor Recreation and Conservation District 2023a, 2023b). The following improvements are discussed in the *Notice of Preparation for the Humboldt Bay Offshore Wind Heavy Lift Multipurpose Marine Terminal Project*.

- Create larger components in the offshore wind supply chain, such as blades, towers, nacelles (turbine hubs), mooring lines, anchors, transmission cables, or floating foundations.
- Include a range of buildings, including manufacturing facilities, transit sheds, offices, or warehouse buildings.
- Develop S&I facilities that include the following.
  - Wharf/terminal/yard facilities, designed to receive, stage, and store offshore wind components, including ship-to-shore unloading capability, fixed-position ring crane unloading capability, crawler crane unloading capability, or roll-on/roll-off capability.
  - Heavy-lift wharves with high bearing capacities that can support large cranes.
- Develop pile-supported berths adjacent to the heavy-lift wharves within which floating foundations can be launched, potentially with a sinking basin; all components can be vertically integrated together on top of a floating foundation and wind turbine generators (WTGs) can be repaired, maintained, or decommissioned and towed out of the bay and into the ocean.
- Develop O&M facilities that can serve as a base of wind farm operations with warehouses/offices, spare part storage, and a marine facility to support vessel provisioning and refueling/charging for O&M vessels during the operational period of the offshore wind farm.
- Develop wet storage space in which floating foundations or WTGs can be temporarily moored to mitigate the risk of weather downtime, vessel traffic, entrance channel congestion, and other transportation risks. This would include both on-terminal and off-terminal wet storage spaces.

The Humboldt Harbor annually maintains the following channels: (1) the Bar and Entrance Channels to a depth of 48 feet mean lower low water (MLLW); (2) the North Bay Channel to 38 feet MLLW; (3) the Samoa Channel, including its turning basin, to 38 feet MLLW; (4) the Eureka Channel to 35 and 23 feet MLLW; and (5) the Fields Landing Channel to 26 feet MLLW. The project would involve modernizing the Samoa Lagoons Dredge Materials Dewatering Area. Dredged materials would be placed at the Humboldt Open Ocean Disposal Site, beneficially used, or disposed of elsewhere (USACE 2023a; Humboldt Bay Harbor Recreation and Conservation District 2023a, 2023b).

The U.S. Coast Guard (USCG) Station Humboldt Bay has applied for a 10-year Department of the Army permit to conduct maintenance dredging in the vessel mooring basin at USCG Station Humboldt Bay in Humboldt Bay in the City of Samoa, Humboldt County, California. The purpose of the proposed dredging is to return the station to the original design depths, thus facilitating safe navigation for USCG vessels. The applicant plans to remove approximately 3,000 cubic yards of sediment from the approximately 0.77-acre dredge site in an initial episode and approximately 10,000 cubic yards of material over the life of the permit. The design depth is -8 feet MLLW, plus an over-depth allowance of 2 feet in the station. The material would be removed using a shallow draft barge-mounted clamshell, hydraulic, suction, backhoe, or hopper dredge and transported by barge to the Humboldt Open Ocean Disposal Site. Prior to each dredging episode, the U.S. Army Corps of Engineers (USACE) and U.S. Environmental Protection Agency (USEPA) will evaluate the sediments to be dredged for disposal or reuse suitability (USACE 2023b).

C.2.5.1.3 Port of Stockton

The Port of Stockton was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 40 acres of existing uplands space may be available for an MF Site at the Port of Stockton.

The Stockton Port District has prepared CEQA documentation for several proposed port infrastructure projects (Stockton Port District 2024a), including the BayoTech Hydrogen Production and Filling Falicity Project, BWC Terminals LLC MOTEMS-Compliant Marine Oil Terminal and Berthing System Development Project, McDonald Island Dredged Material Placement Site, and Warehousing and Distribution Facility Project.

BayoTech Hydrogen Production and Filling Facility Project

BayoTech, Inc. would develop and operate a hydrogen production and filling facility at the Port of Stockton to produce and distribute hydrogen to customers throughout the region. The proposed project includes issuance of a new lease by the Port to BayoTech for the conversion of a vacant, approximately 5-acre parcel into a hydrogen-generation, compression, and storage facility to support an increasing demand for hydrogen fuel for passenger and heavy vehicle transportation fueling, fueling of stationary and mobile fuel cell power applications in the Port, and fueling of stationary and mobile fuel cell power applications for commercial and industrial customers. Anticipated total construction duration is approx. 4 months, sequenced over several phases, and is anticipated to commence in summer 2024 and be completed in fall 2024. The Initial Study/Mitigated Negative Declaration (IS/MND) was released for public review in May 2023. The Port conducted a public meeting for the proposed project on April 9, 2024 (State of California 2024a).

BWC Terminals LLC MOTEMS-Compliant Marine Oil Terminal and Berthing System Development Project

A new permanent dock would be constructed at the Port of Stockton. The proposed permanent dock would meet Marine Oil Terminal Engineering and Maintenance Standards (MOTEMS) seismic and safety regulations. The new permanent MOTEMS dock and berthing system would connect to BWC Terminals LLC's existing facilities at the Port to enable receipt and distribution of renewable diesel and biodiesel by vessel (State of California 2024b).

McDonald Island Dredged Material Placement Site

The Port of Stockton published an IS/MND-EA to evaluate the impacts of constructing a new, expanded dredged material placement site on McDonald Island and operating the site as part of USACE's ongoing Stockton Deep Water Ship Channel O&M program (Port of Stockton 2022). The November 2022 EA is a supplement to the September 1980 (revised February 1981) San Francisco Bay to Stockton EIS, which evaluated impacts of deepening five channels and one strait channel, including the Stockton Deep Water

Ship Channel, and maintenance dredging of the Stockton Deep Water Ship Channel with placement of dredged sediment at 21 upland placement sites. A Final IS/MND is in preparation for the proposed project (Stockton Port District 2024b).

Warehousing and Distribution Facility Project

The proposed project would develop a new warehouse building and associated infrastructure over approximately 60 acres of the Port's West Complex to receive, store, and distribute bulk building products and consumer goods. The proposed project would also include remediation of contaminated soils from past U.S. Navy activities associated with the remedial site, referred to as Site 47 (State of California 2024c; Port of Stockton 2023).

C.2.5.1.4 Port of Benicia

The Port of Benicia is privately owned and operated by AMPORTS (AMPORTS 2021a). No proposed or ongoing infrastructure projects have been identified for the Port of Benicia (Benicia Business 2024). The Port includes three berths and 356,000 square feet of processing buildings. Principal operations are roll-on/roll-off shipping (AMPORTS 2021a). The Port of Benicia was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 20 acres of upland property could be available in Benicia for an MF site.

C.2.5.1.5 Port of Richmond

The Port of Richmond encompasses five City-owned terminals and ten privately owned terminals for handling bulk liquids, dry bulk materials, metals, vehicles, and break-bulk cargoes (City of Richmond 2024a). No proposed or ongoing infrastructure projects have been identified at this port(City of Richmond 2024b). The Port of Richmond was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 40 acres of upland property could be available in Richmond for an MF site.

C.2.5.1.6 Port of San Francisco

The Port of San Francisco was identified as potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 95 acres of existing uplands space may be available for an MF site at the Port of San Francisco.

The Port of San Francisco, and the San Fransisco Coastal Area, is undergoing a Waterfront Resilience Program involving multiple phased projects. The Port's Waterfront Resilience Program, implemented by the Port of San Francisco in partnership with USACE and City/County of San Francisco, is intended to implement actions to reduce seismic and climate change risks to the Port and to the Coastal Area. The projects include earthquake stabilization and seawall, bulkhead, and wharf rehabilitation and replacement projects. As of 1Q 2024, 23 Embarcadero Early Projects had been identified, 11 of which were to advance to pre-design; 5 were on hold pending USACE decision; and 7 were to advance through coordination with port tenants, capital programs, and City agency coordination (Port of San Francisco 2024).

C.2.5.1.7 Port of Oakland

The Port of Oakland in partnership with USACE prepared a Draft Environmental Impact Report (EIR) for the Oakland Harbor Turning Basins Widening Study (Port of Oakland 2023). The EIR was available for public review and comment from October 3, 2023, through December 18, 2023. The proposed project involves widening the diameter of the existing turning basins at the Oakland Seaport. The turning basin widening project would allow vessels to turn around more efficiently and safely upon entering and exiting the Oakland Harbor in Alameda County, California.

The Port of Oakland was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 40 acres of existing uplands space may be available for an MF site at the Port of Oakland.

C.2.5.1.8 Port of Redwood City

The Port of Redwood City provides 5 wharves and has approximately 100 tenants and businesses. The port provides berths for dry bulk, liquid bulk, and other cargoes and provides public access to the San Francisco Bay and water recreational opportunities (Port of Redwood City 2024). The port partners with USACE regularly to support dredging of the main Redwood City harbor channel. The port also funds dredging in and around port wharves 1–4 in the Redwood Creek Channel. The port has prepared a feasibility study of establishing public ferry service in Redwood City (Port of Redwood City 2020).

The Port of Redwood City was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port feasibility study reported that potentially 20 acres of upland property could be available in Redwood City for a MF site.

C.2.5.1.9 Pittsburg

No proposed or ongoing projects have been identified for the waterfront of the City of Pittsburg. Pittsburg was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port Feasibility Study identified potentially 100 acres of existing uplands space may be available for a MF site at Pittsburg.

C.2.5.1.10 Antioch

The Port of Antioch is privately owned and operated by AMPORTS (AMPORTS 2021b). AMPORTS reported that one dedicated berth is under construction for roll-on/roll-off service (AMPORTS 2021b, 2021c). The Port of Antioch was identified as a potential MF site in the BOEM Feasibility Analysis (BOEM 2023a). The BOEM Port Feasibility Study identified potentially 100 acres of existing uplands space may be available for a MF site at Antioch.

C.2.5.1.11 Port of San Luis

The Port of San Luis was identified as a potential O&M site in the *California Floating Offshore Wind Regional Port Feasibility Analysis, OCS Study*. This port was evaluated in the study to assess the feasibility of implementing the required infrastructure improvements for an O&M site. The feasibility study included the following aspects of prospective development.

- **Demolition:** Demolition is included for any existing structures or features such as buildings on the nearshore area.
- **Site acreage:** Based on previous outreach to Port of San Luis, some onshore area is available but may not be directly adjacent to the pier.
- **Wharf:** An extension of the existing pier to accommodate a service operation vessel is required. The extension of the pier is assumed to be 300 feet to accommodate a service operation vessel or crew transfer vessel. Extension of the pier would involve installation of piles potentially requiring pile driving.
- **Berth pocket:** The water depth at the end of the existing pier where the vessels will berth is approximately 35 feet and can accommodate a service operation vessel or crew transfer vessel; therefore, dredging is not required.

A private lessee is seeking to expand Port San Luis for its prospective use as an O&M facility.

C.2.5.1.12 Port of Hueneme

Port Hueneme was identified as a potential O&M site in the *California Floating Offshore Wind Regional Ports Feasibility Analysis, OCS Study*. This port was evaluated in the study to assess the feasibility of implementing the required infrastructure improvements for an O&M site. Therefore, the COPs may propose different or additional improvements in the future (Port of Hueneme 2023; BOEM 2023a). According to the *California Floating Offshore Wind Regional Ports Assessment* (BOEM 2023b), Port Hueneme is ideal for crew transfer due to its proximity to the Morro Bay WEA in comparison to the other ports. However, it does not have enough acreage for an S&I site and would not be able to service a fully assembled turbine system from the offshore wind farm. This turbine system would need to be towed to POLA or POLB.

Infrastructure improvements to support O&M activities include paving improvements and upgrades to fendering systems. The existing berth water depth is approximately -33 feet; therefore, no dredging would be required (BOEM 2023b). However, Port Hueneme's navigation channel may not be deep enough to accommodate drafting depths of fully assembled floating wind turbines. This may require an offshore construction site for the final assembly of constructed wind turbines (CSLC 2021).

C.2.5.1.13 Port of Long Beach

POLB was identified as potential offshore wind S&I site, O&M site, and MF site in the BOEM Feasibility Analysis (BOEM 2023a). POLB was also identified in the BOEM PEIS (BOEM 2023d) to be a potential location for offshore oil and gas platform decommissioning activities, including potential processing of scrap materials. Aspects of POLB include proximity to the offshore oil and gas platforms, access to steel recycling facilities, and potential for large purpose-built sites to support decommissioning activities.

POLB is evaluating the opportunity to develop an approximately 400-acre terminal known as Pier Wind. In-water construction activities would include approximately 50 million cubic yards of dredging for fill material and surcharge. Additionally, as a part of the Deep Draft Navigation Project, a new dredge electric substation would be constructed and dredged material would be placed either at a nearshore placement site, an ocean-dredged material disposal site (LA-2, LA-3, or both), or a combination of the two.[3]

The Pier Wind project would feature a 400-acre terminal with the flexibility to serve offshore wind industry needs (i.e., S&I), foundation fabrication, component manufacturing, and maintenance support. POLB proposes that the terminal would meet the physical, regulatory, and environmental requirements to accommodate the largest floating offshore WTG components and floating foundations being developed (POLB 2023a). On November 30, 2023, POLB published a Notice of Preparation/Notice of Intent to Prepare a Joint EIR/EIS and Notice of Public Scoping Meetings for the proposed Pier Wind project (POLB 2023b, 2023c). POLB anticipates publishing the draft EIR/EIS by summer 2025.

In addition, POLB is planning for the Deep Draft Navigation Project, with the Final EIR/EIS having been published in October 2021 (POLB 2023b; USACE 2021b). This project would include the following improvements.

- Deepen the entrance to the Main Channel from a project depth of -76 feet to -80 feet MLLW.
- Construct an approach channel and turning basin to Pier J South from -50 feet MLLW to a depth of -55 feet MLLW.
- Widen portions of the Main Channel to a depth of -76 feet MLLW.
- Deepen portions of the West Basin and West Basin Approach from -50 feet to a depth of -55 feet.
- Deepen the Pier J Basin and berths J266–J270 in the Pier J South Slip to a depth of -55 feet MLLW.
- Install an additional 15 dredge electric substations on Pier J.
- Implement potential wharf improvements at berths J266–J270 in the Pier J 16 South Slip and at berth T140 along Pier T and create a temporary staging area.

C.2.5.1.14 Port of Los Angeles

POLA was identified as potential S&I site, O&M site, and MF site in the BOEM Feasibility Analysis (BOEM 2023a). Based on previous outreach to POLA, potentially 160 acres of new land could be created in the port for S&I and MF sites. This is assumed to be achieved by dredging portions of POLA to provide the

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[3] The LA-2 site is a permanently designated ocean-dredged material disposal site that POLA has historically managed for the disposal of material dredged primarily from the Los Angeles/Long Beach Harbor complex. The LA-2 disposal site is on the OCS margin, at the upper southern wall of San Pedro Sea Valley, at depths from 380–1,060 feet (110 to 320 meters), about 6.8 miles (11 kilometers) south-southwest of the Queens Gate entrance to the Los Angeles/Long Beach Harbor. The site is centered at 33º37'6" north and 118º17'24" west with an overall radius of 3,000 feet (915 meters). The LA-3 site is offshore of Newport Beach, CA; the center coordinates of the circle-shaped site are: 33° 31′ 00″ north by 117° 53′ 30″ west with a radius of 3,000 feet (915 meters).

necessary sediment to create 160 acres (BOEM 2023a). Planned improvements would include the following.

- **Berth pocket dredging:** USEPA manages three ocean disposal sites off of Southern California: LA-2 off of the Ports of Los Angeles and Long Beach, LA-3 off of Newport Beach, and LA-5 off of San Diego Bay (USACE 2023c). Portions of the port would be substantially dredged to produce enough material to create 160 acres of new land; therefore, the berth pocket could be approximately -60 feet.
- **Sinking basin:** Depending on the floating foundation technology, a sinking basin may be required to off-float the floating foundations. Because there are already deep waters to approximately -80 feet available in the port, only a sinking basin dredging cost to 100 feet is provided. The base of the sinking basin is assumed to be 600 feet by 1,000 feet to accommodate semi-submersible barges (BOEM 2023a).

C.2.5.1.15 Port of San Diego

As of 2024, the Port of San Diego is conducting port development projects including commercial (retail, residential) development and port operations development (Port of San Diego 2024a). Projects under construction in 2024 include the 535-acre Chula Vista Bayfront redevelopment, a partnership between the Port of San Diego and City of Chula Vista (Port of San Diego 2024b). Projects in the planning/CEQA process include the Central Embarcadero Project, a 108-acre project that is to include parks and promenades; piers and marinas; hospitality, retail and restaurants; commercial fishing uses; multiple visitor attractions; an urban beach; and educational uses (Port of San Diego 2024c).

C.2.6 Marine Minerals Use and Ocean-Dredged Material Disposal

C.2.6.1 Marine Minerals

According to the Marine Minerals Information System, there are no marine minerals areas of concern in any proximity to the Affected Environment (MMIS 2024).

C.2.6.2 Dredged Material Disposal

USEPA Region 9 is responsible for designating and managing ocean disposal sites in the Affected Environment, except for disposal of dredged material, which is the responsibility of USACE. Several historical active and inactive ocean disposal sites are in the marine mineral extraction Affected Environment (USEPA 2024a, 2024b; ERDC 2024).

- **Humboldt Bay Harbor (SF-3):** 0.02 square nm (37-meter) radius; closed
- **Humboldt Nearshore Disposal Site (NDS):** 0.17 square nm (317 meters); closed
- **Humboldt Open Ocean Disposal Site (HOODS):** 1 square nm (1,852 meters); active
- **Los Angeles/Long Beach (LA-2):** 3,000-foot radius (914 meters); active
- **Newport Beach (LA-3):** 3,000-foot radius (914 meters); active

C.2.7 National Security and Military Use

The U.S. Navy, within the Department of Defense (DOD), has been using the waters and airspace off the coast of Central and Southern California for military training and testing activities for nearly 80 years. There are specific areas within which it has regular at-sea activities.

Vandenberg Space Force Base is recognized as a DOD Major Range Test Facility Base activity, which is a part of the designated core set of DOD Test and Evaluation infrastructure and associated workforce and is considered a national asset. Vandenberg Space Force Base commands the West Coast Offshore Operating Area, a 200-nm-wide corridor off the West Coast that stretches from Portland, Oregon to the U.S.–Mexican border. The West Coast Offshore Operating Area is used extensively for space lift operations, ballistic missile test events, and aeronautical operations. Moreover, the Navy conducts state-of-the-art weapons systems testing and evaluations in Point Mugu Sea Range, which overlaps with the proposed Chumash Sanctuary area. Point Mugu Sea Range is the Navy's primary ocean testing area for guided missiles and related ordnance and is also recognized as a Major Range Test Facility Base. There are numerous Navy activities that conduct testing and training in this region. Although Point Mugu Sea Range is the largest designated area, other Navy activities such as the U.S. Pacific Fleet and the Naval Sea Systems Command conduct Military Readiness Activities in this region, as well as other services. The Naval History and Heritage Command administers the Navy's authorities and responsibilities under the Sunken Military Craft Act to protect sunken military crafts (CSLC 2021).

The Morro Bay WEA is within at-sea warning areas W-285 and W-532 as designated by the Federal Aviation Administration, which have the purpose of warning non-participating pilots of potential danger from hazardous activities such as military training and testing. W-285 and W-532 are utilized daily for aviation training, supporting strike fighter wing squadrons based at Naval Air Station Lemoore near Lemoore in Kings County (Figure C-9). This warning area is also utilized for training and certification exercises. Navy and Marine Corps Amphibious Ready Group/Marine Expeditionary Units train in this area due to training opportunities at U.S. Army Fort Hunter Liggett in Jolon in southern Monterey County.

DOD will continue to conduct military testing and training activities within and in the vicinity of the Morro Bay WEA during the timeframe considered in the Draft PEIS. These activities include aviation training, carrier strike group training, and amphibious/U.S. Marine expeditionary unit training. Military training and testing activities may be temporarily displaced during the execution of site assessment and characterization activities in the lease areas. Modifications to these activities may be necessary to allow for training and readiness requirements. BOEM and lessees would continue coordination with DOD during conduct of site assessment and characterization activities to deconflict activities when practicable (BOEM 2022b).

On September 23, 2021, the U.S. Navy released its Record of Decision to continue training and testing activities at sea and in associated airspace within the Northwest Training and Testing Study Area (Navy 2021). This area extends offshore Washington and through Oregon and overlaps the Humboldt WEA. The Humboldt and Morro Bay WEAs are not in Special Use Airspace or other specifically designated use areas for Northwest Training and Testing.

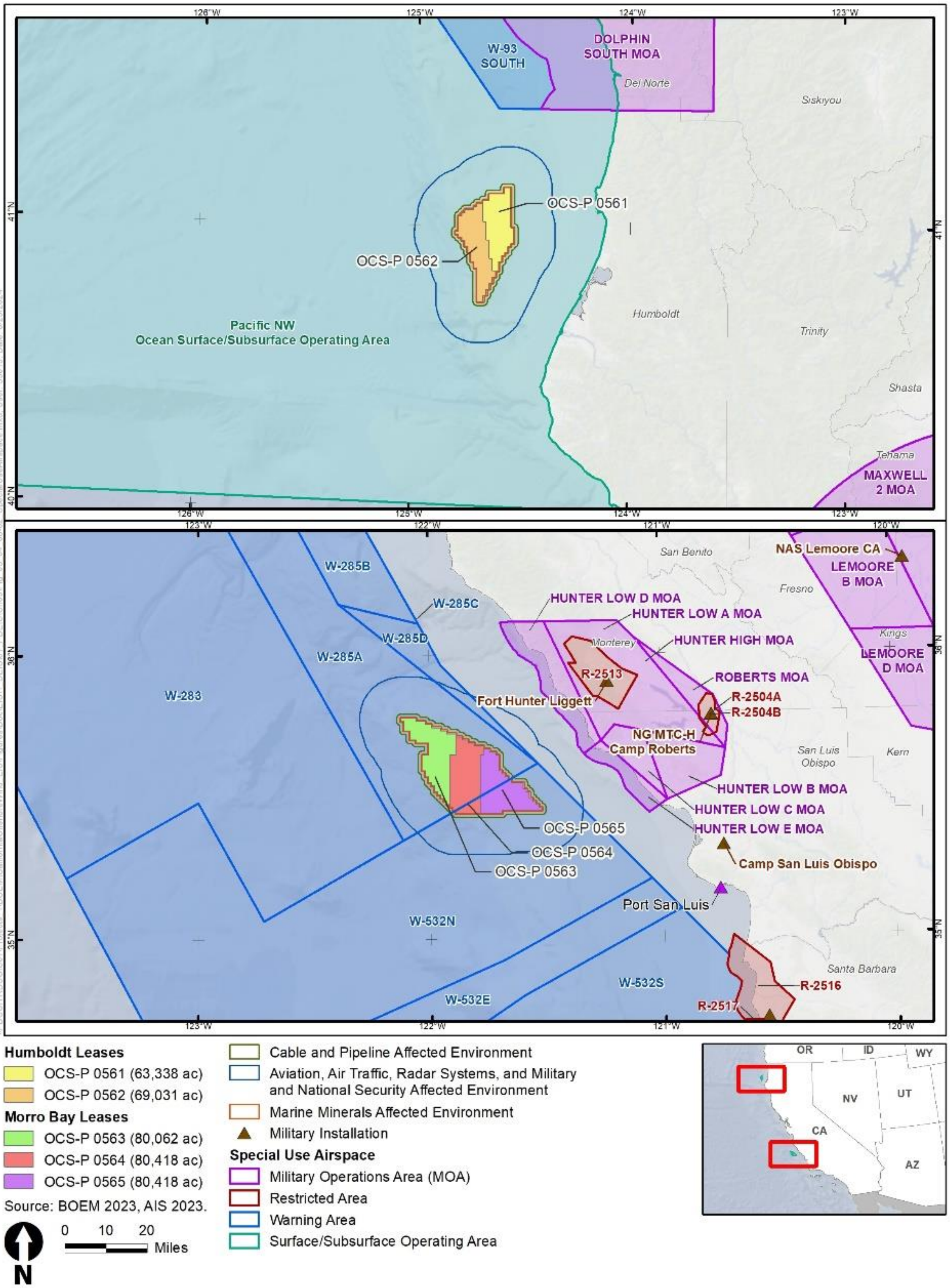

Figure C-9. Military use areas in and adjacent to the Humboldt and Morro Bay WEAs

C.2.8 Marine Transportation

Marine transportation in the region is diverse and sourced from many ports and private harbors. The 2016 expansion of the Panama Canal has shifted freight volume from West Coast ports to East Coast and Gulf Coast ports, and over time may possibly decrease freight transport between Asia to large West Coast United States ports (Park et al. 2020). The expanded Panama Canal allows larger vessels from Asia to travel directly to Atlantic coast U.S. ports.

The Pacific Coast Port Access Route Study was initiated in 2021 to determine whether new or modified vessel routing measures were needed to ensure safety of navigation along the U.S. Pacific Coast due to the quickly evolving demand for use of coastal waters. Figure C-10 shows proposed navigation fairways for California ports in USCG District 11 (USCG 2023).

The area north of POLA and POLB is strongly influenced by POLA/POLB port traffic. A majority of commercial vessel traffic (over 300 gross tons) that transits through the area is either inbound or outbound from the Santa Barbara Channel.

Oil and gas platform abandonment and decommissioning will also likely occur in the next 5 to 10 years in the region and would result in an increase in vessel traffic and port utilization (NOAA 2024b). BOEM prepared a PEIS for decommissioning of oil and gas platforms in the Pacific OCS (BOEM 2023d). During decommissioning activities there would be a small increase in surface vessel traffic in the immediate vicinity of the platform undergoing decommissioning. These vessels might include lift crane vessels, supply and utility boats, tugboats, offshore support vessels, and barges. BOEM (2023d) indicated that increases in vessel traffic as a result of planned decommissioning activities would be negligible as compared to the existing volume of vessel traffic in the area; for example, the POLA and POLB combined receive about 4,000 commercial and cruise vessel arrivals annually, many of which come through the Santa Barbara Channel. BOEM (2023d) indicated that decommissioning activities would have negligible effects on congestion of traffic lanes in the Santa Barbara Channel or on those leading to the POLA and POLB.

Refer to Section C.2.11, *Onshore Development Activities*, regarding anticipated decommissioning activities for oil and gas platforms on the Pacific OCS off the Southern California coast.

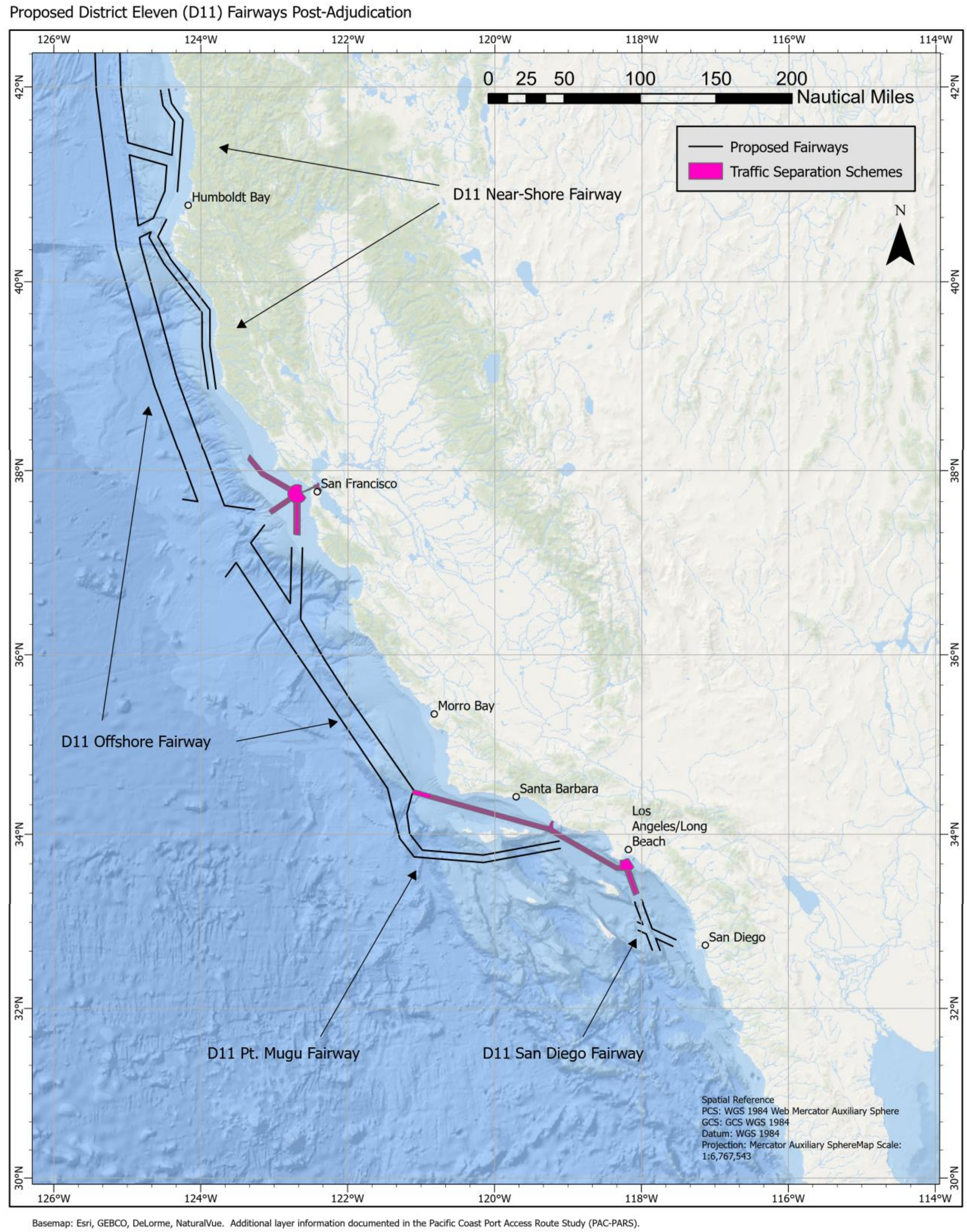

Figure C-10. Proposed District Eleven (D11) Fairways post adjucation
Source: USCG 2023.

C.2.9 Fisheries Use and Management

Each year NOAA's National Marine Fisheries Service (NMFS) conducts several large-scale scientific surveys along the West Coast to monitor and assess the populations of fishery stocks, marine mammal stocks, and threatened and endangered species, as well as their habitats, in the California Current Large Marine Ecosystem. NMFS conducts approximately eight to twelve large-scale surveys each year, including surveys conducted to support fisheries management plans. Refer to Section C.2.9.2. Some of these surveys are conducted in the Humboldt and Morro Bay WEAs. BOEM anticipates continued coordination and cooperation with NMFS to reduce or avoid conflict between site assessment/site characterization activities and scientific surveys.

NMFS's regulatory process, which includes stock assessments for all marine mammals and 5-year reviews for all species listed under the Endangered Species Act (ESA), assists in informing decisions on take authorizations and the assessment of project-specific and cumulative impacts that consider ongoing and planned activities in biological opinions. Stock assessments completed regularly under the Marine Mammal Protection Act include estimates of potential biological removal that stocks of marine mammals can sustainably absorb. Fish stock assessments in the West Coast Region involve both the Northwest and Southwest Fisheries Science Centers within NOAA. These centers collect data to inform the stock assessments from at-sea surveys every year. In Fiscal Year 2021, the centers completed five surveys (NOAA Fisheries 2022a). The Marine Mammal Protection Act authorizations require that a proposed action have no more than a negligible impact on species or stocks, and that it impose the least practicable adverse impact on the species. The Marine Mammal Protection Act authorizations are reinforced by monitoring and reporting requirements so that NMFS is kept informed of deviations from what has been approved. Biological opinions for federal and nonfederal actions are similarly grounded in status reviews and conditioned to avoid jeopardy and allow continued progress toward recovery.

The California Cooperative Oceanic Fisheries Investigations (CalCOFI) is a partnership of the CDFW, NOAA Fisheries, and Scripps Institution of Oceanography. CalCOFI conducts quarterly cruises off the southern and central California coasts to collect a suite of environmental and marine ecosystem data. These data are used to study the California Current, manage its living resources, and monitor indicators of El Niño and climate change (CalCOFI 2024a). Figure C-11 shows the 113 CalCOFI sampling stations, including stations located in state, federal, and international waters.

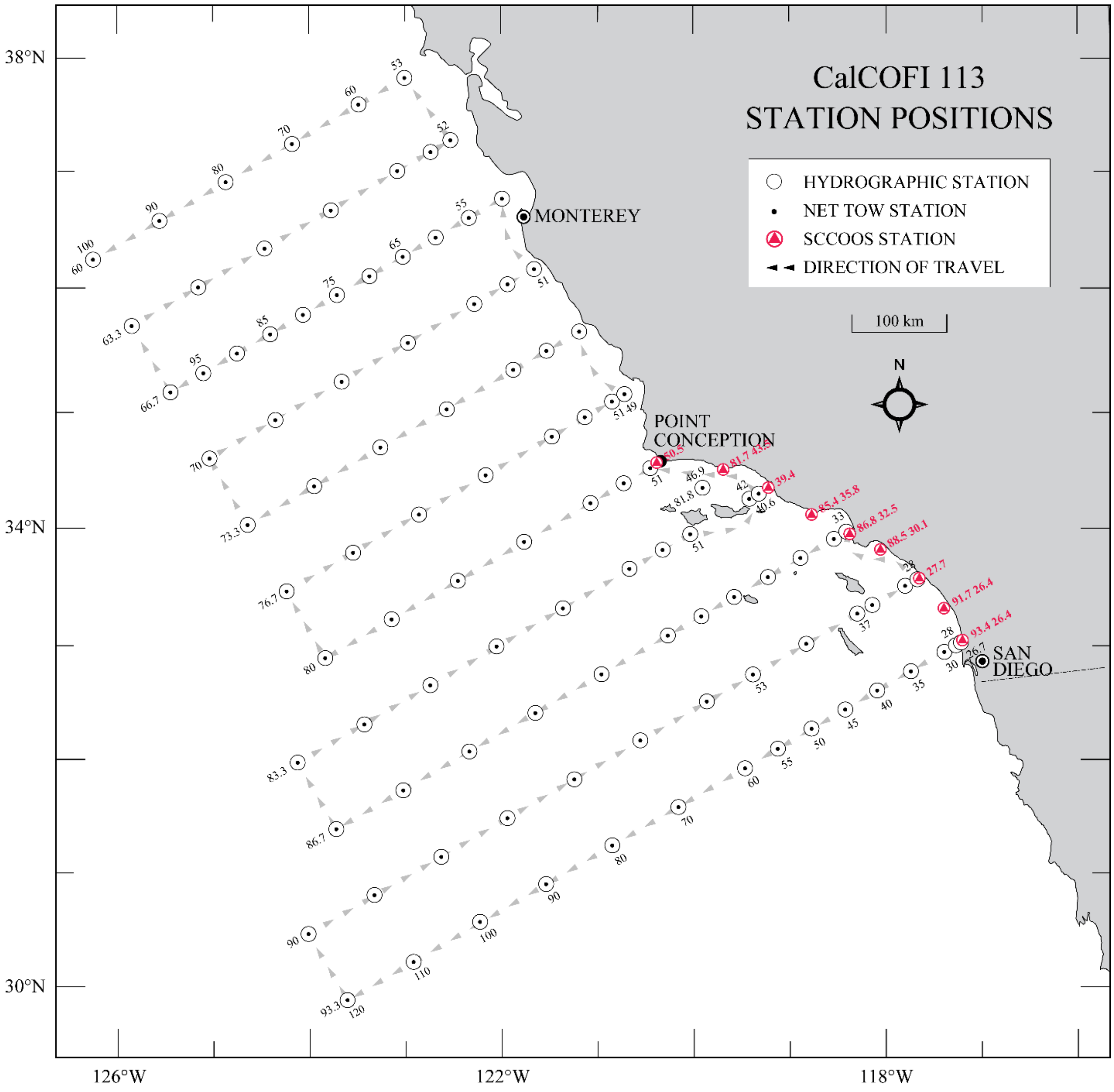

Figure C-11. CalCOFI Station Locations

Source : CalCOFI 2024b.

C.2.9.1 Directed Take Permits for Scientific Research and Enhancement

NMFS issues permits for research on protected species for scientific purposes. The West Coast Region issues permits and authorizations under ESA Sections 4(d) and 10(a) for directed and incidental take of listed species along the West Coast under carefully defined circumstances and as long as such take will not jeopardize the continued existence of the species or adversely modify its critical habitat. These scientific research permits include the authorization of directed take for activities such as capturing animals and taking measurements and biological samples to study their health, tagging animals to study their distribution and migration, photographing and counting animals to get population estimates, taking animals in poor health to an animal hospital, and filming animals. Permits for research or enhancement on Pacific marine and anadromous fish (e.g., salmon, green sturgeon, eulachon) and abalone are processed by the West Coast Region. ESA 4(d) rules contain a limit to take prohibitions for specific scientific research and monitoring activities conducted by employees or contractors of the state fisheries agencies of California, Oregon, and Washington, or as a part of a research and monitoring program overseen by or coordinated with those agencies. This process provides a way for NMFS and the state fisheries agencies to coordinate and review research proposals. The state fisheries agencies screen all research applications and then work with NMFS to ensure authorized research does not operate to the disadvantage of ESA-listed species (NOAA 2022a). NMFS also issues permits for enhancement purposes; these permits are issued to enhance the survival or recovery of a species or stock in the wild by taking actions that increase an individual’s or population’s ability to recover in the wild. Reasonably foreseeable future impacts from scientific research and enhancement permits include physical and behavioral stressors (e.g., restraint and capture, marking, implantable and suction tagging, biological sampling).

C.2.9.2 Fisheries Use and Management

The Humbolt and Morro Bay WEAs overlap with the Pacific Fishery Management Council (PFMC) jurisdictional area. PFMC is responsible for making recommendations for federal fisheries management measures to NMFS for implementation. PFMC manages fisheries for salmon, groundfish, coastal pelagic species (sardines, anchovies, and mackerel), and highly migratory species (tunas, sharks, and swordfish) from 3 to 200 miles off the coasts of Washington, Oregon, and California (pcouncil.org).

PFMC established its fishery management plans in part to avoid overfishing. The management plans include an array of measures such as annual catch quotas, minimum size limits, and closed areas. PFMC created an Ad Hoc Marine Planning Committee to discuss and develop policy for PFMC consideration regarding offshore wind energy and aquaculture activities along the West Coast. BOEM notes that the committee recommends coast-wide cumulative effects analysis of all wind energy proposed areas (taking into consideration all areas closed to fishing) on all commercial and recreational fisheries, fishing communities, and impacts on domestic seafood production (including port-based fishery-specific facilities and related services). The Humboldt WEA overlaps with designated Rocky Reef Habitat Areas of Particular Concern and with the Mad River Rough Patch Essential Fish Habitat Conservation Area for

Pacific groundfish. Both of these spatially discrete areas are closed to bottom trawling and represent a high-priority habitat for conservation, management, or research (NOAA Fisheries 2023b).

The Morro Bay WEA overlaps roughly 50 percent with the Big Sur Coast/Port San Luis Essential Fish Habitat Conservation Areas (PFMC 2023). Essential Fish Habitat Conservation Areas (Figure C-12) are spatially discrete areas closed to bottom trawling and, in some cases, other types of bottom-contact gear, to protect important habitat features. The Big Sur Coast/Port San Luis Essential Fish Habitat Conservation Areas extend from Santa Lucia Bank to Monterey Bay Canyon and encompass an expansive and geologically complicated region of contiguous rock, mixed substrates, submarine canyons, rocky banks, and steep slope terrain. Further bottom-closure areas exist to the western boundary of the Morro Bay WEA; a trawl Rockfish Conservation Area was opened to fishing inshore of the Morro Bay WEA.

NMFS also creates and implements some fisheries management measures as part of U.S. obligations under various international fishery agreements. NMFS 's Highly Migratory Species Program works to develop, implement, and evaluate fisheries policies and regulations for managing sustainable fisheries for eastern Pacific Ocean species such as Pacific tunas, swordfish, sharks, and billfish (NOAA 2024). Table C-2 summarizes other fishery management plans (FMP) and actions in the region.

Table C-2. Other fishery management plans

Area	Plan and Projects	Reference
West Coast	Coastal Pelagic Species Management Plan: A total of seven stocks are managed under the Coastal Pelagic Species FMP, comprising four finfish species, one squid species, and eight krill species	NOAA Fisheries, Coastal Pelagic Species Management Plan (NOAA Fisheries 2023a)
West Coast	Pacific Coast Groundfish FMP. The Pacific Coast Groundfish FMP describes how PFMC develops decisions for management of the groundfish fishery off California, Oregon, and Washington. Since it was first implemented in 1982, PFMC has amended the FMP numerous times in response to changes in the fishery, reauthorizations of the Magnuson-Stevens Fishery Conservation and Management Act, and litigation.	NOAA Fisheries, Pacific Coast Groundfish Fishery Management Plan (NOAA Fisheries 2023b)
West Coast	Pacific Salmon FMP. Pacific salmon fisheries provide for commercial, recreational, and tribal harvest in ocean and inland waters. The broad geographic range and migration route of salmon, from the inland tributaries of Idaho to offshore areas of Alaska and Canada, requires comprehensive management by several entities. NOAA Fisheries works in cooperation with federal, state, tribal, and Canadian officials to manage these fisheries through several forums.	NOAA Fisheries, Pacific Salmon Fisheries Management Plan (NOAA Fisheries 2022b)
West Coast	West Coast Highly Migratory Species. NMFS West Coast Region's Highly Migratory Species Program develops, implements, and evaluates fisheries policies and regulations to manage sustainable fisheries for eastern Pacific Ocean species such as Pacific tunas, swordfish, sharks, and billfish. Highly migratory species are found throughout the Pacific Ocean and migrate across jurisdictional boundaries.	NOAA Fisheries, Fishery Management Plan for U.S. West Coast Highly Migratory Species, (NOAA Fisheries 2023c)

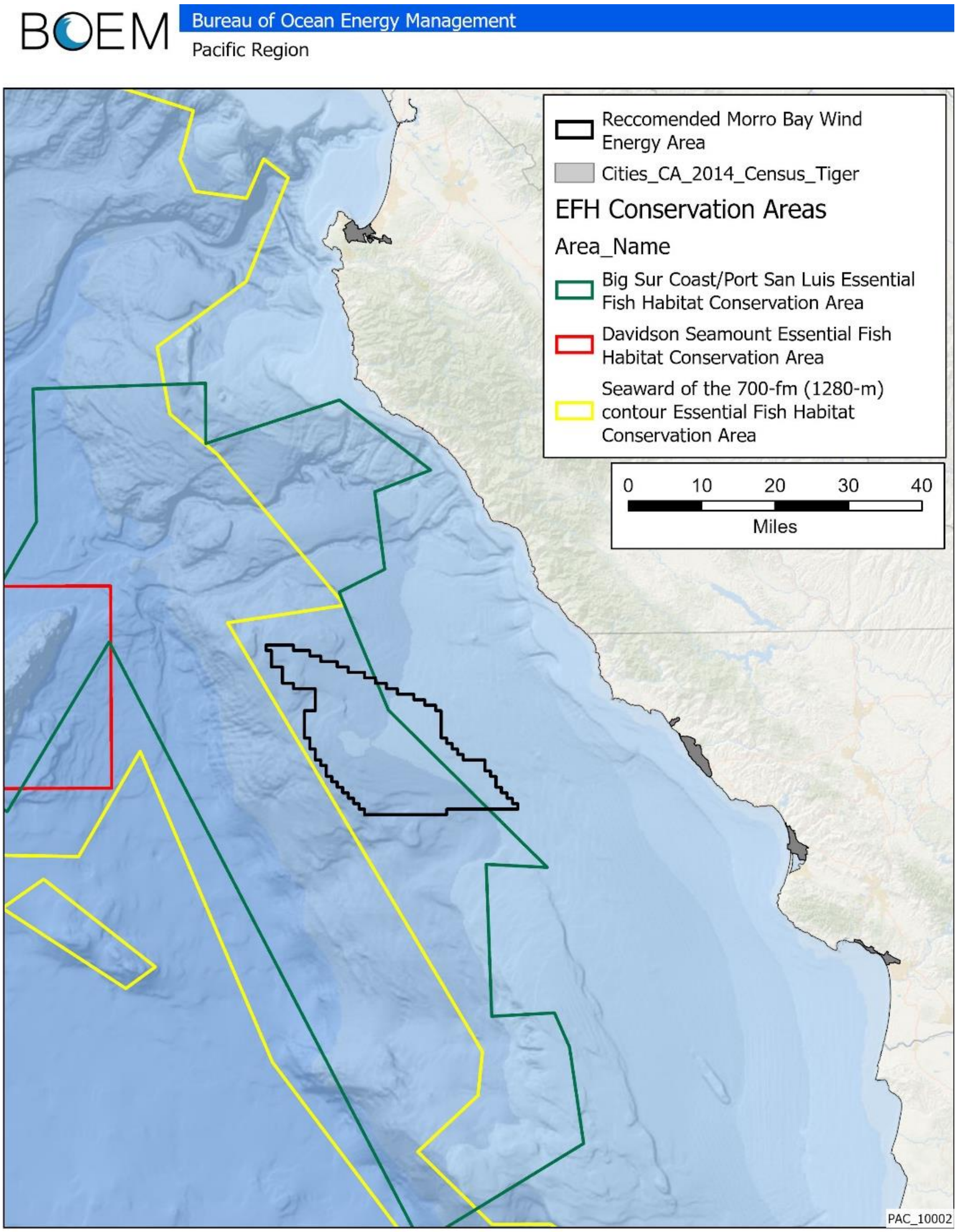

Figure C-12. Essential Fish Habitat Conservation Areas in the Morro Bay WEA
Source: NOAA Fisheries 2024.

C.2.10 Global Climate Change

Climate change results primarily from the increasing concentration of greenhouse gases (GHGs) in the atmosphere, which causes atmospheric warming, leading to global physical, chemical, and biological changes to the environment, substantially affecting the world's oceans and lands. Changes include increases in global atmospheric and oceanic temperature, shifting weather patterns, rising sea levels, and changes in atmospheric and oceanic chemistry (Blunden and Boyer 2021). The Programmatic EIS for Alternative Energy Development and Production and Alternate Use of Activities on the Outer Continental Shelf (MMS 2007) describes global climate change with respect to assessing renewable energy development. Key drivers of climate change are increasing atmospheric concentrations of carbon dioxide (CO_2) and other GHGs, such as methane (CH_4) and nitrous oxide (N_2O). These GHGs reduce the ability of solar radiation to re-radiate out of Earth's atmosphere and into space. Although all three of these GHGs have natural sources, the majority of these GHGs are released from anthropogenic activity. Since the Industrial Revolution, the rate at which solar radiation is re-radiated back into space has slowed, resulting in a net increase of energy in the Earth's system (Solomon et al. 2007). This energy increase presents as heat, raising the planet's temperature and causing climate change.

Fluorinated gases are a type of GHG released in trace amounts but are highly efficient at preventing solar radiation from being re-radiated back into space. They have a much longer lifespan than CO_2, CH_4, and N_2O. Fluorinated gases have no natural sources, are either a product or byproduct of manufacturing processes, including production of aluminum, magnesium, semiconductors, and electrical transmission and distribution equipment, and can have 23,000 times the warming potential of an equal amount of CO_2. These gases include hydrofluorocarbons, perfluorocarbons, nitrogen trifluoride, and sulfur hexafluoride (SF_6). Fluorinated gases that are ozone-depleting substances (ODS) are currently being phased out of commercial production and use under the provisions of the Montreal Protocol; the USEPA Significant New Alternatives Policy (SNAP) Program was established under Section 612 of the Clean Air Act for EPA to identify and evaluate substitutes in end-uses that have historically used ozone-depleting substances (USEPA 2024c); USEPA is also implementing programs to phase out use of ozone-depleting-substance substitutes that have high global warming potentials including hydrofluorocarbons and SF_6 (USEPA 2024d).

Sulfur hexafluoride may still be used in WTG switchgears and offshore substation high-voltage and medium-voltage gas-insulated switchgears an anti-arcing insulator and therefore may contribute to air quality and greenhouse gas emissions impacts of offshore wind installations. Proposed mitigation measures for offshore wind installations would reduce air quality impacts by requiring lessees to evaluate the feasibility and risks of using non-sulfur hexafluoride (SF_6) switchgear as an alternative to SF_6-containing switchgear.

The Intergovernmental Panel on Climate Change released a report in 2023 that compared risks associated with a 1.5-degree-Celsius (°C) increase of global temperatures with 2.0°C and higher increases in global temperature. The report found that climate-related risks depend on the rate, peak, and duration of global warming. An increase of 2°C was associated with greater impacts and risks associated with climatic changes such as extreme weather and drought; global sea level rise; impacts on terrestrial ecosystems including loss of biodiversity, species loss, and mass mortality events; impacts on marine biodiversity, fisheries, and ecosystems and their functions and services to humans; and impacts on health, livelihoods, food security, water supply, and economic growth, including effects of drought and extreme heat events (IPCC 2023). Higher global temperatures increase the chances of sea level rise by the end of the century, with a projected relative sea level rise of 2.0 to 7.2 feet (0.6 to 2.2 meters) along the contiguous U.S. coastline by 2100 (NOAA 2022b). Expected relative sea level rise would cause tide and storm surge heights to increase, leading to a shift in the U.S. coastal flood regimes by 2050 with major and moderate high tide flood events occurring as frequently as moderate and minor high tide flood events occur today (NOAA 2022b).

Local emissions, such as those from maintenance of and accidental chemical leaks from wind energy projects, would contribute incrementally to local GHG emissions. However, local effects of wind energy projects would be superseded by much larger beneficial effects of wind energy generation: the energy generated by wind energy projects is expected to displace energy generated by combustion of fossil fuels, which would lead to reductions in regional emissions of air pollutants and GHGs from fossil-fueled power plants. U.S. Department of Energy reported wind energy produces around 11 grams of CO_2 per kilowatt-hour of electricity generated, compared with about 980 grams of CO_2 per kilowatt-hour for coal and roughly 465 grams of CO_2 per kilowatt-hour for natural gas. Thereby, wind energy creates about 1 percent as much CO_2 as energy from coal and 2 percent as much CO_2 as energy from natural gas (DOE 2023). Wind energy generation in combination with other renewable energy sources can therefore contribute to substantial reductions in GHG emissions. Table C-3 summarizes state plans and policies in place to address climate change; Table C-4 summarizes state resiliency plans.

Table C-3. Climate change plans and policies

Plans and Policies	Summary/Goal
California	
Nature-Based Solutions Executive Order N-82-20 Pathways to 30x30 (2020)	As part of this Executive Order, California committed to the goal of conserving 30% of state lands and coastal waters by 2030.
Extreme Heat Action Plan (2022)	Strategic and comprehensive set of state actions to adapt and strengthen resilience to extreme heat (State of California 2022a).
California's Wildfire and Forest Resilience Plan (2021)	• Increase the pace and scale of climate health projects. • Strengthen protection of communities. • Manage forests to achieve the state's economic and environmental goals. • Drive innovation and measure progress.
Short-Lived Climate Pollutant Reduction(2017)	Legislation requiring a strategy for and reductions in emissions of short-lived climate pollutants by 40–50% below 2013 levels by 2030. Pollutants include the GHGs CH_4 and hydrofluorocarbons, and anthropogenic black carbon.

Plans and Policies	Summary/Goal
Assembly Bill 32 Climate Change Scoping Plan (2022)	• Carbon Neutrality: Assembly Bill 1279 establishes a clear, legally binding, and achievable goal for California to achieve statewide carbon neutrality as soon as possible, and no later than 2045, and ensures an 85% emissions reduction as part of that goal. • 100% Clean Electric Grid: Senate Bill 1020 creates clean energy targets of 90% by 2035 and 95% by 2040, advancing the state's trajectory to 100% clean energy by 2045. • Removing carbon pollution: Senate Bill 905 and Senate Bill 1314 establish a regulatory framework for the safe deployment of carbon removal and carbon capture, utilization, and sequestration, while banning its use for the continued production of fossil fuels. • Protect communities from harmful oil drilling: Senate Bill 1137 establishes a setback distance of 3,200 feet between any new oil well and homes, schools, or parks. Ensures comprehensive pollution controls for existing oil wells within 3,200 feet of these facilities. • Enlisting nature: Assembly Bill 1757 requires the state to develop an achievable carbon removal target for natural and working lands.
Greenhouse Gas Emission Reduction (2022)	Require California to reduce its overall GHG emissions to 1990 levels by 2020 and 40% below 1990 levels by 2030 and appoint the California Air Resources Board to develop policies (ultimately including the state's cap-and-trade program) to achieve this goal.
Advanced Clean Cars (2012, 2022)	Advanced Clean Cars combines several regulations into one package including the Low-Emission Vehicle criteria and GHG regulations and the zero-emission vehicle regulation. Advanced Clean Cars I was adopted in 2012 and Advanced Clean Cars II was adopted in 2022. The Advanced Clean Cars II regulations were adopted in 2022, imposing the next level of low-emission and zero-emission vehicle standards for model years 2026–2035 that contribute to meeting federal ambient air quality ozone standards and California's carbon neutrality targets. By 2035 all new passenger cars, trucks and SUVs sold in California will be zero emissions vehicles. In October 2023, staff launched a new effort to consider potential amendments to the Advanced Clean Cars II regulations, including updates to the tailpipe greenhouse gas emission standard and revisions to the Low-emission Vehicle and Zero-emission Vehicle regulations (California Air Resources Board 2024).
EnergyWise Plan (2010)	The EnergyWise Plan is required by the Conservation and Open Space Element of the *County of San Luis* Obispo General Plan and is intended to facilitate the goals of the element. This plan builds upon the goals and strategies of the element to reduce local GHG emissions. It identifies how the County of San Luis Obispo will achieve the GHG emissions reduction target of 15% below baseline levels by the year 2020 in addition to other energy efficiency, water conservation, and air quality goals identified in the element. This plan will also assist the County of San Luis Obispo's participation in the regional effort to implement land use and transportation measures to reduce regional GHG emissions from the transportation sector by 2035 (County of San Luis Obispo 2010).
Humboldt Regional Climate Action Plan (2022)	The County of Humboldt coordinated with other local agencies and announced a draft regional Climate Action Plan to reduce GHG emissions throughout Humboldt County. This plan explores locally oriented strategies to reduce emissions from vehicle travel, electricity consumption, natural gas use, and other sources of GHGs.

Plans and Policies	Summary/Goal
Oregon	
Climate Action Plan 2021–2026	*Climate Action Plan 2021–2026* is Oregon Department of Transportation's 5-year plan for work to address the impacts of climate change and extreme weather on the transportation system in Oregon. The plan includes actions the department is taking between 2021–2026 to reduce GHG emissions from transportation, improve climate justice, and make the transportation system more resilient to extreme weather events (Oregon Department of Transportation 2021).
Renewable Portfolio Standard	Oregon's Renewable Portfolio Standard sets a requirement for how much of the electricity used must come from renewable resources. The original Renewable Portfolio Standard was adopted in 2007, when just 2% of Oregon's electricity needs were met with renewables. In March 2016, the passage of Oregon Senate Bill 1547 increased Oregon's Renewable Portfolio Standard requirement to 50% renewables by 2040 (Oregon Department of Energy n.d.).
Executive Order 20-04	In March 2020, Governor Kate Brown signed Executive Order 20-04, directing State of Oregon agencies to take action to reduce and regulate GHG emissions toward meeting reduction goals of at least 45% below 1990 emissions levels by 2035 and at least 80% below 1990 levels by 2050. Establishes a goal of 3,500 MW of offshore wind energy generation by 2030 (Oregon Department of Energy 2020).

Table C-4. Resiliency plans and policies

Plans and Policies	Summary
California	
California Climate Adaptation Strategy (California Natural Resources Agency 2024)	The Draft Update to the California Climate Adaptation Strategy elevates six key priorities that must drive all resilience actions in California: • Strengthen Protections for Climate Vulnerable Communities • Bolster Public Health and Safety to Protect Against Increasing Climate Risks • Build a Climate Resilient Economy • Accelerate Nature-Based Climate Solutions and Strengthen Climate Resilience of Natural Systems • Make Decisions Based on the Best Available Climate Science • Partner and Collaborate to Leverage Resources
Protecting Californians from Extreme Heat (State of California 2022)	The substance and organization of this plan was guided by extensive public input, collected over the course of 2021 and 2022, including through five public listening sessions, ten regional workshops, and numerous consultations with California Native American tribes (State of California 2022a). Actions in the plan are organized into four tracks: • Build Public Awareness and Notification • Strengthen Community Services and Response • Increase Resilience of Our Built Environment • Utilize Nature-Based Solutions
Resilient SLO	Facing growing flood, heat, and wildfire risks, the City of San Luis Obispo launched Resilient SLO to build local and regional capacity to adapt and build resilience to climate change impacts (City of San Luis Obispo n.d.).

Plans and Policies	Summary
Humboldt Rising	The Comprehensive Economic Development Strategy is Humboldt County's framework to grow a diverse and thriving economy, outline a plan for regional resilience, and improve the quality of life for everyone who lives in Humboldt. This collaborative process is an opportunity for the community to come together and discuss the key issues it is facing, and to design a roadmap toward mutual thriving (County of Humboldt Economic Development Division n.d.).

C.2.11 Oil and Gas Activities

BOEM is responsible for all OCS leasing policy and program development issues for oil, gas, and other marine minerals. Each lease covers up to 5,760 acres and is generally a square measuring 3 miles by 3 miles. The Bureau of Safety and Environmental Enforcement Pacific Region is responsible for oversight of oil and gas platform infrastructure and operations in federal waters off California (BOEM n.d.a). BOEM currently has lease areas off of Lompoc, Santa Barbara, and Long Beach. As of September 2023, there are 30 existing leases and 23 platforms, with six platforms in the process of being decommissioned, all of which are in the Southern California Planning Area. All 23 of the coast's offshore facilities, installed between the late 1960s and 1990 from Santa Barbara to Orange County, are at the end of their lifespans and subject to eventual decommissioning (BOEM 2021b; Santa Barbara Independent 2023). Figure C-13 shows offshore platforms in the Pacific OCS Region (BOEM 2023d). Figure C-14 illustrates BOEM's program for decommissioning certain offshore platforms in the Pacific OCS Region.

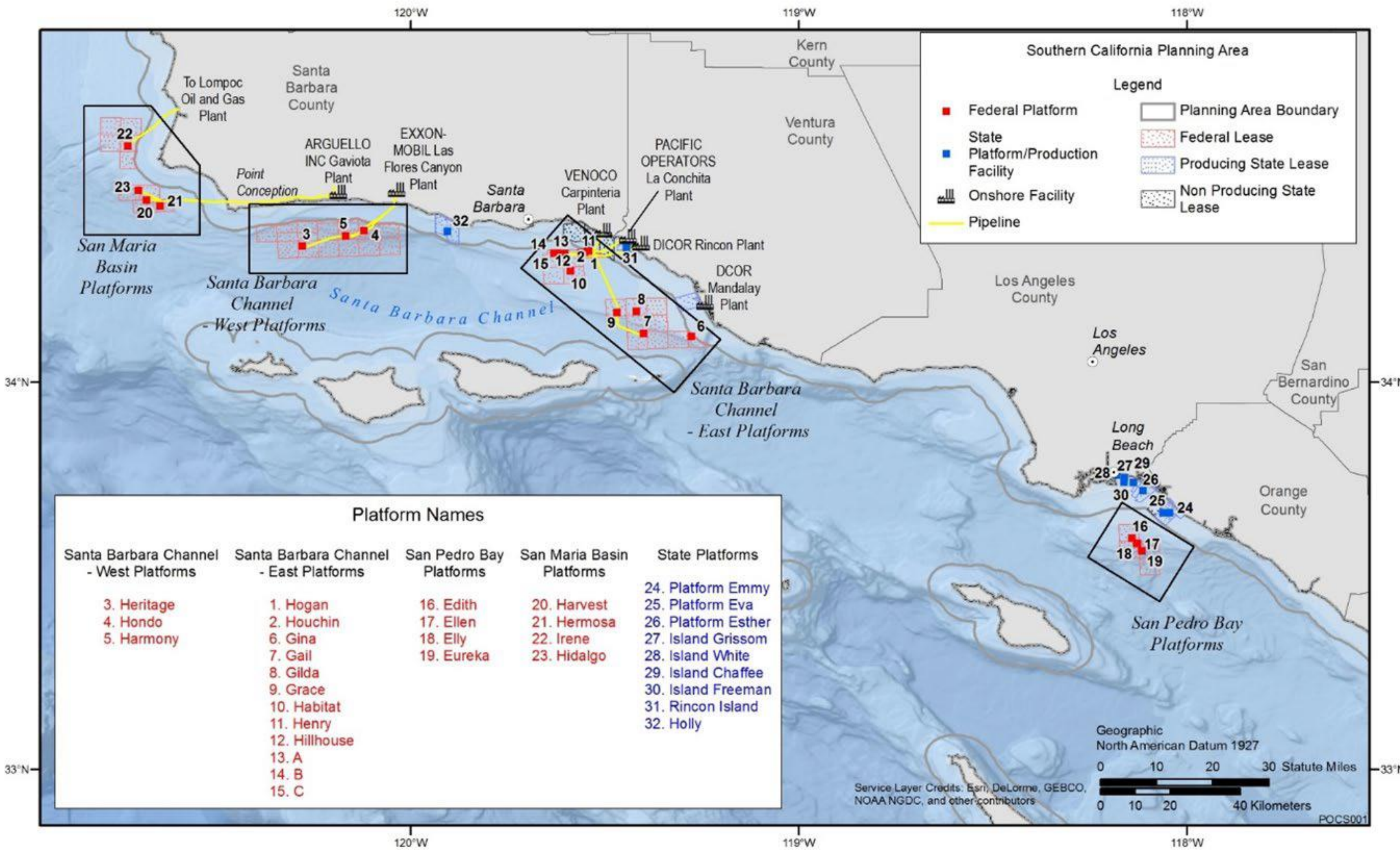

Figure C-13. Locations of Current Lease Areas and Platforms Operating on the Southern California Pacific OCS Planning Area
Note: Red symbols: platforms in federal waters; blue symbols: platforms in state waters.
Source: BOEM 2023d.

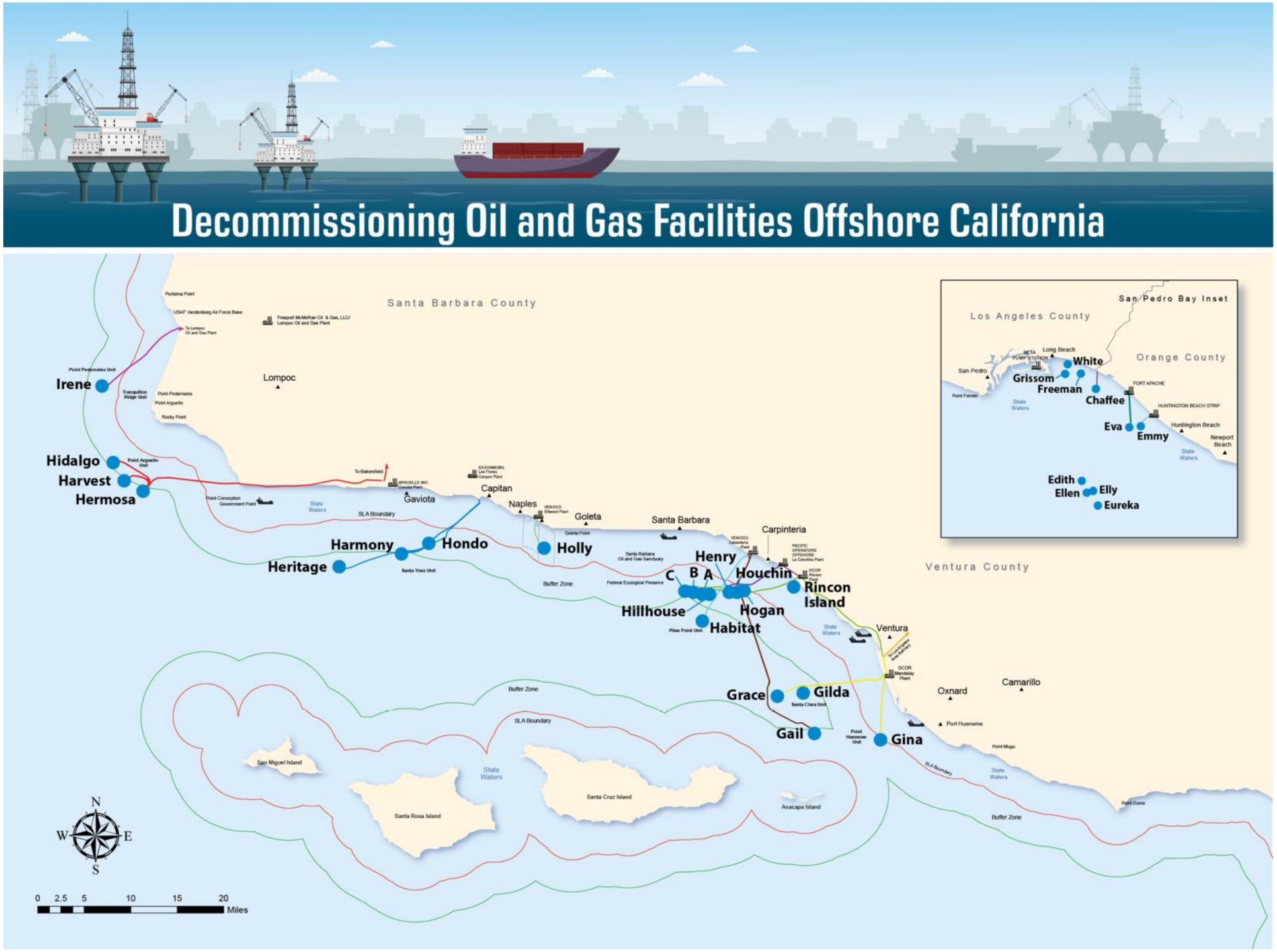

Figure C-14. Decommissioning oil and gas facilities offshore California

Source: BOEM 2023c.

OCS revenues provide annual deposits of nearly $900 million to the Land and Water Conservation Fund and $150 million to the Historical Preservation Fund. By statute, coastal states share a portion of the revenues from OCS leasing and production under three programs: (1) the Outer Continental Shelf Lands Act Section 8(g) revenue sharing program that provides that states with offshore federal leases within the first 3 miles from the state's seaward boundary receive 27 percent of the revenue generated from those leases; (2) the Coastal Impact Assistance Program for Alaska, Alabama, California, Louisiana, Mississippi, and Texas; and (3) the Gulf of Mexico Energy Security Act for Alabama, Louisiana, Mississippi, and Texas (BOEM n.d.b).

BOEM issues geological and geophysical permits to obtain data for hydrocarbon exploration and production; locate and monitor marine mineral resources; aid in locating sites for alternative energy structures and pipelines; identify possible human-made, seafloor, or geological hazards; and locate potential archaeological and benthic resources. Geological and geophysical surveys are typically classified into categories by equipment type and survey technique.

California and Oregon do not have any operating liquefied natural gas terminals or any proposed liquefied natural terminals along the coast (CEC 2024; Oregon DEQ 2024; FERC 2024). One liquefied natural port is under construction on Mexico's Pacific Coast (Table C-5).

Table C-5. Liquefied natural gas terminals on the Pacific Coast

Terminal Name	Type	Company	Jurisdiction	Distance from Project (approximate)	Status
Energia Costa Azul Phase 1	Export terminal	Sempra	Mexico; Baja California Norte	300 miles	Approved, under construction

Source: Sempra Energy 2024.

C.2.12 Onshore Development Activities

Onshore development activities that may contribute to cumulative impacts include visible infrastructure such as onshore wind turbines, buildings (such as offices, retail, and multi-use spaces) and cell towers, port development, transportation projects, onshore coastal developments near landfall locations, and other energy projects such as transmission and pipeline projects. Coastal development projects permitted through regional planning commissions, counties, and towns may also contribute to cumulative impacts. These may include residential, commercial, and industrial developments spurred by population growth in the region (Table C-6).

Table C-6. Existing, approved, and proposed onshore development activities

Type	Description
Local planning documents	
San Luis Obispo County	• County of San Luis Obispo Local Coastal Program Policy Document: The Local Coastal Plan is incorporated into existing county policies and regulations through amendment to the Land Use Element and certification of a Land Use Ordinance for the Coastal Zone. The coastal zone boundary encompasses portions of four of the Land Use Element Planning Areas: North Coast, Estero, San Luis Bay, and South County (County of San Luis Obispo 2007). • San Luis Obispo County Coastal Regional Sediment Management Plan: The plan is a collaborative effort of federal, state, and local agencies and non-governmental organizations committed to evaluating and addressing California's coastal sediment management needs on a regional basis (USACE et al. 2016). • Diablo Canyon Power Plant Decommissioning Project: The proposed project involves the decommissioning and dismantlement of the existing Diablo Canyon Power Plant (County of San Luis Obispo 2023).
Humboldt County	• The City of Eureka Draft Coastal Land Use Plan establishes the Land Use Plan of the Local Coastal Program of the City of Eureka, prepared in accordance with the California Coastal Act of 1976. The Land Use Plan governs land use and development in the Coastal Zone within the City of Eureka (City of Eureka 2023a). • Waterfront Specific Plan: The Waterfront Eureka Plan Area encompasses approximately 130 acres in the northern portion of Eureka, between Humboldt Bay and Downtown Eureka. The Plan Area consists of three districts identified in the City of Eureka 2040 General Plan: Commercial Bayfront, with primarily coastal-dependent, recreation, visitor-serving uses, open space, and the Waterfront Trail, as well as the Blue Ox Mill Works, residences and office buildings; Old Town, the commercial heart of the Plan Area and a premiere historic and cultural district; and Library, a mixed residential/office area, home to the namesake Humboldt County Library and the Carson Mansion (City of Eureka 2023b). • Eureka-Arcata U.S. 101 Corridor Improvement Project: The Eureka-Arcata U.S 101 Corridor Improvement includes the undercrossing at Indianola Road and an upcoming northbound traffic signal at Airport Road, as well as recently completed acceleration and deceleration lane improvements, cable median barrier installation, bridge and rail replacements at Jacoby Creek and Gannon Slough, and tide gate replacements (Caltrans 2023). • Humboldt Bay Trail South: Construction of the Humboldt Bay Trail South project between Eureka and Arcata along the Humboldt Bay shoreline began in July 2023 and is scheduled to be completed in October 2024. The majority of the trail will be situated along the Humboldt Bay shoreline between the railroad and Highway 101, while a 1-mile portion will be placed on top of the levee around the Brainard mill site. The project will create an alternative to vehicular travel between Eureka and Arcata and includes urgent repairs to portions of the shoreline armoring along the railroad prism (County of Humboldt 2023). • City of Arcata Local Coastal Element: The Local Coastal Element of the City of Arcata General Plan is a component of the Land Use Plan as described in the Coastal Act, Section 30108.5 and 30108.55. The City of Arcata uses the Local Coastal Element as the standard of review for required Coastal Development Permits in the Coastal Zone under the City's permit jurisdiction (City of Arcata 2022).

Type	Description
Los Angeles County	• The Pier B On-Dock Rail Support Facility Program includes reconfiguring, expanding, and enhancing the capacity of the existing Pier B Rail Yard Facility. The program will provide a marshaling area to receive and manage the intermodal rail volume growth, provide a destination for westbound trains that currently are not able to enter the port when on-dock track space is unavailable, and allow multiple marine terminals to send small cuts of rail cars to be assembled into destination trains. The EIR for the project was certified by the Long Beach Board of Harbor Commissioners in 2018 (City of Los Angeles Bureau of Engineering 2022). • West Harbor Waterfront Development: The West Harbor project began in December 2022. The public-private commercial development will feature 42 acres of outdoor space for restaurants, retail, fresh markets, office space, waterside activities, and a proposed open-air amphitheater for live entertainment. West Harbor's Phase I is scheduled to open in 2025 (POLA 2023).
Onshore wind projects	
Morro Bay	According to the U.S. Geological Survey Wind Energy database, there are no onshore wind projects in San Luis Obispo County (USGS 2024).
Humboldt	According to the U.S. Geological Survey Wind Energy database, there are no onshore wind projects in Humboldt County (USGS 2024).
Communications towers	
Morro Bay	There are 19 towers and 59 antennas within a 3.0-mile radius of Coleman Dr, Morro Bay, CA 93442 as of January 2, 2024 (AntennaSearch.com 2024a).
Humboldt	There are 32 towers and 162 antennas within a 3.0-mile radius of Samoa Dunes Recreation Area (USCG Station Humboldt), Samoa, CA 95564 as of January 2, 2024 (AntennaSearch.com 2024b).
Onshore Energy Projects	
Morro Bay	Morro Bay Battery Energy Storage Project. The City of Morro Bay published a Notice of Preparation of a Draft EIR under the California Environmental Quality Act on June 3, 2022. The City of Morro Bay is the Lead Agency for the proposed project. The proposed project includes three components: (1) construction and operation of a 600-MW Battery Energy Storage System, (2) demolition and removal of the existing Morro Bay Power Plant building and stacks, and (3) adoption of a Master Plan. Vistra Corporation is the owner of the property on which the defunct Morro Bay Power Plant resides and the proponent of the proposed project. The Battery Energy Storage System Facility would be constructed on a 24-acre portion of the project site and would consist of three two-story buildings with a total building area of 91,000 square feet. Supporting infrastructure including power conversion systems, substations, and tie-ins to the existing Pacific Gas and Electric substation adjacent to the project site would also be included. The project also includes demolition of the existing Morro Bay Power Plant building and stacks and backfill and restoration of the site. A Master Plan would be developed in accordance with the requirements of Plan Morro Bay Policy LU-5.4 to change the land use designation of the 24-acre Battery Energy Storage System portion of the project site from Visitor-Serving Commercial to General (Light) Industrial (Morro Bay Energy 2022; State of California 2022b; Morro Bay Life 2023).

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Appendix D: Consultation and Coordination

D.1 Introduction

This appendix describes the formal consultations, cooperating and participating agency and Cooperating Tribal Government exchanges, public scoping comment period, and other correspondence associated with the development of the California Offshore Wind Draft Programmatic Environmental Impact Statement (PEIS). Interagency consultation, coordination, and correspondence throughout the development of the Draft PEIS occurred primarily through virtual meetings, teleconferences, and written communications (including email).

D.2 Consultations

D.2.1 Endangered Species Act

Section 7(a)(2) of the Endangered Species Act of 1973 (ESA), as amended (16 United States Code [USC] 1531 et seq.), requires that each federal agency ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of those species. When the action of a federal agency may affect a listed species or its critical habitat, that agency is required to consult with either the National Marine Fisheries Service (NMFS) or U.S. Fish and Wildlife Service (USFWS), depending upon the jurisdiction of the services. Pursuant to 50 Code of Federal Regulations (CFR) 402.07, the Bureau of Ocean Energy Management (BOEM) has accepted designation as the lead federal agency for the purposes of fulfilling interagency consultation under Section 7 of the ESA for listed species under the jurisdiction of NMFS and USFWS. BOEM intends to consult on the proposed activities considered in the PEIS with both NMFS and USFWS, and is developing Programmatic Biological Assessments for listed species and designated critical habitats under their respective jurisdictions.

D.2.2 Tribal Consultation

Executive Order 13175 commits federal agencies to engage in government-to-government consultation with Tribal Nations when federal actions have Tribal implications. A June 29, 2018, memorandum outlines BOEM's current Tribal consultation guidance (BOEM 2018). This memorandum states that "consultation is a deliberative process that aims to create effective collaboration and informed federal decision-making" and aligns with the spirit and intent of Executive Order 13175 (BOEM 2018). BOEM implements Tribal consultation policies through formal government-to-government consultation, informal dialogue, collaboration, and other engagement. On January 3, 2024, the BOEM Director sent a letter to Tribal leaders sharing BOEM's revised Draft Tribal Consultation Guidance and inviting government-to-government consultation on that draft document (BOEM 2024).

On November 30, 2022, in conjunction with a White House Tribal Summit held at the Department of the Interior, the Biden-Harris administration issued several directives and updates on Tribal policies, including: Presidential Memorandum on Uniform Standards for Tribal Consultation (November 30, 2022); Department of the Interior Policy on Consultation with Indian Tribes (November 30, 2022); Department of the Interior Procedures for Consulting with Indian Tribes (November 30, 2022); Department of the Interior Policy on Consultation with Alaska Native Claims Settlement Act Corporations (November 30, 2022); Department of the Interior Procedures for Consultation with Alaska Native Claims Settlement Act Corporations (November 30, 2022); Best Practices for Identifying and Protecting Tribal Treaty Rights, Reserved Rights and Other Similar Rights in Federal Regulatory Actions and Federal Decision-Making (Draft September 2022); Guidance for Federal Departments and Agencies on Indigenous Knowledge (November 30, 2022); Memorandum on Implementation of Guidance for Federal Departments and Agencies on Indigenous Knowledge (November 30, 2022); Collaborative and Cooperative Stewardship with Tribes and the Native Hawaiian Community Chapter 1: Policy and Responsibilities (November 30, 2022); and Collaborative and Cooperative Stewardship with Tribes and the Native Hawaiian Community Chapter 2: Committee on Collaborative and Cooperative Stewardship (November 30, 2022). Finally, on April 21, 2023, President Biden issued Executive Order 14096, Revitalizing Our Nation’s Commitment to Environmental Justice for All, which includes coverage for Tribal Nations.[1] On December 5, 2023, BOEM held a virtual informational meeting with leaders and representatives of federally recognized Tribes with connections to the Humboldt and Morro Bay lease areas. BOEM provided information on West Coast leasing activities to date and further actions anticipated, provided an overview of the PEIS process, and advised of the anticipated imminent publication of the Notice of Intent (NOI) to prepare a PEIS for the Humboldt and Morro Bay lease areas. Participants included 19 Tribal representatives from 10 different Tribes.

Questions raised by participants at the December 5, 2023, meeting included the long-term health of fisheries, the connection of fisheries and treaty rights, and the timing and level of analysis to be included in the PEIS.

As of September 2024, the following Tribes have requested formal government-to-government consultation on the California PEIS: Resighini Tribe of Yurok People, Santa Rosa Rancheria Tachi Yokut Tribe, and the Makah Tribe.

D.2.3 National Historic Preservation Act

Section 106 of the National Historic Preservation Act (NHPA) (54 USC 306108) and its implementing regulations (36 CFR Part 800) require federal agencies to consider the effects of their undertakings on historic properties and afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment. In anticipation of the project-level review of Construction and Operation Plans (COPs) for each of the Humboldt and Morro Bay lease areas, BOEM has identified an opportunity to engage the appropriate federally recognized Tribes, California State Historic Preservation Officer (SHPO), and other interested parties to participate as consulting parties in the programmatic Section 106 review process.

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[1] Executive Order 14096 further embeds “environmental justice agenda into the work of federal agencies to achieve real, measurable progress that communities can count on.” This executive order and subsequent guidance will be incorporated into the Final PEIS.

Consulting parties are actively informed of steps in the review process, including public meetings, and their views are actively sought as BOEM identifies historic properties and develops avoidance, minimization, mitigation and monitoring measures. Appendix G, *NHPA Section 106 Summary*, of the Draft PEIS contains a summary of BOEM's Section 106 programmatic review, including a description and summary of BOEM's consultation so far.

D.2.4 Magnuson-Stevens Fishery Conservation and Management Act

Pursuant to Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA), federal agencies are required to consult with NMFS on any action that may result in adverse effects on Essential Fish Habitat (EFH). NMFS regulations implementing the EFH provisions of the MSA can be found at 50 CFR Part 600. As provided for in 50 CFR 600.920(b), BOEM has accepted designation as the lead agency for the purposes of fulfilling EFH consultation obligations under Section 305(b) of the MSA. BOEM is consulting on the proposed activities considered in the PEIS with NMFS.

D.3 Development of Draft Programmatic Environmental Impact Statement

This section provides an overview of the development of the Draft PEIS, including public scoping, cooperating agency involvement, and distribution of the Draft PEIS for public review and comment.

D.3.1 Scoping

On December 19, 2023, BOEM published an NOI to prepare a PEIS consistent with National Environmental Policy Act (NEPA) regulations (42 USC 4321 et seq.) to assess the potential impacts of the Proposed Action and alternatives (87 *Federal Register* 42495). The NOI commenced a public scoping process for identifying issues and potential alternatives for consideration in the PEIS. The formal scoping period was from December 20, 2023, through February 20, 2024. BOEM held two virtual public scoping meetings on February 6, 2024, and February 8, 2024, to share information, solicit feedback, and answer questions. Throughout the scoping period, federal agencies, Tribal Nations, state and local governments, and the general public had the opportunity to help BOEM identify potentially significant resources and issues, impact-producing factors (IPFs), reasonable alternatives, and potential mitigation measures to analyze in the PEIS, as well as provide additional information. BOEM also used the NEPA scoping process to initiate the Section 106 consultation process under the NHPA (54 USC 300101 et seq.), as permitted by 36 CFR 800.2(d)(3), which requires federal agencies to assess the effects of projects on historic properties. The NOI requested comments from the public in written form, delivered by hand or by mail, or through the http://www.regulations.gov web portal.

BOEM received a total of 192 comments during the scoping period. BOEM reviewed and considered all scoping comments in the development of the Draft PEIS. A scoping summary report summarizing the submissions received and the methods for analyzing them is available in Appendix B, *Scoping Report*, of the PEIS. In addition, all public scoping comments received can be viewed online at http://www.regulations.gov by typing "BOEM-2023-0061" in the search field. As detailed in the scoping summary report, the resource areas or NEPA topics most referenced in the scoping comments were the potential impacts on commercial fishing; marine mammals; demographics, employment, and economics; and consideration of potential cumulative impacts.

D.3.2 Cooperating and Participating Agencies and Cooperating Tribal Governments

BOEM invited other federal agencies, Tribal Nations, and state and local governments to consider becoming cooperating agencies in the preparation of the Draft PEIS. According to Council on Environmental Quality (CEQ) guidelines, qualified agencies and governments are those with "jurisdiction by law or special expertise" (CEQ 1981). BOEM also invited agencies that do not have jurisdiction by law or special expertise but that have a vested interest in the Draft PEIS to engage as participating agencies. Agreeing to engage as a cooperating or participating agency allowed agencies the opportunity to participate in discussions and contribute to the development of the Draft PEIS.

BOEM held interagency meetings with cooperating and participating agencies on March 12, 2024, to discuss the environmental review process, schedule, responsibilities, consultation, and potential alternatives. BOEM also met individually and in small groups with cooperating and participating agencies who requested additional discussion on the PEIS at various times throughout development of the Draft PEIS.

As of September 2024, the following federal agencies, Tribal Nations, and state and local governments have supported preparation of the Draft PEIS as cooperating and participating agencies and Cooperating Tribal Governments.

D.3.2.1 Cooperating Agencies

- Bureau of Safety and Environmental Enforcement
- California Coastal Commission
- California Energy Commission
- California State Lands Commission
- California State Water Resources Control Board
- U.S. Environmental Protection Agency
- National Oceanic and Atmospheric Administration—NMFS
- U.S. Army Corps of Engineers

D.3.2.2 Cooperating Tribal Governments

- Elk Valley Rancheria, California
- Yurok Tribe

D.3.2.3 Participating Agencies

- California Department of Fish and Wildlife
- California Ocean Protection Council

  San Luis Obispo County Air Pollution Control District

D.3.3 Distribution of the Draft Programmatic Environmental Impact Statement for Review and Comment

The Draft PEIS is available in electronic format for public viewing at https://www.boem.gov/renewable-energy/state-activities/california. Hard copies of the Draft PEIS can be requested by contacting BOEM's Pacific Region Office in Camarillo, California, at (805) 384-6305. Publication of the Draft PEIS initiates a 45-day comment period where government agencies, members of the public, and interested stakeholders can provide comments and input. BOEM will accept comments in any of the following ways.

- In hard copy form, delivered by mail, enclosed in an envelope labeled "California OSW PEIS" and addressed to Lisa Gilbane, Environmental Analysis Section Chief, Bureau of Ocean Energy Management, 760 Paseo Camarillo, Suite 102 (CM 102), Camarillo, CA 93010.
- Through the regulations.gov web portal by navigating to https://www.regulations.gov/, searching for docket number "BOEM-2023-0061" and clicking the "Comment" button. Enter your information and comment, then click "Submit Comment."
- By attending one of the public meetings on the dates listed in the notice of availability and providing written or verbal comments.

BOEM will use comments received during the public comment period to inform its preparation of the Final PEIS, as appropriate. PEIS notification lists are provided in Appendix L, *Distribution List*.

D.4 References Cited

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Council on Environmental Quality (CEQ). 1981. Memorandum to agencies: forty most asked questions concerning CEQ's National Environmental Policy Act regulation. Amended 1986. Washington (DC): Council on Environmental Quality. Report No.: 46 *Federal Register* 18026. https://www.energy.gov/sites/prod/files/2018/06/f53/G-CEQ-40Questions.pdf.

Appendix E: Mitigation

The Draft Programmatic Environmental Impact Statement (PEIS) assesses the potential physical, biological, socioeconomic, and cultural impacts that could result from the construction, operations and maintenance (O&M), and decommissioning of the two Humboldt and three Morro Bay lease areas in US Federal waters offshore of California, as well as the change in those impacts that could result from adopting programmatic mitigation measures.

The Proposed Action (Alternative C) for the Draft PEIS is the adoption of programmatic mitigation measures that lessees may incorporate into their plans, or the Bureau of Ocean Energy Management (BOEM) may require as conditions of approval, where appropriate, for activities proposed by lessees in Construction and Operations Plans (COP) submitted for the five California lease areas. The COP-specific National Environmental Policy Act (NEPA) analysis may result in additional or different mitigation. Table E-1 presents the mitigation measures analyzed in the Draft PEIS under the Proposed Action.

Measures were derived from best management practices and a subsequent Biological Assessment (BA) for these 5 lease areas offshore California (BOEM 2022a; BOEM 2022b; NOAA 2022). These measures are considered part of the Federal action of lease issuance and required under terms of the lease. Language for these measures were further refined as requirements for the leasing process offshore Oregon (BOEM 2024a). Other measures below come from BOEM NEPA and consultations for offshore the East Coast in the Atlantic Ocean. Please see the following documents for more information and reference, New York Bight Programmatic EIS (BOEM 2024b, Appendix G) and BOEM's Project Design Criteria and Best Management Practices for Protected Species Associated with Offshore Wind Data Collection notice (last revised on November 22, 2021; BOEM 2021) are required under terms of the lease and issuance. These measures are primarily related to reducing impacts on marine life and features from geophysical surveys and vessel traffic during site characterization. BOEM BA Best Management Practices (BMPs) may also apply to all activities associated with the construction, maintenance, and operations of a project as applicable, including all post-lease geophysical and geotechnical (G&G) surveys carried out over the life of the leases. BMPs are therefore not considered separate mitigation measures under this Draft PEIS. Measures required by federal law, such as U.S. Coast Guard (USCG) discharge rules, are not mitigation measures and not included in this appendix because they apply to all vessel operators and are not limited to offshore wind or project-specific activities.

Table E-1. Proposed Action Mitigation Measures

Mitigation Number	Measure Name	Description
MM-1	Near real-time PAM monitoring and alert system for cetaceans	Implementation of a near real-time Passive Acoustic Monitoring (PAM) system for the detection of cetaceans during offshore wind development activities will be required, with an alert system/notice to mariners/construction operators. This could be achieved through the deployment of mobile or fixed PAM systems and through partnership with other industries, academia, NGOs, and federal agencies in a regional effort. Every effort should be made to deploy equipment in advance of any on-water activity, including site characterization work, construction work, etc., for use in mitigating against potential vessel strike risk and other disturbance. Each system will be equipped with reliable PAM technology and marine mammal detection and classification software. Detections will be transmittable to a PAM analyst for verification. This real-time PAM alert system will increase the opportunity to detect marine mammals, providing the opportunity for increased situational awareness (e.g. for vessel strike avoidance) to PSOs and others of marine mammal presence in the area.
MM-2	Long-term PAM monitoring	The lessee must conduct archival, continuous, and long-term PAM to develop baselines and monitor changes in the presence of marine species as well as changes in ambient noise for 1 year before construction through at least 10 years of operations. Throughout deployments and data analysis, the lessee will be expected to follow the best practices outlined in the Regional Wildlife Science Collaborative (RWSC) Best Practices for the Atlantic unless a similar West Coast entity is formed, in which case the lessee should follow the best practices outlined by that entity. The lessee must also process the data to document, minimally, the presence/absence of cetacean vocalizations, and if possible, the locations, of cetacean vocalizations, as well as metrics of ambient noise. The lessee will be expected to archive the full acoustic record at National Centers for Ecological Information and to submit cetacean detections to BOEM, BSEE, and NMFS at least twice a year.
MM-3	Marine mammal and sea turtle entanglement avoidance/prevention	Vessels and facilities must have adequate equipment available and must be prepared to address entanglements, consistent with current guidelines and local marine stranding centers.
MM-4	Vessel speed limit	All offshore wind-related vessels will travel at 10 knots (18.5 kilometers per hour) or less during project-related activities, and while operating in lease areas. The only exception is when the safety of the vessel or crew necessitates deviation from this vessel speed limit.
MM-5	Low Visibility Monitoring Plan	The lessees must submit an Low Visibility Monitoring Plan (LVMP) for any project activities requiring marine mammal and sea turtle monitoring that would be conducted at night or during other low-visibility conditions. The Plan must at a minimum contain two components: (1) Low-Visibility Monitoring and (2) Nighttime Monitoring. The purpose of this plan is to demonstrate that the lessees can meet the visual monitoring criteria for the associated harassment zone(s)/mitigation and monitoring zones plus any agreed-upon buffer zone (these combined zones are referred to henceforth as the nighttime and low-visibility clearance and shutdown zones). The plan will demonstrate effective use of technologies that the lessee is proposing to use for monitoring during nighttime and low-visibility conditions for instances during daylight hours when lighting or weather (e.g., fog, rain, sea state) prevent visual monitoring of the full extent of the clearance and shutdown zones. “Daytime” is defined as 1 hour after civil sunrise to 1.5 hours before civil sunset. The LVMP must be submitted at least 60 days prior to proposed activities, and BOEM and/or BSEE will review and provide comments, if any, on the plan. The lessee must resolve all comments on the LVMP to BOEM’s and/or BSEE’s satisfaction prior to implementing the plan. **Low-Visibility Monitoring**: This part of the plan must at a minimum address: identification of low-visibility monitoring devices (e.g., vessel-mounted thermal infrared [IR] camera systems, handheld or wearable night vision devices [NVDs], handheld IR imagers) that would be used to detect marine mammal and sea turtle species relative to clearance and shutdown zones. **Nighttime Monitoring**: This part of the plan must demonstrate the capability of the proposed monitoring methodology to detect marine mammals and sea turtles within the full extent of the established clearance and shutdown zones (i.e., species can be detected at the same distances and with similar confidence) with the same effectiveness as daytime visual monitoring (i.e., same detection probability). Only devices and methods demonstrated as being capable of detecting marine mammals and sea turtles to the maximum extent of the clearance and shutdown zones will be acceptable. This part of the plan must at a minimum include: identification of nighttime monitoring devices (e.g., vessel-mounted thermal IR camera systems, handheld or wearable NVDs, handheld IR imagers); the lessee must discuss the efficacy (range and accuracy) of each device proposed for nighttime monitoring as demonstrated in field trials.
MM-6	Berm survey and report	Where plows, jets, grapnel runs, or other similar methods are used, post-construction geophysical surveys are required as part of the Post-Installation Cable Monitoring and must be completed to determine the height and width of any created berms. If there are bathymetric significant changes in berm height, the lessee must develop and implement a Berm Remediation Plan to restore created berms to match adjacent natural bathymetric contours (isobaths), as technically and/or economically practical or feasible.
MM-7	Vessel noise reduction guidelines	To the extent reasonable and practicable, follow the most current International Maritime Organization (IMO) guidelines for the reduction of underwater radiated noise, including propulsion noise, machinery noise and dynamic positioning systems of any vessel associated with the project.
MM-8	Protected Species Observers	Qualified third-party Protected Species Observers (PSOs) are required on vessels during project activities. PSOs must complete a training program approved by NMFS. Crew members also must receive training on protected species identification, vessel strike minimization procedures, how and when to communicate with the vessel captain, and reporting requirements. PSOs must have a 360-degree visual coverage around the vessel at all times that noise-producing equipment <180 kHz is operating, or the vessel is transiting. The Low Visibility Monitoring Plan may include requirements for PSOs for activities at nighttime and other instances of low visibility. PSO data must be collected in accordance with standard data reporting, software tools, and electronic data submission standards approved by BOEM, NMFS, or other appropriate agency. Further PSO requirements may arise out of consultation or other environmental review processes.
MM-9	Avoid the use of SF-6	Sulfur hexafluoride (SF_6) is an extremely potent greenhouse gas that is used as an anti-arcing insulator in electrical and transmission systems. Lessees should ensure that a substitute insulator gas rather than SF_6 is used in project infrastructure, as long as the substitute materials do not impose a higher environmental or safety risk. If the lessee determines using non-SF_6 switchgear is infeasible then the lessee should provide written justification of this determination to BOEM. Any instances where the lessee believes there is technical (and/or economic) infeasibility should be supported by a technical feasibility analysis, as appropriate.

Mitigation Number	Measure Name	Description
MM-10	Reducing emissions from vessels, equipment, and vehicles engaged in activities on the OCS	The lessee is encouraged to use zero-emissions technologies when feasible, and to replace diesel fuel and marine fuel oil with alternative fuels such as natural gas, propane, or hydrogen, to the extent that use of such alternative fuels is feasible and provides emissions reductions.
MM-11	Vessel transit strike avoidance	All vessels transiting between a port and the project location must comply with the vessel strike avoidance measures consistent with measures for other marine wildlife. Vessels must avoid transiting through areas of visible aggregations of birds and particularly for species that can occur in larger numbers including alcids, albatrosses, shearwaters, storm-petrels, and cormorants. If operational safety prevents avoidance of such areas, vessels must slow to 4 knots while transiting through such areas. The disturbance avoidance zone for birds is defined as 100 meters from any surface-sitting birds and includes Federally listed species under the ESA (e.g., Marbled Murrelet and Short-tailed Albatross). If surface-sitting birds are sighted within the operating vessel's forward path, the vessel operator must slow down to 4 knots (unless unsafe to do so) and steer away as much as possible. The vessel may resume normal operations once the vessel has passed the individual or flock. Any incidents must be reported.
MM-12	Seasonal cut-in speeds	Lessees may be required to comply with seasonal cut-in speeds to reduce impacts to bats. Specific dates, times, and speed will be determined on a site-specific basis.
MM-13	Avian and bat annual reporting	By January 31 of each year, the lessee must provide an annual report to BOEM and BSEE documenting any dead or injured birds or bats found during construction, operations, or decommissioning. The report must contain the following information: the name of species, date found, location, a picture to confirm species identity (if possible), and any other relevant information. Carcasses with Federal or research bands must be reported to the United States Geological Survey Bird Band Laboratory, available at https://www.usgs.gov/labs/bird-banding laboratory.
MM-14	Bird and bat monitoring plan	Lessees will develop a Bird and Bat Monitoring Plan. Annual monitoring reports are a required component of the plan and will be used to determine the need for adjustments to monitoring approaches, consideration of new monitoring technologies, and/or additional periods of monitoring. Immediate reporting of injured and dead species listed in the Endangered Species Act must occur to BOEM, ideally within 24 hours and no more than 3 days after the sighting.
MM-15	Bird and bat tracking system	The lessee must install bird and bat tracking technology to address information gaps of selected species offshore movements of birds and bats on project infrastructure. Prior coordination will likely be required with other leaseholders and relevant agencies. Currently used technology is Motus (https://motus.org/).
MM-16	Bird-deterrent devices and plan	To minimize the attraction of birds, the lessee must install bird deterrent devices (e.g., anti-perching or other deterrent devices) where appropriate on project facilities before deployment on the OCS. The lessee must develop a Bird Deterrent Plan which will identify how bird deterrent devices would be incorporated into the project and a monitoring plan for the life of the project, allow for modifications and updates as new information and technology becomes available, and track the efficacy of the deterrents.
MM-17	Light impact reduction for birds	The lessee must minimize lighting impacts on avian species to the maximum extent practicable. Any lights used by the lessee to aid marine navigation during construction, operations, and decommissioning must meet USCG requirements for private aids to navigation (https://www.navcen.uscg.gov/pdf/AIS/CG_2554_Paton.pdf) and BOEM's Guidelines for Lighting and Marking of Structures Supporting Renewable Energy Development (https://www.boem.gov/2021-lighting-and-marking-guidelines). Consistent with, and not conflicting with, any measures that may result from USCG requirements, the lessee must use any additional lighting only when necessary, and such lighting must be shielded downward and directed, when possible, to minimize use of high intensity lighting, and reduce upward illumination and illumination of adjacent waters. Additionally, the lessee must ensure that red-flashing strobe aviation obstruction lights emit infrared energy within 675–900 nanometers wavelength to be compatible with Department of Defense night vision goggle equipment.
MM-18	Bird and bat conservation strategy (formerly Compensatory Mitigation Plan)	The lessee must develop a conservation strategy for migratory birds and bats. This strategy will be a life-of-a-project framework for identifying and implementing actions to conserve birds and bats during project planning, construction, operation, maintenance, and decommissioning. It will provide a framework for assessing impacts; avoiding, minimizing, and mitigating impacts; guiding current actions; and planning future impact assessments and actions to conserve birds and bats. The strategy should be updated regularly as new information, including monitoring of project impacts and technical advancements, becomes available. If BOEM determines, through consultation with USFWS or other agencies, that compensatory mitigation is appropriate, the strategy should outline the actions needed to offset take of ESA-listed birds, migratory birds protected under the Migratory Bird Treaty Act, and bats. The components of a compensatory mitigation plan will be identified and developed during the COP review stage.
MM-19	Anchoring Plan	Lessee must develop an anchoring plan to with a Construction and Operation Plan and prior to placing anchors, equipment, or installation of facilities (e.g., buoys, export cable installation, WTG or OSS installation and interarray cable installation) or decommissioning. The plan and plats (designs and maps) must include all available data on bathymetry, and locations of interest with set distances labeled. Locations of interest include hard-bottom, sensitive habitats, cultural resources, ancient submerged landform features, potential shipwrecks, potential hazards and existing and planned infrastructure. The plan will have a description of the navigation equipment that would be used to ensure anchors are accurately set; and anchor handling procedures to prevent or minimize anchor dragging, such as placing and removing all anchors vertically. The plan will require all vessels deploying anchors to use, whenever feasible and safe, mid-line anchor buoys to reduce the amount of anchor chain or line that touches the seafloor. After completion of activity, as-placed plats must be submitted to BOEM and BSEE after completion of an activity show the "as-placed" location of all anchors and any associated anchor chains and/or wire ropes and relevant locations of interest or avoidance on the seabed where applicable. The plats must be at a scale of 1 inch = 1,000 feet (300 meters) and within current BOEM data submission standards.
MM-20	Sensitive Marine Species Characterization and Monitoring Plan	Lessee must develop and submit a plan to characterize the marine biological species and habitats in the water column or on the seafloor that may be affected by a project's activities. Species and habitats that are particularly sensitive to impacts, and beyond those already addressed specifically elsewhere in the Appendix, will be identified, avoided, and require monitoring to track changes over time, allowing for the identification of adverse effects and evaluation of mitigation efforts. Consolidated seafloor sediments (e.g. hard bottom, hard grounds, reefs) are equivalent to sensitive habitats and species (e.g. hard corals, sponges, commercially important fish species, endangered species) and shall be avoided from direct and indirect impacts unless data exists to demonstrate no harm to sensitive species and habitats. Upon or after COP submission, BOEM may require the lessee to conduct additional surveys to define boundaries and avoidance distances and/or may specify the survey methods and instrumentations for conducting the biological survey and specify the contents of the biological report. If, during the conduct of lessee's approved activities, the lessee or BOEM finds that sensitive seafloor habitats, essential fish habitat, or habitat areas of particular concern may be adversely affected by lessee's activities, BOEM must consult with the NFMS (30 CFR 585.703).

Mitigation Number	Measure Name	Description
MM-21	Scour and cable protection plan	The lessee must prepare a Scour and Cable Protection Plan (SCPP) that includes descriptions and specifications for all cable protection materials. Plan(s) must include depictions of the location and extent of scour and cable protection, the habitat delineations for the areas of cable protection measures, and detailed information on the proposed scour or cable protection materials for each area and habitat type. The lessee must avoid engineered stone or concrete mattresses in complex habitat, as practicable and/or feasible. The lessee must ensure that all materials used for scour and cable protection measures consist of natural or engineered stone that does not inhibit epibenthic growth and provides three-dimensional complexity in height and in interstitial spaces, as practicable and feasible. If concrete mattresses are necessary, bioactive concrete (i.e., with bio-enhancing admixtures) must be used as practicable as the primary scour protection (e.g., concrete mattresses) or veneer to support biotic growth. Lessees should consider using materials the blend and compliment the surrounding tapered or sloped edges to reduce hangs for mobile fishing gear. The lessee should avoid the use of plastics/recycled polyesters/net material (i.e., rock-filled mesh bags, fronded mattresses) for scour protection. The lessee must resolve all comments on the SCPP before placement of cable protection measures.
MM-22	Fisheries Compensatory Mitigation	Lessees should consider establishing a compensation process if a project is likely to result in lost income to commercial and recreational fisheries. The compensation process should be equitable and fair across fisheries and fishing communities and consider best practices and consistency across other offshore wind energy projects. Financial compensation can include compensation for gear loss and damage and lost fishing income.
MM-23	Fisheries Communication Plan and Liaison	Lessees should prepare a Fisheries Communication Plan, outlining the specific methods for engaging with and disseminating project information to the local fishing community, as well as other associated stakeholders, throughout each phase of the project. To the greatest extent practicable, the plan should describe how the lessee intends to engage with the various fishing constituencies that are active within a project area. The Fisheries Communication Plan must include the contact information for an individual retained by the lessee as its primary point of contact with fisheries stakeholders (i.e., Fisheries Liaison).
MM-24	Fisheries community involvement	Lessees should work cooperatively with commercial/recreational fishing entities and interests to minimize potential disruptions to commercial and recreational fishing interests during construction, operation, and decommissioning of a project. Lessees should review planned activities with potentially affected fishing organizations and port authorities to prevent unreasonable fishing gear loss or damage. Lessees should notify registered fishermen of the location and time frame of the project construction activities well in advance of mobilization and provide updates throughout the construction period.
MM-25	Environmental Justice (EJ) Communications Plan	The lessee should develop an Environmental Justice (EJ) Communications Plan, in collaboration with communities that have EJ concerns. This plan should aim to outline how the lessee will communicate with these communities, identified as populations affected by environmental justice issues under Executive Order 14096 and the revised implementation regulations for NEPA (National Environmental Policy Act Implementing Regulations Revisions Phase 2; 89 Federal Register 35554 – 35577 (May 1, 2024)), referred to herein as “EJ populations”). Draft EJ Communications Plan should be developed in consultation with community leaders and community organizations who work with the identified EJ population(s). Plans should be specifically designed for EJ populations and advance meaningful engagement based on each affected community’s unique communication and information needs. EJ populations should be identified by any applicable federal and state-level EJ and related screening tools, or other relevant local information. The lessee may utilize efforts or language developed for any state requirements (e.g., measures identified through state renewable energy procurement processes or as requirements of state permits) to satisfy this Draft EJ Communications Plan partially or wholly.
MM-26	Environmental Justice (EJ) Mitigation Plan	The Environmental Justice Impact Mitigation Plan should be developed in collaboration with communities that have environmental justice concerns. The plan must acknowledge existing state or local regulations (such as noise control) that may help mitigate impacts, ensuring that there is no redundancy. The plan should outline procedures for responding to reported impacts, detailing the actions the lessee will take, including the distribution of mitigation resources or other strategies. During the development of this plan, BOEM encourages the lessee to engage with other stakeholders and align this engagement with the broader communication strategy for the project.
MM-27	Fisheries mitigation – potential obstructions from submarine cable installation and decommissioning	All static cables should be buried below the seabed where technically feasible and a benefit to the environment. Lessees should avoid installation techniques that raise the profile of the seabed, such as the ejection of large, previously buried rocks or boulders onto the surface. The ejection of this material may damage fishing gear. The intent of this mitigation measure is to ensure that new obstructions are not unduly introduced for mobile fishing gear. Removal of large marine objects and decommissioning instrumentation and/or anchors should occur as soon as practicable and within required regulations and permits. Future mitigations could include gear identification and or lost survey gear monitoring and reporting.
MM-28	Marine cultural resources avoidance or additional investigation	The lessee must provide the methods and results of an archaeological survey with its COPs. The lessee will conduct HRG surveys prior to conducting bottom disturbing activities such as geotechnical/sediment sampling and avoid all potentially eligible cultural resources or historic properties. The lessee may only conduct geotechnical exploration activities, including geotechnical sampling or other direct sampling or investigation techniques, in areas of the leasehold in which an analysis of the results of geophysical surveys have been completed for that area by a qualified marine archaeologist. BOEM will establish and lessees must comply with requirements for all protective buffers recommended by BOEM for each marine cultural resource (i.e., archaeological resource and ASLFs) based on the size and dimension of the resource. Protective buffers must extend outward from the maximum discernible limit of each resource and are intended to minimize the risk of disturbance during construction. If an adverse effect cannot be avoided, the lessee will be required to conduct further investigations to minimize or resolve effects on these historic properties, per 36 CFR 800.6.
MM-29	Terrestrial archaeological resource avoidance or additional investigation	BOEM will establish avoidance criteria for any historic property or any unevaluated terrestrial archaeological resource. Lessees must avoid impacts on all historic properties and unevaluated archaeological resources. If avoidance is not feasible, the lessee must develop a plan to be submitted to BOEM that addresses the adverse effect on the terrestrial archaeological resource. The lessee may submit this plan with the Terrestrial Archaeological Resources Assessment appendix to the COP or may develop this plan in the course of BOEM’s project-level NEPA review and Section 106 consultation on terrestrial archaeological resources. Avoidance would entail the development and implementation of avoidance buffers around each historic property and unevaluated resource. If avoidance of an unevaluated resource is not feasible, additional investigations must be conducted for the purpose of determining eligibility for listing in the NRHP.
MM-30	Section 106 mitigation fund	Through consultation, BOEM may request that the lessee financially contributes to a third-party managed compensatory mitigation fund to address visual impacts on aboveground historic properties related to OCS offshore wind activities.

Mitigation Number	Measure Name	Description
MM-31	Ancient submerged landform feature (ASLF) monitoring program and marine archaeological post-review discovery plan	BOEM will establish, and the lessees must comply with, monitoring and post-review discovery plans outlining processes to document and review impacts of construction or any seabed-disturbing activities on marine cultural resources. Such plans may be developed in the course of BOEM's project-level NEPA review and Section 106 consultation on marine archaeological resources. A post-review discovery plan approved by BOEM is also required in the event that an unanticipated discovery and/or inadvertent impact of a marine archaeological resource occurs.
MM-32	Shared transmission corridor	Lessees should coordinate transmission infrastructure among projects. Where practicable, transmission infrastructure should use shared intra- and interregional connections, have requirements for meshed infrastructure, apply parallel routing with existing and proposed linear infrastructure (including export cables and other existing infrastructure such as power and telecommunication cables, pipelines), and limit the combined footprint to minimize impacts and maximize potential capacity.
MM-33	Post-installation cable monitoring	The lessee must conduct an inspection of inter-array, interconnector, and export cables to determine cable location, burial depths, the state of the cable, and site conditions within a set time period. These surveys must also be conducted with additional events. The lessee must provide BSEE and BOEM with a cable monitoring report following each inspection with specific methods. The lessee must provide BSEE and BOEM with a cable incident report in the event of entanglement with or accidents involving vessels.
MM-34	Electrical shielding on underwater cables	Lessees should use standard underwater cables that have electrical shielding to reduce the intensity of electromagnetic fields (EMFs).
MM-35	HF radar interference mitigation agreement	Prior to completion of construction or initiation of commercial operations , the lessee must enter into a mitigation agreement with the Surface Currents Program of NOAA's Integrated Ocean Observing System (IOOS) Office to determine if the lessee's project causes radar interference to the degree that radar performance is no longer within the specific radar systems' operational parameters or fails to meet NOAA IOOS's mission objectives. Where possible, the lessee will adhere to the recommendations for mitigation to marine radar interference from the National Academy of Science: *Wind Turbine Generator Impacts to Marine Vessel Radar* (National Academies of Sciences, Engineering, and Medicine 2022).
MM-36	Oceanographic Monitoring Plan	The lessee will develop an Oceanographic Monitoring Plan. Monitoring reports are a required component of the plan and will be used to determine the need for adjustments to monitoring approach, consideration of new monitoring technologies, and or changes to the frequency of monitoring. Components of the plan to consider include coordination with relevant regulatory agencies and neighboring lessees, monitoring strategies for pre-construction, construction, post-construction, and decommissioning phases; comparisons with available model outputs; technologies (e.g., gliders, moorings, Lidar buoys, profilers, floats, ship-based methods) and appropriate physical and biochemical measurements (e.g., ocean temperature, salinity, pH, current velocity, biogeochemistry, and nutrients).
MM-37	Monitoring on strategically placed WTGs	To the extent practicable, lessees should incorporate technologies for detecting tagged (e.g., Innovasea) sea turtles and tagged fish in their project to monitor the effect of increases in habitat use and residency around WTG foundations and share monitoring results/ propose new or additional mitigation measures and/or monitoring methods if appropriate.
MM-38	Trailing suction hopper dredge mitigation	If a trailing suction hopper dredge is used offshore, operators must disengage dredge pumps when the dragheads are not actively dredging and therefore working to keep the draghead firmly on the bottom to prevent impingement or entrainment of ESA-listed fish and sea turtle species. Pumps will be disengaged when lowering dragheads to the bottom to start dredging, turning, or lifting dragheads off the bottom at the completion of dredging.
MM-39	Monitoring impacts on scenic and visual resources	In coordination with BOEM, the lessee must prepare and implement a scenic and visual resource monitoring plan that monitors and compares the visual effects of the wind farm during construction and operations/maintenance (daytime and nighttime) to the findings in the COP Visual Impact Assessment and verifies the accuracy of the visual simulations (photo and video). The monitoring plan must include monitoring and documenting the meteorological influences on actual wind turbine visibility over a duration of time from selected onshore key observation points, as determined by BOEM and the lessee.
MM-40	Regional and federal monitoring and survey program	For long-term scientific surveys that overlap with wind energy development, (e.g. NMFS scientific surveys) the lessee must submit to BOEM a survey mitigation agreement. At a minimum, the survey mitigation agreement must describe actions and the means to address impacts on the affected surveys. The survey mitigation agreement must, where possible, identify activities that will result in the generation of data equivalent to data generated by affected surveys for the duration of the project and address regional-level impacts for the surveys. Lessees are encouraged to coordinate monitoring and survey efforts across lease areas to standardize approaches, understand potential impacts to resources at a regional scale, and maximize efficiencies in monitoring and survey efforts.

E.1 References

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Bureau of Ocean Energy Management (BOEM). 2024b. *New York Bight Draft Programmatic Environmental Impact Statement.* January. Available: https://www.boem.gov/renewable-energy/new-york-bight-draft-programmatic-environmental-impact-statement-draft-peis. Accessed: September 12, 2024.

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Appendix F: Seascape, Landscape, and Visual Impact Assessment

F.1 Introduction

This appendix describes the open ocean, seascape, landscape, and visual impact assessment (SLVIA) methodology and key findings that the Bureau of Ocean Energy Management (BOEM) used to identify the potential impacts of offshore wind structures (wind turbine generators [WTG]) on scenic and visual resources in the Affected Environment. The SLVIA methodology applies to any offshore wind energy development proposed for the Outer Continental Shelf (OCS) and incorporates by reference the detailed description of the methodology described in the *Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States* (BOEM 2021).

Section F.2, *Method of Analysis*, of this appendix describes the specific methodology used to apply the SLVIA methodology to the Humboldt and Morro Bay Wind Energy Areas (WEA) and Section F.3, *Seascape, Landscape, and Visual Impact Assessment Results,* summarizes the wind farm distances, fields of view (FOV), noticeable elements, visual contrasts, scale of change, and prominence that contributed to the determination of impact levels for ocean, seascape, and landscape and each key observation point (KOP) for the Humboldt and Morro Bay WEAs. Overview maps of scenic resources present in the Affected Environment are included in Section 3.4.10, *Scenic and Visual Resources*. Preliminary maps of character areas, KOPs, and other scenic resources within view of each WEA are provided in Section F.3. Visual simulations of the Humboldt and Morro Bay WEAs are provided on BOEM's California Offshore Wind website: https://www.boem.gov/renewable-energy/state-activities/california-visual-simulation

The demarcation line between seascape and open ocean is the U.S. states jurisdictional boundary, 3 nautical miles (nm) (3.45 statute miles or 5.5 kilometers) seaward from the coastline (Submerged Lands Act of 1953). This line coincides with the area of sea visible from the shoreline. The line defining the separation of seascape and landscape is based on the juxtaposition of apparent seacoast and landward landscape elements, including topography, water (bays and estuaries), vegetation, and structures.

F.2 Method of Analysis

The SLVIA has two separate but linked parts: the open ocean, seascape, and landscape impact assessment (SLIA) and the visual impact assessment (VIA). The SLIA analyzes and evaluates the *sensitivity* of the receptor and the *magnitude of change* in consideration of impacts on both the physical elements and features that make up the open ocean, seascape, or landscape. The VIA analyzes and evaluates the impacts on people from adding the proposed development to views from selected viewpoints.

The inclusion of both the SLIA and VIA in the BOEM SLVIA methodology is consistent with the National Environmental Policy Act's (NEPA) objective of providing Americans with aesthetically and culturally pleasing surroundings and its requirement to consider all potentially significant impacts of development.

F.2.1 Seascape and Landscape Impact Assessment Methodology

The SLIA inventories and describes the visual character of the ocean and the coastal landscape and seascape. It analyzes and evaluates the *magnitude of change* and the *sensitivity* of the receptor in consideration of impacts on both the physical elements and features that make up the open ocean, seascape, or landscape. The magnitude of change depends on a project's scale or degree of change, geographic extent, and duration and reversibility.

Sensitivity is measured by the impact receptor's susceptibility to change, its ability to accommodate the impacts of a proposed project without changing its basic character, and its perceived value to society. These impacts affect the feel, character, or sense of place of an area of open ocean, seascape, or landscape, rather than the composition of a view from a particular place. Social value is based on the aesthetic, perceptual, and experiential aspects of the open ocean, seascape, or landscape that make it distinctive. In the SLIA, the impact receptors (the entities that could be affected by a proposed project) are the open ocean/seascape/landscape itself and its components, both its physical features and its distinctive character.

F.2.2 Visual Impact Assessment Methodology

The VIA analyzes and evaluates impacts on people of adding proposed development to views from selected viewpoints. It also evaluates the change to the composition of the view itself and assesses how people who are likely to be at that viewpoint may be affected by the change to the view. Enjoyment of a particular view depends on the viewer, and, in the VIA, the impact receptors are people. Viewers include:

- Residents living in coastal communities or individual residences.
- Tourists visiting, staying in, or traveling through the area.
- Recreational users of the seascape, including those using ocean beaches and tidal areas.
- Recreational users of the open ocean, including those involved in yachting, fishing, boating, and passage on ships and ferries.
- Recreational users of the landscape, including those using landward beaches, golf courses, ballfields, playgrounds, cycle routes, and footpaths.
- Tourists, workers, visitors, or local people using transport routes.
- People working in the countryside, commerce, or dwellings.
- People working in the marine environment, such as those on fishing vessels and in crews of ships.

The VIA for a representative offshore wind project assesses the impacts of adding the proposed development to views from selected viewpoints (referred to as KOPs). The VIA assesses how the change to the view itself caused by the addition of wind energy project components, such as seeing wind turbines instead of an open ocean horizon, affects people who are likely to be at the viewpoint. The change to the view as a result of adding a representative project may affect viewers' experiences of that view. How the addition of a representative project to the view affects the viewers' experiences and their responses depends in part on who they are, what they are doing when viewing the facility, and how much they value the view. The experience of a particular view depends on the viewers, and in the VIA, the impact receptors are people, rather than the seascape or landscape.

F.2.3 Project Visibility Factors

The Affected Environment and VIA analysis are based on clear-day and clear-night visibility to evaluate the most impactful scenario. Larger numbers of viewers, particularly recreational users, are more likely to be present on beaches on sunny days, when viewing conditions are better than on rainy days. Although coastal fog can limit visibility, fog is a common occurrence in the summer and does not necessarily keep visitors away from beaches or other Pacific coastal zones. In contrast to summer, late fall and winter months can have exceptional visibility. Due to California's mild climate, viewers can be found enjoying coastal resources year-round. Trails along elevated coastal bluffs afford greater visibility of offshore elements for viewers.

WTG visibility would be variable throughout the day depending on many factors, such as view angle, sun angle, and atmospheric conditions. Visual contrast of WTGs would vary throughout the day depending on the visual character of the horizon's backdrop and whether the WTGs are backlit, side-lit, or front-lit. If less visual contrast is apparent in the morning hours, then it is likely that the visual contrast may be more pronounced in the afternoon. The inverse is possible as well. These effects are also influenced by varying atmospheric conditions, direction of view, distance between the viewer and the WTGs, and elevation of the viewer.

At closer distances, approximately 16 miles (25.75 kilometers) or closer, the form of the 1,100-foot (335-meter) WTG may be the dominant visual element creating a visual contrast regardless of color. At approximately 12 miles (19.31 kilometers) or closer the form of the 850-foot (260-meter) WTG may be the dominant visual element creating contrast regardless of color. At greater distances, color may become the dominant visual element creating visual contrast under certain visual conditions that gives visual definition to the WTG's form and line. As a viewer's elevation increases, Earth curvature (EC) has a decreasing effect on the visible height of individual WTGs, allowing a greater proportion of turbine infrastructure to be seen.

The noticeable daytime and nighttime elements of a project's WTGs and their range of viewshed distances are listed in for 1,100-foot WTGs and in Table F-4 for 850-foot WTGs. Each WTG would have two L-864 flashing red obstruction lights at the top of the nacelle, one of which is required to be lit (BOEM 2021). WTGs would have additional intermediate lighting on the tower utilizing low-intensity red flashing (L-810) obstruction lighting. Line-of-sight calculations for onshore viewers (5.9-foot [1.8-meter] eye level) are based on intervening EC screening (7.98-inch [20.3-centimeter] height per mile). Heights of WTGs are stated relative to mean lower low water (MLLW), which is 0 feet. Because the WTGs are floating, the heights of noticeable elements will change with tidal fluctuations; however, the WTG height variation from MLLW and mean higher high water would not be noticeable to the typical onshore observer.

Table F-2 and Table F-3 for 1,100-foot WTGs and Table F-5 and Table F-6 for 850-foot WTGs indicate the Humboldt and Morro Bay WEAs' effects based on horizontal and vertical FOVs, respectively, defined as the extent of the observable landscape seen at any given moment, usually measured in degrees (BOEM 2021) from the nearest point onshore. The horizontal FOV would be slightly less for each lease area and will vary based on viewing location. The horizontal FOV will also vary based on the potential WTG density scenarios, and horizontal drift of each WTG, for this reason the horizontal FOV is based on the width of the WEA. The vertical FOV will change slightly based on viewing elevation due to a decrease in EC screening. FOVs are valid and reliable indicators of the magnitude of view occupation by future projects in the Humboldt and Morro Bay WEAs.

Table F-1. Heights of noticeable[1] 1,100-foot WTG elements and offshore substations, and visible distances[2]

Noticeable Element	Height in Feet (Meters)	Visible Distance[2] in Miles (Kilometers)
Rotor Blade Tip	1,100 (335) MLLW	0–43.6 (70.2)
Upper Aviation Light	624.8 (190.4) MLLW	0–33.6 (54.1)
Nacelle	614.5 (187.3) MLLW	0–33.3 (53.6)
Hub	602.4 (183.6) MLLW	0–33.0 (53.1)
Mid-tower Navigation Light	301.2 (92) MLLW	0–24.2 (38.9)
Offshore Substation (OSS)	TBD	0–TBD
Yellow Tower Base Color	50 (15.2) MLLW	0–11.5 (18.5)

[1] Perception of project elements, from 5.9 feet (1.8 meters) human eye level while standing at mean sea level, involves static distance-related sizes, forms, lines, colors, and textures; variable daytime lighting conditions; variable nighttime light conditions; and variable meteorological conditions.
[2] Based on intervening EC and clear-day conditions.
TBD = to be determined

Table F-2. Horizontal FOV occupied by the 1,100-foot WTGs

WEA	Noticeable Element[2]	Width[1] Miles (kilometers)	Nearest Distance Miles (kilometers)	Horizontal FOV	Human FOV	Percent of FOV
Humboldt Samoa Beach[2]	R, AL, N, H, M	28.5 (45.9)	20.1 (32.4)	54.7°	124°	44%
Morro Bay Piedras Blancas[2]	R, AL, N, H, M	37.9 (61.0)	19.0 (30.6)	63.2°	124°	51%

[1] Maximum extent of the visible WEA.
[2] Nearest onshore location to the WEA.

Table F-3. Vertical FOV occupied by the 1,100-foot WTGs

WEA	Noticeable Element	Observer Height[1] Feet (meters)	Distance Miles (kilometers)	WTG Height Above Horizon[2] Feet (meters)	Vertical FOV	Human FOV	Percent of FOV
Humboldt Samoa Beach[3]	R, AL, N, H, M	23.9 (7.3)	20.1 (32.4)	965.3 (294.2)	0.52	55°	0.9%
Morro Bay Piedras Blancas[3]	R, AL, N, H, M	17.9 (5.5)	19.0 (30.6)	972.6 (296.5))	0.55°	55°	1%

[1] Elevation plus 5.9 feet (1.8 meters) human eye level.
[2] Based on intervening EC, clear-day, and clear-night conditions.
[3] Nearest onshore location to the WEA.

Table F-4. Heights of noticeable[1] 850-foot WTG elements and OSS, and visible distances[2]

Noticeable Element	Height in Feet (meters)	Visible Distance[2] in Miles (kilometers)
Rotor Blade Tip	850 (260) MLLW	0–38.7 (62.3)
Aviation Light	514.6 (156.8) MLLW	0–30.7 (49.4)
Nacelle	502.9 (153.3) MLLW	0–30.4 (48.9)
Hub	490.5 (149.5) MLLW	0–30.1 (48.4)
OSS	TBD	TBD
Mid-tower Light	245.3 (74.8) MLLW	0–22.1 (35.6)
Yellow Tower Base Color	50 (15.2) MLLW	0–11.5 (18.5)

[1] Perception of project elements, from 5.9 feet (1.8 meters) human eye level while standing at mean sea level, involves static distance-related sizes, forms, lines, colors, and textures; variable daytime lighting conditions; variable nighttime light conditions; and variable meteorological conditions.
[2] Based on intervening EC and clear-day conditions.

Table F-5. Horizontal FOV occupied by 850-foot WTGs

WEA	Noticeable Element	Width[1] Miles (kilometers)	Distance Miles (kilometers)	Horizontal FOV	Human FOV	Percent of FOV
Humboldt Samoa Beach[2]	R, AL, N, H, M	28.5 (45.9)	20.1 (32.4)	54.7°	124°	44%
Morro Bay Piedras Blancas[2]	R, AL, N, H, M	37.9 (60.0)	19.0 (30.6)	63.2.0°	124°	51%

[1] Maximum extent of the visible WEA.
[2] Nearest onshore location to the WEA.

Table F-6. Vertical FOV occupied by 850-foot WTGs

WEA	Noticeable Element	Observer Height[1] Feet (meters)	Distance Miles (kilometers)	WTG Height Above Horizon[1] Feet (meters)	Vertical FOV	Human FOV	Percent of FOV
Humboldt Samoa Beach[3]	R, AL, N, H, M	23.9 (7.3)	20.1 (32.4)	715.3 (218.0)	0.38°	55°	0.7%
Morro Bay Piedras Blancas[3]	R, AL, N, H, M	17.9 (5.5)	19.0 (30.6)	722.6 (220.3)	0.41°	55°	0.7%

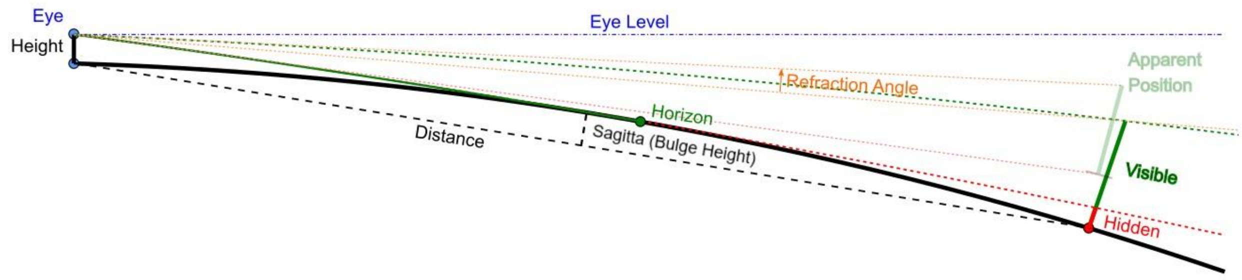
[1] Elevation plus 5.9 feet (1.8 meters) human eye level.
[2] Based on intervening EC, clear-day, and clear-night conditions.
[3] Nearest onshore location to the WEA.

While the coastal shoreline has a prevailing westward viewing direction, localized views may vary from southwest to northwest. All cardinal directions are conceivable when viewing from a lighthouse or a water vessel at sea. When viewing from onshore toward a southerly direction and scanning to the east and west, the color of the horizon backdrop often will vary. Variation will continue as the sun arcs across the sky from sunrise to sunset. Depending on sun angle, the backdrop sky color may have various intensities of white to gray and sky blue to pale blue to dark blue-gray. Partly cloudy to overcast conditions will also influence the color make-up of the horizon's backdrop. The sunrise and sunset have varying degrees of light blue to dark blue, light and dark purples intermixed with oranges, yellows, and reds. Partly cloudy skies may increase the remarkable color effects during the sunset and sunrise periods of the day.

When placing WTGs offshore, the visual interplay and contrasting elements in form, line, color, and texture may vary with the ever-changing character of the backdrop. Front-lit WTGs may have strong color contrast against a darker gray sky, giving definition to the WTG's vertical form and line contrast to the ocean's horizontal character and the line where the sea meets sky, or visually dissipates against a whiter backdrop created by high levels of evaporative atmospheric moisture during clear sunny days. Partly cloudy skies may create varying degrees of sunlight reflecting off the white wind turbines, placing some WTGs in the shadow and making them appear a darker gray and less conspicuous while highlighting others with a bright white color contrast. The level of noticeability would be directly proportional to the degree of visual contrast and scale of change between the WTGs and the corresponding backdrop. These variations through the course of the day may result in periods of moderate to major visual effects while at other times of day would have minor or negligible effects.

WTG blade motion also affects visibility. Empirical studies of offshore wind turbine visibility have shown that WTG blade movement is routinely visible at distances of 21 miles (34 kilometers) or less and as far as 26 miles (42 kilometers) (Sullivan 2013). In a visually empty seascape, the rotational movement of the turbines can dominate the scene during the day. Contrary to static turbine noticeability, blade motion is visible regardless of lighting conditions, sun angle, and sky contrast levels. Blade motion contributes substantially to visual contrast and may contribute relatively more at shorter viewing distances (Sullivan 2013). Blade movement noticeability would be dependent on meteorological conditions. It is critical to note that the studies cited above were conducted on smaller WTGs than those proposed on this or other offshore wind projects in U.S. waters; therefore, noticeability distances would increase with larger wind turbines. It is currently unknown how the pitch and yaw or gyroscopic motions of floating WTGs would affect visibility and viewer response.

Atmospheric refraction of light rays causes fluctuations in the extents and appearances of offshore and onshore facilities. It results from the bending of light rays between viewers and objects due to current air temperature, water vapor, and barometric pressure (Bislins 2022). Atmospheric refraction can increase the visibility of objects, making them look larger or taller, depending on conditions as depicted in Figure F-1 provides a summary of increased visibility ranges for the nearest beach viewers for each lease area and both turbine sizes based on the average sea level refraction calculation coefficient of 0.17 (Bislins 2022) applied to the turbine blade tip viewshed distances. Daytime and nighttime atmospheric refraction-based visibility varies with sea level's continuous increases and decreases in temperature, water vapor, and barometric pressure.



Source: Bislins 2023

Figure F-1. Effects of atmospheric refraction and EC on WTG visibility

Table F-7. Atmospheric refraction summary for all lease areas for 1,100-foot and 850-foot WTGs

WEA	1,100-foot WTG		850-foot WTG	
	Rotor blade tip increased visibility feet (meters)	Nearest beach increased visibility feet (meters)[1]	Rotor blade tip increased visibility feet (meters)	Nearest beach increased visibility feet (meters)[1]
OCS-P 0561	From 0.0 to 199.5 (60.8) = 199.5 (60.8)	From 967.2 (294.8) to 998.7 (304.4) = 31.5 (9.6)	From 0.0 to 155.0 (47.2) = 155.0 (47.2)	From 717.4 (218.7) to 748.9 (228.3) = 31.5 (9.6)
OCS-P 0562	From 0.0 to 199.5 (60.8) = 199.5 (60.8)	From 969.3(295.4) to 1,000.4(304.9) = 31.1 (9.5)	From 0.0 to 155.0 (47.2) = 155.0 (47.2)	From 719.3(219.2) to 750.4 (228.7) = 31.1 (9.5)
OCS-P 0563	From 0.0 to 199.5 (60.8) = 199.5 (60.8)	From 1,062.2 (323.8) to 1,082.0 (329.8) = 19.8 (6.0)	From 0.0 to 155.0 (47.2) = 155.0 (47.2)	From 812.2 (247.6) to 832.0 (253.6) = 19.8 (6.0)
OCS-P 0564	From 0.0 to 199.5 (60.8) = 199.5 (60.8)	From 1,091.7 (332.7) to 1,098.4 (334.8) = 6.7 (2.0)	From 0.0 to 155.0 (47.2) = 155.0 (47.2)	From 841.7 (256.5) to 848.4 (258.6) = 6.7 (2.0)
OCS-P 0565	From 0.0 to 199.5 (60.8) = 199.5 (60.8)	From 971.1 (296.0) to 1,000.7(305.0) = 29.6 (9.0)	From 0.0 to 155.0 (47.2) = 155.0 (47.2)	From 721.1 (219.8) to 750.7 (228.8) = 29.6 (9.0)

[1] See Section 3.4.10, Table 3.4.10-25 for nearest beach and elevation for each lease area.

Visibility thresholds have been described and rated through research by Robert Sullivan at the Argonne National Laboratory based on offshore WTGs in England. Table F-8 describes visibility threshold levels and ratings based on this work. This research along with distance and observer elevation considerations, informed by the VIA simulations (ESS Group 2019), EC calculations, horizontal FOV, and vertical FOV in undeveloped open ocean provide the basis for evaluating visibility and size and scale of change.

Table F-8. Visibility threshold levels

Visibility Rating	Description
Visibility level 1. Visible only after extended, close viewing; otherwise, not visible.	An object/phenomenon that is near the extreme limit of visibility. It could not be seen by a person who was unaware of it in advance and looking for it. Even under those circumstances, the object can be seen only after looking at it closely for an extended period.
Visibility level 2. Visible when scanning in the general direction of the subject; otherwise, likely to be missed by casual observers.	An object/phenomenon that is very small and/or faint, but when the observer is scanning the horizon or looking more closely at an area, can be detected without extended viewing. It could sometimes be noticed by casual observers; however, most people would not notice it without some active looking.
Visibility level 3. Visible after a brief glance in the general direction of the study subject and unlikely to be missed by casual observers.	An object/phenomenon that can be easily detected after a brief look and would be visible to most casual observers, but without sufficient size or contrast to compete with major landscape/seascape elements.
Visibility level 4. Plainly visible, so could not be missed by casual observers, but does not strongly attract visual attention or dominate the view because of its apparent size, for views in the general direction of the study subject.	An object/phenomenon that is obvious and with sufficient size or contrast to compete with other landscape/seascape elements, but with insufficient visual contrast to strongly attract visual attention and insufficient size to occupy most of an observer's visual field.
Visibility level 5. Strongly attracts the visual attention of views in the general direction of the study subject. Attention may be drawn to the strong contrast in form, line, color, or texture, luminance, or motion.	An object/phenomenon that is not large but contrasts with the surrounding landscape elements so strongly that it is a major focus of visual attention, drawing viewer attention immediately and tending to hold attention. Has strong contrasts in form, line, color, and texture. In addition, bright light sources and moving objects contribute substantially to drawing viewer attention. The study subject's visual prominence noticeably interferes with views of nearby landscape/seascape elements.
Visibility level 6. Dominates the view because the study subject fills most of the visual field of views in its general direction. Strong contrasts in form, line, color, texture, luminance, or motions may contribute to view dominance.	An object/phenomenon with strong visual contrasts that is so large it occupies most of the visual field, and views cannot be avoided except by turning one's head more than 45 degrees from a direct view of the object. The phenomenon is the major focus of visual attention, and its large apparent size is a major factor in its view dominance. The study subject's visual prominence noticeably detracts from views of other landscape/seascape elements.

Source: Sullivan et al. 2013.

F.2.4 Geographic Scope

As described in Draft PEIS Section 3.4.10, the scenic and visual resources Affected Environment extends approximately 47.4 miles (76.3 kilometers) offshore and 60 miles (96.6 kilometers) onshore to capture potential views of the Humboldt and Morro Bay WEAs, and includes the coastlines from Humboldt, Monterey, and San Luis Obispo Counties, as well as elevated viewpoints of national significance (e.g., Hearst San Simeon State Historical Monument).

F.2.5 Defining Potential Impacts

Project activities for all phases of a wind energy project's life cycle (construction, operations and maintenance [O&M], and decommissioning) are assessed against the environmental baseline to identify the potential interactions between a project and the seascape, landscape, and viewers. Analysis of visual impacts for the onshore Affected Environment should include an assessment of landfalls, buried onshore export cables, onshore substation/converter station, and transmission connections to the electric grid. Because the locations of onshore infrastructure for the Humboldt and Morry Bay WEA projects are currently unknown, this assessment only analyzes impacts from offshore structures. Visual impacts from onshore infrastructure will be analyzed during future project specific NEPA review for each Construction and Operations Plan (COP). Potential impacts from offshore infrastructure are assessed to determine an impact level consistent with the definitions in Table F-9.

Table F-9. Definitions of potential adverse impact levels for the SLIA and VIA

Impact Level	Impact Type	Definition
Negligible	Adverse	**SLIA**: Very little or no effect on seascape/landscape unit character, features, elements, or key qualities either because unit lacks distinctive character, features, elements, or key qualities; values for these are low; or project visibility would be minimal. **VIA**: Very little or no effect on viewers' visual experience because view value is low, viewers are relatively insensitive to view changes, or project visibility would be minimal.
Minor	Adverse	**SLIA**: The project would introduce features that may have low to medium levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project features may introduce a visual character that is slightly inconsistent with the character of the unit, which may have minor to medium negative effects on the unit's features, elements, or key qualities, but the unit's features, elements, or key qualities have low susceptibility or value. **VIA**: The visibility of the project would introduce a small but noticeable to medium level of change to the view's character; have a low to medium level of visual prominence that attracts but may or may not hold the viewer's attention; and have a small to medium effect on the viewer's experience. The viewer receptor sensitivity/susceptibility/value is low. If the value, susceptibility, and viewer concern for change is medium or high, then evaluate the nature of the sensitivity to determine if elevating the impact to the next level is justified. For instance, a KOP with a low magnitude of change, but that has a high level of viewer concern (combination of susceptibility/value), may justify adjusting to a moderate level of impact.
Moderate	Adverse	**SLIA**: The project would introduce features that would have medium to large levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project would introduce a visual character that is inconsistent with the character of the unit, which may have a moderate negative effect on the unit's features, elements, or the key qualities. In areas affected by large magnitudes of change, the unit's features, elements, or key qualities have low susceptibility and/or value. **VIA:** The visibility of the project would introduce a moderate to large level of change to the view's character; may have a moderate to large level of visual prominence that attracts and holds but may or may not dominate the viewer's attention; and has a moderate effect on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to low. Moderate impacts are typically

Impact Level	Impact Type	Definition
		associated with medium viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has medium levels of change; or low viewer receptor sensitivity (combination of susceptibility/value) in areas where the view's character has large changes to the character. If the value, susceptibility, and viewer concern for change is high, then evaluate the nature of the sensitivity to determine if elevating the impact to the next level is justified.
Major	Adverse	**SLIA:** The project would introduce features that would have dominant levels of visual prominence within the geographic area of an ocean/seascape/landscape character unit. The project would introduce a visual character that is inconsistent with the character of the unit, which may have a major negative effect on the unit's features, elements, or key qualities. The sensitivity to change (combination of susceptibility/value) to the character unit is high. **VIA:** The visibility of the project would introduce a major level of character change to the view; will attract, hold, and dominate the viewer's attention; and have a moderate to major effect on the viewer's visual experience. The viewer receptor sensitivity/susceptibility/value is medium to high. If the magnitude of change to the view's character is medium, but the susceptibility or value at the KOP is high, then evaluate the nature of the sensitivity to determine if elevating the impact to major is justified. If the sensitivity (combination of susceptibility/value) at the KOP is low in an area where the magnitude of change is large, then evaluate the nature of the sensitivity to determine if lowering the impact to moderate is justified.

F.2.6 Laws, Ordinances, and Regulations

Table F-10 lists open ocean, seascape, landscape, and visual resource protection and management laws, ordinances, and regulations.

Table F-10. Laws, ordinances, and regulations

Jurisdiction	Authority	Objectives
Federal		
BOEM	Code of Federal Regulations (CFR) Title 30 of the CFR Part 585, Subpart F, Plans and Information Requirements	This title provides guidance on survey requirements, project-specific information, and information to meet the requirements of the Outer Continental Shelf Lands Act (OCSLA), NEPA, and other applicable laws and regulations. It also specifies that to comply with NEPA and other relevant laws, the COP must include a detailed description of visual resources and various social and economic resources that could be affected by a proposed project, that would be addressed in an SLVIA.
BOEM	OCSLA, Title 43, Chapter 29, Subchapter I, Section 1301 (1953)	The primary purpose of OCSLA is to facilitate the federal government's leasing of its offshore mineral resources and energy resources. As set forth in the Energy Policy Act of 2005, OCSLA was amended to authorize the U.S. Department of the Interior (DOI) to issue submerged land leases for alternate uses and alternative energy development on the OCS. Through this amendment and subsequent delegation by the Secretary of the Interior, BOEM has the authority to issue these leases and regulate activities that occur within them, including the authorization of a COP.
BOEM	Submerged Lands Act of 1953	The Submerged Lands Act grants coastal states title to natural resources located within their coastal submerged lands out to three miles from their coastline.
BOEM	NEPA	NEPA was signed into law in 1970 set forth a national environmental policy in the U.S. which was to ensure federal agencies consider the significant environmental consequences of their proposed actions and inform the public about their decision-making. NEPA established the Council on Environmental Quality to advise agencies on the NEPA process and to oversee and coordinate the development of federal environmental policy. The Council on Environmental Quality issued revised NEPA regulations (40 CFR 1500-1508) in 2021. The regulations include procedures to be used by federal agencies for the NEPA review process.
BOEM	Clean Air Act of 1970	This act authorized the U.S. Environmental Protection Agency to establish National Ambient Air Quality Standards to protect public health and the environment. The states were directed to develop state implementation plans, which consist of emission reduction strategies, with the goal of achieving the National Ambient Air Quality Standards by the legislated date. BOEM has jurisdiction over OCS air emissions in the Gulf of Mexico west of 87.5 degrees west longitude (off the coasts of Texas, Louisiana, Mississippi, and Alabama). BOEM also has jurisdiction over OCS air emissions within the Chukchi and Beaufort Seas in Alaska according to the Consolidated Appropriations Act of 2012. In all other OCS areas, the U.S. Environmental Protection Agency has jurisdiction, as mandated by Section 328 of the Clean Air Act.

Jurisdiction	Authority	Objectives
BOEM	Coastal Zone Management Act of 1972	The U.S. Congress recognized the growth in the coastal zone by passing the Coastal Zone Management Act, which is administered by the National Oceanic and Atmospheric Administration (NOAA). The goal is to "preserve, protect, develop, and where possible, to restore or enhance the resources of the nation's coastal zone." Authorized by the Coastal Zone Management Act in 1972, the Coastal Zone Management Program was established as a voluntary partnership between the federal government and U.S. coastal and Great Lakes states and territories.
BOEM	National Historic Preservation Act of 1966	This act establishes a preservation program and a system of protections, which encourage both the identification and protection of historic resources. As part of this program, historic districts and individual properties are either listed or eligible for listing on the National Register of Historic Places or National Historic Landmarks.
BOEM	Inflation Reduction Act of 2022	This act offers funding, programs, and incentives to accelerate the transition to a clean energy economy and will likely drive significant deployment of new clean electricity resources. The Act incentives reduce renewable energy costs for organizations, businesses, nonprofits, educational institutions, and state, local, and tribal organizations. Taking advantage of Inflation Reduction Act incentives, such as tax credits, is key to lowering greenhouse gas emission footprints and accelerating the clean energy transition.
BOEM	Information Guidelines for a Renewable Energy Construction and Operations Plan Version 4.0. (2020)	BOEM's guidelines indicate that the visual resource assessment should apply appropriate viewshed mapping, photographic photo simulations, and field inventory techniques to determine the visibility of a proposed project to scenic viewpoints.
BOEM	Assessment of Seascape, Landscape, and Visual Impacts of Offshore Wind Energy Developments on the Outer Continental Shelf of the United States (2021)	This OCS Study provides the methodology for assessing the seascape, landscape, and visual impacts of offshore wind within a particular study area. Lessees are to use this guidance in preparation as part of a COP for their lease development. This assessment is to be reviewed by BOEM.

Jurisdiction	Authority	Objectives
DOI, National Park Service	National Register of Historic Places (National Historic Preservation Act of 1966)	The Affected Environment likely contains historic districts and individual properties listed or eligible for listing on the National Register of Historic Places and two properties or districts listed as National Historic Landmarks.
DOI, National Park Service	36 CFR 1 (2023)	In 1968, Congress created Redwood National Park from lands adjacent to three California State Parks (SP) created by the state of California in the 1920s protecting some of the finest remaining examples of coast redwoods. The park also contains open prairie lands, two major rivers, and 37 miles of coastline. The park is located approximately 30 miles from the Humboldt lease area.
DOI, National Park Service	National Natural Landmarks Program (2021)	Lanphere and Ma-le'l Dunes National Natural Landmark is an 834-acre sand dune ecosystem representing the best remaining coastal dune system from this area. The site is located approximately 21 miles from the Humboldt WEA.
DOI, National Park Service	National Natural Landmarks Program (1967)	Point Lobos National Natural Landmark is a 1,398-acre reserve and sanctuary for thousands of sea and shorebirds. It is the only known habitat of Monterey cypress and variegated brodiaea and is one of only two or three areas containing the Gowan's cypress and sea otter. The site is located approximately 51 miles from the Morro Bay WEA.
DOI, National Park Service	National Natural Landmarks Program (1974)	Guadalupe-Nipomo Dunes National Natural Landmark is an 18-mile-long coastal dunes landscape occupying approximately 20,000 acres in southwestern San Luis Obispo County and northwestern Santa Barbara County. The site is located approximately 60 miles from the Morro Bay WEA.
U.S. Department of Transportation	Federal Highway Administration Guidelines for the Visual Impact Assessment of Highway Projects (2015)	These guidelines represent the Federal Highway Administration's best practices in assessing visual impacts, determining the effectiveness of mitigation measures, and incorporating any opportunities for enhancing the visual experience of both travelers and neighbors in the design of their facilities. The document contains the guidelines and basis for conducting a VIA and details of how to conduct VIA.
U.S. Department of Transportation	Federal Highway Administration National Scenic Byways and All-American Roads 23 U.S. Code 162 (2019)	Under the National Scenic Byways Program (23 U.S. Code 162) a roadway can be designated as a State Scenic Byway, a National Scenic Byway, or an All-American Road based upon intrinsic scenic, historic, recreational, cultural, archaeological, or natural qualities. Two sections of roadway within view of the Morro lease site are designated as All-American Roads by the Federal Highway Administration, meaning criteria for two intrinsic qualities are met. Route 1 from the Carmel River to the San Luis Obispo County line was officially designated (OD) a scenic route in 1965, is 72.3 miles long, and located approximately 22 miles from the Morro Bay WEA. Route 1 from the Monterey County line to the city limits of San Luis Obispo was OD a scenic route in 1999, is 74.3 miles long, and located approximately 23 miles from the Morro Bay WEA.

Jurisdiction	Authority	Objectives
U.S. Fish and Wildlife Service	National Wildlife Refuge System 23 CFR part 774 (2022)	Wildlife refuges use a wide range of land management tools aimed at balancing conservation for the benefit of wildlife, functioning ecosystems, and native plant populations. The Humboldt Bay National Wildlife Refuge is located about 23 miles from the Humboldt WEA. The Guadalupe-Nipomo Dunes National Wildlife Refuge is located about 60 miles from the Morro Bay WEA.
U.S. Department of Agriculture, Forest Service and DOI, Bureau of Land Management and National Park Service	Wild and Scenic Rivers Act (1968)	The National Wild and Scenic Rivers (WSR) System was created to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition. Within the lease areas there are four such designated resources. The Smith River WSR is valued for fish, geology, recreation, and scenery and is administered by Six Rivers National Forest and the state of California. Smith River is located approximately 45 miles from the Humboldt lease area. Klamath River WSR is valued for fish and is administered by the Redding Field office, Six Rivers National Forest, Klamath National Forest, state of California, Pacific West Regional Office, Hoopa Valley Indian Tribe, Karuk Tribe, and Yurok Tribe. Klamath River is located approximately 38 miles from the Humboldt WEA. Eel River WSR is valued for fish and recreation and is administered by the state of California, Pacific West Regional Office, Six Rivers National Forest, Mendocino National Forest, Arcata Field Office, and Round Valley Indian Reservation. Eel River is located approximately 21 miles from the Humboldt WEA. Big Sur River WSR is valued for fish, recreation, scenery, and wildlife and is administered by the Los Padres National Forest. Big Sur River is located approximately 36 miles from the Morro Bay WEA.
U.S. Department of Agriculture, Forest Service or DOI, National Park Service	National Scenic Area	A National Scenic Area is a federally designated area of outstanding natural and scenic value receiving a less stringent level of protection than a wilderness designation. Scenic areas are typically occupied partially by people or suitable for a wider range of uses than those permitted under a wilderness designation. A National Scenic Area has been proposed (in 1980) for a portion of the Big Sur Coast from the San Luis Obispo County line north to Malpaso Creek in Monterey County, but the NSA has not been OD by Congress.
NOAA	National Marine Sanctuaries Act U.S. Code Chapter 32, Sections 1431-1445 (2011)	Monterey Bay National Marine Sanctuary is a federally protected marine area offshore of California’s central coast from the north end of the Morro Bay Affected Environment south to Cambria. The sanctuary was established for coastal ecosystem and cultural resource protection, research, and education. The sanctuary has a shoreline length of 276 miles and covers 6,094 square statute miles extending an average of 30 miles from shore. Kayaking, fishing, diving, boating, and surfing are allowed uses. Oil drilling, ocean dumping, and seabed mining are prohibited. The Morro Bay WEA is partly within, adjacent to, or nearly adjacent with the sanctuary boundary.
NOAA, U.S. Environmental Protection Agency, and U.S. Army Corps of Engineers	Coastal Zone Management Act of 1972	The act, administered by NOAA, provides for the management of the nation’s coastal resources. The goal is to “preserve, protect, develop, and where possible, to restore or enhance the resources of the nation’s coastal zone.” “The Secretary may conduct a Coastal and Estuarine Land Conservation Program, in cooperation with appropriate state, regional, and other units of government, for the purposes of protecting important coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that are threatened by conversion from their natural, undeveloped, or recreational state to other uses or could be managed or restored to effectively conserve, enhance, or restore ecological function.”

Jurisdiction	Authority	Objectives
State of California		
California Coastal Commission (CCC)	Public Resources Code Division 20 California Coastal Act (2023)	The California Coastal Act intends to permanently protect the state's natural and scenic resources in the California coastal zone and ensure existing developed uses and future developments are carefully planned and developed consistent with the policies of this division, essential to the economic and social well-being of the people of the state, and especially to working persons employed within the coastal zone. The California Coastal Act requires that all development within the Coastal Zone have a Coastal Development Permit in addition to any other permit required for development by a local or state agency. The act contains Amendment Procedures for Energy Facilities. The act also addresses amendment of the Local Coastal Plan for public works or energy facility projects. Section 30515 states: Any person authorized to undertake a public works project or proposing an energy facility development may request any local government to amend its certified local coastal program (LCP), if the purpose of the proposed amendment is to meet public needs of an area greater than that included within such certified LCP that had not been anticipated by the person making the request at the time the LCP was before the commission for certification. If, after review, the local government determines that the amendment requested would be in conformity with the policies of this division, it may amend its certified LCP as provided in Section 30514. If the local government does not amend its LCP, such person may file with the commission a request for amendment which shall set forth the reasons why the proposed amendment is necessary and how such amendment is in conformity with the policies of this division. The local government shall be provided an opportunity to set forth the reasons for its action. The commission may, after public hearing approve and certify the proposed amendment if it finds after a careful balancing of social, economic, and environmental effects that to do otherwise would adversely affect the public welfare, that a public need of an area greater than that included within the certified LCP would be met, that there is no feasible less environmentally damaging alternative way to meet such need, and that the proposed amendment is in conformity with the policies of this division. The act contains protections for environmentally sensitive habitat areas that addresses siting of development in Section 30240: (a) Environmentally sensitive habitat areas shall be protected against any significant disruption of habitat values, and only uses dependent on such resources shall be allowed within such areas. (b) Development in areas adjacent to environmentally sensitive habitat areas and parks and recreation areas shall be sited and designed to prevent impacts which would significantly degrade such areas, and shall be compatible with the continuance of such habitat areas The act contains protections for scenic and visual qualities in Section 30251: The scenic and visual qualities of coastal areas shall be considered and protected as a resource of public importance. Permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural landforms, to be visually compatible with the character of surrounding areas, and, where feasible, to restore and enhance visual quality in visually degraded areas. New

Jurisdiction	Authority	Objectives
		development in highly scenic areas such as those designated in the California Coastline Preservation and Recreation Plan prepared by the Department of Parks and Recreation and by local government shall be subordinate to the character of its setting. The act addresses the protection of visual attractiveness, special neighborhoods, and communities from new development in Section 30253 Minimization of Adverse Impacts: New development shall do all of the following: … …(e) Where appropriate, protect special communities and neighborhoods that, because of their unique characteristics, are popular visitor destination points for recreational uses. The Coastal Act defines these special communities and neighborhoods as follows: 1. Areas characterized by a particular cultural, historical or architectural heritage that is distinctive in the coastal zone; 2. Areas presently recognized as important visitor destination centers on the coastline; 3. Areas with limited automobile traffic that provide opportunities for pedestrian and bicycle access for visitors to the coast; 4. Areas that add to the visual attractiveness of the coast. The CCC adopted the following statement regarding Section 30251: "The primary concern under this section of the Act is the protection of ocean and coastal views from public areas such as highways, roads, beaches, parks, coastal trails and accessways, vista points, coastal streams and waters used for recreational purposes, and other public preserves rather than coastal views from private residences where no public vistas are involved."
California Department of Fish and Wildlife (CDFW)	Wildlife Areas and Refuges	CDFW manages several properties in the Humboldt lease area including: Pebble Beach Fishing Access near Crescent City, Waukell Creek Wildlife Area near Klamath River, Big Lagoon Wildlife Area near Big Lagoon County Park, Mad River Slough Wildlife Area on Humboldt Bay, Bracut Tidelands on Humboldt Bay, Fay Slough Wildlife Area on Humboldt Bay, Samoa Peninsula Public Access on Humboldt Bay, Elk River Wildlife area south of Eureka, South Spit Wildlife Area near Humboldt Bay National Wildlife Refuge, Eel River Wildlife Area near the Eel River, and Headwaters Forest Ecological Reserve near Fortuna. CDFW manages two properties in the Morro Bay Affected Environment including: Morro Bay Wildlife Area near Morro Bay and Morro Dunes Ecological Reserve near Los Osos. These areas provide recreational opportunities such as walking, hiking, wildlife viewing, boating, sunbathing, hunting, and fishing.

Jurisdiction	Authority	Objectives
CDFW	California's Marine Protected Area (MPA) Network	CDFW's goals are to increase MPA awareness and understanding, facilitate MPA regulatory compliance, support enforcement, and encourage informed enjoyment and stewardship of MPAs. MPAs located within view of the Humboldt lease area include: Point St. George Reef Offshore state Marine Conservation Area (MCA), Reading Rock State Marine Reserve (MR) and MCA, Samoa State MCA, South Humboldt Bay State MR, South Cape Mendocino State MR, Mattole Canyon State MR, Sea Lion Gulch State MR. MPAs located within view of the Morro lease area include: Point Lobos State MCA and MR, Point Sur State MCA and MR, Big Creek State MCA and MR, Piedras Blancas State MCA and MR, Cambria State MCA and MPA, Morro Bay State MR, and Point Buchon State MCA and MR.
California Office of Historic Preservation	California Historical Resources and Landmarks	The Affected Environment contains historic resources that the state has determined are worthy of preservation, but which have either not been determined eligible for inclusion or have not been evaluated for listing in the National Register of Historic Places.
California Department of Parks and Recreation	SPs and State Beaches (SB)	California Department of Parks and Recreation provides access to parks and open spaces including beaches, cultural and historic sites, natural preserves and recreation opportunities for walking, hiking, wildlife viewing, boating, and sunbathing. SP facilities located within view of the Humboldt lease area include: Del Norte Coast Redwoods SP, Prairie Creek Redwoods SP, Humboldt Lagoons SP, Patrick's Point SP, Trinidad SB, Little River SB, South Humboldt Bay State Marine Recreational Management Area, Grizzly Creek Redwoods SP, and Humboldt Redwoods SP. SP facilities located within view of the Morro lease area include: Ishxenta SP, Point Lobos SNR, Garrapata SP, Andrew Molera SP, Pfeiffer Big Sur SP, Julia Pfeiffer Burns SP, Lime Kiln SP, Hearst San Simeon SP, Harmony Headlands SP, Estero Bluffs SP, Morro Strand SB, Morro Bay SP, and Montaña De Oro SP.
California Department of Transportation	Scenic Highway Program (2023)	California has several eligible (E) and OD scenic highways within the study areas. California evaluates E scenic highways the same as OD. Route 101 through Del Norte Coast Redwoods SP was OD a scenic route in 1970, is 12.1 miles long, and located approximately 40 miles from the Humboldt lease area. The remainder of Route 101 through Del Norte and Humboldt counties is designated E. Routes 199, 299, and 36 are classified as E and partly within the visibility area of the Humboldt WEA. Route 1 from the Carmel River to the San Luis Obispo County line was OD a scenic route in 1965, is 72.3 miles long, and located approximately 22 miles from the Morro lease site. Route 1 from the Monterey County line to the city limits of San Luis Obispo was OD a scenic route in 1999, is 74.3 miles long, and located approximately 23 miles from the Morro lease site. Route 46, Route 41 west of Route 101, and Route 101 south of Route 46 are designated as E in San Luis Obispo County and partly within the visibility area of the Morro Bay WEA.
California	Project Design Procedures Manual (2023)	The Project Design Procedures Manual guides the implementation of the California Department of Transportation's policies, procedures, and programs. These include projects involving scenic resource evaluation, VIAs, aesthetic resources, and scenic highways.

Jurisdiction	Authority	Objectives
California Natural Resources Agency	California Wild & Scenic Rivers Act Public Resources Code 5093.50-5093.71 (1972)	"It is the policy of the state of California that certain rivers which possess extraordinary scenic, recreational, fishery, or wildlife values shall be preserved in their free-flowing state, together with their immediate environments, for the benefit and enjoyment of the people of the state." Several rivers are in the California WSR System within the Humboldt Affected Environment including the Smith, Klamath, and Eel Rivers. The Big Sur River is the only river with such designation in the Morro Bay Affected Environment.
Local Governments		
Del Norte County	General Plan (GP) (2003, Amended 2021)	The GP includes goals and policies to preserve and enhance aesthetics and protect visual resources including in environmentally sensitive areas, coastal and riverine areas, recreation areas, and scenic vistas. The county also defines several scenic viewpoints and corridors within the jurisdiction within the Humboldt Affected Environment. The county establishes several policies around the preservation and enhancement of "scenic values" on coastal beaches and "scenic quality of life" for residents and visitors. The county establishes policies encouraging maintenance of open views and scenic viewpoints in highly scenic areas and providing the public access to these scenic vistas and views including coastal trails, scenic routes, and scenic drives. The county defines several highly scenic areas along the coastal zone. The county establishes policies around new development minimizing the alteration of natural landforms, nighttime glare from lighting, undergrounding of utilities, and restoration of natural landforms following construction disturbance.
Del Norte County	GP Coastal Element/LCP (1983)	The county prepared the GP Coastal Element/LCP as mandated by California Coastal Act. The Act requires the identification, protection, and enhancement of "highly scenic" areas within the Coastal Zone. This component of the LCP presents policies designed to maintain and enhance the visual resources of coastal Del Norte County. The LCP identifies particularly visually distinctive elements of the coastal landscape requiring special attention in the planning process and of special interest to the public including views of water bodies (bodies (e.g., ocean, estuary, streams), sensitive habitats and open space (e.g., wetland, rocky intertidal), expressive topographic features (e.g., offshore rocks, sea cliffs), and special cultural features (e.g., historical, maritime settings). The LCP identifies planning issues, guidelines, and policies around alteration of natural landforms, building design and placement, and utility lines siting and placement. Policies defined addressing visual compatibility with scenic surroundings include minimization of the alteration of natural landforms; designing features to blend with, or be screened by the landscape or other natural features; harmonious and compatible placement, material and color selection, and form of built elements; and utility line undergrounding or placement away from scenic views or vistas. Policies also include restoration of disturbed areas to a natural appearance.

Jurisdiction	Authority	Objectives
Del Norte County	Crescent City Harbor Coastal Land Use Plan (LUP) (2021)	The Crescent City Harbor LUP was originally certified by the CCC in 1987 as an independent geographic segment of the county's LUP covering the Harbor Area. This document, certified by the commission in 2023, represents a comprehensive update to the Harbor LUP. The Harbor LUP remains an independent segment with policies separate and apart from the bulk of the county. The Harbor LUP identifies goals and policies for protection of scenic and visual qualities of and access to the coastal zone "including public views to and along the ocean and harbor." The LUP requires permitted development be sited and designed to protect views to and along the ocean and scenic coastal areas, minimize the alteration of natural landforms, and be visually compatible with the character of surrounding areas.
Humboldt County	Humboldt County GP for the Areas Outside of the Coastal Zone (2017)	The county's GP includes goals and policies to protect outstanding scenic resources that may be adversely affected by land use and development. "Scenic beauty is perhaps the most notable characteristic of Humboldt County for visitors and one of the most appreciated attributes among residents. Forested hillsides, working agricultural land, river corridors, and the coast provide a range of stunning scenic areas. Certain of these are exemplary and warrant protections to maintain the county's characteristic scenic beauty and unique sense of place." The plan's goals and policies support the scenic highway system, recognition of the scenic value of resource production lands, and minimization of the disturbance of natural features by permitted development. The plan includes standards for roads and public utility corridors being as narrow as feasible and follow natural contours, and restoration of natural features disturbed for construction purposes. Standards defined also include visual buffers along mapped scenic highways; limitations on the height, bulk, and siting of structures; visual compatibility of structures with the character of surrounding areas; and placement of structures in the landscape with consideration of views or visual screening. The plan provides guidance for grading, access roads, and utility undergrounding in visual buffer areas. The plan identifies standards for light and glare, fully shielded lighting, minimization of upward transmission of light, and lighting intensity at various distances. The plan identifies the placement of and minimization of the visual impacts of above ground transmission lines.

Jurisdiction	Authority	Objectives
Humboldt County	Humboldt County GP Volume II North Coast Area Plan (NCAP) of the Humboldt County LCP (2014)	Humboldt County's Coastal Program document is split into six parts covering six geographic areas north to south: NCAP, Trinidad Area Plan (TAP), McKinleyville Area Plan, Humboldt Bay Area Plan (HBAP), Eel River Area Plan, and South Coast Area Plan (SCAP). The NCAP for the Humboldt County LCP represents the northernmost of the six County coastal planning areas. The NCAP establishes policies for visual resource protection and how permitted development shall be sited and designed to protect views to and along the ocean and scenic coastal areas, to minimize the alteration of natural landforms, and be visually compatible with the character of surrounding areas. No development shall be approved that is not compatible with the physical scale of development (including height and bulk, unless visual screening is incorporated) as designated in the zoning for the subject parcel. The NCAP defines policies for protection of natural landforms including land form alteration for access roads and public utilities. These shall be minimized by running hillside roads and utility corridors along natural contours where feasible. Natural contours, including slope, visible contours of hilltops and treelines, bluffs and rock outcroppings, shall suffer the minimum feasible disturbance compatible with development of any permitted use. The NCAP defines policies protecting coastal scenic areas. All industrial and commercial development within coastal scenic areas shall be subordinate to the character of the designated area and subject to limitations with the policy including building materials, heights, setbacks, and lighting and glare. The intent of the policies is to prevent new development (including industrial development) from blocking coastal views, coastal waterways, and coastal scenic areas from the public. Commercial and industrial proposals shall include detailed plans for exterior design of all structures and signs, location and intensity of outdoor lighting, parking, and landscaping, and this plan shall be the subject of public hearing. Design, lighting, landscaping, overall compatibility with the natural setting, and distance from the road would all be evaluated in this process. A local Design Assistance Committee could become involved to ensure the proposed development is compatible with goals and policies in this plan. The NCAP establishes the policy and describes the need and procedure for establishment of buffer lands around existing public lands from proposed development. The NCAP defines significant natural features within the North Coast Planning Area, and specific protection for retention of these resources.

Jurisdiction	Authority	Objectives
Humboldt County		
Humboldt County	Humboldt County GP Volume II TAP of the Humboldt County LCP (2014)	The TAP for the Humboldt County LCP contains much of the same language as the NCAP. This area plan (from Patrick's Point to the mouth of the Little River) represents one of six county coastal planning areas. The goal and policy language of the TAP general mirrors the language in the NCAP with the following exceptions. The TAP includes additional language around power plant (more than 50 megawatts) and identifies several locations where coastal resources would be adversely affected by the siting of a power plant including coastal scenic areas adjacent to and west of Highway 101. The TAP defines significant natural features within the Trinidad Planning Area, and specific protection for retention of these resources.
Humboldt County	Humboldt County GP Volume II McKinleyville Area Plan of the Humboldt County LCP (2014)	The McKinleyville Area Plan for the Humboldt County LCP contains much of the same language as the previous County LCPs. This area plan (Little River to Mad River) represents one of six county coastal planning areas. The McKinleyville Area Plan defines significant natural features within the McKinleyville Planning Area, and specific protection for retention of these resources.
Humboldt County	Humboldt County GP Volume II HBAP of the Humboldt County LCP (2022)	The HBAP for the Humboldt County LCP contains much of the same language as the previous County LCPs. This area plan (south of Mad River and along Humboldt Bay) represents one of six county coastal planning areas. This document reiterates and mirrors the language within the Energy Element Standards addressing the placement and approach within highly scenic areas from the Humboldt County GP for Electrical Transmission Lines. This document includes additional language for power plant siting differing from previous LCPs. Siting of power plants greater than 50 megawatts has been delegated to the California Energy Commission, and that the CCC has designated certain areas where siting such a power plant would prevent the achievement of the objectives of the Coastal Act. The HBAP indicates several undesignated areas and lists several coastal resources that would be damaged by the siting of a power plant in these areas including "scenic and visual quality areas." The HBAP also differs from the previous LCPs with language regarding wind generating facilities considerations including height, appearance, and design of wind generation facilities. The HBAP defines significant natural features within the Humboldt Bay Planning Area, and specific protection for retention of these resources.
Humboldt County	Humboldt County GP Volume II Eel River Area Plan of the Humboldt County LCP (2014)	The Eel River Area Plan for the Humboldt County LCP contains much of the same language as the previous County LCPs. This area plan (Eel River delta area) represents one of six county coastal planning areas. The language in the Eel River Area Plan mirrors that of the previous LCPs, except that under 3.42 Visual Resource Protection, Section C is titled "Protection of Historical Buildings" and not "Coastal Scenic Areas." The unique Section C includes language that historic buildings shall be considered a scenic and visual resource of public importance and preservation of historic buildings shall be encouraged. The Eel River Area Plan defines significant natural features within the Eel River Planning Area, and specific protection for retention of these resources.

Jurisdiction	Authority	Objectives
Humboldt County	Humboldt County GP Volume II SCAP of the Humboldt County LCP (2014)	The SCAP for the Humboldt County LCP contains much of the same language as the previous County LCPs. This area plan (the area south of the Eel River Delta) represents one of six county coastal planning areas. The language in the SCAP mirrors that of the previous LCPs, except that under visual resource protection, the Coastal Scenic Areas (Section C) is blank and Section D. Coastal View Areas is abbreviated to limit structures to 20 feet in height west of Lower Pacific Drive between Abalone Court and the drainage immediately north of Gull Point. The SCAP defines significant natural features within the South Coast Planning Area, and specific protection for retention of these resources.
Monterey County	GP (2010)	The GP is the blueprint for the future physical, economic, and social development of the unincorporated areas of the county and implements California laws that regulate land use planning and development. A review of the following GP elements was conducted to find goals and policies protecting visual resources in coastal areas, environmentally sensitive areas, and recreation areas: • Land Use Element (2010) • Conservation and Open Space Element (2010) The Land Use Element was reviewed and did not contain visual resource goals or policies relevant to the Morro Bay Affected Environment. The Conservation and Open Space Element of the GP includes goals and policies protecting visual resources in Monterey County. The goals and policies established in the document seek to retain, preserve, conserve, and maintain scenic qualities, natural beauty, character, unique physical features, and natural resources throughout the county and especially within visually sensitive areas. The policies establish guidance for structures including materials, form, siting and placement (below ridgelines), and scale. The policies protect disruption of views through directions on use of lighting. The GP includes goals and policies protecting and conserving the quality of coastal, marine, and river environments. Policies protect special status species, wetlands, and critical habitat areas are established in the document. The GP energy goals and policies do not appear to be germane or relevant to the Morro Bay Affected Environment.

Jurisdiction	Authority	Objectives
Monterey County	Monterey County LCP Carmel Area LUP (1999)	Monterey County's LCP planning area has been divided into four geographical areas. Only the southern two planning areas, Carmel Area and Big Sur Coast, are within the Morro Bay Affected Environment. The Carmel Coastal Segment extends from Pescadero Canyon in the north to Malpaso Creek in the south. Only a small portion of the Morro Bay Affected Environment is within the Carmel Area LUP area. Monterey County has been a leader in the area of scenic protection and this legacy is reflected in these documents. The opening of the Visual Resources section reads, "Protection of the Carmel area's visual resources may be one of the most significant issues concerning the future of this area. The strong policies set forth in this plan are intended to safeguard the coast's scenic beauty and natural appearance." Key Visual Resources Policy: "To protect the scenic resources of the Carmel area [in?] perpetuity, all future development within the viewshed must harmonize and be clearly subordinate to the natural scenic character of the area. All categories of public and private land use and development including all structures, the construction of public and private roads, utilities, and lighting must conform to the basic viewshed policy of minimum visibility except where otherwise stated in the plan." The LUP further establishes additional visual resources "general policies" and "specific policies." The general visual resources policies establish requirements for the design and siting of all structures "shall not detract from the natural beauty of the scenic shoreline and the undeveloped ridgelines and slopes in the public viewshed," new development shall be sited within and naturally screened by existing vegetation and topography, minimization of landscape disturbance, and guidance on design choices and siting including color, texture, and materials. The general policies also establish use of native vegetation and vegetative screening to conceal structures. The specific visual resources policies establish requirements for new developments having individual on-site investigations, access road design and placement, protection of the forested corridor along Highway 1, and design review by the county. The specific visual resources policies establish requirements for several design control measures including setbacks from slopes, siting on slopes, building and structure appearance standards, vegetation protection, and lighting standards minimizing glare and visibility. The specific visual resources policies touch on existing power lines being rerouted or placed underground. "New overhead power or telephone lines will be considered only where overriding natural or physical constraints exist. Where permitted, poles will be placed in the least conspicuous locations out of public, and where possible, private view." The LUP establishes environmentally sensitive habitats key policy, general policies, and specific policies. The policies establish requirements for the protection, maintenance, enhancement, and restoration of these habitat areas. The policies require avoidance of development in these areas, establishing compatibility of development adjacent to habitat areas, field study of habitats potentially affected by development, restrictions on vegetation removal, and use of native vegetation in restoration and screening efforts in proposed landscape and mitigation efforts.

Jurisdiction	Authority	Objectives
Monterey County	Monterey County LCP Big Sur Coast LUP (1996)	The Big Sur Coast LUP is similar to the Carmel Area LUP, but the language around visual resource protection is yet more specific and restrictive. The Big Sur Coast Segment extends from Malpaso Creek in the north to the San Luis Obispo County line and contains the vast majority of the Monterey County Coastline within the Morro Bay Affected Environment. The opening of the Visual Resources section reads, "Recognizing the Big Sur coast's outstanding scenic beauty and its great benefit to the people of the state and the Nation, it is the county's objective to preserve these scenic resources in perpetuity and to promote, wherever possible, the restoration of the natural beauty of visually degraded areas. The county's basic policy is to prohibit all future public or private development visible from Highway 1 and major public viewing areas." The opening continues, "The aesthetic and scenic qualities and semi-wilderness character of the coast have received national and even international acclaim. Accordingly, the issue of visual resource protection is probably the most significant and far-reaching question concerning the future of the Big Sur coast. A major premise of this plan is that unusual action must now be taken to preserve the coast's scenic beauty and natural appearance. The strong policies set forth in this plan are intended to safeguard this critically important resource." Key Visual Resources Policy: "Recognizing the Big Sur coast's outstanding beauty and its great benefit to the people of the state and Nation, it is the county's objective to preserve these scenic resources in perpetuity and to promote the restoration of the natural beauty of visually degraded areas wherever possible. To this end, it is the county's policy to prohibit all future public or private development visible from Highway 1 and major public viewing areas (the critical viewshed), and to condition all new development in areas not visible from Highway 1 or major public viewing areas on the siting and design criteria set forth in Sections 3.2.3, 3.2.4, and 3.2.5 of this plan. This applies to all structures, the construction of public and private roads, utilities, lighting, grading and removal or extraction of natural materials." The LUP further establishes additional visual resources "critical viewshed policies (3.2.3)", "critical viewshed procedures (3.2.4)," and policies for land not in the critical viewshed (3.2.5). The LUP critical viewshed policies establish requirements for the design and siting of structures and access roads and that buildings and structures cannot be visible from the critical viewshed. The LUP critical viewshed procedures require onsite investigations for all development. Photographic documentation, staking, and flagging are required during the project review and approval process as well as during construction. Protection of ocean views from Highway 1 and public viewing areas are required. Procedures limit artificial berming, landscaping, and lighting impeding or altering views from public vantage points. The LUP policies for land not in the critical viewshed establish requirements for buildings and structures not detracting "from the natural beauty of the undeveloped skylines, ridgelines, and the shoreline." The policies require consideration of the "visual effects upon public views as well as the views and privacy of neighbors," placement of buildings and structures in the portion of the parcel least visible from public view points, located

Jurisdiction	Authority	Objectives
		where natural vegetation and topography can screen, minimization of slope and landform disturbance, use of materials and colors (including shapes and textures) that help buildings and structures blend into the landscape, use of landscape screening, and approaches to access road design including utilizing existing roads, avoiding visible alignments, and utilizing alignments preserving existing vegetation. The LUP does indicate two exceptions to the visual resources key policy that could apply to the Morro Bay Affected Environment. Exceptions for utilities state "overhead power or telephone lines will be considered only where overriding natural or physical constraints exist. Poles will be placed in the least conspicuous locations out of public, and where possible, private view." The utilities exception indicates the county's intent for utilities to be installed underground, lighting design to protect from glare and long-range visibility, and "transmitter towers and power facilities must not appear in the critical viewshed." The coastal-dependent uses exception to the visual resources key policy could also apply to the Morro Bay Affected Environment. "Coastal-dependent uses, natural resource management needs, and certain necessary public facilities as specified below are permitted provided that in each case there be a finding that no reasonable alternative exists, that no significant adverse visual impacts will result, and that all such uses are in conformance with Scenic Resources Policy 3.2.4 and all other policies." Exceptions listed in the language do not include renewal or nonrenewal energy production, or projects requiring offshore wind. The language in the Environmentally Sensitive Habitats Goals and Policies section of the Big Sur Coast LUP is nearly the same as the Carmel Coast LUP.
San Luis Obispo County	GP (1980–2020)	The GP is the blueprint for the future physical, economic, and social development of the unincorporated areas of the county and implements California laws that regulate land use planning and development. A review of the following GP elements was conducted to find goals and policies protecting visual resources in coastal areas, environmentally sensitive areas, and recreation areas: • Conservation and Open Space Element (2010) • Offshore Energy Element (1992) • Parks and Recreation Element (2006) The Conservation and Open Space Element of the GP includes goals and policies aligned with encouraging the development of renewable energy sources. Specific policy and implementation language addressing visual resources is included that wind power facilities should be placed near existing power facilities and existing transmission lines; underground all existing electrical distribution lines on the project site; locate new or expanded facilities outside sensitive view corridors, scenic, or recreational areas; and if the proposed location visually impacts views of the site from public roads or lands, prepare a screening plan to minimize visual impacts. Implementation language also includes visual impact guidance for lighting, reducing the visibility and impacts of new transmission lines, siting of transmission lines, and placement of utility access maintenance roads. The intent of the GP visual resource goals, policies and implementation strategies is to protect the visual character and identity of the county while respecting private property rights. The GP defines several goals and

Jurisdiction	Authority	Objectives
		policies protecting rural views, natural and historic character, emphasizing native vegetation and grading to existing natural forms, visual identities of communities and spaces between them, visual sensitive resource areas, views from scenic vistas and vista points, visibility and clarity of the night sky, and minimizing the visual effects of utility lines (e.g., undergrounding). The Offshore Energy Element of the GP includes goals and policies regarding offshore and related onshore oil and gas activities. Specific planning guidance is included for siting transmission lines such as tower spacing to minimize visual impact and selection of least visually intrusive tower configurations. Policies for offshore oil and gas activities include protection and management based on National Marine Sanctuary and the National Estuary Programs, limitations of placement north of and around Morro Bay based on California sea otter range, a buffer zone around the Santa Lucia Bank area, and consideration and evaluation of the potential roles of conservation and alternative energy resources. On shore facility policies include evaluation of buffer zones based on viewsheds, siting facilities in swales and away from horizon lines, and consideration of potential for upset for each facility on a case-by-case basis. The Parks and Recreation Element of the GP establishes goals, policies, and implementation measures for management, renovation, and expansion of existing, and development of new, parks and recreation facilities in order to meet existing and projected needs and to assure an equitable distribution of parks throughout the county. Specific goal and policy language addressing visual resources includes maintaining and augmenting access to the coast and providing and maintaining viewing areas and viewing platforms along the county's beaches.
San Luis Obispo County	San Luis Obispo County GP LCP Land Use Element – Part 1 (2018) and Coastal Plan Policies (2007)	The LCP Land Use Element and the accompanying Coastal Zone Land Use Ordinance provide the framework for county decisions on land use and development and represent the values and goals of the county regarding land use in accordance with the California Coastal Act. The Land Use Element also incorporates the LUP portion of the county LCP certified by the CCC. The LCP identifies goals and objectives intended to protect the visual resources of coastal San Luis Obispo County including preservation of open space, scenic natural beauty, and natural resources; protection of coastal resources such as wetlands, coastal streams, forests, marine habitats, and threatened and endangered species; giving highest priority to avoiding significant environmental impacts from development through site and project design and alternatives; and encouraging better access to the coast through the acquisition and development of coastal accessways, trails, and parks, in appropriate locations. To further protect or "avoid unnecessary impairment of scenic views," the LCP identifies goals in support of enhancing the system of scenic roads and highways, protecting the scenic quality of identified areas and to maintain views from designated scenic roads and highways, siting and design of visible structures, landscaping with native plants, and undergrounding utilities. "Potentially unsightly features should be located to be inconspicuous from streets, highways, public walkways and surrounding properties; or effectively screened from view. Natural topography, vegetation and scenic features of the site should be retained and incorporated into proposed development."

Jurisdiction	Authority	Objectives
		The Coastal Zone Land Use Ordinance provides detailed criteria for the review of projects proposed in the Energy or Extractive Area combining designation to achieve the following objectives: “2. Extraction operations and energy production facilities should be established in areas designated as Scenic and Sensitive lands in the adopted Open Space Plan only when the need for a particular resource or facility location is determined by the Board of Supervisors to outweigh the value of the scenic and sensitive land resource. Scenic and Sensitive lands should be subject to extraction operations or energy facility development only when no feasible alternative sites are available. 3. Extraction operations and energy facilities should be provided with adequate buffering and screening from adjacent land uses.” Coastal Plan Policies – LCP Policy Document Under the Coastal Act mandate, San Luis Obispo County prepared the Coastal Plan Policies addressing state requirements for implementing policies that are more specific and addressing non-traditional issues not commonly associated with the normal role of a local government GP. These Coastal Act policies address specific issues of shoreline access for the public, visitor-serving facilities, coastal-dependent industrial and energy-related facilities and activities, protection of sensitive habitats, protection, and preservation of visual and scenic resources. The Coastal Plan Policies identify aesthetics as one of the principal concerns of siting of industrial and, particularly, major energy facilities in the coastal zone. “Energy and industrial facilities, particularly when sited in rural areas or within view corridors, may have major impacts on scenic and visual resources. Some impacts can be mitigated through proper siting, screening and landscaping; others cannot be reduced, mitigated or minimized.” Policies defined protecting visual resources in energy developments include siting and alternatives analysis for new industrial or energy-related facilities developments, mitigating to the maximum extent feasible adverse environmental impacts from the siting or expansion of coastal-dependent industrial or energy developments, county involvement in power plant siting, development of alternative energy facilities, transmission line siting within coastal zone viewsheds, mitigation for ground disturbances, undergrounding and siting requirements for above ground transmission lines, consolidation of electrical transmission corridors, and utility access roads. The Coastal Plan Policies identify policies to protect visual resources in areas of environmentally sensitive habitats. Policies include locating development as far away from coastal wetlands and habitat areas as possible; establishment of 100-foot (30-meter) minimum buffers around all wetlands; protection of terrestrial habitats and native vegetation; protection of kelp beds, offshore rocks, rocky points, reefs, and intertidal areas; and siting of shoreline structures to minimize impacts on marine habitats. The Coastal Plan Policies establish policies for the protection of visual resources within the coastal zone as “a critical aspect of planning for long-term change and development within highly scenic coastal regions.” Offshore viewing concerns of the visual quality of the ocean as seen from the shore from coastal industrial development (man-induced development such as offshore energy facilities) include the location and appearance of these

Jurisdiction	Authority	Objectives
		facilities. Policies include: protection of unique and attractive features of the landscape, including but not limited to unusual landforms, scenic vistas and sensitive habitats; site selection for new development protecting views to and along the ocean and scenic coastal areas; minimizing the view and design form of new development to blend with existing character; minimization of landform alterations; preservation of native vegetation; undergrounding and siting of utility lines away from coastal views; and minimization of visibility of development features on beaches, sand dunes, and coastal bluffs.

F.3 Seascape, Landscape, and Visual Impact Assessment Results

This section presents the results of the SLVIA analysis, organized by SLIA (Section F.3.1, *Seascape and Landscape Impact Assessment*) and VIA (Section F.3.2, *Visual Impact Assessment*) results. The results are applicable to both action alternatives analyzed in the Draft PEIS, Alternative B and Alternative C, unless otherwise specified.

Visual simulations from representative viewpoints (available on BOEM's California Offshore Wind website: https://www.boem.gov/renewable-energy/state-activities/california) indicate that daytime and nighttime visibility of wind turbines and OSS would be noticeable to the casual observer from the open ocean character area, seascape character areas, landscape character areas, and viewer viewpoints. Figure F-2 and Figure F-3 show character types and areas with KOPs and sensitive resource areas, for the 1,100-foot and 850-foot WTGs. Sensitive resource areas include beaches; trails; local, state, and national parks, conservation areas, cultural and historic areas, recreation areas, wilderness areas, and resource management areas as defined in local and state databases. Overburdened communities are not shown but should be incorporated as part of each lessee's COP SLVIA analysis.

A viewshed analysis was conducted using a digital elevation model to determine the potential visibility of the surrounding seascape and landscape from the Humboldt and Morro Bay WEAs. This viewshed analysis determines the zone of theoretical visibility and was used to determine the scope of the Affected Environment. The zone of theoretical visibility does not account for potential screening from vegetation, buildings, or other structures and generally overestimates visibility. The area of potential effect was determined by overlaying the Affected Environment with the visibility buffers of planned offshore wind projects along the Northern and Central California coastlines. The visibility buffers constitute the maximum theoretical distance a WTG could be visible and were developed using EC-calculated distances based on the minimum and maximum WTG heights. The impact analysis is based on the digital elevation model, not a surface elevation model verified by field surveys. Surface elevation model data were not available at the time of this analysis, and field surveys have not been conducted. BOEM anticipates each lessee will complete surface elevation model viewshed analysis as part of each COP's SLVIA analysis.

Figure F-4 shows the extent of the 1,100-foot WTGs onshore visibility for each WEA using the zone of theoretical visibility. Elevated viewpoints, as are common along Highway 1, will have greater visibility of turbine components. Figure F-5 through Figure F-8 depict the visibility of WTG components for both turbine heights based on viewshed modeling along with character types, character area, and KOPs. Table F-1 and Table F-4 present the visibility rings that are based on calculations presented in using EC for a viewer at MLLW and clear atmospheric conditions.

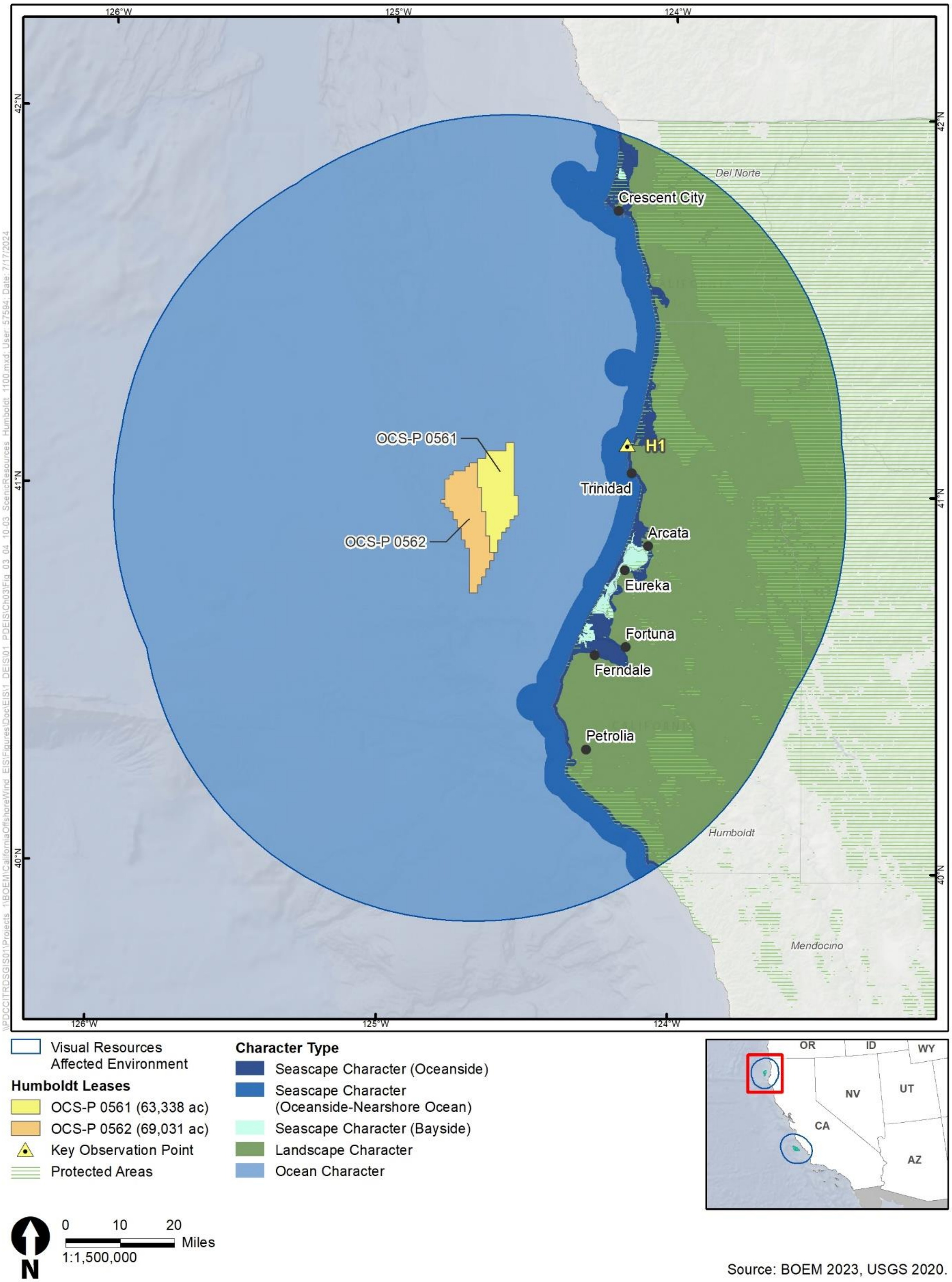


Figure F-2. Scenic resources and character types for Humboldt WEA

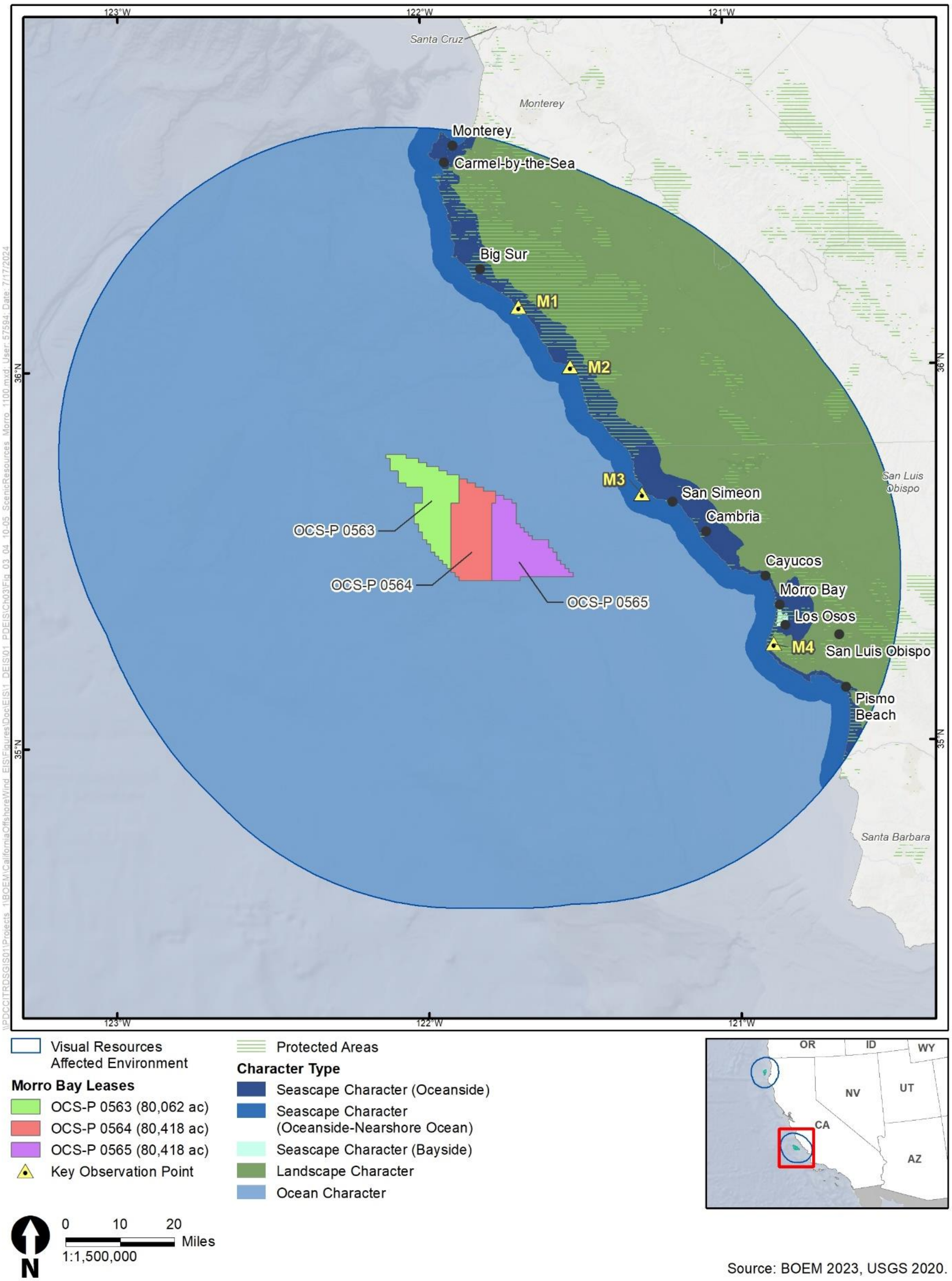


Figure F-3. Scenic resources and character types for Morro Bay WEA

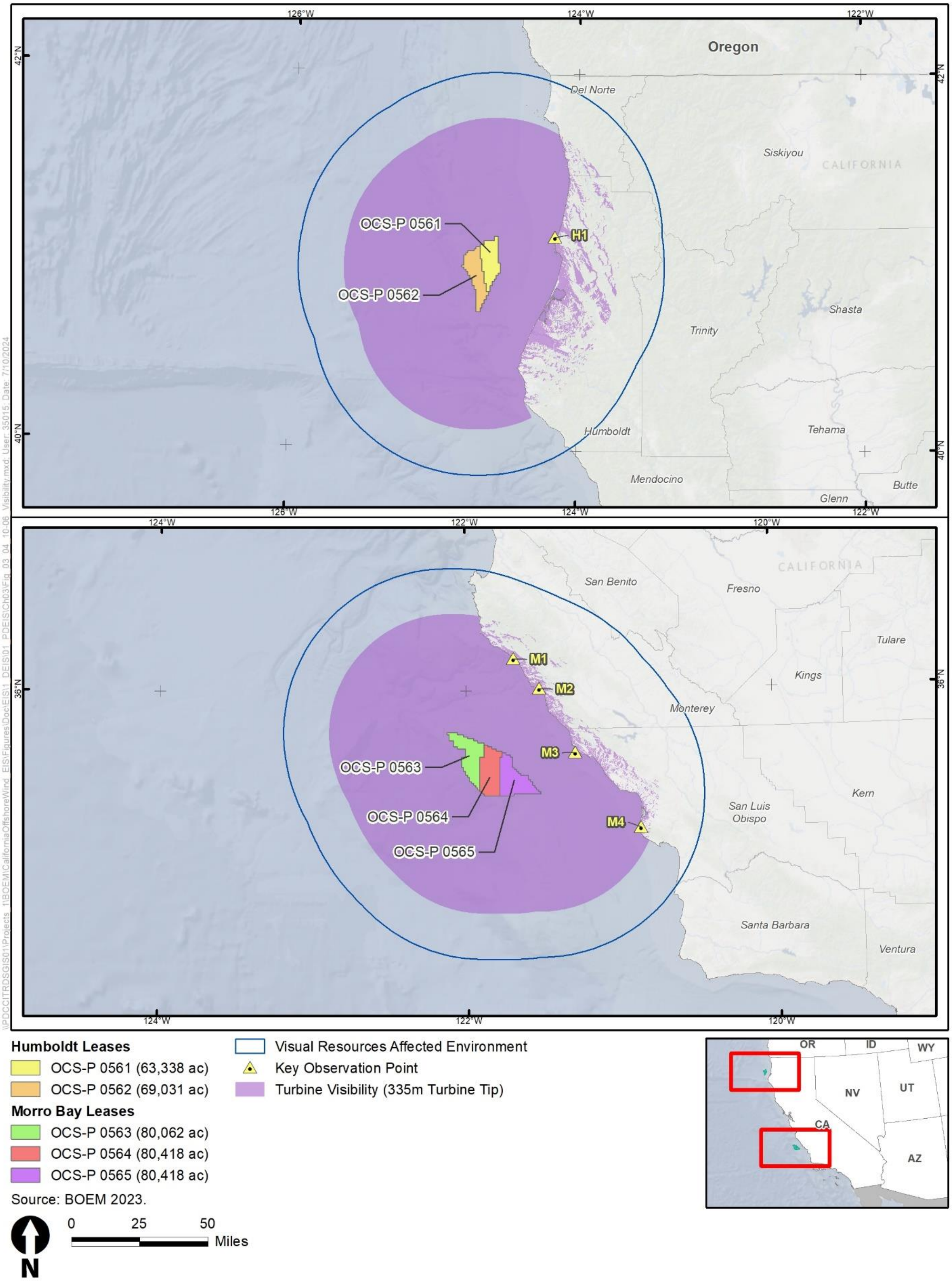
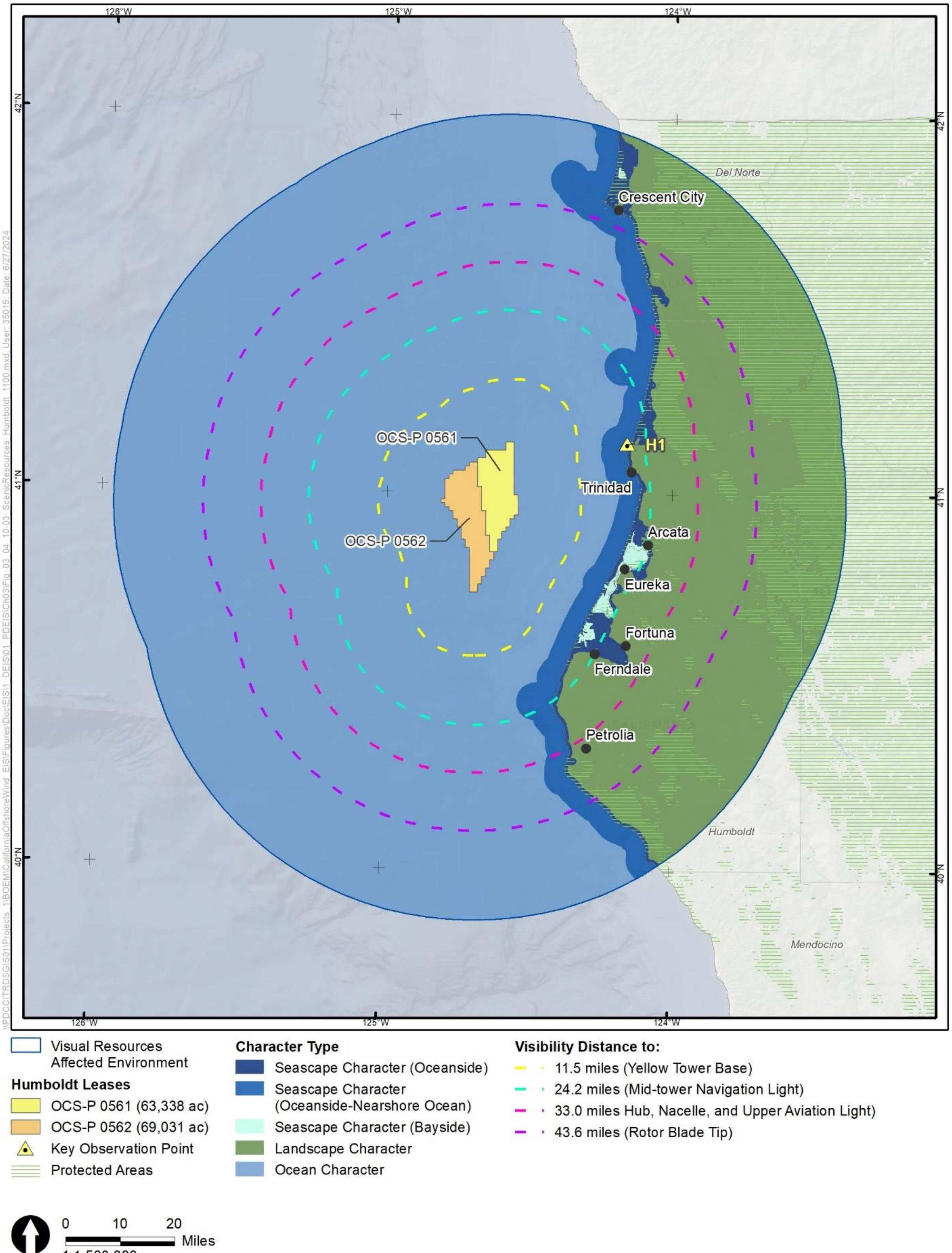
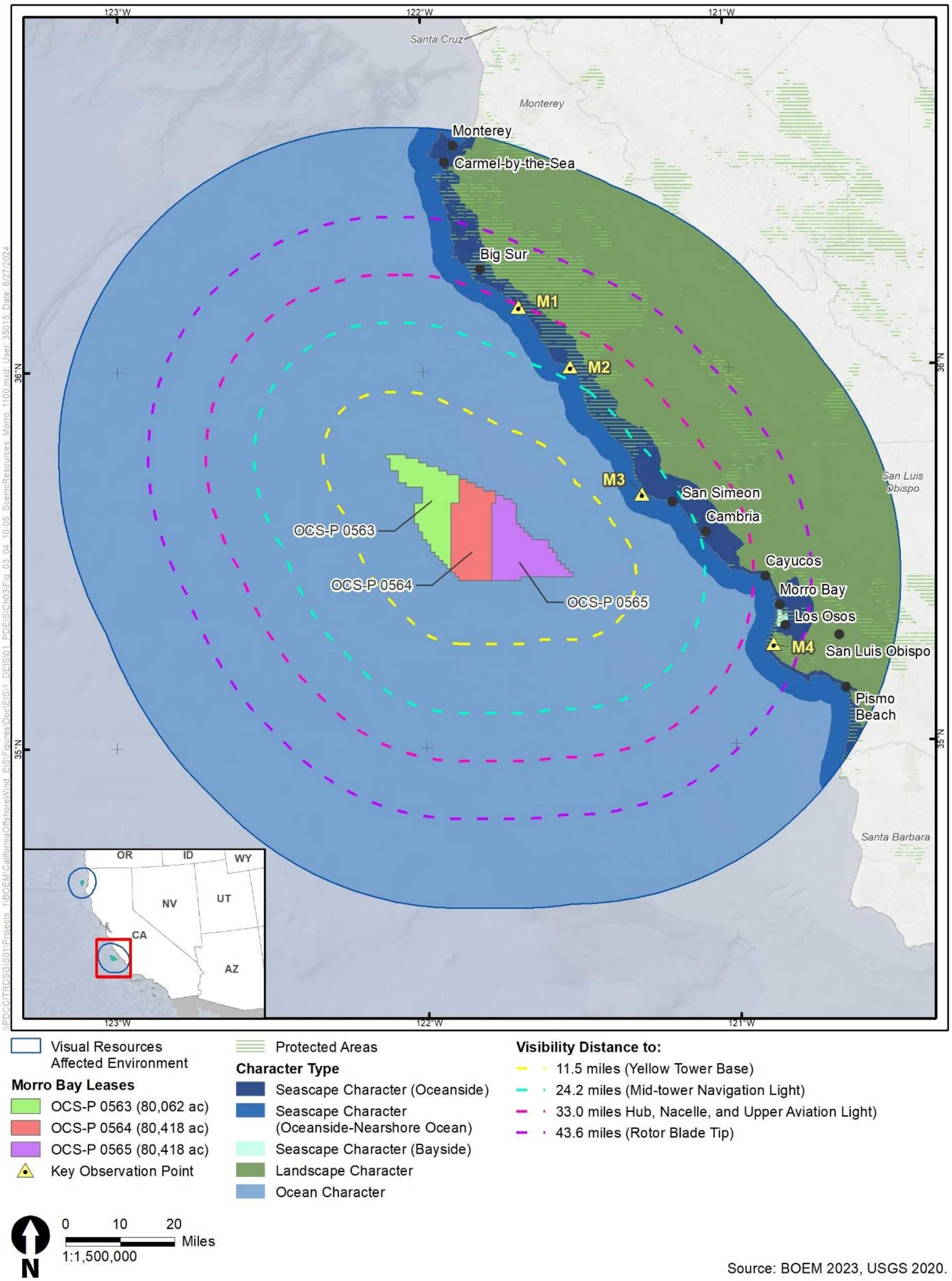


Figure F-4. 1,100-foot WTG visibility based on viewshed model



Source: BOEM 2023, USGS 2020.

Figure F-5. Turbine visibility for 1,100-foot WTGs and KOPs for Humboldt WEA



Source: BOEM 2023, USGS 2020.

Figure F-6. Turbine visibility for 1,100-foot WTGs and KOPs for Morro Bay WEA

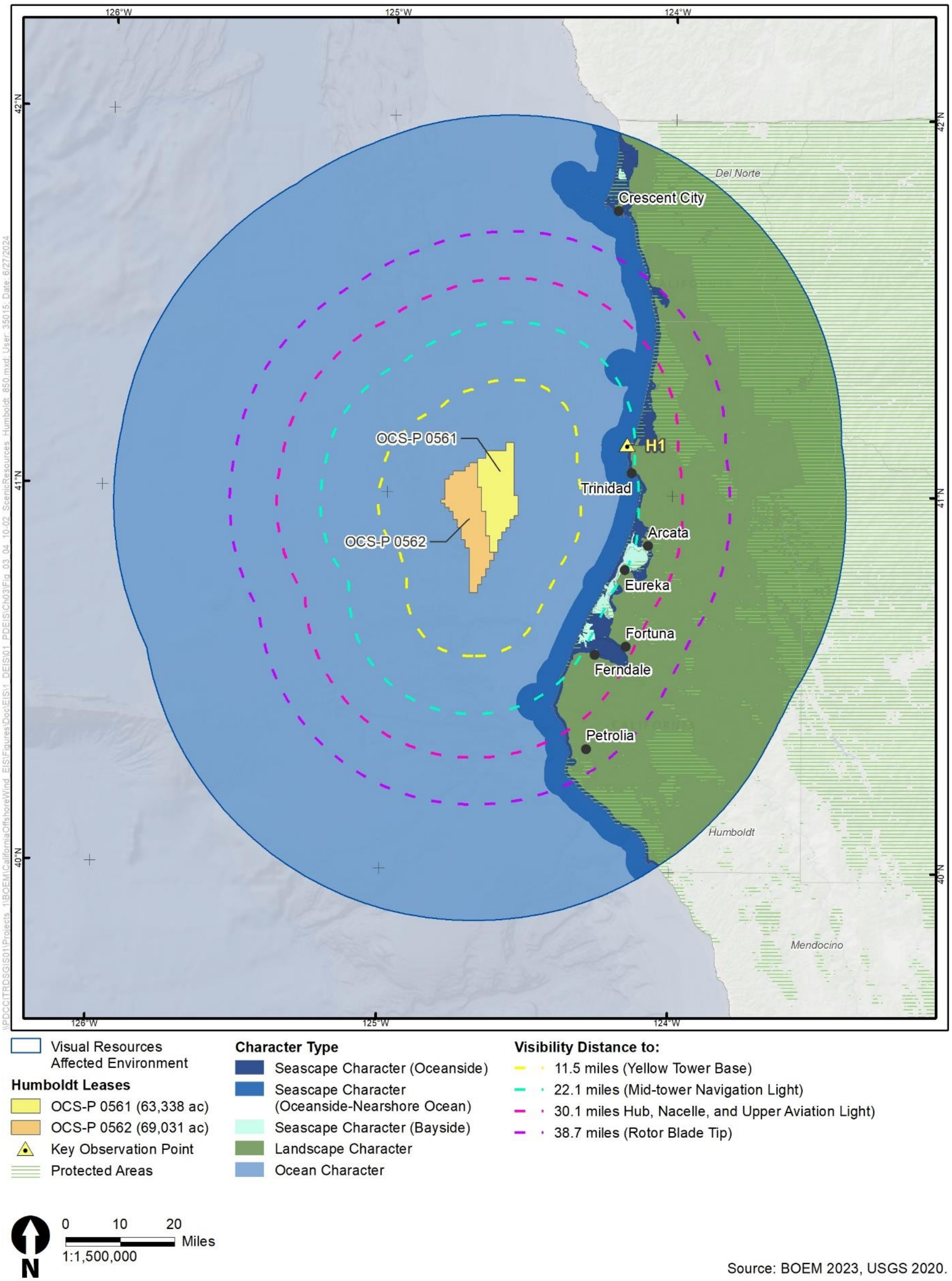


Figure F-7. Turbine visibility for 850-foot WTGs and KOPs for Humboldt WEA

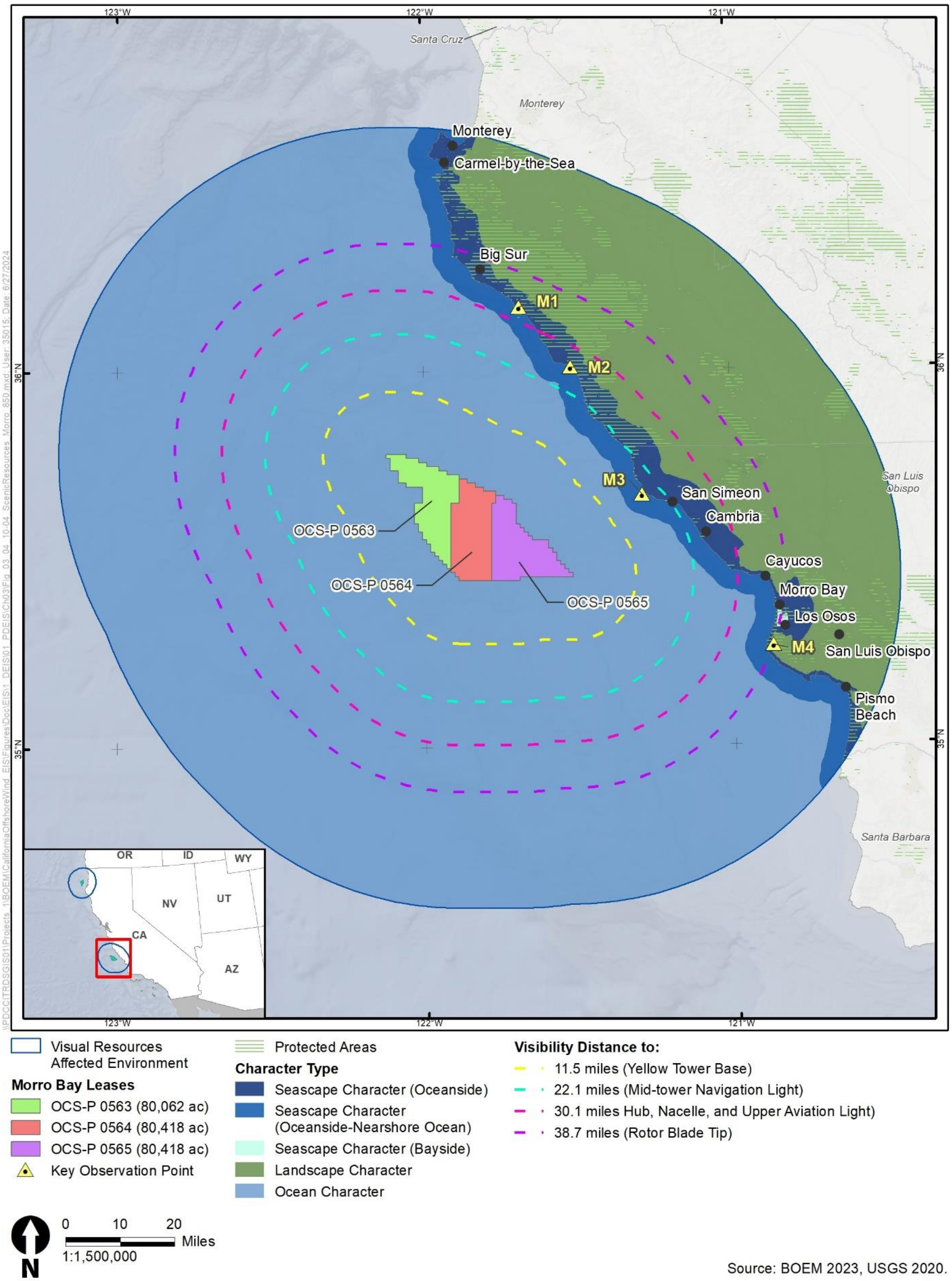


Figure F-8. Turbine visibility for 850-foot WTGs and KOPs for Morro Bay WEA

F.3.1 Seascape and Landscape Impact Assessment

F.3.1.1 Offshore Open Ocean, Seascape, and Landscape Character

Open ocean, seascape, and landscape character in the Affected Environment is organized in the following three-level hierarchy.

- **Level 1:** Defines the broad character of ocean, seascape, and landscape.
- **Level 2:** Character types are relatively homogeneous in character. They are generic in nature and share similar combinations of geology, topography, drainage patterns, vegetation, historical land use and settlement patterns, and perceptual and aesthetic attributes. Level 2 is specific to the seascape character, which is split into two discrete character types which maintain visibility to the ocean (oceanside seascape) and those which maintain visibility to the bay (bayside seascape); if both elements are visible, the discrete area is considered part of the oceanside seascape character area. Level 2 is not represented in ocean or landscape character, only in seascape.
- **Level 3:** Level 3 focuses on the aesthetic, perceptual, and experiential aspects of a character area (or type) with unique qualities that contribute to a sense of place. Within Level 3, character types are further broken down into specific areas with common character and perceptual attributes called character areas. For example, these areas may have similar architectural styles, scale, development patterns, vegetation types, or other similarities that are identified and described for their unique qualities. With the exception of nearshore ocean, level 3 character areas are not defined in this analysis. Character areas must be defined through a combination of geographic information system (GIS) and desktop analysis and field assessment for further analysis and compliance with the SLVIA. It should be noted that level 3 character areas should be uniform across projects for consistency and comparative analysis.

Table F-11 identifies the characters, character types, and character areas delineated in the Affected Environment.

Table F-11. Summary of character (level 1), character types (level 2), and character areas (level 3)

Level 1: Characters	Level 2: Character Types	Level 3: Character Areas
Ocean Character	N/A	Open Ocean
Seascape Character	Bayside	TBD
	Oceanside	Nearshore Ocean
		TBD
Landscape Character	N/A	TBD

N/A = not applicable; TBD = To be determined at project-level COP phase.

The following subsections include a description of each character, character type, and character area used in this analysis.

F.3.1.1.1 Open Ocean Character

The open ocean zone includes the open water of the Pacific Ocean off the coast of California. The defining characteristic of this character area is the presence of open water as a dominant element and unobstructed views in all directions. This primarily includes open waters of the Pacific Ocean that are 3.0 nm (3.45 miles) beyond the Pacific shoreline and unbounded by landforms. Human elements, such as ships of various sizes, lighthouses, buoys, and other infrastructure can be seen at various distances throughout the study area, but the emphasis of the view is consistently on the overall flatness and variable colors of the water.

- **Sensitivity:** The open ocean is highly sensitive and highly susceptible to change due to its pristine, flat, vast, and minimal character, and it is also highly valued due to the high scenic qualities, wildness, tranquility, and locally and regionally held values.
- **Contextual description:** The open ocean character type is consistent throughout the study area in terms of its dominant forms and horizons. It is also relatively consistent from human activities. Freighters and other ships such as cruise ships are occasionally seen in the open ocean along the horizon. Commercial fishing and pleasure crafts are more common in the near view for both Humboldt and Morro Bay WEAs with their nearby coastal communities and harbors. In the case of large ships and smaller craft, neither imposes on the overall visual quality or sense of place.

F.3.1.1.2 Seascape Character Descriptions

The regions that comprise the seascape character are unified by a view of and relationship to the ocean and other saltwater bodies such as bays, coves, and inlets, extending 3 nm (3.45 miles and 5.5 kilometers) from the edge of the ocean's coastline into the ocean. These unified areas include bayside and oceanside features, as they are deeply connected visually, ecologically, and recreationally to each other. Seascape land uses areas may vary significantly, but the emphasis of the connectivity between the land and ocean remains an important visual and experiential element across all areas with seascape character. Communities that fall within the seascape character type include Klamath, Big Lagoon, Patrick's Point, Trinidad, Westhaven, Samoa, Shelter Cove, Notley's Landing, Big Sur, San Simeon, Cambria, Cayucos, Morro Bay, and portions of Crescent City, Arcata, and Eureka.

Bayside Seascape Character Types

Bayside seascape character types maintain a view and direct connection to bays and other related saltwater bodies and associated features such as marinas and other developments along the bay and related waterbodies. These areas, however, may not maintain a direct visual connection to the coastline or ocean itself due to the presence of sand spits and dunes. The bay-facing areas of Eureka and the community of King Salmon are examples of locations within the bayside seascape character type in the Humboldt WEA. The communities of Los Osos, Baywood Park, and Morro Bay are examples of the bayside seascape character type in the Morro Bay WEA.

Sensitivity: The bayside seascape character type is a broad category that hosts a range of sensitivities and values. Natural and recreational areas within the character type are sensitive to change because they do not resemble industrial character like that of a wind farm, making the character highly susceptible to change. These areas are also highly valued because of their scenic qualities, locally held values, and natural/ecological/historic designations. However, the bayside seascape character type for both regions includes industrial resources that have low sensitivity because of their similar industrial characteristics including tall, vertical elements, and blocky infrastructure. The industrial facilities have low scenic quality and are oftentimes in poor condition, which contributes to the low value associated with these areas.

Contextual description: Bayside seascape character types vary greatly between Humboldt and Morro Bay. The Humboldt region has a modest-sized active harbor with commercial fishing and industrial areas for processing and shipping lumber, forestry products, and other industries. It also supports water-based recreational activities. Arcata Bay and South Humboldt Bay are relatively unspoiled brackish marsh complexes and protected areas of the Humboldt Bay National Wildlife Refuge.

The Morro Bay bayside seascape character type includes a small harbor hosting both commercial and recreational fishing and pleasure boats, and its tidal marsh is protected as a State MR. Two human-made jetties protect the harbor entrance. The sand spit and Morro Rock that create the bay geography provide recreation opportunities and ecological benefits and are protected by the state of California. Industrial uses including a water treatment plant and decommissioned power plant are near the harbor entrance.

Both Humboldt and Morro Bays are bordered by residential and commercial development, protected landscapes, recreation areas, and natural areas. Additional analysis through development of the lessees COPs will define these character areas and determine if they are part of the bayside or oceanside seascape.

The following level 3 bayside seascape character areas may be defined at the COP level of analysis.

- Bayside Commercial Park
- Bayside Industrial/Port/Harbor
- Bayside Industrial Resource (i.e., power and sewage treatment plants)
- Bayside Military Site
- Bayside Natural Area Upland
- Bayside Natural Area Wetland
- Bayside Recreation
- Bayside Residential
- Bayside Town Center
- Bayside Waterbodies

Oceanside Seascape Character Types

Oceanside seascape character types are the natural and developed areas that maintain clear visibility and connectivity to the ocean. The shared inter-visibility between natural lands and developed areas and the sea, is such that the land, coastline, and the sea (the 3-nm, or 3.45-mile [5.5-kilometer] distance from the coastline) maintain visibility of the ocean. Any area that may contain both bayside and oceanside views is considered part of the oceanside area (e.g., peninsula areas along Humboldt Bay). Much of the coastline in Morro Bay region features dramatic headlands, cliffs, sea stacks, bayhead beaches, and wave-cut platforms with pristine sand coves. Residential and commercial hamlets are tucked into small coastal valleys or situated on headlands where the topography is more accommodating to modest development. The Humboldt region’s coastal landscape features broad headlands more accommodating to agriculture and development but with similar shoreline features including cliffs, sea stacks, bayhead beaches, wave-cut platforms, and sandy beach coves. Both regions feature exceptional natural, cultural, dark-sky environments and national- and state-protected landscapes.

Sensitivity: Oceanside seascape character type is a broad category that hosts a range of sensitivities and values. Natural and recreational areas within the character type are sensitive to change because they do not resemble industrial character like that of a wind farm, making the character highly susceptible to change. These areas are also highly valued due to their scenic qualities, locally held values, and natural/ecological/historic designations. Built environments including residential and commercial town centers are highly sensitive. The composition of medium density structures ranging from potentially architecturally significant or historic buildings to commercial centers makes for a character that is moderately susceptible to change from a proposed project. Oceanside residential and commercial areas are highly valued due to their scenic quality, the homes’ architectural or historic interest, and locally held values around the importance of oceanside orientation.

Contextual description: Oceanside seascape character types vary greatly between Humboldt and Morro Bay. The Humboldt region with its relatively broad headlands and coastal plain support agriculture and modest size communities that may have more partial ocean views. The terrain along the central coast of Morro Bay is shallow and elevated, creating communities where streets parallel the shoreline and offer most residences an ocean view.

The following additional level 3 oceanside seascape character areas may be defined at the COP level of analysis.

- Oceanside Agriculture
- Oceanside Beach
- Oceanside Natural Area Upland
- Oceanside Wetland/Estuary
- Oceanside Recreation
- Oceanside Residential

- Oceanside Commercial
- Oceanside Town Center

Nearshore Ocean Character Area

The nearshore ocean character area stretches 3.0 nm (3.45 miles and 5.5 kilometers) from the coastline in which the ocean relates to the seascape. Here, long horizontal waves typically roll toward the coast, with regular whitecaps and breaking waves occurring, except in the calm of weather. Colors and textures vary consistently, and change constantly, throughout this stretch of water. The nearshore ocean character area includes sea stacks and rock formations that provide offshore wildlife habitat and iconic coastal scenery. These offshore landforms exposed above mean high tide and within 12 nm (22.2 kilometers) of the mainland along the 1,100-mile (1,770-kilometer) California coastline are part of the California Coastal National Monument managed by the Bureau of Land Management. The national monument also includes six onshore units, four of which are in the Affected Environment: Trinidad Head, Waluplh-Lighthouse Ranch, and Lost Coast Headlands in the Humboldt WEA Affected Environment and Piedras Blancas in the Morro Bay WEA Affected Environment.

Sensitivity: Nearshore ocean is highly sensitive due to its pristine, flat, vast, rugged natural character and lack of infrastructure and industrial elements. It is highly valued for scenic qualities, wildness, tranquility, and dramatic natural features, including numerous sea stacks and rocks, as demonstrated by the National Monument status for most of this character area.

Contextual description: The nearshore ocean varies depending on the atmospheric and tidal conditions but will remain relatively uniform in the Humboldt and Morro Bay regions.

F.3.1.1.3 Landscape Character

Land uses and landcover types vary significantly across the landscape character type. The common thread among the landscape character areas is that they have reduced visibility of and opportunities for interaction with the ocean or seascape in general. Typologies in the Affected Environment study area range from the coastal towns and small cities of Arcata and Eureka to agricultural landscapes of Ferndale and Los Osos to the extensive natural areas of Redwood National Park, Six Rivers National Forest, and Los Padres National Forest. Although steep changes in elevation allow for ocean views from many open landscape vantage points, such as the Big Sur Wilderness, the landscape and seascape boundary follow the CCC Coastal Zone Boundary in most locations and the coast highway (State Route 1 or U.S. 101) wherever direct, ground-level connectivity to the seascape has ended.

Sensitivity: The landscape character type is a broad category that hosts a range of sensitivities and values. Natural, recreational, residential, and commercial areas within the character type are sensitive to change, because they do not resemble industrial character like that of a wind farm, making the character highly susceptible to change. These areas are also highly valued because of their scenic qualities, locally held values, and natural/ecological/historic designations.

Contextual description: Landscape character types vary greatly between Humboldt and Morro Bay. The Humboldt region with its relatively broad headlands and coastal plain support agriculture and larger communities many of which do not have views of the ocean or a close contextual relationship to the shoreline besides the coastal fog that rolls in and out of the landscape throughout the seasons. The terrain that falls within the landscape character type along the central coast is steep and rugged and mostly part of the Los Padres National Forest or other undeveloped protected lands with a few exceptions (e.g., Hearst Castle State Historic Park).

The following additional examples of level 3 landscape character areas may be defined at the COP level of analysis.

- Inland Agriculture
- Inland Commercial Park
- Inland Industrial
- Inland Industrial/Energy Resource
- Inland Military Site
- Inland Natural Area (Forest, Woodland, Chaparral, or Grassland)
- Inland Recreation
- Inland Rural
- Inland Suburban Residential
- Inland Town Center

F.3.1.2 Sensitivity

The sensitivity of an ocean, seascape, or landscape impact receptor is dependent on its susceptibility to change and its perceived value to society. The susceptibility of the seascape/landscape is its ability to accommodate the impacts of a proposed project without incurring substantial change to the basic existing characteristics of the seascape/landscape. This includes the overall character of the character area or an individual element or feature, or a particular aesthetic, experiential, and perceptual aspect that contributes to character of the area. The relative value of areas of seascape/landscape are high when their character is judged to be distinctive and where scenic quality, wildness or tranquility, and natural and cultural heritage features contribute to their aesthetic. Receptor sensitivity is recorded on an ordinal scale of high, medium, or low based on information from the baseline data collected; therefore, sensitivity of each character area is determined and described in the character area classification part of the methodology.

Table F-12 summarizes the susceptibility, value, and sensitivity ratings for the ocean, seascape, and landscape character as described in the preceding character area descriptions. Level 3 character areas may show greater nuance with susceptibility, value, and sensitivity ratings once they are identified and mapped. At this high-level analysis, based on federal, state, and local designations; laws and ordinances; scenic highway status, and overall desirability of the seascape and landscape for tourism, recreation, and residence these areas are considered of high value to the people of California, highly susceptible to shifts in the visual environment and, therefore, highly sensitive to change.

Table F-12. Open ocean, seascape, and landscape sensitivity

Open Ocean, Seascape, and Landscape Character Types and Areas	Susceptibility	Value	Sensitivity
Open Ocean	High	High	High
Open Ocean Character Area	High	High	High
Seascape - Bayside Seascape	High	High	High
Seascape - Oceanside Seascape	High	High	High
Nearshore Ocean Character Area	High	High	High
Landscape	High	High	High

F.3.1.3 Magnitude of Change

The magnitude of effect in an open ocean, seascape, or landscape depends on the size or scale of the change associated with a proposed project, the geographic extent of the change based on the viewshed, and the duration and reversibility of an offshore wind energy project in the Humboldt and Morro Bay areas.

Size and scale of change considers changes to the physical elements of the ocean, seascape, and landscape, and their aesthetic, experiential, and perceptual aspects. Although size and scale does not refer to the size and scale of a project per se, understanding the degree of visibility (Table F-8) provides measurable context for analyzing the perceptual aspects of scale, prominence, and impacts to ocean, seascape, and landscape. Table F-13 presents the impact definitions for size and scale of changes based on the degree of visibility.

Table F-13. Impact definitions of size and scale of change

Size and Scale of Change	Definition
Large	An object/phenomenon that is obvious to most receptors/observers and prominent or even dominant in the view and is of sufficient scale or difference to constitute a notable change to the existing character area context. In such circumstances, the object would represent a key new characteristic element in the character area at a representative viewpoint to any great extent.
Medium	An object/phenomenon that is readily apparent after even a brief look and would be visible to most casual observers. The object is clearly evident and represents a prominent new feature within a largely unchanged wider context and would not compete with key characteristic character area elements at a representative viewpoint to any great extent.

Size and Scale of Change	Definition
Small	An object/phenomenon that appears very small, faint or recessive, but when the observer is scanning the horizon or looking more closely at an area, can be detected without prolonged viewing. It could sometimes be noticed by casual observers. It represents a highly localized and small-scale change that would be unlikely to compete, to any notable extent, with key characteristic character area elements at a representative viewpoint.
Negligible	An object/phenomenon that is not discernible or presents no contrast or apparent change and which, therefore, would not alter the character area.

The assessment of magnitude of impact includes consideration of the geographic extent over which the impact will be experienced based on a project's viewshed, specifically the area of potential visual impact. Table F-14 defines relative impact ratings for geographic extent based on a threshold of the percent of visible area.

Table F-14. Thresholds for geographic extent ratings

Geographic Extent	Definition
Large	Area equivalent to between 30% and 100% of the character area.
Medium	Area equivalent to between 10% and 30 % of the character area.
Small	Area equivalent to less than 10% of the character area.
Negligible	Area equivalent to less than or equal to 0.001 square mile (0.003 square kilometer) of the character area, or where theoretical visibility does not occur, or where field reconnaissance suggests there would be no actual visibility due to the screening effect of micro-topography (not represented in terrain or surface data).

Acreages of character types and areas in the offshore Affected Environment overall and within the viewshed (i.e., the amount of character type and area from which the WTG array would be visible) are listed in Table F-15 and Table F-17 for the 1,100-foot WTGs for Humboldt and Morro Bay WEAs, respectively, and Table F-16 and Table F-18 for the 850-foot WTGs for Humboldt and Morro Bay WEAs, respectively. Table F-19 and Table F-20 list specific locations where the Humboldt and Morro Bay WEA projects' noticeable features, based on their heights, distances, and EC for the 1,100-foot WTGs and 850-foot WTGs, respectively, have a perceptual effect on the open ocean, seascape, or landscape. Higher impact levels would stem from unique, extensive, and long-term appearance of strongly contrasting, large, and prominent vertical structures in the otherwise horizontal open ocean and seascape environments where wind turbine structures are an unexpected element. Table F-19 through Table F-22 break out the geographic extent of each character type and area based on project noticeability and provide additional detail to describe the degree of change from existing conditions based on viewshed models and GIS.

Operational effects of a project's offshore infrastructure are expected to be similar to those of end-stage construction, long term (35 years), and fully reversible. This is documented for each character type and area in Table F-21 and Table F-22.

Table F-15. Area of open ocean, seascape, and landscape character areas in lease area viewsheds for 1,100-foot WTGs

Character Types and Area	Total Area in the Humboldt WEA Affected Environment		Area within 1,100-Foot WTG Viewshed[1]					
			Humboldt WEA All Lease Areas		OCS-P 0561		OCS-P 0562	
	Square Miles	Square Kilometers	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected
Open Ocean Character Type	6,735.01	17,443.60	6,674.34 (17,286.5)	100.0	5,797.32 (15,015.0)	86.1	6,505.61 (16,849.5)	96.6
Bayside Seascape Character Type	42.02	108.83	39.83 (103.2)	94.8	39.32 (101.8)	93.6	39.21 (101.5)	93.3
Oceanside Seascape Character Type	659.70	1,708.61	603.48 (1,563.0)	91.5	579.97 (1,502.1)	87.9	543.99 (1,408.9)	82.5
Nearshore Ocean Character Area	491.37	1,272.64	479.64 (1,242.3)	97.6	460.20 (1,191.9)	93.7	429.08 (1,111.3)	87.3
Undefined	168.33	435.97	123.84 (320.7)	73.6	119.78 (310.2)	71.5	114.90 (297.6)	68.3
Landscape Character Type	1,717.36	4,447.95	382.78 (991.4)	22.3	351.04 (909.2)	20.4	287.36 (744.3)	16.7

[1] Areas are not additive across leases due to overlap in character areas. Some areas are affected by more than one lease.
sq km = square kilometers

Table F-16. Area of open ocean, seascape, and landscape character types and areas in lease area viewsheds for 850-foot WTGs

Character Types and Area	Total Area in the Humboldt WEA Affected Environment		Area within 850-Foot WTG Viewshed[1]					
			Humboldt WEA All Lease Areas		OCS-P 0561		OCS-P 0562	
	Square Miles	Square Kilometers	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected
Open Ocean Character Type	5,752.46	14,898.81	5,752.42 (14,898.7)	100.0	4,961.66 (12,850.7)	86.3	5,561.09 (14,403.2)	96.7
Bayside Seascape Character Type	42.02	108.83	38.80 (100.5)	92.3	38.10 (98.7)	90.7	38.08 (98.6)	90.6
Oceanside Seascape Character Type	594.19	1,538.95	552.13 (1,430.0)	92.9	520.66 (1,348.5)	87.6	491.05 (1,271.8)	82.6
Nearshore Ocean Character Area	434.42	1,125.14	433.48 (1,122.7)	99.8	408.16 (1,057.1)	94.0	382.70 (991.2)	88.1
Undefined	159.77	413.81	118.64 (307.3)	74.3	112.50 (291.4)	70.4	108.35 (280.6)	67.8
Landscape Character Type	1,167.63	3,024.14	284.23 (736.2)	24.3	255.89 (662.8)	21.9	220.41 (570.9)	18.9

[1] Areas are not additive across leases due to overlap in character areas. Some areas are affected by more than one lease.
sq km = square kilometers

Table F-17. Area of open ocean, seascape, and landscape character areas in lease area viewsheds for 1,100-foot WTGs

Character Types and Area	Total Area in the Morro Bay WEA Affected Environment		Area within 1,100-foot WTG Viewshed[1]							
			Morro Bay All Lease Areas		OCS-P 0563		OCS-P 0564		OCS-P 0565	
	Square Miles	Square Kilometers	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected
Open Ocean Character Type	8,328.17	21,569.86	8,237.96 (21,336.22)	98.9	7,423.48 (19,226.72)	88.8	6,834.46 (17,701.17)	82.0	6,458.51 (16,727.46)	77.4
Bayside Seascape Character Type	5.71	14.79	2.38 (6.2)	41.6	--	--	--	--	5.71 (14.79)	100
Oceanside Seascape Character Type	841.69	2,179.97	621.26 (1,609.08)	73.8	543.47 (1,408.17)	51.8	638.5 (1,653.71)	54.7	774.90 (1,436.6)	66.4
Nearshore Ocean Character Area	436.09	1,129.47	432.54 (1,120.3)	99.2	304.98 (789.89)	69.5	323.01 (836.59)	73.6	404.24 (1,047.0)	92.3
Undefined	405.60	1,050.50	188.72 (488.8)	46.5	283.57 (734.26)	32.7	315.49 (817.11)	34.3	370.66 (960.0)	38.5
Landscape Character Type	1,195.64	3,096.69	58.98 (152.8)	4.9	564.14 (1,461.12)	1.2	772.42 (2,000.5)	1.9	1,153.98 (2,988.80)	4.5

Note: Areas <0.00 square miles (0.00 square kilometers) = 0.64 acre or less.

[1] Areas are not additive across leases due to overlap in character areas. Some areas are affected by more than one lease.

sq km = square kilometers

Table F-18. Area of open ocean, seascape, and landscape character areas in lease area viewsheds for 850-foot WTGs

Character Types and Area	Total Area in the Morro Bay WEA Affected Environment		Area within 850-foot WTG Viewshed[1]							
			Morro Bay All Lease Areas		OCS-P 0563		OCS-P 0564		OCS-P 0565	
	Square Miles	Square Kilometers	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected	Square Miles (sq km)	Percent Affected
Open Ocean Character Type	7,201.71	18,652.35	7,184.10 (18,606.7)	99.8	6,270.22 (16,239.8)	87.1	5,782.27 (14,976.0)	80.3	5,495.26 (14,232.7)	76.3
Bayside Seascape Character Type	2.37	6.15	0.16 (0.4)	6.8	--	--		--	0.16 (0.4)	6.8
Oceanside Seascape Character Type	726.19	1,880.83	571.28 (1,479.6)	78.7	373.73 (968.0)	51.5	400.35 (1,036.9)	55.1	500.69 (1,296.8)	68.9
Nearshore Ocean Character Area	397.14	1,028.60	396.37 (1,026.6)	99.8	258.05 (668.3)	65.0	277.02 (717.5)	69.8	360.03 (932.5)	90.7
Undefined	329.05	852.24	174.91 (453.0)	53.2	115.68 (299.6)	35.2	123.33 (319.4)	37.5	140.66 (364.3)	42.7
Landscape Character Type	727.15	1,883.30	42.41 (109.8)	5.8	3.56 (9.2)	0.5	11.22 (29.1)	1.5	40.23 (104.2)	5.5

Note: Areas <0.00 square miles (0.00 square kilometers) = 0.64 acre or less.

[1] Areas are not additive across leases due to overlap in character areas. Some areas are affected by more than one lease.

sq km = square kilometers

Table F-19. Noticeable elements and impacts by open ocean, seascape, and landscape character types and areas for 1,100-foot WTGs

Noticeable Elements Impacts	Open Ocean Area, Seascape Types and Area, and Landscape Types
R, AL, N, H, O, M, and/or Y Prominence 5 or 6	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (OCS-P 0561, 0562, 0564, 0565) Nearshore Ocean Character Area (all leases) Bayside Seascape Character Type (OCS-P 0561, 0562) Landscape Character Type (OCS-P 0561, 0562)
R, AL, N, H Prominence 3 - 4	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (all leases) Nearshore Ocean Character Area (all leases) Bayside Seascape Character Type (OCS-P 0561, 0562) Landscape Character Type (all leases)
R Prominence 1 - 2	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (all leases) Nearshore Ocean Character Area (all leases) Bayside Character Type (OCS-P 0565) Landscape Character Type (OCS-P 0561, 0562, 0565)

R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, Y = yellow tower base color.
Prominence: 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV

Table F-20. Noticeable elements and impacts by open ocean, seascape, and landscape character types and areas for 850-foot WTGs

Noticeable Elements Impacts	Open Ocean Area, Seascape Areas, and Landscape Areas
R, AL, N, H, O, M, and/or Y Prominence 5 or 6	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (OCS-P 0561, 0562, 0565) Nearshore Ocean Character Area (all leases) Bayside Seascape Character Type (OCS-P 0561, 0562)
R, AL, N, H Prominence 3 - 4	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (all leases) Nearshore Ocean Character Area (all leases) Bayside Seascape Character Type (OCS-P 0561, 0562)
R Prominence 1 - 2	Open Ocean Character Area: Ocean (all leases) Oceanside Seascape Character Type (all leases) Nearshore Ocean Character Area (all leases) Landscape Character Type (all leases)
Not visible	Bayside Character Type

R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, Y = yellow tower base color.
Prominence: 0 = Not visible. 1 = Visible only after extended study; otherwise not visible. 2 = Visible when viewing in general direction of the wind farm; otherwise likely to be missed by casual observer. 3 = Visible after brief glance in general direction of the wind farm; unlikely to be missed by casual observer. 4 = Plainly visible; could not be missed by casual observer, but does not strongly attract visual attention or dominate view. 5 = Strongly attracts viewers' attention to the wind farm; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6 = Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV

F.3.1.4 Seascape and Landscape Impact Assessment Summary and Impact Levels

Table F-21 and Table F-22 summarize the effects of the 1,100-foot and 850-foot WTGs, respectively, from the offshore components of the Humboldt and Morro Bay WEAs on sensitivity, magnitude, and visibility thresholds (Table F-8). The tables also present the impact levels for each character area based on the impact level definitions in Table F-9.

Lease areas farther from shore (i.e., OCS-P 0562 and OCS-P 0563) have less effect on seascape and landscape character areas because of their smaller perceptive scale. In contrast, lease areas nearer to shore (i.e., OCS-P 0565) have a greater perceptive scale and therefore a greater effect on oceanside seascape character type sense of place.

High to moderate magnitudes of visual impact would occur in the ocean-facing and bay-facing seascape character areas and diminish to moderate and minor as distance increases and screening effects increase from topography, structures, and vegetation. Nearshore Ocean is the largest and most vulnerable character area to change, outside of the Open Ocean. Medium to minor size or scale changes to character type sense of place would occur in all other seascape and landscape character areas. Impacts of the Humboldt and Morro Bay WEA projects on open ocean character, seascape character, and landscape character range from **negligible** to **major**.

Table F-21. Open ocean, seascape character, and landscape character SLIA summary for 1,100-foot WTGs

Character Type	Sensitivity						Magnitude of Impact									Visibility Threshold Rating				Impact Levels	
	Susceptibility			Value			Size and Scale of Change			Geographic Extent			Duration and Reversibility								
	High	Moderate	Low	High	Moderate	Low	Large	Medium	Small	Large	Medium	Small	Permanent	Long Term	Short Term	High (5-6)	Moderate (3-4)	Low (1-2)	Unseen	Alternative B	Alternative C
Humboldt WEA																					
Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Bayside Seascape Character Type	X			X				X		X				X		X				Major	Same as Alternative B
Oceanside Seascape Character Type	X			X			X			X				X		X				Major	Same as Alternative B
Nearshore Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Landscape Character Type	X			X				X			X			X			X			Moderate	Same as Alternative B
Morro Bay WEA																					
Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Bayside Seascape Character Type	X			X				X		X				X				X		Moderate	Same as Alternative B
Oceanside Seascape Character Type	X			X			X			X				X		X				Major	Same as Alternative B
Nearshore Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Landscape Character Type	X			X				X				X		X			X			Moderate	Same as Alternative B

Table F-22. Open ocean, seascape character, and landscape character SLIA summary for 850-foot WTGs

Character Type	Sensitivity						Magnitude of Impact									Visibility Threshold Rating				Impact Levels	
	Susceptibility			Value			Size and Scale of Change			Geographic Extent			Duration and Reversibility								
	High	Moderate	Low	High	Moderate	Low	Large	Medium	Small	Large	Medium	Small	Permanent	Long Term	Short Term	High (5-6)	Moderate (3-4)	Low (1-2)	Unseen	Alternative B	Alternative C
Humboldt WEA																					
Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Bayside Seascape Character Type	X			X				X		X				X		X				Major	Same as Alternative B
Oceanside Seascape Character Type	X			X			X			X				X		X				Major	Same as Alternative B
Nearshore Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Landscape Character Type	X			X				X			X			X			X			Moderate	Same as Alternative B
Morro Bay WEA																					
Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Bayside Seascape Character Type	X			X										X					X	Negligible	Same as Alternative B
Oceanside Seascape Character Type	X			X			X			X				X		X				Major	Same as Alternative B
Nearshore Ocean Character Area	X			X			X			X				X		X				Major	Same as Alternative B
Landscape Character Type	X			X			X					X		X				X		Minor	Same as Alternative B

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F.3.2 Visual Impact Assessment

F.3.2.1 Key Observation Points

KOPs are selected through discussions with BOEM staff, staff from other agencies, and other interested parties through stakeholder involvement activities. Selection is also informed by viewshed analysis, fieldwork, and desktop analysis.

KOPs typically include the following categories.

- Scenic overlooks and viewpoints within specially designated areas.
- Road, trails, and other transport routes (on land and sea).
- Places where people work.
- Places where people engage in recreational activities.
- Places where people live.

Selected KOPs also generally fall into several categories.

- Specific locations where the view is highly valued.
- Representative KOPs intended to capture the general nature of views or users within a larger area that lacks specific viewpoints and to represent seascape or landscape character within SLIA.
- Illustrative KOPs selected to demonstrate a particular effect or issue of great concern to stakeholders.

The KOPs typically cover a wide range of situations as is necessary and reasonable to evaluate and demonstrate the likely range of effects. A total of five KOPs with specific locations were selected for the PEIS, one in the Humboldt region and 4 in the Morro Bay region. In addition, two representative KOPs are included to reflect viewer experiences from the open ocean, KOP-A Representative Recreational Fishing, Pleasure, and Tour Boat Area and KOP-B Representative Commercial and Cruise Ship Shipping Lanes. Table F-23 presents the characteristics of each selected KOP. It is anticipated that additional KOPs will be identified and evaluated as part of individual lease areas COP level visual analysis.

Simulations were created by ESS Group in 2019 for all five KOPs and cover a range of seasons and weather conditions. Simulations were created for four lighting conditions: morning, midday, and late afternoon, and nighttime. Several of the KOPs have simulations representing different atmospheric clarity: 15-, 17-, and 20-mile visibility conditions. The simulations depict an 889-foot (271-meter) WTG blade tip height and a representative portion of the eastern-most WTG positions for each WEA. The analysis in this document examines the effect of full build-out for each WEA and each lease area and two turbine heights, one taller and one shorter than what was simulated.

Table F-23. KOP descriptions

KOP	Type of Viewpoint	Likely Viewers and Accessibility	View Experience and Type	View Properties	WTGs Represented (simulations)
Humboldt WEA					
H1 Patrick's Point - Sue-meg SP	Overlook from SP trail	Tourists, recreationists, hikers	Static, long-distance, panoramic view	Late spring, cloudy Elevation 157 feet View framed by coastal bluffs and offshore rocks	67
Morro Bay WEA					
M1 Julia Pfeiffer SP – Tin House Road	Roadside overlook with parking	Tourists, residents	Static, long-distance, panoramic view	Late winter, partly cloudy but clear viewing conditions Elevation 912 feet Coastal bluffs frame view	67
M2 Limekiln SP – Pitkins Curve Trail Overlook	Trail overlook with bench	Tourists, residents, hikers	Static, long-distance, panoramic view	Late winter, partly cloudy but clear viewing conditions Elevation 912 feet Coastal bluffs frame view	67
M3 Piedras Blancas Lighthouse/ State MR[1]	Viewpoint (lighthouse) or wildlife viewing overlook	Tourists	Static, short-, medium, and long-distance views	Late spring, cloudy Elevation 157 feet View framed by coastal bluffs and offshore rocks	67
M4 Valencia Peak – Montaña de Oro SP	Mountain peak	Hikers, recreationists	Static, long-distance, panoramic view	Late winter, mostly cloudy and overcast conditions. Elevation 1,344 feet Overlooking Morro Bay and coastal bluffs	67

[1] The calculations in the following tables are based on the viewpoint at the Piedras Blancas Lighthouse. The simulation viewpoint is near the shoreline at the Elephant Seal Vista Point.

F.3.2.2 Sensitivity

Impacts on people are considered in evaluating KOPs. The susceptibility of viewers to changes in views is a function of the activities in which the viewers are engaged and their attention or interest on the view. Visual receptors most susceptible to change generally include residents with views toward a proposed project from their homes, people engaged in outdoor recreation whose attention is focused on the views, visitors to historic or culturally important sites where views are an important contributor to the experience, people who regard the visual environment as an asset to their community, and people traveling scenic highways or other transport specifically for enjoyment of the views.

KOPs are generally selected to represent high value, highly susceptible viewpoints to evaluate impacts at these special places; therefore, it is not surprising that all the KOPs are highly sensitive. Table F-24 documents the susceptibility, value, and sensitivity of viewers at each KOP. Overall, residents, tourists, and visitors engaging in recreation at these viewpoints are highly susceptible to changes from wind energy development due to their interest in ocean-facing views and the visual environment being an important asset to their community or their experience. Many of the KOPs have special local, state, or national designations which demonstrate their value. For all the KOPs, their expansive ocean-facing views define their experiential character, which contributes to their overall view value.

Table F-24.Table F-12 View value, susceptibility, and viewer sensitivity for each KOP

KOP	Susceptibility	Value	Sensitivity
Humboldt WEA			
H1 Patrick's Point - Sue-meg SP	Overlook from SP trail; therefore, view-based activities (e.g., whale watching and birding) are the activity with interest and attention focused on the open ocean and seascape.	Popular SP with natural and cultural/historic significance. Scenic viewpoint along coastal trail. Accessible to pedestrians.	High
Morro Bay WEA			
M1 Julia Pfeiffer SP – Tin House Road	Overlook from SP along coastal Highway 1; therefore, view-based activities (e.g., photography, whale watching and birding) are the activity with interest and attention focused on the open ocean and seascape.	Roadside overlook with parking along designated State Scenic Highway in SP; dark-sky designation; visitor amenities including parking, benches, and interpretive panels; widely publicized on websites, guidebooks, and tourism service providers. Approximately 1 mile north of the much-photographed McWay Falls.	High
M2 Limekiln SP – Pitkins Curve Trail Overlook	Overlook from SP along a dirt road off coastal Highway 1; therefore, view-based activities (e.g., photography, whale watching and birding) are the activity with interest and attention focused on the open ocean and seascape.	Roadside overlook with parking along designated State Scenic Highway in SP; dark-sky designation; bench available.	High
M3 Piedras Blancas Lighthouse/ State MR[1]	Viewpoint (LH) and/or wildlife viewing overlook in State MR with visitor amenities. Viewers at State MR elephant seal viewing overlook are generally focused on wildlife in the foreground; however, views of open ocean and seascape are an important contribution to the experience and would be the focus when wildlife are not present.	Highly accessible roadside overlook with parking along designated State Scenic Highway in SP; viewer amenities include parking, bike rack, interpretive panels, picnic shelter, and hiking trails. Viewpoint is widely publicized on websites, guidebooks, and tourism service providers.	High
M4 Valencia Peak – Montaña de Oro SP	SP mountain peak with 365° views of seascape and landscape; prominent viewpoint and destination for recreators.	SP with natural and cultural/historic significance. Scenic viewpoint along coastal trail. Accessible to pedestrians, mountain bikers, and equestrians.	High

[1] Elevated
[2] Representative

F.3.2.3 Magnitude of Impact

The measure of magnitude of visual impacts is similar to that used for SLIA and is based on the size or scale of change, the geographic extent of its effects, and its duration and reversibility. Large-scale changes that introduce new, non-characteristic, discordant, or intrusive elements are more important than small changes or changes involving similar features already present within the view.

Size and scale of change and geographic extent is measured by project's distances, horizontal FOVs, noticeable features based on their heights and EC, and visual contrasts. The analysis considers the introduction of WTGs and OSS to an open ocean baseline.

The scale, size, contrast, and prominence of change focuses on the following arrangement and positioning.

- Arrangement of WTGs and OSS in the view.
- Horizontal and vertical FOV scale of the wind turbine array, based on WTG and OSS size and number.
- Position of the array in the open ocean.
- Position of the array in the view.
- Wind turbine array's distance from the viewer.

Visibility, character-changing effects, scale, prominence, and visual contrasts reduce steadily with distance from the observation point. Visibility, character-changing effects, scale, prominence, and visual contrasts increase with elevated observer positions in comparison with the wind turbine array. Distance and observer elevation considerations are informed by the visual simulations (BOEM's California Offshore Wind website: https://www.boem.gov/renewable-energy/state-activities/california), EC calculations, horizontal FOV, and vertical FOV in undeveloped open ocean.

The wind turbine array and nearest WTGs would be positioned accordingly.

- Unavoidably dominant features in the boat and ship ocean view between 0 and 5 miles (0 and 8.0 kilometers) distance.
- Strongly pervasive features in the onshore to offshore view between 5 and 12 miles (8 and 19.3 kilometers) distance.
- Clearly visible features in the onshore to offshore view between 12 and 20 miles (19.3 and 45.1 kilometers) distance.
- Low on the horizon, but persistent features in the onshore to offshore view between 20 and 36.1 miles (45.1 and 58.1 kilometers) distance.
- Intermittently noticed features in the onshore to offshore view between 36.1 and 47.4 miles (58.1 and 76.3 kilometers) distance.
- Below the horizon beyond 47.4 miles (76.3 kilometers) distance.

Construction involving moving and stationary visual feature contrasts to forms, lines, colors, and textures, scale, and prominence in formerly open seascape may have more effect on viewers than operational and decommissioning impacts, where the viewing context is existing WTGs and OSSs.

The following construction impacts would be temporary.

- Daytime and nighttime movement of construction vessels, cranes, and other equipment visible in the seascape in and around the lease area.
- Dawn, dusk, and nighttime construction lighting on WTGs and OSSs.
- Beach, other sensitive land-based, and boat and cruise ship views of WTGs and OSSs under construction.

Foreground influence assessments, involving the presence of intervening or framing elements and their influence on effects of project characteristics, are based on each KOP's locale photography and visual simulations and summarized in Table F-25.

Table F-25. Foreground view framing and intervening elements between the KOPs and the lease areas

Foreground Element(s) Influence[1]	Offshore KOPs
Open Ocean **Negligible Influence**	O1 Recreational Fishing, Pleasure, and Tour Boat Area O2 Commercial and Cruise Ship Shipping Lanes
Bluffs, Sea Rocks, and Ocean **Minor Influence**	H1 Patrick's Point M1 Julia Pfeiffer SP
Structures, Sea Rocks, and Ocean **Minor Influence**	M2 Limekiln M3 Piedras Blancas Lighthouse
Bay, Vegetation, and Topography **Moderate Influence**	M4 Valencia Peak Montaña de Oro SP
Cove, Vegetation, Sea Rocks, and Structures **Moderate Influence**	M3 Piedras Blancas State MR

[1] Based on conditions portrayed by representative aerial photography [Google Earth]. Nearby view receptor locations may vary from screened to open views of the lease area.

Visual contrast determinations on viewer experience are based on visual simulations for 5 representative KOPs. Potential viewpoints' evaluations range from faint to dominant. Visual contrast determinations involve comparisons of characteristics of the KOPs before and after implementation of the Humboldt and Morro Bay WEA projects. The range of potential contrasts includes strong, moderate, weak, and none. The strongest daytime contrasts would result from tranquil and flat seas combined with sunlit WTG towers, nacelles, flickering rotors, and the yellow tower 50-foot (15.2-meter) base color against a dark background sky and an undifferentiated foreground. The weakest daytime contrasts would result from turbulent seas combined with overcast daylight conditions on WTG towers, nacelles, and rotors against an overcast background sky and a foreground modulated by varied landscape elements. The strongest nighttime contrasts would result from dark skies (absent moonlight) combined with aviation lights, lighting on the OSS, mid-tower lights, and project lighting reflections on low clouds and active (non-reflective) surf, and the dark-sky light dome. The weakest nighttime contrasts would result from moonlit, cloudless skies; tranquil (reflective) seas.

There would be daily variation in WTG color contrast as sun angles change from backlit to front-lit (sunrise to sunset), and the backdrop would vary under different lighting and atmospheric conditions. Photo simulations were produced for each of the selected KOPs. They illustrate predicted visibility for a subset of the anticipated WTGs (67 total) at a height of 889 feet (271 meters) to blade tip, which is slightly larger (39 feet [11.9 meters]) than the smaller proposed WTGs, but 211 feet (64.3 meters) shorter than the largest proposed WTGs. All of the simulations depict views at four different times, morning, midday, afternoon, and night based on the atmospheric clarity on the day the photograph was taken. Three of the KOP simulations also model three predicted atmospheric visibility conditions, 15, 17, and 20 miles (24.1, 27.4, and 32.2 kilometers). Future analysis should analyze WTGs at all proposed heights and at maximum build-out to understand worst-case scenario. For this analysis, worst-case analysis is based on GIS modeling of WTG height and quantity.

Visual contrasts, scale of change, and prominence comparisons of viewer experience existing conditions and implementation of the Humboldt and Morro Bay WEA projects are included in the summary tables. Visual contrast, scale of change, and prominence determinations for KOPs are listed in Table F-26 through Table F-29 for each WEA and lease area, individually and combined, for the 1,100-foot and 850-foot WTGs, respectively.

Table F-26. 1,100-foot WTG Humboldt WEA projects magnitude and impacts for Humboldt WEA and lease areas

Lease	KOP	Distance in Miles (km) and Noticeable Elements [1]	Visible Horizontal FOV Degrees (% of 124°)	Contrast, Scale of Change, and Prominence						Impact Level	
				Form	Line	Color	Texture (movement)	Scale	Prominence[2]	1,100-Foot WTG	Alternative C
OCS-P 0561	H1 Patrick's Point – Day[3] H1 Patrick's Point - Night[3]	20.61 (33.18) R, AL, N, H, M, O, Y	44.6° (36%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0562	H1 Patrick's Point – Day[3] H1 Patrick's Point - Night[3]	27.47 (44.20) R, AL, H, N, M, O	40.9° (33%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
Humboldt WEA	H1 Patrick's Point - Day[3] H1 Patrick's Point - Night[3]	20.61 (33.18) R, AL, N, H, M, O, Y	45.6° (37%)	Strong Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B

[1] Noticeable elements: R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, and Y = yellow tower base color.

[2] WTGs and offshore or onshore substation visibility: 0-Not visible. 1-Visible only after extended study; otherwise not visible. 2-Visible when viewing in general direction of the wind turbine array; otherwise, likely to be missed by casual observer. 3-Visible after brief glance in general direction of the wind turbine array; unlikely to be missed by casual observer. 4-Plainly visible; could not be missed by casual observer but does not strongly attract visual attention or dominate view. 5-Strongly attracts viewers' attention to the wind turbine array; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6-Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (Sullivan 2013).

[3] Elevated viewpoint: H1 = 156.

km = kilometer

Table F-27. 1,100-foot WTG Morro Bay WEA projects magnitude and impacts for Morro Bay WEA and lease areas

Lease	KOP	Distance in Miles (km) and Noticeable Elements[1]	Visible Horizontal FOV Degrees (% of 124°)	Contrast, Scale of Change, and Prominence						Impact Level	
				Form	Line	Color	Texture (movement)	Scale	Prominence[2]	1,100-Foot WTGs	Alternative C
OCS-P 0563	M1 Julia Pfeiffer – Day[3] M1 Julia Pfeiffer - Night[3]	32.69 (52.61) R, AL, N, H, M, O, Y	60.4° (48.5%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	28.54 (45.7) R, AL, N, H, M, O, Y	29.4° (24%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	33.83 (54.44) R	33.4° (27%)	Weak	Moderate	Weak	Moderate	Small	2 0	Minor Negligible	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	60.80 (97.84) R, AL, N, H, M, O	15.8° (13%)	Weak Weak	Weak Weak	Weak Weak	Weak Weak	Small Small	1 2	Minor Minor	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0564	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	32.7 (52.6) R, AL, N, H, M, O, Y	13.3° (11%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.64 (42.87) R, AL, N, H, M, O, Y	17.6° (14%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	27.09 (43.60) R, AL, N, H	36.0° (29%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	4 5	Moderate Major	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	53.04 (85.45) R, AL, N, H, M, O, Y	18.5° (15%)	Weak Weak	Weak Moderate	Weak Moderate	Weak Weak	Small Small	1 3	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0565	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	34.66 (57.78) R, AL, N, H, M, O, Y	69.9° (56.4%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.52 (42.67) R, AL, N, H, M, O, Y	38.1° (31%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	19.21 (30.91) R, AL, N, H, M	47.0° (38%)	Moderate Weak	Strong Strong	Strong Strong	Strong Weak	Medium Medium	4 5	Moderate Major	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	38.6 (62.12) R, AL, N, H, M, O, Y	22.35° (18%)	Weak Weak	Moderate Moderate	Weak Moderate	Moderate Weak	Small Small	3 4	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
Morro Bay WEA	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	32.7 (54.23) R, AL, N, H, M, O, Y	69.9° (56.4%)	Moderate Weak	Moderate Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.64 (42.68) R, AL, N, H, M, O, Y	56.9° (46%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	19.21 (30.91) R, AL, N, H, M	64.9° (52%)	Moderate Weak	Strong Strong	Strong Strong	Strong Weak	Medium Medium	4 5	Moderate Major	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	38.3 (62.44) R, AL, N, H, M, O, Y	22.4° (18%)	Weak Weak	Moderate Moderate	Weak Moderate	Moderate Weak	Small Small	3 4	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B

[1] Noticeable elements: R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, and Y = yellow tower base color.
[2] WTGs and offshore or onshore substation visibility: 0-Not visible. 1-Visible only after extended study; otherwise not visible. 2-Visible when viewing in general direction of the wind turbine array; otherwise, likely to be missed by casual observer. 3-Visible after brief glance in general direction of the wind turbine array; unlikely to be missed by casual observer. 4-Plainly visible; could not be missed by casual observer but does not strongly attract visual attention or dominate view. 5-Strongly attracts viewers' attention to the wind turbine array; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6-Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (Sullivan 2013).
[3] Elevated viewpoint: M1 = 458 feet, M2 = 779 feet, M4 = 1,344 feet.
km = kilometer

Table F-28. 850-foot WTG Humboldt WEA projects magnitude and impacts for Humboldt WEA and lease areas

Lease	KOP	Distance in Miles (km) and Noticeable Elements[1]	Visible Horizontal FOV Degrees (% of 124°)	Contrast, Scale of Change, and Prominence						Impact Level	
				Form	Line	Color	Texture	Scale	Prominence[2]	850-Foot WTG	Alternative C
OCS-P 0561	H1 Patrick's Point - Day[3] H1 Patrick's Point - Night[3]	20.61 (33.18) R, AL, N, H, M, O, Y	44.6° (37%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0562	H1 Patrick's Point – Day[3] H1 Patrick's Point - Night[3]	27.47 (44.20) R, AL, N, H, M, O	40.9° (33%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
Humboldt WEA	H1 Patrick's Point – Day[3] H1 Patrick's Point- Night[3]	20.61 (33.18) R, AL, N, H, M, O, Y	45.6° (37%)	Strong Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B

[1] Noticeable elements: R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, and Y = yellow tower base color.
[2] WTGs and offshore or onshore substation visibility: 0-Not visible. 1-Visible only after extended study; otherwise not visible. 2-Visible when viewing in general direction of the wind turbine array; otherwise, likely to be missed by casual observer. 3-Visible after brief glance in general direction of the wind turbine array; unlikely to be missed by casual observer. 4-Plainly visible; could not be missed by casual observer but does not strongly attract visual attention or dominate view. 5-Strongly attracts viewers' attention to the wind turbine array; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6-Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (Sullivan 2013).
[3] Elevated viewpoint: H1 = 156.
km = kilometer

Table F-29. 850-foot WTG Morro Bay WEA projects magnitude and impacts for Morro Bay WEA and lease areas

Lease	KOP	Distance in Miles (km) and Noticeable Elements[1]	Visible Horizontal FOV Degrees (% of 124°)	Contrast, Scale of Change, and Prominence						Impact Level	
				Form	Line	Color	Texture	Scale	Prominence[2]	850-Foot WTGs	Alternative C
OCS-P 0563	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	32.7 (52.6) R, AL, N, H, M, O, Y	13.3° (11%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	28.54 (45.7) R, AL, N, H, M, O, Y	29.4° (24%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	33.83 (54.44) R, None	33.4° (27%)	Weak	Moderate	Weak	Moderate	Small	2 0	Minor Negligible	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	60.80 (97.84) R, AL, N, H, M, O, Y	15.8° (13%)	Weak Weak	Weak Weak	Weak Weak	Weak Weak	Small Small	1 2	Minor Minor	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0564	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	32.7 (52.6) R, AL, N, H, M, O, Y	69.9° (56.4%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.64 (42.87) R, AL, N, H, M, O, Y	17.6° (14%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	27.09 (43.60) R, AL, N, H	36.0° (29%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	4 5	Moderate Major	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	53.04 (85.45) R, AL, N, H, M, O, Y	18.5° (15%)	Weak Weak	Weak Moderate	Weak Moderate	Weak Weak	Small Small	1 3	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
OCS-P 0565	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	34.66 (57.78) R, AL, N, H, M, O, Y	69.9° (56.4%)	Moderate Weak	Moderate Strong	Moderate Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.52 (42.67) R, AL, N, H, M, O, Y	38.1° (31%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	19.21 (30.91) R, AL, N, H, M	47.0° (38%)	Moderate Weak	Strong Strong	Strong Strong	Strong Weak	Medium Medium	4 5	Moderate Major	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - Night[3]	38.6 (62.12) R, AL, N, H, M, O, Y	22.35° (18%)	Weak Weak	Moderate Moderate	Weak Moderate	Moderate Weak	Small Small	3 4	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
Morro Bay WEA	M1 Julia Pfeiffer - Day[3] M1 Julia Pfeiffer - Night[3]	33.7 (54.23) R, AL, N, H, M, O, Y	44.1° (36%)	Moderate Weak	Moderate Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Moderate Major	Same as Alternative B
	M2 Limekiln SP - Day[3] M2 Limekiln SP - Night[3]	26.64 (42.68) R, AL, N, H, M, O, Y	56.9° (46%)	Moderate Weak	Strong Strong	Strong Strong	Moderate Weak	Medium Medium	5 5	Major Major	Same as Alternative B
	M3 Piedras Blancas – Day M3 Piedras Blancas - Night	19.21 (30.91) R, AL, N, H, M	64.9° (52%)	Weak Weak	Moderate Moderate	Weak Moderate	Moderate Weak	Small Small	3 4	Minor Moderate	Same as Alternative B
	M4 Valencia Peak - Day[3] M4 Valencia Peak - NIght[3]	38.3 (62.44) R, AL, N, H, M, O, Y	22.4° (18%)	Weak Weak	Moderate Moderate	Weak Moderate	Moderate Weak	Small Small	3 4	Minor Moderate	Same as Alternative B
	O1 Recreational Area	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B
	O2 Commercial Lanes	0–43.3 (0–69.7) R, AL, N, H, M, O, Y	0–360° (300%)	Strong	Strong	Strong	Strong	Large	6	Major	Same as Alternative B

[1] Noticeable elements: R = rotor, AL = aviation light, N = nacelle, H = hub, M = mid-tower light, O = OSS, and Y = yellow tower base color.
[2] WTGs and offshore or onshore substation visibility: 0-Not visible. 1-Visible only after extended study; otherwise not visible. 2-Visible when viewing in general direction of the wind turbine array; otherwise, likely to be missed by casual observer. 3-Visible after brief glance in general direction of the wind turbine array; unlikely to be missed by casual observer. 4-Plainly visible; could not be missed by casual observer but does not strongly attract visual attention or dominate view. 5-Strongly attracts viewers' attention to the wind turbine array; moderate to strong contrasts in form, line, color, or texture, luminance, or motion. 6-Dominates view; strong contrasts in form, line, color, texture, luminance, or motion fill most of the horizontal FOV or vertical FOV (Sullivan 2013).
[3] Elevated viewpoint: M1 = 458 feet, M2 = 779 feet, M4 = 1,344 feet.
km = kilometer

The viewer experiences would be affected by noticeable features of wind energy projects in the lease areas; applicable distances and FOV extents; open views versus view framing and intervening foregrounds, and form, line, color, and texture contrasts; scale of change; and prominence in the characteristic seascape and landscape. Higher impact levels would stem from unique, extensive, and long-term appearance of strongly contrasting, large, and prominent vertical structures in the otherwise horizontal seascape environment; where structures are an unexpected element and viewer experience is of formerly open views of high-sensitivity seascape and landscape; and from high-sensitivity view receptors.

The Humboldt and Morro Bay WEA projects would be visible from seascape KOPs. WTGs would be more visible to viewers at elevated KOPs. All KOPs except for KOP M3 Piedras Blancas are substantially elevated and on a clear atmospheric day, WTG noticeable features would be apparent, including the yellow tower base. The majority of landward visibility would occur within 28 miles (45.1 kilometers) of the Humboldt and Morro Bay WEA projects. Visibility would diminish between 28 miles (45.1 kilometers) and 43.3 miles (69.7 kilometers); therefore, distance reduces the impact of noticeability created by elevated viewpoints.

Operational effects would be similar to those of end-stage construction and would be long term and fully reversible.

Impacts on high-sensitivity KOPs would be major. The daytime and nighttime (lighting) presence of the WTGs, OSSs, and construction and O&M vessel traffic would change perception of this area from natural, undeveloped seascape to a developed wind energy environment characterized by visually dominant WTGs and OSSs.

Maintenance activities would cause minor increases in these vessel movements would be noticeable to offshore viewers but are unlikely to have a significant effect.

Decommissioning would involve the removal of all offshore structures and is expected to follow the reverse of the construction activity. Decommissioning activities would cause effects similar to those of construction activities.

Viewshed analyses determined that clear-weather visibility of the WTGs and OSSs would occur within the Humboldt and Morro Bay WEA projects’ zone of visual influence. Due to coastal meteorological conditions, visibility varies throughout the day and seasons along the California coast. Visibility of the Humboldt WEA projects would be noticeably reduced on approximately 2 out of 3 days. Visibility of the Morro Bay WEA projects would be noticeably reduced on approximately 1 out of 3 days.

Daytime lighting of WTGs is not required. The nighttime aviation lighting on WTGs and OSSs would result in major impacts. In additional to aviation lighting, safety lighting on the up to three OSSs, as required by the Occupational Safety and Health Administration for the safety of O&M personnel, potentially would be visible from beaches and adjoining land and the built environment during hours of darkness. The nighttime sky light dome and cloud lighting caused by reflections from the water surface may be seen from distances beyond the Affected Environment, depending on variable ocean surface and meteorological reflectivity.

F.3.2.4 Visual Impact Assessment Summary

The VIA considers the characteristics of the view receptor, characteristics of the view toward the Humboldt and Morro Bay WEA project facilities, and the experiential impacts of the Humboldt and Morro Bay WEA projects. Based on VIA impact range factors presented in Table F-26 through Table F-29 and the Affected Environment viewer experience analyses, Table F-30 summarizes the viewer sensitivity, view receptor susceptibility, view value, and measures of effects from the visible character and magnitude of the offshore and onshore components (BOEM 2021). Impacts of the Humboldt and Morro Bay WEA projects on viewer experiences range from **minor** to **major**.

Table F-30. Summary of Humboldt and Morro Bay WEA viewer experiences

KOP	Sensitivity						Magnitude of Impact									Visibility Threshold Rating				Impact Levels[1]		
	Susceptibility			Value			Size and Scale of Change			Geographic Extent			Duration and Reversibility									
	High	Moderate	Low	High	Moderate	Low	Large	Medium	Small	Large	Medium	Small	Permanent	Long Term	Short Term	High (5-6)	Moderate (3-4)	Low (1-2)	Unseen	1,100-foot WTG	850-foot WTG	Alternative C
Humboldt WEA																						
H1 Patrick's Point	X			X			X				X			X		X				Major	Major	Same as Alternative B
H1 nighttime	X			X			X				X			X		X				Major	Major	Same as Alternative B
H2 Patrick's Point	X			X			X				X			X		X				Major	Major	Same as Alternative B
H2 nighttime	X			X			X				X			X		X				Major	Major	Same as Alternative B
Morro Bay WEA																						
M1 Julia Pfeiffer Burns SP	X			X			X				X			X			X			Major	Major	Same as Alternative B
M1 nighttime	X			X			X				X			X		X				Major	Major	Same as Alternative B
M2 Limekiln SP	X			X			X				X			X			X			Major	Major	Same as Alternative B
M2 nighttime	X			X			X				X			X		X				Major	Major	Same as Alternative B
M3 Piedras Blancas Lighthouse	X			X			X				X			X			X			Major	Major	Same as Alternative B
M3 nighttime	X						X				X			X		X				Major	Major	Same as Alternative B
M4 Valencia Peak Montaña de Oro SP [2]	X			X			X					X		X			X			Minor	Minor	Same as Alternative B
M4 nighttime	X			X			X					X		X			X			Moderate	Moderate	Same as Alternative B
O1 Recreational Fishing, Pleasure, and Tour Boat Area [2]	X			X			X			X				X		X				Major	Major	Same as Alternative B
O2 Commercial and Cruise Shipping Lanes [2]	X			X			X			X				X		X				Major	Major	Same as Alternative B

[1] Impact levels elevated because of sensitivity.
[2] Representative KOP.

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Appendix G: NHPA Section 106 Summary

G.1 Project Overview

G.1.1 Background

This document summarizes the Bureau of Ocean Energy Management's (BOEM) consideration of programmatic tools for compliance with Section 106 of the National Historic Preservation Act (NHPA or Section 106) and documents BOEM's process for engaging the Advisory Council on Historic Preservation (ACHP), California State Historic Preservation Officer (SHPO), Native American Tribes, and other organizations with an interest in the protection of historic properties in advance of BOEM's future project-level reviews of Construction and Operation Plans (COP) for five commercial wind energy lease areas in the Humboldt and Morro Bay Wind Energy Areas (WEA). This Section 106 summary is included as an appendix to the Programmatic Environmental Impact Statement (PEIS) being prepared in compliance with the National Environmental Policy Act (NEPA).

BOEM is considering the development of a set of standard mitigation measures that would be made available to lessees prior to submittal of COPs. BOEM has already implemented a programmatic agreement pursuant to 36 Code of Federal Regulations (CFR) 800.14(b) to fulfill its obligations under Section 106 of the NHPA for renewable energy activities on the Outer Continental Shelf (OCS) offshore California. This agreement was developed for two primary reasons: first, BOEM's decisions to issue leases and approve plans (e.g., Site Assessment Plans, COPs, or General Activity Plans) are complex and involve multiple stages of decision-making and multiple undertakings; and second, BOEM will not have the results of archaeological surveys prior to the issuance of leases or grants and, as such, will be conducting historic property identification and evaluation efforts in phases (36 CFR 800.4(b)(2)). The *Programmatic Agreement Among The U.S. Department of the Interior, Bureau of Ocean Energy Management, The State Historic Preservation Officer of California, The Advisory Council on Historic Preservation Regarding Review of Outer Continental Shelf Renewable Energy Activities Offshore California Under Section 106 of the National Historic Preservation Act* (California PA) was executed December 18, 2019, by BOEM, SHPO, ACHP, and the Santa Ynez Band of Chumash Indians. This agreement provides for Section 106 consultation to continue through BOEM's decision-making process and allows for a phased identification and evaluation of historic properties (36 CFR 800.4(b)(2)).

The current programmatic review of the five Humboldt and Morro Bay lease areas seeks to provide the signatories the opportunity to consider whether additions to the California PA are necessary in order to support BOEM's review and approval of COPs anywhere off the coast of California. In addition to the Signatories to the California PA, BOEM invited a broader set of potential consulting parties to participate, allowing them to provide input on possible revisions to the California PA. By capturing the results in this Section 106 summary, BOEM seeks to achieve greater consistency across the five lease areas while reducing the consultation burden for consulting Tribes, SHPOs, ACHP, and other parties.

G.1.2 Consultation with Tribes and Consulting Parties and Public Involvement

On December 19, 2023, BOEM contacted representatives of federally recognized Tribes, other federal agencies, state and local governments, preservation organizations, lessees of the five Humboldt and Morro Bay lease areas, and other potentially interested consulting parties to determine their interest in participating as consulting parties. Parties that responded with interest in participating are listed in Table G-1. BOEM will continue consulting with federally recognized Tribes, California SHPO, ACHP, and other consulting parties regarding the project-level review procedures and potential changes to the California PA.

Table G-1. Participating Section 106 consulting parties for the Humboldt and Morro Bay lease areas

Organization Type	Participating Consulting Parties
Federally Recognized Tribe	Resighini Tribe of Yurok People
Federally Recognized Tribe	Santa Rosa Rancheria Tachi Yokut Tribe
ACHP	TBD
State Government (SHPO)	TBD
State Government	California State Lands Commission
Federal Government	Bureau of Land Management, California Coastal National Monument
Non-Federally Recognized Tribe	Coastal Band of the Chumash Nation
Non-Federally Recognized Tribe	Salinan Tribe of Monterey & San Luis Obispo Counties
Local Government	San Luis Obispo County
Non-Governmental Organization	Historical Society of Morro Bay
Non-Governmental Organization	Monterey County Historical Society
Non-Governmental Organization	Piedras Blancas Light Station Association

G.1.3 Defining Project Areas of Potential Effect

In 36 CFR 800.16(d), an area of potential effects (APE) is defined as “the geographic area or areas within which an undertaking may directly or indirectly cause alteration in the character or use of historic properties, if any such properties exist.” The California PA further defines the APE as “the depth and breadth of the seabed that could potentially be impacted by seafloor/bottom-disturbing activities associated with the undertakings; the offshore and onshore viewshed from which renewable energy structures would be visible; and, if applicable, the depth, breadth, and viewshed of onshore locations where transmission cables or pipelines come ashore until they connect to existing power grid structures” (Stipulation II.A).

In accordance with Stipulation II.A of the California PA, there are three parts to an APE. The marine portion (Marine APE) includes areas potentially affected by seabed-disturbing activities. The visual portion (Visual APE) includes the maximum viewshed from which offshore renewable energy structures would be visible. The terrestrial portion of the APE would include onshore locations where transmission cables or pipelines come ashore until they connect to existing power grid structures.

BOEM expects each lessee to complete the requisite cultural resource technical studies per historic property identification guidelines (BOEM 2020) including, but not limited to, the delineation of a preliminary APE per the COP Project Design Envelope, completion of associated cultural resource and historic property identification efforts, assessment of potential effects, and development of potential mitigation measures for identified historic properties.

After BOEM has reviewed the lessee-prepared preliminary APE and technical reports, BOEM will then delineate the COP APE and assess the specific impacts on historic properties for COP-specific NEPA and NHPA reviews and consultations. BOEM also acknowledges that Tribal Nations may have knowledge about cultural, religious, archaeological, and traditional ecological properties that may be adversely affected by a project and, therefore, would require consideration under the NHPA and NEPA reviews.

BOEM recognizes several types and subtypes of cultural resources as defined in Table G-2. Discussion of the cultural resource types in this section is further organized by their known or potential presence in along the coast of California.

Table G-2. Definitions of cultural resource types used in the analysis

Term	Definition
Ancient submerged landform feature (ASLF)	A type of marine cultural resource, ASLFs are landforms that have the potential to contain Native American archaeological resources inundated and buried as sea levels rose at the end of the Last Glacial Maximum. Additionally, Native American Tribes in the region may consider ASLFs to be independent or contributing elements to previously subaerial traditional cultural places (TCP) representing places where their ancestors once lived.
Cultural landscape and maritime cultural landscape	The National Park Service (2006) defines a *cultural landscape* as a "geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person, or exhibiting other cultural or aesthetic values." In this analysis, cultural landscapes are considered a type of historic aboveground resource. The National Oceanic and Atmospheric Administration (2024) defines a maritime cultural landscape as "a geographic area where the combination and interrelationships of human activity and the marine environment is expressed in significant ways, such as the distribution of heritage resources, traditions and cultural practices, or culturally important locations. Every maritime cultural landscape captures a unique combination of both material and intangible heritage, and includes meaning attached to a given location by different stakeholder groups."
Cultural resource	The phrase *cultural resource* refers to a physical resource valued by a group of people such as an archaeological resource, building, structure, object, district, landscape, or TCP. Cultural resources can date to the pre-Contact or post-Contact periods (e.g., respectively, the time prior to the arrival of Europeans in North America and thereafter) and may be listed on national, state, or local historic registers or be identified as important to a particular group during consultation, including any of those with cultural or religious significance to Native American Tribes. Cultural resources in this analysis are divided into several types and subtypes: marine cultural resources, terrestrial archaeological resources, historic aboveground resources, and TCPs.

Term	Definition
Marine archaeological resource	*Marine archaeological resources* are the physical remnants of past human activity that occurred at least 50 years ago and are submerged underwater. They may date to the pre-Contact period (e.g., those inundated and buried as sea levels rose at the end of the Last Glacial Maximum) or post-Contact period (e.g., shipwrecks, downed aircraft, and related debris fields).
Historic aboveground resource	*Historic aboveground resources* are subaerial features or structures of cultural significance at least 50 years in age and include those that date to the pre-Contact or post-Contact periods. Example types that are or may have historic aboveground components include standing buildings, bridges, dams, historic districts, cultural landscapes, and TCPs.
Historic district	A *historic district* is an area composed of a collection of either or both archaeological and aboveground resources.
Historic property	As defined in 36 CFR 800.16(l)(1), the phrase *historic property* refers to any "prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the [National Register of Historic Places (NRHP)] maintained by the Secretary of the Interior." Historic property also includes National Historic Landmarks, as well as properties of religious and cultural significance to Native American Tribal Nations that meet NRHP criteria.
Terrestrial archaeological resource	*Terrestrial archaeological resources* are the physical remnants of past human activity that occurred at least 50 years ago and are located on or within lands not submerged underwater. They may date to the pre-Contact period (e.g., have associations with Native American populations dating to before European colonization of the Americas) or post-Contact period (e.g., have associations with African American, European American, or Native American populations dating to after European colonization of the Americas).
Traditional cultural place	National Register Bulletin 38 (Parker and King 1990, revised 1992 and 1998; and NPS 2023) defines a *traditional cultural place* as a "building, structure, object, site, or district that may be listed or eligible for listing in the National Register for its significance to a living community because of its association with cultural beliefs, customs, or practices that are rooted in the community's history and that are important in maintaining the community's cultural identity" (NPS 2023:12). TCPs may be locations, places, or cultural landscapes and have either or both archaeological and aboveground elements.

G.2 Historic Property Identification

G.2.1 Historic Properties in the Marine Portion of the APE

Marine cultural resources in the region include pre- and post-Contact marine archaeological resources and ASLFs on the OCS (BOEM 2015). WEAs off the coast of California have a high probability for containing shipwrecks, downed aircraft, and related debris fields that may be subject to potential impacts by seabed-disturbing activities from offshore wind development (BOEM 2015). ASLFs have a moderate (Northern California) to low (Central California) probability of occurrence on the OCS (BOEM 2015). BOEM will require each lessee to conduct identification efforts for marine archaeological resources, intertidal archaeological resources, and ASLFs and present findings in a Marine Archaeological Resources Assessment report prepared in partial fulfillment of a sufficient COP. These efforts will be required to include areas of potential impacts by seabed-disturbing activities in the intertidal zone closer to the existing shoreline that may include Indigenous resources, including habitation sites, procurement and quarry sites, submerged canoes, etc. BOEM will fully analyze impacts on marine cultural, intertidal archaeological, and ASLF resources in COP-specific NEPA and NHPA reviews and consultations.

G.2.2 Historic Properties in the Terrestrial Portion of the APE

BOEM will require each Humboldt and Morro Bay lessee to conduct identification efforts for terrestrial archaeological resources and present findings in a Terrestrial Archaeological Resources Assessment report prepared in partial fulfillment of a sufficient COP. This should include incorporation of information about terrestrial archaeological resources that have been identified as historic properties in the course of NEPA and Section 106 review of other lease areas that have already progressed into or completed NEPA and Section 106 review for their COPs, as the APE for those projects may overlap.

G.2.3 Historic Properties in the Visual Portion of the APE

WEAs off the coast of California are likely to encompass historically settled areas of coastal California. As such, a number of historic aboveground resources are anticipated to be located in the Visual APE, of which a proportion are anticipated to be historic properties or potential historic properties listed or eligible for listing in the NRHP. These aboveground historic properties may include buildings, historic districts, cultural landscapes, and TCPs. BOEM will require each lessee to conduct identification efforts for historic aboveground resources and present findings in a Historic Resources Visual Effects Assessment report prepared in partial fulfillment of a sufficient COP. BOEM will fully analyze impacts on such resources in COP-specific NEPA and NHPA reviews and consultations.

G.3 Assessing Effects on Historic Properties

In the course of conducting the NEPA analysis for the PEIS, and through input gained during the Section 106 consultation meetings, BOEM has considered recommendations about types of effects that are likely to occur. The following section discusses thresholds and methods for considering effects during the COP-level reviews and is intended to create consistency across projects, which in turn will support more focused and meaningful project-level Section 106 consultation.

G.3.1 Criteria of Adverse Effect

The Criteria of Adverse Effect under NHPA Section 106 (36 CFR 800.5(a)(1)) states that an undertaking has an adverse effect on a historic property if the following occurs: “when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association.…Adverse Effects may include reasonably foreseeable effects caused by the undertaking that may occur later in time, be farther removed in distance or be cumulative.” According to regulation, adverse effects on historic properties include, but are not limited to (36 CFR 800.5(a)(2)):

i. Physical destruction of or damage to all or part of the property;

ii. Alteration of a property, including restoration, rehabilitation, repair, maintenance, stabilization, hazardous material remediation, and provision of handicapped access, that is not consistent with the Secretary of the Interior's standards for the treatment of historic properties (36 CFR 68) and applicable guidelines;

iii. Removal of the property from its historic location;

iv. Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance;

v. Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features;

vi. Neglect of a property, which causes its deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian Tribe or Native Hawaiian organization; and

vii. Transfer, lease, or sale of property out of federal ownership or control without adequate and legally enforceable restrictions or conditions to ensure long-term preservation of the property's historic significance.

G.3.2 Marine Cultural Resources

Marine cultural resources such as shipwrecks and downed aircraft may be individually eligible for listing in the NRHP under Criterion A, B, or D. ASLFs may be individually eligible for listing in the NRHP or considered contributing elements to a TCP eligible for listing in the NRHP. ASLFs in the Marine APE are considered archaeologically sensitive. If undiscovered archaeological resources are present within the identified ASLFs and they retain sufficient integrity, these resources could be eligible for listing in the NRHP under Criterion D, which is a resource that yields or may be likely to yield information important in prehistory or history. Furthermore, ASLFs are considered by Tribal Nations in the region to be culturally significant resources as the lands where their ancestors lived and as locations where events described in Tribal histories occurred prior to inundation. BOEM recognizes these landforms could be eligible for listing in the NRHP under Criterion A.

The severity of project effects would depend on the extent to which integral or significant components of affected marine archaeological resources or ASLFs are disturbed, damaged, or destroyed, resulting in the loss of contributing elements to the historic property's eligibility for listing in the NRHP.

G.3.3 Terrestrial Archaeological Resources

The severity of effects would depend on the extent to which integral or significant components of affected archaeological resources are disturbed, damaged, or destroyed, resulting in the loss of contributing elements to the historic property's eligibility for listing in the NRHP.

G.3.4 Historic Aboveground Resources

As each lessee finalizes layouts within their lease area and the specifications for their offshore wind structures, the lease-specific preliminary APE can be delineated using the same methods that were used for the Humboldt and Morro Bay programmatic APE. The development of those APEs and the analysis that follows will be more credible in general, and consistent between lease areas, by using the methods developed during the programmatic review.

Assessing the effect of offshore project components generally involves the following steps.

1. Briefly summarize the historical significance of the historic property.
2. Characterize the views that comprise the character-defining views as they relate directly to the significance of the historic property. Include all character-defining views, both maritime and otherwise.
3. Describe what can be identified from Google Earth or Street View about other features in the vicinity that currently affect views from the historic property toward the character-defining maritime views (such as tall buildings between the property and the ocean, or if the property is on elevated ground).
4. Explain what can be extrapolated from the visual impact assessment performed for scenic resources, focusing on the nearest key observation point and associated visual simulations.
5. State how all of the above would alter the historical integrity of the character-defining views, discussing the aspects of integrity related to feeling and setting relative to how one experiences the maritime character-defining views, and the aspect of association relative to how one understands the functional role of the ocean in the property’s significance.
6. Conclude with a recommended finding of effect.

G.3.5 Representative Visual Effects Analysis

The objective of a visual effects analysis is to assess how the introduction of offshore development (WTGs, offshore substations) would change the relationship between an individual historic property and its maritime views, which could alter several aspects of historical integrity including feeling, setting, and association. It is important to note that not every historic property that has a view of the ocean necessarily relies on that maritime view to define its historical integrity. Each lessee will prepare project-level documentation of historic properties located within the preliminary APE for their lease, and must include a discussion of whether the maritime view is a character-defining feature of each NRHP-eligible or -listed historic property.

The effects of the project, and cumulative effects of multiple projects, will need to be individually assessed for each historic property, based on its unique historical significance, relationship with the maritime view, and interpretation of the visual simulations for the nearest key observation point. In general, for each historic property whose historical significance is associated with the maritime setting and that has retained the integrity of its maritime view, if the visual simulation from either that location or a comparable key observation point indicate that the WTGs would be visible, a finding of adverse effect is appropriate.

The effects on character-defining views of historic properties within the visual APE could vary based on the number and proximity to shore of WTGs and offshore substations, as illustrated by the visual simulations of ocean views from two different historic properties. Refer to Appendix F, *Seascape, Landscape, and Visual Impact Assessment*, for additional information about the visual simulations BOEM prepared for the Humboldt and Morro Bay WEAs. The visual simulations from Julia Pfeiffer Burns, Limekiln State Park, Piedras Blancas Lighthouse, Piedras Blancas in Morro Bay, and Valencia Peak show that simulated WTGs more than 40 miles away (in the Morro Bay WEA) appear small and indistinguishable. In contrast, visual simulations from Sue-meg State Park and Montaña de Oro State Park show that WTGs closer to shore relative to the location of the visual simulation disrupt the visual experience of the maritime setting of the respective resources.

These examples illustrate the multiple variables involved in the analysis of visual adverse effects and the importance of conducting a careful analysis of project specifics against the unique qualities that qualify each historic property for listing in the NRHP.

BOEM does not anticipate that it will be necessary to prepare visual simulations for each of the historic properties within each project's visual APE. However, it is unlikely that the visual simulations prepared for the PEIS will be sufficient, as project-specific details such as the height and spacing of the WTGs are likely to differ from the Representative Project Design Envelope and the 750-foot (230-meter) and 1,250-foot (330-meter) assumptions used as a basis for creating the PEIS simulations. BOEM will review effects recommendations provided in the COP documents to determine sufficiency, and will consult with federally recognized Tribes, California SHPO, ACHP, and other consulting parties regarding BOEM's preliminary findings of effect.

G.4 Programmatic Mitigation Measures

As an outcome of the NEPA programmatic review of the Humboldt and Morro Bay lease areas, the PEIS for the Humboldt and Morro Bay offshore wind activities includes a list of standard mitigation measures that can be selected in the event that adverse effects on historic properties are identified during project-level review. These measures may also be considered for incorporation into the California PA, depending on how consultation between the signatories progresses.

The types of avoidance measures may include an agreement to completely avoid impacts on known or potential marine cultural resources identified during high-resolution remote-sensing surveys (MM-28). Avoidance buffer zones will be designated for marine cultural resources (i.e., marine archaeological resources and ASLFs) to ensure that any adverse bottom-disturbing activities do not occur near the cultural resources. In the event the known or potential cultural resource or its buffer zones cannot be completely avoided or in the event the cultural resource will be destroyed during construction activities, an archaeological investigation of the resource may be required to further determine appropriate mitigation measures or to completely document the cultural resources prior to the site's disturbance or destruction.

To minimize impacts on marine cultural resources, BOEM may also specify mitigation measures that reduce impacts on sites. This may include the use of specific construction techniques, methods, or technologies/equipment that reduce the amount of seafloor impact or adverse effects on a cultural resource such as MM-19 (Anchoring Plan) and MM-21 (Scour and Cable Protection Plan). In addition, BOEM may specify monitoring and post-review discovery plans to mitigate impacts on ASLFs (MM-31).

To minimize impacts on terrestrial cultural resources, BOEM may specify mitigation measures involving resource avoidance or additional investigation (MM-29). BOEM will establish avoidance criteria for historic properties or unevaluated terrestrial archaeological resources, and if avoidance is not feasible, BOEM will require development of a plan to address any adverse effects on the resource or additional investigations to determine eligibility for the NRHP.

Potential programmatic mitigation measures for visual effects may result in BOEM requesting the lessee to fund a compensatory mitigation fund to address visual impacts on aboveground historic properties related to OCS offshore wind activities (MM-30).

Based on the type of effect and the historic property adversely affected, possible mitigation measures can include the preparation of documentation in accordance with National Park Service guidance (https://www.nps.gov/subjects/heritagedocumentation/index.htm); historic preservation–related activity that could extend a historic property's existence and use following the Secretary of the Interior's Standards for the Treatment of Historic Properties (https://www.nps.gov/orgs/1739/secretary-standards-treatment-historic-properties.htm); and education-related deliverables that enhance the public's understanding of the historic property's original setting and context (e.g., ethnographic research; website highlighting the local community or historic property's history; interpretation of heritage collections; historic preservation planning for that particular historic property or the types of historic properties in a municipality; climate change–related activities that would help extend the use of historic properties that are adversely affected such as a climate change resiliency plan).

BOEM has included measures for avoiding or reducing impacts on historic properties in the PEIS as part of the mitigation measures analyzed in Alternative C. Refer to PEIS Chapter 3, Section 3.4.2, *Cultural Resources*, for a description of these measures. The mitigation measures include procedures for phased identification, post-review discoveries, consideration of standard mitigation measures, and preparation of treatment plans when adverse effects cannot be avoided. BOEM has consulted with the Section 106 consulting parties to receive feedback about the anticipated effectiveness of these measures and to identify any additional measures for inclusion in the Final PEIS.

Appendix H: Background on Underwater Sound

This appendix provides additional context on sources and effects of underwater sound. As of the publication date of this Draft Programmatic Environmental Impact Statement (PEIS), most research on underwater sound and its effects have been focused on the Atlantic Ocean. Notwithstanding, BOEM believes this appendix continues to provide valuable contextual information for this Draft PEIS. BOEM may update and/or expand this appendix with publication of a Final PEIS.

H.1 Sources of Underwater Sound

Ocean sounds originate from a variety of sources. Some come from non-biological sources such as wind and waves, while others come from the movements or vocalizations of marine life (Hildebrand 2009). In addition, humans introduce sound into the marine environment through activities like oil and gas exploration, construction, military sonars, and vessel traffic (Hildebrand 2009). The acoustic environment or "soundscape" of a given ecosystem comprises all such sounds—biological, non-biological, and anthropogenic (Pijanowski et al. 2011). Soundscapes are highly variable across space, time, and water depth, among other factors, due to the properties of sound transmission and the types of sound sources present in each area. A soundscape is sometimes called the "acoustic habitat," as it is a vital attribute of a given area where an animal may live (i.e., habitat) (Hatch et al. 2016).

H.2 Physics of Underwater Sound

Sounds are created by the vibration of an object within its medium (Figure H-1). This movement generates kinetic energy (KE), which travels as a propagating wave away from the sound source. As this wave moves through the medium, the particles undergo tiny back-and-forth movements (particle motion) along the axis of propagation, but the particles themselves do not travel with the wave. Instead, they oscillate in roughly the same location, transferring their energy to surrounding particles. The vibration is transferred to adjacent particles, which are pushed into areas of high pressure (i.e., compression) and low pressure (i.e., rarefaction). Acoustic pressure is a non-directional (i.e., scalar) quantity, whereas particle motion is an inherently directional quantity (i.e., a vector) taking place in the axis of sound transmission. The total energy of the sound wave includes the potential energy (PE) associated with the sound pressure, as well as the KE from particle motion.

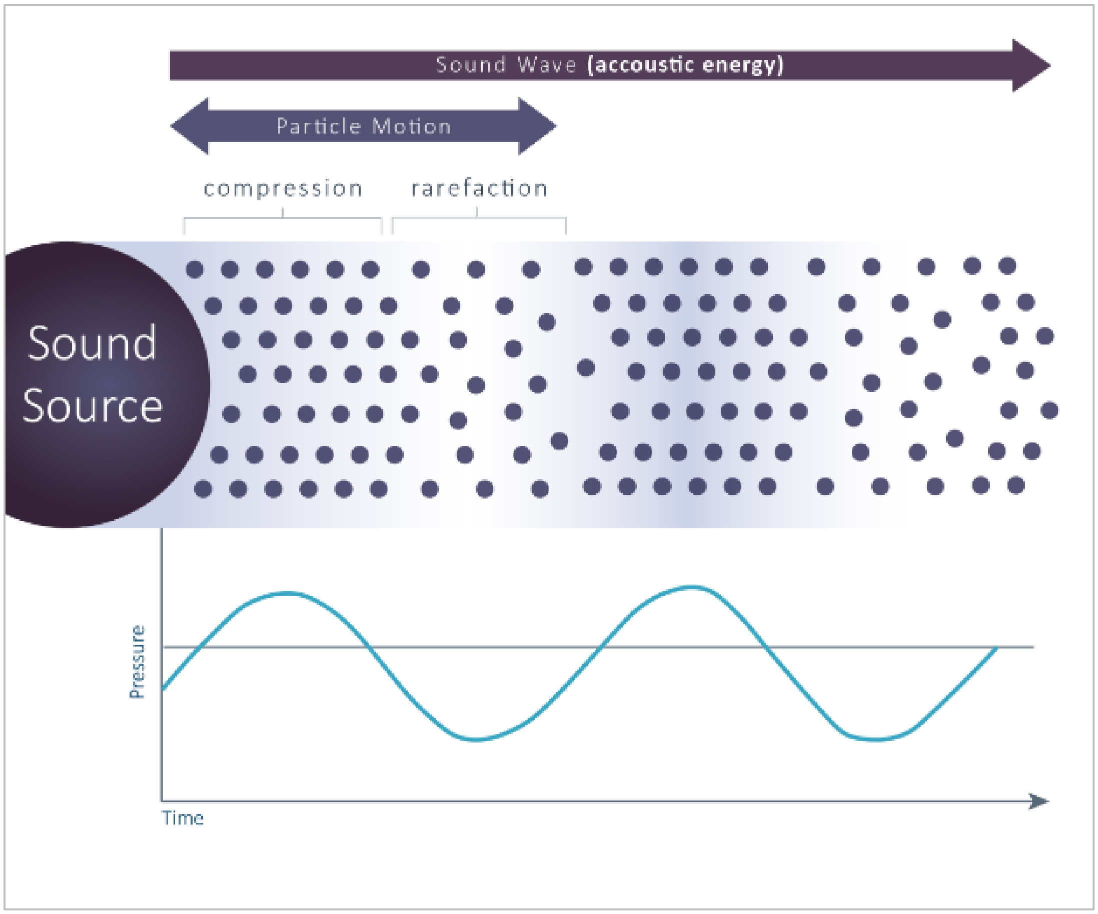

Figure H-1. Basic mechanics of a sound wave

H.2.1 Units of Measurement

Sound can be quantified and characterized based on a number of physical parameters. A complete description of the units can be found in ISO 18405:2017. Some of the major parameters and their International System of Units (SI) units (in parentheses) are as follows.

Acoustic pressure (pascal, Pa): The values used to describe the acoustic (or sound) pressure are peak pressure, peak-to-peak pressure, and root-mean-square (rms) pressure deviation. The peak sound pressure is defined as the maximum absolute sound pressure deviation within a defined time period and is considered an instantaneous value. The peak-to-peak pressure is the range of pressure change from the most negative to the most positive pressure amplitude of a signal (Figure H-2). The rms sound pressure represents a time-averaged pressure and is calculated as the square root of the mean (average) of the time-varying sound pressure over a given period (Figure H-2). The peak level (L_{pk}), peak-to-peak level ($L_{pk\text{-}pk}$), and sound pressure level (L_{rms} or SPL) are computed by multiplying the logarithm of the ratio of the peak or rms pressures to a reference pressure (1 microPascal [µPa] in water) by a factor of 20 and are reported in decibels, see *Sound levels* below.

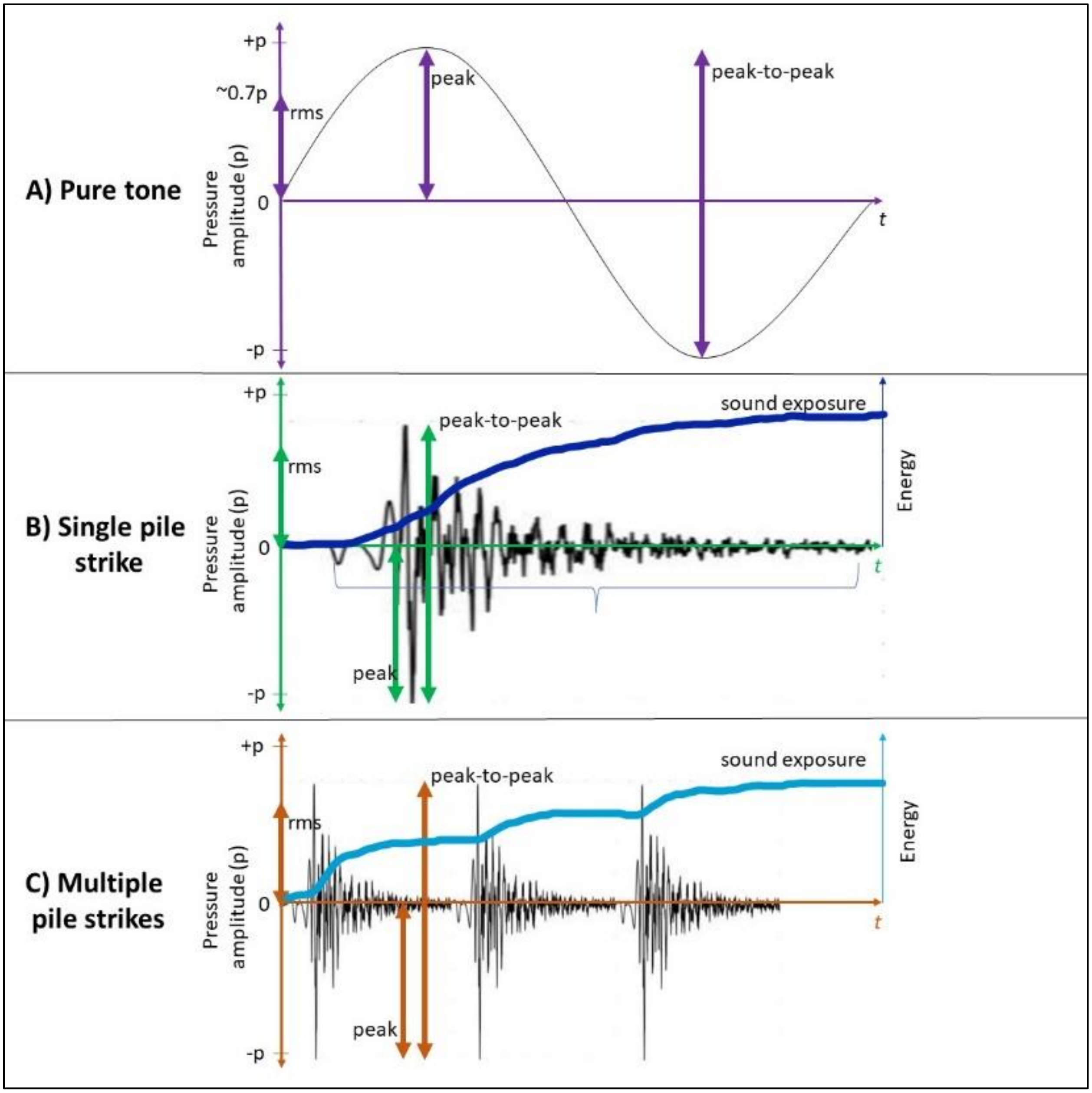

Figure H-2. Sound pressure wave representations of four metrics: root-mean-square (L_{rms}), peak (L_{pk}), peak-to-peak (L_{pk-pk}), and sound exposure level (SEL)

A) A sine wave of a pure tonal signal with equal positive and negative peaks, so peak-to-peak is exactly twice the peak and rms is approximately 0.7 x peak.

B) A single pile-driving strike with one large positive pulse and a large negative pulse that isn't necessarily the same magnitude. In this example, the negative pulse is more extreme so is the reported peak value, and the peak-to-peak is less than double that. Sound exposure is shown as it accumulates across the time window. The final sound exposure would be considered the "single-shot" exposure, and the rms value is that divided by the duration of the pulse.

C) Three consecutive pile-driving strikes with peak and peak-to-peak assessed the same way as in (B). Sound exposure is shown accumulating across all three strikes, and rms is the total sound exposure divided by the entire time window shown. The cumulative sound exposure for this series of signals would be considered the total energy from all three pile-strikes.

Particle velocity (meter per second, m/s): Particle velocity describes the change in position of the oscillating particles about its origin over a unit of time. Similar to sound pressure, particle velocity is dynamic and changes as the particles move back and forth. Therefore, peak particle velocity and root-mean-square particle velocity can be used to describe this physical quantity. One major difference between sound pressure and particle velocity is that the former is a scalar (i.e., without the directional component) and the latter is a vector (i.e., includes both magnitude and direction). Particle acceleration can also be used to describe particle motion; particle motion is defined as the rate of change of velocity of a particle with respect to time. It is measured in units of meters per second squared, or m/s^2.

Sound exposure (pascal-squared second, or Pa^2-s): Sound exposure is proportional to the acoustic energy of a sound. It is the time-integrated squared sound pressure over a stated period or acoustic event (Figure H-2). Unlike sound pressure, which provides an instantaneous or time-averaged value of acoustic pressure, sound exposure is cumulative over a period of time.

Acoustic intensity (watts per square meter, or W/m^2): Acoustic or sound intensity is the amount of acoustic energy that passes through a unit area normal to the direction of propagation per second. It is the product of the sound pressure and the sound velocity. With an idealized constant source, the pressure and particle velocity will vary in proportion to each other at a given location, but the intensity will remain constant.

Sound levels: There is an extremely wide dynamic range of values when measuring acoustic pressure in pascals, so it is customary to use a logarithmic scale to compress the range of values. Aside from the ease it creates for comparing a wide range of values, animals (including humans) perceive sound on a logarithmic scale. These logarithmic acoustic quantities are known as sound levels and are expressed in decibels (dB), which is the logarithmic ratio of the measurement in question to a fixed reference value. Underwater acoustic sound pressure levels are referenced to a pressure of 1 µPa (equal to 10^{-6} pascals [Pa] or 10^{-11} bar). Note: airborne sound pressure levels have a different reference pressure: 20 µPa.

The metrics previously described (sound pressure, sound exposure, and acoustic intensity) can also be expressed as levels, and are commonly used in this way:

- Root-mean-square sound pressure level (L_{rms} or SPL, units of dB re 1 µPa)
- Peak pressure level (L_{pk}, units of dB re 1 µPa)
- Peak-to-peak pressure level (L_{pk-pk}, units of dB re 1 µPa)
- Sound exposure level (SEL, units of dB re 1 $\mu Pa^2 s$)

Note: A few commonly used time periods are used for SEL, including a 24-hour period (used in the United States for the regulation of noise impacts on marine mammals (SEL_{24}), or the duration of a single event, such as a single pile-driving strike or an air gun pulse, called the single strike SEL (SEL_{ss}). A sound exposure for some other period of time, such as the entire installation of a pile, may be written without a subscript (SEL), but to be meaningful, should always denote the duration of the event.

Source level: Another commonly discussed concept is source level. Source level is a representation of the amount of acoustic power radiated from the sound source being described. It describes how loud a particular source is in a way that can inform expected received levels at various ranges. It can be conceptualized as the product of the pressure at a particular location and the range from that location to a spherical (omnidirectional) source in an idealized infinite lossless medium. The source level is the sum of the received level and the propagation loss to that receiver. It is often discussed as what the received level would be 3.3 feet (1 meter) from the source, but this can lead to confusion as an actual measurement at 3.3 feet (1 meter) is likely to be impossible for large or non-spherical sources. The most common type is an SPL source level in units of dB re 1 µPa-m, though in some circumstances a SEL source level (in dB re 1 $\mu Pa^2 s\text{-}m^2$) may be expressed; peak source level (in units of dB re 1 µPa-m) may also be appropriate for some sources.

H.2.2 Propagation of Sound in the Ocean

Underwater sound can be described through a source-path-receiver model. An acoustic source emits sound energy that radiates outward and travels through the water and the seafloor. The sound level decreases with increasing distance from the acoustic source as the sound travels through the environment. The amount by which the sound levels decrease between the theoretical source level and a receiver is called *propagation loss.* Among other things, the amount of propagation loss that occurs depends on the source-receiver separation, the geometry of the environment the sound is propagating through, the frequency of the sound, the properties of the water column, and the properties of the seafloor and sea surface.

When sound waves travel through the ocean, they may encounter areas with different physical properties that will likely alter the propagation pathway of the sound, compared to a homogenous and boundaryless environment. For example, near the ocean's surface, water temperature is usually higher, resulting in relatively fast sound speeds. As temperature decreases with increasing depth, the sound speed decreases. Sounds bend toward areas with lower speeds (Urick 1983). Ocean sound speeds are often slowest at mid-latitude depths of about 3,281 feet (1,000 meters), and because of sound's preference for lower speeds, sound waves above and below this "deep sound channel" often bend towards it. Sounds originating in this layer can travel great distances. Sounds can also be trapped in the mixed layer near the ocean's surface (Urick 1983). Latitude, weather, and local circulation patterns influence the depth of the mixed layer, and the propagation of sounds near the surface is highly variable and difficult to predict.

At the boundaries near the sea surface and the sea floor, acoustic energy can be scattered, reflected, or attenuated depending on the properties at the surface (e.g., roughness, presence of wave activity, or bubbles) or seafloor (e.g., bathymetric features, substrate heterogeneity). For example, fine-grain sediments tend to absorb sounds well, while hard bottom substrates reflect much of the acoustic energy back into the water column. The presence of ice on the ocean's surface can also affect sound propagation. For example, the presence of solid ice may dampen sound levels by blocking surface winds. The presence of ice can also increase sound levels when pieces of ice break or scrape together (Urick 1983). The effect will also depend on the thickness and roughness of the ice, among many other factors related to the ambient conditions. As a sound wave moves from a source to a receiver (i.e., an animal), it may travel on multiple pathways that may be direct, reflected, refracted, or a combination of these mechanisms, creating a complex pattern of transmission across range and depth. The patterns may become even more complicated in shallow waters due to repeated interactions with the surface and the bottom, frequency-specific propagation, and more heterogenous seafloor properties. All of these variables contribute to the difficulty in reliably predicting the sound field in a given marine environment at any particular time.

H.2.3 Sound Source Classification

In the current regulatory context, anthropogenic sound sources are divided into four types: impulsive, non-impulsive, continuous, and intermittent, based on their differing potential to affect marine species (NMFS 2018). Specifically, when it comes to potential damage to marine mammal hearing, sounds are classified as either impulsive or non-impulsive, and when considering the potential to affect behavior or acoustic masking, sounds are classified as either continuous or intermittent.

Impulsive noises are characterized as having (ANSI S1.13-2005, Finneran 2016):

- Broadband frequency content
- Fast rise-times and rapid decay times
- Short durations (i.e., <1 s)
- High peak sound pressures

Whereas the characteristics of non-impulsive sound sources are less clear but may be:

- Variable in spectral composition (i.e., broadband, narrowband, or tonal)
- Longer rise-time/decay times, and total durations compared to an impulsive sound
- Continuous (e.g., vessel engine radiated noise), or intermittent (e.g., echosounder pulses).

It is generally accepted that sources like explosions, air guns, sparkers, boomers, and impact pile driving are impulsive and have a greater likelihood of causing hearing damage than non-impulsive sources. Impulsive sounds are more likely to induce physiological effects, including temporary threshold shift (TTS) and permanent threshold shift (PTS), than non-impulsive sounds with the same energy. This binary, at-the-source classification of sound types, therefore, provides a conservative framework upon which to predict potential adverse hearing impacts on marine mammals.

For behavioral effects of anthropogenic sound on marine mammals, the National Marine Fisheries Service (NMFS) classifies sound sources as either intermittent or continuous (NMFS 2018). Continuous sounds, such as drilling or vibratory pile-driving, remain “on,” i.e., above ambient noise, for a given period of time, though this is not well-defined. An intermittent sound typically consists of bursts or pulses of sound on a regular on-off pattern, also called the duty-cycle. Examples of intermittent sounds are those from scientific echosounders, sub-bottom profilers, and even pile-driving. It is important to recognize that these delineations are not always practical in application, as a continuous yet moving sound source (such as a vessel passing over a fixed receiver) could be considered intermittent from the perspective of the receiver.

In reality, animals will encounter many signals in their environment that may contain many or all of these sound types, called complex sounds. And even for sounds that are impulsive at the source, as the signal propagates through the water, the degree of impulsiveness decreases (Martin et al. 2020). While there is evidence, at least in terrestrial mammals (Hamernik and Hsueh 1991), that complex sounds can be more damaging than continuous sounds, there is not currently a regulatory category for this type of sound. One current approach for assessing the impulsiveness of a sound that has gained attention is to compute the *kurtosis* of that signal. Kurtosis is a statistical measure that describes the prevalence of extreme values within a distribution of observations, in other words the "spikiness" of the data. By definition, a sound with a kurtosis value of 3 or less has very few extreme values and is generally considered *Gaussian* (i.e., normally distributed) noise. Martin et al. (2020) showed that a kurtosis value greater than 40 represents a distribution of observations with many extreme values and is very spiky. This generally describes an impulsive noise. A distribution of sound level observations from a time series with a kurtosis value somewhere in between these two values would be considered a complex sound.

H.3 Sound Sources Related to Offshore Wind Development

H.3.1 Geophysical and Geotechnical Surveys

Geophysical and geotechnical surveys are conducted to characterize the bathymetry, sediment type, and benthic habitat characteristics of the marine environment. They may also be used to identify archaeological resources or obstacles on the seafloor. These types of surveys occur in the site assessment phase to inform the placement of offshore wind foundations but may also occur intermittently during and after turbine construction to identify, guide, and confirm the locations of turbine foundations. The suite of high-resolution geophysical (HRG) sources that may be used in geophysical surveys includes side-scan sonars (SSS), multibeam echosounders (MBES), magnetometers and gradiometers, parametric sub-bottom profilers, compressed high-intensity radiated pulses (CHIRP) sub-bottom profilers, boomers, and sparkers. Seismic airguns are not expected to be used for offshore wind applications. These HRG sources may be towed behind a ship, mounted on a ship's hull, or deployed from remotely operated vehicles (ROVs) or autonomous underwater vehicles (AUVs).

Many HRG sources are active acoustic sources, meaning they produce sound deliberately to obtain information about the environment. With the exception of some MBES and SSS, they produce sounds below 180 kilohertz (kHz) and thus may be audible to marine species. Source levels vary widely depending on source type and operational power level used, from ~145 dB re 1 µPa-m for towed sub-bottom profilers up to 245 dB re 1 µPa-m for some multibeam echosounders (Crocker and Fratantonio 2016). Generally speaking, sources that emit sound in narrow beams directed at the seafloor are less likely to affect marine species because they ensonify a smaller portion of the water column, thus reducing the likelihood that an animal encounters the sound (Ruppel et al. 2022). While sparkers are omnidirectional, most other HRG sources have narrower beamwidths (e.g., MBES: up to 6°, parametric

SBPs: 30°, boomers: 30–90°) (Crocker and Fratantonio 2016). Most HRG sources emit short pulses of sound, with periods of silence in between. This means that only several “pings” emitted from a vessel towing an active acoustic source would reach an animal below, even if the animal was stationary (Ruppel et al. 2022). HRG surveys may occur throughout the construction area with the potential for greater effort in some areas.

Geotechnical surveys may use vibracores, jet probes, bottom-grab samplers, deep borings, or other methods to obtain samples of sediments at each potential turbine location and along the cable route. For most of these methods, source levels have not been directly measured, available data for vibracores indicate this equipment will produce low-frequency (<3 kHz), non-impulsive noise with a back-calculated SPL source level of 187.4 dB re 1 µPa-m (Chorney et al. 2011), and it is generally assumed that low-frequency, low-level noise will be introduced as a byproduct of all other activities given the nature of the equipment (BOEM 2023). It is likely that the sound of the vessel will exceed that generated by the geotechnical method itself.

The potential impacts of geophysical and geotechnical surveys during construction activities on marine mammals and sea turtles are analyzed in Chapter 3, *Affected Environment and Environmental Consequences,* of the PEIS.

H.3.2 Unexploded Ordnance Detonations

Unexploded Ordnances (UXOs) may be discovered on the seabed in offshore wind lease areas or along export cable routes. While non-explosive methods may be employed to lift and move these objects, some may need to be detonated. Underwater explosions of this type create a shock wave with a nearly instantaneous rise in pressure, followed by a series of symmetrical bubble pulses. Shock waves are supersonic, so they travel faster than the speed of sound. The explosive sound field is extremely complex, especially in shallow waters. In 2015, (von Benda-Beckmann et al. 2015) measured received levels of explosions in shallow waters at distances ranging from 328–6,562 feet (100–2,000 meters) from the source, in water depths ranging from 20–72 feet (6–22 meters). The measured SEL from the explosive removal of a 263 kilogram (kg) charge was 216 dB re 1 μPa^2 s at a distance of 100 meters and 196 dB re 1 μPa^2 s at 6,562 feet (2,000 meters). They found that SELs were lower near the surface than near the seafloor or in the middle of the water column, suggesting that if an animal is near the surface, the effects may be less damaging. Most of the acoustic energy for underwater explosions is below 1,000 hertz (Hz). The potential impacts of UXO detonations on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

As an alternative to traditional detonation, a newer method called deflagration allows for the controlled burning of underwater ammunition. Typically, an ROV uses a small, targeted charge to initiate rapid burning of the ordnance; once this process is complete, the remaining debris can be cleared away. Recent work has demonstrated that both L_{pk} and SEL measured from deflagration events may be as much as 20 dB lower than equivalently sized high-order detonations (Robinson et al. 2020).

To predict potential UXO impacts on marine species, several models have been developed. Goertner (1982) developed a model for physical injuries to cetaceans at a range of depths. NMFS recommends a modified version of this model for predicting injury impacts on marine mammals (NMFS 2023a). In 2022, Hannay and Zykov modeled the distance to NMFS auditory exceedance thresholds (refer to Chapter 3, Section 3.3.6.1.3, *The Importance of Sound to Marine Mammals*, for further detail on thresholds) for five species groups (low-, mid-, and high-frequency cetaceans; phocid pinnipeds; otariid pinnipeds/sea turtles) exposed to UXO detonations of various charge masses at four sites in the Revolution Wind Project area. Modeled distances to auditory injury thresholds (i.e., PTS PK or SEL noise metrics) were larger than modeled distances to mortality and non-auditory injury criteria for UXOs. Maximum mortality and non-auditory injury ranges, based on worst case scenario modeling (i.e., charge category Navy bin E12; 1,000 pound [454 kilogram] equivalent weight), was estimated for porpoise pup/calf mortality at 2,848 feet (868 meters); for non-auditory injury (lung injury) at 4,980 feet (1,518 meters) for porpoises pup/calf; and for gastrointestinal injury at 1,178 feet (359 meters) for all marine mammal species (Hannay and Zykov 2022). The largest auditory effect ranges were predicted for high-frequency cetaceans exposed to a 1,000-pound (454-kilogram) detonation (the largest charge mass modeled) and ranged from 7.0 miles (11.3 kilometers) for PTS to 12.6 miles (20.2 kilometers) for TTS (Hannay and Zykov 2022). An individual explosion is nearly instantaneous; therefore, behavioral effects, if any, would be short term and highly contextual.

H.3.3 Construction

H.3.3.1 Impact and Vibratory Pile-Driving

Impact and vibratory pile driving may be used during construction of the California offshore wind projects, including the sea-to-shore export cable connection and the tension leg platform (TLP) foundation.

Impact pile-driving employs a hammer to strike the pile head and force the pile into the sediment with a typical hammer strike rate of approximately 30 to 50 strikes/minute (sm). Typically, force is applied over a period of less than 20 sm, but the pile can generate sound for upwards of 0.5 s. Pile-driving noise is characterized as impulsive because of its high peak pressure, short duration, and rapid onset time. Underwater sound levels generated during pile driving depend on many factors including the pile material and size, characteristics of the substrate, penetration of the pile in the seabed, hammer energy and size, and water depth. The propagation of pile-driving sounds depends on factors such as the sound speed in the water column (influenced by temperature, salinity, and depth), the bathymetry, and the composition of sediments in the seabed, and will therefore vary among sites. Due to variation in these features, sounds may not radiate symmetrically outward from a pile.

Vibratory hammers may be used in combination with, or as an alternative to impact pile-driving. The vibratory hammer continuously exerts vertical vibrations into the pile, which causes the sediment surrounding the pile to liquefy, allowing the pile to penetrate the substrate. The vibratory hammer typically oscillates at a frequency of 20 to 40 Hz (Matuschek and Betke 2009) and produces most of its acoustic energy below 2 kHz.

The sea-to-shore export cable connection may include installation of temporary steel casing pipes (goal posts) and/or steel sheet piles (cofferdams) to accommodate the conduit used for pulling the cable from the seabed through to the shore after HDD. This activity usually occurs within a few kilometers from shore. Piles would be driven using a combination of vibratory and impact driving methods. Upon completion of the cable connection, all piles would be removed using vibratory methods. In a review of MMPA applications for offshore wind construction, goal post piles ranged from 42 to 46 inches in size (88 FR 22696; 88 FR 28656; 88 FR 72562). Installation of all piles is typically completed in 10 to 60 days (depending on the number of goal posts or cofferdams required) with less than 4 hours of active piling during any single day. Removal time is comparable to the time required to install.

Piles associated with TLP foundations may driven by an underwater impact or vibratory hammer comparable to what is used in pile driving performed above the sea surface. Other seabed installation methods include use of suction piles, helical pile group anchors, drilled piles, or ECO-TLP which would not require traditional hammering of foundation template piles and therefore would produce lesser acoustic impacts than installation using impact or vibratory hammering of traditional TLP piles. For TLP installation using vibratory or impact hammering, pile sizes will vary by structural design but are typically between 3.3 and 9.8 feet (1 and 3 meters) diameter (DNVGL-ST-0119). There are no measurement data available for TLP piling, but ranges to thresholds can be estimated by the pile size using NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx). The calculator tool does not provide input data on maximum TLP pile size or source level data from deep water piling; however, using maximal proxy data in the calculator tool can provide magnitude-level impact ranges. Notably, the underwater hammering will result in different propagation physics, but at this time no measurements or modeling for TLP piling in deep water are available. This analysis used the NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx) to identify ranges to thresholds for potential piling associated with TLP foundations. Source levels for each pile and installation type were obtained from the proxy sound level tabs within the calculator tool, with the assumption that up to 2 piles would be installed per day requiring up to 6,409 strikes per pile for impact pile driving, and 30 minutes of vibratory hammering per pile for installation, based on assumptions for comparable projects. There was no proxy data available for impact pile driving for a 54-inch (1.3-meter) pile, so data for a 60-inch (1.5-meter) pile was used instead. Similarly, there was no proxy data available for vibratory pile driving for a 54-inch (1.3-meter) or a 96-inch (2.4-meter) pile, so data for a 66-inch (1.7-meter) and a 72-inch (1.8-meter) pile were used instead. Results for all pile types and sizes for impact and vibratory pile driving are summarized in Table H-1 through Table H-4.

Table H-1. Estimated distances to thresholds[1] for marine mammals, sea turtles, and fish during impact pile driving of a 54-inch (1.3-meter) TLP pile with no noise mitigation

Faunal Group	PTS Lpk Threshold Distance (m)	PTS SEL_{24h} Threshold Distance (m)	Behavioral Disturbance Threshold Distance (m)
LFC	2.5	7,435.1	2,154.4
MFC	0.5	264.4	2,154.4
HFC	34.1	8,856.3	2,154.4
Phocid pinnipeds	2.9	3,978.9	2,154.4
Otariid pinnipeds and other marine carnivores	0.3	289.7	2,154.4
Sea turtles	0.3	296.6	215.4
Fish ≥2 g	18.5[2]	2,154.4[2]	10,000
Fish <2 g	18.5[2]	2,154.4[2]	10,000

[1] Distances calculated using the NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx).
[2] There are no thresholds for fish focused on auditory injury; rather the threshold distances provided here are for non-auditory/physical injury and not PTS.
HFC = high-frequency cetacean; LFC = low-frequency cetacean; Lpk = peak sound pressure level in units of decibels referenced to 1 micropascal; MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = cumulative sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; TLP = tension leg platform.

Table H-2. Estimated distances to thresholds[1] for marine mammals, sea turtles, and fish during impact pile driving of a 96-inch (2.4-meter) TLP pile with no noise mitigation

Faunal Group	PTS Lpk Threshold Distance (m)	PTS SEL_{24h} Threshold Distance (m)	Behavioral Disturbance Threshold Distance (m)
LFC	11.7	34,510.5	10,000
MFC	2.2	1,227.4	10,000
HFC	158.5	41,107.4	10,000
Phocid pinnipeds	13.6	18,468.4	10,000
Otariid pinnipeds and other marine carnivores	1.6	1,344.7	10,000
Sea turtles	1.6	1,376.8	1,000
Fish ≥2 g	85.8[2]	10,000[2]	46,415.9
Fish <2 g	85.8[2]	10,000[2]	46,415.9

[1] Distances calculated using the NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx).
[2] There are no thresholds for fish focused on auditory injury; rather the threshold distances provided here are for non-auditory/physical injury and not PTS.
HFC = high-frequency cetacean; LFC = low-frequency cetacean; Lpk = peak sound pressure level in units of decibels referenced to 1 micropascal; MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = cumulative sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; TLP = tension leg platform.

Table H-3. Estimated distances to thresholds[1] for marine mammals, sea turtles, and fish during vibratory pile driving of a 54-inch (1.3-meter) TLP pile with no noise mitigation

Faunal Group	PTS SEL_{24h} Threshold Distance (m)	Behavioral Disturbance Threshold Distance (m)
LFC	8.0	6,309.6
MFC	0.7	6,309.6
HFC	11.8	6,309.6
Phocid pinnipeds	4.8	6,309.6
Otariid pinnipeds and other marine carnivores	0.3	6,309.6
Sea turtles	0.3	1.4
Fish ≥2 g	NA[2]	63.1
Fish <2 g	NA[2]	63.1

[1] Distances calculated using the NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx).
[2] There are no thresholds for fish focused on auditory injury for non-impulsive; rather the available threshold are for non-auditory/physical injury and not PTS. Therefore, the non-auditory/physical injury thresholds for impulsive sources applied for impact pile driving in the tables above would also apply for vibratory pile driving.
HFC = high-frequency cetacean; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = cumulative sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; TLP = tension leg platform.

Table H-4. Estimated distances to thresholds[1] for marine mammals, sea turtles, and fish during vibratory pile driving of a 96-inch (2.4-meter) TLP pile with no noise mitigation

Faunal Group	PTS SEL_{24h} Threshold Distance (m)	Behavioral Disturbance Threshold Distance (m)
LFC	126.2	100,000
MFC	11.2	100,000
HFC	186.6	100,000
Phocid pinnipeds	76.7	100,000
Otariid pinnipeds and other marine carnivores	5.4	100,000
Sea turtles	5.1	21.5
Fish ≥2 g	NA[2]	1,000
Fish <2 g	NA[2]	1,000

[1] Distances calculated using the NMFS Multi-Species Calculator Tool (Excel Multispecies calculator MarineMammals)https://www.fisheries.noaa.gov/s3/2023-10/Acousticwebpage-multispeciescalculator-MarineMammals-OPR1.xlsx).
[2] There are no thresholds for fish focused on auditory injury for non-impulsive; rather the available threshold are for non-auditory/physical injury and not PTS. Therefore, the non-auditory/physical injury thresholds for impulsive sources applied for impact pile driving in the tables above would also apply for vibratory pile driving.
HFC = high-frequency cetacean; LFC = low-frequency cetacean; MFC = mid-frequency cetacean; PTS = permanent threshold shift; SEL_{24h} = cumulative sound exposure level over 24 hours in units of decibels referenced to 1 micropascal squared second; TLP = tension leg platform.

There are no accepted threshold ranges for the onset of physical injury in fish for non-impulsive sources, so the results for the thresholds provided above for impact pile driving are applied for vibratory pile driving as well. Additionally, for sea turtles and fish, there are only one set of behavioral disturbance thresholds which apply to both impulsive and non-impulsive sound sources, so differences in the threshold ranges between impact and vibratory pile driving are driven by differences in the source levels between these two activities. Finally, the NMFS Multi-Species Calculator Tool does not account for local bathymetric and oceanographic features that would influence underwater sound propagation which are not known for this programmatic assessment. Site-specific information used in a project-specific model would likely alter the predicted threshold ranges for all species, but this will not be conducted until future project-specific consultations are initiated.

Various noise abatement technologies, such as bubble curtains, arrays of enclosed air resonators, or segmented nets of rubber or foam, may be employed to reduce noise from impact pile-driving. Measurements from European wind farms have shown that a single noise abatement system can reduce broadband sound levels by 10–15 dB, while using two systems together can reduce sound levels as much as 20 dB (Bellmann et al. 2020). Approximate sound level reduction is 3 to 5 dB below 200 Hz, and 8 to 20 dB above 200 Hz, depending on the characteristics of the bubble curtain (Amaral et al. 2020). While the pile sizes and environment for California offshore wind projects will differ slightly, the general estimates in noise reduction when using noise abatement technology are still expected to apply.

H.3.3.2 Drilling

Drilling may be used during installation of anchoring piles (seabeds of lease areas) and HDD at export cable landfalls. Drilling sounds are generally considered to be non-impulsive and are nearly continuous in nature, though they may be highly variable depending on the type of substrate that is encountered (Richardson et al. 1995). There could be tonal sound generated by the drill bit, mechanical noise transferred through the ship's hull, and noise from the vessels and dynamic positioning systems. HDD uses equipment that is generally located on shore, and the sound that propagates into the water is expected to be negligible. Geotechnical drilling SPLs (in the 30–2000 Hz band) have been measured up to 145 dB re 1 µPa m from a jack-up platform (Erbe and McPherson 2017), and up to 162 dB re 1 µPa m from an anchored drilling vessel (Huang et al. 2023). If drilling is required for anchor installation, it is likely the type of drill used would differ from those used for geotechnical drilling. While measurements of these operations specifically for offshore floating wind anchor installation have not been conducted, the closest proxy is from oil and gas-related operations, where a 19.6-foot (6-meter)-diameter drill bit was used for the excavation of mudline cellars (Austin et al. 2018). Austin et al. (2018) measured received levels at 3,280 feet (1,000 meters) from the operations and back-calculated the SPL source levels to be between 191 and 193 dB re 1 µPa m.

H.3.3.3 Vessels

During construction, vessels and aircraft may be used to transport crew and equipment. See Section H.3.4, *Operations and Maintenance,* for further detail about sounds related to those activities. Large vessels will also be used during the construction phase to conduct pile-driving, and may use Dynamic

Positioning (DP) systems. DP is the process by which a vessel holds station over a specific seafloor location for some time period using input from gyrocompasses, motion sensors, Global Positioning Systems (GPS), active acoustic positioning systems, and wind sensors to determine relative movement and environmental forces at work. Generally speaking, most acoustic energy is <1,000 Hz, often below 50 Hz, with tones related to engine and propeller size and type. The sound can also vary directionally, and this directionality is much more pronounced at higher frequencies. Because this is a dynamic operation, the sound levels produced will vary based on the specific operation, DP system used (e.g., jet or propeller rotation, versus a rudder or steering mechanism), and factors such as the blade rate and cavitation, in some cases. Representative sound field measurements from the use of DP are difficult to obtain because the sound transmitted is often highly directional and context specific. The direction of sound propagation may change as different DP needs requiring different configurations are applied.

Many studies have found that the measured sound levels of DP alone are, counterintuitively, higher than those of DP combined with the intended activities such as drilling (Jiménez-Arranz et al. 2020; Kyhn et al. 2011; Nedwell and Edwards 2004) and coring (Warner and McCrodan 2011). Nedwell and Edwards (2004) reported that DP thrusters of the semi-submersible drill rig *Jack Bates* produced periodic noise (corresponding to the rate of the thruster blades) with most energy between 3 and 30 Hz. The received SPL measured at 328 feet (100 meters) from the vessel was 188 dB re 1 µPa. Warner and McCrodan (2011) found that most DP-related sounds from the self-propelled drill ship, R/V *Fugro Synergy* were in the 110 to 140 Hz range, with an estimated source level of 169 dB re 1 µPa-m. Sounds in this frequency range varied by 12 dB during DP, while the broadband levels, which also included diesel generators and other equipment sounds, varied by only 5 dB over the same time period. All of the above sources report high variability in levels with time. This is due in part to the intermittent usage and relatively slow rotation rates of thrusters used in DP. It is also difficult to provide a realistic range of source levels from the data thus far because most reports do not identify the direction from which sound was measured relative to the vessel, and DP thrusters are highly directional systems.

The active acoustic positioning systems used in DP can be additional sources of high frequency sound. These systems usually consist of a transducer mounted through the vessel's hull and one or more transponders affixed to the seabed. The Kongsberg High Precision Acoustic Positioning (HiPAP) system produces pings in the 10 to 32 kHz frequency range. The hull-mounted transducers have source levels of 188 to 206 dB re 1 µPa-m depending on adjustable power settings (Kongsberg Maritime AS 2013). The fixed transponders have maximum source levels of 186 to 206 dB re 1 µPa-m depending on model and beam width settings from 15 to 90° (Jiminez-Arranz et al. 2020). These systems have high source levels, but beyond 1.2 miles (2 kilometers), they are generally quieter than other sound components from DP vessels for various reasons including: their pulses are produced in narrowly directed beams, each individual pulse is very short, and their high frequency content leads to faster attenuation. The potential impacts of vessel noise on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

H.3.3.4 Site Preparation

Prior to offshore wind project foundation and export cable installation, boulder clearance and pre-lay grapnel runs may be conducted to clear the area of obstructions. This may involve the use of a displacement plow, a subsea grab or, in shallower waters, a backhoe dredger. Sandwave clearance may also be conducted in advance of export cable installation to remove mobile sediments using a suction hopper dredger, controlled flow excavation, or plow. At landfall locations, export cables may be installed using HDD, which may require mechanical dredging of the HDD exit pit.

Sounds from site preparation activities are considered non-impulsive and are nearly continuous in nature. Dredging produces distinct sounds during each specific phase of operation: excavation, transport, and placement of dredged material (Central Dredging Association 2021; Jiminez-Arranz et al. 2020). Engines, pumps, and support vessels used throughout all phases may introduce low-level, continuous noise into the marine environment. The sounds produced during excavation vary depending on the sediment type—the denser and more consolidated the sediment is, the more force the dredger needs to impart, and the higher sound levels that are produced (Robinson et al. 2011). Sounds from mechanical dredges occur in intervals as the dredge lowers a bucket, digs, and raises the bucket with a winch. During the sediment transport phase, many factors—including the load capacity, draft, and speed of the vessel—influence the sound levels that are produced (Reine et al. 2014). SPL source levels during backhoe dredge operations range from 163 to 179 dB re 1 µPa-m (Nedwell et al. 2008; Reine et al. 2012). As a whole, dredging activities generally produce low-frequency sounds, with most energy below 1,000 Hz and frequency peaks typically occurring between 150 and 300 Hz (McQueen et al. 2018). Additional detail and measurements of dredging sounds can be found in Jiminez-Arranz et al. (2020), McQueen et al. (2018), and Robinson et al. (2011).

The potential impacts of site preparation activities on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

H.3.3.5 Trenching and Cable-Laying

Cable installation can be done by towing a tool behind a vessel to simultaneously open the seabed and lay the cable, or by laying the cable and following with a tool to embed the cable. Possible methods for these options include jetting, vertical injection, control flow excavation, trenching, and plowing. Burial depth of the cables is typically 3.3–9.8 feet (1–2 meters). Cable installation vessels may use dynamic positioning to lay the cables, which can introduce considerable levels of noise into the marine environment (Section H.3.3.3, *Vessels*).

Nedwell and Edwards (2004) measured sounds from a 426.5-foot (130-meter)-long trenching vessel and found that sound levels were similar to those produced during pipeline-laying in the same area, with the exception of a 20 kHz tonal sound, which they attributed to the vessel's DP thrusters. Nedwell et al. (2003) recorded underwater sound 525 feet (160 meters) away from trenching activity (water depth 7–11 meters) and back-calculated the SPL source level of trenching to be 178 dB re 1 µPa-m (assuming propagation loss of 22logR). They described the sound as generally spanning a wide range of frequencies, variable over time, and accompanied by some tonal machinery noise and transient noises associated with rock breakage.

Johansson and Andersson (2012) recorded underwater noise levels during both pipelaying and trenching. The mean SPL measured (at 1,500 meters from the pipeline) during pipelay operations was 130.5 dB re 1 µPa, nearly 20 dB higher than average background noise at the same location. There were eight support vessels in the vicinity during pipelaying operations. During trenching, with only one vessel in the vicinity, received levels were 126 dB re 1 µPa, and the authors back-calculated the SPL source level to be 183.5 dB re 1 µPa, similar to that of commercial vessels in the region.

H.3.4 Operations and Maintenance

H.3.4.1 Aircraft

Staffed aircraft consist of propeller and jet engines, fixed-wing craft, as well as helicopters. Unmanned systems also exist. For jet engine aircraft, the engine is the primary source of sound. For propeller driven aircraft and helicopters, the propellors and rotors also produce noise. Aircraft generally produce low-frequency sound below 500 Hz (Richardson et al. 1995). While aircraft noise can be substantial in air, penetration of aircraft noise into the water is limited because much of the noise is reflected off the water’s surface (Richardson et al. 1995). The noise that penetrates into the water column does this via a critical incident angle or cone. With an idealized flat sea surface, the maximum critical incident angle is ~13 degrees (Urick 1983); beyond this, sound is reflected off the surface. When the sea surface is not flat, there may be some additional penetration into the water column in areas outside of this 13-degree cone. Nonetheless, the extent of noise from passing aircraft is more localized in water than it is in air.

Jiménez-Arranz et al. (2020) reviewed Richardson et al.’s (1995) sound measurements recorded below passing aircraft of various models. These SPL measurements included 124 dB re 1 µPa (dominant frequencies between 56 and 80 Hz) from a maritime patrol aircraft with an altitude of 76 meters, 109 dB re 1 µPa (dominant frequency content below 22 Hz) from a utility helicopter with an altitude of 152 meters, and 107 dB re 1 µPa (tonal, 82 Hz) from a turbo propeller with an altitude of 457 meters. Recent published levels associated with unmanned aircraft (Christiansen et al. 2016; Erbe et al. 2017) indicate source levels around or below 100 dB re 1 µPa-m. The potential impacts of aircraft noise on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

H.3.4.2 Vessels in Transit

During operations, small vessels may be used to transport crew and supplies. Noise from vessel transit is considered to be continuous, with a combination of broadband and tonal sounds (Richardson et al. 1995; Ross 1976). Transiting vessels generate continuous sound from their engines, propeller cavitation, onboard machinery, and hydrodynamics of water flows (Ross 1976). The actual radiated sound depends on several factors, including the type of machinery on the ship, the material conditions of the hull, how recently the hull has been cleaned, interactions with the sea surface, and shielding from the hull, which reduces sound levels in front of the ship.

In general, vessel noise increases with ship size, power, speed, propeller blade size, number of blades, and rotations per minute. Source levels for large container ships can range from 177 to 188 dB re 1 µPa-m (McKenna et al. 2013) with most energy below 1 kHz. Smaller vessels typically produce higher-frequency sound concentrated in the 1 to 5 kHz range. Kipple and Gabriele (2003) measured underwater sound from vessels ranging from 14 to 65 feet long (25 to 420 horsepower) and back-calculated source levels to be 157 to 181 dB re 1 µPa-m. Similar levels are reported by Jiménez-Arranz et al. (2020), who provide a review of measurements for support and crew vessels, tugs, rigid hull inflatable boats, icebreakers, cargo ships, oil tankers, and more.

During transit to and from shore bases, survey vessels typically travel at speeds that optimize efficiency, except in areas where transit speed is restricted. The vessel strike speed restrictions that are in place along the Atlantic OCS are expected to offer a secondary benefit of underwater noise reduction. For example, recordings from a speed reduction program in the Port of Vancouver (210- to 250-meter water depths) showed that reducing speeds to 11 knots reduced vessel source levels by 5.9 to 11.5 dB, depending on the vessel type (MacGillivray et al. 2019). Vessel noise is also expected to be lower during geological and geophysical surveys, as they typically travel around 5 knots when towing instruments. The potential impacts of vessel noise on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

H.3.4.3 Turbine Operations

Once windfarms are operational, low-level sounds are generated by each wind turbine generator (WTG), but sound levels are much lower than during construction. This type of sound is considered to be continuous, omnidirectional radially from the pile, and non-impulsive. Most of the energy associated with operations is below 120 Hz. Sound levels from wind turbine operations are likely to increase somewhat with increasing generator size and power ratings, as well as with wind speeds. Recordings from BIWF indicated that there was a correlation between underwater sound levels and increasing wind speed, but this was not clearly influenced by turbine machinery; rather it may have been explained by the natural effects that wind and sea state have on underwater sound levels (Elliott et al. 2019; Urick 1983).

A recent compilation (Tougaard et al. 2020) of operational noise from several wind farms, with turbines up to 6.15 megawatts (MW) in size, showed that operational noise generally attenuates rapidly with distance from the turbines, falling to near ambient sound levels within ~1 kilometer from the source; the combined noise levels from multiple turbines is lower or comparable to that generated by a small cargo ship. Tougaard et al. (2020) developed a formula predicting a 13.6 dB increase for every 10-fold increase in WTG power rating. This means that operational noise could be expected to increase by 13.6 dB when increasing in size from a 0.5 MW turbine to a 5 MW one, or from 1 MW to 10 MW. The least squares fit of that dataset would predict that the SPL measured 100 meters from a hypothetical 15 MW turbine in operation in 10 meters per second (19 kilotons [kt] or 22 miles per hour [mph]) wind would be 125 dB re 1 µPa. However, all of the 46 data points in that dataset, with the exception of the two from BIWF, were from WTGs operated with gear boxes of various designs rather than the newer use of direct drive technology, which is expected to lower underwater noise levels significantly. Stöber and Thomsen (2021) make predictions for source levels of 10 MW turbines based on a linear extrapolation of maximum received levels from WTGs with ratings up to 6.15 MW. The linear fit is likely inappropriate, and the resulting predictions may be exaggerated. Tougaard et al. (2020) point out that received level differences among different pile types could be confounded by differences in water depth and turbine size. In any case, additional data are needed to fully understand the effects of size, foundation type properties (e.g., structural rigidity and strength), and drive type on the amount of sound produced during turbine operation. The potential impacts of operational turbine noise on marine mammals and sea turtles are analyzed in PEIS Chapter 3.

Efforts to measure operational noise have focused on fixed-bottom WTGs (Farr et al. 2021), though a recent study characterized operational noise from floating WTG in Scotland (Risch et al. 2023) and showed that operational sounds from floating turbines were concentrated in the frequencies below 200 Hz and seem to change with blade rotational speed and mooring structures (Risch et al. 2023; Maxwell et al. 2022). At semisubmersible foundations, sounds ranged between 50 and 80 Hz at and 25 and 75 Hz on spar-buoys (Risch et al. 2023). At similar distances from the source, these levels are like those from fixed turbines (Risch et al. 2023). Incremental increases of wind speed led to differing increases of operational sound. At a wind speed of 50 feet per second (15 meters per second) operational noise levels were found to be about 3 dB higher at the semisubmersible foundations (148.8 dB re 1 µPa) as compared to spar-buoys (145.4 dB re 1 µPa) (Risch et al. 2023).

Heaving movements of ropes, chains, and WTG platforms during operations can also cause noise. Currently, there is no information on such sources, even from comparable oil and gas structures. In a study conducted on wave energy devices deployed off Scotland, the main noise source related to the device was the anchor chains, which emitted sporadic sounds between 3 and 4 kHz (Beharie et al. 2015). Measurements in the Beharie et al. (2015) study estimated source levels of anchor chain noise of 131 to 200 dB re 1 µPa for 4.2- to 5⅜-inch chains. The wide range of source levels was event driven and not related to the type or location of the mooring overall.

H.3.5 Decommissioning

The methods that may be used for decommissioning floating platforms are not well understood at this time. It is possible that explosives may be used (Section H.3.2, *Unexploded Ordnance Detonations*). However, given the general trend of reducing the use of underwater explosives that has been observed in the oil and gas industry, it is likely that floating offshore wind structures would instead be removed through other means. Additional noise from vessels (Section H.3.3.3, *Vessels in Transit*) and other machinery may also be introduced throughout the decommissioning process.

H.4 Importance of Sound to Marine Mammals

Marine mammals rely heavily on acoustic cues for extracting information from their environment. Sound travels faster and farther in water (approximately 4,921 feet [1,500 meters] per second) than it does in air (approximately 1,148 feet [350 meters] per second), making this a reliable mode of information transfer across large distances and in dark environments where visual cues are limited. Acoustic communication is used in a variety of contexts, such as attracting mates, communicating to young, or conveying other relevant information (Bradbury and Vehrencamp 2011). Marine mammals can also glean information about their environment by listening to acoustic cues, like ambient sounds from a reef, the sound of an approaching storm, or the call from a nearby predator. Toothed whales produce and listen to echolocation clicks to locate food and to navigate (Madsen and Surlykke 2013).

H.4.1 Hearing Anatomy

Like terrestrial mammals, the auditory anatomy of marine mammals generally includes the inner, middle, and outer ear (Ketten 1994). Not all marine mammals have an outer ear, but if it is present, it funnels sound into the auditory pathway, capturing the sound. The middle ear acts as a transformer, filtering and amplifying the sound. The inner ear is where auditory reception takes place. The key structure in the inner ear responsible for auditory perception is the cochlea, a spiral-shaped structure containing the basilar membrane, which is lined with auditory hair cells. Specific areas of the basilar membrane vibrate in response to the frequency content of the acoustic stimulus, causing hair cells mapped to specific frequencies to be differentially stimulated and send signals to the brain (Ketten 1994). While the cochlea and basilar membrane are well conserved structures across all mammalian taxa, there are some key differences in the auditory anatomy of terrestrial versus marine mammals that require explanation. Marine mammals have the unique need to hear in aqueous environments. Amphibious marine mammals (including seals, sea otters, and sea lions) have evolved to hear in both air and under water; however, there are distinct anatomical and audiometric data that support separation of phocid pinnipeds and other marine carnivores (i.e., sea lions, fur seals, walruses, sea otters, polar bears) (Finneran 2016; Southall et al. 2019). All amphibious marine mammals except phocid pinnipeds have external ear appendages. Cetaceans do not have external ears, do not have air-filled external canals, and the bony portions of the ear are much denser than those of terrestrial mammals (Ketten 1994).

All marine mammals use both ears to hear (binaural hearing) and can extract directional information from sound. But the pathway that sound takes into the inner ear is not well understood for all cetaceans and may not be the same for all species. For example, in baleen whales (i.e., mysticetes), bone conduction through the lower jaw may play a role in hearing (Cranford and Krysl 2015), while odontocetes have a fat-filled portion of the lower jaw, which is thought to funnel sound toward the ear (Mooney et al. 2012). Hearing tests have been conducted on several species of odontocetes, but there has yet to be a hearing test on a baleen whale, so most of our understanding comes from examining the ears from deceased whales (Erbe et al. 2017; Houser et al. 2017).

Many marine mammal species produce sounds through vibrations in their larynx (Frankel 2002). In baleen whales, for example, air in the lungs and laryngeal sac expands and contracts, producing vibrations and sounds within the larynx (Frankel 2002). Baleen whales produce low-frequency sounds that can be used to communicate with other animals over great distances (Clark and Gagnon 2002). Differences in sound production among marine mammals vary, in part, with their use of the marine acoustic environment. Toothed whales hunt for their prey using high-frequency echolocation signals. To produce these signals, the whales have a specialized structure called the *melon* on the top of their head that is used for sound production. When air passes through the phonic lips, a vibration is produced. The melon helps transmit the vibration from the phonic lips to the environment as a directed beam of sound (Frankel 2002). It is generally believed that if an animal produces and uses a sound at a certain frequency, its hearing sensitivity will at least overlap with those particular frequencies. An animal's hearing range is broader than this because they rely heavily on acoustic information—beyond the signals they produce themselves—to understand their environment.

H.4.2 Functional Hearing Groups

Marine mammal species have been classified into functional hearing groups based on similar anatomical auditory structures and frequency-specific hearing sensitivity obtained from hearing tests on a subset of species (Finneran 2015a; NMFS 2018; Southall et al. 2019). For those species for which empirical measurements have not been made, the grouping of phylogenetic and ecologically similar species is used for categorization. This concept of marine mammal functional hearing groups was first described in Southall et al. (2007) and included five groups: low-, mid-, and high-frequency cetaceans; pinnipeds in water; and pinnipeds in air. The groups were further modified by NMFS in the agency's underwater acoustic guidance document (NMFS 2018), mainly to separate phocid pinnipeds from otariid pinnipeds, and updated again by Southall et al. (2019). The science (Southall et al. 2019) now supports the need for at least eight functional hearing groups, i.e., low-frequency cetaceans, high-frequency cetaceans, very high-frequency cetaceans, sirenians, phocids in air, phocids in water, other marine carnivores in air, and other marine carnivores in water (Southall et al. 2019). NMFS has regulatory authority over the protection of cetaceans and most pinnipeds species, and Table H-5 provides the functional hearing groups. The U.S. Fish and Wildlife Service (USFWS) oversees the protection of sirenia and other marine carnivores (i.e., polar bears, walruses, and sea otters). The distinction between otariid pinnipeds and other marine carnivores in the NMFS (2018) technical guidance is driven by regulatory restrictions rather than differences in hearing capabilities. As noted in Table H-5, NMFS does not have jurisdiction marine carnivores; however, NMFS (2018) determined the generalized hearing range for the otariid pinniped hearing group was derived used audiogram data from a Pacific walrus (Kastelein et al. 2002) and a sea otter (Ghoul and Reichmuth 2014). The reports used to define these hearing ranges (Finneran 2016; Southall et al. 2019) group otariid pinnipeds and other marine carnivores into one hearing group category. Therefore, this hearing group includes sea lions and fur seals (which are under NMFS jurisdiction), as well as sea otters, walruses, and polar bears (which are under USFWS jurisdiction).

Table H-5. Marine mammal functional hearing groups[1]

Hearing Group	Generalized Hearing Range[2]
Low-frequency cetaceans (baleen whales)	7 Hz to 35 kHz
Mid-frequency cetaceans (dolphins, toothed whales, beaked whales, bottlenose whales)	150 Hz to 160 kHz
High-frequency cetaceans (true porpoises, Kogia, river dolphins, cephalorhynchid, *Lagenorhynchus cruciger*, and *L. australis*)	275 Hz to 160 kHz
Phocid pinnipeds (underwater) (true seals)	50 Hz to 86 kHz
Otariid pinnipeds and other non-phocid marine carnivores (underwater) (sea lions, fur seals, walruses, sea otters, polar bears)[3]	60 Hz to 39 kHz

[1] From NMFS 2018 technical guidance showing the most current marine mammal hearing groups used in the regulatory process in the United States.
[2] Represents the generalized hearing range for the entire group as a composite (i.e., all species within the group), where individual species' hearing ranges are typically not as broad. Generalized hearing range chosen based on ~65 dB threshold from normalized composite audiogram, with the exception for lower limits for low-frequency cetaceans (Southall et al. 2007) and phocid pinnipeds (approximation).
[3] Walruses, sea otters, and polar bears are under USFWS jurisdiction, not NMFS, and are therefore not directly included in the NMFS 2018 technical guidance from which these hearing ranges were obtained. However, the NMFS 2018 technical guidance indicates that audiogram data from a Pacific walrus and a sea otter were included in the derivation of the composite audiogram for otariid pinniped species due to the limited datasets available for in-water hearing for these species. Additionally, Finneran (2016) provided in Appendix A of the NMFS 2018 technical guidance groups together all these species in their technical report and audiogram calculations.
kHz = kilohertz.

H.4.3 Potential Impacts of Underwater Sound

Depending on the level of exposure, context, and type of sound, potential impacts of underwater sound on marine mammals may include non-auditory injury, permanent or temporary hearing loss, behavioral changes, acoustic masking, or increases in physiological stress (OSPAR Commission 2009). The following discussion analyzes each of these impacts.

Non-auditory injury: Non-auditory physiological impacts are possible for very intense sounds or blasts, such as explosions. This kind of impact is not expected for most of the activities associated with offshore wind development; it is only possible during detonation of unexploded ordnances or if explosives are used in decommissioning. Although many marine mammals can adapt to changes in pressure during their deep foraging dives, the shock waves produced by explosives expose the animal to rapid changes in pressure, which in turn causes a rapid expansion of air-filled cavities (e.g., the lungs). This forces the surrounding tissue or bone to move beyond its limits, which may lead to tears, breaks, or hemorrhaging. The extent and severity to which such injury would occur depends on several factors, including the size of these air-filled cavities, ambient pressure, how close an animal is to the blast, and blast size (DoN 2017). In extreme cases, injuries can lead to severe lung damage, which can directly kill the animal; a less-severe lung injury may indirectly lead to death due to an increased vulnerability to predation or the inability to complete foraging dives.

Permanent or temporary hearing loss: An animal's auditory sensitivity to a sound depends on the spectral, temporal, and amplitude characteristics of the sound (Richardson et al. 1995). When exposed to sounds of significant duration and amplitude (typically within close range of a source), marine mammals may experience noise-induced threshold shifts. PTS is an irreversible loss of hearing due to hair cell loss or other structural damage to auditory tissues (Henderson et al. 2008; Saunders et al. 1985). TTS is a relatively short-term (e.g., within several hours or days) reversible loss of hearing following noise exposure (Finneran 2015b; Southall et al. 2007), often resulting from hair cell fatigue (Saunders et al. 1985; Yost 2000). While experiencing TTS, the hearing threshold rises, meaning that a sound must be louder to be detected. Prolonged or repeated exposure to sounds at levels that are sufficient to induce TTS without adequate recovery time can lead to PTS (Finneran 2015b; Southall et al. 2007).

Behavioral disturbance: Farther away from a source and at lower received levels, marine mammals show varying levels of disturbance to underwater noise sources, ranging from no observable response to overt behavioral changes. Individuals may flee from an area to avoid the noise source, may exhibit changes in vocal activity, stop foraging, or change their typical dive behavior, among other responses (National Research Council 2003). Behavioral responses can cause disruption in foraging patterns, increases in physiological stress, and reduced breeding opportunities, among other responses. When exposed to the same sound repeatedly, it is possible that marine mammals may become either habituated (show a reduced response) or sensitized (show an increased response) (Bejder et al. 2009). A number of contextual factors play a role in whether an animal exhibits a response to a sound source, including those intrinsic to the animal and those related to the sound source. Some of these factors include (1) the exposure context (e.g., behavioral state of the animal, habitat characteristics), (2) the biological relevance of the signal (e.g., whether the signal is audible, whether the signal sounds like a predator), (3) the life stage of the animal (e.g., juvenile, mother and calf), (4) prior experience of the animal (e.g., is it a novel sound source), (5) sound properties (e.g., duration of sound exposure, sound pressure level, sound type, mobility/directionality of the source), and (6) acoustic properties of the medium (e.g., bathymetry, temperature, salinity) (Southall et al. 2021). Because of these many factors, behavioral disturbances are challenging to both predict and measure. Disturbances remain an ongoing field of study within marine mammal bioacoustics. Furthermore, the implications of behavioral disturbances can range from temporary displacement of an individual to long-term consequences on a population if there is a demonstrable reduction in fitness (e.g., due to a reduction in foraging success).

Auditory masking: Auditory masking may occur over larger spatial scales than noise-induced threshold shift or behavioral disturbance. Masking occurs when a noise source overlaps in time, space, and frequency as a signal that the animal is either producing or trying to extract from its environment (Richardson et al. 1995; Clark et al. 2009). Masking can reduce an individual's *communication space* (the range at which it can effectively transmit and receive acoustic cues from conspecifics) or *listening space* (the range at which it can detect relevant acoustic cues from the environment). A growing body of research is focused on the risk of masking from anthropogenic sources, the ecological significance of masking, and what anti-masking strategies may be used by marine animals. This understanding is essential before masking can be properly incorporated into regulation or mitigation approaches (Erbe et al. 2019). As a result, most assessments only consider the overlap in frequency between the sound source and the hearing range of marine mammals.

Physiological stress: The presence of anthropogenic noise, even at low levels, can increase physiological stress in a range of taxa, including humans (Kight and Swaddle 2011; Wright et al. 2007) This is difficult to measure in wild animals, but several methods have recently emerged that may allow for reliable measurements in marine mammals. Baleen plates store both adrenal steroids (stress biomarkers, e.g., cortisol) and reproductive hormones and, at least in bowhead whales, can be reliably analyzed to determine the retrospective record of prior reproductive cycles (Hunt et al. 2014). Waxy earplugs from baleen whales can be extracted from museum specimens and assayed for cortisol levels; one study demonstrated a potential link between historical whaling levels and stress (Trumble et al. 2018). These retrospective methods are helpful for answering certain questions, while the collection of fecal samples is a promising method for addressing questions about more recent stressors (Rolland et al. 2005).

The effects of anthropogenic sound on marine life have been studied for more than half a century. In that time, it has become clear that this is a complex subject with many interacting factors and variability in response from one sound source to another and from species to species. But some general trends have emerged from this body of work. First, the louder and more impulsive the received sound is, the higher the likelihood that there will be an adverse physiological effect, such as PTS or TTS. These impacts generally occur at relatively close distances to a source, in comparison to behavioral effects, masking, or increases in stress, which can occur wherever the sound can be heard. Secondly, the hearing sensitivity of an animal plays a major role in whether it will be affected by a sound or not. There is a wide range of hearing sensitivities among marine mammal species. Regulation to protect marine life from anthropogenic sound has formed around these general concepts.

H.4.4 Regulation of Underwater Sound for Marine Mammals

The MMPA prohibits the *take* of marine mammals, defined as the harassment, hunting, capturing, killing, or an attempt of any of those actions on a marine mammal. This act requires that an incidental take authorization be obtained for the incidental take of marine mammals as a result of anthropogenic activities. The MMPA classifies take by harassment as Level A or Level B, defined as follows.

- **Level A harassment**: Any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild.
- **Level B harassment**: Any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but that does not have the potential to injure a marine mammal or marine mammal stock in the wild (16 USC 1362).

With respect to anthropogenic sounds, Level A takes generally include injurious impacts like PTS, whereas Level B takes include behavioral effects, as well as TTS. The current regulatory framework used by NMFS for evaluating an acoustic take of a marine mammal involves assessing whether the animal's received sound level exceeds a given threshold. For Level A, this threshold differs by functional hearing group, but for Level B, the same threshold is used across all marine mammals.

H.4.4.1 Thresholds for Auditory Injury

The current injury (Level A) thresholds consist of dual criteria of L_{pk} and 24-hour cumulative SEL thresholds (cumulative sound exposure level) (Table H-6). These criteria are used to predict the potential range from the source within which injury may occur. The criterion that results in the larger physical impact range is generally used, to be most conservative. The SEL thresholds are frequency weighted, which means that the sound is essentially filtered based on the animal's frequency-specific hearing sensitivity, de-emphasizing the frequencies at which the animal is less sensitive (refer to Table

H-5 for the frequency range of hearing for each group). The frequency weighting functions are described in detail in Finneran (2016).

Table H-6. The acoustic thresholds for onset of PTS and TTS for marine mammals for both impulsive and non-impulsive sound sources

Marine Mammal Functional Hearing Group	Effect	Impulsive Source		Non-Impulsive Source
		Lpk (dB re 1 μPa)	Weighted SEL_{24h} (dB re 1 μPa²s)	Weighted SEL_{24h} (dB re 1 μPa²s)
Low-frequency cetaceans	PTS	219	183	199
	TTS	213	168	179
Mid-frequency cetaceans	PTS	230	185	198
	TTS	224	170	178
High-frequency cetaceans	PTS	202	155	173
	TTS	196	140	153
Phocid pinnipeds underwater	PTS	218	185	201
	TTS	212	170	181
Otariid pinnipeds and other marine carnivores underwater[1]	PTS	232	203	199
	TTS	226	188	199

Source: NMFS 2018.

[1] Walruses, sea otters, and polar bears are under USFWS jurisdiction, not NMFS, and are, therefore, not directly included in the NMFS 2018 technical guidance from which these hearing ranges were obtained. However, the NMFS 2018 technical guidance indicates that audiogram data from a Pacific walrus and a sea otter were included in the derivation of the composite audiogram for otariid pinniped species due to the limited datasets available for in-water hearing for these species. Additionally, Finneran (2016) provided in Appendix A of the NMFS 2018 technical guidance groups together all these species in their technical report and audiogram calculations.

Lpk values are unweighted within the generalized hearing range of marine mammals (i.e., 7 Hz to 160 kHz): Values presented for SEL use a 24-hour accumulation period unless stated otherwise, and are weighted based on the relevant marine mammal functional hearing group (Finneran 2016).

dB re 1 μPa = decibels referenced to 1 micropascal; dB re 1 μPa² s = decibels referenced to 1 micropascal squared second. Note: non-impulsive sources can also be compared to the Lpk criteria if there is a chance of exceedance.

Auditory injury from explosives: The supersonic shock wave from an explosion transition to a normal pressure wave at a range determined by the weight and type of the explosive used. The ranges to the TTS and PTS threshold are outside of these radii. The normal impulsive TTS and PTS thresholds (Table H-6) are applicable for determining auditory injury impacts (NMFS 2018).

H.4.4.2 Thresholds for Behavioral Disturbance

NMFS currently uses a threshold for behavioral disturbance (Level B) of 160 dB re 1 μPa SPL for non-explosive impulsive sounds (e.g., airguns and impact pile driving) and intermittent sound sources (e.g., scientific and non-tactical sonar), and 120 dB re 1 μPa SPL for continuous sounds (e.g., drilling) (NMFS 2023a). USFWS currently does not provide acoustic exposure criteria for fissipeds, but as noted previously, data used to derive the hearing range for otariid pinnipeds and other marine carnivores includes sea otters (Finneran 2016; Southall et al. 2019), so fissipeds are included in this group. This is an unweighted criterion applicable for all marine mammal species. In-air behavioral thresholds exist for harbor seals and non-harbor seal pinnipeds at 90 dB re 20 µPa SPL and 100 dB re 20 µPa SPL, respectively (NMFS 2023b). Unlike with sound exposure level-based thresholds, the accumulation of acoustic energy over time is not relevant for this criterion—meaning that a Level B take can occur even if an animal experiences a received SPL of 160 dB re 1 µPa very briefly in one instance.

While the Level B criterion is generally applied in a binary fashion, as alluded to previously, there are numerous factors that determine whether an individual will be affected by a sound, resulting in substantial variability even in similar exposure scenarios. In particular, it is recognized that the context in which a sound is received affects the nature and extent of responses to a stimulus (Ellison et al. 2012; Southall et al. 2007). Therefore, a "step function" concept for Level B harassment was introduced by Wood et al. (2012) whereby proportions of exposed individuals experience behavioral disturbance at different received levels, centered at an SPL of 160 dB re 1 µPa. These probabilistic thresholds reflect the higher sensitivity that has been observed in beaked whales and migrating mysticete whales (Table H-7). At the moment, this step function provides additional insight to calculating Level B takes for certain species groups. The M-weighting functions, described by Southall et al. (2007) and used for the Wood et al. (2012) probabilistic disturbance step thresholds, are different from the weighting functions by Finneran (2016), previously mentioned. The M-weighting was specifically developed for interpreting the likelihood of audibility, whereas the Finneran weighting functions were developed to predict the likelihood of auditory injury.

Table H-7. Probabilistic disturbance $L_{p,rms}$ thresholds (M-weighted) used to predict a behavioral response[1]

Marine Mammal Group	Probabilistic Disturbance $L_{p,rms}$ Thresholds (M-weighted) dB re 1 µPa			
	120	140	160	180
Porpoises/beaked whales	50%	90%		
Migrating mysticete whales	10%	50%	90%	
All other species/behaviors		10%	50%	90%

Source: Wood et al. (2012).
[1] Probabilities are not additive and reflect single points on a theoretical response curve.

Behavioral disturbance from explosives: Single blast events within a 24-hour period are not currently considered by NMFS to produce behavioral effects if exposures are below the onset of TTS thresholds for frequency-weighted SEL and peak pressure level. Only short-term startle responses are expected as far as behavioral responses. For multiple detonations, the threshold applied for behavioral effects is that same TTS threshold minus 5 dB.

H.4.4.3 Thresholds for Non-Auditory Injury

Shock waves associated with underwater detonations can induce non-auditory physiological effects, including mortality and direct tissue damage (i.e., severe lung injury, slight lung injury, and gastrointestinal tract injury). The magnitude of the acoustic impulse, measured in Pascal-seconds, is the integral of the positive-pressure shock pulse over time and serves as the threshold to predict non-auditory lung injury and mortality. Because lung capacity or size is generally directly related to the size of an animal, body mass is one parameter used to predict the likelihood of lung injury. Additionally, the depth of the animal is used, as this represents the ambient pressure conditions of the animal, as a scaling parameter for lung volume. Gastrointestinal tract injury potential is identified using the peak SPL and is considered to occur beginning at levels of 237 dB re 1 µPa. The U.S. Navy established thresholds to assess the potential for mortality and slight lung injury from explosive sources based on a modified Goertner Equation (DoN 2017). This model is recommended by NMFS for predicting injury impacts on marine mammals from explosives. Table H-8 provides an estimate of mass of the different marine mammal species covered in this assessment. Table H-9 and Table H-10 list the equations used to calculate thresholds based on effects observed in 50 percent and 1 percent of animals, respectively.

Table H-8. Representative calf/pup and adult mass estimates used for assessing impulse-based onset of lung injury and mortality threshold exceedance distances

Impulse Animal Group	Representative Species	Calf/Pup Mass (kilograms)	Adult Mass (kilograms)
Baleen whales and sperm whale	Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*)	650	16,000
Pilot and minke whales	Minke whale (*Balaenoptera acutorostrata*)	200	4,000
Beaked whales	Gervais' beaked whale (*Mesoplodon europaeus*)	49	366
Dolphins, *Kogia* spp., pinnipeds, and sea turtles	Harbor seal (*Phoca vitulina*)	8	60
Porpoises	Harbor porpoise (*Phocoena phocoena*)	5	40

Table H-9. U.S. Navy impulse and peak pressure threshold equations for estimating numbers of marine mammals and turtles that may experience mortality or injury due to explosives

Impact Assessment Criterion	Threshold
Mortality – Impulse	$144M^{1/3}(1+D/10.1)^{1/6}$ Pa-s
Injury – Impulse	$65.8M^{1/3}(1+D/10.1)^{1/6}$ Pa-s
Injury – Peak Pressure	Lpk of 243 dB re 1 µPa

Source: U.S. Department of the Navy 2017.
Where M is animal mass (kg) and D is animal depth (meters).

Table H-10. U.S. Navy impulse and peak pressure threshold equations for estimating distances to onset of potential effect for marine mammal and turtle mortality and slight lung injury due to explosives

Impact Assessment Criterion	Threshold
Onset Mortality – Impulse	$103M^{1/3}(1+D/10.1)^{1/6}$ Pa-s
Onset Injury (Non-auditory) – Impulse	$47.5M^{1/3}(1+D/10.1)^{1/6}$ Pa-s
Onset Injury (Non-auditory) – Peak Pressure	Lpk of 237 dB re 1 µPa

Source: U.S. Department of the Navy 2017.
[1] These thresholds are relevant for mitigation planning.
Where M is animal mass (kg) and D is animal depth (meters).

H.4.5 General Approach to Acoustic Exposure Modeling

To predict the number of individuals of a given species that may be exposed to harmful levels of sound from a specific activity, a series of modeling exercises are conducted. First, the sound field of a sound-generating activity is modeled based on characteristics of the source and the physical environment. From the sound field, the range to the U.S. regulatory acoustic threshold isopleths can be predicted. This approach is referred to as *acoustic modeling*. By overlaying the marine mammal density information for a certain species or population in the geographical area of the activity, the number of animals exposed within the acoustic threshold isopleths is then predicted. This is called *exposure modeling*. Some models further incorporate animal movement to make more realistic predictions of exposure numbers. Animal movement models may incorporate behavioral parameters, including swim speeds, dive depths, course changes, or reactions to certain sound types, among other factors. Acoustic exposure modeling is conducted based on project-specific information detailed in a lessee's Construction and Operations Plan (COP) as related to noise-generating construction activities. Because this assessment is programmatic (no COPs have been prepared or submitted for floating wind projects on the West Coast), such specific details are not available. Therefore, no acoustic exposure modeling has been conducted.

H.5 Importance of Sound to Fish and Invertebrates

Many fishes and invertebrates produce sounds for basic biological functions like attracting a mate and defending territory. A study revealed that sound production in fishes has evolved at least 33 times throughout evolutionary time, and that most ray-finned fishes are likely capable of producing sounds (Rice et al. 2022). Fish may produce sounds through a variety of mechanisms, such as vibrating muscles near the swim bladder, rubbing parts of their skeleton together, or snapping their pectoral fin tendons (Ladich and Bass 2011; Rice et al. 2022). Similarly, many marine invertebrates produce sounds, ranging from the ubiquitous snapping shrimp "snaps" (Johnson et al. 1947) to spiny lobster "rasps" (Patek 2002) to mantis shrimp "rumbles" (Staaterman et al. 2011). Some sounds are also produced as a byproduct of other activities, such as the scraping sound of urchins feeding (Radford et al. 2008a) and even a "coughing" sound made when scallops open and close their shells (Di Iorio et al. 2012).

There are some aquatic species that do not appear to produce sounds, but still have acute hearing (e.g., the goldfish), which has led authors to surmise that animals glean a great deal of information about their environment through acoustic cues, a process called *auditory scene analysis* (Fay 2009). All sounds in a given environment—biological, abiotic, and anthropogenic—comprise the "soundscape" (Pijanowski et al. 2011). Soundscapes naturally vary over space and time. There is increasing evidence that some fish and invertebrate species can distinguish between soundscapes of different habitats (Kaplan et al. 2015; McWilliam and Hawkins 2013; Radford et al. 2008b). In fact, some pelagic larvae may use soundscapes as a cue to orient towards suitable settlement habitat (Lillis et al. 2015; Montgomery 2006; Radford et al. 2007; Simpson et al. 2005; Vermeij et al. 2010) or to induce molting into their juvenile forms (Lillis et al. 2013; Stanley et al. 2015). It seems that the unique acoustic signatures of marine habitats provide vital information to the range of species that reside within and around them.

Compared to marine mammals, scientists have only begun to study and understand the importance of sound to the vast number of extant marine fish and invertebrate species. Yet there are sufficient data to conclude that underwater sound is vitally important to their basic life functions, such as finding a mate, deterring a predator, or defending territory (Popper and Hawkins 2018, 2019). Thus, these lower taxonomic groups must be able to detect components of marine soundscapes. This detectability could be adversely affected by the addition of noise from anthropogenic activity.

H.5.1 Hearing Anatomy

All fishes and invertebrates are capable of sensing the particle motion component of a sound wave. The inner ear of fishes is similar to that of all vertebrates. Each ear has three otolithic end organs, which contain a sensory epithelium lined with hair cells, as well as a dense structure called an otolith (Popper et al. 2021). As the back-and-forth particle motion moves the body of the fish (which has a density similar to seawater), the denser otoliths lag behind, creating a shearing force on the hair cells, which sends a signal to the brain via the auditory nerve (Fay and Popper 2000). Many invertebrates have structures called statocysts, which, like fish ears, act like accelerometers: a dense statolith sits within a body of hair cells. When the animal is moved by particle motion, it results in a shearing force on the hair cells (Budelmann 1992; Mooney et al. 2010). Some invertebrates also have sensory hairs on the exterior of their bodies, allowing them to sense changes in the particle motion field around them (Budelmann 1992), and the lateral line in fishes also plays a role in hearing (McCormick 2011). The research thus far shows that the primary hearing range of most particle-motion sensitive organisms is below 1 kHz (Popper et al. 2021).

In addition to particle motion detection, which is shared across all fishes, some species are also capable of detecting acoustic pressure (Fay and Popper 2000). Special adaptations of the swim bladder (e.g., anterior projections, additional gas bubbles, or bony parts) bring it near the ear; as the swim bladder expands and contracts, pressure signals are radiated within the body of the fish, making their way to the ear in the form of particle motion (Popper et al. 2021). These species can typically detect a broader range of acoustic frequencies (up to 3 to 4 kHz) (Wiernicki et al. 2020) and are, therefore, considered to be more sensitive to underwater sound than those only detecting particle motion. Hearing sensitivity in fishes is generally considered to fall along a spectrum: the least-sensitive (sometimes called *hearing generalists*) are those that do not possess a swim bladder and cannot detect sound above 1 kHz, while the most sensitive (*hearing specialists*) possess specialized structures enabling pressure detection (Popper et al. 2021). A few species in the herring family can detect ultrasonic (>20 kHz) sounds (Mann et al. 2001), but this is considered to be very rare among the bony fishes. Another important distinction for species that do possess swim bladders is whether it is open or closed: species with open swim bladders can release pressure via a connection to the gut, while those with closed swim bladders can only release pressure very slowly, making them more prone to injury when experiencing rapid changes in pressure (Popper et al. 2019).

H.5.2 Potential Impacts of Underwater Sound

Activities associated mostly with the construction phase of the project life cycle that produce sound, particularly impulsive sound, have potential consequences for fish and invertebrate species. As with marine mammals, fishes and invertebrates may experience a range of impacts from underwater sound depending on physical qualities of the sound source and the environment, as well as the physiological characteristics and the behavioral context of the species of interest. Unlike mammals, whose hair cells do not regenerate, fishes are able to regrow hair cells that die or become damaged (Corwin 1981), making it unlikely that they could experience PTS; therefore, there are no thresholds focused explicitly on auditory injury. However, fishes do experience TTS. When very close to impulsive sound sources or explosions they could experience *barotrauma*, a term that refers to a class of injuries ranging from recoverable bruises to organ damage (which could ultimately lead to death) (Popper et al. 2014; Stephenson et al. 2010). When the air-filled swim bladder inside the body of the fish quickly expands and contracts due to a rapid change in pressure, it can cause internal injuries to the nearby tissues (Halvorsen et al. 2012). The greater the difference between the static pressure at the site of the fish and the positive/negative pressures associated with the sound source, the greater the risk of barotrauma. This means that impulsive sounds may present a risk of injury due to the rapid changes in acoustic pressure (Hamernik and Hsueh 1991). Damage to invertebrate statocysts has been observed as a result of sound exposure, but it is unclear whether the hair cells can regenerate, like they do in fishes (Solé et al. 2013, 2017, 2023). Continuous, lower-level sources (e.g., vessel noise) are unlikely to result in auditory injury but could induce changes in behavior, physiological effects (increased or decreased respiration and stress hormone levels), or acoustic masking (Solé et al. 2023). Solé et al. (2023) identified a lack of detailed metrics to compare the levels of sound impacts across the diverse marine invertebrate community. Chronic anthropogenic noise at some level can be detrimental to the natural ecosystem but these levels have not been defined and more research is required (Solé et al. 2023).

H.5.3 Hearing Groups

While there is a wide variety in hearing anatomy and sensitivity among fishes and invertebrates, the scientific community has generally accepted three categories to describe fish hearing (Table H-11).

Table H-11. Fish and invertebrate groupings based on hearing anatomy

Group	Hearing Anatomy	Example Species in the Affected Environment	Sensitivity to Underwater Sound
1	Fishes with no swim bladder or other gas chamber, invertebrates, eggs and larvae	Flatfish, sharks, rays, cephalopods, crustaceans, bivalves	Detect particle motion but not acoustic pressure. Sensitive to sound over relatively small spatial scales. Not susceptible to barotrauma. Generally capable of detecting sounds up to 1 kHz.[1]
2	Fishes with swim bladders in which hearing does not involve the swim bladder or other gas volume	Rockfish, salmonids, Pacific smelt	Detect particle motion but not acoustic pressure. May be susceptible to barotrauma due to the presence of a swim bladder. May be sensitive to sounds up to ~3 kHz.

Group	Hearing Anatomy	Example Species in the Affected Environment	Sensitivity to Underwater Sound
3	Fishes in which hearing involves a swim bladder or other gas volume	Pacific herring, northern anchovy, sardines, mackerels, green sturgeon	Detect particle motion and acoustic pressure. May be susceptible to barotrauma. Sounds can be detected over larger spatial scales and are generally considered to be the most sensitive to impacts from anthropogenic sound. May be able to detect sounds up to 5 kHz and in some rare cases (e.g., herring) >20 kHz.

[1] Solé et al. (2023) present data showing that some invertebrate species may detect sounds above the level presented.

H.5.4 Regulation of Underwater Sound for Fishes and Invertebrates

H.5.4.1 Thresholds for Non-Auditory Injury

During reconstruction of the east span of the San Francisco–Oakland Bay Bridge, researchers observed dead fish near pile-driving operations, suggesting that fish could be killed when very close (<33 feet [<10 meters]) to the pile (Caltrans 2004). Further work around this construction project led to the formation of dual interim criteria by the Fisheries Hydroacoustic Working Group (2008), which were later adopted by NMFS. With these interim criteria, the maximum permitted Lpk for a single pile-driving strike is 206 dB re 1 µPa. The maximum accumulated SEL is 187 dB re 1µPa^2 s for fishes greater than 2 grams, and 183 dB re 1µPa^2 s for fishes less than 2 grams (Table H-12). These criteria are still being used by NMFS, but the appropriateness of these thresholds is being reconsidered (Popper et al. 2019). Currently, there are no underwater noise thresholds for invertebrates, but the effect ranges are expected to be similar to those predicted for fishes in Group 1 (Table H-11).

Table H-12. Acoustic thresholds for fishes for exposure to pile-driving sound

Fish Hearing Group	Mortality and Non-Recoverable injury		Recoverable Injury		TTS
	L_{pk}	SEL	L_{pk}	SEL	SEL
Fish without swim bladder (Group 1)[1]	>213	>219	>213	>216	>186
Fish with swim bladder not involved in hearing (Group 2)[1]	>207	210	>207	203	>186
Fish with swim bladder involved in hearing (Group 3)[1]	>207	207	>207	203	186
Eggs and Larvae[1]	>207	>210	--	--	--
Fish ≥2 g[2]	--	--	206	187	--
Fish <2 g[2]	--	--	206	183	--

[1] Popper et al. (2014) Sound Exposure Guidelines. Note that Popper et al. (2014) uses the notation "SEL_{cum}," but SEL without a subscript is the preferred nomenclature, used here to describe the energy that would be accumulated over an entire pile-driving event (i.e., installation of a pile).
[2] Fisheries Hydroacoustic Working Group (2008).
g = grams; L_{pk} = peak sound pressure; SEL = sound exposure level; TTS = temporary threshold shift.

For underwater explosions, Popper et al. (2014) present criteria for mortality and non-recoverable injury resulting from fish and invertebrate exposure to detonations. They note that it is difficult to disentangle the effects of the compressive forces of the shock wave (very close to the explosion) from the decompressive effect (area of negative pressure, further from the explosion), but either can lead to barotrauma or mortality in fishes. Several studies (Goertner 1978b; Yelverton et al. 1975) have worked with different species, with different charge sizes and water depths—all of which are important factors in predicting the effects of explosives. Yet Popper et al. (2014) derive their thresholds using data from an older study, which represents the lowest amplitude that caused consistent mortality across species (Hubbs and Rechnitzer 1952). Therefore, for all fishes, regardless of hearing anatomy, the Lpk threshold for mortality and non-recoverable injury is given as a range: 229–234 dB re 1 µPa by Popper et al. (2014), but in practice, 229 dB is generally used.

H.5.4.2 Thresholds for Behavioral Disturbance

NOAA Fisheries currently uses a root-mean-square sound pressure level (SPL) criterion of 150 dB re 1 µPa for the onset of behavioral effects in fishes (GARFO 2020). The scientific rationale for this criterion is not well supported by the data (Hastings 2008), and there has been criticism about its use (Popper et al. 2019). Notably, the differences in hearing anatomy among fishes suggest the use of a single criterion may be too simplistic. Furthermore, a wide range of behavioral responses have been observed in empirical studies thus far (ranging from startle responses to changes in schooling behavior). It is difficult to ascertain which, if any, of those responses may lead to significant biological consequences. Several recent studies on free-ranging fishes (Hawkins et al. 2014; Roberts et al. 2016) have observed the onset of different behavioral responses at similar received levels (peak-to-peak sound pressure level [Lpk-pk] of 152 to 167 dB re 1 µPa). However, Popper et al. (2019) suggests that a received Lpk-pk of 163 dB re 1 µPa might be more appropriate than the current SPL criterion of 150 re 1 µPa. Finally, given that most species are more sensitive to particle motion and not acoustic pressure, the criteria should, at least in part, be expressed in terms of particle motion. However, until there is further empirical evidence to support a different criterion, the SPL 150 dB re 1 µPa threshold remains in place as the interim metric that regulatory agencies have agreed upon.

H.6 Importance of Sound to Sea Turtles

While few studies explore sound production in sea turtles, evidence suggests they can hear sounds in air and water. The significance of sound-to-sea turtle ecology is unclear, but they may use sound in various ways. Nesting leatherbacks produce sound when breathing, likely due to exertion rather than communication (Cook & Forest 2005). Sea turtle embryos and hatchlings reportedly make airborne sounds, possibly for synchronizing hatching and nest emergence (Monteiro et al. 2019; Ferrara et al. 2014a, 2014b, 2019; McKenna et al. 2019). Charrier et al. (2022) identified 10 different underwater sounds in juvenile green sea turtles, some within and above their hearing frequency range. While our understanding of sea turtle sound production and hearing is limited, the growing body of knowledge suggests sound may be crucial to these animals.

H.6.1 Hearing Anatomy of Sea Turtles

Sea turtle ear anatomy distinguishes sea turtles from their terrestrial and semi-aquatic counterparts. The sea turtle's tympanum, its ear's outermost part, is enveloped by a thick skin layer. This layer, in turn, covers a fatty layer that transmits sound from water to the ear's middle and inner sections. While the thick outer layer impedes their air hearing, it enhances sound transfer from water into the ear (Ketten et al. 1999). The middle ear has two components encased in bone, the columella and extracolumella, which provide the pathway for sound from the tympanum on the surface of the turtle head to the inner ear. The middle ear is connected to the throat by the eustachian tube. The inner ear consists of the cochlea and basilar membrane. Because there is air in the middle ear, it is generally believed that sea turtles detect sound pressure rather than particle motion. Sea turtle ears are described as being similar to reptilian ears, but because of the historically limited data regarding sea turtles and reptiles, fish hearing is often used as an analog when considering potential impacts of underwater sound.

A number of studies have examined sea turtle hearing, both in air and in water, over a limited number of life stages. In general, sea turtles in water hear best between 200 and 750 Hz; they do not hear well above 1 kHz. However, there are species-specific and life-stage-specific differences in sea turtle hearing (Table H-13). Sea turtles are also generally less sensitive to sound than marine mammals, with the most sensitive hearing thresholds underwater measured at or above 75 dB re 1 µPa (Reese et al. 2023; Papale et al. 2020). Loggerhead sea turtle hearing has been studied more thoroughly than other turtle species (Lavender et al. 2012, 2014; Bartol et al. 1999; Lavender et al. 2012, 2014; Martin et al. 2012).

Table H-13. Hearing capabilities, including hearing frequency range and peak sensitivity in sea turtles, by species

Species	Life Stages Tested	Hearing Frequency Range (Hz)	Maximum Sensitivity (Hz)	References
Loggerhead	Post-hatchling, juvenile	100–900 (in air)	500–700	Ketten and Bartol 2006
	Post-hatchling, juvenile, adult	50–1,100 (underwater)	100–400	Bartol and Bartol 2012; Lavender et al. 2014; Martin et al. 2012; Lenhardt 2002; Bartol et al. 1999
Green	Juvenile, sub-adult	50–2,000 (in air)	200–700	Ridgway et al. 1969; Ketten and Bartol 2006; Piniak et al. 2016
	Juvenile	50–1,600 (underwater)	200–400	Piniak et al. 2016
Leatherback	Hatchling	50–1,600 (in air)	300	Piniak 2012; Dow Piniak et al. 2012
	Hatchling	50–1,200 (underwater)	300	Piniak 2012; Dow Piniak et al. 2012
Lepidochelys sp.[1]	Juvenile	100–500 (in air)	100–200	Ketten and Bartol 2006

Source: NMFS 2023a.

[1] Although the hearing capabilities provided are specific to Kemp's ridley species (*Lepidochelys kempii*), olive ridleys (*Lepidochelys olivacea)*, which belong to the same genus as Kemp's ridley, may exhibit similar hearing ranges.

H.6.2 Potential Impacts of Underwater Sound

As with marine mammals, sea turtles may experience a range of impacts from underwater sound including non-auditory injury, permanent (PTS) or temporary (TTS) hearing loss, behavioral changes, acoustic masking, or increases in physiological stress. Potential impacts will depend on physical qualities of sound source(s) and the environment, as well as physiological characteristics and behavioral context of the species of interest. Noise from activities such as pile driving, seismic surveys, and drilling could affect sea turtles, given the overlap between sea turtles' hearing range and the frequency range of these sound sources.

A number of studies have examined potential noise impacts on sea turtles. Although there is no direct evidence of PTS occurring in sea turtles, underwater noise-induced hearing loss in a freshwater turtle species has been recorded, which suggests turtles may be more sensitive to sound than previously understood (Mooney 2022). TTS has been demonstrated in many marine mammal species from exposure to impulsive and non-impulsive noise (Finneran et al. [2017]). Prolonged or repeated exposure to sound levels sufficient to induce TTS without recovery time can lead to PTS (Southall et al. 2007). Few studies have looked at hair cell damage in reptiles and have not indicated if sea turtles can regenerate injured sensory hair cells (Warchol 2011). Although several studies have examined physiological responses of sea turtles to physically stressful events (e.g., incidental or directed capture in fishing nets, cold stunning, handling, transport), to date no research has been published on potential stress responses to elevated noise (Reese et al. 2023). Stress response studies characterizing physiological (stress/hormone) responses to sound are ongoing to estimate potential acoustic impacts from industry sound sources. Elevated levels of corticosterone have been observed in Kemp's ridley sea turtles and green turtles in response to stressful stimuli such as ground transport for rehabilitation and disease (Aguirre et al. 1995; Hunt et al. 2016). Other physiological impacts due to chronic stress include immunosuppression (Milton and Lutz 2003). Samuel et al. (2005) demonstrated that anthropogenic sound levels from boating and recreational activity near Long Island, New York, were more than two orders of magnitude greater than sound levels during the periods with the lowest human activity; this suggested exposure to such levels could affect sea turtle behavior. Chronic exposure to anthropogenic noise may result in increased stress responses in sea turtles, which could have direct consequences on individual fitness (Reese et al. 2023). For all these studies, however, sea turtle behavioral and physiological response may be variable as noise impacts are still not well understood.

H.6.3 Regulation of Underwater Sound for Sea Turtles

Few examples of empirical data are available to form regulatory thresholds for sea turtle sound exposure. For several years, the regulatory community accepted the recommendations of Popper et al. (2014) and used their thresholds for fishes without swim bladders as a proxy for sea turtles. NMFS has adopted the U.S. Department of the Navy PTS and TTS thresholds as their own.[1] NMFS' recommended

[1] Although there are still no official NMFS acoustic thresholds, work by the U.S. Navy (Finneran et al. 2017) and used by NMFS (NMFS 2023c), which was based on exposure studies (McCauley et al. 2000), now serves as the foundation of present-day thresholds for PTS, TTS, and behavioral responses. The U.S. Navy uses thresholds that

behavioral threshold (NMFS 2023a) has a sound pressure level (SPL) of 175 dB re 1 μPa (Finneran et al. 2017; McCauley et al. 2000) (Table H-14). The threshold applies to all life stages.

Table H-14. Acoustic thresholds for sea turtles currently used by the NMFS Office of Protected Resources and BOEM for auditory effects from impulsive and non-impulsive signals as well as thresholds for behavioral disturbance

Impulsive Signals				Non-impulsive Signals		All Behavior
PTS		TTS		PTS	TTS	
Lpk	SEL_{24h}	Lpk	SEL_{24h}	SEL_{24h}	SPL	
232	204	226	189	220	200	175

Sources: Finneran et al. 2017; McCauley et al. 2000.
Lpk = peak sound pressure (dB re 1 μPa); SEL_{24h} = sound exposure level accumulated over 24 hours (dB re 1 μPa^2 s);
SPL = root-mean-square sound pressure (dB re 1 μPa); PTS = permanent threshold shift; TTS = temporary threshold shift, which is a recoverable hearing effect.

H.6.3.1 Thresholds for Auditory Injury

Determining injury thresholds remains a subject of study. Popper et al. (2014) suggested using sound thresholds for fish without swim bladders for sea turtles, given their similar hearing range. Finneran et al. (2017) agreed, noting that, although still unsatisfactory, data from fish provide a better analogy because of the similar hearing range. When exposed to acoustic signals representative of low- and mid-frequency active sonar, Halvorsen et al. (2012, 2013) reported TTS in some species of fish exposed to an SEL_{24h} of approximately 220 dB re 1 micropascal squared second (μPa^2 s) between 2 and 3 kHz and 210 to 215 dB re 1 μPa^2 s between 170 and 320 Hz, respectively (Finneran et al. 2017). Based on the data, the U.S. Navy uses an estimated SEL_{24h} of 200 dB re 1 μPa^2 s for TTS onset in sea turtles. An 11-dB difference, on average, was found between SEL-based impulsive and non-impulsive TTS thresholds for marine mammals. By applying the same rule to turtles, Finneran et al. (2017) derived a weighted SEL-based impulsive TTS threshold of 189 dB re 1 μPa^2 s, which is 3 dB higher than the previously recommended unweighted threshold by Popper et al. (2014) of 186 dB re 1 μPa^2 s. Based on the relatively high SEL-based TTS threshold derived for sea turtles, Finneran et al. (2017) hypothesized that the Lpk-based threshold for sea turtles would be higher than that for marine mammals. Consequently, the sea turtle Lpk-based TTS threshold for impulsive noise is set to 226 dB re 1 μPa to match the highest marine mammal value. Sea turtle PTS data from impulsive noise exposures do not exist; therefore, PTS onset was estimated by adding 15 dB to the derived SEL-based TTS thresholds and adding 6 dB to the Lpk thresholds (Finneran et al. 2017; Southall et al. 2007).

H.6.3.2 Thresholds for Behavioral Disturbance

There is little pertinent data on sea turtle behavioral responses to anthropogenic noise and none specific to offshore wind. Several publications have attempted to examine sea turtles’ immediate behavioral

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include dual criteria (peak sound pressure [L_{pk}] and SEL), as suggested for PTS and TTS, along with auditory weighting functions published by Finneran et al. (2017) and used in conjunction with SEL thresholds for PTS and TTS.

responses, most focusing on seismic airgun noise. McCauley et al. (2000) observed that one green turtle and one loggerhead sea turtle in an open water pen increased swimming behaviors in response to a single seismic airgun at received levels of 166 dB re 1 µPa and exhibited erratic behavior at received levels greater than 175 dB re 1 µPa. Other empirical work has shown a range of responses. NMFS developed sea turtle behavioral criteria that were based on the studies by McCauley et al. (2000). The sound level at which sea turtles are expected to exhibit a behavioral response to both impulsive and non-impulsive sound is a received SPL of 175 dB re 1 µPa.

H.6.3.3 Thresholds for Non-auditory Injury

For both turtles and mammals, NMFS has adopted U.S. Navy criteria to assess the potential for non-auditory injury from underwater explosive sources, as presented in Finneran et al. (2017). The criteria include thresholds for the following non-auditory effects: mortality, lung injury, and gastrointestinal injury. Unlike auditory thresholds, these depend upon an animal's mass and depth. The U.S. Navy has published two sets of equations for the thresholds (PEIS Section 3.3.6, *Marine Mammals*). The first set of equations (Table H-9) is usually intended for estimating the number of animals that may be affected, while the second set of equations (Table H-10) is more conservative and normally used for defining mitigation zones. The approach requires choosing a set of representative animal masses to assess.

Appendix I: References Cited

I.1 Executive Summary

None.

I.2 Chapter 1, Introduction

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I.4 Chapter 3, Affected Environment and Environmental Consequences

I.4.1 Section 3.1 Impact Analysis Terms and Definitions

None.

I.4.2 Section 3.2.1, Air Quality and Greenhouse Gas Emissions

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I.4.9 Section 3.3.6, Marine Mammals

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I.4.10 Section 3.3.7, Sea Turtles

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I.5 Chapter 4, Other Required Impact Analysis

None.

Appendix J: Glossary

Term	Definition
Affected Environment	Environment as it exists today that could be potentially affected by the Proposed Action or other action alternatives
algal blooms	Rapid growth of the population of algae, also known as *algae bloom*
allision	A moving ship running into a stationary ship
anchoring	Attachment of a floating offshore structure including wind turbine generators (WTG) or offshore substations (OSS) to the sea bottom by use of an anchor; anchoring types considered in the representative project design envelope include suction caisson, helical anchor, plate anchor (vertically loaded anchor or suction-embedded plate anchor), dynamically embedded (torpedo) anchor, drag embedment anchor, drilled pile, and micropile
anthropogenic	Generated by human activity
archaeological resource	Historical place, site, building, shipwreck, or other archaeological site
below grade	Below ground level
benthic	Related to the bottom of a body of water
benthic resources	The seafloor surface, the substrate itself, and the communities of bottom-dwelling organisms that live on and within these habitats
biogenic habitat	Benthic habitats created by structure-forming species (e.g., eelgrass, mussel beds, worm tubes)
Cetacea	Order of aquatic mammals made up of whales, dolphins, and porpoises
coastal habitat	Coastal areas where flora and fauna live, including salt marshes and aquatic habitats
coastal waters	Waters in nearshore areas where bottom depth is less than 98.4 feet (30 meters)
coastal zone	The lands and waters starting at 3 nautical miles (5.6 kilometers) from the land and ending at the first major land transportation route
commercial fisheries	Areas or entities raising and catching fish for commercial profit
commercial-scale wind energy facility	Wind energy facility usually greater than 1 megawatt that sells the produced electricity
concrete mattress	Concrete mat used to protect underwater pipelines or stabilize soil or the seabed; can be formed underwater by divers rolling out geosynthetic mattress fabric, zipping it together, and using a pump to fill it with highly fluid small aggregate concrete
criteria pollutant	One of six common air pollutants for which the United States Environmental Protection Agency sets National Ambient Air Quality Standards: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, or sulfur dioxide
critical habitat	Geographic area containing features essential to the conservation of threatened or endangered species
cultural resource	Historical districts, objects, places, sites, buildings, shipwrecks, and archaeological sites on the American landscape, as well as sites of traditional, religious, or cultural significance to cultural groups, including Native American Tribes
culvert	Structure, usually a tunnel, allowing water to flow under an obstruction (e.g., road, trail)
deflagration	Combustion of an explosive at subsonic speeds, driven by transfer of heat
demersal	Living close to the ocean floor
demosponge	Class of sponges that account for more than 90% of all sponges alive, including bath, boring, barrel, carnivorous, and freshwater sponges

Term	Definition
dredging	Removal of sediments and debris from the bottom of lakes, rivers, harbors, and other waterbodies
duct bank	Underground structure that houses the onshore export cables, which consists of polyvinyl chloride pipes encased in concrete
ecosystem	Community of interacting living organisms and nonliving components (such as air, water, soil)
electromagnetic field (EMF)	A field of force produced by electrically charged objects and containing both electric and magnetic components
embayment	Recessed part of a shoreline
endangered species	A species that is in danger of extinction in all or a significant portion of its range
Endangered Species Act (ESA)–listed species	Species listed under the Endangered Species Act of 1973 (as amended)
ensonification	The process of filling with sound
environmental protection measure	Measure proposed to avoid or minimize potential impacts
environmental consequences	The potential direct, indirect, and cumulative impacts that the construction, operations and maintenance, and decommissioning of a proposed project would have on the environment
environmental justice communities	Minority and low-income populations potentially affected by a proposed project, as defined by both federal and applicable state criteria
epifauna	Fauna that lives on the surface of a seabed (or riverbed), or is attached to underwater objects or aquatic plants or animals
essential fish habitat (EFH)	"Those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (50 Code of Federal Regulations part 600)
export cable	Cable connecting the offshore wind facility to the onshore electrical grid power
export cable corridor	Area identified for routing the entire length of the onshore and offshore export cables
federal aids to navigation	Visual references operated and maintained by the United States Coast Guard, including radar transponders, lights, sound signals, buoys, and lighthouses, that support safe maritime navigation
fishes	Vertebrate and cartilaginous fish species, not including crustaceans, cephalopods, or other mollusks
for-hire commercial fishing	Commercial fishing on a for-hire vessel (i.e., a vessel on which the passengers contribute to a person having an interest in the vessel in exchange for carriage)
for-hire recreational fishing	Fishing from a vessel carrying a passenger for hire who is engaged in recreational fishing
frond mattress	Anti-scour protection consisting of aerated polyethylene fronds that when installed on the seabed will naturally float to resemble natural seaweed; as local currents transport sediment through the frond mattress strands encouraging sand, silt, or soil to be deposited onto the mattress, the frond mattress forms a natural fiber reinforced sand bank to protect the area in question
geomagnetic	Relating to the magnetism of the Earth
gravity-based structure	Typically constructed of steel, concrete, or a combination of both; gravity-based structures sit on top of the seafloor and are not pile driven
hard-bottom habitat	Benthic habitats composed of hard-bottom (e.g., cobble, rock, and ledge) substrates

Term	Definition
historic property	As defined in 36 Code of Federal Regulations 800.16(l)(1), a prehistoric or historic district, site, building, structure, or object that is eligible for or already listed in the National Register of Historic Places; also includes any artifacts, records, and remains (surface or subsurface) related to and located within such a resource
historical resource	There is no common or consistent legal definition for a historic resource; therefore, it is defined the same as an historic property; a prehistoric or historic district, site, building, structure, or object that is eligible for or already listed in the National Register of Historic Places; also includes any artifacts, records, and remains (surface or subsurface) related to and located within such a resource
horizontal directional drilling (HDD)	Trenchless technique for installing underground cables, pipes, and conduits using a surface-launched drilling rig
hull	Watertight frame or body of a ship
infauna	Fauna living in the sediments of the ocean floor (or river or lake beds)
interarray cables	Cables connecting the WTGs to the electrical service platforms
interdunal	Habitat between dunes
invertebrate	Animal with no backbone
jacket foundation	Latticed steel frame with three or four supporting piles driven into the seabed
jack-up vessel	Mobile and self-elevating platform with buoyant hull
jet excavation	Process of moving or removing soil with a jet
jet plowing	Plowing in which the jet plow, with an adjustable blade, or plow, rests on the seafloor and is towed by a surface vessel; the jet plow creates a narrow trench at the designated depth, while water jets fluidize the sediment within the trench
knot	Unit of speed equaling 1 nautical mile (1.8 kilometer) per hour
landfall site	The shoreline landing site at which the offshore cable transitions to onshore
marine mammal	Aquatic vertebrate distinguished by the presence of mammary glands, hair, three middle ear bones, and a neocortex (a region of the brain)
marine waters	Waters in offshore areas where bottom depth is more than 98.4 feet (30 meters)
mechanical cutter	Method of submarine cable installation equipment that involves a cutting wheel or excavation chain to cut a narrow trench into the seabed allowing the cable to sink under its own weight or be pushed to the bottom of the trench via a cable depressor
mechanical plow	Method of submarine cable installation equipment that involves pulling a plow along the cable route to lay and bury the cable; the plow's share cuts into the soil, opening a temporary trench, which is held open by the side walls of the share, while the cable is lowered to the base of the trench via a depressor; some plows may use additional jets to fluidize the soil in front of the share
metocean	The syllabic abbreviation of meteorology and oceanography; a metocean study is used to estimate the environmental conditions including the wind, wave, and climate conditions found at a certain location
monopile or monopile foundation	A long steel tube driven into the seabed that supports a tower
mooring dolphin	Isolated marine structure used for mooring and securing vessels near pier structures to control the transverse movement of vessels while docked
nautical mile (nm)	A unit used to measure sea distances and equivalent to approximately 1.15 miles (1.85 kilometers)
nearshore (waters)	Ocean area within 3 nautical miles of coast, also considered state waters
offshore (water)	See *outer continental shelf (OCS)* below

Term	Definition
offshore project area	The offshore components that collectively make up the California offshore project area include the lease areas, WTGs, OSSs, scour protection for foundations, interarray and substation interconnection cables, and offshore export cables
offshore substation (OSS)	The interconnection point between the WTGs and the export cable; the necessary electrical equipment needed to connect the interarray cables to the offshore export cables
onshore project area	The onshore components that collectively make up the California onshore project area include the landfall sites, the sea-to-shore transition that connects the offshore export cables to the onshore export cables, onshore export cable routes to onshore substations or converter stations, and the connection from the onshore substations or converter stations to the existing grid
onshore substation	Substation connecting a project to the existing bulk power grid system
operations and maintenance facilities	Would include offices, control rooms, warehouses, shop space, and pier space
Outer Continental Shelf (OCS)	All submerged land, subsoil, and seabed belonging to the United States but outside of states' jurisdiction
permanent threshold shift (PTS)	Affecting animals as a result of sound exposure, permanent threshold shift is an irreversible loss of hearing due to hair cell loss or other structural damage to auditory tissues
pile	A type of foundation akin to a pole
pile-driving	Installing foundation piles by driving them into the seafloor
pinnipeds	Carnivorous, semiaquatic marine mammals with fins, also known as seals
pin pile	Small-diameter pipe driven into the ground as foundation support
plume	Column of fluid moving through another fluid
private aids to navigation	Visual references on structures positioned in or near navigable waters of the United States, including radar transponders, lights, sound signals, buoys, and lighthouses, that support safe maritime navigation; permits for the aids are administered by United States Coast Guard
Proposed Action	Specifically Alternative C, under which mitigation measures would be adopted such that the potential impacts described in Alternative B may be avoided, reduced, or mitigated
protected species	Endangered or threatened species that receive federal protection under the Endangered Species Act of 1973 (as amended)
quay	Concrete, stone, or metal platform lying alongside or projecting into water for loading and unloading ships
Representative Project Design Envelope (RPDE)	The range of technical parameters that describe a wind energy project that could occur within the Humboldt and Morro Bay lease areas
rock bags	Bags constructed of mesh material filled with rock or rip rap, making it a flexible protection system for marine construction work
scour protection	Protection consisting of rock and stone that would be placed around all foundations to stabilize the seabed near the foundations as well as the foundations themselves
scrublands	Plant community dominated by shrubs and often also including grasses and herbs
seabed spacer	An underwater cable system designed to hold and protect cables
sessile	Attached directly by the base
silt substrate	Substrate made of a granular material originating from quartz and feldspar, and whose size is between sand and clay
soft-bottom habitat	Benthic habitats that include soft-bottom (i.e., unconsolidated sediments) and hard-bottom (e.g., cobble, rock, ledge) substrates

Term	Definition
spud barge	Sometimes called a jack-up barge, a spud barge is a specialized type of barge commonly used for marine construction operations; the barge is moored by steel shafts or through-deck piling, which are essentially pipes driven right into the soil or sand at the bottom of the water to provide stability
substrate	Earthy material at the bottom of a marine habitat; the natural environment that an organism lives in
suction-bucket jacket	Latticed steel frame with three to four supporting suction-bucket foundations securing the structure to the seabed
suspended sediments	Very fine particles that remain in suspension in water for a considerable period of time without contact with the bottom; such material remains in suspension due to the upward components of turbulence and currents, or by suspension
temporary threshold shift (TTS)	Affecting animals as a result of sound exposure, temporary threshold shift is a relatively short-term (e.g., within several hours or days), reversible loss of hearing following noise exposure, often resulting from hair cell fatigue
threatened species	A species that is likely to become endangered within the foreseeable future
tidal energy project	Project related to the conversion of the energy of tides into usable energy, usually electricity
tidal flushing	Replacement of water in an estuary or bay because of tidal flow
trawl	A large fishing net dragged by a vessel at the bottom or in the middle of sea or lake water
turbidity	A measure of water clarity
utility right-of-way	Registered easement on private land that allows utility companies to access the utilities or services located there
vibracore	Technology/technique for collecting core samples of underwater sediments and wetland soils
viewshed	Area visible from a specific location
visual resource	The visible physical features on a landscape, including natural elements such as topography, landforms, water, vegetation, and anthropogenic structures
wetland	Land saturated with water, and includes marshes and swamps
wind energy	Electricity from naturally occurring wind
wind energy area (WEA)	Areas with significant wind energy potential and defined by the Bureau of Ocean Energy Management (BOEM)
wind turbine generator (WTG)	Component that puts out electricity in a structure that converts kinetic energy from wind into electricity

Appendix K: List of Preparers and Reviewers

Table K-1. Bureau of Ocean Energy Management contributors

Name	Role/Resource Area
Gilbane, Lisa	Project Manager
Hunter, Melanie	Project National Environmental Policy Act (NEPA) Coordinator
Ryder, Abby	Outreach Coordinator
Keeler, Katsumi	Air Quality; Environmental Justice
Gilbane, Lisa/Hunter, Melanie	Water Quality
Reeb, Desray	Marine Mammals; Sea Turtles
Ho, Bert	Section 106 Consultation
Ball, Dave	Tribal Resources; Outreach
Pereksta, Dave	Birds; Bats
Schroeder, Donna	Benthic; Fish
Kojima-Clark, Alice	Benthic; Wetlands
McCarty, John	Visual Resources
Blazek, Matt	Navigation/Vessel Traffic
Biedron, Ingrid	Commercial Fishing
Webb, Stephanie	Demographics/Employment; Recreation and Tourism

Table K-2. Reviewers

Name	Agency
Bureau of Ocean Energy Management (BOEM) and U.S. Department of the Interior (DOI) Reviewers	
Gilbane, Lisa	BOEM
Cooperating and Participating Agency Reviewers	
Ise, Lilah	National Oceanic and Atmospheric Administration (NOAA) - National Marine Fisheries Service (NMFS)
Michael, Paul	NOAA - NMFS
Borack, Alexandra	California State Lands Commission (CSLC)
Calvo, Lucinda	CSLC
Dobroski, Nicole	CSLC
Garrett, Jamie	CSLC
Tuohy, Robin	CSLC
Vierra, Amy	CSLC
Wiermer, Michaela	CSLC
Flannery, Corianna	California Department of Fish and Wildlife (CDFW)
Hsu, Maya	California Ocean Protection Council (COPC)
Kimball, Justine	COPC
Wang, Yi-Hui	COPC

Name	Agency
Christen, Matt	California Coastal Commission (CCC)
McNair, Heather	CCC
Wyer, Holly	CCC
Anderson, Kari	California Energy Commission (CEC)
Barminski, Lizzie	CEC
Harland, Eli	CEC
Drexler, Dora	San Luis Obispo County Air Pollution Control District (SLO APCD)
Mutziger, Andy	SLO APCD
Strachan, Susan	SLO APCD
Tupper, Karl	SLO APCD
Jacob, Rod	Elk Valley
Stewart, Christa	Elk Valley
Mesher, Alex	Yurok Tribe
Newell, Michael	U.S. Coast Guard (USCG)
Zamora, Robert	USCG
Kat, Faick	California State Water Resources Control Board (State Water Board)

Table K-3. Consultants

Name	Role/Resource Area
ICF	
Baer, Sarah	Demographics, Employment, and Economics, Environmental Justice
Brown, Sheri	Scenic Resources and Viewer Experiences
Byram, Saadia	Support Editor
Cherry, Kenneth	Support Editor
Cook, John	Project Manager
Crawford, Karen	Indian Trust Assets/Tribal Values and Concerns Analysis
Cuevas Leber, Nicky	Senior Reviewer
Diller, Elizabeth	Program Director
Ernst, David	Air Quality
Gardner, Rachel	Bats, Birds
Ha, Anthony	Publications Specialist
Jones, Gray	Recreation and Tourism
Jost, Rebecca	Deputy Project Manager, Other Uses (Marine Minerals, Military Use, Aviation, Scientific Research and Surveys)
Lassell, Susan	Cultural Resources and Section 106 Lead
Lundstrom, Kristen	Lead Editor
Mayor, Jordan	Coastal Habitat and Fauna/Wetlands
Oberoi, Rabiya	Other Uses (Marine Minerals, Military Use, Aviation, Scientific Research and Surveys)
Piggott, Jennifer	Public Involvement Lead and Facilitator

Name	Role/Resource Area
Reed, Brent	Geographic information system (GIS) Lead
Schultz, Kait	Support Editor
Sukola, Katrina	Water Quality
Swanson, Megan	Project Coordinator, Land Use and Coastal Infrastructure
Thompson, Kate	Environmental Justice
Tsao, Danika	Bats, Birds
Valley, Nathalie	Navigation and Vessel Traffic
Warburton, Manna	Coastal Habitat and Fauna/Wetlands
Widdowson, Margaret	Coastal Habitat and Fauna/Wetlands
CSA Ocean Sciences Inc.	
Barkaszi, Mary Jo	Marine Mammals
Cady, Robert	Quality Assurance/Quality Control
Cahill, Melanie	CSA Project Manager
Hartigan, Kayla	Sea Turtles
Martin, Tony	Fishes, Invertebrates, and Essential Fish Habitat
McMahon, Adrianna	Benthic Resources
Tiggelaar, John	Commercial Fisheries and For-Hire Recreational Fishing

Appendix L: Distribution List

The Draft Programmatic Environmental Impact Statement (PEIS) is available in electronic form for public viewing at https://www.boem.gov/renewable-energy/state-activities/california. Hard copies and digital copies of the Draft PEIS can be requested by contacting the Bureau of Ocean Energy Management (BOEM) Pacific Region Office in Camarillo, California, at (805) 384-6305.

Publication of the Draft PEIS initiates a 45-day comment period where government agencies, members of the public, and other interested parties can provide comments and input. BOEM will accept comments in any of the following ways.

- In hard copy form, delivered by mail, enclosed in an envelope labeled "California OSW PEIS" and addressed to Lisa Gilbane, Environmental Analysis Section Chief, Bureau of Ocean Energy Management, 760 Paseo Camarillo, Suite 102 (CM 102), Camarillo, CA 93010.
- Through the regulations.gov web portal by navigating to https://www.regulations.gov/, searching for docket number "BOEM-2023-0061," and clicking the "Comment" button. Enter your information and comment and click "Submit Comment."
- By attending one of the public meetings at the location and dates listed in the Notice of Availability and providing written or verbal comments.

BOEM will use comments received during the public comment period to inform its preparation of the Final PEIS, as appropriate. Notification lists for the Draft PEIS are provided in Tables L-1 through L-4.

L.1 Notification List

Table L-1. Federal Agencies

Agency	Contact
Cooperating Federal Agencies	
National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS)	Lilah Ise
NOAA, National Marine Sanctuaries (NMS)	Paul Michel
U.S. Department of the Interior (DOI), Bureau of Safety and Environmental Enforcement (BSEE)	James Salmon
U.S. Army Corps of Engineers (USACE)	Kasey Sirkin Theresa Stevens
U.S. Coast Guard (USCG)	Michael Newell Robert Zamora
U.S. Environmental Protection Agency (USEPA) Region 9	Jason Gerdes

Table L-2. Cooperating Tribal Governments and State and Local Agencies

Agency	Contact
Cooperating Tribal Government	
Elk Valley Rancheria, California	Rod Jacob
Yurok Tribe	Alex Mesher
Cooperating State and Local Agencies	
California State Lands Commission (CSLC)	Amy Vierra
California Coastal Commission (CCC)	Holly Wyer Heather McNair
California Energy Commission (CEC)	Eli Harland
California State Water Resources Control Board (CSWRCB)	Kat Faick
Participating State and Local Agencies	
California Department of Fish and Wildlife (CDFW)	Corianna Flannery
California Ocean Protection Council (COPC)	Yi-Hui Wang
San Luis Obispo County Air Pollution Control District (SLO APCD)	Andy Mutziger

Table L-3. Tribal Nations

Tribal Nation	Contact
Amah Mutsun Tribal Band	Valentin Lopez
Barbareño Band of Chumash Indians	Eleanor Fishburn
Barbareño/Ventureño Band of Mission Indians	Matthew Vestuto
Bear River Band of Rohnerville Rancheria	Josefina Frank Melanie McCauvour
Big Lagoon Rancheria	Birgil Moorehead Claudia Brundin
Cher-Ae Heights Indian Community of the Trinidad Rancheria	Garth Sundberg
Coastal Band of the Chumash Nation	Gabriel Frausto
Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians	Brad Kneaper
Confederated Tribes of Umatilla Indian Reservation	Kathryn Brigham
Conquille Indian Tribe	Brenda Meade
Costanoan Rumsen Carmel Tribe	Tony Cerda
Elk Valley Rancheria, California	Dale Miller
Esselen Tribe of Monterey County	Tom Little Bear Nason
Hoh Indian Tribe	Dawn Gomez
Hoopa Valley Tribe	Joe Davis Keduescha Lara-Colegrove
Karuk Tribe	Russell Attebery
Makah Tribe	Timothy Green, Sr.
Northern Chumash Tribal Council	Violet Sage Walker
Ohlone/Costanoan Esselen Nation	Louise Miranda Ramirez

Tribal Nation	Contact
Quileute Tribe	Douglas Woodruff
Quinault Indian Nation	Guy Capoeman
Pulikla Tribe of Yurok People	Fawn Murphy
Resighini Tribe of Yurok People	Megan Rocha
Salinan Tribe of Monterey & San Luis Obispo Counties	Robert Piatti
Santa Rosa Rancheria Tachi	Shana Powers
Santa Ynez Band of Chumash Indians	Kenneth Kahn
Tolowa Dee-Ni` Nation	Jeri Lynn Thompson
Wiyot Tribe	Theodore Hernandez
Xolon Salinan Tribe	Karen White
yak tityu tityu yak tiłhini (ytt) - Northern Chumash Tribe of the San Luis Obispo County and Region	Mona Tucker
Yurok Tribe	Megan Siaosi

Table L-4.Section 106 consulting parties

Organization Type	Organization	Contact
Federal Government	Advisory Council on Historic Preservation	Christopher Daniel
	Bureau of Land Management California Coastal National Monument	Leiskya Parrott
Federally Recognized Tribes	Bear River Band of Rohnerville Rancheria	Josefina Frank Melanie McCauvour
	Coastal Band of the Chumash Nation	Gabriel Fraustro
	Makah Tribe	Chris Martinez
	Resighini Tribe of Yurok People	Megan Rocha
	Salinan Tribe of Monterey & San Luis Obispo Counties	Robert Piatti
	Santa Rosa Rancheria Tachi	Shana Powers
	Wiyot Tribe	Theodore Hernandez
	Yurok Tribe	Megan Siaosi
Other Potentially Interested Parties	Piedras Blancas Light Station Association	David Cooper
Preservation Organizations	Historical Society of Morro Bay	Glenn Silloway
	Monterey County Historical Society	James Perry
State Government	California State Lands Commission	Yessica Ramirez
State Government (SHPO)	California State Historic Preservation Office	Julianne Polanco
Lessees	OCS-P0561	RWE Offshore Wind Holdings, LLC
	OCS-P0562	California North Floating, LLC
	OCS-P0563	Equinor Wind US, LLC
	OCS-P0564	Golden State Wind, LLC
	OCS-P0565	Invenergy California Offshore, LLC

Appendix M Supplemental Information

M.1 Climate and Meteorology

The five commercial leases analyzed in this Draft Programmatic Environmental Impact Statement (PEIS) are OCS-P 0561, 0562, 0563, 0564, and 0565 (hereafter referred to as the lease areas), covering two wind energy areas (WEA) offshore California. Two lease areas offshore Northern California are within the Humboldt WEA and are approximately 21 miles (34 kilometers) from the city of Eureka. Three lease areas offshore Central California are within the Morro Bay WEA and are approximately 20 miles from the city of Morro Bay. The Humboldt WEA spans approximately 132,368 acres (206 square miles) and water depths range from approximately 1,640 to 3,609 feet (500 to 1,100 meters) (BOEM 2022a). The Morro Bay WEA spans approximately 240,898 acres (376 square miles) and water depths range from approximately 2,953 to 4,265 feet (900 to 1,300 meters) (BOEM 2022b).

Conditions that affect the weather and climate in an area include wind speed and direction, air temperature, and precipitation. Long-term averages of these conditions produce the regional climate. Over the open ocean, meteorological characteristics are fundamentally influenced by oceanographic conditions and are therefore sometimes jointly discussed as “metocean” conditions. In the Pacific, several metocean conditions are highly seasonal and driven by both atmospheric and oceanic circulation patterns. Daily variability in meteorological conditions will drive fluctuations in wind farm power production and associated stresses on the wind turbine generators (WTGs), while long-term performance may be estimated based on the climatic conditions.

M.1.1 Regional Climate Overview

The California coast is classified as a Mediterranean climate zone based on the Köppen Climate Classification System. The Mediterranean climate zone in California has three variations: one is the cool summer and cool winter climate found along the coast and the western slope of the Sierra Nevada mountains, the second is similar to the first but with frequent summer fog, and the third is an interior valley version with hotter summers and cooler winters (Kauffman 2003). In the summer, poleward extension and expansion of the subtropical anticyclone over the Pacific brings subsiding air to the California region, with clear skies and high temperatures. When the anticyclone moves Equator-ward in winter, it is replaced by traveling, frontal cyclones with their attendant precipitation (Britannica 2023).

Consistent with the larger Pacific region, the climate across California is highly variable and diverse (NOAA 2022). The deserts in the south are hot and dry, while higher elevations can experience low temperatures and heavy snowfall (NOAA 2022). Due to the moderating effect of the Pacific Ocean, coastal locations experience mild year-round temperatures, while inland locations experience a wider range of temperatures (NOAA 2022). Annual precipitation varies from less than 3 inches in Death Valley in the southeast to more than 100 inches near Eureka in the northwest (NOAA 2022). Precipitation is also highly variable from year to year, with statewide totals ranging from 7.9 inches in 2013 to 42.5 inches in 1983 (NOAA 2022). Because of California’s large north-south extent and the existence of several mountain ranges, extreme climate events often affect only a portion of the state (NOAA 2022).

Extreme precipitation events resulting in damaging flooding occur periodically and are often caused by atmospheric river events (NOAA 2022). Coastal areas in California are especially prone to flooding and sea level rise as over 200,000 people live 3 feet (0.9 meter) or less above sea level (Gonzalez et al. 2018). Periodic droughts also occur in California due to prolonged dry periods, which can be exacerbated by warm temperatures (NOAA 2022).

Climatic oscillations such as the Pacific Decadal Oscillation and El Nino Southern Oscillation can significantly alter the mean pressure and wind fields in coastal California (Kaplan et al. 2010). Surface winds along the Pacific seaboard are dynamic and primarily driven by three persistent, large-scale features of the surface atmospheric pressure field: the North Pacific High, the Aleutian Low, and the Thermal Low (Kaplan et al. 2010). The North Pacific High is a climatological mean surface high pressure pattern that is typically situated over the eastern North Pacific and drives the winds southward along the California coast (Kaplan et al. 2010). The Aleutian Low is a mean surface low-pressure pattern that is typically situated over the Gulf of Alaska and drives the winds northward along affected portions of the California coast. The Thermal Low is a mean surface low-pressure pattern caused by local surface heating in the southwest United States and assists the North Pacific High in driving winds southward along the California coast (Kaplan et al. 2010).

The United States Southwest region is currently subject to climate changes associated with global warming that are primarily attributed to human activities, especially the production of heat-trapping gases (i.e., greenhouse gases [GHG]) (Gonzalez et al. 2018; Hayhoe et al. 2018; IPCC 2021). The average annual temperature of the Southwest region increased 1.6 degrees Fahrenheit (°F) (increase of 0.9 degree Celsius [°C]) between 1901 and 2016 (Gonzalez et al. 2018). According to the National Oceanic and Atmospheric Administration (NOAA), temperatures in California have risen almost 3°F (1.7°C) since the beginning of the 20th century (NOAA 2022). Higher temperatures have intensified severe droughts in California and the Colorado River Basin, threatening water supplies to the Southwest region (Gonzalez et al. 2018). Hotter temperatures have already contributed to reductions of seasonal snowpack and its water content over the past 30 to 65 years (Gonzalez et al. 2018). Increased temperatures further cause increased evapotranspiration, which reduces the effectiveness of precipitation in replenishing soil moisture and surface water (Gonzalez et al. 2018). In addition, sea level has risen 9 inches (22 centimeters) between 1854 and 2016 at the Golden Gate Bridge in San Francisco, California (Gonzalez et al. 2018). In San Diego, sea level rose 9.5 inches (24 centimeters) from 1906 to 2016 (Gonzalez et al. 2018). California's coastal oceans have also warmed by approximately 1.26°F (0.7°C) from 1900 to 2016 (Bedsworth et al. 2018). Ocean water acidity off the coast of California increased 25 percent to 40 percent (decreases of 0.10 to 0.15 pH units) from the preindustrial area (circa 1750) due to increasing concentrations of atmospheric carbon dioxide from human activities (Gonzalez et al. 2018). Refer to Section M.1.3, *Projected Future Climate*, for additional information regarding projected future climate changes in the California offshore area.

M.1.2 Current Meteorology, Visibility, and Climate Trends

This section incorporates by reference the *Meteorological Conditions Report, Humboldt Offshore Wind Call Area* (ESS Group, Inc. 2019a) and *Meteorological Conditions Report, Morro Bay and Diablo Canyon Offshore Wind Call Area* (ESS Group, Inc. 2019b) prepared for the Bureau of Ocean Energy Management

(BOEM) to assist in understanding the meteorological conditions experienced in this area and how they may influence the visibility of a wind energy project. Results from these reports are summarized in this appendix.

M.1.2.1 Meteorological Conditions

Table M.1-1 and Table M.1-2 present representative seasonal and annual meteorological conditions observed at the Arcata-Eureka Airport for the Humboldt WEA and at the San Luis County Regional Airport for the Morro Bay WEA and the frequency of occurrence and distribution of clear, foggy, rainy, hazy, and cloudy conditions. The data have been rounded to whole-day values. The topmost data group presents the average number of days per season/per year when each of the five conditions was observed to occur at least for 1 hour during the daylight period. These numbers are independent of each other and should not be summed, as multiple tallies could occur in any single daylight period. For example, clouds and fog could occur in the early morning, giving way to clear skies later in the morning. A thunderstorm could occur in the late afternoon. In that case, clear, cloudy, rainy, and foggy conditions would all occur for at least 1 hour.

The second data grouping characterizes days when each day is clear, cloudy, rainy, foggy, or hazy and only a single tally is made for any daylight period. This characterization is based on which of the five meteorological conditions occur for at least 50 percent of the hours in the daylight period. These numbers can be summed to equal to the number of valid daylight periods occurring during the year.

The third data group presents the distribution of the five meteorological conditions during daylight hours as a percentage. Each hour is characterized as clear, foggy, rainy, hazy, or cloudy. The percentages of the five meteorological conditions can be summed to equal 100 percent.

The fourth data group presents the distribution of the five meteorological conditions during nighttime hours as a percentage. Each hour is characterized as clear, foggy, rainy, hazy, or cloudy. The percentages of the five meteorological conditions can be summed to equal 100 percent.

M.1.2.1.1 Humboldt WEA

Table M.1-1. Summary of meteorological conditions, Humboldt WEA

Condition	Winter	Spring	Summer	Autumn	Annual
Days/Years with One or More Daylight Observations					
Clear	66	70	59	70	266
Foggy	11	10	34	15	71
Rainy	30	22	13	27	91
Hazy	3	7	8	4	22
Cloudy	66	81	85	63	295

Condition	Winter	Spring	Summer	Autumn	Annual
Days/Years with 50% or More Daylight Observations					
Clear	40	33	22	42	137
Foggy	2	<1	6	4	13
Rainy	10	4	<1	6	20
Hazy	<1	<1	<1	<1	<1
Cloudy	27	47	58	28	161
Distribution of Hourly Daylight Observations (%)					
Clear	44	37	27	48	38
Foggy	4	2	10	6	6
Rainy	19	10	3	13	10
Hazy	<1	<1	1	<1	<1
Cloudy	33	50	60	33	46
Distribution of Hourly Nighttime Observations (%)					
Clear	48	56	55	50	52
Foggy	2	<1	4	4	3
Rainy	16	8	1	11	10
Hazy	3	1	2	3	3
Cloudy	31	33	38	31	33

Clear conditions occur for at least 1 hour during daylight 266 days per year, with seasonal values ranging from 59 days during summer to 70 days during autumn and winter. Cloudy conditions occur 295 days per year, with seasonal values ranging from 63 days in autumn to 85 days in summer. Fog occurred 71 days per year. Seasonal values range from 10 days in spring to 34 days in summer. Rain, without associated fog, occurred 91 days per year. Seasonal values range from 13 days in summer to 30 days in winter. Haze occurred about 22 days per year, ranging from 3 days in winter to 8 days in summer.

Days were characterized as clear, foggy, rainy, hazy, or cloudy based on an occurrence of the meteorological condition during 50 percent or more of daylight hours. Clear days occurred 137 days per year, with seasonal values ranging from 22 days in summer to 42 days in autumn. Foggy days occurred 13 days per year, with seasonal values ranging from less than 1 day in spring to 6 days in summer. Rainy days occurred 20 days per year, ranging from less than 1 day in summer to 10 days in winter. Haze occurred less than 1 day both annually and seasonally. Cloudy days occurred 161 days per year, ranging from 27 days in winter to 58 days in summer.

Clear conditions occurred during 38 percent of the daylight hours over the course of the year, with seasonal values ranging from 27 percent in summer to 48 percent in autumn. Fog occurred 6 percent of the time, with seasonal values ranging from 2 percent in spring to 10 percent in summer. Rain, without associated fog, occurred 10 percent of the time, with seasonal values ranging from 3 percent in summer to 19 percent in winter. Cloudy conditions, without associated fog or rain, occurred 46 percent of the time, with seasonal values ranging from 33 percent in autumn and winter to 60 percent in summer. Haze occurred 3 percent of the time, with seasonal values ranging from 1 percent in autumn to 6 percent in summer.

Clear conditions occurred during 60 percent of the nighttime hours over the course of the year, with seasonal values ranging from 57 percent in autumn to 63 percent in winter. Fog occurred 2 percent of the time, with seasonal values ranging from less than 1 percent in summer to 2 percent in spring. Rain, without associated fog, occurred 19 percent of the time, with seasonal values ranging from 18 percent in summer to 20 percent in autumn and winter. Cloudy conditions, without associated fog or rain, occurred 17 percent of the time, with seasonal values ranging from 14 percent in summer to 20 percent in autumn. Haze occurred less than 1 percent of the time, with seasonal values ranging from less than 1 percent in autumn, spring, and winter to 1 percent in summer.

M.1.2.1.2 Morro Bay WEA

Table M.1-2. Summary of meteorological conditions, Morro Bay WEA

Condition	Winter	Spring	Summer	Autumn	Annual
Days/Years with One or More Daylight Observations					
Clear	79	85	86	80	331
Foggy	11	9	9	14	40
Rainy	18	8	2	10	38
Hazy	2	4	7	2	16
Cloudy	49	64	76	49	237
Days/Years with 50% or More Daylight Observations					
Clear	60	52	41	61	214
Foggy	2	<1	<1	3	5
Rainy	6	<1	<1	2	9
Hazy	<1	<1	<1	<1	<1
Cloudy	22	36	36	20	125
Distribution of Hourly Daylight Observations (%)					
Clear	66	57	50	65	59
Foggy	3	2	1	4	3
Rainy	6	2	2	2	3
Hazy	<1	<1	1	<1	<1
Cloudy	25	38	46	28	35
Distribution of Hourly Nighttime Observations (%)					
Clear	70	78	86	78	77
Foggy	<1	<1	<1	<1	<1
Rainy	5	2	1	3	3
Hazy	<1	<1	<1	<1	<1
Cloudy	25	20	12	18	19

Clear conditions occur for at least 1 hour during daylight 331 days per year, with seasonal values ranging from 79 days during winter to 86 days during summer. Cloudy conditions occur 237 days per year, with seasonal values ranging from 49 days in autumn and winter to 76 days in summer. Fog occurred 40 days per year. Seasonal values range from 9 days in spring and summer to 18 days in winter. Rain, without associated fog, occurred 38 days per year. Seasonal values range from 2 days in summer to 18 days in winter. Haze occurred about 16 days per year, ranging from 2 days in winter and spring to 9 days in autumn.

Days were characterized as clear, foggy, rainy, hazy, or cloudy based on an occurrence of the meteorological condition during 50 percent or more of daylight hours. Clear days occurred 214 days per year, with seasonal values ranging from 41 days in summer to 61 days in autumn. Foggy days occurred 5 days per year, with seasonal values ranging from less than 1 day in spring and summer to 3 days in autumn. Rainy days occurred 9 days per year, ranging from less than 1 day in spring and summer to 9 days in winter. Haze occurred less than 1 day both annually and seasonally. Cloudy days occurred 125 days per year, ranging from 20 days in autumn to 46 days in summer.

Clear conditions occurred 59 percent of the daylight hours over the course of the year, with seasonal values ranging from 57 percent in summer to 66 percent in winter. Fog occurred 3 percent of the time, with seasonal values ranging from 1 percent in summer to 3 percent in autumn. Rain, without associated fog, occurred 3 percent of the time, with seasonal values ranging from 2 percent in spring, summer, and autumn to 6 percent in winter. Cloudy conditions, without associated fog or rain, occurred 35 percent of the time, with seasonal values ranging from 25 percent in winter to 46 percent in summer. Haze occurred 1 percent of the time, with seasonal values ranging from less than 1 percent in winter, spring, and autumn to 1 percent in summer.

Clear conditions occurred during 77 percent of the nighttime hours over the course of the year, with seasonal values ranging from 70 percent in winter to 86 percent in summer. Fog occurred less than 1 percent of the time, both annually and seasonally. Rain, without associated fog, occurred 3 percent of the time, with seasonal values ranging from 1 percent in summer to 5 percent in winter. Cloudy conditions, without associated fog or rain, occurred 19 percent of the time, with seasonal values ranging from 12 percent in summer to 25 percent in autumn. Haze occurred less than 1 percent of the time both annually and seasonally.

M.1.2.2 Visibility

Visibility observations in the National Weather Service surface data are limited to a maximum of 10 statute miles; therefore, in order to evaluate visibility at the 20-nautical-mile (nm) and 30-nm distances, a methodology was developed using the observed visibility (out to 10 statute miles) and a relational algorithm.

Hourly surface observations from Eureka for the Humboldt WEA and from San Luis County for the Morro Bay WEA do not include calculated relative humidity values. Relative humidity is calculated from ambient and dew point temperatures, which were also included in the data record. As previously stated, relative humidity values are not provided in the data record. These values are calculated using the temperature observations. There were some missing relative humidity values; however, in every case, this appears to be because there were insufficient temperature data to perform the relative humidity calculation.

Visibility calculations were performed for each hour with a valid relative humidity. The calculated distance was compared to the observed distance to determine which value to carry forward in the analysis. Observations up to 10 statute miles used the observed value. Observations at 10 statute miles used the greater of the observed or calculated value.

Table M.1-3 and Table M.1-4 present representative estimated visibility distances and the frequency of occurrence of visibility greater than 10, 20, and 30 nm, along with the average visibility for clear, foggy, rainy, hazy, and cloudy conditions. The topmost data group presents the average number of days per season/per year that there was at least 1 hour when visibility was at least 10, 20, and 30 nm during a daylight period. The count for the 20- and 30-nm entries are also contained in the 10-nm entry. The count for the 30-nm entry is also contained in the 20-nm count.

The second and third data groups present the number of days per season/per year that visibility exceeded 10, 20, and 30 nm during at least 50 percent and 75 percent of the daylight hours. As is the case with the topmost data group, the 20-nm and 30-nm values are subsets of the 10-nm values. The 30-nm values are subsets of the 20-nm values.

The last two data groups present the average seasonal and annual visibility distance for clear, foggy, rainy, hazy, and cloudy conditions for daylight and nighttime hours. The annual and seasonal averages were determined by taking a weighted average of the five meteorological conditions.

Observations up to 10 statute miles used the observed value and observations reported as 10 statute miles in the data used the greater of the observed or calculated value, resulting in a conservative estimate of visibility. Table M.1-3 and Table M.1-4 present a summary of the visibility results.

M.1.2.2.1 Humboldt WEA

Table M.1-3. Summary of visibility, Humboldt WEA

Distance	Winter	Spring	Summer	Autumn	Annual
Days/Years with One or More Daylight Observations					
10 nm	43	56	34	38	171
20 nm	17	17	8	17	58
30 nm	6	5	4	7	23
Days/Years with 50% or More Daylight Observations					
10 nm	9	5	<1	9	24
20 nm	3	<1	<1	3	6
30 nm	<1	<1	<1	<1	1
Days/Years with 75% or More Daylight Observations					
10 nm	5	2	<1	5	12
20 nm	1	<1	<1	<1	2
30 nm	<1	<1	<1	<1	<1

Distance	Winter	Spring	Summer	Autumn	Annual
Average Daylight Visibility (nm)					
Clear	10	10	9	10	10
Foggy	<1	<1	<1	<1	<1
Rainy	6	6	4	6	6
Hazy	4	4	4	4	4
Cloudy	9	8	6	9	8
Average	9	9	6	8	8
Average Nighttime Visibility (nm)					
Clear	14	14	10	14	13
Foggy	<1	<1	<1	<1	<1
Rainy	6	6	5	6	6
Hazy	4	5	4	4	4
Cloudy	10	10	8	10	9
Average	11	12	9	11	11

Visibility of at least 10 nm occurred for at least 1 hour during daylight 171 days per year, with seasonal values ranging from 34 days during summer to 56 days during spring. Visibility to 20 nm occurred 58 days per year, with seasonal values ranging from 8 days in summer to 17 days in the other seasons. Visibility extended to 30 nm for 23 days per year. Seasonal values range from 4 days in summer to 7 days in autumn.

Visibility extended to 10 nm for 50 percent or more of the daylight hours 24 days per year, with seasonal values ranging from less than 1 day in summer to 9 days in winter and autumn. Visibility to 20 nm occurred 6 days per year, ranging from less than 1 day in summer to 3 days in winter and autumn. Visibility to 30 nm occurred 1 day per year. Values were less than 1 day in all four seasons.

Visibility extended to 10 nm for 75 percent or more of the daylight hours 12 days per year, with seasonal values ranging from less than 1 day in summer to 5 days in winter and autumn. Visibility to 20 nm occurred 2 days per year, ranging from less than 1 day in spring, summer, and autumn to 1 day in winter. Visibility to 30 nm occurred less than 1 day per year. Values were less than 1 day in all four seasons.

The average daylight visibility for clear conditions was 10 nm, with little variability seasonally. Cloudy conditions reduce the average visibility to 8 miles, ranging from 6 nm in summer to 9 nm in winter and autumn. Rainy, hazy, and foggy conditions have an average visibility of 6, 4, and less than 1 nm, respectively. These visibilities are consistent through the year. The average daylight visibility in winter, spring, summer, and autumn, regardless of meteorological condition, is 9, 9, 6, and 8 nm, respectively.

The average nighttime visibility for clear conditions is 13 nm, with seasonal values ranging from 10 nm in summer to 14 nm in winter, spring, and autumn. Cloudy conditions reduce the average visibility to 9 nm, with little seasonal variability. Rainy, hazy, and foggy conditions have an average visibility of 6, 4, and less than 1 nm, respectively. These visibilities are consistent through the year. The average nighttime visibility in winter, spring, summer, and autumn, regardless of meteorological condition, is 11, 12, 9, and 11 nm, respectively.

M.1.2.2.2 Morro Bay WEA

Table M.1-4. Summary of visibility, Morro Bay WEA

Distance	Winter	Spring	Summer	Autumn	Annual
Days/Years with One or More Daylight Observations					
10 nm	43	56	34	38	171
20 nm	17	17	8	17	58
30 nm	6	5	4	7	23
Days/Years with 50% or More Daylight Observations					
10 nm	9	5	<1	9	24
20 nm	3	<1	<1	3	6
30 nm	<1	<1	<1	<1	1
Days/Years with 75% or More Daylight Observations					
10 nm	5	2	<1	5	12
20 nm	1	<1	<1	<1	2
30 nm	<1	<1	<1	<1	<1
Average Daylight Visibility (nm)					
Clear	10	10	9	10	10
Foggy	<1	<1	<1	<1	<1
Rainy	6	6	4	6	6
Hazy	4	4	4	4	4
Cloudy	9	8	6	9	8
Average	9	9	6	8	8
Average Nighttime Visibility (nm)					
Clear	14	14	10	14	13
Foggy	<1	<1	<1	<1	<1
Rainy	6	6	5	6	6
Hazy	4	5	4	4	4
Cloudy	10	10	8	10	9
Average	11	12	9	11	11

Visibility of at least 10 nm occurred for at least 1 hour during daylight 317 days per year, with seasonal values ranging from 70 days during winter and autumn to 89 days during spring. Visibility to 20 nm occurred 249 days per year, with seasonal values ranging from 42 days in winter to 76 days in spring. Visibility extended to 30 nm for 114 days per year. Seasonal values range from 21 days in winter to 36 days in spring.

Visibility extended to 10 nm for 50 percent or more of the daylight hours 108 days per year, with seasonal values ranging from 12 days in summer to 36 days in autumn. Visibility to 20 nm occurred 41 days per year, ranging from 3 days in summer to 17 days in autumn. Visibility to 30 nm occurred 15 days per year. Seasonal values ranged from less than 1 day in summer to 8 days in autumn.

Visibility extended to 10 nm for 75 percent or more of the daylight hours 76 days per year, with seasonal values ranging from 7 days in summer to 28 days in autumn. Visibility to 20 nm occurred 28 days per year, ranging from 1 day in summer to 13 days in autumn. Visibility to 30 nm occurred 10 days per year. Seasonal values ranged from less than 1 day in summer to 6 days in autumn.

The average daylight visibility for clear conditions was 16 nm, with seasonal values ranging from 15 nm in winter and summer to 18 nm in autumn. Cloudy conditions reduce the average visibility to 9 miles, ranging from 8 nm in summer to 10 nm in winter and autumn. Rainy, hazy, and foggy conditions have an average visibility of 5, 5, and less than 1 nm, respectively. These visibilities are consistent through the year. The average daylight visibility in winter, spring, summer, and autumn, regardless of meteorological condition, is 13, 13, 11, and 14 nm, respectively.

The average nighttime visibility for clear conditions is 25 nm, with seasonal values ranging from 23 nm in spring and summer to 27 nm in autumn. Cloudy conditions reduce the average visibility to 16 miles, with little seasonal variability. Visibility for rainy conditions is 6 nm, with seasonal values ranging from 5 nm in winter to 14 nm in summer. Visibility for foggy conditions is less than 1 nm, with seasonal values consistent throughout the year. Visibility for hazy conditions is 10 nm, ranging from 5 nm in spring to 12 nm in autumn. The average nighttime visibility in winter, spring, summer, and autumn, regardless of meteorological condition, is 22, 21, 22, and 24 nm, respectively.

M.1.2.3 Effect of Haze on Visibility

M.1.2.3.1 Humboldt WEA

As shown in Table M.1-3, haze can reduce visibility. Clear skies, on average, result in daytime visibilities of 9 to 10 nm, whereas hazy skies result in an average visibility of approximately 4 nm, with little seasonal variability. This represents an approximately 60-percent reduction in visibility.

Nighttime hazy skies result in average visibilities of 4 nm compared to 13 nm for clear conditions. In winter, clear skies have an average visibility of 14 nm compared to 4 nm for hazy skies. This represents an approximately 71-percent reduction in visibility. In spring, visibility decreases from 14 nm for clear conditions to 5 nm for hazy conditions, a reduction of approximately 64 percent. In summer, the average visibility for clear skies is 10 nm compared to 4 nm for hazy skies, representing a 60-percent reduction in visibility. In autumn, clear skies have an average visibility of 13 nm, compared to 4 nm for hazy conditions, an approximately 69-percent reduction in visibility.

M.1.2.3.2 Morro Bay WEA

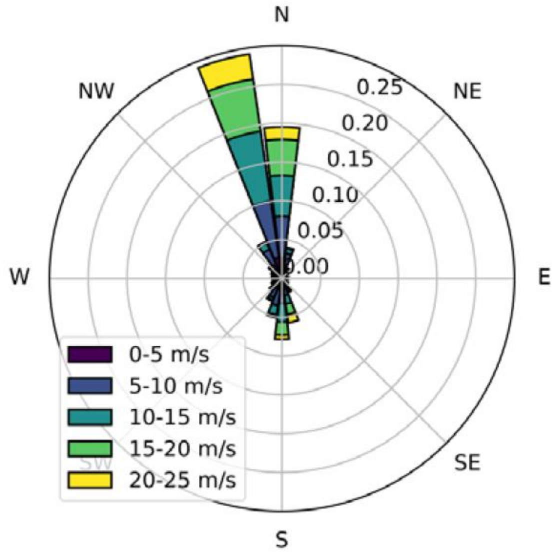
As shown in Table M.1-4, haze can reduce visibility. Clear skies, on average, result in daytime visibilities of 15 to 18 nm, whereas hazy skies result in an average visibility of 4 to 8 nm. This represents an approximately 50-percent reduction in visibility.

Nighttime hazy skies result in average visibilities of 10 nm compared to 25 nm for clear conditions. In winter, clear skies have an average visibility of 25 nm compared to 8 nm for hazy skies. This represents an approximately 67-percent reduction in visibility. In spring, visibility decreases from 23 nm for clear conditions to 5 nm for hazy conditions, a reduction of approximately 78 percent. In summer, the average visibility for clear skies is 23 nm compared to 10 nm for hazy skies, representing a 57-percent reduction in visibility. In autumn, clear skies have an average visibility of 27 nm, compared to 12 nm for hazy conditions, an approximately 56-percent reduction in visibility.

M.1.2.4 Winds

The prevailing wind directions in both the Humboldt WEA and Morro Bay WEA are extremely consistent from the north-northwest, with the prevailing winds in the Humboldt WEA originating from about 15 degrees northward of those in the Morro Bay WEA (Cooperman et al. 2022). In the Humboldt WEA, mean wind speeds at a height of 100 meters are between 9.75 meters per second (m/s) and 11.0 m/s. In the Morro Bay WEA, mean wind speeds at a height of 100 meters are between 9.0 m/s and 10.0 m/s (Cooperman et al. 2022). There is little difference in the wind speed and direction between hub heights of 100 meters and 150 meters in both WEAs (Cooperman et al. 2022).

During the day, wind speeds in both WEAs tend to dip slightly in the morning and peak in the midafternoon to early evening (Cooperman et al. 2022). Average wind speeds in the Humboldt WEA are more consistent throughout the day compared to the Morro Bay WEA, although there is some seasonal variation with the highest wind speeds observed in the summer (Cooperman et al. 2022). The average wind speed in the Morro Bay WEA reaches a lower minimum compared to the Humboldt WEA, and the difference between the minimum and maximum wind speeds is larger, producing a steeper rise to the evening peak (Cooperman et al. 2022). Wind speeds and directions for the Humboldt WEA and Morro Bay WEA are provided below in Figure M.1-1 and Figure M.1-2, respectively (Cooperman et al. 2022; Optis et al. 2020).



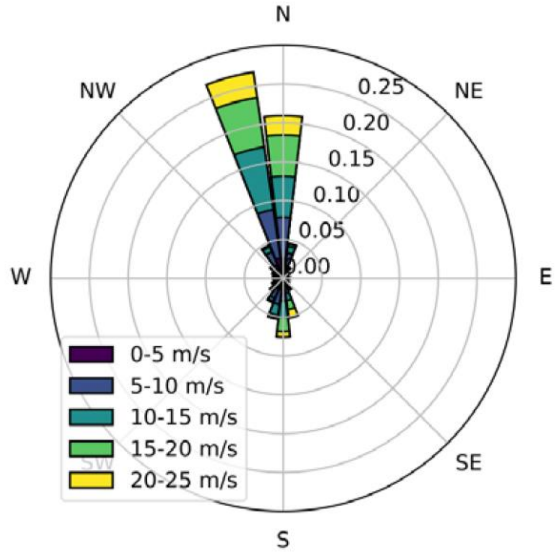
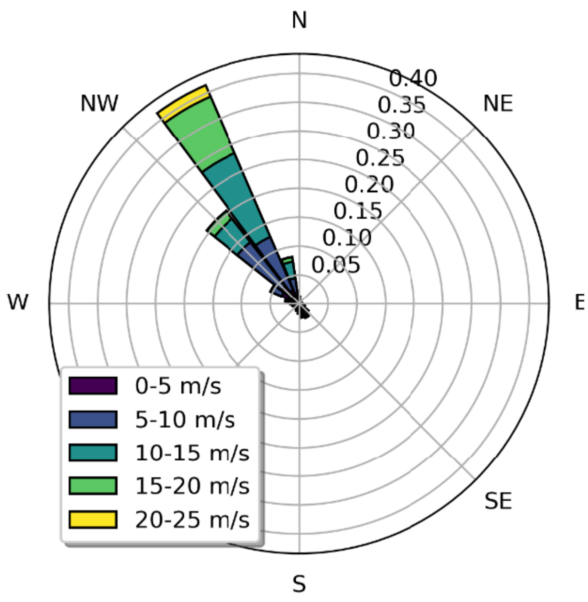


Figure M.1-1. Wind roses at 100 meters (left) and 150 meters (right) above mean sea level at the centroid of the Humboldt WEA for 2000–2019

Sources: Cooperman et al. 2022; Optis et al. 2020



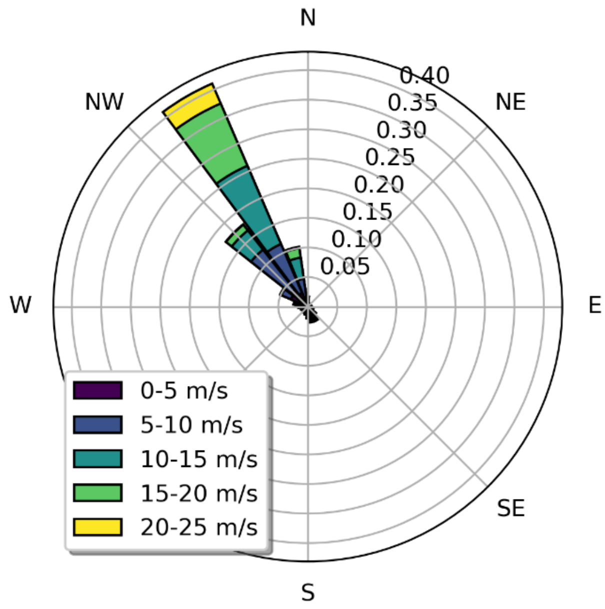


Figure M.1-2. Wind roses at 100 meters (left) and 150 meters (right) above mean sea level at the centroid of the Morro Bay WEA for 2000–2019

Sources: Cooperman et al. 2022; Optis et al. 2020

In addition to the wind data presented above, representative data for wind speed and wind direction are publicly available from NOAA's National Data Buoy Center for the Eel River Buoy (Buoy No. 44022) (NOAA 2023a) and the Cape San Martin Buoy (Buoy No. 46028) (NOAA 2023b). The Eel River Buoy is near the Humboldt WEA at latitude 40.713, longitude -124.540 and is 17 nm west-southwest of the city of Eureka (NOAA 2023a). The Cape San Martin Buoy is near the Morro Bay WEA at latitude 35.770, longitude -121.903 and is 55 nm northwest of the city of Morro Bay (NOAA 2023b).

The most recent data available from the Eel River Buoy, near the Humboldt WEA, are for January 2017 through December 2022. The maximum wind speed[1] recorded during this period was 50.1 miles per hour (mph) (21.2 m/s) in 2017, with average wind speeds from 11.3 to 14.1 mph (5.1 to 6.3 m/s) across these 6 years (Table M.1-5). Using 2022 as an example year to consider monthly averages, the maximum wind speed was recorded in December 2022 at 46.5 mph (20.8 m/s) and the highest average monthly wind speed of was recorded in February 2022 at 15.3 mph (6.8 m/s) (Table M.1-6). The average wind direction for all seasons between 2017 and 2022 was from the north.

[1] NOAA buoy measurements for wind speed are averaged over an 8-minute period. Higher speeds are recorded for 5- to 8-second gusts.

Table M.1-5. Annual average and maximum wind speed and direction at Eel River Buoy (Buoy No. 46022) from January 2017 to December 2022

Year	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
2017	13.3	5.9	50.1	22.4	349 (North)
2018	11.3	5.1	42.3	18.9	4 (North)
2019	14.1	6.3	46.8	20.9	24 (Northeast)
2020	11.9	5.3	42.1	18.8	3 (North)
2021	13.5	6.0	45.9	20.5	357 (North)
2022	11.8	5.3	46.5	20.8	7 (North)

Source: NOAA 2023a
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

Table M.1-6. Monthly average and maximum wind speed and direction at Eel River Buoy (Buoy No. 46022) in 2022

Season	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
January	11.5	5.2	41.2	18.4	79 (Northeast)
February	15.3	6.8	36.2	16.2	356 (North)
March	14.0	6.3	35.8	16.0	358 (North)
April	13.9	6.2	38.3	17.1	357 (North)
May	14.4	6.4	36.9	16.5	336 (Northwest)
June	11.8	5.3	30.6	13.7	346 (Northwest)
July	9.3	4.2	27.1	12.1	349 (Northwest)
August	10.3	4.6	26.8	12.0	3 (North)
September	8.6	3.9	30.2	13.5	13 (Northeast)
October	8.8	3.9	23.0	10.3	22 (Northeast)
November	9.2	4.1	34.2	15.3	75 (Northeast)
December	14.1	6.3	46.5	20.8	334 (Northwest)

Source: NOAA 2023a
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

The most recent data available from the Cape San Martin Buoy, near the Morro Bay WEA, are for January 2017 through December 2022. The maximum wind speed[2] recorded during this period was 40.7 mph (18.2 m/s) in 2019, with average wind speeds from 12.8 to 15.3 mph (5.7 to 6.8 m/s) across these 6 years (Table M.1-7). Using 2022 as an example year to consider monthly averages, the maximum wind speed was recorded in the April 2022 at 39.4 mph (17.6 m/s) and the highest average monthly wind speed was recorded in May 2022 at 21.8 mph (9.7 m/s) (Table M.1-8). The average wind direction for all seasons between 2017 and 2022 was from the northwest.

[2] NOAA buoy measurements for wind speed are averaged over an 8-minute period. Higher speeds are recorded for 5- to 8-second gusts.

Table M.1-7. Annual average and maximum wind speed and direction at Cape San Martin Buoy (Buoy No. 46028) from January 2017 to December 2022

Year	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
2017	14.9	6.7	38.5	17.2	320 (Northwest)
2018	12.8	5.7	36.9	16.5	326 (Northwest)
2019	13.4	6.0	40.7	18.2	326 (Northwest)
2020	14.6	6.5	38.3	17.1	317 (Northwest)
2021	14.6	6.5	38.9	17.4	317 (Northwest)
2022	15.3	6.8	39.4	17.6	324 (Northwest)

Source: NOAA 2023b
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

Table M.1-8. Monthly average and maximum wind speed and direction at Cape San Martin Buoy (Buoy No. 46028) in 2022

Season	Average Wind Speed		Maximum Wind Speed		Average Wind Direction
	mph	m/s	mph	m/s	Degrees from True North
January	10.4	4.7	33.6	15.0	327 (Northwest)
February	13.0	5.8	32.7	14.6	325 (Northwest)
March	18.6	8.3	33.1	14.8	322 (Northwest)
April	19.8	8.9	39.4	17.6	320 (Northwest)
May	21.8	9.7	38.3	17.1	323 (Northwest)
June	19.3	8.6	34.9	15.6	318 (Northwest)
July	16.1	7.2	34.0	15.2	327 (Northwest)
August	13.2	5.9	31.8	14.2	326 (Northwest)
September	14.7	6.6	32.7	14.6	325 (Northwest)
October	13.7	6.1	32.0	14.3	332 (Northwest)
November	12.8	5.7	32.4	14.5	330 (Northwest)
December	10.2	4.6	31.1	13.9	302 (Northwest)

Source: NOAA 2023b
Note: NOAA buoy measurements for wind speed are averaged over an 8-minute period.

Wind roses representative of the potential ports to be used during construction, operation, and decommissioning of the project are provided below based on data from the Iowa State University's Iowa Environmental Mesonet. The representative wind roses are provided in order from north to south for the following ports: Port of Humboldt Bay, Morro Bay, Port of San Luis, Port of Hueneme, Port of Los Angeles, and Port of Long Beach.

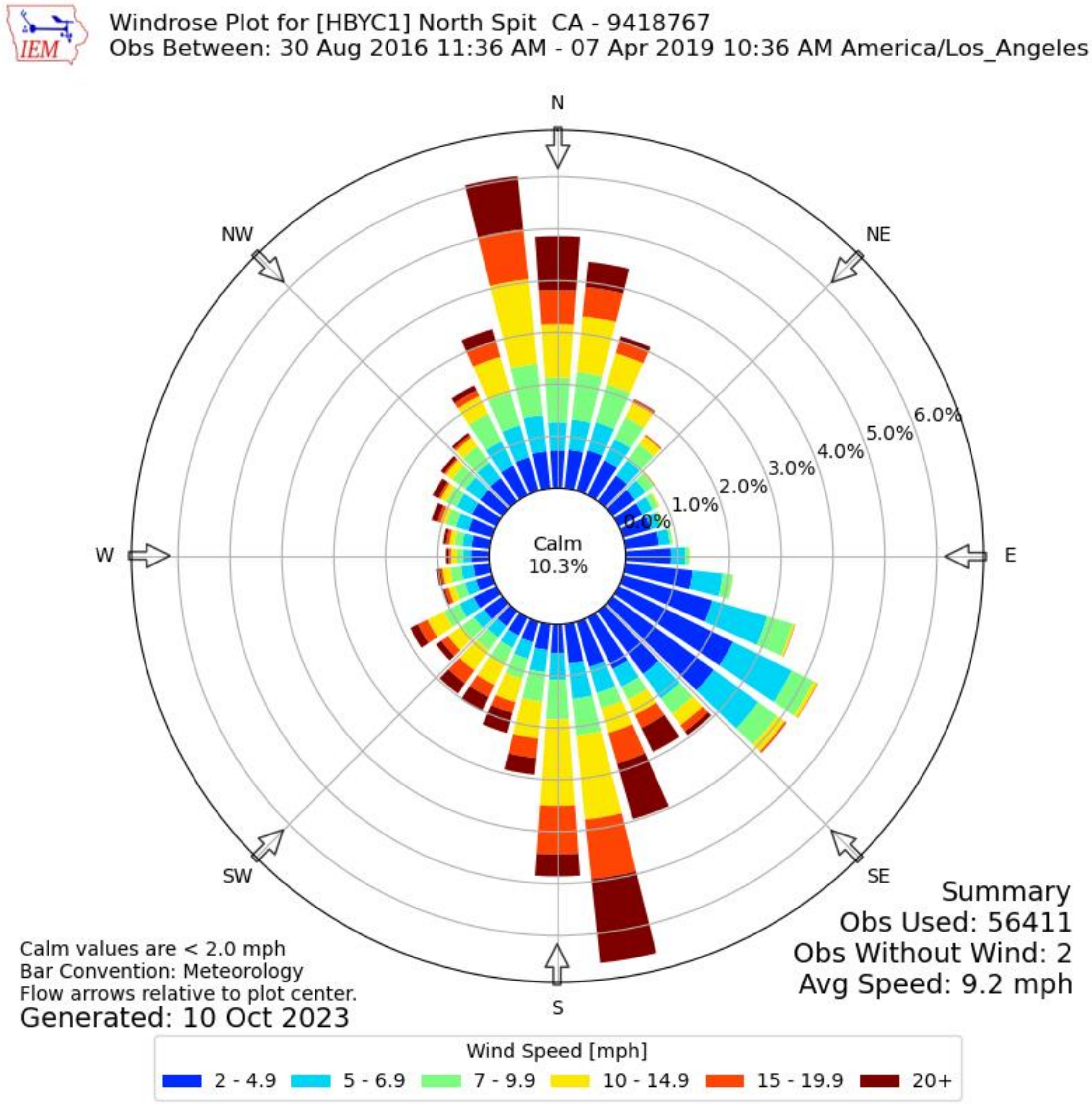


Figure M.1-3. Wind rose representative of Port of Humboldt collected at North Spit from August 2016–April 2019

Source: Iowa State University 2024a

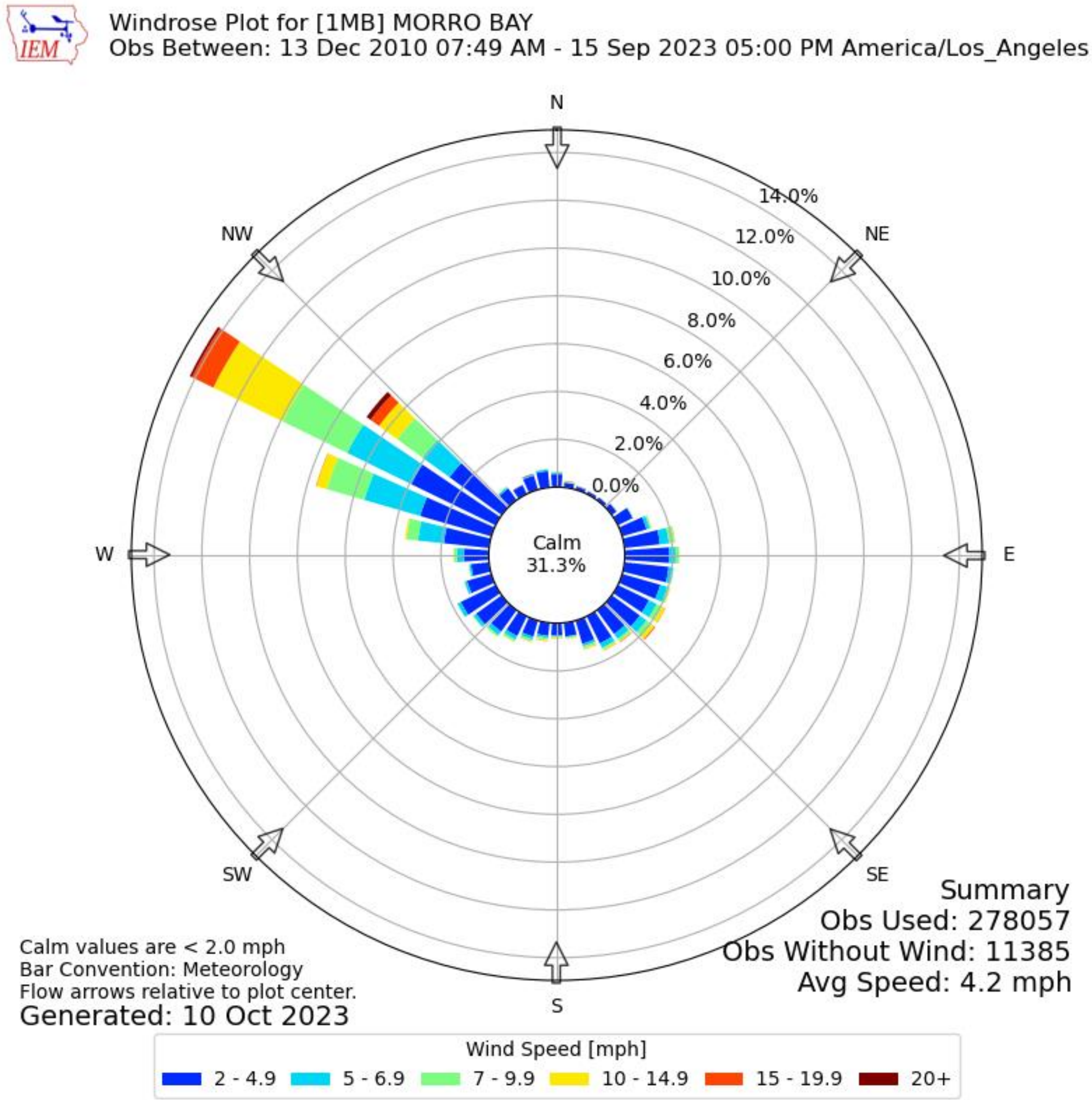


Figure M.1-4. Wind rose representative of Morro Bay collected at Morro Bay from December 2010–September 2023

Source: Iowa State University 2024b

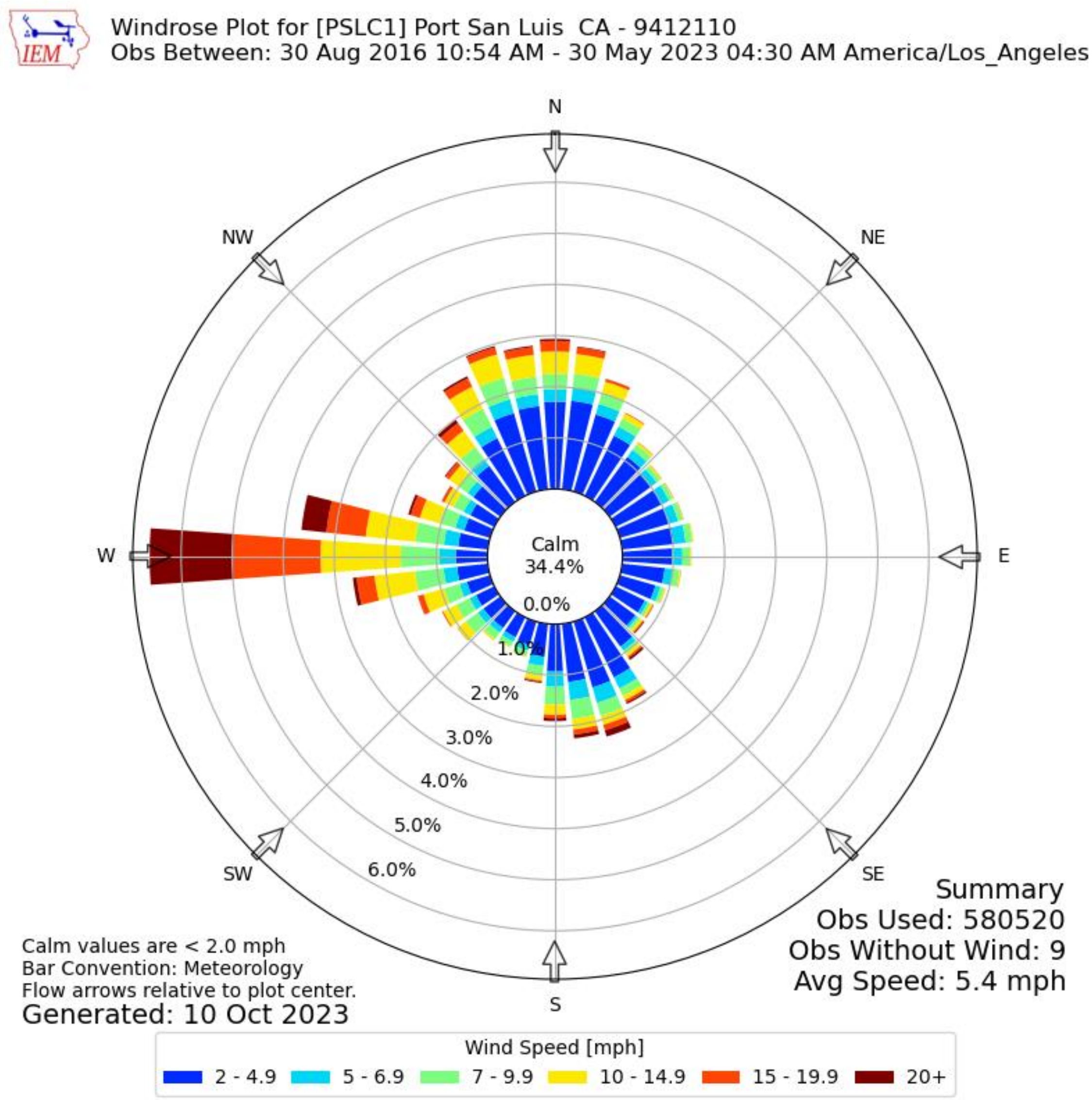


Figure M.1-5. Wind rose representative of Port of San Luis collected at Port of San Luis from August 2016–May 2023

Source: Iowa State University 2024c

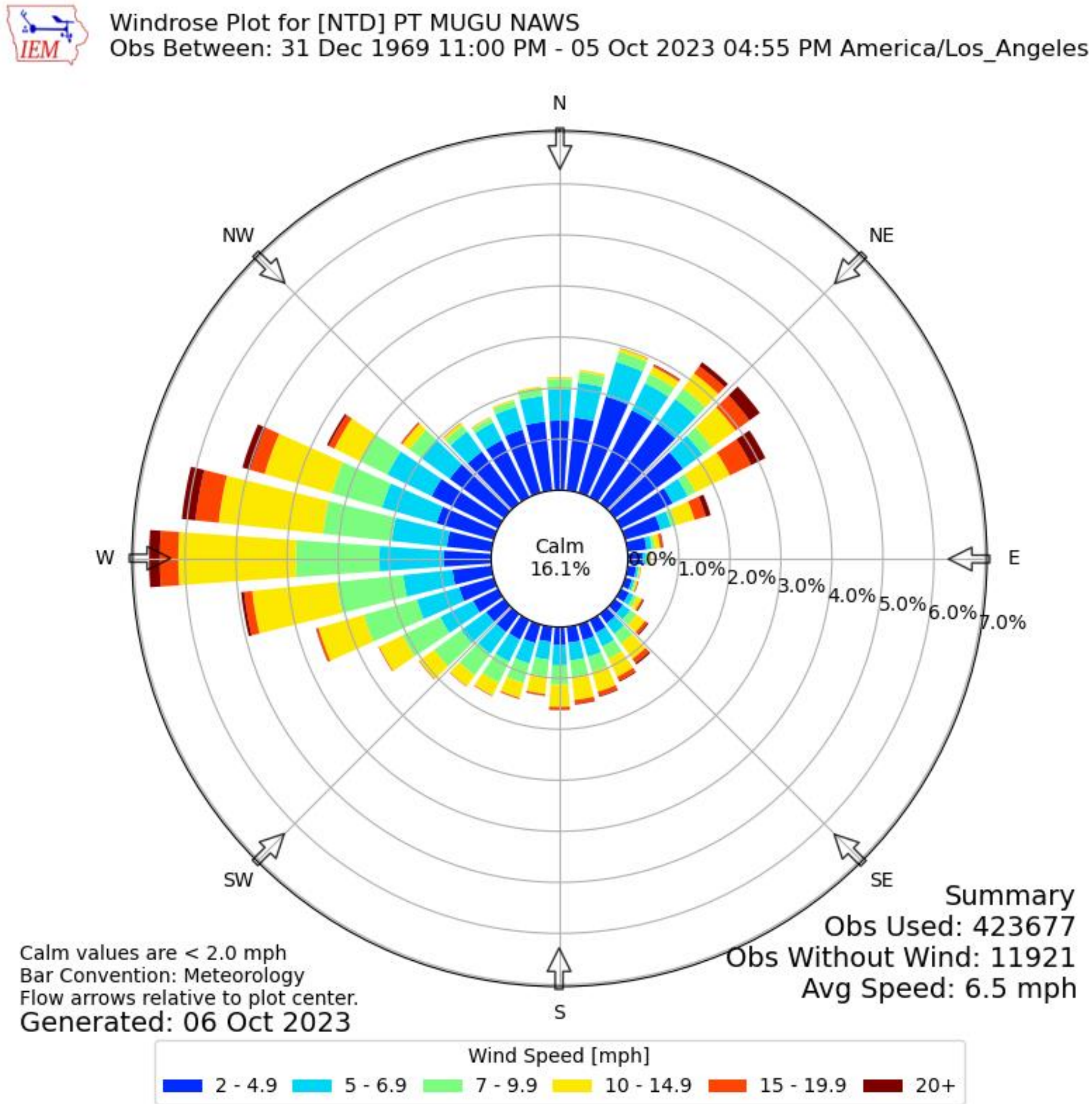


Figure M.1-6. Wind rose representative of Port of Hueneme collected at Point Mugu National Air Weapons Station from December 1969–October 2023

Source: Iowa State University 2024d

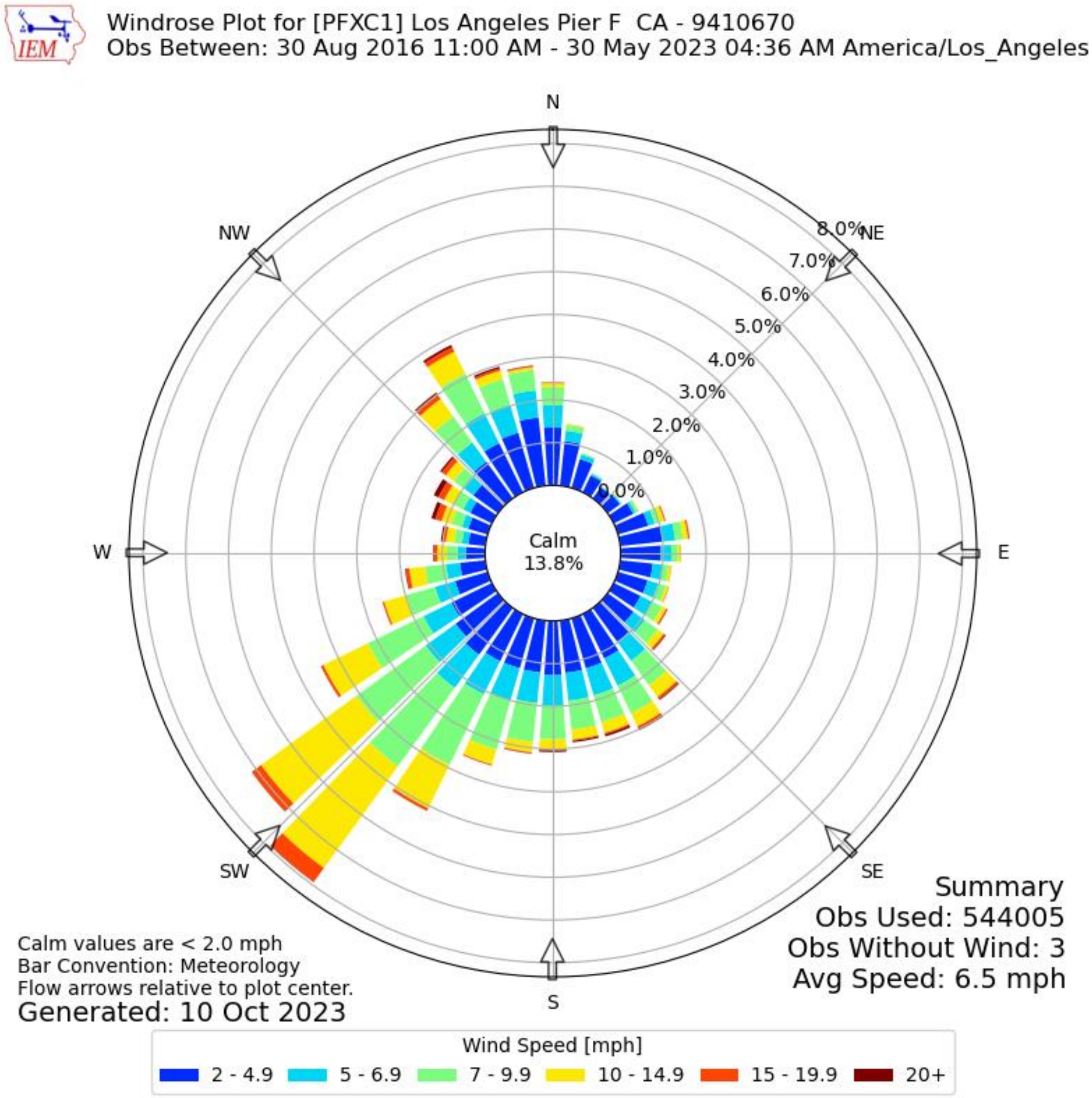


Figure M.1-7. Wind rose representative of Port of Los Angeles collected at Pier F from August 2016–May 2023

Source: Iowa State University 2024e

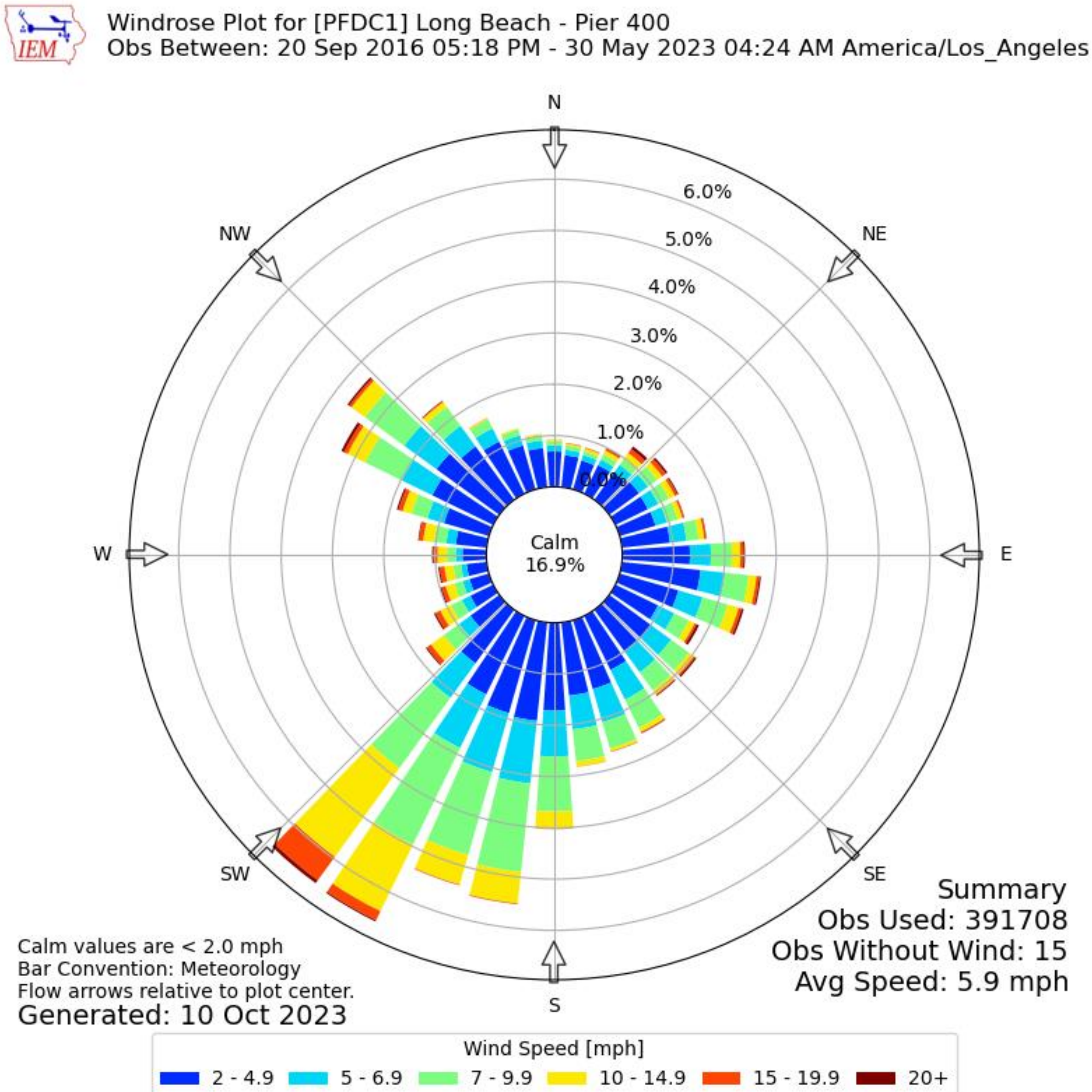


Figure M.1-8. Wind rose representative of Port of Long Beach collected at Pier 400 from September 2016–May 2023

Source: Iowa State University 2024f

M.1.2.5 Air Temperature

NOAA's National Centers for Environmental Information (NCEI), formerly the National Climatic Data Center, defines distinct climatological divisions to represent areas that are nearly climatically homogeneous. Locations within the same climatic division are considered to share the same overall climatic features and influences. The Humboldt WEA is nearest to the North Coast Drainage division or California Climate Division 1 (NOAA NCEI 2023a). The Morro Bay WEA is nearest to the Central Coast Drainage division or California Coastal Division 4 (NOAA NCEI 2023a).

The mean average annual air temperature in the North Coast Drainage division of California was 51.7°F (10.9°C) between 1901 and 2000 (NOAA NCEI 2023b). The seasonal mean ranged from 40.0°F (4.4°C) in winter (December through February) to 64.4°F (18.0°C) in summer (June through August) (NOAA NCEI 2023b).

A summary of monthly and annual mean temperature data collected for the North Coast Drainage division of California between 1895 and 2023 is presented in Table M.1-9. These data are representative of the ambient air temperatures near the Humboldt WEA.

Table M.1-9. Mean temperatures for California North Coast Drainage division, 1895 to 2023

Source: NOAA NCEI 2023b

The mean average annual air temperature in the Central Coast Drainage division of California was 57.2°F (14.0°C) between 1901 and 2000 (NOAA NCEI 2023b). The seasonal mean ranged from 47.6°F (8.7°C) in winter (December through February) to 67.0°F (19.4°C) in summer (June through August) (NOAA NCEI 2023b).

A summary of monthly and annual mean temperature data collected for the North Coast Drainage division of California between 1895 and 2023 is presented in Table M.1-10. These data are representative of the ambient air temperatures near the Morro Bay WEA.

Table M.1-10. Mean temperatures for California Central Coast Drainage division, 1895 to 2023

Season	Average Mean Temperature		Maximum Mean Temperature		Minimum Mean Temperature	
	°F	°C	°F	°F	°C	°F
January	39.5	4.2	46.2	39.5	4.2	46.2
February	41.8	5.4	48.4	41.8	5.4	48.4
March	44.3	6.8	51.9	44.3	6.8	51.9
April	48.2	9.0	53.2	48.2	9.0	53.2
May	54.1	12.3	60.8	54.1	12.3	60.8
June	60.6	15.9	67.5	60.6	15.9	67.5
July	67.2	19.5	72.5	67.2	19.5	72.5
August	66.7	19.3	71.7	66.7	19.3	71.7
September	62.6	17.0	67.5	62.6	17.0	67.5
October	54.4	12.4	60.6	54.4	12.4	60.6
November	45.1	7.3	50.2	45.1	7.3	50.2
December	39.7	4.3	45.0	39.7	4.3	45.0
Annual	**52.0**	**11.1**	**58.0**	**14.4**	**46.1**	**7.8**

Source: NOAA NCEI 2023b

Representative air temperature information for the Humboldt WEA and Morro Bay WEA are also available from NOAA's National Data Buoy Center Eel River Buoy (Buoy No. 44022) and Cape San Martin Buoy (Buoy No. 44028), respectively. Using 2022 as an example year to consider monthly averages, temperature values are presented in Table M.1-11 for each buoy. As shown below, temperatures as the Eel River Buoy ranged from 48.83°F to 58.61°F (9.35°C to 14.79°C), with the higher temperatures during the summer months (NOAA 2023b). At the Cape San Martin Buoy, air temperatures ranged from 52.78°F to 60.85°F (11.54°C to 16.03°C) (NOAA 2023b).

Table M.1-11. Average Air Temperature at NOAA Buoys in 2022

Month	Average Air Temperature in °F (°C)	
	Buoy No. 44022 (near Humboldt WEA)	Buoy No. 44028 (near Morro Bay WEA)
January	50.10 (10.05)	55.45 (13.03)
February	48.83 (9.35)	54.28 (12.38)
March	49.42 (9.68)	53.19 (11.77)
April	49.44 (9.69)	53.25 (11.80)
May	51.39 (10.77)	52.78 (11.54)
June	55.13 (12.85)	54.84 (12.69)
July	55.39 (12.99)	57.58 (14.21)
August	58.61 (14.79)	59.23 (15.13)
September	57.31 (14.06)	60.85 (16.03)
October	54.35 (12.42)	58.95 (14.97)
November	50.71 (10.40)	55.95 (13.30)
December	50.04 (10.02)	54.91 (12.73)

Sources: NOAA 2023b

Given the temperate air temperatures experienced near the Humboldt WEA and Morro Bay WEA, there is minor risk for icing of equipment and vessels above the water line in the region. However, the occurrence of fog in the California coastal region has potential to affect visibility within the Humboldt WEA and Morro Bay WEA. The West Coast of the United States has been identified as one of the major fog-producing regions in the world (Filonczuk et al. 1995). Based on marine observations from 1949 to 1991, fog was observed during 8.54 percent of observations in the region that includes the Humboldt WEA (24,467 total observations) and fog was observed during 6.6 percent of observations in the region that includes the Morro Bay WEA (54,140 total observations) (Filonczuk et al. 1995).

M.1.2.6 Precipitation

NOAA's NCEI additionally provides precipitation values for each climate division. In the North Coast Drainage division, nearest to the Humboldt WEA, the mean annual precipitation between 1901 and 2000 was 48.68 inches (123.65 centimeters) (NOAA NCEI 2023c). The seasonal mean ranged from 25.39 inches (64.49 centimeters) in winter (December through February) to 1.29 inches (3.28 centimeters) in summer (June through August) (NOAA NCEI 2023c).

A summary of monthly and annual mean precipitation data collected for the North Coast Drainage division of California between 1895 and 2023 is presented in Table M.1-12. This data is representative of the precipitation trends near the Humboldt WEA.

Table M.1-12. Mean Precipitation for California North Coast Drainage division, 1895 to 2023

Month	Average Mean Precipitation		Maximum Mean Precipitation		Minimum Mean Precipitation	
	in	cm	in	cm	in	cm
January	8.84	22.46	27.30	69.34	0.83	2.11
February	7.39	18.77	22.59	57.38	0.40	1.02
March	6.25	15.88	17.88	45.42	0.20	0.51
April	3.39	8.62	10.35	26.29	0.15	0.38
May	1.95	4.97	7.12	18.08	0.10	0.25
June	0.80	2.04	2.79	7.09	0.00	0.00
July	0.19	0.47	0.93	2.36	0.00	0.00
August	0.26	0.65	1.64	4.17	0.00	0.00
September	0.84	2.13	3.32	8.43	0.00	0.00
October	2.98	7.56	12.23	31.06	0.00	0.00
November	6.42	16.29	19.75	50.17	0.02	0.05
December	8.69	22.08	23.98	60.91	0.61	1.55
Annual	**4.00**	**10.16**	**12.49**	**31.72**	**0.19**	**0.49**

Source: NOAA NCEI 2023c

In the Central Coast Drainage division, nearest to the Morro Bay WEA, the mean annual precipitation between 1901 and 2000 was 20.96 inches (53.24 centimeters) (NOAA NCEI 2023c). The seasonal mean ranged from 12.26 inches (31.14 centimeters) in winter (December through February) to 0.14 inch (0.36 centimeter) in summer (June through August) (NOAA NCEI 2023c).

A summary of monthly and annual mean precipitation data collected for the Central Coast Drainage division of California between 1895 and 2023 is presented in Table M.1-13. These data are representative of the precipitation trends near the Morro Bay WEA.

Table M.1-13. Mean Precipitation for California Central Coast Drainage division, 1895 to 2023

Month	Average Mean Precipitation		Maximum Mean Precipitation		Minimum Mean Precipitation	
	in	cm	in	in	cm	in
January	4.46	11.34	14.12	35.86	0.10	0.25
February	3.85	9.77	14.86	37.74	0.01	0.03
March	3.34	8.49	11.31	28.73	0.07	0.18
April	1.47	3.72	6.10	15.49	0.00	0.00
May	0.53	1.34	2.70	6.86	0.00	0.00
June	0.09	0.23	0.52	1.32	0.00	0.00
July	0.01	0.04	0.11	0.28	0.00	0.00
August	0.03	0.07	0.25	0.64	0.00	0.00
September	0.19	0.48	1.25	3.18	0.00	0.00
October	0.90	2.29	4.19	10.64	0.00	0.00

Month	Average Mean Precipitation		Maximum Mean Precipitation		Minimum Mean Precipitation	
	in	cm	in	in	cm	in
November	2.11	5.36	8.03	20.40	0.00	0.00
December	3.74	9.50	13.36	33.93	0.03	0.08
Annual	**1.73**	**4.39**	**6.40**	**16.26**	**0.02**	**0.04**

Source: NOAA NCEI 2023c

M.1.2.7 Extreme Storm Events

Extreme storm events along the California coast can include tropical storms. Zero tropical storms have reached the vicinity of the Humboldt WEA since at least 1950 according to the NOAA's Historical Hurricane Tracks database (NOAA 2023c). However, three tropical storms have reached the vicinity of the Morro Bay WEA in the same timeframe (NOAA 2023c). The tropical storms that reached the vicinity of the Morro Bay WEA arrived in the summer month of August. Such storms that travel along the coastline of California have the potential to affect the Morro Bay WEA and adjacent coastal communities with high winds and severe flooding.

Figure M.1-9 identifies the lack of tropical storm tracks surrounding the Humboldt WEA between 1950 and 2020 (NOAA 2023c). Figure M.1-10 identifies the three tropical storm tracks surrounding the Morro Bay WEA between 1950 and 2020 (NOAA 2023c). The category for each storm is designated by a color for each segment of its track on each figure. Table M.1-14 lists each of the tropical storms affecting the Morro Bay WEA and the corresponding maximum storm categories while the tropical storm was within approximately 200 nm (370 kilometers) of the Morro Bay WEA for the corresponding period (NOAA 2023c). The 200-nm (370-kilometer) radius circles were centered within the Humboldt Bay WEA (latitude 40.98, longitude -124.67) and the Morro Bay WEA (latitude 35.58, longitude -121.85).

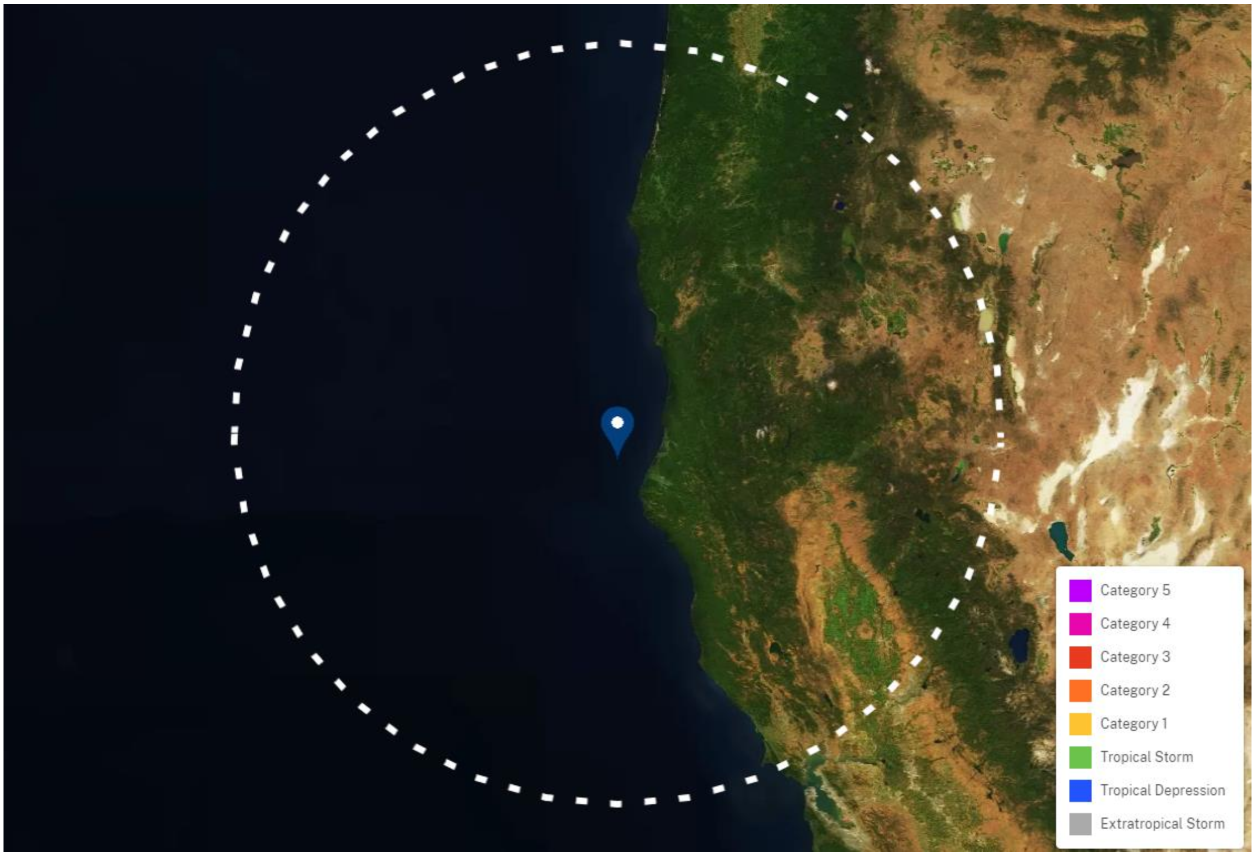


Figure M.1-9. Tracks of hurricanes, tropical storms, tropical depressions, and extratropical storms between 1950 and 2020 within a 200-nm (370-kilometer) radius of the Humboldt WEA

Source: NOAA 2023c

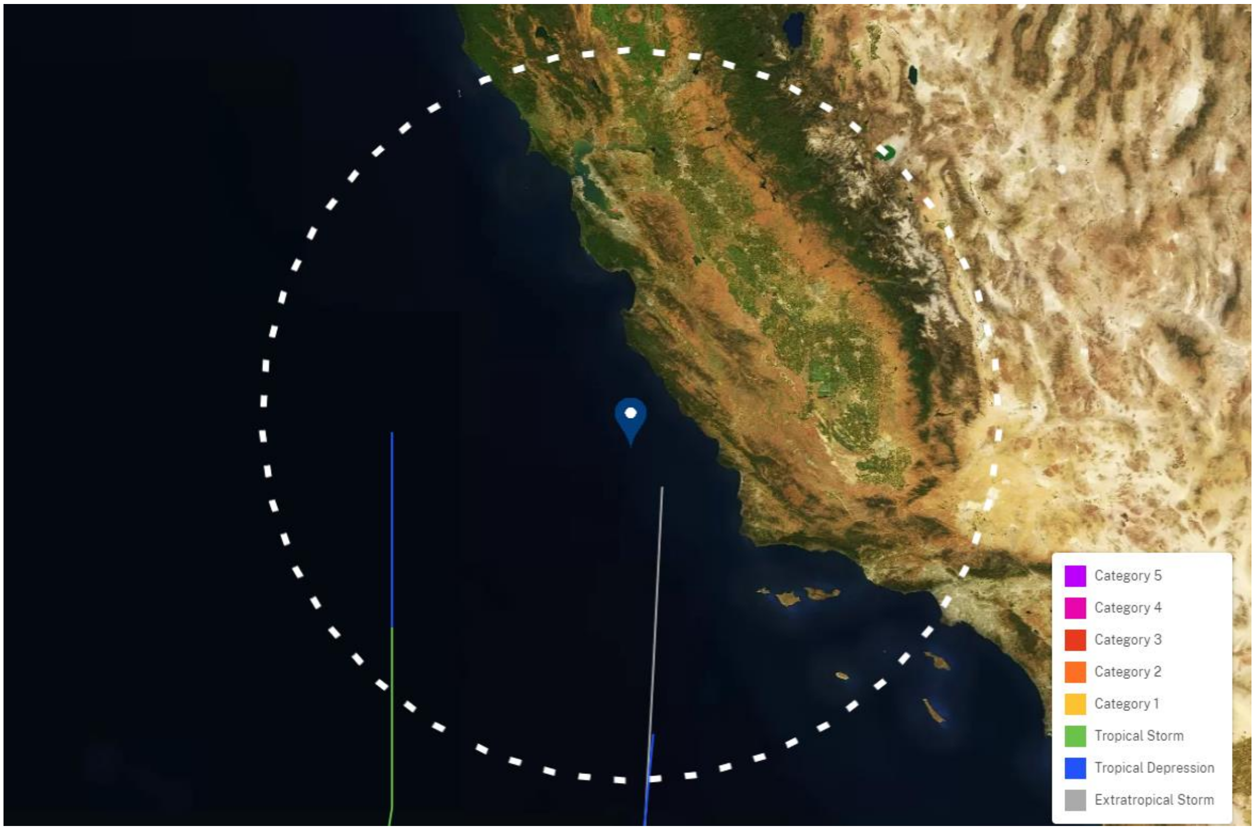


Figure M.1-10. Tracks of hurricanes, tropical storms, tropical depressions, and extratropical storms between 1950 and 2020 within a 200-nm (370-kilometer) radius of the Morro Bay WEA
Source: NOAA 2023c

Table M.1-14. Tropical storm tracks passing within 200 nm (370 kilometers) of the Morro Bay WEA between 1950 and 2020

Storm Name	Year	Maximum Storm Category
Ignacio	1997	Tropical Storm
Hilda	1991	Tropical Storm
Claudia	1965	Tropical Storm

Source: NOAA 2023c
Note: Zero tropical storms, tropical depressions, or extratropical storms passed within 200 nm of the Humboldt WEA between 1950 and 2020.

M.1.3 Projected Future Climate

Projected future climate conditions include changes to the above metocean characteristics as well as other climate characteristics, including ocean warming, ocean acidification, and sea level rise. Uncertainty in the magnitude of such climate changes exists due to the uncertainty of future GHG emissions rates—which are directly related to the rate of climate change—and the inherent uncertainty of climate modeling methods. Future climate change projections are categorized by GHG emissions scenarios ranging from low global GHG emissions scenarios to high global GHG emissions scenarios. Low global GHG emissions scenarios imply less change to climate conditions, while high global GHG scenarios imply greater change to climate conditions. The subsections below describe the expected changes to climate conditions in the California coastal region under the U.S. Environmental Protection Agency (USEPA) (2017) lower (Representation Concentration Pathways [RCP] 4.5) and higher (RCP 8.5) GHG emissions scenarios, unless noted otherwise.[3] Future projected changes to wind and ocean warming conditions in the California coastal region are not included, as such changes are not explicitly characterized by available studies.

M.1.3.1 Air Temperature

Under a higher emissions pathway, historically unprecedented warming is projected during the 21st century in California (NOAA 2022). Even under the lower emissions pathway, annual average temperatures are projected to exceed historical record levels most likely by the middle of the 21st century (NOAA 2022). Under the RCP 8.5 scenario, climate models project an increase of 5.8°F (3.2°C) by mid-century and an increase of 8.8°F (4.9°C) by late-century in the state (Bedsworth et al. 2018). Under the RCP 4.5 scenario, climate models project an increase of 4.4°F (2.4°C) by mid-century (2040–2069) and an increase of 5.6°F (3.1°C) by late-century (2070–2100) in the state (Bedsworth et al. 2018).

M.1.3.2 Precipitation

Climate models show a tendency for the northern part of California to become wetter, and the southern part of California to become drier; however, this tendency is relatively small compared to the amount of year-to-year variation in precipitation in the state (Bedsworth et al. 2018). Climate models project less frequent but more extreme daily precipitation, with an increase in the number of dry years (Bedsworth et al. 2018). The RCP 8.5 scenario projects that much of the mountain area in California currently dominated by snow would begin to receive more precipitation as rain and then only rain by 2050 (Gonzalez et al. 2018). Higher spring temperatures will also result in earlier melting of the snowpack in California, which has critical implications for California's water supply (NOAA 2022). Projected hotter temperatures further increase probabilities of decadal to multi-decadal megadroughts, which are persistent droughts lasting more than one decade, even when precipitation increases (Gonzalez et al. 2018). One severe drought in California, which was intensified by climate change, reduced hydroelectric generation by two-thirds from 2011 to 2015 (Gonzalez et al. 2018). The efficiency of all water-cooled electric power plants that burn fuel depends on the temperature of the external cooling water, so climate change could reduce energy efficiency up to 15 percent across the Southwest by 2050 (Gonzalez et al. 2018).

M.1.3.3 Extreme Storm Events

Climate models project an increase in the frequency of heavy downpours in the Southwest region, especially through atmospheric rivers, which are narrow bands of highly concentrated storms that move in from the Pacific Ocean (Gonzalez et al. 2018). Such atmospheric rivers have caused many large floods

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[3] The RCPs are identified by their approximate total radiative forcing (not GHG emissions) in the year 2100, relative to 1750: 2.6 watts per meter squared (RCP 2.6), 4.5 watts per meter squared (RCP 4.5), and 8.5 watts per meter squared (RCP 8.5) (USEPA 2017).

in California (Gonzalez et al. 2018). Under the higher RCP 8.5 climate change scenario, the intensity and frequency of atmospheric rivers are expected to increase (Gonzalez et al. 2018).

M.1.3.4 Ocean Acidification

The ocean absorbs approximately 30 percent of the carbon dioxide released into the atmosphere every year, increasing the acidity of the ocean (Bedsworth et al. 2018). Ocean acidification is predicted to occur especially rapidly along the West Coast, which presents a threat to coastal communities through its significant impacts on commercial fisheries as well as on ocean ecosystems on a broader scale (Bedsworth et al. 2018). Species vulnerable to ocean acidification account for approximately half of the total fisheries revenue on the West Coast (Bedsworth et al. 2018). Surface ocean pH is already 0.1 unit lower than preindustrial values (Orr et al. 2005). By the end of the 21st century, surface ocean pH is projected to become another 0.3 to 0.4 unit lower, which translates to a 100- to 150-percent increase in acidity (Orr et al. 2005).

M.1.3.5 Ocean Acidification

Global sea level is projected to rise, with a likely range of 12 to 48 inches by 2100 (NOAA 2022). Under the RCP 8.5 scenario, sea levels near San Francisco would rise between 19 and 41 inches (49 to 104 centimeters) by 2100 (Gonzalez et al. 2018). Flooding from sea level rise and coastal wave events lead to bluff, cliff, and beach erosion, which could affect large geographic areas (Bedsworth et al. 2018). Under mid to high sea level rise scenarios, 31 to 67 percent of Southern California beaches may completely erode by 2100 without large-scale human interventions (Bedsworth et al. 2018).

M.1.3.6 Sea Level Rise

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M.1.4 Potential General Impacts of Offshore Wind Facilities on Meteorological Conditions

A known impact of offshore wind facilities on meteorological conditions is the "wake effect" (Christiansen and Hasager 2005). A WTG extracts energy from the free flow of wind, creating turbulence downstream of the WTG. The resulting atmospheric wake effect is the aggregated influence of the WTGs for the entire wind farm on the available wind resource and the energy production potential of any facility downstream. Christiansen and Hasager (2005) observed offshore wake effects from existing facilities via satellite with synthetic aperture radar to last anywhere from 1.2 to 12.4 miles (2 to 20 kilometers) depending on ambient wind speed, direction, degree of atmospheric stability, and the number of turbines within a facility. During stable atmospheric conditions, these offshore wakes can be longer than 43.5 miles (70 kilometers).

Under certain conditions, offshore wind farms can also affect temperature and moisture downwind of the facilities. For example, from September 2016 to October 2017, a study using aircraft observations accompanied by mesoscale simulations examined the spatial dimensions of micrometeorological impacts from a wind energy facility in the North Sea (Siedersleben et al. 2018). Measurements and associated modeling indicated that measurable redistribution of moisture and heat were possible up to 62 miles (100 kilometers) downwind of the wind farm. However, this occurred only when (1) there was a strong, sustained temperature inversion at or below hub height and (2) wind speeds were greater than approximately 13.4 mph (6 m/s) (Siedersleben et al. 2018). Typically, air temperature will decrease with height above the sea surface in the lower atmosphere (i.e., the troposphere), and air will freely rise and disperse up to a "mixing height" (Holzworth 1972; Ramaswamy et al. 2006). A temperature inversion occurs when a warmer overlying air mass causes temperatures to increase with height; a strong inversion inhibits the further rise of cooler surface air masses, thus limiting the mixing height (Ramaswamy et al. 2006). Therefore, the North Sea study suggests that rapidly spinning turbines with hub heights at or above a strong inversion may induce mixing between air masses that would otherwise remain separated, which can significantly affect temperature and humidity downwind of a wind farm.

Table M.1-15 presents atmospheric mixing height data from the nearest measurement location to the Humboldt WEA and Morro Bay WEA (Oakland, California). As shown in the table, the minimum average mixing height is 1,461 feet (445 meters), while the maximum average mixing height is 3,130 feet (954 meters).

Table M.1-15. Representative seasonal mixing height data

Season	Data Hours Included[1]	Oakland, California Average Mixing Height (feet/meters)
Winter (December, January, February)	Morning: No-Precipitation Hours	1,461/445
	Morning: All Hours	1,600/488
	Afternoon: No-Precipitation Hours	2,147/654
	Afternoon: All Hours	2,049/625
Spring (March, April, May)	Morning: No-Precipitation Hours	2,091/637
	Morning: All Hours	2,242/683
	Afternoon: No-Precipitation Hours	3,130/954
	Afternoon: All Hours	3,104/946
Summer (June, July, August)	Morning: No-Precipitation Hours	1,773/540
	Morning: All Hours	1,794/547
	Afternoon: No-Precipitation Hours	2,260/689
	Afternoon: All Hours	2,276/694

Season	Data Hours Included[1]	Oakland, California Average Mixing Height (feet/meters)
Fall (September, October, November)	Morning: No-Precipitation Hours	1,575/480
	Morning: All Hours	1,635/498
	Afternoon: No-Precipitation Hours	2,468/752
	Afternoon: All Hours	2,442/744
Annual Average	Morning: No-Precipitation Hours	1,725/526
	Morning: All Hours	1,817/554
	Afternoon: No-Precipitation Hours	2,501/762
	Afternoon: All Hours	2,468/752

Source: USEPA 2023

[1] Missing values are not included.

WTG hub heights are expected to remain well below the typical mixing height and associated temperature inversions over the open ocean in the Pacific region. As such, the redistribution of moisture and heat due to rotor-induced vertical mixing, and any associated shifts to the microclimate, would be limited to the immediate vicinity of a wind facility in this region.

Additionally, mixing height affects air quality by acting as a lid on the height to which air pollutants can vertically disperse. Lower mixing heights allow less air volume for pollutant dispersion and lead to higher ground-level pollutant concentrations than do higher mixing heights.

M.1.5 Air Quality Standards

Air quality is measured in comparison to the National Ambient Air Quality Standards (NAAQS), which are standards established by USEPA pursuant to the Clean Air Act (42 U.S. Code 7409) for several common air pollutants, known as criteria pollutants, to protect human health and welfare. Primary standards are set at levels to protect human health with a margin of safety. Secondary standards are set at levels to protect public welfare including plants, animals, ecosystems, and materials. The criteria pollutants are carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter smaller than 10 microns in diameter, particulate matter smaller than 2.5 microns in diameter, and sulfur dioxide. California has established ambient air quality standards similar to the NAAQS. Table M.1-16 shows the NAAQS for criteria pollutants.

Table M.1-16. NAAQS

Pollutant	Averaging Period	National Ambient Air Quality Standards ($\mu g/m^3$)	
		Primary	Secondary
Carbon Monoxide (CO)	8-hour[1]	10,000	None
	1-hour[1]	40,000	None
Lead (Pb)	Rolling 3-month average[2]	0.15	0.15
Nitrogen Dioxide (NO_2)	Annual[2]	100	100
	1-hour[3]	188	None
Ozone (O_3)	8-hour[4]	137 (70 ppb)	137 (70 ppb)
	1-hour[1]	None	None
Particulate Matter (PM_{10})	24-hour[5]	150	150
Particulate Matter ($PM_{2.5}$)	Annual[6]	9.0	15
	24-hour[7]	35	35
Sulfur Dioxide (SO_2)	Annual[2]	80	None
	24-hour[1]	None	None
	3-hour[1]	None	1,300
	1-hour[8]	196	None

Source: 40 Code of Federal Regulations 50
[1] Not to be exceeded more than once per year.
[2] Not to be exceeded.
[3] 98th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
[4] Annual 4th-highest daily maximum 8-hour concentration, averaged over 3 years.
[5] Not to be exceeded more than once per year on average over 3 years.
[6] Annual mean, averaged over 3 years.
[7] 98th percentile, averaged over 3 years.
[8] 99th percentile of 1-hour daily maximum concentrations, averaged over 3 years.
$\mu g/m^3$ = micrograms of pollutant per cubic meter of air; ppb = parts per billion.