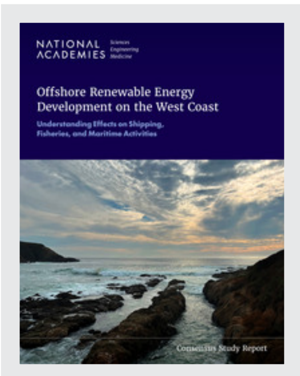

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Understanding Effects on Shipping, Fisheries, and Maritime Activities

Committee on Impacts on Shipping and Commercial, Tribal, and Recreational Fisheries from Development of Renewable Energy on the West Coast

Earth Systems and Resources Program Area

Center for Health, People, and Places

Consensus Study Report

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COMMITTEE ON IMPACTS ON SHIPPING AND COMMERCIAL, TRIBAL, AND RECREATIONAL FISHERIES FROM DEVELOPMENT OF RENEWABLE ENERGY ON THE WEST COAST

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This Consensus Study Report was reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise. The purpose of this independent review is to provide candid and critical comments that will assist the National Academies of Sciences, Engineering, and Medicine in making each published report as sound as possible and to ensure that it meets the institutional standards for quality, objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We thank the following individuals for their review of this report:

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Although the reviewers listed above provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations of this report nor did they see the final draft before its release. The review of this report was overseen by **BONNIE McCAY,** Rutgers University, and **RICHARD SEARS,** Stanford University. They were responsible for making certain that an independent examination of this report was carried out in accordance with the standards of the National Academies and that all review comments were carefully considered. Responsibility for the final content rests entirely with the authoring committee and the National Academies.

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Boxes, Figures, and Tables

BOXES

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Acronyms and Abbreviations

AIS	automatic identification system
ATON	aids to navigation
BIOWP	Block Island Offshore Wind Power
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CBA	community benefits agreement
CC	California Current
CCE	California Current Ecosystem
CF	capacity factor
COP	construction and operations plan
CPFV	commercial passenger fishing vessel
CPS	coastal pelagic species
CZMA	Coastal Zone Management Act
DOD	Department of Defense
DOI	Department of Interior
DSC	digital selective calling
EDS	environmental data server
EEZ	exclusive economic zone
EIS	environmental impact statement
EMF	electromagnetic field
EPIRB	emergency position indicating radio beacon
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FMP	fishery management plan

fms	fathoms
ft	feet
FOW	floating offshore wind
GAO	Government Accountability Office
GW	gigawatt(s)
HF	high frequency
HMS	highly migratory species
IIoT	industrial internet of things
IMO	International Maritime Organization
IPHC	International Pacific Halibut Commission
km	kilometer
kt	knots
kV	kilovolt
lb	pound
m	meter
M&F	manufacturing and fabrication
mi	mile
m/s	meter per second
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSP	marine spatial planning
mt	metric tons
MTSA	Maritime Transportation Security Act
MW	megawatt
NAIS	Nationwide Automatic Identification System
NASEM	National Academies of Sciences, Engineering, and Medicine
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NM	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory
ODFW	Oregon Department of Fish and Wildlife
O&M	operations and maintenance
OCS	outer continental shelf
OCSLA	Outer Continental Shelf Lands Act of 1953
ORE	offshore renewable energy
PAC-PARS	Pacific Area Port Access Route Study
PFMC	Pacific Fishery Management Council
POC	probability of containment
POD	probability of detection
POS	probability of success

RCC	rescue coordination center
REAT	renewable energy action team
RFI	request for developer interest
SAP	site assessment plan
SAR	search and rescue
SAROPS	Search and Rescue Optimal Planning System
TRL	technology readiness level
TWh	terawatt hour
UNCLOS	United Nations Convention on the Law of the Sea
USACE	U.S. Army Corps of Engineers
VMS	vessel monitoring system
WAMS	waterways analysis and management system
WEA	wind energy area

Preface

In 2005, the Bureau of Ocean and Energy Management (BOEM) was named the lead federal agency responsible for offshore renewable energy (including wind) development in federal waters. BOEM established wind energy call areas for California in October 2018 and, for Oregon, in April 2022. The offshore wind development processes in those states culminated in BOEM designating the Humboldt wind energy area off the northern California coast in July 2021, the Morro Bay wind energy areas in November 2021 and two wind energy areas off the southern Oregon coast in February 2024.

All three west coast states have adopted robust renewable energy goals. Oregon plans to achieve 100 percent clean electricity by 2040, and California and Washington have adopted similar goals to achieve that target by 2045 with specific benchmarks for 2030 (60 percent for California and 80 percent each for Washington and Oregon) and 2035 (90 percent each for California and Oregon). California's renewable energy goals include plans for offshore wind development with targets of 2–5 gigawatts (GW) by 2030 and 25 GW by 2045, which is enough to power over 25 million homes. Oregon is in the process of developing a comprehensive offshore wind energy roadmap, which will examine the feasibility of integrating up to 3 GW of floating offshore wind by 2030, while ensuring minimal negative impact on existing industries like commercial fishing and coastal communities. Washington does not have a specific goal for offshore renewable energy, but the state commissioned a study in 2024 to develop a framework for offshore wind engagement.

However, the development of offshore renewable energy has been temporarily hampered at the federal level by a series of presidential memorandums, executive orders, and federal agency actions. In July 2025 BOEM rescinded all designated areas in federal waters that had been targeted for offshore wind development. During the course of this study, the committee on Impacts on Shipping and Commercial, Tribal, and Recreational Fisheries from Development of Renewable Energy on the West Coast found that the establishment of call areas and designation of wind energy areas on the West Coast offshore waters was contentious with many constituents including the Tribes and fishing communities that believed they were not effectively engaged during the offshore wind development process. Also, the committee found that further research is needed to better understand how large offshore wind installations affect the ocean environment. The committee believes the current pause in designated future wind energy areas off the West Coast can be put to good use by proceeding with research on impacts and mitigation measures and implementing improvements in the regulatory processes. The recommendations in the report reflect these findings.

While the report concentrates on renewable energy, we were careful to evaluate the wide range of current and potential uses of the ocean as they are all critical to the economic health and security of the nation. As specified in the Statement of Task, the report focuses on three affected groups: the Tribes and their legal rights to the oceans and its associated resources; the Tribal, recreational, and commercial fisheries and fishing communities who could be significantly affected by offshore wind installations; and the U.S. Coast Guard, whose search and rescue and navigational safety capability will need to adapt if large wind projects are installed in the West Coast offshore waters.

Because of the diversity of subject matter taken under consideration in this study, the National Academies of Sciences, Engineering, and Medicine (NASEM) brought together a committee with wide-ranging expertise. Committee members had expertise in offshore wind and hydrokinetic technology, the offshore wind regulatory process, West Coast Tribal, commercial and recreational fisheries, Tribal rights and customs, Coast Guard operations including navigation and search and rescue, and ocean and coastal shipping. We are pleased to have co-chaired this committee, whose members worked together cohesively to meld their varied knowledge into this consensus report. We are thankful for the commitment and cooperation they demonstrated throughout this effort.

The committee is also indebted to the many people who shared their extensive knowledge on the subject matter with the committee, including representatives from BOEM, National Oceanic and Atmospheric Administration, and the Coast Guard; representatives from the states of California, Oregon, and Washington; authorities on port development; offshore floating wind and wave energy designers; experts on the ocean environment; members of the fishing community; and the Tribal leadership and representatives who presented to the committee.

We are most thankful for the guidance and support we received from the NASEM staff. Over an eight-month period, the committee conducted extensive outreach and then jointly drafted this report. This would not have been possible without the unwavering support and encouragement provided by Study Director Caroline Bell and the numerous other NASEM staff members who participated in this effort.

Michele K. Conrad, *Co-chair*
R. Keith Michel, *Co-chair*
Committee on Impacts on Shipping and Commercial, Tribal, and Recreational Fisheries from Development of Renewable Energy Development on the West Coast
February 2025

Summary[1]

The U.S. West Coast is entering a transformative period in its relationship with the ocean. The region's unique oceanographic and economic characteristics—deep offshore waters, the productive California Current ecosystem (CCE), major global ports, and culturally and economically significant fisheries—are now intersecting with a regional imperative to expand renewable energy generation. Offshore renewable energy (ORE), including floating offshore wind (FOW) and marine hydrokinetic (wave and tidal) technologies, is emerging as a viable clean energy option. These ORE projects will intersect existing ecological, economic, social, and maritime systems of the West Coast. Steps can be taken to ensure the benefits of ORE development will outweigh burdens on coastal communities.

Recognizing these complexities, Congress, through the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (P.L. 117-263), directed the National Academies of Sciences, Engineering, and Medicine to assess the potential impacts of offshore renewable energy development on maritime traffic and fisheries—including commercial, recreational, and Tribal fisheries—along the U.S. West Coast.

The committee's charge was to:

1. Document historic and current uses of offshore areas, including commercial, Tribal, and recreational fishing, Tribal usual and accustomed fishing, and shipping.
2. Analyze current and expected Coast Guard operations relevant to commercial fishing activities.
3. Evaluate anticipated interactions—positive and negative—between ORE infrastructure and maritime uses.
4. Review the ORE decision-making process and recommend improvements to account for affected communities and activities.

To meet this charge, the committee members reviewed scientific and policy literature; convened information-gathering sessions with federal and state agencies, Tribal representatives, fishing and maritime stakeholders, and subject-matter experts; and drew from their own experience to conduct a deliberative analysis.

The study area encompasses state and federal waters off California, Oregon, and Washington, extending from the U.S.–Mexico to the U.S.–Canada borders and offshore 200-nautical mile (NM) to the outer limit of the exclusive economic zone (EEZ) (Figure S-1).

[1] This summary does not include references. Citations for the information presented herein are provided in the main text.

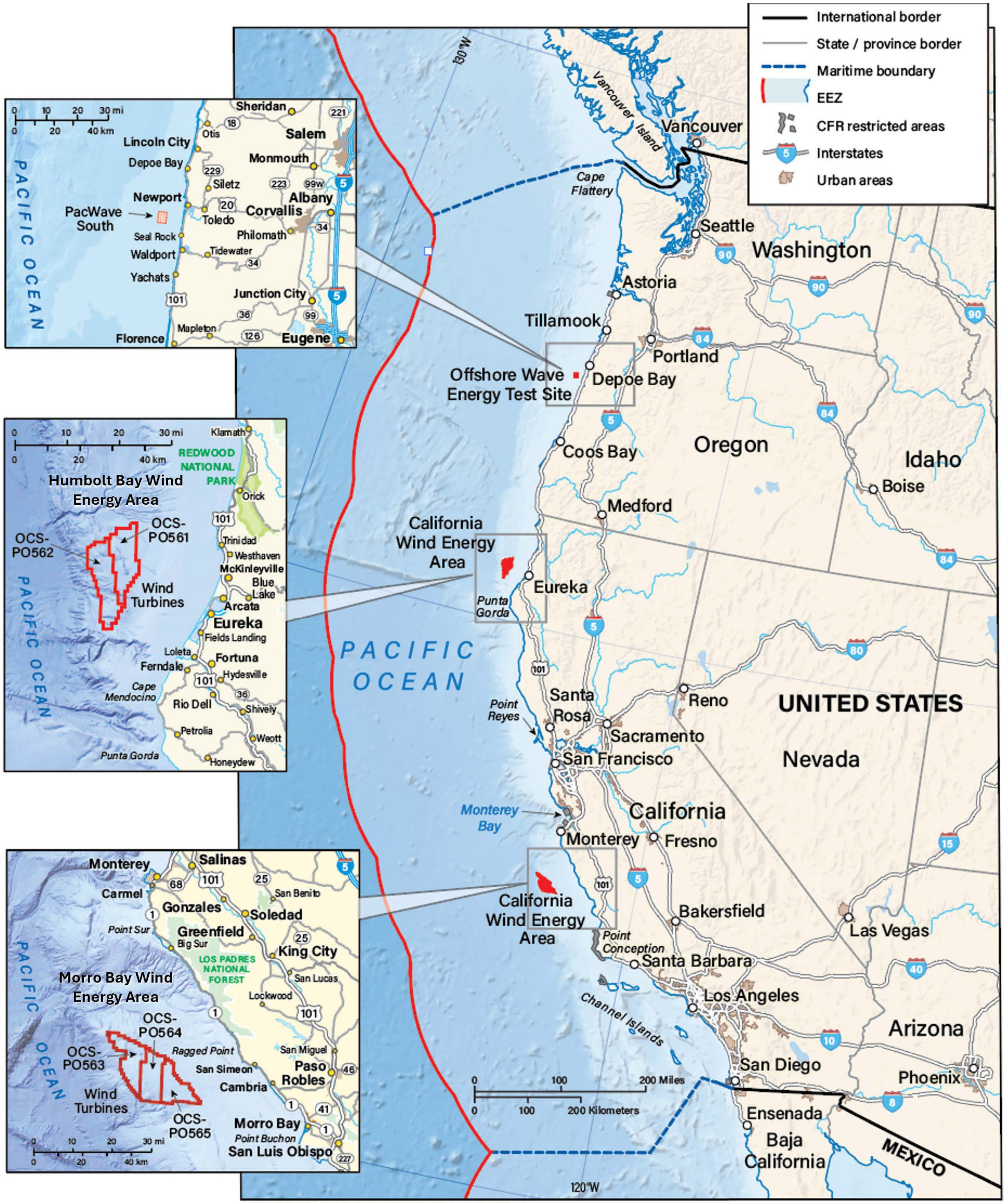

FIGURE S-1 Map of study area.
NOTE: OCS = Outer Continental Shelf; OSC – P0561, OSC-P0562, OSC-P0563, OSC-P0564, and OSC-P0565 are individual lease areas.
SOURCE: Created for the committee by International Mapping.

THE SETTING: MARITIME ACTIVITY AND ECOSYSTEM CONTEXT

Maritime Activity on the West Coast

The U.S. West Coast has 7,863 miles of shoreline, supporting a diverse array of maritime activities including commercial shipping, commercial, recreational, and Tribal fisheries, recreation, aquaculture, defense operations, and energy production. Fourteen deep-draft ports form the backbone of the region's commercial shipping system, from San Diego to Tacoma. In 2023, maritime transportation accounted for over 40 percent of the total value of U.S. global trade, with West Coast ports handling more than one-third of that and supporting nearly 12 million user-related jobs.

Analysis of the Coast Guard's Pacific Coast Port Access Route Study (PAC-PARS) revealed rising vessel traffic over the 2017–2021 period, measuring activity through total tracked vessel movements. To analyze vessel movement, PAC-PARS used automatic identification system (AIS) and vessel monitoring system (VMS) data, which capture the vast majority of commercial ships involved in international and domestic trade. However, commercial fishing vessels, and many recreational vessels, are not required to carry AIS or VMS, notably if they are less than 65 ft in length. PAC-PARS found commercial cargo and tanker traffic mostly occurs within 25–40 NM offshore, and the numbers of these vessels rose slightly over the period. Recreational vessels and small fishing craft stay closer to shore and the study saw a large increase in recreational vessels.

Through an inclusive engagement process which included federal and state agencies, stakeholders, Tribes, and fishing communities, the Coast Guard considered current and future uses of the West Coast waterways. The Coast Guard's PAC-PARS recommendations—currently pending implementation—include establishing coastwise and nearshore fairways to codify existing traffic patterns and thus increase navigational safety.

The California Current Ecosystem and Fisheries

The CCE extends roughly 1,860 mi from Southern California to Washington, forming one of the most productive marine ecosystems in the world. Seasonal upwelling of nutrient-rich water supports a diverse community, from plankton and forage fish (sardine, anchovy, squid) to higher predators (tuna, salmon, seabirds, and marine mammals). Winds that drive seasonal upwelling also make the region favorable for offshore wind energy development. Figure S-2 shows annual windspeeds and direction along the coast, with higher windspeeds in orange and red.

Commercial, Tribal, and recreational fishing are central to coastal economies and cultures. Throughout the West Coast region from 2011-2020 Dungeness crab accounted for about 30 percent of total commercial fishery value, followed by Pacific oyster[2], Pacific whiting, and market squid. National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) reported more than $700 million in commercial ex-vessel revenue and 290,000 jobs across the three coastal states in 2022. Recreational fisheries across the region in 2022 accounted for 7,500 jobs and over $800 million in trip expenditure.

Tribal fisheries—rooted in usufructuary rights[3] and, in some cases guaranteed by treaties and reaffirmed by the courts—are foundational for both cultural and subsistence uses. Fishing rights encompass both access and habitat integrity, requiring careful consideration in the siting and operation of ORE infrastructure. The Stevens Treaties of the 1850s reserved Tribes' rights to fish in their usual and accustomed areas in the Pacific Northwest. Later in the 1970s the Boldt Decision (*United States v. Washington*) reaffirmed these rights allowing Tribes the right to half the allowable catch and establishing co-management between Tribes and the states. Federal regulations list the locations for usual and accustomed fishing for the four Tribes that exercise their treaty rights in 50 CFR 660.4. Other federally and state recognized Tribes also engage in fishing throughout the West Coast.

Area-use data for commercial and recreational fishing activity to identify historic and current fishing grounds come from AIS and VMS vessel tracking data, commercial and charter fishing logbooks, and efforts by local fishermen to map fishing grounds. Some challenges arise in identifying fishing grounds because many vessels are not

[2] Pacific oysters are harvested through aquaculture in bays and estuaries.
[3] Usufructuary right are defined as rights to use and benefit from a property without owning it.

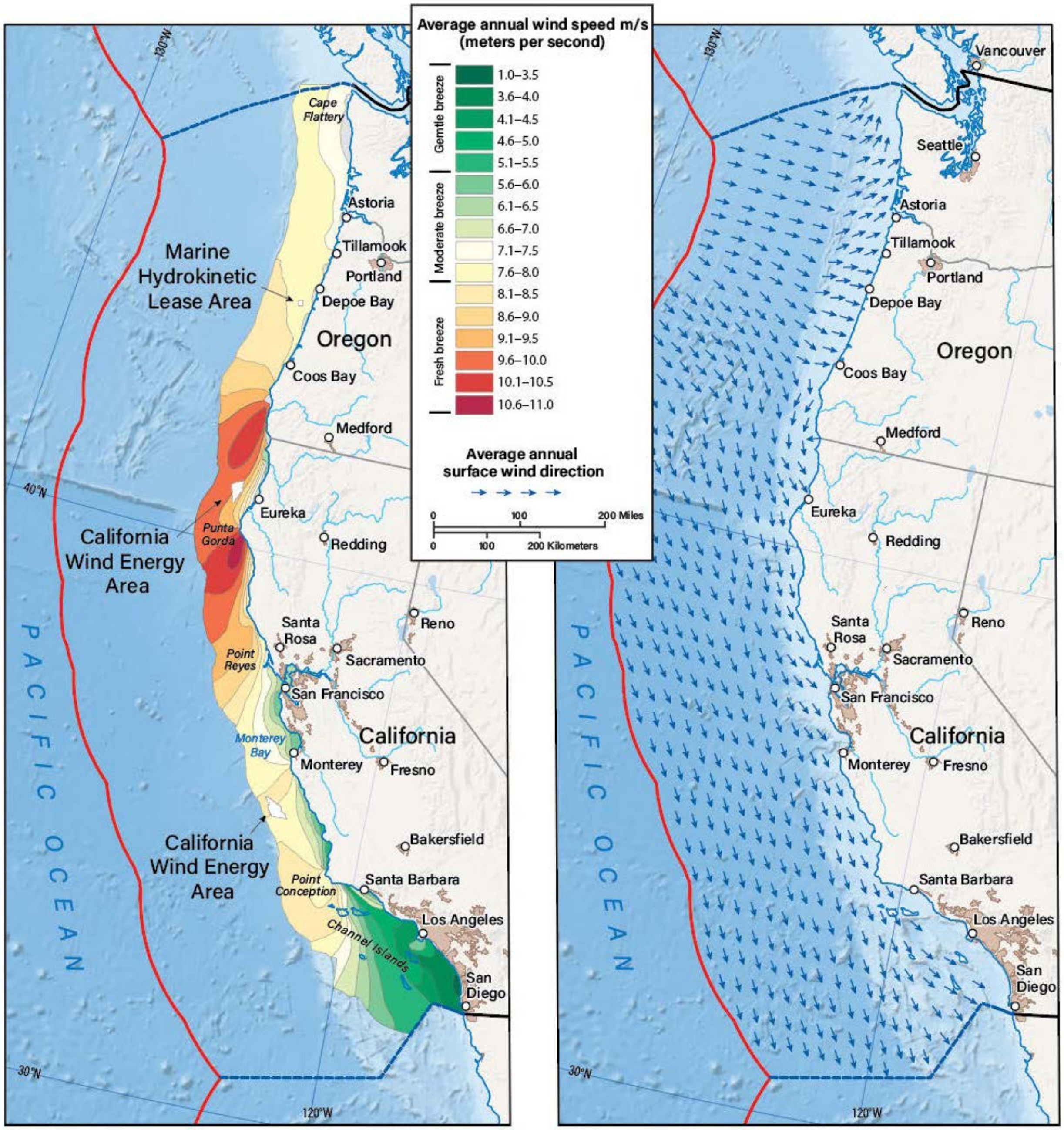

FIGURE S-2 Average annual wind speed (m/s) at 100 m above the surface (*left*) and wind direction (*right*) in covered waters off the West Coast.
SOURCE: Created for the committee by Map by International Mapping. Based on data from Draxl et al., 2015.

required to carry AIS or VMS[4] and fishing vessel information derived from logbooks often lack spatially discrete data upon which conclusions can be reached about where specific fishing activities are occurring.

Coast Guard Operations and Maritime Safety

The Coast Guard has extensive responsibilities for search and rescue (SAR), maritime safety and security, aids to navigation (ATON), law enforcement, and environmental protection across the EEZ offshore California, Oregon, and Washington. This study was asked to focus on Coast Guard operations relevant to commercial fishing activities near ORE sites, specifically related to SAR and safety at sea. Two Rescue Coordination Centers (RCCs)—RCC Alameda and RCC Seattle—oversee regional operations, supported by Sectors, Cutters, small boat stations, and air stations (Figure S-3).

For commercial fishing vessels, Coast Guard involvement remains critical. Vessel losses and fatalities have declined since the 1980s, and SAR activity continues to peak seasonally during spring and summer, but often some of the worst cases occur in winter and fall when poor weather conditions affect search conditions.

The Coast Guard's operations also affect commercial fishing through its fisheries enforcement, and waterways management missions. In partnership with NOAA, the Coast Guard regulates fisheries and fishing vessel safety in part through boardings across the three West Coast states. Its waterways management mission additionally includes maintaining over 2,700 fixed and floating ATON along the continental West Coast.

OFFSHORE RENEWABLE ENERGY TECHNOLOGIES

Floating Offshore Wind

FOW is the most applicable and relevant ORE technology for the Pacific coast due to the region's narrow continental shelf and deep offshore waters. FOW turbines on the West Coast are expected to exceed 15 megawatt (MW) capacity, with rotor diameters up to 250 m and mounted on floating platforms (spar, semi-submersible, or tension-leg designs) moored to the seafloor. FOW arrays are expected to include inter-array cables that connect platforms with dynamic (suspended) and static (lying on the seafloor) sections, substation transformers, and submarine cables to transfer energy to shore. FOW projects on the West Coast are in the planning phase and at the time of writing; exact project configurations have not been proposed.

In 2022, Bureau of Ocean and Energy Management awarded five lease areas off California—two near Humboldt Bay (North Coast) and three near Morro Bay (Central Coast)—covering 583 sq mi. These sites, located 20–50 NM offshore, are expected to host hundreds of turbines spaced roughly one mile apart with an expected generation capacity of 4.6 to 8.1 GW. At the end of 2024 a draft programmatic environmental impact statement was published, and lessees are conducting site assessments, but subsequent federal policy changes have halted further federal actions.

Wave and Tidal Energy

Wave and tidal technologies remain in earlier stages of commercial development. The PacWave South test site off Newport, Oregon, represents the first grid-connected wave energy facility in U.S. federal waters. It consists of four berths capable of hosting up to 20 wave energy converters with a combined capacity of 20 MW. The nearby PacWave North site supports non-grid-connected prototype testing.

Tidal energy converters harness tidal currents through various device archetypes such as axial-flow and cross-flow turbines or oscillating hydrofoils. The predictability of tidal currents makes tidal current energy conversion attractive. Technology readiness levels for wave and tidal systems generally range from 5 to 8, below the 8–9 range typical for mature wind systems.

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[4] Automatic Identification Systems (AIS) are continuous communication systems between ships and shore while Vessel Monitoring Systems (VMS) are scheduled broadcasts from vessels to satellites that are then transmitted to shore.

FIGURE S-3 Location of U.S. Coast Guard units on the West Coast.
SOURCE: Created for the committee by International Mapping.

PLANNING AND REGULATORY FRAMEWORK

Federal Governance

Offshore renewable energy in federal waters (beyond 3 NM baseline) is governed by the Outer Continental Shelf Lands Act as amended by the Energy Policy Act of 2005. The process is overseen by the Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE). BOEM manages planning, leasing, and site assessment, while BSEE oversees construction, operation, and decommissioning (Figure S-4).

The six-step federal process includes

1. Planning and analysis,
2. Leasing,
3. Site assessment,
4. Construction,
5. Operation, and
6. Decommissioning.

BOEM, in consultation with other federal agencies (e.g. NOAA, Coast Guard, Environmental Protection Agency), initiates planning through requests for interest, call areas, and designation of wind energy areas (WEAs). Developers compete in auctions to obtain leases, followed by submission of site assessment plans (SAPs) and construction and operations plans (COPs). Federal review under the National Environmental Policy Act (NEPA) and consultation under the Endangered Species Act, National Historic Preservation Act (NHPA), and Coastal Zone Management Act (CZMA) help to ensure environmental and cultural compliance. This review is conducted as an environmental and technical review once the COP is received (Figure S-4).

Through information gathering meetings, the committee heard that BOEM's engagement with Tribal, fishery participants and local communities on the West Coast during these stages has often been limited and one-directional, characterized by information provision rather than dialogue. Enhancing this engagement, including early consultation with Tribal governments and evaluating co-management or co-development practices, can lead to informed decision making that maximizes benefits from clean energy development while minimizing impacts to communities.

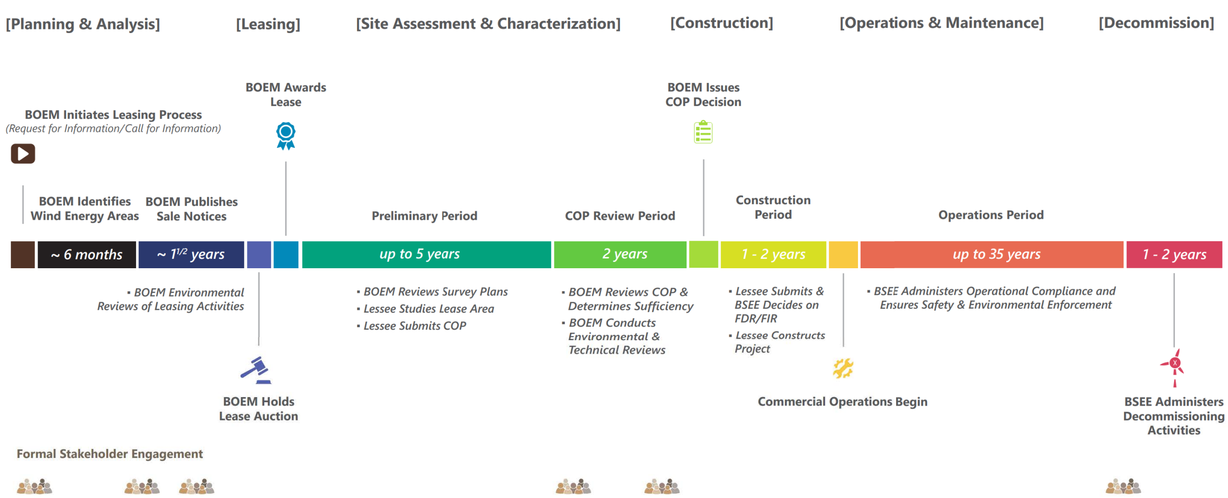

FIGURE S-4 BOEM and BSEE regulatory states and timeline
NOTE: BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; COP = construction and operations plan; FDR/FIR = Facility Design Reports/Fabrication and Installation Reports.
SOURCE: BOEM, n.d.

State-Level Frameworks

California has developed a state roadmap for offshore wind through Assembly Bill 525 (2021) and the 2024 Offshore Wind Energy Strategic Plan. California set targets of 2 to 5 GW by 2030 and 25 GW by 2045 and calls for coordinated permitting, meaningful Tribal consultation, and mitigation of impacts to fisheries and local communities. Senate Bill 605 (2023) further mandates evaluation of wave and tidal energy feasibility and spatial suitability mapping.

Oregon's House Bill 4080 (2024) directs creation of an Offshore Wind Roadmap emphasizing effective stakeholder engagement, environmental protection, and Tribal inclusion. Oregon's decarbonization goals—100 percent clean electricity by 2040—anchor these efforts.

Washington's Clean Energy Transformation Act targets carbon-free electricity by 2045. The Washington State Energy Strategy for 2021 includes adding 4 GW of offshore wind between 2040 and 2050. Although no leasing has begun, Washington's approach integrates offshore wind into regional energy and transmission planning.

Marine Spatial Planning and Data Needs

Marine spatial planning (MSP) is central to integrating multiple ocean uses. High-quality spatial data—for commercial, Tribal, and recreational fisheries, fish habitats, shipping, and other maritime activities—are foundational to siting decisions that minimize impacts on the environment, other ocean users, and local communities. However, data gaps persist especially for commercial, Tribal, and recreational fisheries. Using transparent spatial suitability models, developed collaboratively with states, Tribes, coastal communities, fishermen, and stakeholders, would improve siting and reduce future conflicts.

INTERACTIONS, EFFECTS, AND BENEFITS

Ecosystem Effects

Environmental considerations for FOW include wake effects, effects on upwelling, seabed disturbance, underwater noise, electromagnetic fields (EMFs), and interactions with marine life. While FOW reduces the need for pile driving relative to fixed-bottom systems and may limit the other environmental effects during installation, actions such as anchoring ORE devices with mooring cables, potential bottom sweeping from mooring cables, and transmission cables running to shore have the potential to disturb sensitive bottom habitat and may create new environmental effects. Underwater noise and EMFs may influence species behavior. For example, laboratory studies suggest shore crabs linger near EMF sources, while some larval fish exhibit altered swimming behavior. However, these effects are highly localized.

Modeling studies of FOW arrays (up to 8 GW capacity) indicate potential localized impacts on upwelling, nutrient flux, and primary productivity around the two lease areas off California. Modeled results also showed effects diminishing in magnitude from physical processes to biological outcomes. Continued research and monitoring are warranted to understand effects from greater FOW capacity.

Entanglement risk for large marine mammals is low for primary interaction with mooring cables but uncertain for both secondary entanglement involving fishing gear lost or snared at an ORE site and tertiary entanglement when already entangled and caught on mooring lines and inter-array cables. Ongoing monitoring and adaptive management will be needed to ensure that large marine mammals are not disturbed or harmed.

Fisheries and Tribal Impacts

FOW infrastructure may create *de facto* exclusion zones for certain fishing methods because of the risk of gear becoming entangled. Mobile and bottom-contact gears (e.g., trawls, longlines) are least compatible with floating platforms and dynamic inter-array cables, while surface and hook-and-line fisheries may be less affected.

ORE may also disrupt long-standing Tribal fishing activities and treaty-protected habitats. Tribes' usufructuary rights include both access to fisheries and protection of habitat from degradation. Meaningful government-to-government consultation and co-management approaches are required. Beyond direct fishing impacts, ORE development could displace port-dependent industries, reduce harbor capacity, and create congestion during installation (e.g., turbine towing) and maintenance operations.

FOW infrastructure may provide the benefit by acting as a floating fish aggregation device. Structures in the FOW arrays (e.g. anchor systems, and underwater portion of turbines) can attract various fish species. The extent of these effects will differ than those observed at fixed bottom offshore wind projects on the U.S. East Coast and in Europe.

Fisheries Management and Research

ORE installations may impede NOAA's long-term fishery-independent surveys by restricting vessel access or altering fish distributions. Such disruptions would compromise stock assessments and ecosystem models. New methodologies—autonomous platforms, modified survey designs, and adaptive sampling— can mitigate survey disruption and maintain data continuity. ORE development projects also provide the opportunity monitor the marine environment through research studies on understanding their potential impact and as a platform for sensors and new technologies.

Shipping and Navigation

Floating wind arrays will occupy ocean space that may affect vessel transits. While large commercial ships are expected to avoid arrays, smaller vessels (fishing boats, tugs) may choose to navigate through or around them. The Coast Guard recommends arrays be configured in straight rows with 1 NM spacing to maintain safe navigation and SAR operations. Consideration of transit corridors might be appropriate to allow safe navigation if multiple projects are developed adjacent to each other.

Wind turbines can create radar clutter, potentially affecting vessel and aircraft navigation. One mitigation method includes radar signal processing upgrades. Additionally, BOEM and the Coast Guard have developed standards for developers including the use of AIS identification of platforms, and differentiated lighting and marking of specific platforms. Continued coordination between BOEM and the Coast Guard on the West Coast will incorporate navigational safety early in siting decisions and throughout project construction.

Coast Guard Operations

ORE development will influence many aspects of Coast Guard operations particularly around SAR operations. FOW arrays complicate search planning by creating drift obstructions unaccounted for in the Coast Guard's Search and Rescue Optimal Planning System model. High-frequency radar shadows behind turbines could further reduce drift model accuracy. Turbulence, lighting, and tower structures pose hazards to low-altitude helicopter operations. Coordination on turbine shutdown procedures and compatible lighting can mitigate the impacts. Increased offshore workforce may generate more medevac cases and require coordination between industry and Coast Guard response assets.

Social Dimensions and Engagement

Public perception, social acceptance, and procedural fairness are central to the sustainability of ORE development. Research on East Coast projects indicates that meaningful participation—defined by two-way dialogue, transparency, and tangible influence on outcomes—is strongly correlated with local support.

The committee observed that BOEM's engagement to date has been largely procedural and inconsistent across regions. The Government Accountability Office (GAO) (2025) found that BOEM "had not consistently demonstrated efforts to consider or address Tribal concerns." Many Tribes lack the resources or personnel to engage fully in technical consultations. Engagement with Tribal governments is an essential part of the ORE development process and there may be multiple appropriate engagement methods because of the sovereignty of each federally recognized Tribe or Nation.

Community benefit agreements, workforce training investments, and fishery compensation programs represent emerging tools to balance benefits and burdens. Developing these mechanisms in a way that is transparent and co-designed with affected groups can build trust and legitimacy.

Economic and Infrastructure Considerations

Port infrastructure on the West Coast is a limiting factor for ORE deployment. California found that only the Ports of Humboldt, Los Angeles, and Long Beach have the potential to support full assembly and staging of floating turbines. California's AB 525 port readiness study estimates that $11.7 billion in investment will be needed for port upgrades.

These port developments can bring substantial economic opportunities, including local manufacturing, operations and maintenance jobs, and supply-chain growth. There is a risk of displacing existing maritime and fishing activities with port upgrades and balanced planning, informed by cumulative impact assessments, is essential to align economic benefits with community resilience.

COMMITTEE RECOMMENDATIONS

The committee's recommendations are created to capture best practices, organized by topic area, and are intended to improve research, engagement, safety, and governance.

Recommendation 7-1: National Oceanic and Atmospheric Administration's National Marine Fisheries Service should identify research and data needs to better understand the potential effects (e.g., on upwelling, nutrient levels, productivity, species distributions) of offshore renewable energy development on the broader California Current Large Marine Ecosystem and West Coast fisheries and commence to fill identified gaps as resources allow.

Recommendation 7-2: Congress should designate funding or resources to support consultation and collaboration by Tribes and other engagement by Tribes who do not have resources to meaningfully engage in the Bureau of Ocean Energy Management process.

Recommendation 7-3: Lead federal agency(ies) for offshore renewable energy projects (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers) should meaningfully engage and establish a dialogue with states, Tribes, fishing and coastal communities, other ocean users, and interested persons to exchange and integrate local knowledge while gaining a mutual understanding of the needs and concerns of all users.

Recommendation 7-4: Lead federal agency(ies), (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers), in collaboration with National Oceanic and Atmospheric Administration and state agencies, should require offshore renewable energy projects to develop and implement scientifically robust long-term environmental monitoring plans for leased sites that ensure comparability across sites and results in publicly accessible data. Monitoring plans should include elements that are designed at a regional level and use standardized, comparable methods across sites.

Recommendation 7-5: National Oceanic and Atmospheric Administration National Marine Fisheries Service, in conjunction with lead federal agency(ies) for offshore renewable energy projects (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers), should develop a Federal Survey Mitigation Implementation Strategy for the Pacific U.S.

Region. The Mitigation Strategy would minimize disruptions to long-running datasets that are used for stock assessments and other fishery management decisions.

Recommendation 7-6: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, in consultation and collaboration with other applicable federal agencies, states and Tribes, should conduct a marine geospatial assessment, including a spatial suitability model, for the West Coast. This assessment would be used to evaluate the competing uses, and assess the risks, mitigations, costs, and benefits of the different uses.

Recommendation 7-7: The Coast Guard should expedite enactment of the Pacific Area Port Access Route Study fairways for the U.S. West Coast.

Recommendation 7-8: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, should engage the Coast Guard and other applicable federal agencies, commercial, Tribal and recreational fisherman, and maritime stakeholders to study whether transit corridors through or between offshore wind lease sites are needed to allow for safe passage for fishing, vessel traffic, and Coast Guard operations.

Recommendation 7-9: The Coast Guard, Bureau of Ocean Energy Management, and Bureau of Safety and Environmental Enforcement should continue adding, refining, and standardizing measures for offshore renewable energy projects in order to mitigate the risk to Coast Guard operations, including surface, subsurface, air, cyber and command-and-control operations.

Recommendation 7-10: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, should require offshore renewable energy area lessees to provide services for 24/7 vessel and aircraft search and rescue response capabilities to support their personnel and assets. Additionally, the Coast Guard should establish planning and coordination procedures with operators to facilitate search and rescue response.

CONCLUSION

Offshore renewable energy development on the U.S. West Coast is both promising and complex. Commercial-scale ORE deployment can proceed responsibly if underpinned by scientific understanding, robust interagency coordination, and early engagement with Tribes, fishing communities, and other maritime users.

West Coast ORE development can contribute meaningfully to decarbonization and energy resilience while preserving maritime safety, ecosystem health, and community cultural integrity. Achieving this balance requires proactive investment in research, planning, and governance mechanisms that honor the ocean's multiple values and users.

Through the conclusions and recommendations articulated herein, the committee envisions a pathway toward sustainable, science-based, and socially just ORE development—one that provides the benefits of clean energy and reflects the diverse interests, histories, and futures of the West Coast and its people.

Introduction

To date few ORE projects have been developed on the U.S. West Coast, due to the narrow continental shelf, deep waters, heavy seismic activity, severe winter storms, and the lack of ports and shoreside infrastructure outside major metropolitan areas. With recent advances in FOW and hydrokinetic technologies and a growing demand for clean energy sources, ORE development has emerged as a feasible and viable option for the West Coast. These new energy possibilities bring new challenges and raise questions of how these changes may affect the diverse and complex ecosystems, existing maritime activity, and coastal communities. Clean energy, including ORE, is a public good and has the potential for wide benefits such as improved local economy and quality of life. However, ORE must be developed in a way that reduces or avoids stresses on coastal communities, the marine environment, and ocean resource use.

Similar to ORE development on the East Coast, other uses of the offshore region come into consideration when contemplating where to site offshore renewable installations. Key maritime uses include maritime traffic (e.g., shipping lanes), recreational boating, commercial, Tribal, and recreational fishing, and the usual and accustomed fishing areas of West Coast Tribes. These sectors have raised significant concerns, including access to fishing grounds, shifts in vessel traffic patterns, disruption and displacement in ports supporting ORE development, interference between wind turbines and radars used for navigation and SAR, and other safety concerns. The construction and operation of ORE facilities also raise concerns about the potential to affect marine ecosystems through changes in hydrodynamics, shifts in feeding patterns, and changes in marine mammal and other migration routes that may be impacted by or impact shipping and fishing.

Complicating this picture are the anticipated shifts in maritime traffic and fishing due to an increased demand for shipping and potential changes in the ranges and distribution of marine species because of changing ocean conditions.

ORIGIN AND PURPOSE OF THE STUDY

In the James M. Inhofe National Defense Authorization Act for Fiscal Year 2023 (P. L. 117-263), Congress included a request for a National Academies of Sciences, Engineering, and Medicine study assessing the impacts on shipping and commercial, Tribal, and recreational fisheries from the development of ORE on the West Coast (Sec 11319).

The study description was developed through consultation with representatives from the U.S. Coast Guard, Bureau of Indian Affairs, BOEM, and NOAA NMFS.

STUDY APPROACH

Following the congressional request to assess the impacts of ORE development on the West Coast, the National Academies established an ad hoc committee of experts. With the help of the National Academies resource center, the committee conducted a literature review analyzing existing research on relevant fisheries present in the study area, effects of ORE on various communities and the environment, and ORE technologies in both the United States and abroad. During open public sessions, the committee heard from various experts in areas such as academia, industry, fisheries, federal and state government, and several Tribes and Nations. Using information from the literature review, information gathering sessions with regional and technical specialists, listening sessions with community members and resource users, and the committee's own expertise, the committee deliberated and produced conclusions and recommendations.

To effectively respond to the statement of task, the committee divided their work into three levels of assessment: (1) recognition of relevant stakeholders and communities that could be affected directly or indirectly by ORE development and operation; (2) review of existing and developing ORE technologies and analysis of existing ORE development processes at both the state and federal level; and (3) identification of potential burdens and benefits associated with ORE development. A complete statement of task can be found in Box 1-1.

Covered waters in the statement of task refers to Federal and State waters off the coasts of California, Oregon, and Washington from the U.S.–Mexico border to the U.S.–Canada border and offshore to 200 NM (Figure 1-1). Within this area there are existing offshore wind lease areas off Morro Bay and Humbolt Bay, California, and an offshore hydrokinetic test site off Newport, Oregon. Other ocean use areas include marine sanctuaries, marine reserves, marine protected areas, restricted areas, danger zones, shipping lanes, common fishing grounds, and Tribal usual and accustomed fishing areas.

STUDY CONTEXT

To understand the potential impacts and factors affecting ORE development, this study explores the topics of maritime activity, ecosystem and fisheries dynamics, Coast Guard operations, and the ORE planning process.

Maritime Activities

Maritime activity and uses on the U.S. West Coast include shipping, commercial and recreational fishing, Tribal fishing, recreational activities, military activities, space launch and recovery, aquaculture, ORE, offshore oil and gas, and offshore subsurface cables. Some areas, such as National Marine Sanctuaries are set aside for conservation purposes. Many maritime activities compete for the same ocean space, while others can happen adjacent or within the same space. Careful planning must be undertaken when considering new activities that may disrupt or displace existing ocean uses and impact the ecosystem, such as with ORE development.

Waterborne vessels are the principal mode of transportation for international trade of goods (DOT, 2025). In 2024, commercial shipping moved 41.5 percent of the U.S. global trade's value, or $2.1 trillion worth of goods, with ports along the West Coast accounting for more than one-third of all imports to the United States, over 1 million tons of cargo per day (PMA, 2024). The reach of West Coast ports extends far beyond the docks and the vessels they accommodate, in 2024 ports supported an estimated 161,000 direct jobs, 375,000 induced and indirect jobs, and an additional 11.9 million jobs related to port activity and commerce (PMA, 2024). The basis of this vast trade network starts with the ports and relies on the commercial ships that carry cargo and people in and out of the ports.

BOX 1-1
Statement of Task

The objective of this study is to understand potential impacts of offshore renewable energy development on maritime traffic and fisheries (commercial, recreational, and Tribal) on the West Coast in federal and state waters. The study will consist of a literature review and information gathering through public meetings to document the historic and current uses of areas that could be considered for renewable energy development and assess how they may be affected by the installation and operation of wind turbines and/or hydrokinetic energy structures. Specifically, the committee will:

1. Document historic and current uses of offshore areas based on available, published information to include—

(A) Historic and current Tribal, commercial, and recreational fishing grounds, as well as areas where fish stocks are anticipated to shift in the future;

(B) Tribal usual and accustomed fishing areas in all covered waters;

(C) Historic, current, and potential future shipping lanes, based on projected growth in shipping traffic in all covered waters.

2. Analyze—

(A) Current and expected Coast Guard operations relevant to commercial fishing activities, including search and rescue, radar, navigation, communications, and safety within and near renewable energy sites;

(B) Anticipated, substantial interactions with, and adverse impacts on, maritime activities with the placement of renewable energy infrastructure and the associated construction, maintenance, and operation; and

(C) Anticipated, substantial benefits and methods to mitigate adverse impacts through design, siting, maintenance and operational plans for renewable energy infrastructure, and including adjustments in management of fishing, shipping, and other maritime activities.

3. Review the current decision-making process for offshore wind in covered waters, and outline recommendations for governmental consideration of all impacted coastal communities, particularly Tribal governments and fisheries communities, in the decision-making process for offshore wind in covered waters, including recommendations for—

(A) Ensuring the appropriate governmental considerations of potential benefits of offshore wind in covered waters; and

(B) Risk reduction and mitigation of adverse impacts for safety at sea and search and rescue Coast Guard operations relevant to commercial fishing activities.

Ecosystems

West Coast ecosystems support fisheries that benefit commercial, Tribal, and recreational fisherman and dependent fishing communities. The foundational ecosystem is the California Current Ecosystem (CCE), a roughly 3,000-km stretch of ocean ranging from southern California through Washington State (PFMC, 2022). The living marine resources of the CCE include a wide variety of plants and animals, resident and migratory, in the water column (pelagic) and near (demersal) or on (benthic) the seafloor. The CCE is known for its high productivity due to predictable seasonal upwelling patterns that bring cold, nutrient-rich water to the surface of the ocean, supporting the populations of plankton and forage fish (e.g., sardines, anchovies, and squid) found along the coast (PFMC, 2022). This abundance in forage in turn sustains larger populations of commercial fish species, marine mammals, and seabirds. Invertebrates include squid, octopus, bivalves, and crustaceans (shrimp, crabs, lobsters). Vertebrates include small pelagic fish (e.g., anchovy and sardine), groundfish (e.g., Pacific hake and sablefish), highly migratory fish (e.g., albacore and Pacific bluefin tuna) and anadromous fish (e.g., salmon). Annually, NOAA publishes a California Current Integrated Ecosystem Assessment report that includes information on current ocean

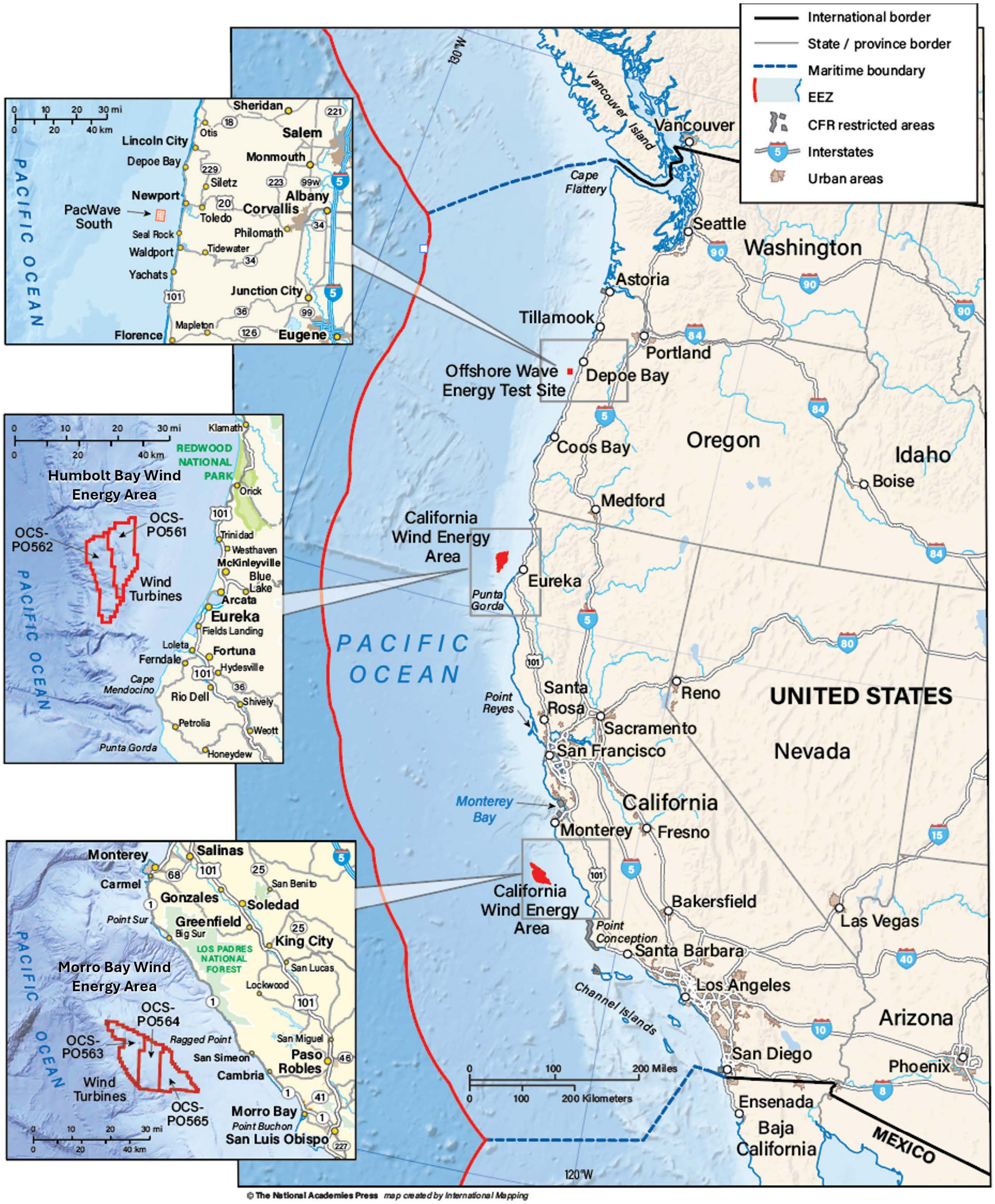

FIGURE 1-1 Map of study area.
NOTE: OCS = Outer Continental Shelf; OSC – P0561, OSC-P0562, OSC-P0563, OSC-P0564, and OSC-P0565 are individual lease areas.
SOURCE: Created for the committee by International Mapping.

conditions, habitats, populations and abundances of fish stocks and data on fish landings. The report is presented to the Pacific Fishery Management Council (PFMC) in March each year to help inform management decisions in the upcoming fishing year.

Plants, birds, and marine mammals are also a key part of the CCE. Plants of commercial importance include kelps and other algae attached to the bottom, often in relatively shallow water. Both migratory and resident varieties of birds and mammal species are important to the ecosystem and may be affected by ORE development. Migratory species include birds (sooty shearwater, common murre, Black-footed albatross) and whales (blue, gray, humpback, minke whales, and West Coast Bigg's Transient killer whales). Resident birds include many shorebirds and seabirds, particularly those associated with upwelling, including cormorants, pelicans, and boobies. Resident marine mammals include sea lions, seals, dolphins and the Southern Resident killer whale (NOAA Fisheries, n.d.).

A significant fraction of plankton production at times sinks and decays at depth, causing low oxygen in deeper and bottom waters (Zheng et al., 2020). Upwelled waters can be low in oxygen, though primarily on the inner shelf (Ren et al., 2025). Mixing due to wind and stratification due to solar heating also affects the vertical movement of water, nutrient fluxes, and production of organic matter by plankton and fish. ORE projects may affect both upwelling and mixing, particularly locally, with subsequent effects on plankton, fish, and fisheries.

Commercial, Tribal, and Recreational Fishing

West Coast ecosystems support various communities including fishing industries, commercial and recreational maritime users, and a number of Tribes and Tribal Nations. Commercial fishing along the West Coast began in the 1800s and has since grown into an industry employing thousands of people. Fisheries' relative importance has changed over time. Figure 1-2 shows fishing activity since the 1970s, which has been impacted by major climate events and closures. Although target species have shifted over time, fishing remains a substantial industry on the West Coast. In its most recent annual economics report, NMFS reported over $700 million in commercial fishing ex-vessel revenue and 290,000 jobs throughout California, Oregon and Washington in 2022 (NMFS, 2024). Ex-vessel revenue represents dollars paid to fishermen and does not capture the downstream economic benefits. Table 1-1 compares the relative value of commercial fisheries along the U.S. West Coast for 2011-2020. Dungeness crab (benthic) was the most valuable fishery. Pacific whiting (groundfish) was third. Whiting is broadly distributed along the U.S. West Coast and migrates, reproducing in the south and feeding and growing in the north (Hollowed 1992). Market squid (pelagic) was fourth and pink shrimp (benthic) sixth. Albacore tuna (highly migratory), ranked seventh, migrate shoreward in spring to fall to feed on small pelagic fish, including anchovy and sardine. Chinook salmon ranked eighth and are of particular importance to Tribes situated on the West Coast and inland, given salmon migration up and down river systems. Chinook salmon are also the primary food of Southern Resident killer whales, a population federally listed as endangered.

In the United States, there are 574 federally recognized Tribes, hundreds of which can be found along the California, Oregon, and Washington coasts (Schwartz, 2024). In addition, there are several Tribes that are non-federally recognized but have been recognized by individual states. Fishing practices have sustained many of the coastal and some inland Tribes and continue to be important economically and culturally.

Coast Guard Operations

The Coast Guard conducts extensive operations along the West Coast that directly affect commercial fishing vessels, recreational boaters, and commercial maritime traffic through SAR services, navigation safety programs, fisheries law enforcement, marine environmental protection, and more. As stated in Box 1-1 the committee's task focuses on Coast Guard operations related to commercial fishing activity. Beyond basic navigation safety operations, the Coast Guard's SAR program represents perhaps the most critical service for commercial fishermen, with rescue coordination centers in Alameda, California and Seattle, Washington managing emergency responses for areas offshore California, Oregon, and Washington. Despite dramatic improvements since the 1980s, when nearly 250 commercial fishing vessels were lost annually nationwide, the Coast Guard still responds to significant numbers of fishing vessel emergencies. In 2023 the Coast Guard conducted 258 assistance cases for commercial

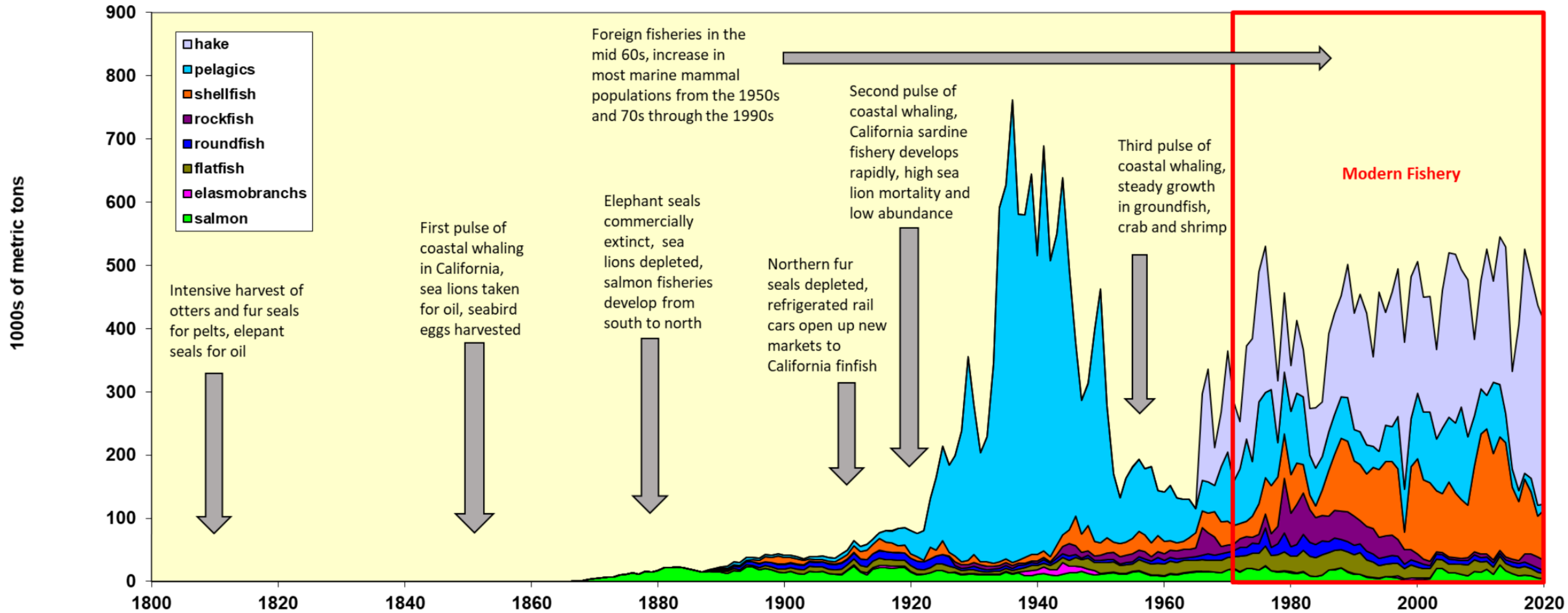

FIGURE 1-2 Fishing activity within the U.S. portion of the California Current Ecosystem since the 1970's.
NOTE: CCA = Cowcod Conservation Area; CWA = Clean Water Act; ESA = Endangered Species Act; MMPA = Marine Mammal Protection Act; MSA = Magnuson-Stevens Act; NEPA = National Environmental Policy Act; RCA = Rockfish Conservation Area.
SOURCE: PFMC, 2022.

TABLE 1-1 Relative Commercial Fishing Value by Species

Rank	Common Name	Gross Revenue of Landings (%)
1	Dungeness crab	30.9
2	Pacific oyster [a]	8.2
3	Pacific (whiting) hake	8.2
4	California market squid	7.9
5	Geoduck	6.0
6	Ocean pink shrimp	5.9
7	Pacific albacore tuna	5.4
8	Chinook salmon	5.1
9	Sablefish	4.2
10	California spiny lobster	2.2

[a] Pacific oysters are all cultured within bays and estuaries.
SOURCE: Modified from Feist et al., 2025.

fishing vessels, saving 17 lives while documenting 4 fatalities and 9 total vessel losses off California, Oregon and Washington (USCG, 2024). The agency maintains a two-hour response goal for emergencies in areas reasonably supported by cutters, small boat stations, and air stations, though this standard cannot always be met in remote ocean areas, where many commercial fishing operations occur.

The Coast Guard's regulatory and enforcement activities also shape the daily operations of West Coast commercial fishermen through fisheries law enforcement, vessel safety examinations, waterways management, and environmental protection measures. Working in partnership with the NMFS, Coast Guard units patrol over 130,000 sq mi of the exclusive economic zone (EEZ) off California alone, conducting approximately 1,500 commercial and recreational fishery boardings in 2023 across the three West Coast states. The agency also maintains critical navigation infrastructure including nearly 2,800 ATON along the waters off continental West Coast, manages port access routes and traffic separation schemes that affect vessel transit patterns, and enforces marine environmental protection measures designed to conserve the fish stocks and habitats upon which commercial fishermen depend.

Offshore Renewable Energy Planning

The development and management of ORE infrastructure is influenced by both federal and state regulations. Federal agencies included in the ORE development process are summarized in Table 1-2. Table 1-3 summarizes relevant state and federal law related to ORE.

Executive orders are another important aspect of ORE policy that can both indirectly and directly impact the process of development and subsequent management of these resources. An example of an executive order that indirectly impacts the development process for ORE is Bill Clinton's May 24, 1996, Executive Order 13007, "Indian Sacred Sites," which directs managers of federal lands to accommodate access to and limit adverse effects on areas deemed sacred to federally recognized Tribes. Similarly, executive memorandums and proclamations are presidential directives that can have a comparable impact to executive orders. For example, the Presidential Memorandum on January 20, 2025, "Temporary Withdrawal of All Areas on the Outer Continental Shelf from Offshore Wind Leasing and Review of the Federal Government's Leasing and Permitting Practices for Wind Projects," which temporarily withdraws all areas on the outer continental shelf (OCS) from new or renewed offshore wind leasing.

Executive Order 13175, "Consultation and Coordination with Indian Tribal Governments," requires federal agencies to take Tribal perspectives into account when developing and managing these kinds of projects by defining the need for a consultation process. Due to the sovereign nature of each federally-recognized Tribe or Nation, there is no single method of engagement that is appropriate. Engagement with Tribal governments is an essential part of the ORE development process. Some agencies have worked to develop a framework for their consultation

TABLE 1-2 Federal Agencies Involved in Offshore Renewable Energy Development

Federal Agency	Summary of Responsibilities
Bureau of Safety and Environmental Enforcement	Enforcement of offshore environmental and safety regulations including site inspections, environmental and safety responses, permit enforcement.
Bureau of Ocean Energy Management	Development of offshore wind energy projects including identifying suitable development areas, administering leases, conducting environmental studies under National Environmental Policy Act, and permitting. Leasing for hydrokinetic projects in federal waters.
Department of Energy	Supporting research and development of offshore renewable energy (ORE) technology, fosters growth of supply chains and manufacturing of ORE parts, and plan for project grid integration
Federal Energy Regulatory Commission	Regulation of grid interconnection, transmission and wholesale electricity markets, and the development of hydropower and hydrokinetics.
National Oceanic and Atmospheric Administration	Research and policy development related to the atmosphere and the oceans, including weather monitoring and forecasts, coastal restoration, fisheries management, protection of some species of marine mammals, coastal zone management, and marine sanctuary management.
U.S. Coast Guard	Navigation safety, management and enforcement of maritime operations, including law enforcement, prevention and response (including search and rescue), marine transportation, security, and defense.
U.S. Army Corps of Engineers	Regulation of structures and building projects in navigable waterways including on the Outer Continental Shelf, regulation of dredge and fill material discharge, and oversight of ORE export cables onshore

SOURCE: Pribyl, 2025.

TABLE 1-3 Laws Granting Regulatory Authority for Offshore Renewable Energy Development.

Act	State or Federal Power	Summary
Coastal Zone Management Act (1972)	State	Provides for state planning and regulation of coastal resources and can aid in the protection of coastal habitats. Grants states the authority to consider whether to certify federal actions and whether federal permittees affecting the coastal zone are consistent with enforceable state policies.
Submerged Lands Act (1953)	State	Defines the jurisdictional coastal lands of 3 NM* out from shore for the West Coast states.
Outer Continental Shelf Lands Act (OCSLA) (1953)	Federal	Regulates the placement, operation and decommissioning of offshore oil and gas and offshore wind infrastructure on the sea floor and mining from 3 NM from shore to the outer extent of the continental shelf, which is generally 200 NM
Energy Policy Act (2005)	Federal	Amends the OCSLA to grant Department of the Interior authority to regulate alternative energy which includes offshore wind. Defines the framework associated with offshore development as it relates to the regulations, permitting, and other legalities.
National Environmental Policy Act (1969)	Federal	Develops the foundation for federal agencies to assess and report on the environmental impacts of actions funded, carried out, or authorized by federal agencies.
National Historic Preservation Act (1966)	Federal	Defines requirement of federal agencies to consult with Tribal Nations when a project can affect properties with cultural significance to Tribes.

NOTE: This is not a complete list of appliable laws, but those relevant to discussion in this report.
* A straight baseline is drawn across Monterey Bay from Monterey to Santa Cruz to including the whole bay in state waters, extending the state water further than 3 NM from shore.
SOURCE: Pribyl, 2025

process, and other independent organizations have developed guidance documents that can provide a structure for engagement. However, these do not replace the need for involved agencies to develop individual relationships with affected Tribes and Nations to best determine suitable methods of engagement

REPORT ORGANIZATION

Drawing on information from several in-person and virtual information-gathering sessions and a review of current literature, the committee addressed the statement of task. The report is broken into seven chapters. Chapters 2 through 4 provide information on past and current uses of the maritime space including shipping, fisheries and Coast Guard operations. Chapter 2 presents an overview of maritime activity on the West Coast, and historic, current and future shipping activity. In chapter 3, we examine historic and future commercial, recreational, and Tribal fisheries as well as information on anticipated shifts in fish stocks. Chapter 4 covers an analysis of Coast Guard operations on the West Coast, focusing on those relevant to commercial fishing as outlined in the committee's Statement of Task.

Then, in Chapters 5 and 6 the report introduces ORE technology and the current planning process for development. Chapter 5 presents the state of ORE, FOW, wave, and tidal energy, and development sites on the West Coast. In Chapter 6 we discuss the ORE development planning process 6 at both the federal and state planning levels and discuss community engagement.

The report concludes with a chapter on the interactions between ORE and other ocean use. In Chapter 7 we discuss interactions between ORE development and topics covered in Chapters 2 through 6, discussing potential benefits and burdens of these interactions. Conclusions are included throughout Chapters 2 through 7. In addition to highlighting both potential benefits and burdens from ORE development on the West Coast we provide recommendations at the end of Chapter 7.

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2

Uses of Offshore Areas: Maritime Activity

The West Coast of the continental United States has 7,863 mi of shoreline, with major port complexes in the Los Angeles, Seattle, San Francisco, Portland and San Diego areas (NOAA Office for Coastal Management, n.d.). The U.S. EEZ generally extends offshore from the territorial sea out to 200 NM[1] (Figure 2-1). A wide variety of maritime activity operates in, around, and between the ports, up and down the coast, and inside and outside of the EEZ. This chapter first provides an overview of maritime activities within the territorial sea and EEZ. Next is a discussion of the overlaps between certain types of maritime activities. The chapter concludes with a description of recent vessel activity and potential shifts in activity along the U.S. West Coast. This chapter mentions fishing activity, but a detailed discussion is provided in Chapter 3. Discussion of navigational safety, maritime domain awareness and Coast Guard operations are in Chapter 4. Interactions between maritime activity and ORE development are discussed in Chapter 7.

MARITIME ACTIVITY ON THE WEST COAST

Commercial Shipping

Commercial shipping along the West Coast flows into, out of, and between as many as 14 deep-draft commercial ports from San Diego, California through Tacoma, Washington (DOC 2025-a, 2025-b). Commercial ships can be grouped into the following vessel types: bulk carriers, container ships, general cargo ships, oil tankers, chemical tankers, liquefied gas carriers, offshore supply vessels, ferries and passenger ships, and other vessels (UN, 2024). All of these types of vessels, along with smaller types such as towing vessels, barges, and other domestic trade vessels, operate on the West Coast, many rely on the deep-draft channels.

The Coast Guard, as part of their role in supporting safe maritime activity including proposing routing changes within the territorial seas and ports, or proposing offshore fairways and transit routes to the International Maritime Organization (IMO), conducts a Port Access Route Study. A Port Access Route Study presents routing recommendations that include consideration of the access and use needs of shipping, tug and barge activity, commercial and Tribal fishing. From 2021 through 2022 the Coast Guard conducted a PAC-PARS, for the ports of the continental U.S. West Coast (USCG, 2023). During the PAC-PARS study process, the Coast Guard coordinated with other

[1] 33 CFR 2.30

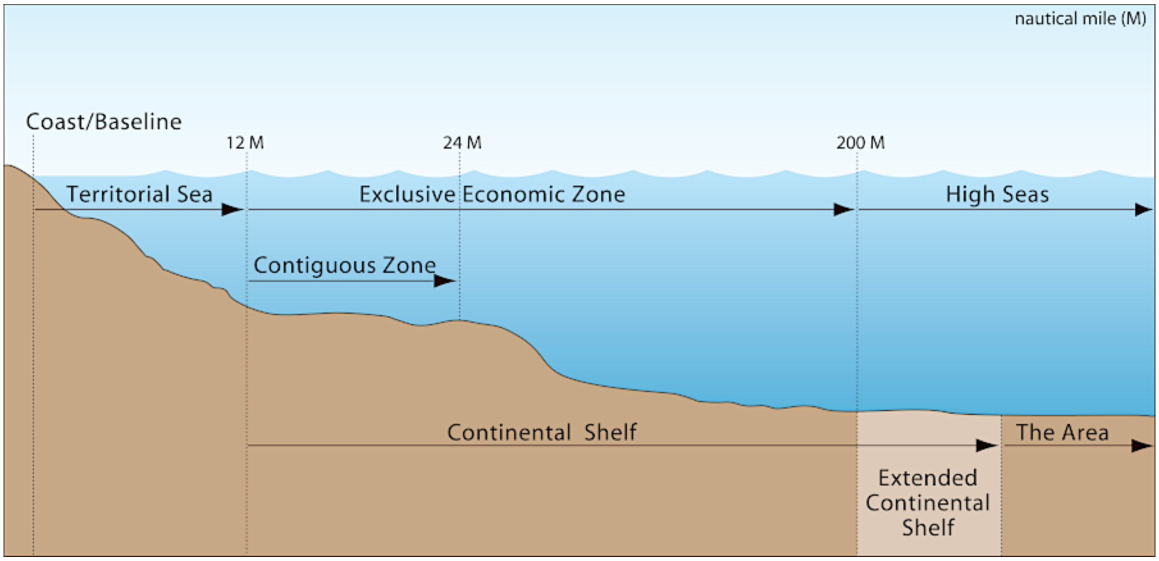


FIGURE 2-1 Maritime zones.
NOTE: M = nautical miles.
SOURCE: DOS, n.d.

Federal and State agencies and engaged with interested parties including maritime community representatives, environmental groups, Tribes, and commercial and recreational fishermen. The Coast Guard engagement process is further discussed in Chapter 7 (Shipping and Coast Guard Maritime Geospatial Planning Considerations). The Coast Guard enacts its final decisions on those recommendations by designating or adjusting fairways, traffic separation schemes, regulated navigation areas, safety zones, and security zones to provide safe access routes for vessel traffic proceeding to and from ports or places that fall under U.S. jurisdiction. As a matter of international law and U.S. policy, these designations recognize “the paramount right of navigation over all other uses” in the designated areas (USCG, 2023).

As a part of the study, the Coast Guard collected information using available data from AIS and VMS on vessels operating along the coast and out to about 200 NM. While these monitoring systems are not required for all vessels and thus cannot provide a complete view of the total traffic along the coast, they do provide a picture of the shipping lanes, which are favored by many operators. Table 2-1 provides an overview, from the PAC-PARS, of the volume and type of traffic operating on the West Coast as informed by AIS and VMS data during a five-year period. The PAC-PARS classified vessels as cargo (bulk carriers, container ships, general cargo ships), tanker (oil tankers, chemical tankers, gas carriers), passenger, tug/tow, fishing, recreational, and other.

Title 33, Navigation and Navigable Waters, requires AIS to be used on many vessels including certain commercial ships, towing vessels, and passenger vessels[2]. AIS data captures the vast majority of commercial ships involved in international and domestic trade but fails to capture vessels that fall below the regulatory threshold and choose not to carry AIS equipment. This includes fishing vessels that are under 65 feet in length and recreational vessels. Some fishing vessels are required by NOAA to carry a VMS, a distinct system used to monitor whether ships are operating in closed areas (NOAA Fisheries, n.d.-b). On the West Coast, the VMS requirements mostly pertain to vessels involved in specific fisheries (see Chapter 3). As a result, the numbers reflected in Table 2-1 vastly underestimate the number of fishing trips during that period. Additional discussion of AIS and VMS can be found in Chapter 4.

[2] 33 CFR 164.46

TABLE 2-1 Vessel Movement (Track Count) by Type along the West Coast (2017-2021)

Vessel Type	2017	2018	2019	2020	2021
Cargo	8,700	8,152	7,387	16,414	30,862
Tanker	2,768	2,179	2,008	4,674	4,570
Passenger	12,392	13,474	14,714	10,527	12,838
Tug/Tow	2,985	2,927	2,231	2,692	3,515
Fishing	8,595	10,594	9,687	10,103	12,536
Recreational	19,114	23,439	27,811	36,709	42,703
Other	5,686	6,523	6,002	6,014	7,293
Total	60,240	67,288	69,840	87,133	114,317

NOTE: Cargo includes bulk carriers, container ships, general cargo ships; these are total tracks, not unique vessel tracks.
SOURCE: Modified from PAC-PARS, Enclosure 1.

The PAC-PARS consolidated data on commercial vessels' operating locations on the West Coast and was used to generate heat maps showing vessel transits between 2017 and 2021. Figure 2-2 shows that many of the vessels using AIS follow the same transit patterns. The heat map shows clear east–west transit routes into and out of the ports on the West Coast, with a few transit routes leading diagonally in and out of ports. There are also heavily used north–south transit lanes that follow the coastline, some closer to shore than others.

The California Coast Pilot and the Washington/Oregon Coast Pilot both include recommendations for offshore vessel traffic, which was based on a West Coast Offshore Vessel Traffic Risk Management Project published July 2002. The Coast Pilots recommend that vessels 300 gross tons or larger transiting along the coast should voluntarily stay 25 NM or greater distance offshore (unless there is a traffic separation scheme, Vessel Traffic Service, or recommended route; DOC, 2025-a, 2025-b). It also recommends that tank ships laden with petroleum products should voluntarily stay 50 NM or greater distance offshore. These recommendations are intended to reduce vessel groundings and resulting oil spills, but they do not apply to short coastal transits. The heat map in Figure 2-3 shows that the large majority of cargo and tanker vessels complied with these recommendations.

It is important to note that the California Air Resource Board adopted a rule in 2008 prohibiting the use of high sulfur fuels within 24 NM of the state's shore, which also keeps vessels offshore when not transiting to or from port (CARB, n.d.). Additionally, IMO has implemented an Emissions Control Area on the West Coast, which requires ships to burn cleaner fuels within 200 NM of the coast, and has led to an additional north–south transit lane greater than 200 NM offshore. Some tug and tow vessels also followed the recommended offshore routing, even though they are often smaller than other types of commercial cargo ships. Other tug and tows followed routes that kept them much closer to the shoreline, as seen in Figure 2-4, which was likely due to safety and/or economic reasons.

In addition to the recommended ship routing found in the Coast Pilots, the IMO has adopted four traffic separation schemes, which are published in its international ship routing guidance (IMO, n.d.). These traffic separation schemes are located outside of San Francisco Bay, on the approach to Los Angeles–Long Beach, on the approach to and inside of the Strait of Juan de Fuca, and on the approach to and inside Puget Sound (DOC, 2025a). A traffic separation scheme establishes traffic lanes to separate the opposing streams of traffic.

In 2023 the PAC-PARS made the following recommendations regarding vessel traffic routes for the continental U.S. West Coast, but at the time of this report, these recommendations had not yet been implemented (USCG, 2023):

- Establishing a 15-NM-wide coastwise fairway that connects with existing traffic separation schemes (Strait of Juan de Fuca, San Francisco, Santa Barbara and Los Angeles–Long Beach) and key ports along the West Coast following existing vessel traffic patterns. The Coast Guard had found that Coastwise cargo vessel transits tended to follow similar tracks approximately 25–40 NM from shore;
- Establishing a 5-NM-wide nearshore fairway in Northern California and a coastal fairway zone in Oregon and Washington in order to support the Crabber/Towboat Lane Agreement (1971), amended in November 2019;

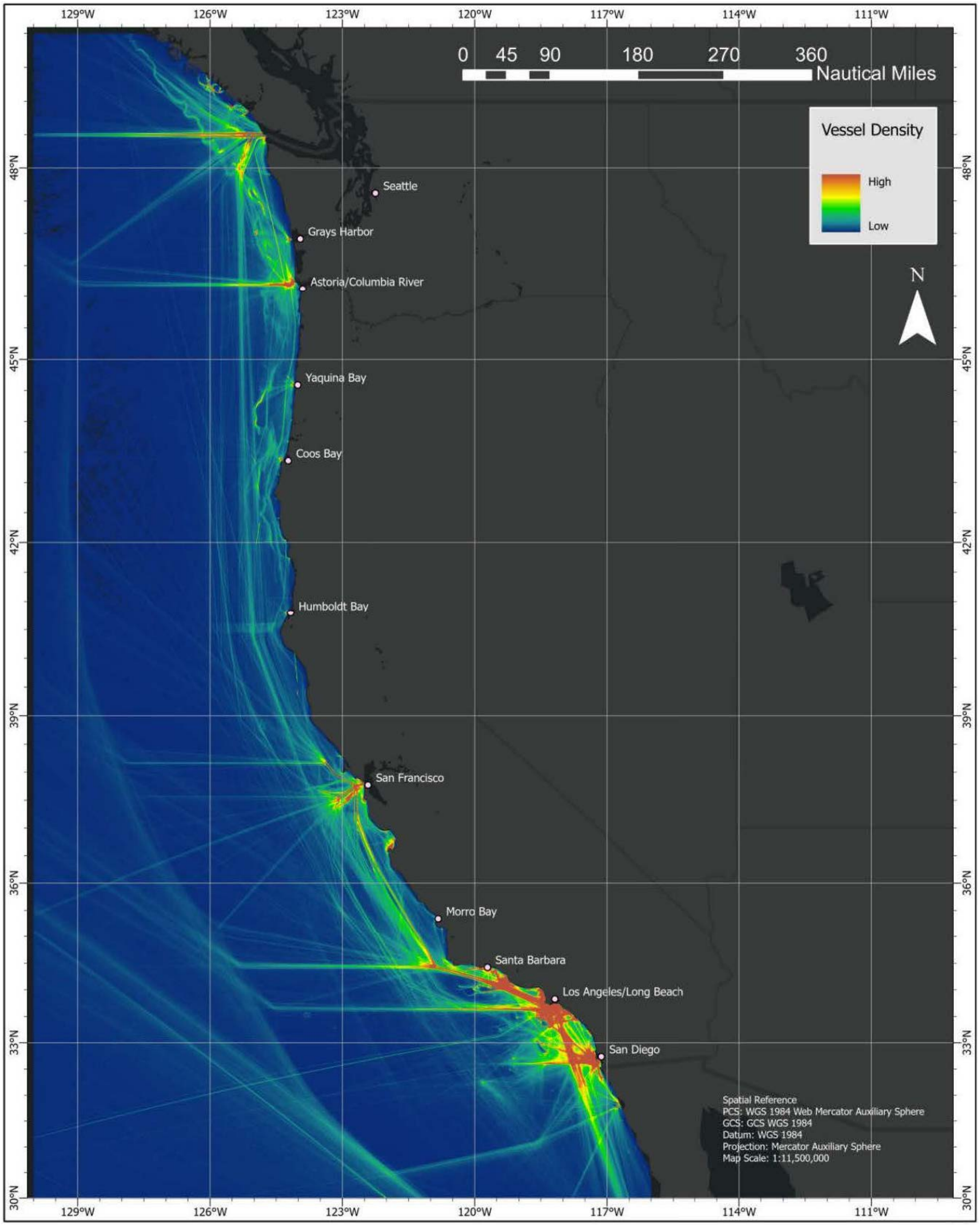


FIGURE 2-2 Annual AIS vessel density: average of all vessel types (2017–2021).
SOURCE: USCG, 2023, PAC-PARS Enclosure 1.

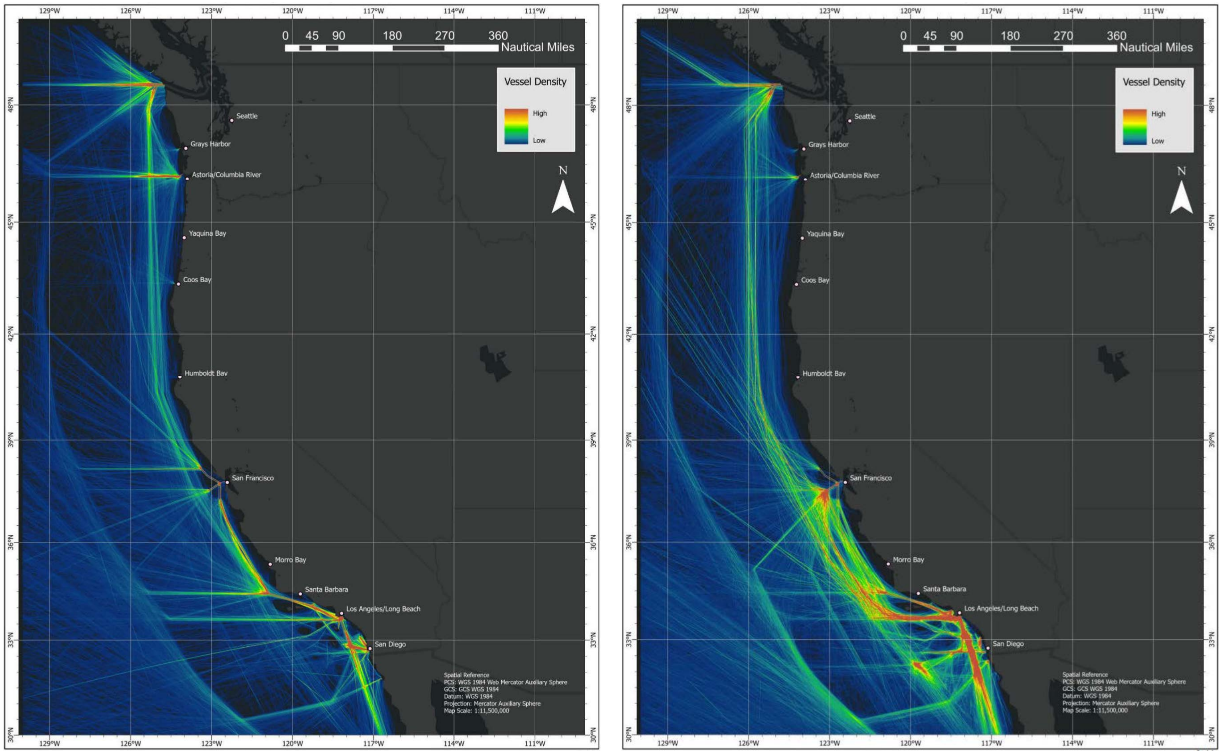


FIGURE 2-3 Average annual AIS vessel density from 2017-2021 of cargo vessels (left) and tanker vessels (right). SOURCE: USCG, 2023, PAC-PARS Enclosure 1.

- Establishing 5-NM-wide voluntary fairways to provide a southern route around the Channel Islands and to provide two angled approach and departure routes to and from the San Diego and Los Angeles areas;
- Removing the existing IMO recommended routes located offshore the Monterey Bay National Marine Sanctuary; and
- Continuing support for bulk chemical and petroleum carriers to voluntarily maintain a minimum of 50 NM offshore where there are not charted lanes in accordance with 2002 Pacific States/British Columbia Oil Spill Task Force recommendations.

Commercial Fisheries

The CCE in the Northern Pacific Ocean is a dynamic and diverse marine environment. This ecosystem spans the entire U.S. West Coast and encompasses the EEZ, the territorial zone, coastal land-sea interface, and adjacent terrestrial watersheds (PFMC, 2022). The diverse and complex ecosystem is home to hundreds of aquatic species, many of which are commercially harvested. These commercial fisheries have significant economic, social, and cultural importance to West Coast communities. A detailed discussion of the commercial fisheries can be found in Chapter 3.

Tribal Fisheries

Along the West Coast, numerous Indigenous Tribes engage in fishing activities. Additionally, treaties reserve the right of several Tribes to fish in their usual and accustomed locations in the Pacific Northwest. Further discussions of Tribal fisheries are contained in Chapter 3.

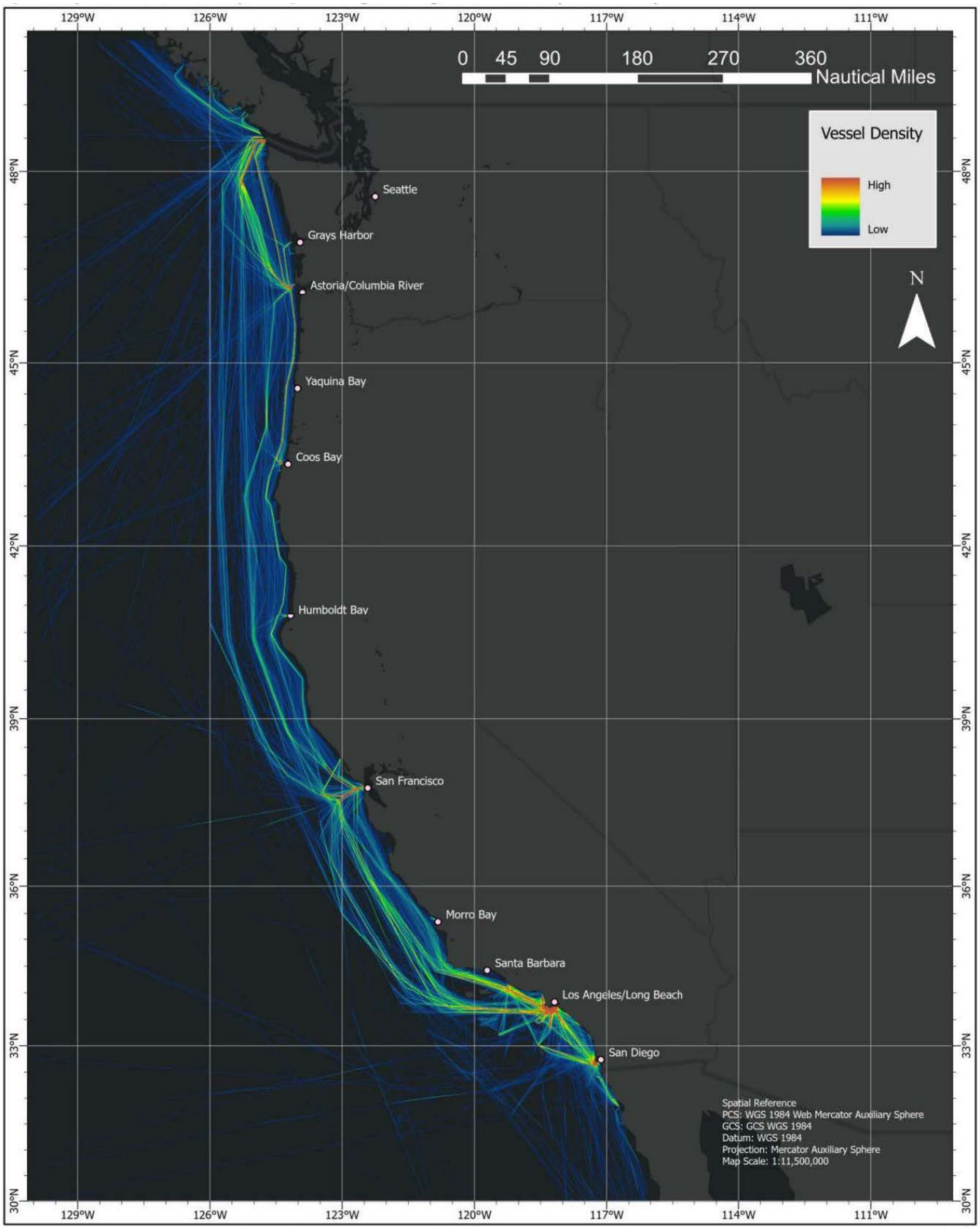


FIGURE 2-4 Annual AIS vessel density: average of tug/tow vessels (2017–2021).
SOURCE: USCG, 2023, PAC-PARS Enclosure 1.

BOX 2-1
Crabber/Towboat Lane Agreement

An example of shared offshore space benefiting both parties is the agreement developed between Dungeness crabbers and ocean-going tug and barge vessels off the coast of Washington, Oregon, and California. The agreement, brokered by Sea Grant programs in the 1970s, was developed because crab pots were fouling tugs and causing crabbers to lose revenue and replace costly gear. The conflicts were becoming a major problem for both sets of ocean space users (Washington Sea Grant, 2021). The agreement established towboat and barge lanes in crabbing areas from San Franscisco, California north to Cape Flattery, Washington. The tow lanes are flexible and maintained by annual negotiations, with resulting lanes shared and charted. The cooperation works because both industries are accommodated without compromising their values. For example, when fuel prices rose, the crab fleet opened inside tow lanes a month earlier in springtime to shorten the transit distance and save money for the towboat industry, and when crabbers lost access to certain fishing areas in 1994, towboat representatives responded by narrowing the lanes from 2 NM to 1 NM wide (Washington Sea Grant, 2021). A quote from the original tow lane book captures the spirit of the agreement; "A place to fish, a place to tow. Where all mariners benefit, there are no losers in the crabber-towline world."

SOURCE: Washington Sea Grant, 2021.

Recreational Activity

There are a wide variety of recreational activities on the West Coast, which can include recreational fishing, sailing, pleasure boating, wildlife viewing, and offshore athletics such as windsurfing, paddle boarding, scuba diving, and surfing. Many of these activities take place very close to the shoreline with some boat-based activities extending further offshore, such as recreational fishing, although much of the recreational boating traffic is concentrated near shore as well. According to the Coast Guard, more than a million recreational boats were registered in California, Oregon, and Washington in 2023 (USCG, 2024). Some recreational vessels carry AIS equipment, which was captured in the 2023 PAC-PARS as depicted in Figure 2-5, but since AIS is not required on all recreational vessels, the figure does not present a complete picture of recreational activity. The AIS data does show a large concentration of activity in Southern California as well as near-shore dominance for much of the activity.

Military Activities

Along the West Coast are a number of military bases, some of which conduct activities over the water. As discussed later in this chapter, certain offshore military areas can be closed to outside activities in order to protect non-military operations from the danger associated with military testing or training, particularly when weapons are involved.

National Marine Sanctuaries

A national marine sanctuary is a protected area designated to conserve and manage "certain areas of the marine environment [that] possess conservation, recreational, ecological, historical, scientific, educational, cultural, archeological, or esthetic qualities," along with "human-use values" and living marine resources communities.[3] While these areas can allow activities such as responsible commercial and recreational fishing, recreation, and tourism, they focus on providing public education and community engagement without sacrificing conservation

[3] 16 USC§ 1431

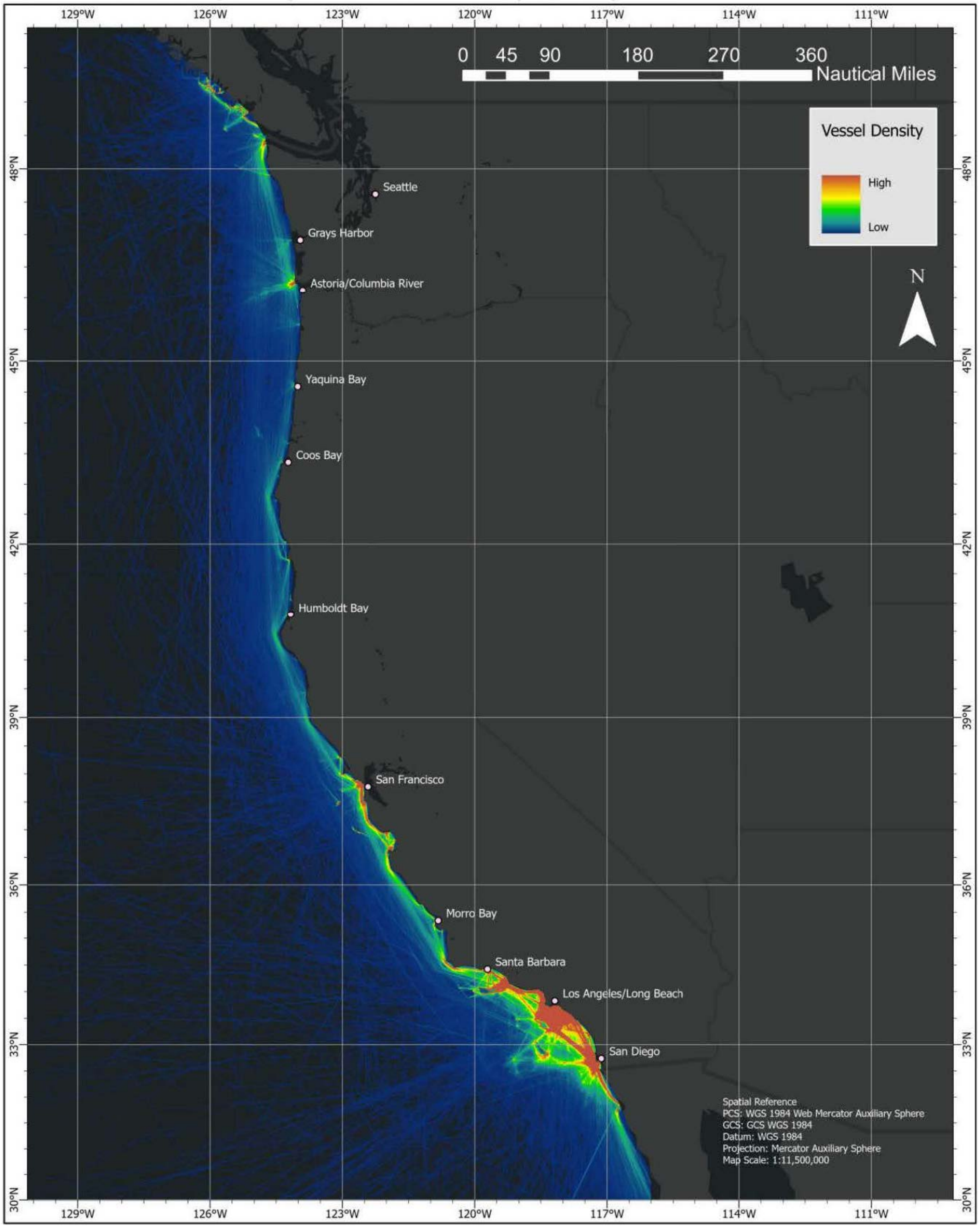


FIGURE 2-5 Annual AIS vessel density: average of recreational vessels (2017–2021).
SOURCE: USCG, 2023, PAC-PARS Enclosure 1.

and scientific research. Sanctuary habitats are diverse areas; they can encompass entire coral reefs or kelp forests, include whale migration corridors or deep-sea canyons, or be underwater archaeological sites (NOAA National Marine Sanctuaries, n.d.). Sanctuaries are often safe havens for many aquatic species and protect historical sites such as shipwrecks. Each sanctuary is unique, and separate management plans and legal protections are established to properly safeguard each site.

The six sanctuaries on the West Coast are the Channel Islands (California), Chumash Heritage (California), Monterey Bay (California), Greater Farallones (California), Cordell Bank (California), and Olympic Coast (Washington) National Marine Sanctuaries. They range in size from 1,286 sq mi (Cordell Bank) to over 6,000 sq mi (Monterey Bay) (NOAA National Marine Sanctuaries, n.d.; NOAA Cordell Bank National Marine Sanctuary, n.d.; NOAA Monterey Bay National Marine Sanctuary, n.d.) These locations contain a range of habitats and historic sites including kelp forests in the Channel Islands, whale feeding grounds in the Greater Farallones sanctuary, the Rodriguez Seamount in the Chumash Heritage sanctuary, and hundreds of shipwrecks scattered throughout (NOAA National Marine Sanctuaries, n.d.).

Aquaculture

Aquaculture is the act of breeding, raising, and harvesting aquatic plants and animals (NOAA National Ocean Service, n.d.). Marine aquaculture, commonly called mariculture, is the farming of ocean and estuarine resources such as shellfish, fish species like salmon or sablefish, and algae species like kelp. Mariculture methods include net pens which are placed in open water and are used to grow out fish until they're ready for harvest, or "seeding" the ocean floor or racks with shellfish.

Aquaculture is used to increase food production, restore degraded habitats, or help to rebuild wild populations or stocks of vulnerable species (NOAA National Ocean Service, n.d.). Depending on where an aquaculture farm is located, it may require permits from the U.S. Army Corps of Engineers (USACE), Environmental Protection Agency, NOAA NMFS, or various state agencies (NOAA Fisheries, 2022). On the U.S. West Coast, marine aquaculture produces numerous species of shellfish and finfish and promotes seaweed farming (NOAA Fisheries, n.d.-a).

Offshore Oil and Gas

Five companies operate 23 oil and gas platforms in federal waters off the coast of Southern California (BSEE, n.d.-a). Of the 23, one platform is a processing facility, and the rest were built to produce oil and gas. Pipelines run between the platforms, linking to a hub between several platforms, or even connecting directly to shore. As of December 2024, eight of those platforms were no longer producing and were in various stages of decommissioning (BSEE, n.d.-b).

Offshore Renewable Energy

ORE refers to energy that is harnessed from, on, or above ocean-based resources. This can include capturing energy from winds, solar, ocean currents, waves, tides, ocean thermal gradients and salinity gradients (IRENA, 2020). The present state of offshore wind and hydrokinetic energy (wave and tidal) development and their potential impacts are the main topics of this report. The state of development varies for the respective renewable energy sources, with offshore wind projects further along in the commercialization process. Chapter 5 discusses the development of ORE on the West Coast, focusing on FOW, wave and tidal energy.

Space Launch and Recovery

The West Coast includes a range of space launch activity primarily from the Vandenberg Space Force Base, located northwest of Los Angeles near Point Conception. The base supports launch activities for various federal and military groups as well as some private industry contracts, most notably SpaceX (USSF Vandenberg Space Force Base, n.d.). Over the years, SpaceX has worked to increase its total launch numbers, with the current goal of

95 launches per year despite pushback from the California Coastal Commission (Gorman, 2025). Space launches over water are complex and include not only danger zones and zone clearances around the launch site but special recovery missions for fallen debris and parts (Masunaga, 2021).

Subsurface Cables

The Federal Communications Commission (n.d.) licenses submarine communication cables and associated cable landing stations in the U.S; however, licenses are not required when a cable and both of its terminals lie wholly within the continental U.S. Along the West Coast there are numerous cables and landing sites. While landing sites tend to be concentrated to a few main locations, cables run in all directions once they're offshore. Maps of the West Coast with submarine telecommunication cables and their landing sites can be viewed on the North American Submarine Cable Association website (NASCA, 2025).

Subsurface Mining Activity

Seabed mining is an ongoing, worldwide area of interest. Along the seabed are many minerals, several of which are deemed critical to society, including cobalt-rich crusts, manganese nodules, polymetallic sulfides, and marine phosphorites (PCMSC, 2022). These critical minerals are considered "essential to the economic or national security of the nation and often have a vulnerable supply-chain" (PCMSC, 2022).

While there is not currently any active mining of deep-sea minerals on the International Seabed, recent work is being done to prepare for mining projects. Within the U.S. continental shelf, BOEM oversees prospecting and leasing activities of the seabed, which includes mining activities. In order to learn more about the locations and deposit types of minerals currently on the U.S. continental seabed, BOEM is conducting a National Offshore Critical Minerals Inventory using NOAA and U.S. Geological Survey resources (BOEM, n.d.). Outside the US EEZ, marine mining is governed by the International Seabed Authority, which is currently drafting regulations (PCMSC, 2022).

MARITIME ACTIVITY OVERLAPS

Few offshore locations on the West Coast are reserved exclusively for one particular maritime activity or use. Instead, most locations host a variety of maritime activities. In most cases, when there are competing demands on the use of the waterway, maritime activities have achieved a relative balance among each other. This section provides a general overview of the interactions between the different types of maritime activities on the West Coast. The discussion focuses on what activities cannot take place in the same maritime space as others and is primarily centered on activities that exist or are planned at the time of this report. The Committee recognizes that there will be additional novel and new maritime activity overlaps in the future that are not addressed in this report.

Commercial Shipping

Given the number and the size of commercial ships moving along the West Coast, many maritime activities either voluntarily try to avoid operating in commercial shipping lanes or do not receive permits to operate in those locations. Commercial fishing, Tribal fishing, and recreational boating are all allowed in commercial shipping lanes, but they generally try to reduce their time spent in a shipping lane or plan their activities when there is less traffic. Additionally, there can be regulatory restrictions within narrow channels and traffic separation schemes. In accordance with the 1972 International Regulations for Preventing Collisions at Sea and 1980 U.S. Inland Navigation Rules (H.R. 6671), fishing vessels cannot actively obstruct navigation through narrow channels or fairways or impact the passage of vessels following traffic lanes. Vessels smaller than 20 m and sailboats must follow similar rules. They cannot obstruct power-driven vessels in a traffic lane or inhibit passage of vessel with limited navigational options in narrow channels or fairways.

Offshore oil and gas facilities cannot be located within federally or internationally designated fairways or traffic separation schemes. They may be located in informal shipping lanes but that can lead to an increased risk of allisions (when a ship strikes a stationary object). The same will be true for ORE facilities that are installed in the future. Thousands of oil and gas facilities, both fixed and floating, operate in the Gulf of Mexico which create a complicated maze for commercial ships to navigate.

It is far less risky to site offshore facilities outside shipping lanes, which was the rationale behind the Coast Guard's PAC-PARS. The Coast Guard, wanting to ensure the safety of navigation along the West Coast with the rapidly changing demand for the use of coastal waters, aimed to study whether new or modified vessel routing measures should be established. Using vessel traffic data from the past decade and input from key stakeholders, Tribal governments, and the public, PAC-PARS resulted in a series of recommendations to ensure continued safe, efficient, and predictable vessel navigation alongside other reasonable waterway uses. The study recommended establishing voluntary shipping fairways for coastwise and nearshore vessel traffic to promote safe and unobstructed navigation. If these shipping fairways are implemented, they will provide a clear picture of areas that future maritime activities should avoid such as an ORE project or a mining project with a surface facility. Although the use of fairways is voluntary, most vessels have historically complied with the recommended lanes.

Conclusion 2-1: The committee found that the Pacific Area Port Access Route Study routing recommendations were developed using a comprehensive process that engaged Tribes, federal and state agencies, and stakeholders, considered current and future maritime activities, and provided for the current use and further growth of shipping.

Commercial and Tribal Fishing

As seen in Chapter 3, a wide variety of locations up and down the West Coast experience commercial and Tribal fishing. Fishing in a particular location does not typically prevent other maritime activities from happening in that same location. On the other hand, many maritime activities can prevent or restrict fishing in a particular location. As such, new maritime activities and uses should account for fishing grounds and seek ways to allow coexistence. Agencies planning maritime activities should consider potential shifts in the distribution of fishing activity due to factors such as expansion of conservation areas, or impacts to commercially and recreationally targeted fish stocks due to changing ocean conditions.

Marine Life

In some cases, maritime activities need to account for the presence of marine life, particularly as it relates to whale strikes. Vessel speed reductions are one example of a method management agencies can promote to help protect this wildlife (NOAA Greater Farallones National Marine Sanctuary, n.d.). These speed reductions occur in specific areas and ask vessel operators to reduce their speed, often to 10 knots, while transiting within specific areas. This reduction can help reduce the risk of fatal whale strikes to protected species along the coast, as well as reducing noise and air pollution in the area. Along the West Coast, there are two examples of vessel speed reduction zones. NOAA issues voluntary vessel speed reductions off San Francisco, Monterey, and Southern California from May-Dec (NOAA Greater Farallones National Marine Sanctuary, n.d.). The second occurs near the Straits of Juan de Fuca, assisting with the Port of Vancouver's Enhancing Cetacean Habitat Observation Program (Port of Vancouver, 2025).

Recreational Activity

There are few situations where recreational activities prevent other maritime activities in the same location, because in most cases, people engaged in recreation try to avoid other maritime activities. Exceptions can occur when large, organized events, like regattas, marine parades, or recreational fishing contests, "introduce extra or unusual hazards that could impact safety of the waterways."[4] The Coast Guard requires these large events, or any event that is expected to draw crowds (e.g. sailing races), to acquire permits in order to promote safety. A marine event permit may or may not include additional regulations, such as vessel restrictions.

Military Activity

When military activities occur over water, the area associated with military activity can fall into two categories: danger zones and restricted areas. Danger zones are designated areas for operations such as rocket launches, target practices, and other hazardous activities. Restricted areas are places that limit public access.[5] Danger zones can be implemented full-time or as needed to align with the military's needs. Restricted areas are often used to provide additional security for government property or to reduce the risk to the public from military activity.

There are several large danger zones located offshore Point Mugu, California, and San Clemente Island, California, along with several smaller danger zones near Naval Base Coronado, California, San Pedro, California, San Miguel Island, California, Fort Ord, California, and Camp Rilea, Oregon. Restricted areas are typically located in the immediate vicinity of military bases that have waterfront access, both coastal and inland.

National Marine Sanctuaries

The National Marine Sanctuaries Act[6] is the statutory framework governing national marine sanctuaries. Each national marine sanctuary has its own set of regulations outlining prohibited activities within its boundaries, but many of the requirements are similar. Within all the national marine sanctuaries, certain activities are prohibited in order to protect the ecological and cultural integrity of the sites. Such activities include exploring for or extracting oil, gas, or minerals (except in existing leases), discharging or depositing materials into the sanctuary from within or beyond its boundaries (with limited vessel-related exceptions), and disturbing historical and ecological resources unless permitted for lawful fishing, aquaculture, or kelp harvesting. Additional restrictions are placed on drilling, dredging, or placing structures on submerged lands or the taking or possession of marine mammals, sea turtles, or seabirds without legal authorization. Introducing nonnative species is generally banned, except for specific cases like releasing striped bass during catch-and-release fishing on the Wast Coast and authorized aquaculture in Tomales Bay. The above prohibitions do not apply to certain military activities, activities that are specifically permitted by the sanctuary, or when an activity is necessary to respond to an emergency. Moreover, this is not an exhaustive list. National marine sanctuaries have individual management plans, which should be consulted for information about other activities. For example, depending on the sanctuary and the location inside it, there may be restrictions on fishing, fishing gear, anchoring, vessel traffic, and motorized aircraft or motorized personal watercraft.

Aquaculture

At the moment, aquaculture is not expected to overlap with West Coast FOW development, as aquaculture is typically closer to shore than the areas with the greatest wind energy resource. However, there is some anticipation of possible overlap or co-location with wave and tidal projects. Information on areas of overlap can be found in the Final Programmatic Environmental Impact Statement (EIS) for the Identification of Aquaculture Opportunity Areas in U.S. Federal Waters off Southern California (NMFS, 2025).

Offshore Oil & Gas

Offshore oil and gas platforms prevent other activities from happening in the same location. Activities such as shipping, fishing and recreation may be able to operate or navigate around the platforms, but activities like other offshore energy facilities, aquaculture, or mining projects cannot be located in the same place. Structures and their

[4] 33 CFR Part 100
[5] 33 CFR Part 334
[6] 16 U.S.C. 1431 et seq

moorings must avoid defined submarine cables routes. Military activity cannot take place on or under the surface of the ocean in the position of an oil and gas platform but might occur in the airspace above it.

In addition to the above restrictions, 15 of the 23 oil and gas platforms on the West Coast have established safety zones around them.[7] These zones prohibit vessels that are 100 ft or longer, or vessels engaged in towing, from coming within 500 m of the structure's outer edge. For platforms that do not have published safety zones, a vessel can get as close as it wants to the facility without penalty.

Offshore Renewable Energy

An ORE platform would likely have the same localized impacts as an offshore oil and gas platform. An array of offshore wind energy platforms would have additional impacts on some maritime activities. While the U.S. does not prevent vessels from operating within a wind turbine array, limitations would likely cause some types of vessels to avoid the entire offshore wind array. Large commercial vessels would likely transit around a wind array, due to the spacing of the wind turbines in comparison to the turning radius of the vessel. Commercial fishing vessels using bottom-tending gears, mid-water trawls, or purse seine gear and research (survey) vessels using similar types of gear and instruments would likely not have enough space to conduct operations between wind turbines either, due to the length of their gear, operational needs of the gear, the presence of inter-array cables suspended between the turbines, and the distance between turbine platform moorings. Other types of commercial fishing vessels might fish inside of a wind array, dependent on the size and spacing of the turbines and presence of inter-array cables suspended in the water column. Discussion of transit corridors in ORE wind arrays is presented in Chapter 7.

Other types of ORE projects, such as wave energy converters or tidal energy converters, if installed on the surface, would have similar impacts as an offshore oil and gas platform. Projects installed below the surface of the ocean might present fewer impacts on other maritime activities, depending on the depth of water and the type of infrastructure installed for the project.

Potential Offshore Wind Development

Currently there are no commercial ORE projects on the West Coast, but there has been a strong interest in pursuing them to meet individual states' carbon and greenhouse gas reduction goals. The State of California has established a goal of 100 percent zero-carbon energy by 2045 (CEC, 2024). This planning goal includes the installation of 25 GW of offshore wind energy capacity by 2045.

Outside California, Oregon's Clean Energy Targets Bill established a greenhouse reduction goal of 100 percent to be reached in 2040 (DEQ, n.d.). The Oregon State Legislature passed this bill to require reductions in greenhouse gas emissions from energy suppliers and developed a target-centered plan to achieve their goal by 2040. Additionally, Oregon required its Department of Land Conservation and Development to create an offshore wind energy roadmap which would outline the standards and process required for an offshore wind development project to be considered in Oregon (Oregon Coastal Management Program, n.d.).

Since 2019 Washington has implemented its Clean Energy Transformation Act with the goal of achieving electricity without greenhouse gas emissions by 2045 (WSDC, n.d.). Utility companies are required to create plans that meet the act's requirements.

Space Launch and Recovery

Due to the potential for debris falling after a space launch, there is a danger zone located offshore Vandenberg Space Force Base. This danger zone area is subdivided into nine smaller zones in order to limit the amount of space required to be evacuated during tests and operations.[8] When there are no active space launches, much of the danger zone is open to fishing and navigation, but once a launch is scheduled to occur closures are announced,

[7] 33 CFR 147
[8] 33 CFR 334.1130

and vessels must leave the area during the prescribed time. Fixed and movable oil drilling platforms located inside the danger zone must halt operations throughout the closure.

Subsurface Cables

Subsurface cables are identified on nautical charts after information is reported to NOAA and the responsible agency recommends they be charted. While the presence of subsurface cables does not prevent another maritime activity from operating in that location, vessel operators must be aware and cautious when anchoring, fishing or engaging in underwater operations near reported cable areas, as there could be severe consequences for both the vessel and the cable if an anchor or gear is fouled on a submarine cable. The location of a cable can shift after it is installed and charted, and cables that were originally buried can later become exposed. Additionally, some cables carry high voltages (DOC, 2025-a).

The installation of ORE will likely require the installation of new subsurface cables. These cables could be co-located and routed into existing cable routes. Cable placement will be an important consideration for future ORE developments.

Subsurface Mining Activity

As of 2025, there is no mining of deep-sea critical minerals. As such, it is hard to know exactly what type of maritime activities would be impacted by a mining project. A subsurface mining project with associated operations or facilities on the surface of the water would likely prevent most other activities from occurring nearby during operations. Shipping, fishing, and recreational activity could not take place, and new subsurface cables could not be installed in the same space as active mining projects. Offshore energy facilities and aquaculture projects likewise could not be in the same position. If a subsurface mining project did not involve any surface operations or facilities, there might be less impact on other maritime activities, depending on how much the mining activity disturbed the water or the aquatic life.

POTENTIAL SHIFTS IN MARITIME ACTIVITY

It is difficult to predict the future of maritime activity on the West Coast. Many factors affect what is happening offshore, such as climate variability; economics, including national interests in reshoring manufacturing; geopolitical risks; changing demographics; the need for supply chain resiliency; and emerging technologies.

The volume of commercial shipping is expected to increase, based on a continuing trend of increases in global maritime trade over the last 50 years (UNCTAD, n.d.). Figure 2-6 and Table 2-2 show the long-term growth in metric tons of goods moved in global maritime trade since 2000 (Figure 2-6) and millions of tons loaded since 1970 (Table 2-2). Figures 2-7 and 2-8 show trends of tonnage (Figure 2-7) and TEU's (Figure 2-8) moving through U.S. West Coast ports also increased since the early 2000's through 2022. The United Nations Conference on Trade and Development forecasts continued growth in the coming years, although it hesitates to provide quantitative prediction due to significant uncertainty related to other factors.

Shipping and vessel activity on the West Coast follows the global trend of increased activity when comparing AIS data from 2012 to 2021 (Figure 2-9). Although it is uncertain at the time of writing whether or not increasing trends will continue, the last decade's trends are evident.

With a continued projected growth in the volume of commercial shipping around the world and off the U.S. West Coast, it is important to discuss where those ships may operate. The PAC-PARS concluded that due to the continued growth of competing waterway uses and projects off the coasts of California, Oregon, and Washington, there was a need for safe access routes that could allow vessels to move along the coast and in and out of ports. The report recommended six voluntary fairways for vessel traffic (see Figure 2-10), which are designed to accommodate the current and future navigation requirements necessary to maintain the safe and reliable shipping routes on the West Coast, while also accommodating other reasonable waterway uses. Once the Coast Guard completes the steps to implement these voluntary fairways, most of the commercial vessel traffic is expected to use these them.

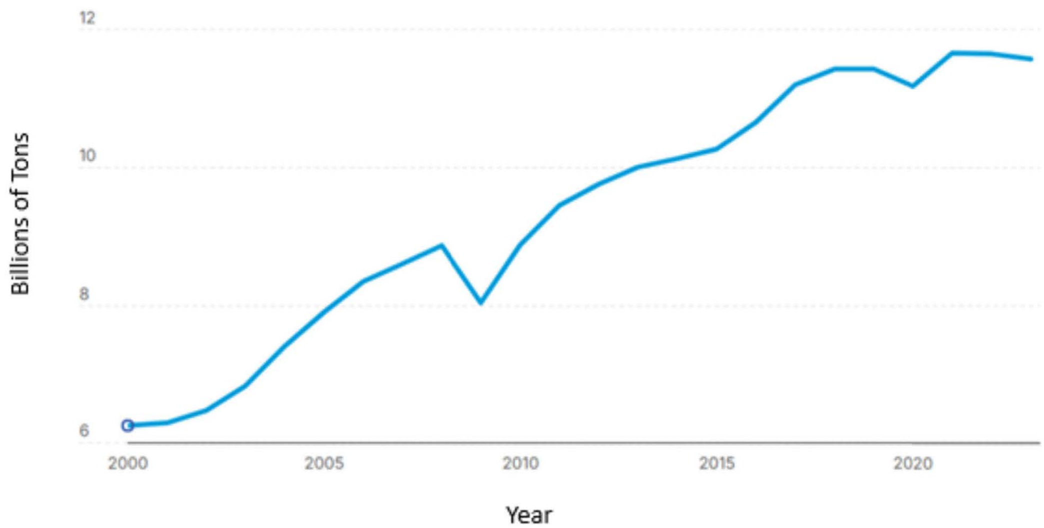


FIGURE 2-6 Goods loaded in the worldwide maritime trade.
NOTE: In billions of tons from 2000 to 2023.
SOURCE: Modified from UNCTAD, n.d.

Table 2-2 International Maritime Trade in Millions of Tons Loaded

Year	Tanker	Bulk Carrier	Other Dry Cargo	Total Cargo
1970	1,440	448	717	2,605
1980	1,871	608	1,225	3,704
1990	1,755	988	1,265	4,008
2000	2,163	1,186	2,635	5,984
2005	2,422	1,597	3,108	7,109
2010	2,752	2,232	3,423	8,408
2015	2,932	2,930	4,161	10,023
2019	3,163	3,218	4,690	11,071
2020	2,918	3,196	4,531	10,645
2021	2,952	3,272	4,761	10,985

NOTE: Tanker includes crude oil, refined petroleum products, gas, and chemicals. Bulk Carrier includes iron ore, grain, coal, bauxite/alumina and phosphate (until 2005). Other Dry Cargo includes bauxite/alumina and phosphate (from 2006), containerized trade, and residual general cargo.
SOURCE: Modified from Christiansen et al., 2025.

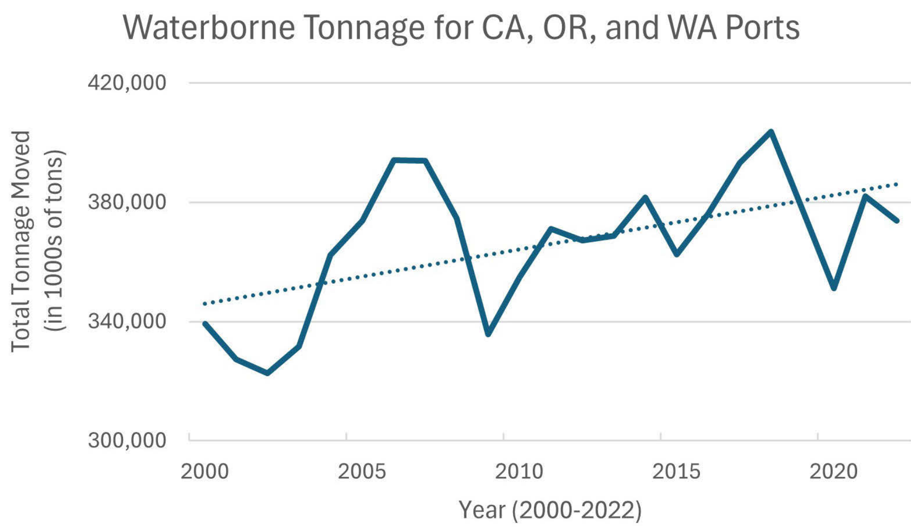


FIGURE 2-7 Waterborne tonnage for California, Oregon, and Washington ports.
NOTE: In thousands of tons from 2000 to 2022.
SOURCE: Created by the Committee using data from USACE, 2022-b.

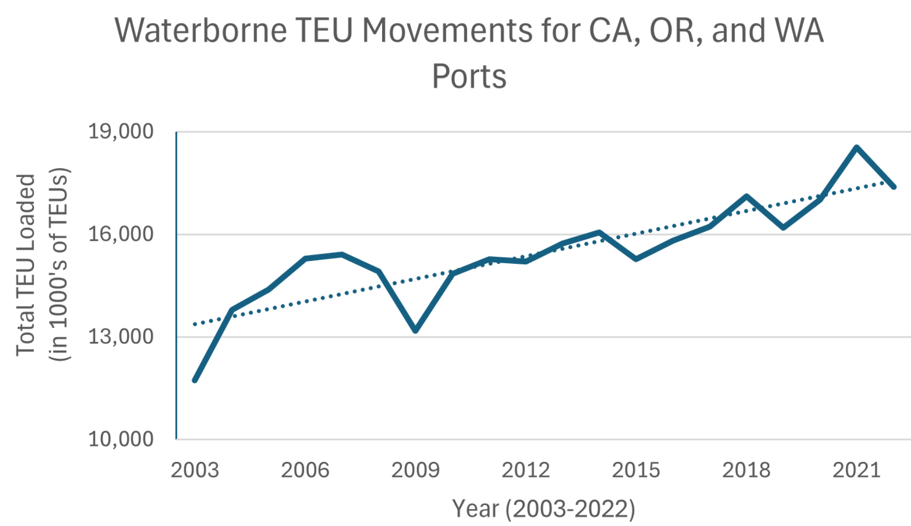
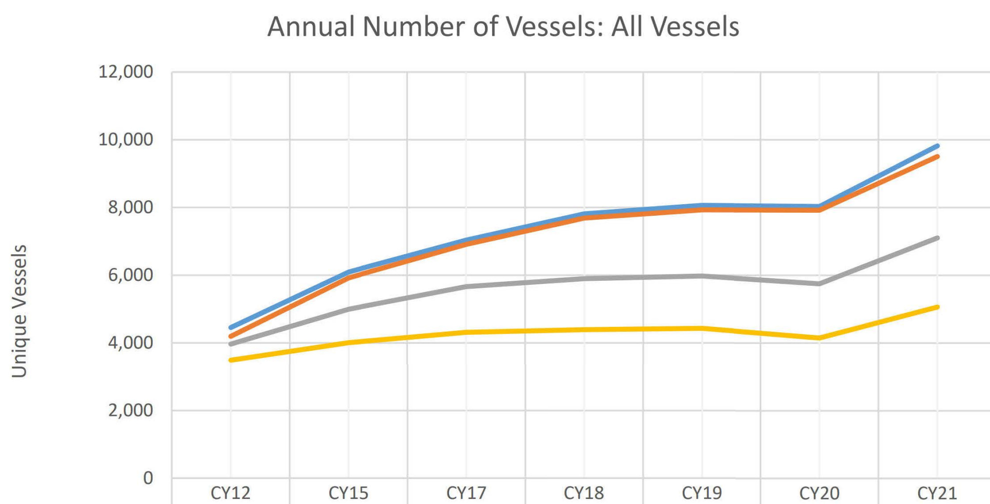


FIGURE 2-8 Waterborne TEU movements for California, Oregon, and Washington ports.
NOTE: In thousands of TEUs from 2003 to 2022.
SOURCE: Created by the Committee using data from USACE, 2022-a.



	CY12	CY15	CY17	CY18	CY19	CY20	CY21
Study Area	4,452	6,094	7,037	7,809	8,060	8,033	9,820
0-12 nm	4,193	5,922	6,912	7,686	7,931	7,919	9,505
12-24 nm	3,964	4,992	5,662	5,895	5,978	5,751	7,102
24-200 nm	3,488	4,003	4,312	4,390	4,433	4,147	5,062

FIGURE 2-9 Annual number of vessels along the U.S. West Coast from AIS data.
NOTE: CY12 = 2012, CY15 = 2015, CY17 = 2017, CY18 = 2018, CY19 = 2019, CY20 = 2020, CY21 = 2021.
SOURCE: USCG, 2023, PAC-PARS Enclosure 1, Attachment 2

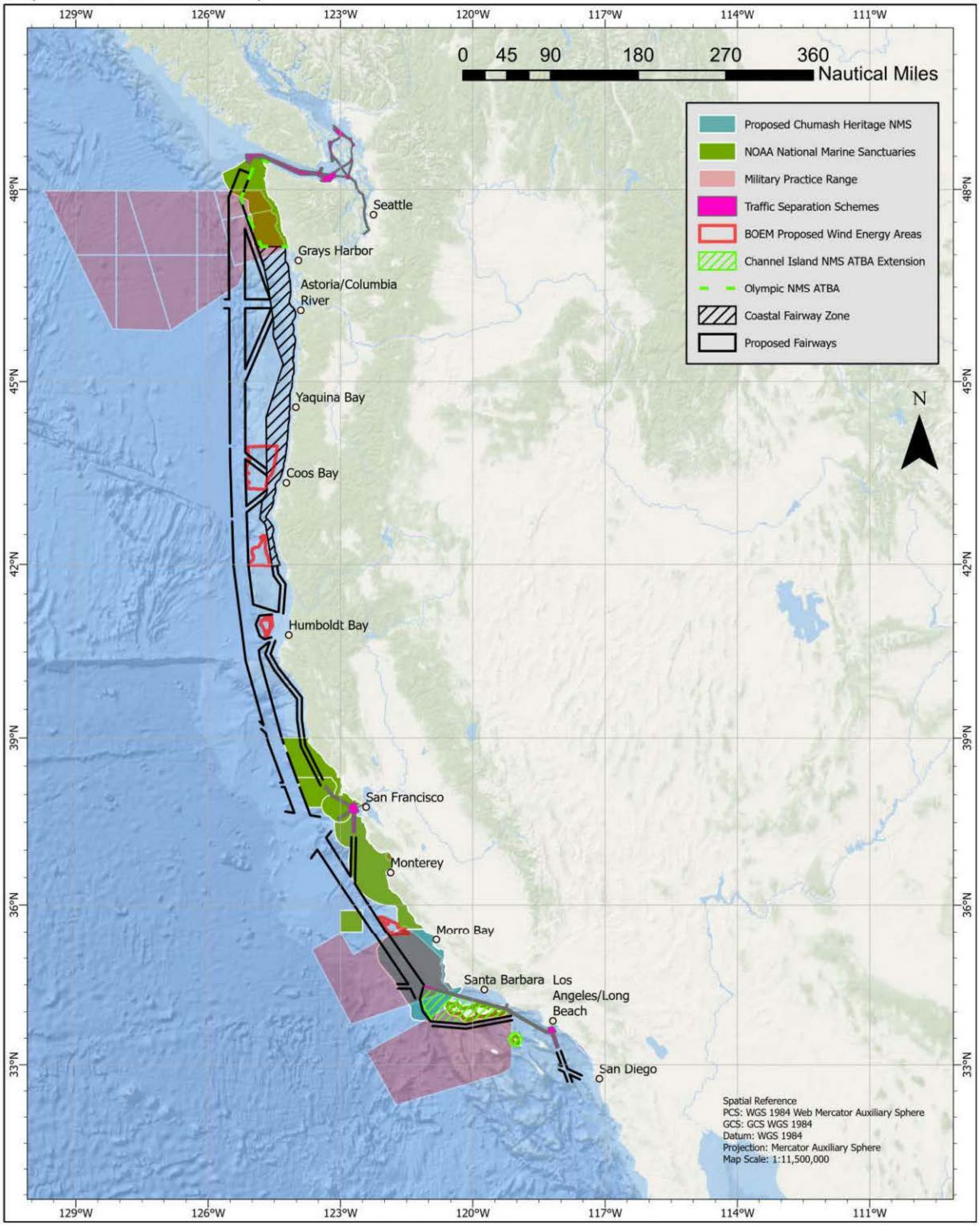


FIGURE 2-10 Proposed Pacific Coast fairways.
NOTE: The Chumash Heritage National Marine Sanctuary (show as proposed) was designated in November 2024.
SOURCE: USCG, 2023, PAC-PARS Appendix 1.

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3

Uses of Offshore Areas: Fishing Activity

This chapter documents historical and current fishing activity off the West Coast as a foundation for understanding how ORE may affect and interact with fishing activities. It also considers how ongoing changes to fish stocks may affect ORE interactions with fishing activity in the future. The chapter provides an overview of West Coast fishing activity including commercial, Tribal, and recreational fisheries and their associated gear, and historical and current fishing ground locations. Next is a discussion of the CCE including the hydrodynamics which supports upwelling and primary production along the West Coast and affects potential future shifts in fish stocks. The chapter concludes by examining how fisheries may move or expand because of changing ocean conditions, possibly into areas with no historical or current fishing activity. The interactions between fisheries and ORE development are discussed in Chapter 7.

WEST COAST FISHERIES

Fisheries are often defined by the type of fishing gear they use, the geographic area they cover, and the species they target or harvest. Fisheries may be commercial, fishing for profit; recreational, fishing for pleasure or sport; or subsistence, which refers to fishing for personal consumption in support of families, individuals or communities (NOAA Fisheries, n.d.-n).

The West Coast is home to diverse commercial, recreational, and Tribal fisheries targeting shellfish, salmon, a variety of bottom-dwelling species known as groundfish, highly migratory species (HMS; e.g., tuna, swordfish), coastal pelagic species (CPS; e.g., sardine, squid), and others. These fisheries are managed through complex systems involving international, federal, and state processes. They are managed for various purposes including providing a sustainable supply of seafood, protecting ecosystems, supporting economies, and maintaining community resilience.

Fisheries that operate within federal waters are managed by both NMFS and regional fisheries management organizations.[1] Regional fisheries management organizations are guided by several laws, including the Magnuson-Stevens Fishery Conservation and Management Act (MSA),[2] which outlines national standards for fisheries

[1] Regional Fisheries Management Organizations are international bodies formed by countries with fishing interests in specific areas of the ocean. These organizations play a crucial role in ocean governance and sustainable fisheries management worldwide.

[2] H.R.5103, 118th Congress.

management. These standards help establish sustainability within fisheries by fostering objectives such as habitat protection, prevention of overfishing, and the rebuilding of overfished stocks.

Fishing is a way of life and an important source of income and well-being for many people. It fosters a sense of community, supports local economies, and can be a tradition passed down through generations. The act of fishing requires a willing crew, a degree of skill and technical knowhow, and specialized gear. Within communities, fisheries are supported by businesses such as fuel docks, ice suppliers, fishing gear and marine suppliers, offloading stations and facilities, fish buying and processing facilities, and cold storage facilities.

Additionally, several Tribes on the West Coast have treaties reserving their right to fish in "usual and accustomed" fishing areas. Federal fisheries and Washington State fisheries in Pacific Ocean waters are co-managed with Tribes with treaty-reserved fishing rights (PFMC, n.d.-c).

Detailed descriptions of the primary West Coast commercial and recreational fisheries that may be impacted by ORE development in Pacific Ocean waters and more information on Tribal treaty rights, co-management, and Tribal fisheries are provided later in this chapter.

U.S. West Coast Fisheries Management

Federal fisheries within the EEZ off California, Oregon, and Washington are managed by the PFMC through fishery management plans (FMPs). The PFMC is one of eight regional management councils established by the MSA and has jurisdiction over the 3,200 miles of the EEZ off California, Oregon, and Washington (PFMC, n.d.-d). The MSA requires regional fishery management councils to set catch limits for each FMP-managed stock through their plans and include fishery goals, objectives, and policies to provide the framework for stock-specific catch limits and fishery-specific management regulations (NOAA Fisheries, n.d.-f). The PFMC also produces stock assessment and fishery evaluation reports for the fisheries it manages, including groundfish, salmon, CPS (e.g., sardine, anchovy, market squid), and HMS (e.g., tunas, swordfish, pelagic sharks; PFMC, n.d.-b). These reports summarize the status of the stocks managed under the FMP, socioeconomic conditions of the fishery and fishery participants, and the available data for each fishery. West Coast coordination for internationally managed fisheries, such as Pacific halibut, and international fishery management entities formed by treaties or agreements for stocks such as Pacific whiting, Pacific salmon (Chinook and coho), albacore tuna, and other tunas and billfish also occurs through the PFMC process (PFMC, n.d.-d).

Management of a fishery is often based on the size of the fish stock, its projected change (i.e., annual change incorporating catch, recruitment, other causes of mortality), and a rule on what fraction of that change should be caught (i.e., catch targets or quotas). Stock sizes and their change are often derived from data and data models. Fishery data includes both fishery dependent data and fishery independent data. Records of catch, landings and, ideally, effort, which may be sourced directly from fishery participants and/or observers are examples of fishery dependent data, while information collected and estimated through independent surveys would be fishery independent data. NOAA conducts a variety of U.S. West Coast–wide surveys (Table 3-1 and Figure 3-1). Fishery models use the data to reconstruct past and predict future stock sizes, which in turn helps management councils determine the future sustainable catch and fishing rules.

Commercial Fisheries

According to MSA provisions NMFS maintains a list of authorized fisheries and gear (commercial and recreational) allowed to operate on the west coast EEZ (NOAA Fisheries, n.d.-g). NMFS is additionally required to classify all U.S. commercial fisheries regarding the level of its interactions with marine mammals and produces a separate List of Fisheries by area. Not only is this list useful for understanding the likelihood of fishery-specific encounters with marine mammals, but it also includes the estimated number of vessels participating in federal- and state-managed commercial fisheries. Table 3-2 provides a list of West Coast commercial fisheries. Summary descriptions of these fisheries and gear types and potential interactions with ORE structures follow in the text.

TABLE 3-1 NOAA's National Marine Fisheries Service Scientific Surveys along the U.S. West Coast

	Survey	Year Started	Informs Mandated Activities Under
1	West Coast Groundfish Bottom Trawl Survey	1998	MSA, ESA
2	Integrated Ecosystem and Pacific Hake Survey	1977	MSA
3	West Coast Pelagic Fish Survey	2006	MSA
4	West Coast Marine Mammal Survey	1991	MMPA, ESA
5	Pacific Orcinus Distribution Surveys	2015	MMPA, ESA
6	Rockfish Recruitment and Ecosystem Survey	1983	MSA
7	Pre-Recruitment Survey	2011	MSA
8	Juvenile Salmon and Ocean Ecosystem Survey	1998	MSA, ESA
9	Trinidad Head Line	2007	MSA, ESA
10	CalCOFI Survey	1949	MSA, ESA
11	Newport Hydrographic Line	1996	MSA, ESA
12	Southern California Shelf Rockfish Hook and Line Survey	2003	MSA
13	Northern California Current Ecosystem Survey	1996	MSA

NOTE: Numbers correspond to key in Figure 2-2. ESA = Endangered Species Act, MMPA = Marine Mammal Protection Act, MSA = Magnuson- Stevens Act.
SOURCE: Modified from Ise and Amiotte, 2025. Presentation to the committee.

West Coast Commercial Fisheries' Management Structure and Regulations by Fishery

Every fishery is unique and often requires a distinct management process, fishing year,[3] and specific regulations for gear types, fishing seasons, and other restrictions, such as area closures. The majority of fisheries operating off the West Coast are subject to license limitation programs in which fishing licenses or permits must be acquired from federal or state agencies and are limited in number. Other fisheries, such as groundfish (e.g., sablefish, lingcod) and HMS (e.g., tunas), are not limited to licenses, and permits and are considered open access. The total number of vessels participating in a fishery can vary from year to year with some fishermen regularly participating and others only engaging when other opportunities are constrained.

Some fisheries have existed for decades, and many were active before they were ever managed under an FMP. The types and sizes of vessels participating include a wide range and often depend on the targeted stock and gear utilized, with smaller vessels typically fishing closer to shore. Many larger West Coast-based vessels may also transit to Alaska to participate in fisheries in the North Pacific, such as pollock or halibut, or fish out on the high seas (i.e., further than 200 NM offshore) on a regular basis.

The largest West Coast commercial fisheries, with a target species landed weight of over 100 metric tons (mt) or that generated over $1 million in ex-vessel revenue in 2024, are listed in Table 3-3 (PSMFC, 2025). Landing and revenue in Table 3-3 do not capture Tribal fisheries data, but Tribes do participate in these fisheries. The respective fisheries and gear types are described in the following discussion.

Dungeness Crab Pot Fishery

The Dungeness crab pot fishery is a fishery managed at the state level. State management allows each state to adopt and enforce laws and regulations that apply to all vessels fishing for Dungeness crab off their coasts (with the exception of vessels exercising Tribal treaty rights).[4] A Tri-State Dungeness Crab agreement exists between

[3] "Fishing year" is a term used in fisheries management to define a period of activity for fishing certain species or in a particular region that does not align to a typical calendar year. For example, a fishing year can be April 1–March 31.

[4] Magnuson-Stevens Fishery Conservation and Management Act, H.R.5946, 109th Congress 2005-2006.

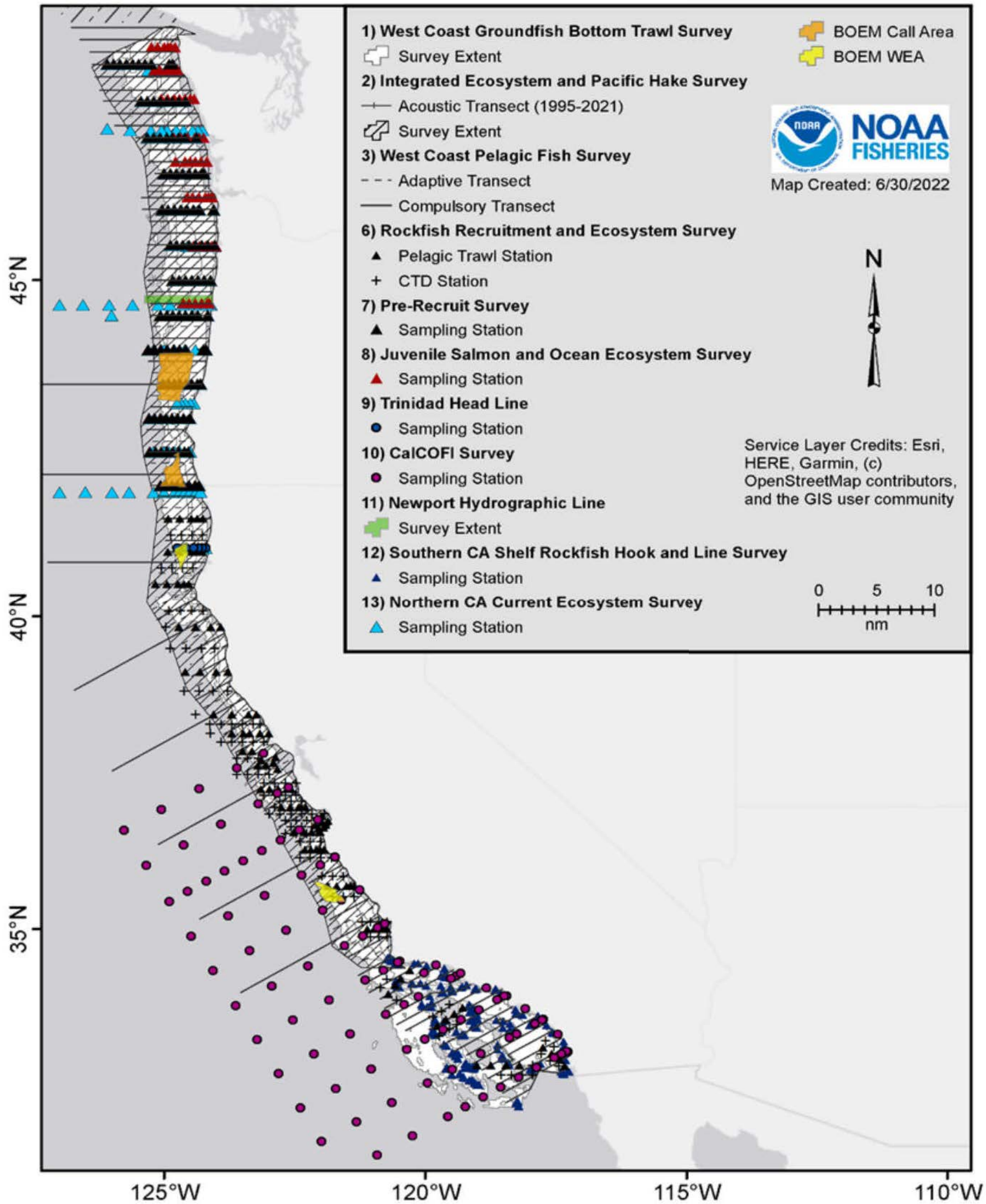

FIGURE 3-1 Map of NOAA's National Marine Fisheries Service surveys supporting fisheries management by survey type with offshore wind energy areas and offshore wind call areas overlaid from 2022.
NOTE: BOEM Call Areas (orange polygons) offshore Oregon were rescinded in 2024.
SOURCE: Ise and Amiotte, 2025. Presentation to the committee.

BOX 3-1
NOAA Fisheries Economics

Every year NMFS produces a report entitled Fisheries Economics of the United States (NMFS, 2024a). The most recent, published in November of 2024, outlines the 2022 Economic Impacts of the Pacific Seafood Industry in terms of jobs and dollars.

The Commercial Fishing Sector

The Pacific Region Commercial Seafood Industry (California, Oregon, and Washington), including imports, contributed:

- 1,041,235,000 pounds of seafood with revenues totaling $711,067,000
- 290,474 jobs
- $43,756,774,000 in sales
- $9,934,064,000 in income
- $16,110,887,000 in added value (contribution to the gross domestic product of the region)

The Recreational Fishing Sector

The Pacific Region Recreational Fishing Industry, accounted for

- 7,537 jobs
- $1,113,000,000 in sales
- $419,000,000 in income
- $663,000,000 in value added
- $807,000,000 in trip expenditures and durable goods (e.g., equipment costs)

Note that some participants in and representatives of the recreational fishing industry question whether these numbers adequately reflect the economic contributions of that sector.

California, Oregon, and Washington to effectively manage fishery policy issues and regulatory changes and to address public health issues resulting from harmful algal blooms (PSMFC, n.d.-b).

Participation in the Dungeness crab fishery is limited, and each state has adopted permit-specific limitations on the amount of gear (pots or crab traps) that can be fished (e.g., 200, 300, or 500 pots; NOAA Fisheries, n.d.-a; NOAA Fisheries, n.d.-h; NOAA Fisheries, n.d.-p). Gear types include crab pots and traps which, today, have a maximum volume of 13 cu ft and are mostly individually set with each pot connected to its own buoy (Figure 3-2). However, some fishermen in California have applied for experimental fishing permits to test pop-up gear or longline trap gear reducing the number of vertical lines in the water (National Marine Sanctuary Foundation, 2023). Gear requirements for individual pot and buoy tags and any marking of lines that connect pots to a main buoy are comparable between the states (NOAA Fisheries, n.d.-h).

In response to an increase in whale entanglements in crab gear during the 2014-2018 large marine heatwave event, the California Department of Fish and Wildlife has managed its Dungeness crab fishery under its risk assessment and mitigation program, and all three states have enacted measures to reduce entanglement risk (CDFW, n.d.-c; ODFW, n.d.; WDFW, 2024).

The Dungeness crab fishery occurs in Pacific Ocean waters in depths typically less than 50 fathoms (fms),[5] with effort concentrated off Oregon and California in water depths between 10 and 40 fms. Seasons vary by region but typically fall between late fall and early winter through summer. Opening and closing dates for each season

[5] A fathom is a nautical measure of depth and equals six feet.

TABLE 3-2. West Coast Commercial Fisheries in Pacific Ocean Waters with Estimated Number of Vessels, 2024

Target Species	Gear	Estimated Number of Vessels
Groundfish	trawl (bottom or midwater)	118
	longline	314
	pot/trap	144
	hook and line	689
Pacific whiting (hake)	trawl (midwater)	34
	at-sea trawl	6–7 (16 permits)
Salmon	troll (surface hook and line)	1,030
Coastal pelagic species (CPS) —WA/OR sardine	purse seine	6
CPS—WA/OR herring/anchovy/smelt/squid	purse seine	41
CPS—CA squid	purse seine	68
CPS—CA anchovy/mackerel/sardine	purse seine	53
Highly migratory species (HMS) —Albacore tuna	troll (surface hook and line)	556
HMS—Swordfish	drift gillnet	21
	harpoon	21
HMS— CA Tuna	purse seine	14
HMS (other than albacore)	hook and line	124
Pacific halibut	longline	130
Dungeness crab (WA)	pot	204
Dungeness crab (OR)	pot	323
Dungeness crab (CA)	pot	471
Pink shrimp (WA/OR/CA)	trawl	130
Spot prawn/shrimp (WA/OR/CA)	pot/trap	50
Hagfish (WA/OR/CA)	pot/trap	63
Spiny lobster (CA)	pot/trap	189
Rock crab (CA)	pot/trap	113
Coonstripe shrimp (CA)	pot/trap	9
California halibut (CA)	trawl	23
CA halibut/white seabass (CA)	set gillnet	39
	hook and line	388
Yellowtail/barracuda/white seabass (CA)	drift gillnet	20
Nearshore finfish (CA)	trap	42
Sea cucumber (CA)	trawl	11
Dive fisheries (WA/OR/CA)	hand collection	186

NOTE: U.S. federally regulated fisheries are bold, except Pacific halibut which are managed by the International Pacific Halibut Commission and coordinated through PFMC. CA = California, OR = Oregon, WA = Washington.
SOURCE: Marine Mammal Protection Act List of Fisheries for 2024, 89 FR 12257.

TABLE 3-3 Commercial Fisheries Landings and Ex-Vessel Revenue from Pacific Ocean off the Coasts of Washington, Oregon, and California, 2024

Target Species	Landings (mt)	Revenue ($)
Groundfish		
Pacific whiting*	143,561.1	$35,598,485
Sablefish	5,289.5	$13,481,213
Other groundfish	24,972.2	$29,616,170
Salmon*	9,625.9	$29,877,558
Coastal pelagic species		
Market squid	57,532.9	$68,115,282
Highly migratory species		
Albacore tuna	4,531.2	$16,070,988
Other Tuna (Bluefin, Bigeye, Yellowfin)*	368.2	$4,085,470
Pacific halibut	400.5	$4,761,017
Shellfish		
Dungeness crab (WA/OR/CA)	29,256.8	$264,057,772
Pink shrimp (WA/OR/CA)	31,232.4	$37,236,408
Spiny lobster (CA)	490.0	$20,897,875
Red sea urchin (CA)	967.1	$7,479,310
Spot prawn (WA/OR/CA)	252.2	$9,660,726
Rock crab (CA)	430.4	$2,200,363
Other shrimp (WA/OR/CA)	167.0	$2,590,749
California halibut (CA)	460.3	$5,755,676
Total	**309,537.7**	**$551,485,062**

* Some data is withheld from the species catch report for confidentiality purposes. CA = California, OR = Oregon, WA = Washington.
NOTE: Federal fisheries are set in bold, except Pacific halibut which are managed by the International Pacific Halibut Commission and coordinated through PFMC.
SOURCE: PSMFC, 2025.

are affected by factors such as whale presence, crab shell conditions, and more. (NOAA Fisheries, n.d.-a; NOAA Fisheries, n.d.-h; NOAA Fisheries, n.d.-p).

Groundfish Bottom-Trawl Fisheries

Groundfish bottom-trawl fisheries, managed as a "catch share" fishery with individual fishing quotas, tow a net along the ocean floor (Figure 3-3) and target a mixture of stocks within the larger groundfish complex (e.g., petrale sole, flatfish, sablefish or black cod, rockfish; NOAA Fisheries, n.d.-i). Vessels participating in this fishery range in length from 35 to 95 ft, and fishing occurs year-round at various depths, primarily over 50 fms.

Pink Shrimp Trawl

The pink shrimp trawl fishery also uses bottom (or demersal) trawl gear and is managed by the states of Washington, Oregon, and California (NOAA Fisheries, n.d.-s). While each state has their own permit requirements, the fishery for all three states is closed from November 1 through March 31, with common fishery regulations for bycatch reduction and monitoring. Fishing generally occurs in federal waters at depths between 40 and 150 fms

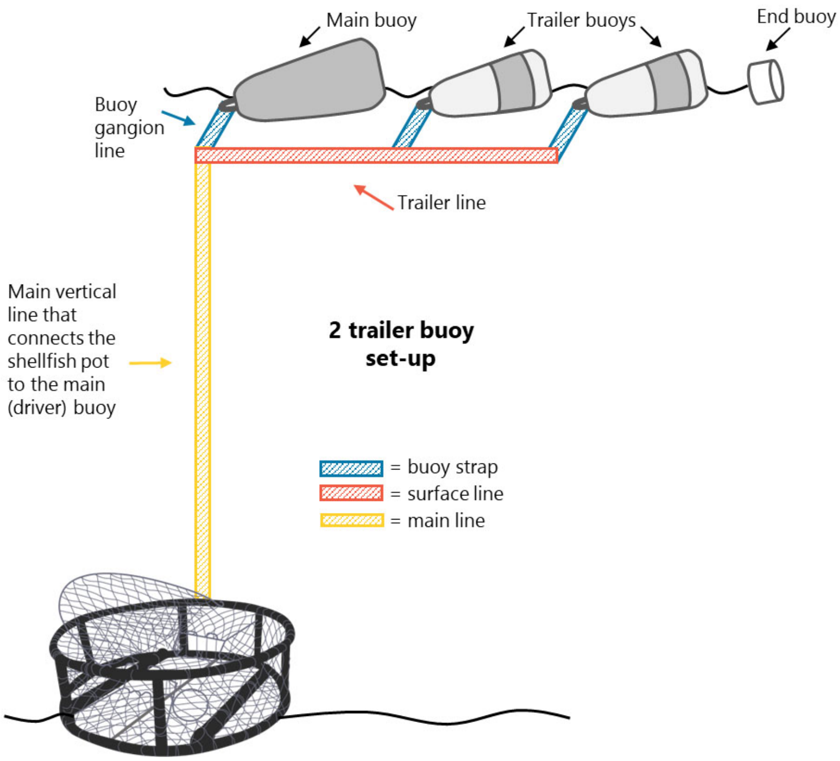

FIGURE 3-2 Dungeness crab pot.
SOURCE: WDFW, 2025a.

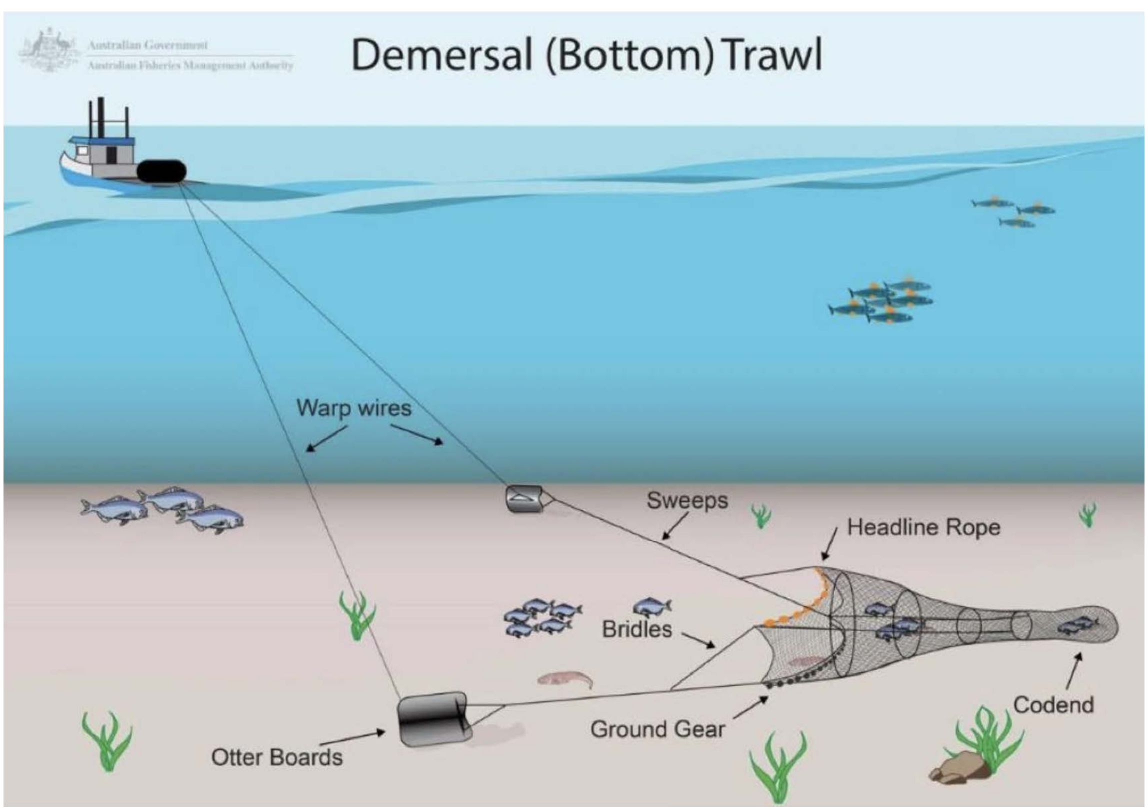

FIGURE 3-3 Bottom-trawl gear.
SOURCE: Australian Fisheries Management Authority, 2023.

north of Point Conception, California. South of Point Conception there is no pink shrimp fishery, but there is a trawl fishery that primarily targets ridgeback prawn, which is caught at depths between 10 and 110 fms.

Groundfish Midwater Trawl

There are two federal groundfish midwater trawl fisheries off the West Coast—one targeting Pacific whiting (or hake) and the other targeting pelagic yellowtail rockfish and widow rockfish (NOAA Fisheries, n.d.-i). Midwater trawl vessels pull nets through the water column, rather than on the bottom as bottom trawlers do (Figure 3-4; NOAA Fisheries, n.d.-d).

Pacific Whiting Midwater Trawl

The Pacific whiting midwater trawl fishery is the highest volume commercial fishery on the West Coast with annual landings in excess of 140,000 mt in 2024 (Table 3-3). The Joint Management Committee for the U.S./Canada Pacific Hake/Whiting Treaty develops recommendations for the total allowable catch or quota each year based on advice from the Joint Technical Committee, Scientific Review Group, and Advisory Panel (NOAA Fisheries, n.d.-e). The Pacific Hake/Whiting Treaty allocates the total allowable catch between the United States (73.88 percent) and Canada (26.12 percent).[6] The Joint Management Committee's recommendations are considered and discussed by the PFMC, which provides guidance to NMFS on implementing the annual total allowable catch.

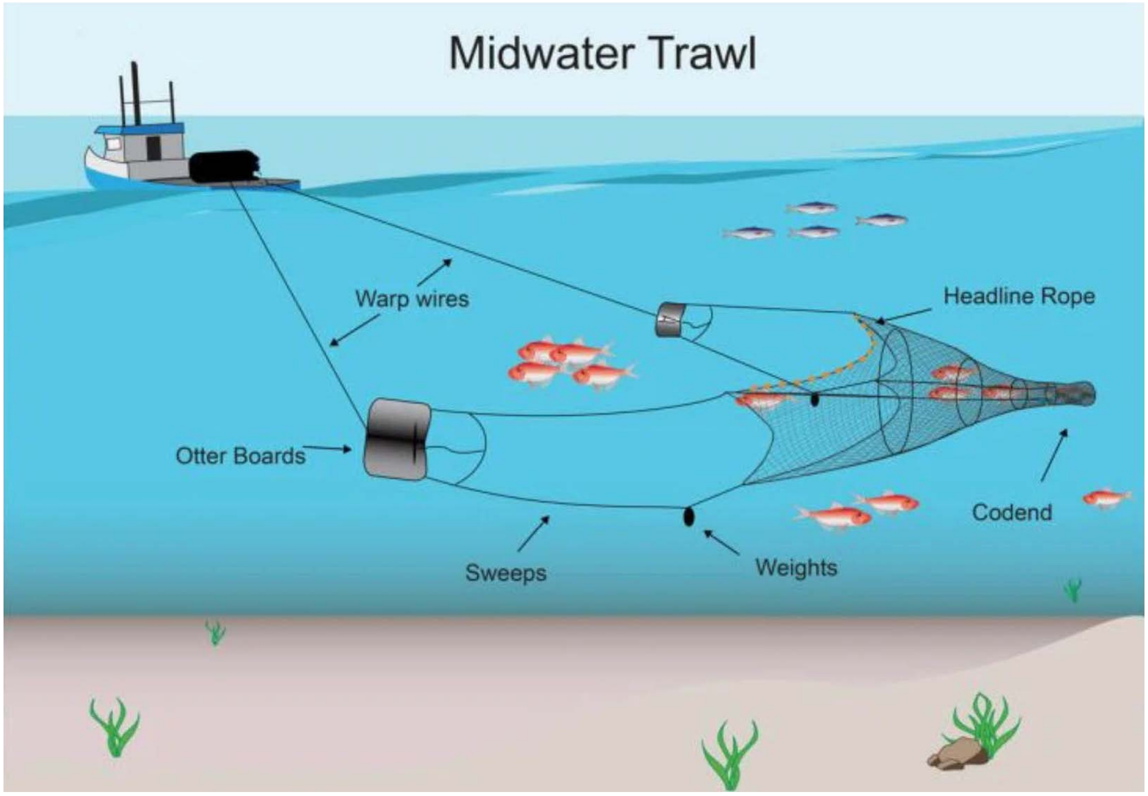

FIGURE 3-4 Midwater trawl gear.
SOURCE: Australian Fisheries Management Authority, 2023.

[6] Agreement between the Government of the United States of America and the Government of Canada on Pacific Hake/Whiting. Seattle, Washington. November 21, 2003, S. Treaty Doc No. 108-24

The whiting fishery includes both an at sea process sector and a shoreside processing sector (NOAA Fisheries, n.d.-i). Shoreside processing occurs when fishing vessels deliver their catch to a facility onshore. The majority of the whiting landed shoreside were fished at depths of 50–200 fms (Somers et al, 2023).

At-Sea Whiting Trawl

The at-sea whiting trawl fishery has two sectors, the mothership sector and catcher-processor sector. In the mothership sector, catcher vessels catch the fish and transfer their codends at-sea to the mothership platform, which has a factory and processes the whiting onboard. In the catcher-processor sector, vessels both catch and process whiting in their onboard factory. Participation in the at-sea whiting fishery is limited and is only allowed in waters off Washington and Oregon. At-sea whiting vessels range in length from about 150 ft to over 300 ft and fish in depths of 50–200 fms (NOAA Fisheries, n.d.-i; Somers et al, 2023).

Groundfish Fixed-Gear Fishery

The federal groundfish fixed-gear fishery includes both bottom longline fisheries (Figure 3-5) and pot/trap fisheries with gear attached to a groundline (Figure 3-6). These gear types are primarily used to target sablefish, although rockfish and flatfish, such as Pacific halibut, are other targets (NOAA Fisheries, n.d.-i). The sablefish fishery includes a limited-entry sector with permits for individual catch limits, and an open-access sector, managed by trip limits. Sablefish fixed-gear vessels range in size from 33 to 95 ft. The groundfish pot fishery primarily

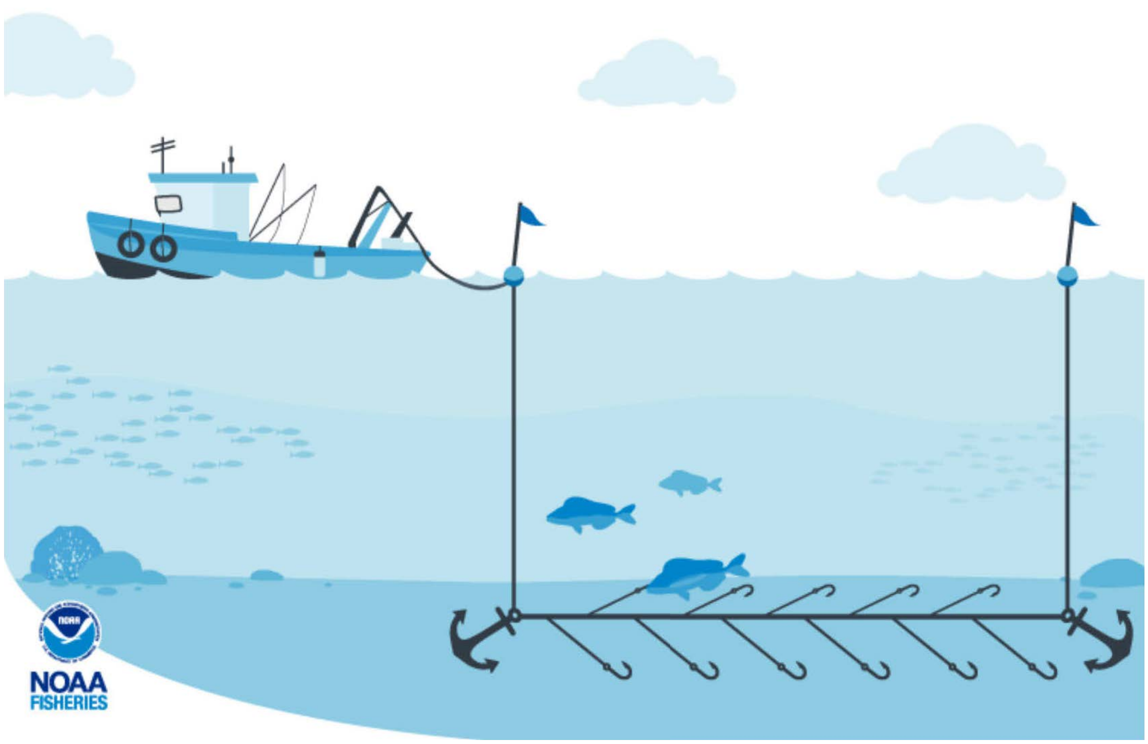

FIGURE 3-5 Bottom longline gear.
SOURCE: NOAA Fisheries, 2025.

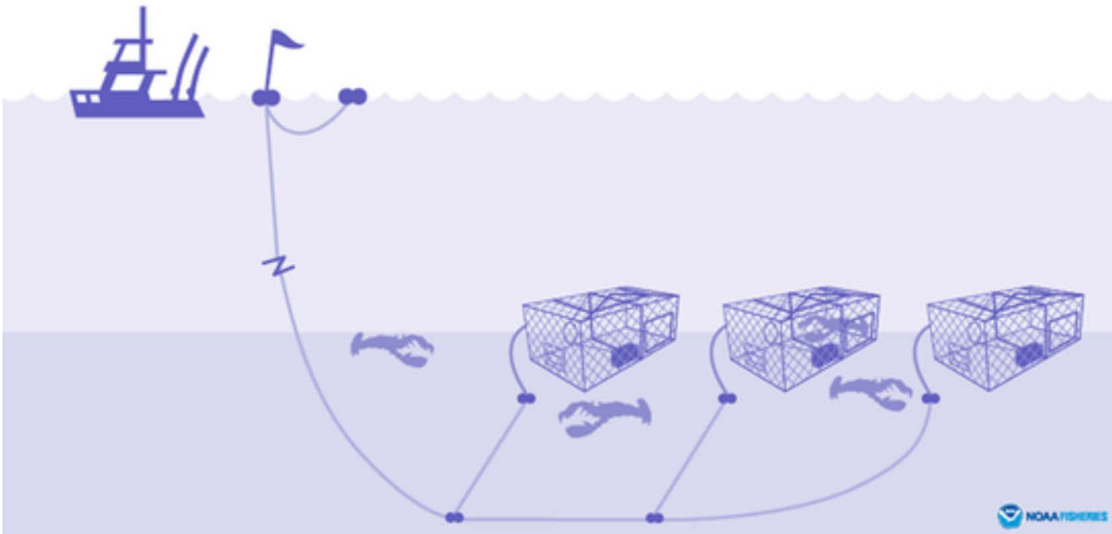

FIGURE 3-6 Pot/trap gear connected with groundline.
SOURCE: NOAA Fisheries, 2025.

occurs in depths from 150–350 fms with a maximum depth of 600 fms while the majority of the longline fishery occurs in waters 200–250 fms deep but has occurred in depths up to 750 fms (Somers et al, 2023).

Pacific Halibut Longline

The International Pacific Halibut Commission (IPHC) sets the Pacific halibut longline fishery annual harvest limits for each of its management areas, which include waters off the U.S. West Coast, British Columbia, Canada, and Alaska (IPHC, n.d.). The U.S. West Coast is managed as IPHC Regulatory Area 2A, and annual harvest limits are allocated by PFMC via the Area 2A Pacific Halibut Catch Sharing Plan. Participation in the 2A commercial halibut fishery is not limited, but vessels are required to have a valid fishing license from the IPHC and a permit from NMFS. Similar to the groundfish longline fishery, vessels use a weighted ground-line that is set on the bottom with a 25 to 50 lb anchor at each end and hooks attached to the main line every 3–4 ft (NOAA Fisheries, n.d.-r). The halibut fishery occurs at depths of 15–150 fms.

Albacore Tuna Troll and Other HMS Fisheries

The albacore tuna troll fishery is managed by PFMC as part of the HMS FMP and is coordinated internationally, given the pan-Pacific migration of the stock. The Inter-American Tropical Tuna Commission and the Western and Central Pacific Fisheries Commission use resolutions and conservation and management measures to inform domestic management of albacore tuna in different areas of the Pacific Ocean (NOAA Fisheries, n.d.-j). The United States additionally has a treaty with Canada that allows vessels from each country to fish in each other's waters beyond 12 NM from shore (NOAA Fisheries, n.d.-q).

Albacore troll vessels use surface hook-and-line gear, typically trolling 10-20 lines with artificial lures at a speed of 4–8 kts, to target schooling fish in the water column (NOAA Fisheries, n.d.-o). Some participants in the albacore tuna fishery also use pole and line gear, which are rigid rods with baited hooks. Participation in the albacore troll fishery is not limited but vessels are required to have permits from NMFS and be listed on the Inter-American Tropical Tuna Commission Vessel Registry. Albacore tuna fishing occurs both offshore, within the EEZ, and on the high seas (greater than 200 NM offshore) typically between June and October. Fishermen using trolling gear can spend extended periods offshore, ranging from 1–3 weeks for vessels less than 50 ft, to upwards of two months for vessels over 50 ft (NOAA Fisheries, n.d.-q).

Other HMS fisheries include the drift gillnet swordfish fishery, a swordfish harpoon fishery, a limited entry fishery using deep-set buoy gear in the Southern California bight, a growing rod-and-reel fishery, and the tuna purse seine fishery (NOAA Fisheries, n.d.-o). Additionally, while pelagic longline gear is not allowed within the EEZ, some West Coast–based vessels participate in the longline fisheries on the high seas and Hawaii-based vessels offload their catch in California in the fall and winter.

Ocean Salmon Troll Fishery

The ocean salmon troll fishery primarily targets Chinook and coho salmon off Washington and Oregon, and Chinook salmon off California (NOAA Fisheries, n.d.-b). Pacific salmon are iconic species on the West Coast and some of the stocks that originate in the Pacific Northwest migrate northward to waters off Canada and Alaska before returning to spawn (PFMC, 2024d). To address management concerns of these transboundary stocks, in 1985 the United States and Canada entered into the Pacific Salmon Treaty,[7] which is implemented by the Pacific Salmon Commission. The Pacific Salmon Commission receives advice from four regional panels of scientists and fishery experts from the United States and Canada and manages the commercial, sport, and subsistence fisheries in both countries, communicating management decisions to the PFMC (PSC, n.d.-a; n.d.-b).

Federal permits are not required for the ocean salmon troll fishery, as it is managed by PFMC. The PFMC requires state licenses for vessels using troll or surface hook-and-line gear to target salmon; however, the gear configuration is different than the troll fishery targeting albacore tuna. Outriggers are used to avoid tangling the fishing lines, and up to six lines from each outrigger are trolled through the water at 1–4 kts with 10 to 50 lb weights (Figure 3-7) (NOAA Fisheries, n.d.-b). Fishing typically occurs from shore out to 15–20 NM, mostly in the summer and fall with limited opportunities in the spring in certain areas in some years.

Coastal Pelagic Species Purse Seine

CPS purse seine fisheries target smaller forage fish, such as market squid, sardine, and mackerel (PFMC, n.d.-a). While these stocks are managed by PFMC as part of the CPS FMP, the California Department of Fish and Wildlife primarily manages the market squid fishery off California (NOAA Fisheries, n.d.-c). Purse seines are large nets with a float line attached to the top. A skiff holds the end of the net while the purse seine vessel encircles the school of fish with the net creating a wall, which is then "pursed" closed at the bottom to prevent fish from escaping (Figure 3-8). The squid purse seine fishery generally occurs at night, and vessels use large, bright lights to attract squid to the surface. In some cases, aerial surveys can assist fishermen and fish surveyors targeting other CPS, such as sardines. In these surveys a spotter plane locates schools of fish from the air and communicates their location with a partner vessel prepared to catch the school using a purse seine (NOAA Fisheries, 2017).

CPS-targeted fisheries typically occur in the nearshore area with state-specific regulations and seasons (NOAA Fisheries, n.d.-c). This fishery (excluding market squid) is divided into subareas for the regulation of fishing for CPS. The area south of Point Arena, California requires a federally issued limited-entry permit, and north of Point Arena, Pacific sardine and mackerel are managed by PFMC and by the State Departments of Fish and Wildlife in Washington, Oregon, and California (PFMC, 2024a; NOAA Fisheries, n.d.-t). While the primary directed fishery for Pacific sardine has been closed since 2015, because the estimated biomass has been below the harvest cutoff specified in the FMP of 150,000 mt, incidental harvest of sardine is still allowed (NOAA Fisheries, n.d.-t).

Recreational Fisheries

Recreational anglers fish for a variety of species on the West Coast, including groundfish, salmon, tunas, and Pacific halibut, with fishing occurring in both state and federal waters. These fisheries are important socially, economically, and culturally to the coastal states and communities. In 2022, recreational fishing supported approximately 7,500 jobs and $1.1 billion in sales on the West Coast (NMFS, 2024a). Depending on the targeted stocks,

[7] Public Law 99–5, enacted on March 15, 1985. 16 U.S.C. §§ 3631–3644

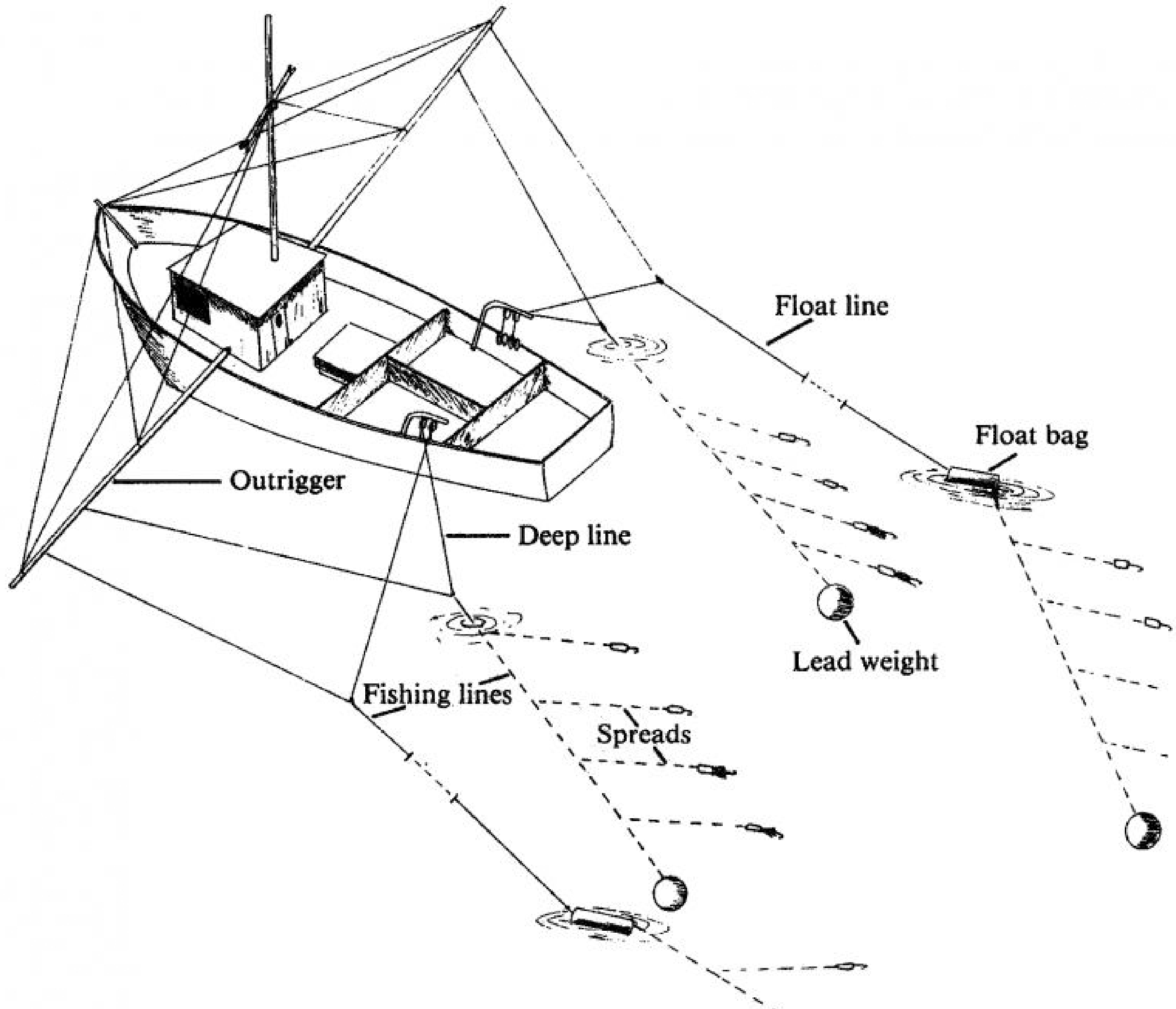

FIGURE 3-7 Salmon troll gear.
SOURCE: California Sea Grant, n.d.

recreational fisheries are managed under a federal FMP, through a PFMC process, or by the individual states. Tables 3-4 and 3-5 outline recreational fishing effort in angler trips by state for groundfish and salmon, and Table 3-6 outlines the catches of albacore tuna, by state. The State Departments of Fish and Wildlife in Washington, Oregon, and California regulate the time, place and manner of fishing for recreational fisheries, including license requirements and setting seasons and individual angler limits (e.g., daily bag limits; WDFW, 2025b; ODFW, 2025; CDFW, n.d.-b). While seasons for specific species are set based on various factors, including stock status, catch limits, and co-occurrence with other species, multiple recreational fishing opportunities are available on the West Coast throughout the year.

Charter Fishing

Charter fishing provides a unique opportunity for members of the public to fish for a variety of species on for-hire vessels. Depending on the species targeted, the vessel may be required to hold federal permits, such as when targeting HMS or Pacific halibut, and all states require licenses for charter boats (NOAA Fisheries, n.d.-l).

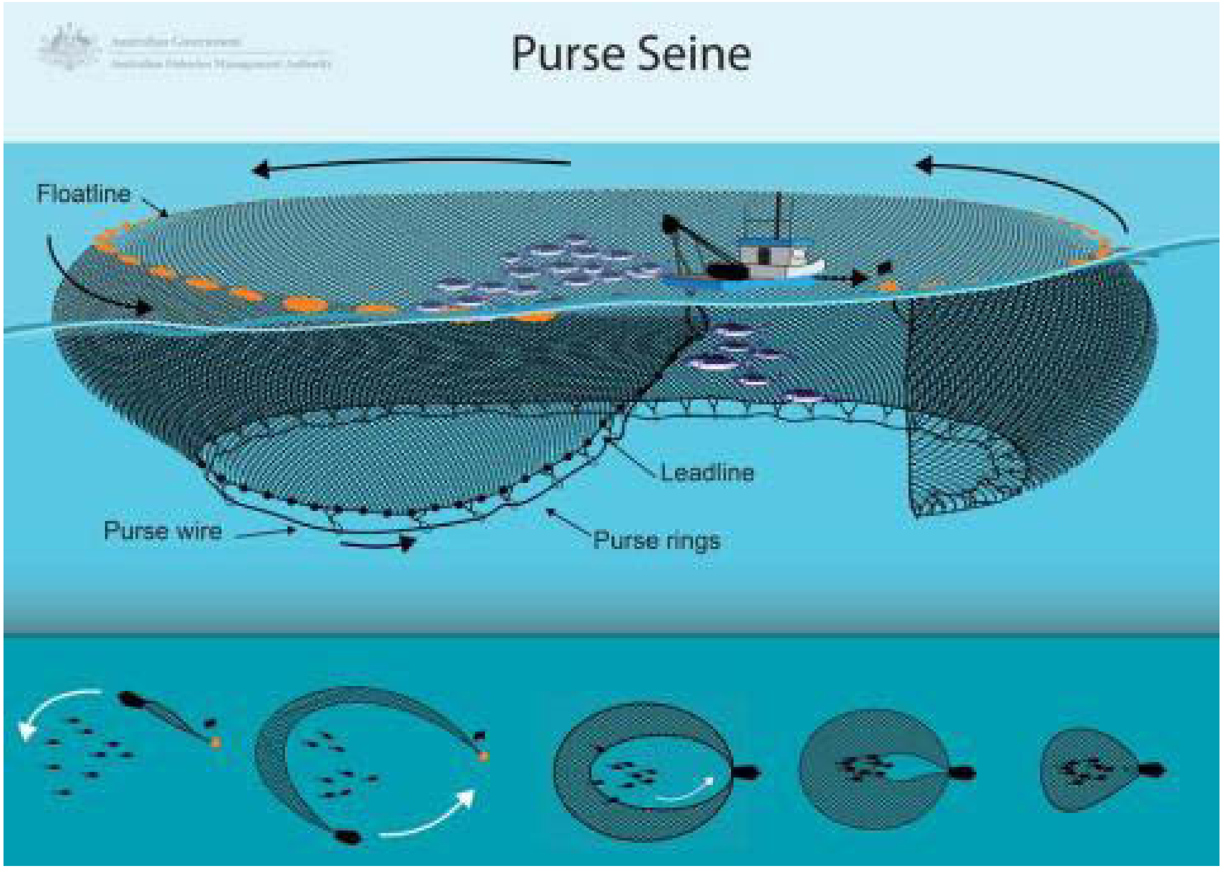

FIGURE 3-8 Purse seine gear.
SOURCE: Australian Fisheries Management Authority, n.d.

Additionally, in most cases, vessels and states require participating anglers to purchase fishing licenses before departure (WDFW, 2025b; ODFW, 2025; CDFW, n.d.-b). California has additional requirements for commercial passenger fishing vessels (CPFVs or charter vessels) to complete and submit logbooks, which include catch and effort information (CDFW, n.d.-a). Oregon and Washington also have logbook requirements which include catch and effort information.

Each state has its own recreational fishery sampling program, which collects data from recreational anglers and estimates catch and effort by mode (e.g., charter or private) and target species (e.g., salmon, bottomfish, tuna). State programs are then coordinated through the Pacific States Marine Fisheries Commission's Recreational Fishing Information Network program (PSMFC, n.d.-a). Recreational fishing data collection programs and priorities are outlined in the Pacific States Marine Fisheries Commission's Recreational Fishing Information Network /Marine Recreational Information Program Regional Implementation Plan, which uses dockside angler interviews to collect general fishing area information (NOAA Fisheries, 2023).

Historical, Current and Migrating Fishing Grounds (Commercial and Recreational)

Identifying historical and current fishing grounds is a critical step in determining which fisheries may be impacted by ORE developments, although the amount of available information varies by fishery and fishery sector. Some commercial fisheries are required to use VMS, which can provide detailed information about historic and current fishing grounds. While VMS is not required for all vessel types, it is required for some, including certain

TABLE 3-4 Average Recreational Ocean Groundfish Trips by Mode (Charter or Private), 2019–2023

	Charter	Private	Combined
Washington	14,116	16,622	30,738
Oregon	47,773	57,546	105,319
California	395,172	186,313	581,485
Total	457,061	260,481	717,542

SOURCE: PFMC, 2024-b.

TABLE 3-5 Recreational Ocean Salmon Angler Trips by State and Year, 2022–2024, and 2019–2023 Average

	2022	2023	2024	2019-2023 average
Washington	69,300	66,900	61,700	59,300
Oregon	96,400	76,400	77,400	84,500
California	98,900	0	0	70,200
Total	264,600	143,300	139,100	214,000

SOURCE: PFMC, 2025-b.

TABLE 3-6 Recreational Albacore Tuna Catch (Numbers of Fish) by State and Year, 2021–2023

	2021	2022	2023
Washington	10,732	51,363	33,813
Oregon	21,596	21,823	36,502
California	9,707	32,383	18,834
Total	42,035	105,569	89,149

SOURCE: PFMC, 2024-c.

commercial vessels targeting groundfish (dependent on gear type), vessels using gillnets to target HMS, vessels larger than 24 m targeting tuna or tuna-like species, and U.S. vessels with a high seas permit (NOAA Fisheries, n.d.-m, n.d.-k). As discussed in Chapter 2, vessels' AIS are another source of data to track vessel movements, but fishing vessels under 65 ft in length are not required to carry AIS equipment. Figure 3-9 provides a map of fishing activity by gear type of data derived from AIS and VMS sources from Global Fishing Watch. This map demonstrates the limitations of trying to identify fishing grounds utilizing these sources alone. Other kinds of fishing data for charter vessels or CPFVs are derived from logbooks which can lack spatially discrete information. There is little data on recreational fishing activity, and as noted in a letter to BOEM from the PFMC (2023b), the data that is available is generally at too coarse a scale to be used for identifying recreational fishing grounds. Box 3-2 provides examples of targeted commercial fishing mapping initiatives conducted during ORE development planning off California. Additionally, the next section describes an initiative to capture fisheries data off the Oregon coast through a collaboration between Oregon Department of Fish and Wildlife and NMFS.

Oregon Department of Fish and Wildlife/National Marine Fisheries Service Fishery Data Layers

Oregon's Department of Fish and Wildlife (ODFW) and NMFS worked together to develop fishery data layers for inclusion in NOAA's National Centers for Coastal Ocean Science (NCCOS) spatial suitability model, which was used to identify wind energy areas (WEAs) off the Oregon Coast (Carlton et al., 2023). While 11 fisheries were initially considered for the model, only 9 were included as data layers. Salmon and halibut were excluded

FIGURE 3-9 Commercial fishing activity by gear type from AIS and VMS data.
SOURCE: Created by International Mapping with data from Global Fishing Watch.

BOX 3-2
Commercial Fishing Mapping Initiatives

During the leasing process for the five leases off California, commercial fishing associations and local fishermen undertook efforts to map commercial fishing grounds in their local areas developing two projects within Central California and Northern California (MBCFO et al., n.d.; Humboldt Fishermen's Marketing Association et al., n.d.).

The Central Coast Fishing Heritage Mapping Project (Central Coast Project)

Led by the Morro Bay Commercial Fisherman's Organization, fishermen between Point Sur and Point Conception identified commercial fishing grounds and categorized them by factors such as species types, gear types, and level of safety (MBCFO et al., n.d.). Other considerations included seasonality, habitat, trip length, time of day, home and landing ports, and environmental or regulatory factors affecting the grounds.

The product of the Central Coast Project includes a map showing historic and current fishing grounds displayed as a story map that provides additional detail for fisheries of blackcod/sablefish and thornyhead, the nearshore rockfish complex, groundfish trawl, pink (ocean) shrimp, California halibut and white seabass, California halibut trawl, market squid, CPS, Dungeness crab, rock crab, slime eel/hagfish, surf perch, red sea urchin, salmon, spot prawn, and HMS.

The North Coast Fisheries Mapping Project (North Coast Project)

Three Northern California Commercial Fishermen's Associations—the Humboldt Fishermen's Marketing Association, Salmon Troller's Marketing Association, and the Crescent City Commercial Fishermen's Association—collaborated on the North Coast Project Fisheries Mapping Project (Humboldt Fishermen's Marketing Association et al., n.d.). The goal of this mapping project was to map community fishing grounds by species or species complex, gear type, depth, seafloor substrate, and season.

Similarly, the North Coast presents a story map with identified fishing grounds and information for commercial fisheries operating along the North Coast including Chinook salmon, Dungeness crab, groundfish, coonstripe shrimp, Pacific halibut, hagfish (slime eel), market squid, HMS, spot prawn, red sea urchin, smelts, and CPS.

It is important to note that these projects do not fully reflect which species are expanding, declining, or limited by environmental conditions, regulation, or socioeconomic concerns.

due to spatial data limitations and time constraints, which are further described in Table 3-7. Together with fishery specific data, the NCCOS Model utilized AIS in developing data layers for some marine uses. AIS data from fishing vessels was excluded as it did not paint a complete picture, as AIS is not common on recreational vessels and not all commercial vessels are required to carry it (PFMC, 2025).

Additional considerations

The NOAA Northwest Fisheries Science Center and Pacific States Marine Fisheries Commission collaborate to create the Pacific Fishing Effort Mapping project; a tool being created to provide access to fisheries spatial data for management activities and marine planning efforts along the West Coast (PFMC, 2023-a). Once this project is available, it will likely be another powerful data source for ORE planning. Several groups, including NOAA, have highlighted the need to consider how ORE development will impact the fisheries whose distribution is shifting due to changing ocean conditions or stock recovery (NOAA, 2023).

TABLE 3-7 Fisheries Data Used by ODFW and NMFS for NCCOS Data Layer

Fishery	Data source time series	Data source
Groundfish bottom trawl (limited entry plus catch shares)	2002–2020	Logbooks from PacFIN via the NWFSC observer program database
At-sea hake midwater trawl (mothership and catcher/ processor vessels)	a) 2011–2020	a) NWFSC Observer Program, PacFIN
	b) 2002–2019	b) Logbooks from PacFIN via the NWFSC observer program database
Shoreside hake mid-water trawl	a) 2011–2020	a) NWFSC Observer Program, PacFIN
	b) 2002–2020	b) Logbooks from PacFIN via the observer program database for 2011–2019 and logbooks for 2002–2010 and 2020 from ODFW
Groundfish fixed gear—pot	2011–2020	ODFW
Groundfish fixed gear—long-line	2011–2020	ODFW
Commercial albacore gear—troll/hook-and-line	a) 2011–2020	a) SWFSC, PacFIN
	b) 2005–2021	b) SWFSC
Recreational charter albacore—troll/hook-and-line	2005–2021	SWFSC
Pink shrimp trawl	2011–2020	ODFW logbook, PacFIN
Dungeness crab pot	a) 2011–2020	ODFW logbook, PacFIN
	b) 2007/08–2010/11 and	
	2018/19–2019/20 seasons	

NOTE: PacFIN: Pacific Fisheries Information Network, NWFSC: Northwest Fisheries Science Center, SWFSC: Southwest Fisheries Science Center.
SOURCE: Modified from Table E-1 of the NCCOS Report (Carlton, et al., 2023).

TRIBAL FISHERIES

Some federally recognized Indian Tribes have reserved rights to fish in certain areas along the West Coast as identified in several treaties between the Tribes and the United States. These treaties were signed in 1854 and 1855 and are referred to as the Stevens Treaties.[8] As a result of the treaties, the Tribes ceded large amounts of land and bordering offshore waters in what is currently Washington State. Some of the ceded areas include parts of the Olympic Peninsula and all of the Puget Sound watershed. Although the Tribes ceded these lands, the treaty language reserved rights to fish in their "usual and accustomed areas" as defined in article 5 of the Treaty of Point Elliott:

> The right of taking fish at usual and accustomed grounds and stations is further secured to said Indians in common with all citizens of the Territory, and of erecting temporary houses for the purpose of curing, together with the privilege of hunting and gathering roots and berries on open and unclaimed lands. Provided however, that they shall not take shellfish from any beds staked or cultivated by citizens.[9]

By the 1950s the language about "usual and accustomed" fishing access was subject to dispute. The state of Washington began enforcing fishing regulations against Tribal members who were engaged in fishing practices pursuant to the treaties (Gallagher Law Library, n.d.). In 1970 the United States, as trustee for several Tribes, filed

[8] *United States v. Washington*, 853 F.3d 946, 953 (9th Cir. 2017).
[9] Treaty of Point Elliott, 12 Stat. 927 (Jan. 22, 1855).

a suit against the state of Washington. In 1974, Judge George Boldt issued his first decision interpreting fishing right in the Stevens Treaties and established a co-management requirement between the Tribes and the state. That landmark court decision became known as the Boldt Decision.[10]

Federal courts have also determined that the treaty Tribes are entitled to up to half of the harvestable surplus of fish stocks that reside in or pass through their usual and accustomed areas.[11] Many stocks of fish that these Tribes have rights to can also be found in waters off Alaska, Canada, and other areas off the West Coast where they are harvested in ocean fisheries.

The Stevens Treaties have been incorporated into federal regulation at 50 CFR Part 300.6 and 300.95, regulations for Pacific Halibut and Sockeye and Pink Salmon fisheries, respectively. The regulations at 50 CFR Part 300.6 reflect the locations for current halibut fisheries in offshore waters where thirteen Tribes are exercising their treaty rights. The regulations at 50 CFR 300.95 reflect the federal regulations for the Fraser River Sockeye and Pink Salmon fisheries and include specific language to reflect treaty fishing areas under federal regulations. The reserved Tribal fishing locations are identified with references to orders from federal court cases interpreting the Stevens Treaties and include specific geographical location markers. Tribal fishermen pursue annual offshore fisheries for halibut and salmon that could be impacted by ORE projects.

Fisheries management along the coast of Washington State is carried out by three governments: Tribal, state and federal. This "co-management" regime means that Tribal governments participate in management decisions with state and federal regulators, including those related to hatchery production, habitat conservation, hydropower, and fisheries harvest. Tribes have inherent authority to regulate fisheries in their adjudicated "usual and accustomed" areas. Therefore, Tribal governments have direct regulatory authority over fisheries and Tribal fishermen. Tribal governments set fishing regulations like fishing openings, gear restrictions and catch limits. Tribal governments are also involved in conservation management with state and federal governments.

Tribal Fisheries and Usual and Accustomed Fishing Areas

Twenty-six West Coast Indian Tribes have federally recognized fishing rights within their Usual and Accustomed fishing areas. These include twenty treaty Tribes in western Washington, four Columbia River treaty Tribes and two Klamath River Tribes in California with reservation-based fishing rights. The western Washington and Columbia River Tribes' rights are based on treaties signed between the Tribes and the United States in the mid-1850s and each of these Tribes are entitled to harvest up to 50 percent of the harvestable surplus of fish residing in or passing through their "usual and accustomed" areas[12].

All of the twenty-six Tribes harvest salmon within their usual and accustomed areas, which includes off-reservation marine areas for many of the Tribes, and the western Washington Tribes also retain rights to harvest a variety of marine species and shellfish. Thirteen western Washington Tribes, for example, have treaty rights to harvest Pacific halibut, which are managed Federally and Internationally.

The federal courts in United States v. Oregon,[13] the Belloni Decision, for the Columbia River Tribes, and United States v. Washington,[14] the Boldt Decision, for the western Washington Tribes, determined that the Tribes would co-manage their fisheries resources with their respective states. The U. S. Secretary of Commerce also recognizes sovereign status and co-management roles of treaty Tribes over shared federal and Tribal fishery resources.[15]

Four Washington coastal Tribes, Makah, Quileute, Hoh and Quinault, have fishing rights and usual and accustomed fishing areas in the Pacific Ocean including within federal waters. These treaty rights include allocations or set asides for salmon, groundfish, shellfish, halibut, CPS and HMS. Judge Boldt determined the northern and southern usual and accustomed area for each of the four Tribes in his original 1974 decision and in subsequent sub proceedings and the western boundaries in later sub proceedings. The current combined usual and accustomed area of the four Tribes extends from the U.S.–Canada boundary in the north to the southern end of Grays Harbor in the south and 40 mi from shore in the northern portion and 30 mi from shore in the south. Box 3-3 described the Makah Tribe's usual and accustomed fishing area.

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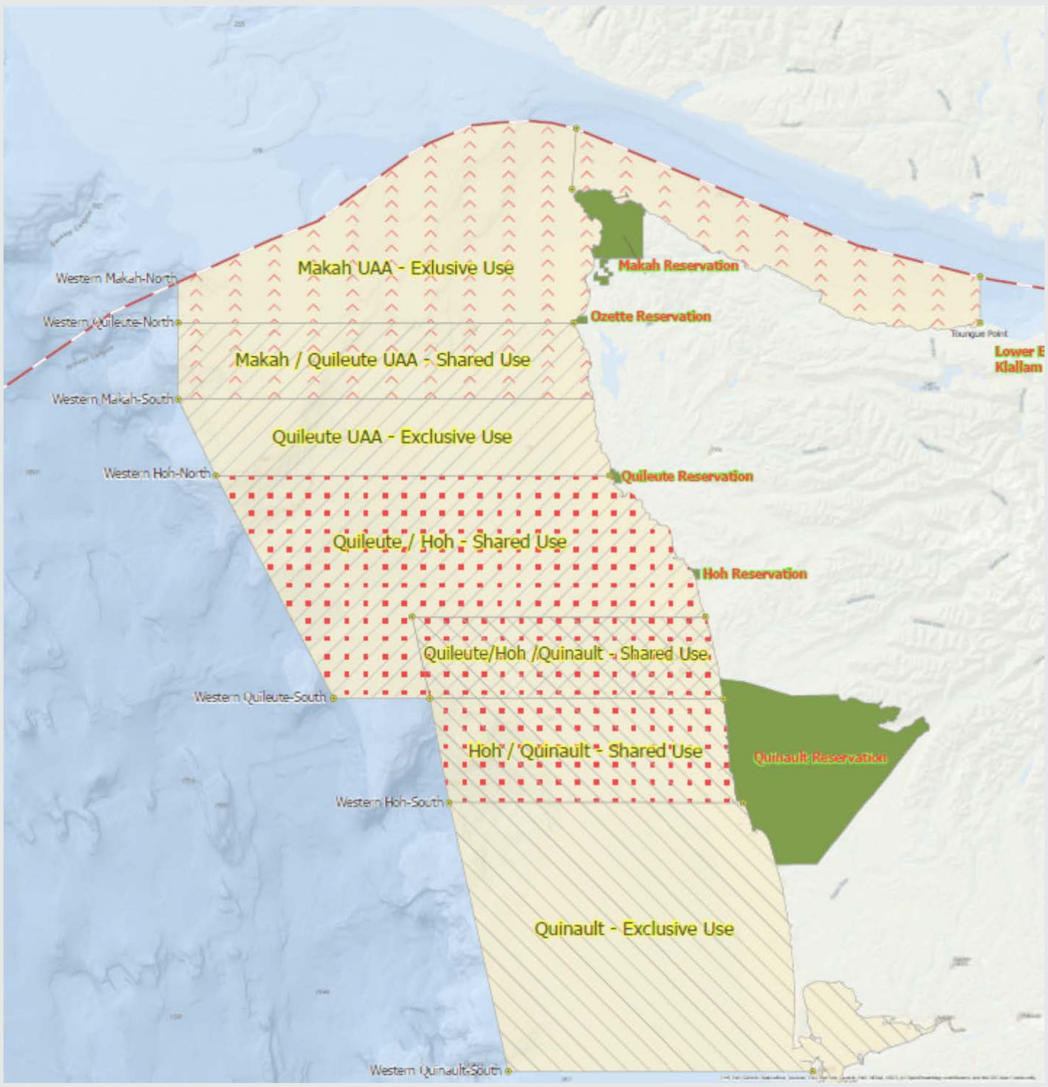
[10] United States v. Washington, 384 F. Supp. 312 (W.D. Wash. 1974), aff'd 520 F.2d 676 (9th Cir. 1975).
[11] *Id*. at pinpoint to first cite to Boldt Decision.
[12] *Id*. at pinpoint to first cite to Boldt Decision.
[13] 302 F. Supp. 899
[14] *Id*. at pinpoint to first cite to Boldt Decision.
[15] Pacific Coast Treaty Indian rights. 50 CFR § 660.706.

BOX 3-3
The Makah Tribe's Usual and Accustomed Fishing Area

As an example, the Makah Tribe adjudicated their usual and accustomed fishing area in 1974 from Judge Boldt and established their grounds in the Pacific Ocean extending from the U.S./Canada boundary south. The Makah Tribe's usual and accustomed can be seen in the provided map and is approximately 20 mi south from the U.S.–Canada border to 48° 02 minutes north latitude, extends west 40 mi from shore to 125° 44 minutes west longitude, and eastward in the Strait of Juan de Fuca approximately 60 mi to a location west of Port Angeles, Washington.



Following the establishment of the U.S. EEZ in 1976 and the subsequent federal fisheries management within the EEZ, it was necessary for the Tribes to establish western boundaries for their fishing areas. The Makah Tribe began that process in 1978, and in 1982 the court established the Makah western boundary 40 NM from shore based on evidence of their traditional fishing areas and practices. The western boundaries for the other three coastal Treaty Tribes—Quileute, Hoh and Quinault—were determined by subsequent court rulings.

NOTE: The above map was provided to the Committee by the Makah Tribe in order to visually show an example of Usual and Accustomed fishing areas. This map was not created with, nor does it fully represent, the Quinault Nations's, Hoh Tribe's, and Quileute Tribe's usual and accustomed fishing areas.

CALIFORNIA CURRENT ECOSYSTEM

Overview

The covered waters of this study, from the California-Mexico border to the Washington-Canada border, are part of the CCE. The Ecosystem is defined by the California Current (CC), which flows equatorward along the Pacific Coast of the United States from Canada to Mexico. The CC is a physically energetic system driven by winds that arise from variations in surface heating in the Northern Hemisphere and the Earth's rotation. Winds from the north, particularly in spring and summer, cause upwelling of cold, nutrient-rich water coastally primarily off California, secondarily off Oregon and less so off Washington (Jacox et al., 2018). The cross-shelf change in wind and water temperature from cold, nearshore water to warmer, offshore water is balanced by the mean southward but varying flow of the CC in the upper 300 m (Marchesiello et al., 2003). A southward flowing coastal jet occurs close to shore, particularly at times of strong upwelling. Fall and winter winds from the south cause an onshore flow, a weakening of the CC and the occurrence of the poleward Davidson Current at the surface, particularly off California. Most of the year, the California Undercurrent flows poleward beneath the CC. A key characteristic of the CC system is its variability in space, along the coasts of Washington, Oregon and California, and time, from days to decades and beyond (Bograd et al., 2023).

Wind that powers the CC is a potential source of ORE and affects marine traffic and safety along the West Coast. Annual average wind speeds are reliably strong along the West Coast from Point Conception in CA north to Cape Flattery in WA, with highest speeds found in northern CA and southern OR (Figure 3-10). Winds vary in time and space along the West Coast. Monthly average wind speeds can reach over 10 m/s at 100 m above the surface (Draxl et al., 2015), with higher speeds during extreme events.

The California Current

The CC is, on average, approximately 250-350 km (135-190 NM) offshore of Washington and Oregon and, in California, 430 km (230 NM) off Cape Mendocino and 270 km (150 NM) off Point Conception (Hickey 1979). Thus, the CC flows over and beyond bottom depths up to 1,300 m (Cooperman et al., 2024a). Areas optimal for wind turbines off the West Coast are, in general, shoreward of the average location of the maximal flow of the CC off southern Oregon and northern California (von Krauland et al., 2023). Locations most suitable for hydrokinetic energy installations are in shallower waters nearer to shore. Chapter 5 provides more information about offshore wind energy development and hydrokinetic energy development off the West Coast.

Ecosystem

The CCE is the ecosystem bounded by the CC to the west and shore to the east. The CCE includes a broad range of habitats, ranging from shallow waters nearshore to waters overlying basins, the continental slope and deep ocean offshore. Upwelling brings nutrients to the sunlit surface waters that nourish the plankton, nekton, seabirds and marine mammals which, in turn, support fisheries and other activities vital to coastal communities and Tribes.

Two types of wind-driven upwelling of nutrient-rich water occur off the U.S. West Coast (Rykaczewski and Checkley 2008, Jacox et al., 2018). Coastal upwelling occurs when equatorward wind parallel to the shore causes surface waters to move offshore and be replaced by cooler water from 50-200 m. Wind-stress curl-driven upwelling occurs when equatorward wind accelerates with distance offshore, causing a divergence in surface flow resulting in a slow but broadscale upwelling from similar depths as coastal upwelling. Upwelled nutrients are used by phytoplankton which, in turn, is consumed by zooplankton and fish. Coastal upwelling is faster and favors larger plankton and anchovy, while offshore upwelling is slower and favors smaller plankton and sardine. While coastal upwelling generally occurs within 20 km of the coast and curl-driven upwelling further offshore, both can co-occur (Jacox et al., 2018, Raghukumar et al., 2023).

The CC can be linear or include meanders, eddies, jets and filaments (Marchesiello et al., 2003). Such physical features can cause upwelling, downwelling and transport, which affect the chemistry and biology of the CCE, including the production and distribution of plankton, fish and other parts of the ecosystem. Variability is characteristic of the CCE. The topography and bathymetry of the West Coast affect local upwelling, currents, waves,

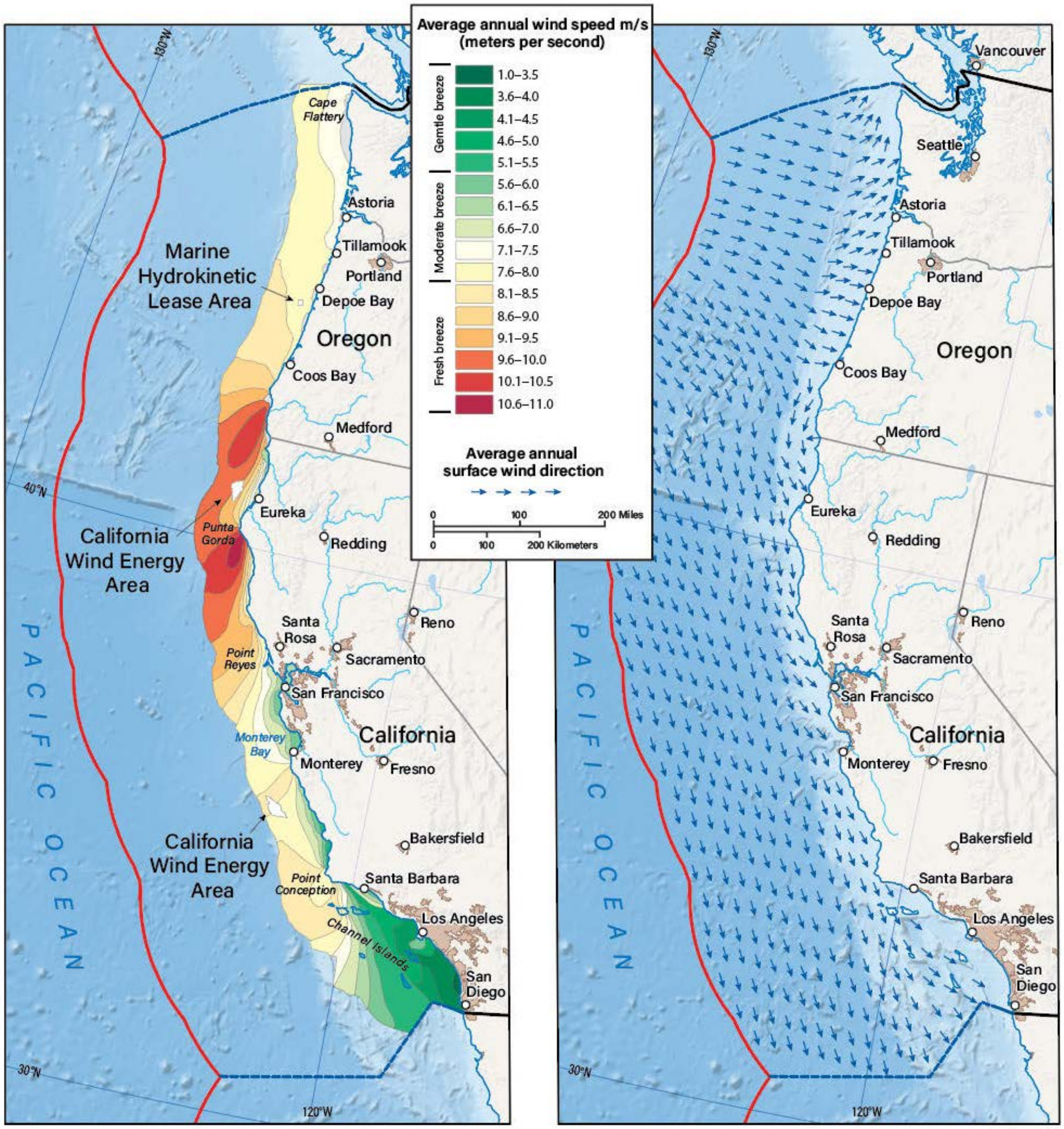


FIGURE 3-10 Average annual wind speed (m/s) at 100m above the surface (*left*) and wind direction (*right*) in covered waters off the West Coast.
SOURCE: Created by International Mapping, based on data from Draxl et al., 2015.

productivity and hence the living marine resources and their use. The locations of usual and accustomed resource used by Tribes and fishing communities are related to these spatial characteristics of the CCE. Winds, upwelling, water temperature, and dissolved oxygen vary over days to decades, including storms, El Niño and the Pacific Decadal Oscillation, which again affect living marine resources (Checkley and Barth 2009). Heat waves are increasingly common (Marcos *et al.,* 2025). Long-term changes in climate overlay all other variations. Poleward shifts in species and, hence, their availability to and use by humans, are predicted (Liu *et al.,* 2023).

FOW installations will extract wind energy from the CCE. A discussion of wind wake effect and the removal of energy by FOW is presented in Chapter 5. The energy extraction from FOW may further impact the variability of upwelling. See Chapter 7 for the potential impact of FOW projects on upwelling.

Conclusion 3-1: The high productivity of the CCE is dependent upon the predictable seasonal upwelling patterns, which affect nutrient availability, primary productivity, and species distribution. The upwelling patterns are subject to natural variability and longer-term changes in climate.

CURRENT AND FUTURE SHIFTS IN FISH STOCKS

Understanding species response to changing oceans is critical to understanding how ORE will influence fisheries access, catches, and yields. The establishment of ORE projects off the west coast will shift fishing effort to other areas resulting in increased competition and pressure in those areas. To understand how ORE will impact West Coast fisheries requires an understanding of how West Coast species are responding to and will continue to respond to changing ocean conditions.

Marine species in the CCE exhibit substantial changes in response to short-term, episodic shifts, like marine heat waves, and longer-term shifts in ocean temperatures. All major species groups—groundfish, CPS, salmon and HMS—are experiencing these changes. The most readily observable responses to changing ocean conditions are species distributions, that is, where species are likely to be found at the surface or in the water column (Liu et al., 2023). However, species responses to changing ocean conditions can also lead to other less readily observable, but equally influential, changes, such as variation in abundance, shifts in weight at age, variability in maturity, or greater interspecific competition due to increased species overlap (Hinchliffe et al., 2025; Head et al., 2025; Daly et al., 2024). These impacts have been observed across a wide range of marine species, from myctophids to humpback whales, using an equally wide range of methodological approaches including retrospective forecasting, simulation modeling, climate vulnerability analyses, and climate projections. Changing ocean conditions may increase habitat availability for some species, while decreasing available habitat for others. Species responses to changes in ocean conditions have been found to have significant direct (changes in fishing areas and catch) and indirect (increased bycatch of protected species) effects on fisheries on the West Coast (Santora et al., 2020, Frawley et al., 2025, Lezama-Ochoa et al., 2024).

Conclusion 3- 2: Many studies indicate that various fish species, including groundfish, coastal pelagic, salmon, and highly migratory stocks, are already responding to changing ocean conditions with shifts in distribution. Distribution shifts may be poleward, shoreward or seaward, or may occur within the water column, depending on the species and how their habitat availability is affected by ecological changes.

Conclusion 3-3: Further ongoing studies are needed to monitor how changing ocean conditions are affecting habitat availability for marine species and fisheries.

Future Stock Distributions

Consistent with climate impact analyses in other ocean regions (O'Leary et al., 2022, Vestfals et al., 2019), CCE system species have demonstrated significant changes in overall distribution, often reported as center of gravity, in response to changing ocean conditions. These observable changes are likely accompanied by other less readily detectable shifts in abundance, recruitment, and other demographic shifts. Analyses of data over the last

25 years have consistently found that fish species have already exhibited significant responses to both episodic and long-term shifts in ocean conditions. Box 3-4 describes how modeling is used to understand these shifts and predict changing climate conditions. Many, but not all, species have exhibited a northward shift in distribution, e.g., swordfish (Lezama-Ochoa et al., 2024). For some species, shoreward or deeper shifts have also been observed, particularly in response to episodic warming events. Over the past 25 years, commercially important juvenile sablefish have exhibited a significant nearshore expansion in Oregon and Washington (Daly et al., 2024). Humpback whales have exhibited episodic shoreward compression in response to marine heat wave (MHW) conditions between 2014-2016 (Santora et al., 2020). Similar shifts have been noted in the water column, e.g., mesopelagic forage species have been found to shift their vertical distributions in response to marine heat waves (Iglesias et al., 2024).

The combination of changing ocean conditions, increased variability and intensity of pulse climate events, recovering fish stocks and protected species populations, and active fishing fleets point to significant impacts on fisheries from changing climatic conditions. Shifting species distributions have been found to have a substantial impact on fisheries yield, although the direction of the effect differs among fleets (Liu et al., 2023). The impact

BOX 3-4
Modeling Approaches

Retrospective forecasting

Empirical ocean and species data collected since the mid-1990s have provided an opportunity to conduct retrospective forecasting of how species distributions, both at surface and at depth, and movement patterns have already changed over the past 25 years. Retrospective forecasting commonly uses species distribution models (SDMs) that explore relationships between species occurrences and ocean conditions. These retrospective analyses serve as a robust foundation for the projected shifts that are likely to occur in the upcoming decades based on global and downscaled regional climate models. A number of SDMs have been developed to characterize distributions of target, bycatch and protected marine species in the CCE system (Smith et al., 2023, Lezama-Ochoa et al., 2024).

Simulation models

Simulation models provide another way to incorporate data on ocean physics, species ecology and fisheries dynamics. There is a CC system-specific, spatially-explicit simulation model that considers how species groups change dynamically in response to ocean conditions and evaluates how that influences the demography, recruitment, trophic interactions and fisheries catches of species (Liu et al 2023).

Climate Vulnerability Assessments

Impacts of changing ocean conditions have also been assessed using climate vulnerability assessment (CVA) frameworks. CVAs adopt a synoptic approach to systematically evaluate the exposure, sensitivity, and adaptive capacity of species to projected changes in ocean conditions, leveraging all available information on a species life history, biology, and ecology (Frawley et al., 2025).

Climate Projection Models

Building on the strong foundation of historical data, climate projection models, which pair global or downscaled regional climate models with in-situ biological data, have also provided key insights into the impact of climate change on fisheries-relevant species. Downscaled regional climate models facilitate the integration of important and specific regional-scale features, which are usually missing or poorly represented when using global models (Pozo Buil et al., 2021). To account for uncertainty in projecting future climate conditions, it is common to use multiple climate models and compare output among the models, e.g., the Geophysical Fluid Dynamics Laboratory (GFDL) ESM2M, Institut Pierre Simon Laplace (IPSL) CM5A-MR and the Hadley Center HadGEM2-ES (Brodie et al., 2022).

of changing ocean conditions on fleets is both direct and indirect. Recent analyses indicate that some West Coast fisheries have been negatively affected by changing ocean conditions over the past 15 years (Wang et al., 2022). A review of groundfish response to climate change suggests some groundfish stocks are shifting northward and to deeper waters, which may negatively affect fishing access. (Liu et al., 2023). Albacore and swordfish, two other commercially important HMS, have also shifted northwards which has had implications for fisheries catch (Lezama-Ochoa et al., 2024, Smith et al., 2023). A recent analysis suggests that albacore landings are likely to decrease in Southern California but may increase or remain stable in other West Coast areas (Smith et al., 2023). Swordfish distribution may have expanded in response to the changing ocean (Lezama-Ochoa et al., 2024). Many other target species of West Coast fisheries have been identified as highly vulnerable to climate impacts (Frawley et al., 2025). There have also been negative impacts of climate change on Dungeness crab fisheries in California (Santora et al., 2020). The shoreward compression of whale habitat and their forage species resulted in an unprecedented spike in the number of confirmed whale entanglements in fixed gear buoy lines from multiple fisheries, during the 2014-2016 marine heat wave.

When analyzing fishery impacts from ORE development, consideration must be given to how distributions of commercially and recreationally important fish stocks will continue to change and shifts in response to ongoing changes in ocean conditions. For example, in 2014 the population of Pacific Bluefin tuna was estimated to be roughly 2.6 percent of its unfished biomass (Craig et al., 2017). Thanks to effective management measures, Pacific Bluefin achieved its rebuilding targets ten years earlier than anticipated. Recovery of the stock and changing ocean conditions has resulted in it being commercially and recreationally available well outside its historic range. This example shows that fisheries with no historic activity within an area deemed suitable for ORE development may shift to occur in that area in the future.

How ongoing and intensifying shifts in ocean conditions and stocks will impact fisheries ultimately will depend on how fleets are able to respond to these changes. This ability to adapt and respond to changes may further be compromised by ORE development. For example, there may be different implications and impacts depending on whether vessels adapt in place to take advantage of changing portfolios or whether fleets can adapt by continuing to follow the shifting distributions (Samhouri et al., 2024; Frawley et al., 2021). These fleet responses will also be directly influenced or dictated by ORE development.

In 2024 NMFS published a strategic science plan for the West Coast that identifies their priorities for research to understand interactions between ORE development and fish, fisheries, and their habitats. Research priorities include ecosystem and climate interactions to distinguish between effects from ORE development and climate variability and change, impacts to fisheries and fishing communities, and species abundance and distribution (NMSF, 2024b). These research areas can help understand the impacts and opportunities for ecosystem monitoring as ORE projects are developed. Further discussion of ORE effects on fisheries and fishing activity can be found in Chapter 7.

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4

U.S. Coast Guard Operations and Safety Considerations

The Coast Guard conducts extensive West Coast operations that directly impact commercial fishing vessels through a comprehensive framework of safety, security, and regulatory activities. This chapter documents current Coast Guard operations relevant to ORE development, focusing on describing systems, operational capabilities, and documented performance metrics relevant to commercial fishing vessels, as directed by the Committee's task described in Chapter 1 and in Box 1-1. This overview provides a baseline of Coast Guard activities on the West Coast that may intersect with commercial fishing vessels and ORE programs, and this baseline is reasonably applicable to Tribal and recreational fishing as well. The chapter uses a commercial fishing vessel context to present information about SAR coordination, navigation infrastructure including ATON and vessel traffic schemes, fisheries enforcement partnerships, and marine environmental response capabilities. A comprehensive evaluation of Coast Guard effectiveness, resource allocation priorities, and alternative safety paradigms is beyond the scope of this study. Discussion of interactions between Coast Guard operations and ORE development is in Chapter 7.

SEARCH AND RESCUE

The Coast Guard's SAR program aims to save lives and protect property in waters around the United States. When emergencies occur, SAR missions follow four main steps:

- Monitoring and communication—detecting distress calls and maintaining contact
- Search planning—determining where and how to look for people in trouble
- Search coordination—managing multiple rescue units and resources
- Rescue operations—saving people and property

SAR is a shared responsibility, with privately-owned vessels and federal, state, local, and Tribal governmental agencies contributing to the overall effort coordinated by the Coast Guard.

The Coast Guard has broad legal authority to conduct SAR in U.S. waters and on the high seas, but this authority recognizes that Coast Guard boats, cutters, and aircraft may at times be unable to safely respond to distress calls. Accordingly, while the Coast Guard is generally required to coordinate a response following its response procedures, it may not be able to physically respond. The law states the Coast Guard "shall" maintain rescue facilities, and the service maintains strict standards for responding to help people in distress. Once the agency determines a rescue mission can be safely and reasonably attempted and commits to undertaking the mission, the Coast Guard is legally bound to act with reasonable care. The Coast Guard aims to position rescue units so they can reach most locations within their assigned area within two hours of being notified. This includes 30 minutes to prepare and launch, plus 90 minutes' travel time at normal cruising speed under good weather conditions. This is a planning goal, not a legal guarantee of a physical response, and actual response times may be longer due to bad weather, dangerous conditions, or other circumstances (USCG, 2025c).

The West Coast is divided into two large rescue regions—one centered in California and one in Washington State—with local Coast Guard cutters, small boat stations, and air stations handling individual emergencies under the oversight of regional command centers (see Figure 4-1). RCC Alameda coordinates SAR missions in the U.S.

FIGURE 4-1 U.S. Coast Guard units on the West Coast.
SOURCE: Created for the committee by International Mapping.

Coast Guard Southwest District, covering California's coast; RCC Seattle coordinates missions for the U.S. Coast Guard Northwest District, covering Washington and Oregon. Each RCC organizes and coordinates all SAR operations in its region, manages both boat and aircraft emergencies, and oversees multiple local Coast Guard Sectors along the coast. These Sectors, located in San Diego, Los Angeles, San Francisco, Humbolt Bay, Portland (Sector North Bend), and Seattle (Sector Puget Sound), have their own command centers that handle day-to-day rescue operations in their local area, control rescue boats and helicopters, and report to and coordinate with their primary RCC. This creates a coordinated system from local to regional levels for managing water and aviation rescues.

According to the Coast Guard's profile of incidents, over 95 percent of SAR cases are within 20 NM of shore and roughly 90 percent involve assistance or rescue with no searching (USCG, 2025c). When there are searches, 8 percent are considered minor, with less than 24 hours of searching, and 2 percent are major with over 40 hours of searching.

The PAC-PARS study reported that on the West Coast of the continental United States, from 2014–2024, over 35,000 SAR cases occurred between shore and seaward to 200 NM. Of these cases, 80 percent occurred within 12 NM of shore (USCG, 2023a). The most common types of distress were disabled vessels (accounting for one third of all cases), followed by distress alerts (which do not always progress into actual SAR cases) and a person in the water (whether from falls overboard or from the shore). Along the U.S. West Coast winds predominantly blow toward shore, which typically cause vessels that lose propulsion to drift toward shore.

Commercial Fishing Vessel Search and Rescue

The number of commercial fishing vessel emergencies and associated losses of life have fallen dramatically since the early 1980s, when almost 250 vessels and 50–80 lives were lost annually. In 2018, the nationwide average had fallen to 25 vessels and 11 lives lost per year (USCG, n.d.-b). Nevertheless, emergencies at sea remain a serious risk for commercial fishermen off the West Coast. The Coast Guard reported to the PFMC that between 2014 and 2023, approximately 47 lives were lost in emergencies at sea (USCG, 2024b). The Centers for Disease Control and Prevention reported in 2018 that between 2000 and 2016, 204 commercial fishermen accidentally fell overboard and died across the country, 26 of those along the West Coast (Case et al., 2018). The study also found that none of the victims were wearing a personal flotation device (PFD) when they went overboard.

Given the predominant cold water conditions off the West Coast, falls into the water can be lethal.[1] Several variables affect the time a person in the water remains functional (for instance, able to use their hands) or can survive. The Coast Guard developed a model that includes factors such as water temperature, estimate of personal health and fitness, type of clothing worn, and type or lack of PFD to inform probability of survival and inform the Coast Guard's search plan.

Throughout 2023, Coast Guard operations responded to 3,321 SAR cases along the West Coast in both coastal and inland waters (USCG, 2024b). Commercial fishing vessels were involved in 258 of the cases, where the Coast Guard saved 17 lives. Four lives were lost along the West Coast which is slightly lower than the Coast Guard–reported average of 4.7 lives lost per year. Additionally, 9 commercial fishing vessels were classified as a "total loss" from either grounding or sinking.

Generally, SAR off the West Coast is seasonal, with peak activity starting in April and ending in mid-September, ahead of the recurring early October major storm events. Fairer weather and calmer seas tend to draw more vessel traffic and in turn increase SAR cases. Distress calls and rescues still occur in the heavy weather seasons and are often higher profile given their occurrence in extreme weather conditions. Heavy weather rescues can

[1] The U.S. Coast Guard's (2025) Search and Rescue Addendum notes that "there are four stages of immersion in which death can occur in cold waters. (1) The initial Cold Shock Response can kill within 1-3 minutes of immersion by respiratory or cardiac problems leading to drowning or sudden death. (2) Cold Incapacitation can kill with 5-30 minutes of immersion by impairing physical performance, thus leading to the inability to self-help, swimming failure, and then drowning. (3) Hypothermia occurs after 20-30 minutes of immersion and will progress until shivering stops and unconsciousness occurs. This will lead to drowning if the head is not held above water, or eventual cardiac standstill if the head is held above water. (4) Circum-Rescue Collapse can occur just prior to, or during, rescue. It can also occur minutes to several hours post-rescue."

include breaking surf and extreme seas, and involve towing large fishing vessels in distress, often over the bar.[2] Most often used in commercial fishing vessel towing cases, the Coast Guard's fleet of 52 ft boats built in the 1950s became increasingly unreliable and difficult to maintain and were recently retired (Shipman, 2025). The Coast Guard awarded a contract to replace these boats with six new Special Purpose Heavy Weather craft, prospectively to be stationed in the Pacific Northwest (USCG, 2025a).

Distress Communications

The most common and preferred method for vessels to call for help is by VHF marine radio on Channel 16, the international distress frequency that Coast Guard units monitor continuously. Newer digital selective calling (DSC) radios send digital distress alerts containing the vessel's position and nature of the emergency. These calls are conducted through the National Distress and Response System, which is the Coast Guard's main communication system for detecting emergency calls and coordinating rescues in U.S. coastal waters. The system's radio network can reliably receive distress calls from most boats with standard equipment within 20 NM of shore around major U.S. coastlines at least 90 percent of the time (USCG, 2025c). When a distress call comes in, it is picked up by the nearest Coast Guard Sector command center, where trained watchstanders monitor for distress calls. The Coast Guard's Rescue 21 system of coastal radio towers can pinpoint where distress radio broadcasts are coming from using direction-finding technology.

The Global Maritime Distress and Safety System is an international framework that combines various communication methods for vessels in different ocean areas. For vessels close to shore (Sea Area A1), VHF radio and DSC provide primary coverage. Further offshore (Sea Area A2), medium-frequency radio systems extend the range. In remote ocean areas (Sea Area A3), satellite communication systems like Inmarsat become essential, allowing vessels to send distress alerts, receive safety information, and maintain two-way communication with rescue centers anywhere in the world.

The Coast Guard relies on these systems for two-way communication. For example, the Coast Guard can broadcast urgent information to vessels through SafetyNET, a satellite-based messaging system that reaches ships globally (USCG, 2025c). This communication capability is frequently used to coordinate mutual assistance for vessels in remote areas, where another commercial vessel may be the closest responder.

Emergency position indicating radio beacons (EPIRBs) are critical safety devices that work through the international COSPAS-SARSAT satellite system. EPIRBs are registered to specific vessels, so the Coast Guard immediately knows details about the boat and its owner, though compliance with maintaining registrations is a persistent problem. When activated, these beacons send distress signals with the beacon's precise GPS location to ground stations, which then forward the information to Coast Guard RCCs. Similar devices include emergency locator transmitters for aircraft and personal locator beacons for individual use—all working through the same satellite network to provide worldwide emergency coverage.

As was true over 30 years ago when the Coast Guard launched its modern commercial fishing vessel safety program, commercial fishing operations rely extensively on advanced communication technologies. Electronic navigation, communications, and fish-locating equipment fills many gaps (NRC, 1991). Beyond the challenge of a vastly diverse communications array in the fishing fleet, communication technology creates challenges for crew familiarization, training, and increased possibility of human error. Recent research indicates how important effective onboard interpersonal communication can be, both internally and in distress communication. In recent years, language barriers leading to communications problems have impacted marine safety (Suresh and Krithika, 2023). Studies address broader maritime communication issues or focus on international shipping, which leaves gaps related to commercial fishing operations around

[2] Maritime bars are shoals of sand, gravel, or silt across the entrance to a river, harbor, or bay where freshwater meets the ocean. The strong outflow of river water meets Pacific swells and tides, producing breaking waves, turbulent currents, and shifting sandbars that make crossing these bars one of the most challenging tasks for mariners in the region. In the Pacific Northwest, bars are most pronounced at river mouths such as the Columbia River, Grays Harbor, Tillamook Bay, Rogue River, and others along the Oregon and Washington coasts.

- Communication challenges specific to small-scale fishing operations,
- Technology adoption rates and effectiveness in fishing vessel communications both for navigation safety and for distress communications,
- Training effectiveness for multilingual fishing crews, and
- Regional variations in communication difficulties across U.S. fishing grounds.

Search Planning

To conduct search planning the Coast Guard uses a software system, Search and Rescue Optimal Planning System (SAROPS) that interfaces with Esri's ArcGIS platform (USCG, n.d.-g). SAROPS allows Coast Guard watchstanders to input specific information about the search case including search object (e.g., person in the water, vessel by type, life raft), search asset (e.g., Coast Guard cutter, small boat, helicopter), environmental factors, other information including last known position, and details about the search object. An important input to SAROPS is data from an environmental data server (EDS) real-time gridded environmental product.

SAROPS uses a Monte Carlo–based simulation to model the drift of thousands of simulated particles (search objects). After simulation, the program identifies probable locations of where the search object may have drifted, based on time since last known position, weather, and environmental conditions. Then SAROPS creates search patterns for each Coast Guard asset assigned to the case that maximizes the probability of success (POS). POS considers the likelihood that the search object is within the defined search area (probability of containment or POC) and the likelihood that the search object will be detected (probability of detection or POD). The POD considers the likelihood that the search object will be seen by the SAR unit given visibility, sea state, search pattern characteristics, the detection capabilities aboard the unit, and human error. Overall, the POS in locating a search object equals the POD times the POC. Watchstanders have some ability to modify search patterns based on local knowledge and prevailing weather conditions that may affect searching (e.g., swell direction, visibility including sun glare, deteriorating or improving weather conditions). SAROPS can also account for previously completed search patterns and generate new plans.

Accurate environmental data input into SAROPS is critical for effective search planning and detection. Both wind and current data are fed into SAROPS from modeled sources, high-frequency (HF) radar observations, or current on scene conditions (from buoys deployed by Coast Guard search units). Traditionally, Coast Guard crews deployed buoys to measure current speed and direction in the search areas. These direct measurements are still widely used, but HF radars measure larger areas with the detail needed for search planning. EDS draws heavily on NOAA data systems, notably the HF radar systems that are part of the Integrated Ocean Observing System. HF radar measures coastal currents from near shore to about 100 NM offshore and operates in all weather conditions (IOOS, n.d.). The Coast Guard first integrated HF radar data into SAROPS in 2009. While this HF data has been imported into SAROPS on the Atlantic Coast through EDS, this enhancement has not yet been fully incorporated on the West Coast. Still, there are HF stations along much of the California and Washington Coast (Harrison, 2025; Terrill et al., n.d.). Recent reporting suggests proposed cuts to NOAA's Integrated Ocean Observing System regional observations, which might reduce or eliminate funding for many HF radars, buoys, and other sensors that feed surface current and wave data (SECOORA, 2025). The proposed cuts may impact the reliability and timeliness of EDS inputs, that could cause degradation to Coast Guard SAROPS modeling.

Three factors are particularly significant for commercial fishing vessels when considering POD. First, detection is greatly enhanced by signaling devices, lights, and AIS or VMS. Second, detection is profoundly affected by the size of the object in the water. A person in the water presents a small profile as only the person's head may be visible at the surface, which is harder to detect than a drifting vessel or life raft. Searching for a person in the water requires close track-spacing, meaning the SAR units must make many passes with narrow sweep widths to get 100 percent coverage through a search area (Harrison, 2025). For helicopter searches, the size of the object also necessitates varying altitudes for an effective search, ranging from 200 to 500 ft for a person in the water compared to 1,000 to 3000 ft for a medium-sized vessel like a commercial fishing vessel (USCG, 2025b, Table H-8). Third and finally sea state and visibility greatly affect POD; the worse the visibility, the narrower the sweep width. Similarly, SAR units may deviate from the planned (and optimized) search pattern to accommodate a variety of factors, most commonly the direction of prevailing seas and waves. Managing the degree of roll on board a small boat is vital to the crew's ability to conduct adequate searches and to the duration of time the crew can endure on-scene searching before becoming ineffective.

Search planning for commercial fishing vessels is challenged by three principal factors: (1) the enormous variance in the size, distress communication, and configuration of vessels; (2) the proprietary nature of commercial fishing locations; and (3) frequent lack of detailed information about a specific commercial fishing vessel, which increases the complexity in selecting the correct drift object configuration for the search. The first challenge presents the Coast Guard with a wide range of scenarios—no two commercial fishing vessel SAR cases are alike, with smaller, less heavily equipped vessels presenting the greatest difficulty for planning an effective search. The second challenge makes search planning difficult because the specific areas in which a commercial fishing vessel frequently operates are either unknown or vary significantly. A fishing vessel reported overdue may not have a known trackline where SAR units can search, so the unit would need to cover an entire fishing area that may not be well known to people not on the missing vessel. The third challenge, lack of detailed information about the missing vessel, presents complexity for search planners in selecting a drift object that accurately represents the vessel. The more accurate the drift information, the higher the likelihood of SAR mission success.

Search Coordination Involving Commercial Fishing Vessels

During SAR operations after the action plan has been completed and search patterns delivered to responders, the Sector or RCC assumes a monitoring and guidance role, ensuring that the search plan is received, understood, and followed by all responders. In fact, while searches are ongoing, the command center staff usually plans subsequent searches based on updated information and the assumption that the ongoing search will be unsuccessful (USCG, 2025c). Importantly, the SAROPS system updates its calculations of drift and probable locations based on planned and conducted searches. While overwhelmingly helpful in optimizing the search effort, the current system is limited by lack of data input from SAR assets. Without the ability to import position data to define exactly how the SAR units on-scene adjusted the search pattern, SAROPS simply assumes the search pattern was conducted as planned. Given the extensive modification of search patterns required to account for seas, winds, physical obstructions, and water depth, Coast Guard operational personnel perceive SAROPS's inability to import geo-position data from their helicopters, boats, and cutters as a major limitation.

The Coast Guard search plans coordinate all available responders, not only Coast Guard, federal, or governmental SAR units. Long-standing maritime custom, international law, and U.S. law obligate mariners to render assistance to each other within reasonable bounds. With regard to search coordination, the Coast Guard generally asks these good Samaritan responders to rescue people from the water, prioritizing victims not wearing life jackets first; establish contact with a distressed vessel master, and assist as requested within the Good Samaritan's vessel and crew capability; establish and maintain contact with the Coast Guard for search coordination purposes; and assume the on scene coordinator role if first on scene, which involves taking control of other arriving vessels and coordinating rescue actions until relieved by the SAR mission coordinator.

Commercial fishing vessels in particular can benefit from mutual fleet assistance. The Coast Guard sponsors the Automated Mutual-Assistance Vessel Rescue System, a worldwide voluntary reporting system that encourages ships to share detailed sailing plans and positions to assist in SAR efforts. SAR mission coordinators use this system to arrange assistance to people in distress, including fishing vessel rescues. Commercial fishermen frequently engage in smaller, informal versions of mutual assistance, like a buddy system, for vessels operating on similar voyage routes and in proximity.

Rescue Operations involving Commercial Fishing Vessels

The Coast Guard follows policy and procedure with detailed guidance on SAR operations in various distress scenarios. For commercial fishing vessels on the West Coast, the Coast Guard has detailed operational guidance on assistance towing. In emergencies, the Coast Guard responds immediately using whatever resources are available —Coast Guard cutters, boats, or helicopters, Coast Guard Auxiliary volunteers, or commercial towing companies.

For nonemergency situations (e.g., disabled vessel not in danger) the Coast Guard follows a "private enterprise first" approach. If a commercial towing company, marina, or private sector vessel can reach the disabled boat within about an hour, the Coast Guard will monitor and coordinate the response but will not generally launch its own boats, cutters, or helicopters. The Coast Guard focuses on life-threatening emergencies while encouraging private enterprise to handle routine breakdowns and assistance calls, ensuring that resources are used efficiently while maintaining fair competition in the marine assistance industry. Commercial towing is typically available along the Pacific Coast for smaller vessels but may not be available for larger commercial fishing vessels or may not be timely, depending on distance offshore, remoteness of the location, or extreme weather. This, in part, explains the Coast Guard's emphasis on the new special purpose heavy weather craft; its predecessor fleet of heavy weather craft were frequently involved in towing large fishing vessels, tows far offshore, and in heavy weather.

Helicopter hoist rescues are extremely dangerous because the helicopter's rotors generate hurricane-force winds that can turn any loose debris into deadly projectiles that could be sucked into the jet turbines, potentially shutting down engines and threatening the lives of rescuers. The powerful rotor wash creates significant static electrical charges that can injure anyone who touches rescue equipment before it properly discharges on the deck. The downward force can also blow crew members overboard or cause serious injuries from flying objects.

The precision required for successful hoist operations adds another layer of danger, as pilots must maintain exact positioning while crew members coordinate complex maneuvers in chaotic conditions. Poor visibility, pitching or rolling seas, and impaired depth perception make night operations particularly hazardous, requiring careful lighting coordination to avoid blinding the flight crew with inappropriate illumination (Harrison, 2025; Jackson, 2025).

The rescue process itself involves multiple critical safety protocols—from securing patients properly in litters to prevent limb injuries against the helicopter's side, managing trail lines to prevent fouling, and ensuring crew members never tie hoist cables to the vessel. Helicopter hoists from commercial fishing vessels are extremely dangerous for a variety of reasons; commercial fishing vessels rarely have open deck space perfectly suited to transfer areas when a medical evacuation is needed, the vessel is pitching and rolling in the seas, lighting is poor at night, and many commercial fishing vessels have masts and other hoist-cable entanglement risks. Such rescues require extraordinary aircraft team dynamics, coordination, and communication, even under optimal circumstances (Pollitt, 2023). Coast Guard air and small boat crews practice relentlessly to avoid fouling the hoist line. If a hoist line becomes entangled, the air crew may have only seconds to cut the metal hoist cable; the consequences of entanglement could include failure to complete the medical evacuation rescue, blade strikes, loss of aircraft control, and possibly ditching or crash landing in the water (GAO, 2022).

Commercial Fishing Vessel Safety

To address industry hazards, the Coast Guard develops and implements policies and regulations to help ensure commercial fishing vessel safety. At the Sector level, the Coast Guard conducts vessel safety examinations in port, checks safety requirements while conducting at sea boardings, assists vessels in distress, investigates vessel accidents, and generally promotes accident prevention and safety measures through awareness and education for commercial fishing participants (USCG, n.d.-c). In 2022 the GAO evaluated the Coast Guard's commercial fishing vessel safety program. The GAO report concluded the agency implemented many safety improvements but found it had not fully implemented 17 key statutory requirements related to commercial fishing vessel safety enacted into law between 2011 and 2021 (GAO, 2022). The most notable included an alternate safety compliance program that the GAO concluded would improve the safety of older vessels, which have made up almost 80 percent of commercial fishing vessel losses in recent years (GAO, 2022).

Navigation Safety and Waterways Management

The Coast Guard conducts activities and operations under the broad rubric of waterways management, including maintaining navigation safety and managing the nation's vast ATON system (USCG Pacific Area, n.d.-a). Apart from the ATON system, commercial fishermen on the West Coast are primarily impacted by Coast Guard efforts to maintain safe and efficient port access routes, and to balance safety and the competing needs of waterway users (discussed in Chapter 2).

Within the territorial sea and federal inland waterways, the Coast Guard may also establish regulated navigation areas, safety zones, and security zones that affect commercial fishermen. Regulated navigation areas are specific water areas with clearly defined boundaries, inside which vessels must navigate in ways that control vessel traffic around specific and usually long-standing hazardous conditions. For more transitory or temporary safety or security concerns, the Coast Guard may enact safety or security zones on the water that control access to an area or impose specify temporary operating conditions inside the zone. Safety zones are often restricted to within the territorial sea, but they may be extended or established to include areas around an OCS facility (USCG, n.d.-f).

Although data is imperfect for smaller commercial fishing vessels, the PAC-PARS analyzed VMS data for the study area out to 200 NM offshore from 2017 to 2020. The Coast Guard created a map of commercial fishing vessel densities and compared those densities to AIS data to validate fishing vessel activity within the study area (USCG, 2023a). Importantly for commercial fishermen, the PAC-PARS validated the Crabber/Towboat Lane Agreement (Box 2-1) of 1971. This agreement deconflicted commercial fishing and towing uses of the waterway by providing navigable towboat and barge lanes through the crabbing grounds between Cape Flattery, Washington, and San Francisco. The Coast Guard's traffic analysis found that a significant portion of tug and tow vessels appeared to follow the crabber-towboat lanes when transiting along the West Coast.

Aids to Navigation

The Coast Guard manages a massive network of nearly 46,000 navigation aids across the U.S. territorial seas, including the roughly 1,924 fixed aid structures and 846 floating aids along the continental West Coast (GAO, 2020). These include lighthouses, ranges, and day-boards, as well as floating buoys marking fair water[3] for the marine transportation system. In early 2025 the Coast Guard's Northeast District Coastal Buoy Modernization Proposal—now suspended—proposed removing 350 navigational aids along portions of the Northeast coast (roughly from New York harbor to the Maine/Canada border; USCG, 2025e). More broadly, the Coast Guard's fiscal year 2026 President's Budget Shore Facilities and Aids to Navigation procurement, construction, and improvements program project or activity request is $21.3 million, down from $187.5 million in fiscal year 2025—a proposed decrease of $166.2 million, with potential significant impact to the program and number of ATON, if enacted at that level (USCG, 2025d).

The Coast Guard may establish aids to maritime navigation "required to serve the needs of the armed forces or of the commerce of the United States," provided that "aids to navigation other than electronic aids to navigation systems shall be established and operated only within the United States, the waters above the Continental Shelf, the territories and possessions of the United States, the Trust Territory of the Pacific Islands, and beyond the territorial jurisdiction of the United States at places where naval or military bases of the United States are or may be located."[4]

The ATON system covers about 25,000 mi of waterways, including rivers, harbors, and coastal areas serving all mariners, from commercial ships to recreational boaters. The ATON system is designed and updated through the Waterways Analysis and Management System (WAMS). Every five years, WAMS studies are conducted on areas deemed "Navigable Waterways," and aim to enhance safe navigation, anticipate and plan for budgeting, and ensure that the ATON system remains effective and efficient (USCG Pacific Area, n.d.-b). In conducting a WAMS study, the Coast Guard solicits waterway user input, rides various vessels to view the waterway firsthand, reviews existing navigational literature (charts, Coast Pilots, Light Lists, sailing directions, etc.), and gathers other input about the waterway. The additional input can include user data from the Nationwide Automatic Identification System (NAIS), changes to geological or physical characteristics that affect the waterway, economic trends, reoccurring accidents near navigational aids or in specific portion of a waterway, and sensitive military or environmental

[3] "Fair water" refers to the portion of a channel or waterway where vessels are expected to travel; water that is clear, safe, and unobstructed for normal vessel passage.

[4] 14 U.S.C. § 541(a)

issues (GAO, 2020). Although there is no quantitative analysis of the degree to which commercial fishermen rely upon the West Coast ATON system, there is evidence of commercial fishing input to WAMS, and of Coast Guard consideration of conflicts with commercial fishing areas in the territorial seas (USCG, 2023a).

The Coast Guard is also responsible for ensuring navigation aids are working properly and are in the right places. This includes maintaining lights and signals, and replacing buoys, anchors, and chains that have been damaged by storms or wear and tear. A 2018 estimate calculated that replacing all of these navigation aids would cost about $1.6 billion, which places in context how valuable and extensive this system is. The Coast Guard also oversees private navigation aids that individuals or companies install, and those ATON maintained by Tribal, state, and local governmental authorities (GAO, 2020).

Living Marine Resources and Fisheries Law Enforcement

Commercial fishermen rely on two related Coast Guard activities: one directed at enforcing fisheries measures under an international treaty outside the U.S. EEZ, and the second directed at enforcing U.S. fisheries and living marine resource measures within the EEZ, territorial sea, and inland waterways. The Coast Guard enforces fisheries laws in partnership with NMFS, providing the at-sea law enforcement presence to complement NMFS and state management (Departments of Fish and Wildlife for California, Oregon, and Washington) and enforcement efforts for fisheries conservation.

In its 2024 report to the PFMC, the Coast Guard noted that it was experiencing a significant workforce shortage and could not maintain past levels of effort on fisheries enforcement. Managing the shortfall required the Coast Guard to reallocate personnel and assets from outlying small boat stations to more centralized locations, to accelerate the decommissioning of cutters, and to change the manning and mission standards. The primary method of fisheries enforcement on the West Coast was through Coast Guard Cutters who patrolled for over 6,500 hours in 2023, compared to the combined patrolling effort from aircraft and small boats of 1,907 hours in 2023 (USCG, 2024b). In 2023, the Coast Guard conducted more than 1,500 commercial and recreational fisheries boardings off the West Coast, with 20 percent occurring on commercial fishing vessels. These boardings resulted in 23 fisheries violations by commercial vessels, 249 safety violations, and 31 fishing voyage terminations from both commercial and recreational participants (USCG, 2024b).

The Coast Guard relies primarily on patrol boats to conduct the surface fisheries law enforcement patrol mission; these patrols are conducted by the 87 ft Coastal Patrol Boats, 110 ft Patrol Boats, and 154 ft Fast Response Cutters. In California, this includes eleven 87 ft Coastal Patrol Boats located at coastal ports throughout California and four 154 ft Fast Response Cutters in San Pedro (USCG, 2018b; USCG, 2023b). In Washington and Oregon, this includes seven 87 ft Coastal Patrol Boats located in Salish Sea ports, as well as one 110 ft Patrol Boat homeported in Port Angeles, Washington, and one in Coos Bay, Oregon. The 154 ft Fast Response Cutters bring significant new capability including longer unsupported patrol lengths, SAR capability, and the ability to launch boarding teams in higher sea state conditions. The Fast Response Cutters do have a relatively limited towing capability relative to some commercial fishing vessels. Commercial fishing vessels operating off the West Coast—including large tuna boats, crab vessels, and factory ships—can be over 100 ft in length and displace hundreds of tons, requiring significant towing capacity. Coast Guard buoy tenders also conduct fisheries enforcement patrols; California buoy tenders include one 225 ft Seagoing Buoy Tender homeported in San Francisco and one 175 ft Coastal Buoy Tender in San Pedro (USCG, 2018b). Washington and Oregon buoy tenders include a 225 ft Seagoing Buoy Tender homeported in Astoria, and a 175 ft Coastal Buoy Tender homeported in Everett, Washington. Two 210 ft Medium Endurance Cutters located in Astoria, Oregon and in Port Angeles, Washington also conduct West Coast fisheries patrols several times a year.

Air Station Sacramento typically provides medium range fixed-wing HC-27J Spartan aircraft for flights along the West Coast, but, in 2023 structural cracks to these Coast Guard aircraft resulted in an indefinite grounding that reduced patrol hours (Hooper, 2023). This condition has proven difficult to resolve, and the Coast Guard has indicated the HC-27J platform (all aircraft) is scheduled to be divested by late 2027 and will be replaced by at least 2 HC-130s at Air Station Sacramento. To provide some temporary relief, Air Station Kodiak deployed several HC-130J aircraft to Sacramento (USCG, 2024b). Because of the range of these aircraft, Air Station Kodiak, Alaska, maintains five HC-130Js.

Small boats from coastal stations primarily conduct SAR, but boat crews are trained in fisheries law enforcement and conduct patrols to enforce domestic fisheries and safety regulations. The Coast Guard has 14 stations along the California coast and 15 stations along the Washington and Oregon coasts and inland waters (USCG, 2024b).

Beyond patrols and enforcement boardings within the EEZ and territorial seas, commercial fishermen rely on Coast Guard enforcement on the high seas to prevent incursions of foreign fishing vessels into the U.S. EEZ. The Coast Guard works with the Department of State to monitor international laws and treaties, such as the United Nation's moratorium on large-scale high-seas drift-net fishing. The Coast Guard is also responsible for enforcing laws that protect marine mammals and all endangered species.

In 2024 the Coast Guard reported that these enforcement efforts specific to the West Coast were primarily associated with the international boundaries with Canada and Mexico. The Northwest District has a comprehensive multi-agency enforcement plan to deter illegal incursions into the U.S. EEZ, and the Southwest District undertakes similar operations along the U.S.–Mexico EEZ boundary. For example, the Coast Guard reports responding to multiple EEZ incursions on the U.S.–Mexico boundary line from Mexican fishing vessels in concert with NOAA's Office of Law Enforcement (USCG, 2024b). Similarly, the Coast Guard responded to reports of multiple Canadian whiting vessels operating near the U.S. EEZ off the coast of northwest Washington, but aircraft and cutters launched to investigate did not identify any active incursions. The Coast Guard reported in March 2025, however, that it tripled the number of forces—including aircraft, cutters, small boats, and crews—operating on the Pacific southwest maritime border in coordination with Department of Homeland Security partner agencies to detect, deter, and interdict irregular maritime migration and drug smuggling ventures. The Coast Guard has not explicitly stated what effect the reallocation of these assets will have on fisheries enforcement efforts along the Pacific West Coast (USCG, 2025b).

Marine Environmental Protection and Response

The Coast Guard's marine environmental protection and response operations affect commercial fishermen who are reliant on the health of the West Coast fisheries and their critical habitats and ecosystems. These diverse operations seek to prevent oil spills and hazardous chemical releases in U.S. waters, and to respond when spills do occur. The Coast Guard handles this mission through three main approaches: prevention operations, stopping spills and releases before they happen; preparedness, planning and training for when spills and releases do occur; and response, coordinating nation efforts, overseeing private responders, directly cleaning up spills and releases, and investigating what went wrong. The Coast Guard is the lead federal agency responsible for dealing with oil spills and hazardous material releases in coastal areas. It coordinates with other agencies and organizations through the National Response System, which is essentially a nationwide plan for handling environmental emergencies.[5]

The Coast Guard relies on a wide array of mission partners and the private sector, particularly where the agency lacks direct authority. For example, BSEE is responsible for overseeing the safety measures on offshore platforms, including renewable energy platforms, and for reviewing and approving their oil spill response plans, and NOAA provides scientific support including dispersant modeling and analysis of harm to the environment (OR&R, n.d.). The Coast Guard coordinates and cooperates extensively with BSEE and NOAA through the various Area Committees and documents agreed upon joint procedures in Area Contingency Plans. Additionally, Coast Guard waterways management, fisheries enforcement, and fishing vessel safety missions and operations rely heavily on effective, extensive cooperation with California, Washington and Oregon state agencies, who share authority and responsibility in these missions within their jurisdictions. Second, the Coast Guard's interlocking missions and operations complement one another, as can been seen in its enforcement of protection of marine protected areas, and in NOAA Sea Grant–led agreements, which keep bulk oil and chemical ships 50 NM offshore voluntarily (unless transiting into ports). Thus, while commercial fishermen are subject to Coast Guard (and partner agency) regulations and response plan requirements, they are arguably more significantly affected by the network of Coast Guard operations aimed at keeping other potential polluters from damaging fish stocks and critical habitats.

[5] 40 CFR Part 300. National Oil and Hazardous Substances Pollution Contingency Plan

Finally, the United States is party to extensive international agreements with both Mexico and Canada regarding oil and hazardous materials spills and releases, and engages frequently in joint drills and exercises to test the procedures agreed-upon between the three nations.

Ports, Waterways, and Coastal Security

Commercial fishermen encounter Coast Guard security operations, both on the territorial and inland waters, and within the EEZ. The Coast Guard defines its security mission as "the protection of the U.S. Maritime Domain and the U.S. Marine Transportation System and those who live, work or recreate near them" (USCG, n.d.-e). Although commercial fishermen rarely experience security boardings and other security operations directly targeted at them, they are affected by two aspects of security operations: moving and fixed Coast Guard security zones, and Coast Guard maritime domain awareness activities.

Maritime Domain Awareness

Maritime domain awareness includes anything that could impact the safety, security, environment, or economy within the United States marine area, and relevant operations include periodic or continuous surveillance, detection, classification, identification, and understanding (NIMO, 2023). These operations use awareness data from various sources including field intelligence, the NAIS, and America's Waterway Watch (USCG, n.d.-e). NAIS is recognized as a "global standard for ship-to-ship, ship-to-shore, and shore-to-ship communication" using shipboard AIS (USCG, n.d.-d). NAIS reached full capacity in the United States in 2018 and provides real-time data on vessels, including their names, speed, position, and charted course to more than 80 Coast Guard and other government agency systems (USCG, 2018a). The NAIS system also allows important safety and security messages to be shared with vessels in a port area including electronic ATON, safety and security zones. The Coast Guard's NAIS system can receive vessel transmissions from as far as 50 NM from transceivers on shore, and, when using satellite data, can expand its coverage to 2,000 NM (EPIC, n.d.).

AIS and VMS carriage requirements for commercial fishing vessels in U.S. waters vary by vessel size, fishery type, and operating area. As discussed in Chapter 2, fishing vessels that are 65 ft or more in length are required to carry AIS devices.[6] Any vessels equipped with AIS—whether mandatory or voluntarily—must abide by the requirements in 33 CFR 164.46, which includes that AIS must be properly installed and that its assigned Maritime Mobile Service Identity number be broadcasted, that its data must be accessible from the primary operating position of the vessel and that it always be in effective operating condition. NOAA Fisheries manages VMS in the United States to monitor the location and movement of commercial fishing vessels in the U.S. EEZ and treaty areas. VMS uses satellite communications, providing global coverage rather than being limited by VHF radio range. VMS is required on vessels with a limited entry "A" endorsed permit, any vessel that uses non-groundfish trawl gear in the EEZ, and any vessel that uses open access gear for groundfish in the EEZ[7]. Additional regional requirements apply to Alaska and Pacific Coast fisheries (NOAA Fisheries, n.d.).

Emerging Cyber Security Risk Management

Coast Guard maritime security operations under the Maritime Transportation Security Act (MTSA) increasingly treat electronic, communications, and cybersecurity as core elements of risk management where modern vessels and facilities rely on networked information and operational technology, satellite connectivity, and internet-linked navigation/communications systems that can be disrupted or manipulated, creating risk of incidents or accidents in the physical domain. The MTSA vessel-security framework may not comprehensively apply to fishing vessels (and related small commercial operators), leaving acknowledged gaps in consistent cyber inspection

[6] 33 CFR 164.46 Automatic Identification System
[7] 50 CFR 660.14 Vessel Monitoring System (VMS) requirements

coverage and enforceable requirements across the maritime domain.[8] Future research might inform emerging Coast Guard cyber operations for certain fishing vessels by examining the proliferation of automated and "intelligent" onboard systems and the expanding cyber-physical attack surface created by integrated bridge systems, electronic chart display and information systems, global navigation satellite systems, AIS, remote maintenance pathways, and data links to shoreside enterprise networks—plus emerging real-time sensor ecosystems on ORE and other offshore OCS platforms (GAO, 2025; USCG, 2024a).

Offshore Area Maritime Security Committee

After the terrorist attacks on September 11, 2001, the Coast Guard reevaluated and reinforced their risk profiles associated with ports, waterways, critical infrastructure, and coasts. resulting in the 2002 MTSA. Among other measures, this law created Area Maritime Security Committees to connect interested parties such as federal, state, and local agencies and port and industry stakeholders for purposes such as contingency planning or updating Area Maritime Security Plans, and to address relevant maritime security issues (USCG, n.d.-a). The MTSA applies to oil and gas exploration and production facilities on the OCS; facilities must develop individual facility security assessments, be in compliance with national maritime security directives, and create a facility security plan[9]. The Commander of the U.S. Coast Guard Heartland District used MTSA authority to form a Gulf of Mexico Area Maritime Security Advisory Committee to aid the Eighth District with coordination, communication, and improvement of security procedures to decrease the vulnerability of resources in the Gulf.[10] This committee was asked to study and consider issues related to security and aid with actions such as review of the Area Maritime Security Plans, communicating threats to mariners in the region, and identifying or quantifying threats. The Area Maritime Security Advisory Committee is also intended to serve as an interface between regulators and industry and will assist governmental agencies to implement policies and procedures to improve security in the Gulf.

The Commanders of the U.S. Coast Guard Southwest and Northwest Districts have not formed similar offshore Area Maritime Security Advisory Committees, likely because of the relatively few offshore oil and gas platforms on the West Coast and the existing platforms' proximity to shore. With the development of ORE projects, regional offshore committees may provide benefit to regional security.

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[8] 33 C.F.R. § 104.105, 2025
[9] 33 CFR Part 106
[10] 89 FR 83896

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5

Offshore Renewable Energy on the West Coast

To date, no commercial-scale renewable energy projects have been installed offshore of the U.S. West Coast. Five California offshore wind leases over two wind energy areas, offshore Humboldt Bay and Morro Bay, have been issued by BOEM, and PacWave South, off the Oregon coast, has secured a Federal Energy Regulatory Commission (FERC) license for its grid-connected wave energy test site (CEC, 2024). Additionally, the PacWave North wave energy site, also off the Oregon coast, tests wave energy devices not connected to the grid. A wind energy test site has been proposed off the Central California coast, but the project planned for this location was placed on hold in August of 2024. This chapter provides an overview of FOW, wave, and tidal energy development, and summarizes West Coast ORE activities. A description of the ORE decision making process at the federal level and planning processes for California, Oregon, and Washington can be found in Chapter 6.

OFFSHORE WIND ENERGY

A typical modern commercial-scale wind turbine has three blades mounted on a horizontal axis rotor (hub and blades). The turbine uses yaw controls to turn and face the wind so that the rotor remains upwind of the tower as the wind direction shifts. It converts the kinetic energy of the wind to electrical energy through a generator and related components housed in the nacelle. The balance of an offshore wind power project includes inter-array cables, offshore substations (the number of which will vary depending on the size of the project, and could be zero for a small project and up to three for a large project), export cables to connect to the land-based grid, and switchgear for control and protection (see Figure 5-1). Turbines are used in a host of energy systems including hydropower and natural gas, though at a different scale than those used in wind turbines.

Offshore wind turbines are similar in appearance to land-based wind turbines but tend to have much larger capacity (measured in MW) and are significantly taller, with longer blades. This is driven both by project economics and by physics, using the stronger winds found offshore while reducing the number of turbines (and foundations) required to produce the same power. Practical factors also influence the size of onshore and offshore turbine components. Land-based wind must contend with moving parts by road or rail, while offshore components can be manufactured and assembled in ports or quayside, then transferred onto vessels, allowing for use of much larger components. Given the harshness of the marine environment, and the greater difficulty to service equipment in marine environments, there is a premium on reliability, and a shift toward direct drive machines that do not include a gearbox which can be susceptible to failure. Foundation design is also critical for both fixed-bottom and floating platforms, given that offshore wind turbines must contend not only with high and consistent wind-loading forces but also with wave-loading forces.

Transmission of electricity from the individual turbines to the shore-based grid is accomplished by inter-array cables connecting the individual wind turbine generators to a common substation facility which sends the power to shore via an export cable (World Forum Offshore Wind, 2024). This is shown schematically in Figure 5-1. The inter-array cables for floating wind projects are suspended in the water column (i.e., they do not extend to the seafloor) while the export cable from the offshore substation to shore does extend to the seafloor and is, in some cases, buried. The voltage rating for inter-array cables is generally lower than for the export cables and actual voltages are driven by the project needs. Typical ratings for inter-array cables are 36 kV (kilovolt) or 66 kV. In contrast, export cables are generally rated for 220 kV (World Forum Offshore Wind, 2024). It is expected that these voltage ratings will increase in the future as larger turbines and larger projects are developed.

The Pacific Northwest National Laboratory and the National Renewable Energy Laboratory (NREL) published a West Coast transmission study (2025) that addresses projected transmission requirements for offshore wind along the West Coast. The transmission arrangement described above addresses the needs of a single wind project. As multiple projects are developed, each one may have its own transmission arrangement (termed a distributed or radial approach), though multiple projects may combine their transmission to shore (termed concentrated or inter-regional approach) to limit cabling needs and grid interconnections (Douville et al., 2025).

Floating Offshore Wind Overview

Floating wind turbines installed off the West Coast will likely be at least 15 MW in capacity, with rotor diameters of 250 m or more. A variety of platform types have been proposed including semi-submersible, spar, and tension-leg platforms (see Figure 5-2). All arrangements would be anchored to the seabed with mooring lines and be interconnected with array cables (Figure 5-1). Considerations including water depth and platform type will influence the mooring line and anchor configurations. Likely spacing of wind turbines will be in the range of 1 to 1.5 mi.

Fixed-bottom Offshore Wind Overview

Most of the world's installed offshore wind turbines, including those sited to date off the U.S. East Coast, use fixed-bottom foundations. These are primarily monopile foundations, but other foundations such as jackets (like an offshore oil platform) and gravity foundations may be used in shallow waters. At greater depths (>60–80 m), extending a fixed-bottom foundation to the seafloor would be too costly.

Other than in the Gulf of Maine, the U.S. East Coast has a gently sloping continental shelf which is ideal for fixed-bottom foundations. As a result, BOEM and the U.S. offshore wind industry first concentrated on the waters

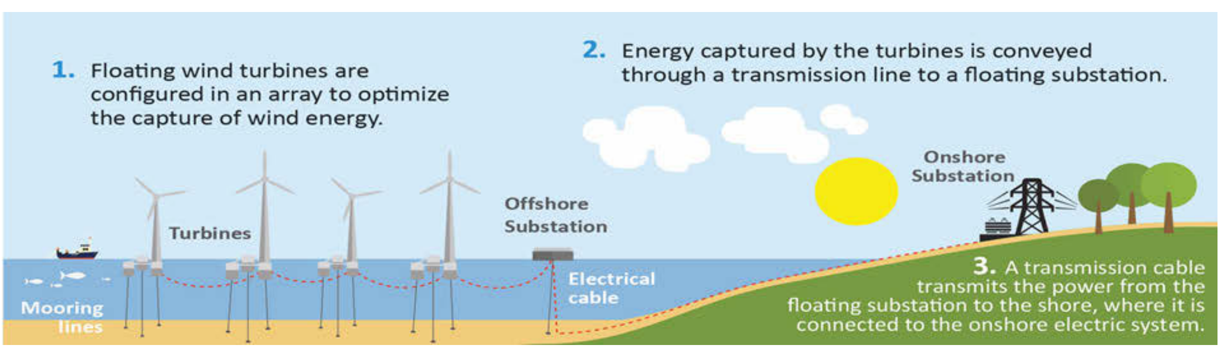

FIGURE 5-1 Offshore wind arrays with floating foundations and suspended inter-array cables connected to a floating substation and to the onshore electric grid.
SOURCE: Hildreth, 2025. Presentation to committee.

FIGURE 5-2 Common floating offshore wind support structures; (*left to right*) spar, semisubmersible, and tension-leg platform
SOURCE: Cooperman et al., 2024. Illustration by Joshua Bauer, NREL.

from Nantucket Island to North Carolina (wind speeds decrease as you proceed north to south along the U.S. East Coast). NREL published a report on the state of U.S. offshore wind energy projects as of May 2024 (McCoy et al., 2024). At that time there were 174 MW of installed offshore wind capacity in operation, including the 30 MW in Rhode Island state waters near Block Island, a two-turbine demonstration project off Virginia (12 MW), and the recently operational 132-MW South Fork Wind Power Project[1] located off Rhode Island/Massachusetts but grid-connected to Long Island. Sunrise Wind, Empire Wind, Vineyard Wind I, Revolution Wind, and Coastal Virgina Offshore Wind projects are in the construction phase as of October 2025. BOEM has also approved additional projects, including Atlantic Shores South, South Coast Wind, and U.S. Wind's Maryland projects. At the same time, since 2023, given financial issues and U.S. policies pausing development, several projects have been canceled, including the Atlantic Shores project. Names and locations of East Coast projects can be found in Figures 5-3 and 5-4.

The Department of the Interior and BOEM are implementing President Donald Trump's January 20, 2025, presidential memorandum temporarily halting offshore wind leasing on the OCS. The memorandum also pauses new or renewed approvals, rights-of-way, permits, leases, or loans for offshore wind projects pending a review of federal wind leasing and permitting practices. Empire Wind 1 received a stop-work order that was subsequently lifted in May 2025 (NYSERDA, 2025), and Revolution Wind received a stop-work order, but as of this writing, a federal court has issued an injunction against the stop-work order and its enforcement (Office of the Attorney

[1] South Fork Wind Power Project is comprised of 12 fixed-bottom turbines at 11 MW each.

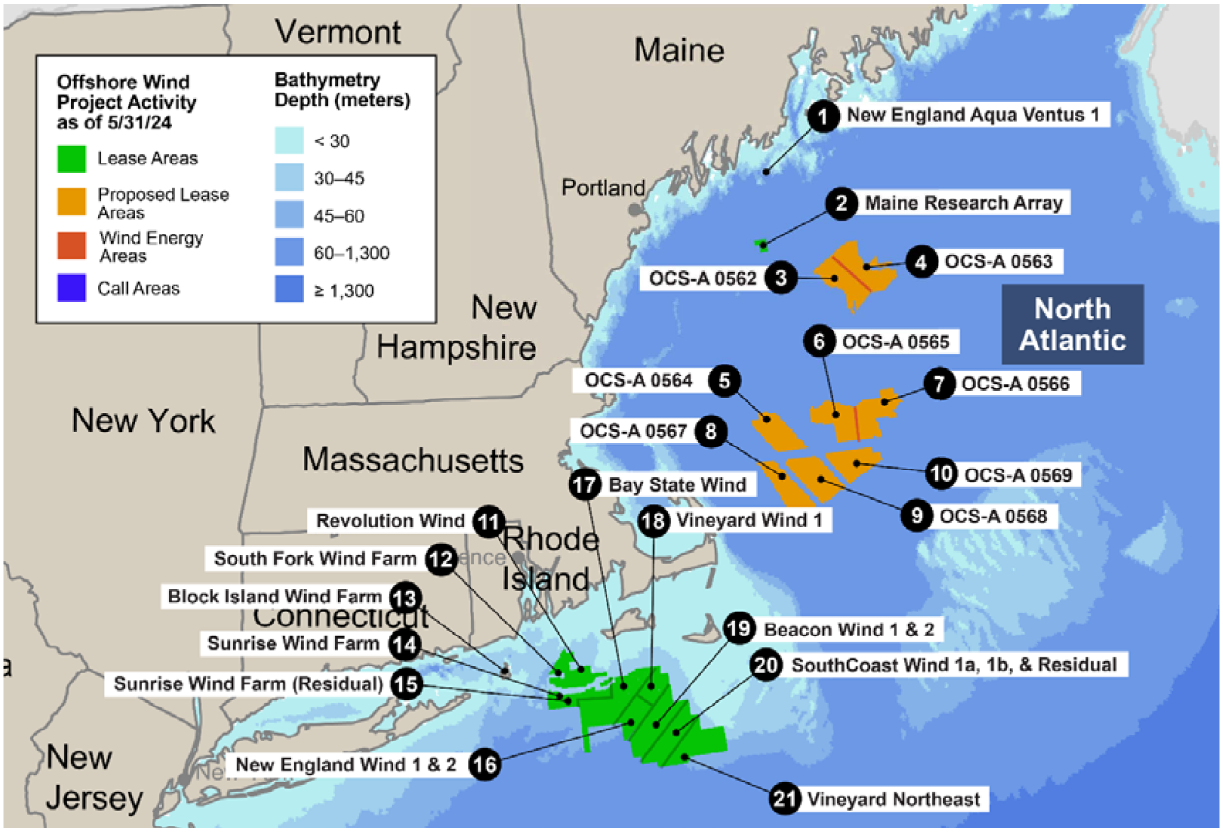

FIGURE 5-3 Offshore Wind Activity in the North Atlantic.
SOURCE: McCoy et al., 2024.

General Connecticut, 2025). The Trump administration has asked several courts in which litigation is pending on projects approved during the Biden administration to remand the approvals back to BOEM to modify or revoke approvals. Most recently, on December 22, 2025, BOEM issued Director's Orders to each of the five offshore wind power projects under construction requiring the suspension of activities for ninety days based on undisclosed national security threats given the evolution of "adversary technologies" and the projects "sensitive" location on the East Coast; Operational offshore wind projects were not suspended. Multiple lawsuits were filed. On January 12, 2026, the judge in the case brought by Revolution Wind issued a stay and a preliminary injunction against enforcement of the BOEM Order.

Wind Project Wake Effects

A wind turbine extracts kinetic energy from the wind to produce power, resulting in reduced wind speeds and increased turbulence downwind, called a "wake," like the wake created by a boat. Wake effects in wind arrays occur when the wind slows down and becomes more turbulent after passing through a wind turbine, disrupting the airflow to other turbines downwind. This wake effect turbulence reduces the efficiency of downwind turbines and can also impact the energy production of downwind wind projects, depending on their proximity and orientation. Offshore wind projects are located over the water, which has lower surface roughness and thus less turbulence compared to onshore. While these relatively stable conditions are favorable for reducing the load fatigue on wind turbines, resulting in extended life of the turbines, the lower turbulence also slows the recovery process producing wakes that persist and propagate over longer distances. Under certain weather conditions, wakes could reach

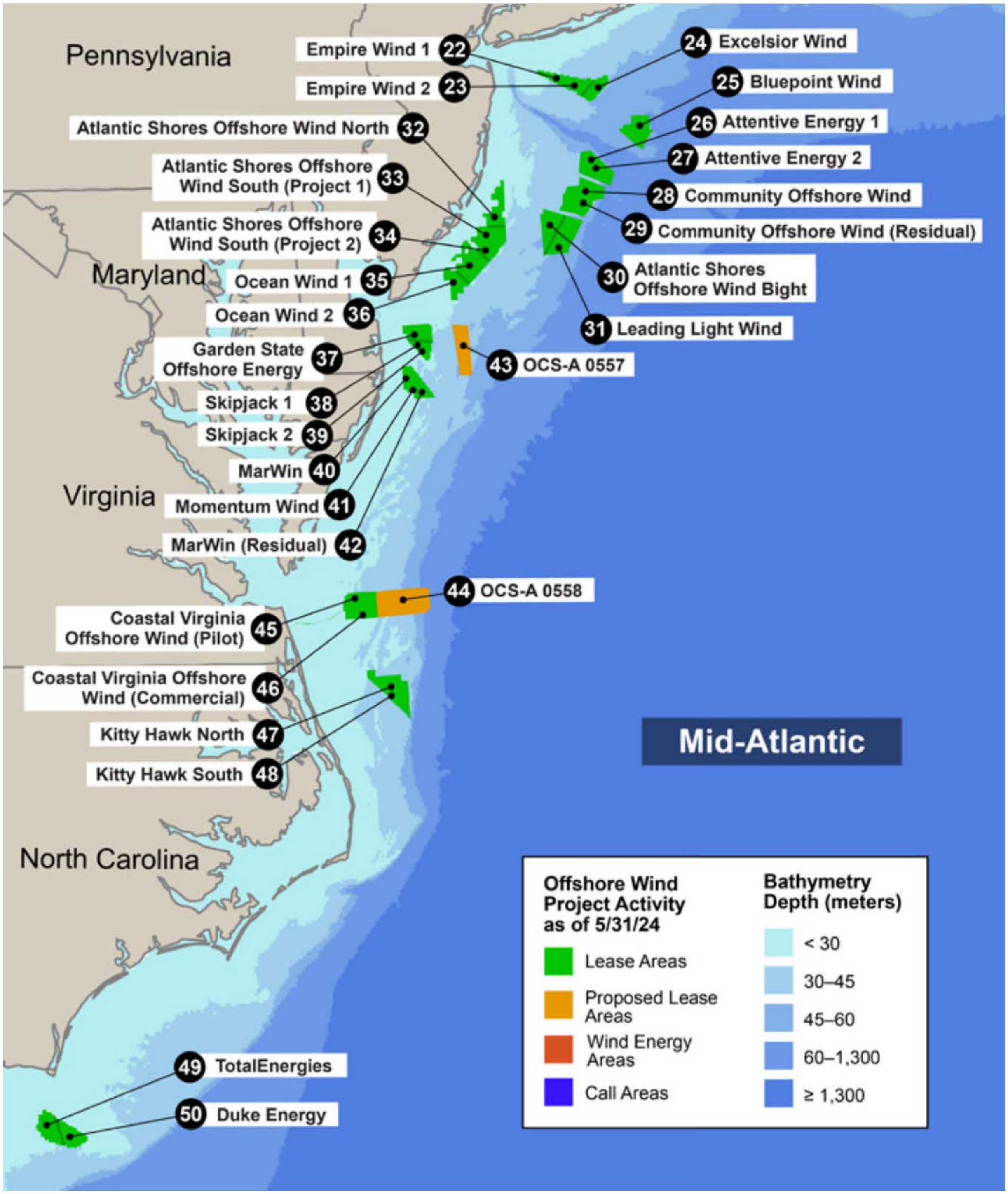

FIGURE 5-4 Offshore Wind Activity in the Mid-Atlantic.
SOURCE: McCoy et al., 2024.

turbines as far as 55 km (34 mi) downwind, with 7 percent wind speed deficits 100 km away, and have a greater negative effect on downwind turbines and wind projects than onshore wind arrays (Rosencrans et al., 2024; GWEC Global Wind Energy Report, 2025). In addition to reducing the efficiency of downwind turbines, wake effect turbulence can affect low altitude aircraft flight near offshore wind arrays and may impact coastal upwelling. These are discussed further in Chapter 7.

California Offshore Wind Leases

In 2022 BOEM awarded five lease areas in two sites off the California coast. Figure 5-5 shows the five California offshore wind leases, which are in two WEAs: one offshore Northern California, near Humboldt Bay, and the other offshore Central California, near Morro Bay. These lease sites encompass 583 sq mi and are located between 20 and 50 mi offshore. Pending future permitting decisions, the lease sites are intended for the deployment of offshore wind turbine arrays with floating foundations and suspended inter-array cables as depicted in Figure 5-1. Completed and ongoing activities for these lease areas include offshore surveys for geotechnical and geophysical data of benthic, biological, and archaeological resources. A California Offshore Wind Draft Programmatic EIS was

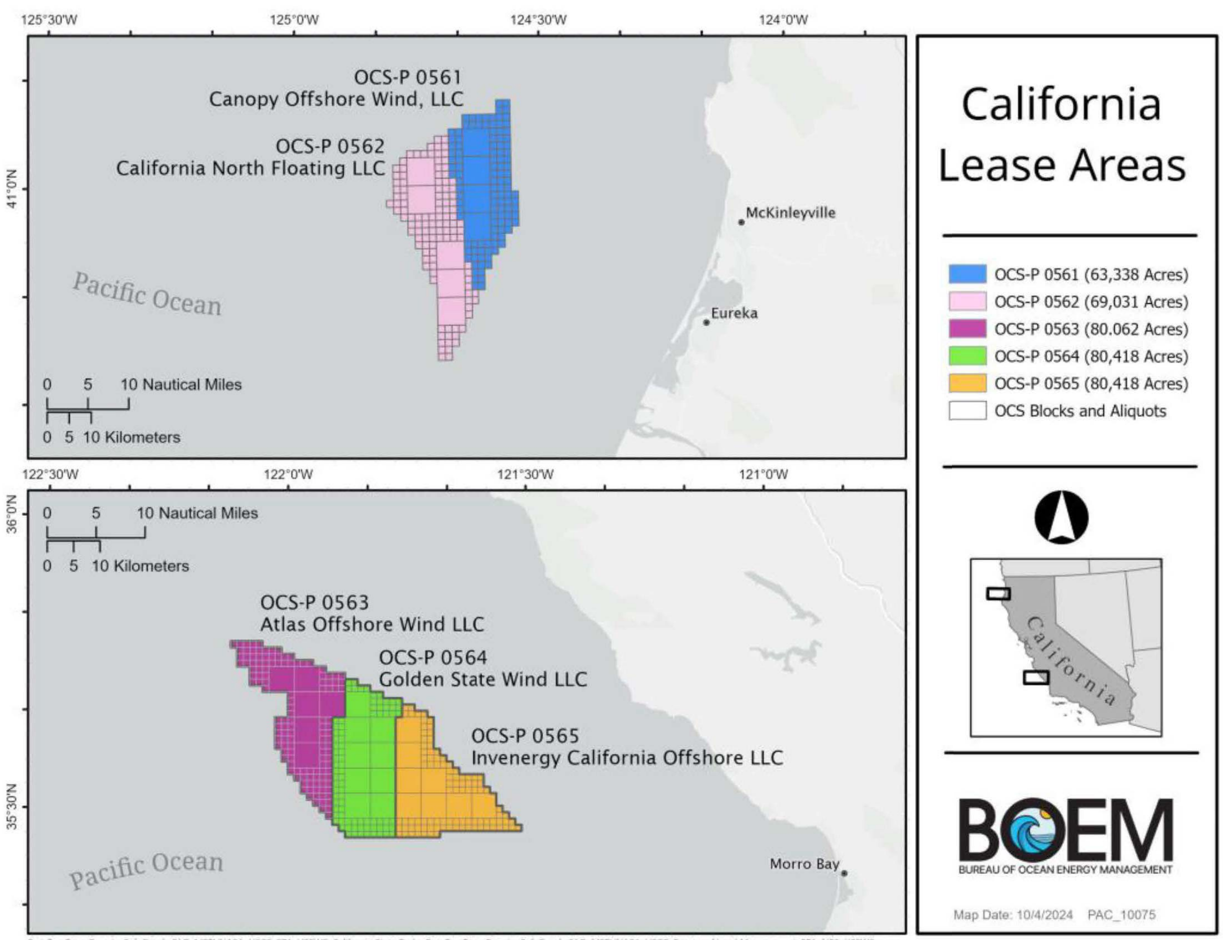

FIGURE 5-5 Five California Offshore Wind Lease Areas.
SOURCE: Hildreth, 2025. Presentation to committee.

published by BOEM in November 2024 but following the January 20, 2025, presidential memorandum pausing offshore wind activity,[2] no further federal actions have been taken on these projects (BOEM, n.d.-a).

CADEMO Test Site

The CADEMO project is a proposed pilot-scale wind energy test project off the Central Coast of California, near Vandenberg Space Force Base (VSFB). It is located within California state waters, 2.5 NM offshore Point Arguello, which simplifies permitting requirements. The project was proposed by developer CADEMO (formerly Cierco) in 2019 and is designed to test four full-scale wind turbines (12–15MW capacity) on different floating platform designs to demonstrate viability of those technologies in deeper waters (CSLC, n.d.). The project would also serve as a pilot site for environmental assessments to gather evidence about impacts on birds, bats, cetaceans, fish, and other marine organisms.

The turbines will be connected via inter-array cables, with power transmitted to shore via a subsea cable to a landing point near Point Arguello (within VSFB) and connect via overhead wires to a new substation approximately 11 mi to the north of the landing position. A preliminary environmental assessment commenced in 2019 and was completed in October 2021 and has since been approved to prepare a full Environmental Impact Report pursuant to the California Environmental Quality Act. The Air Force would serve as the federal lead agency for the NEPA[3] process, because of the project's proximity to VSFB. In August 2024, however, the developers placed the project on hold (CSLC, n.d.).

Comparative Density

It can be helpful to compare the size and spacing of proposed FOW projects off California to the density of oil and gas leased areas off the U.S. gulf coast. Standard blocks that are leased for oil and gas production are 3 NM. by 3 NM (BOEM, 2022). Figure 5-6 shows most of the current active leases (green shading). Figure 5-7 shows the currently installed fixed and floating platforms.

In deeper water areas, the platforms are spaced miles apart. Figure 5-8 shows an example of the Green Canyon area with the blocks containing three facilities highlighted. Each 9-sq-mi block contains a single platform and the distance between facilities is large. For example, Brutus to Genesis is roughly 8 mi, and Genesis to Front Runner is roughly 12 mi. In shallower regions there are more closely spaced platforms, some forming bridge connected complexes. Figure 5-9 shows a shallower area of the Gulf in less than 150 ft of water with 7 platforms across 3 lease blocks. The densest spacing is in block 214, with 4 platforms in 9 sq mi.

It is not unusual for lease blocks to be grouped with a single production platform for the total area. For example, the Thunder Horse development is 3 contiguous blocks, the Auger development is 4 blocks, and the Mars-Ursa Basin development is 6 and 8 continuous blocks, respectively, for totals of 54 and 72 sq mi (Marine Link, n.d.; Offshore Technology, 2023, 2021, 2000). Oil and gas production density ranges from 0.1 platforms per square mile or less to 0.5 platforms per square mile.

For comparison, the five California lease areas range from 100–125 sq mi each, while the former Oregon lease areas were 96 and 200 sq mi each. Accordingly, the existing lease areas are larger than, but roughly comparable, to the assembled clusters of offshore lease blocks off Texas and Louisiana. Unlike oil and gas production facilities, there will be many wind turbine platforms per lease area for both fixed offshore wind (East Coast) and FOW (West Coast), and the platforms will be comparatively more closely spaced (e.g., 1 NM spacing) to facilitate electrical interconnection and transfer of produced power to shore and maximize project economics.

BOEM's Draft Programmatic EIS uses a representative design of ~30–200 wind turbine platforms per project (per lease) for the 5 California wind lease areas (BOEM, n.d.-a). BOEM's visual simulations modeled 262 turbines total for the former Oregon leases using 20-MW machines: 74 in one WEA and 188 in the other (BOEM, n.d.-b). In

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[2] Donald Trump. Temporary Withdrawal of All Areas on the Outer Continental Shelf from Offshore Wind Leasing and Review of the Federal Government's Leasing and Permitting Practices for Wind Projects. Washington, DC. January 20, 2025

[3] 42 U.S.C. §§ 4321et seq.

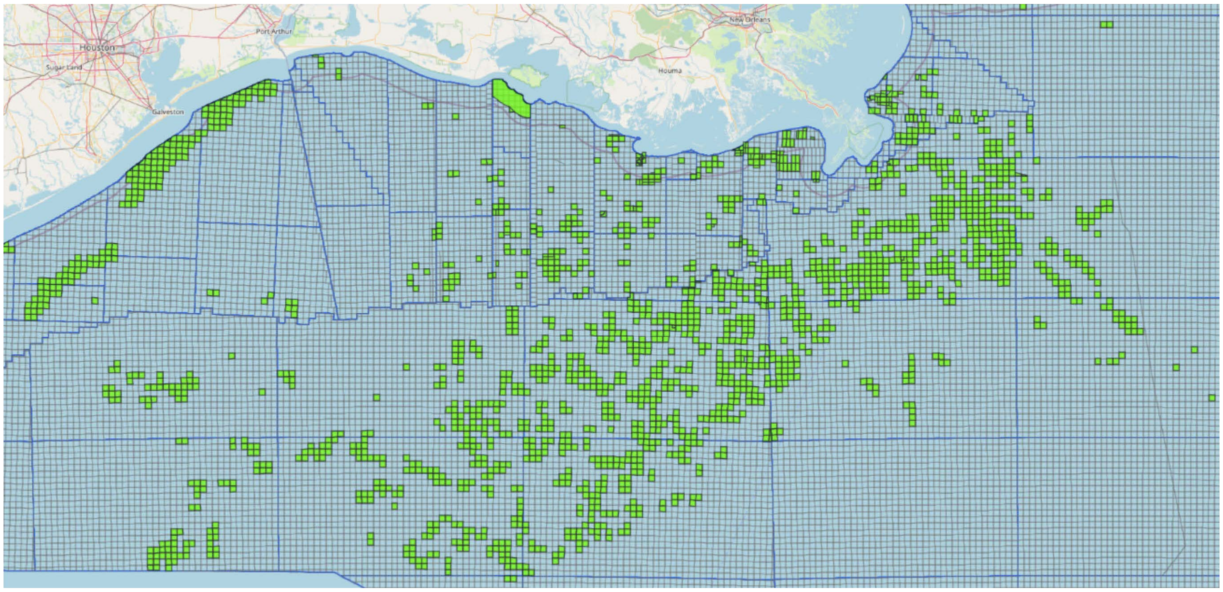

FIGURE 5-6 . Current active lease blocks per BOEM data offshore of Texas and Louisiana.
SOURCE: Modified from BOEM Data Center, n.d.

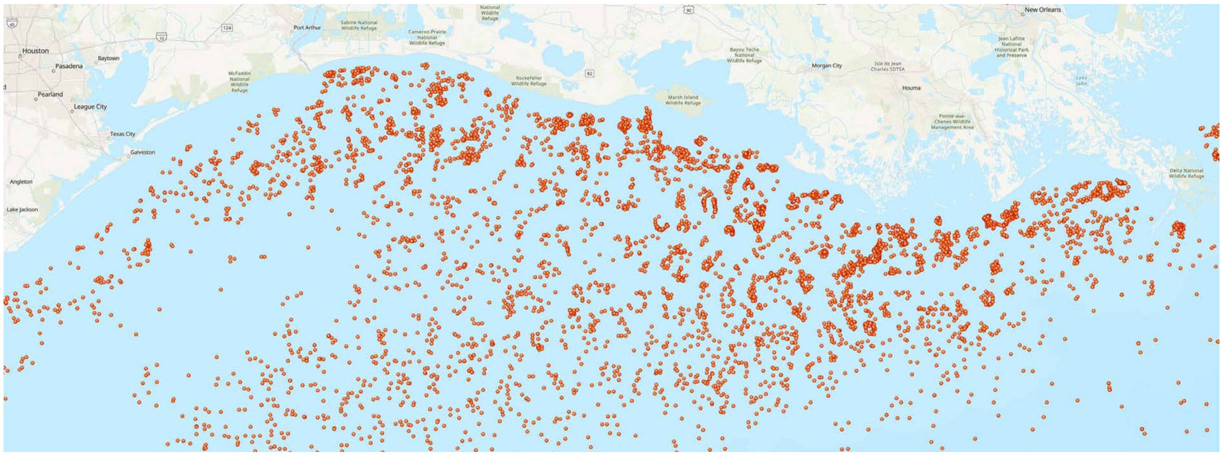

FIGURE 5-7. Installed oil and gas platforms offshore Texas and Louisiana.
SOURCE: Graafieland and BSEE, 2024.

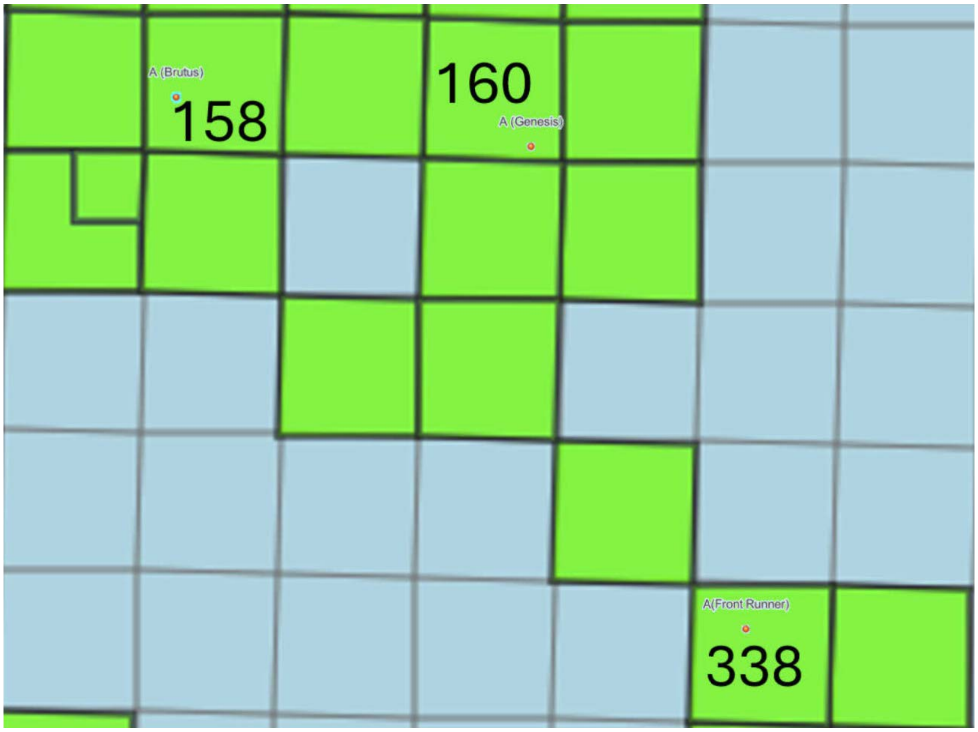

FIGURE 5-8. Location of three deepwater platforms in the Green Canyon region.
NOTE: Blocks are 3 NM by 3 NM squares.
SOURCE: Modified from BOEM Data Center, n.d.

the California lease areas, this equates to 0.25 to 2.0 offshore platforms per square mile in these lease areas, noting the Coast Guard's recommended mitigation of 1 NM track spacing would restrict the higher end of this range, and spacing is also dependent on turbine capacity. These platforms would likely be spaced relatively evenly across the lease area. In the former Oregon lease area, it would have equated to less than one platform per square mile.

For comparison with fixed offshore wind density, the Coastal Virginia Offshore Wind project will have 176 turbines in a lease area of 176 sq. mi, or 1 turbine per sq mi (Dominion Energy, n.d.).

WAVE ENERGY

Ocean wave energy conversion harnesses the kinetic and potential energy of a surface wave and converts it into usable energy. Surface waves are created by wind blowing across the ocean. Wave energy has the potential for grid applications (MW-scale) and niche, autonomous and off-grid applications (kW-scale) such as providing energy for vessel charging, robotic systems, operating equipment and data gathering (Prudell, 2025). The NREL Marine Energy Atlas estimates the total theoretical wave energy resource along the U.S. coastline to be 1400 Terawatt hour (TWh) annually, with 240 TWh annually along the West Coast, with waves generated by global winds blowing from west to east (Kilcher et al., 2021). The density of ocean wave power off the West Coast is seasonal but predictable, averaging on the order of tens of kilowatts per meter of crest length (perpendicular to the direction the wave is moving toward the shore; von Jouanne and Brekken, 2017). The wave energy resource is higher at higher latitudes, with the highest energy off the U.S. West Coast in Northern California, Oregon and Washington.

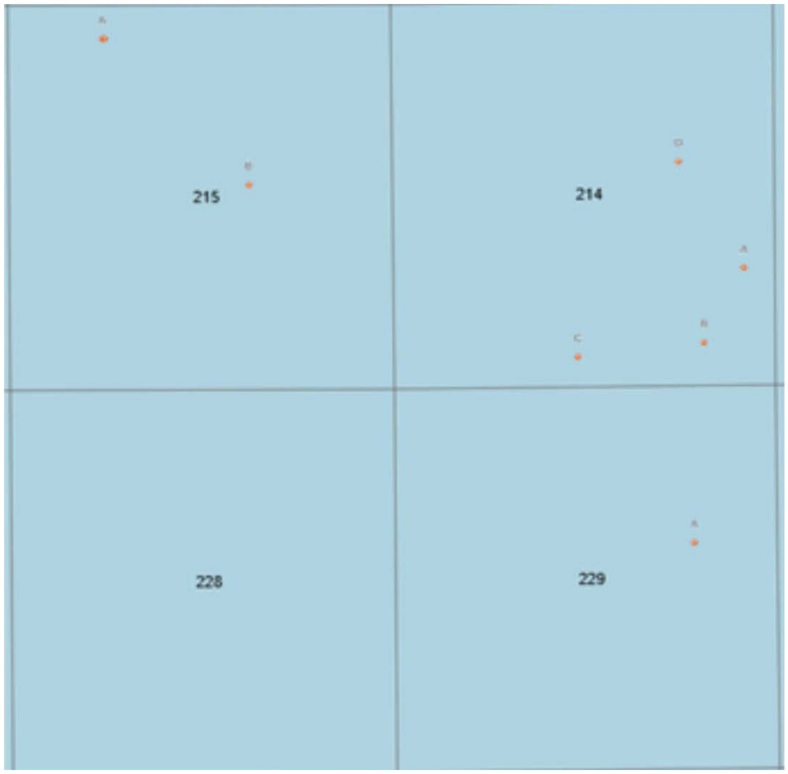

FIGURE 5-9. Location of seven platforms in the Vermillion area in less than 150 ft of water
NOTE: Blocks are 3 NM by 3 NM squares.
SOURCE: Modified from BOEM Data Center, n.d.

It is substantially lower in Southern California, due to the sheltering effect of Point Conception and the Channel Islands. There is also substantial seasonality in the direction of wave energy, which can heavily influence annual energy production, but may align with energy demand in seasonal fisheries, for example.

Wave energy converter technologies function at different depths and conditions, may be floating, submerged, or attached to a fixed structure, and generally fall into six main categories based on their principle of operation (CEC, 2024):

- Attenuators
- Point absorbers
- Pressure differentials
- Oscillating water columns
- Overtopping
- Oscillating wave surge converters

Table 5-1 gives a summary of the six main wave energy converter device archetypes (categorized by the primary principle of operation) and Figure 5-10 illustrates examples of existing devices within each archetype.

TABLE 5-1 Summary of Six Main Wave Energy Converter Devices

Device Archetype	**Configuration**	*Optimal Conditions*
Attenuator	Generally floating with mooring line(s) and bottom anchor(s)	Offshore swell, tens of meters water depth (outside breaker zone)
Point absorber	Floating, semi submerged, or submerged with mooring line(s) and bottom anchor(s)	Optimal conditions: moderate to high wave energy densities (offshore)
Pressure differential	Submerged with mooring line(s) and bottom anchor(s)	Flexible
Oscillating water column	Shore-based, fixed structure, or floating, moored offshore	Flexible
Overtopping	Shore-based, fixed structure, or floating, moored offshore	Flexible
Oscillating wave surge	Surface floating or subsurface and moored and/or bottom-mounted	Relatively shallow water depths (10-12 m)

SOURCE: Modified from SB605 Report, Aspen Environmental Group.

PacWave South Wave Energy Test Site

The PacWave South wave energy testing site is a partnership between the U.S. Department of Energy, the State of Oregon, Oregon State University, and local stakeholders. PacWave South is an open ocean test site located 6 NM off Newport, Oregon, with four berths (see Figure 5-11) occupying 2 sq NM of ocean at a depth of 65–78 m with a cable route to shore extending south to Driftwood Beach (see Figure 5-13). The site has been permitted for the testing of up to 20 wave energy converters, allowing different technologies to be tested at the same time, with a maximum power output of 20 MW. Each berth has a dedicated 5-MW-capable power and data cable connection.

PacWave North Wave Energy Test Site

Before the development of the PacWave South site, the PacWave North wave energy test site seen at the top of Figure 5-13 was developed to facilitate open ocean testing of wave energy converters without a cable-to-shore grid connection. PacWave North is located north of Newport, Oregon, 2 NM off the coastline in water depths of 45–55 m. The Ocean Sentinel mobile test berth (Figure 5-13) is used at the PacWave North site and was designed with load banks to emulate the grid while enabling power analysis and data acquisition of the WECs under test.

TIDAL ENERGY

Tidal currents are generated by gravitational interactions of the earth, moon, and sun, and tidal energy technologies harness the kinetic energy in that moving water (CEC, 2024). Current speeds of 0.5 m/s up to 3 m/s are generally considered viable for tidal energy conversion (Kilcher et al., 2021). The NREL Marine Energy Atlas estimates the theoretical tidal energy resource to be 440 TWh annually in the United States (Kilcher et al., 2021). Tidal energy converters vary by size, shape, and energy capture methods and their characteristics depend on the available resource, deployment area, and mounting methods. Six common tidal device archetypes are given below and summarized in Table 5-2:

- Axial-flow turbines
- Cross-flow turbines
- Oscillating Hydrofoil
- Tidal kite
- Archimedes screw
- Vortex-induced vibration

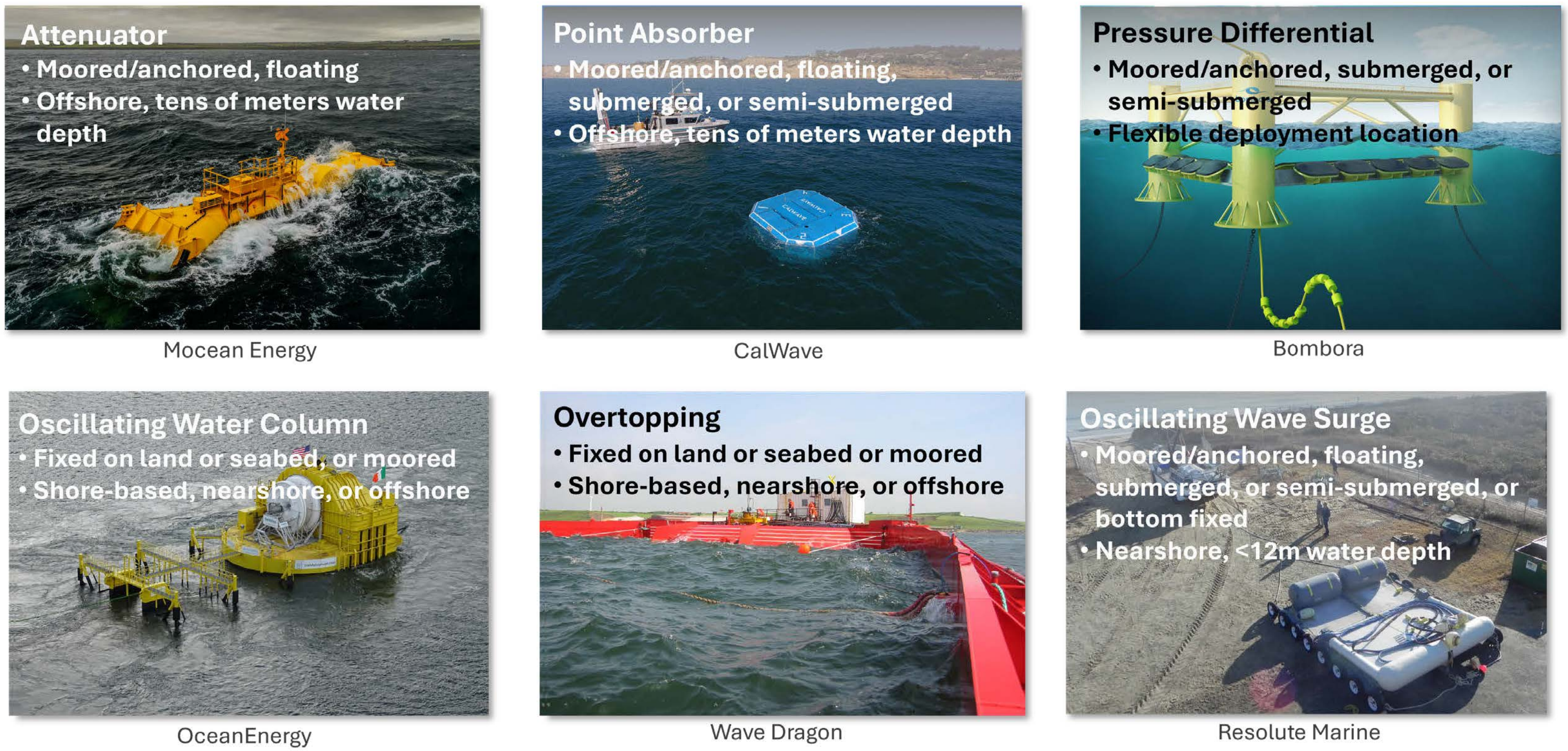

FIGURE 5-10 Examples of the six main wave energy converter archetypes including the configurations, optimal conditions, and device name or developer.
SOURCE: Top row: Mocean Energy (left), CalWave (center), Bombora (right); Bottom row: OceanEnergy (left), Wave Dragon (center), Resolute Marine (right).

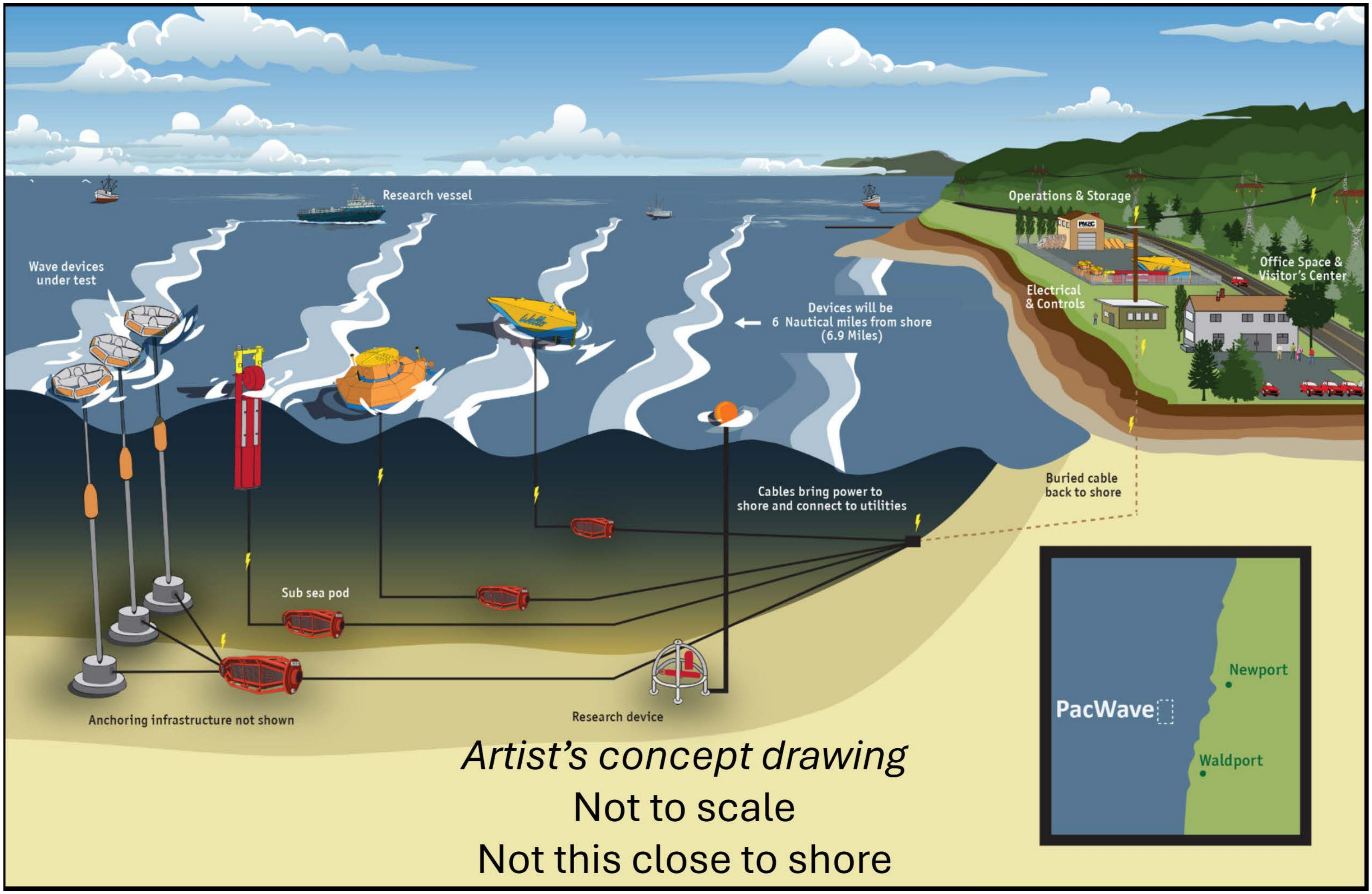

FIGURE 5-11 Artist rendition of PacWave South wave energy testing site.
SOURCE: Henkel, 2025. Presentation to committee.

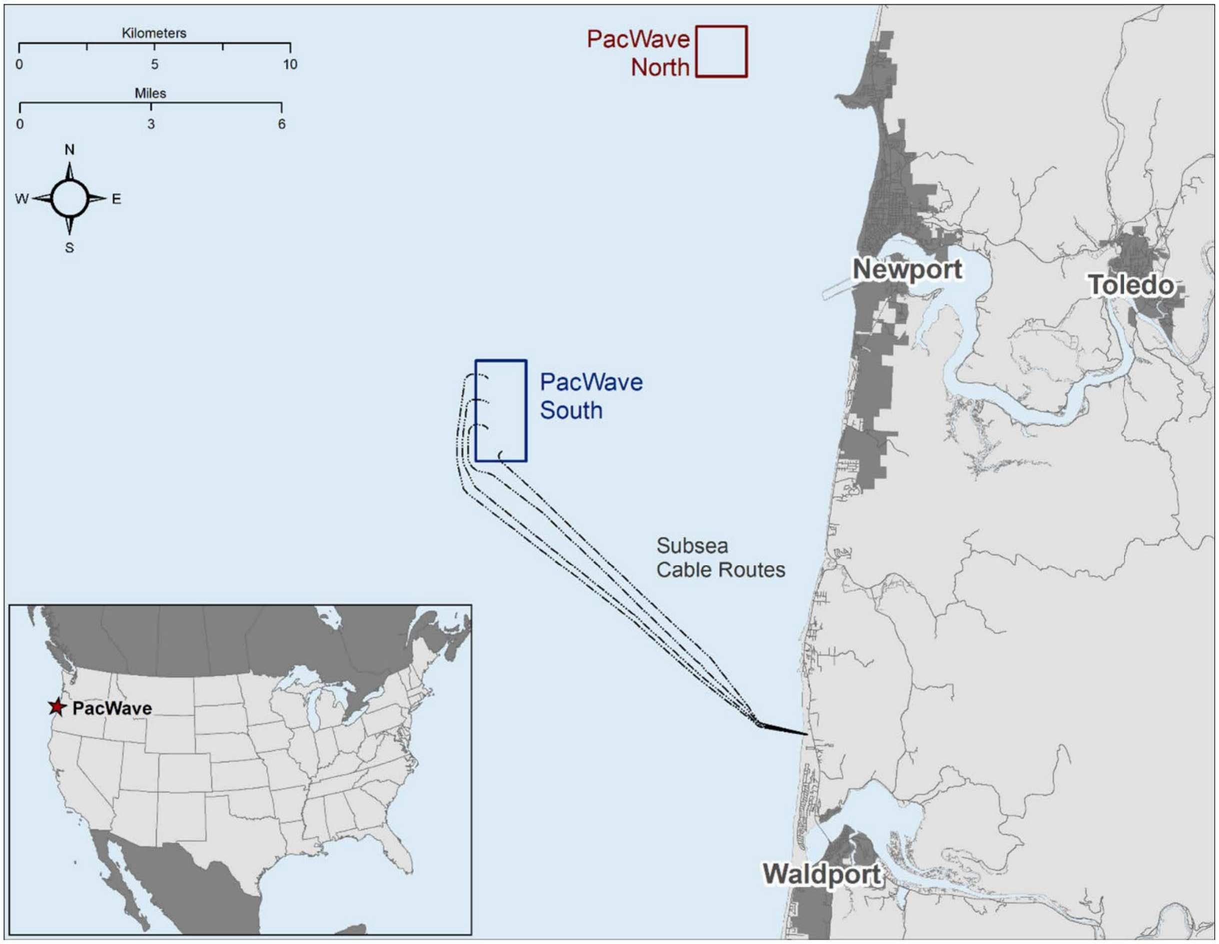

FIGURE 5-12 PacWave South and PacWave North Site locations off Oregon Coast.
SOURCE: Tethys, n.d.

Table 5-2 and Figure 5-14 provide industry examples from U.S.-based and international companies, sourced from publicly accessible online references.

OFFSHORE RENEWABLE ENERGY TECHNOLOGY

ORE technology is rapidly developing to meet global clean energy demands. Fixed-bottom wind turbines are the most widely deployed, with several U.S. projects on the East Coast at or near completion. Globally FOW projects have also been developed in several countries over the last decade, including China, France, Norway, Portugal, and Scotland (Su et al., 2024). These projects demonstrate various foundation types (spar, semi-submersible, barge, and tension leg) and vary in unit capacity from 4 to 10 MW (Su et al., 2024). Projects on the West Coast are still early in the planning stages but are expected to be larger, with unit capacity up to 15 MW. Although the technical feasibility of FOW has been successfully demonstrated through a number of prototype projects, widespread commercialization of FOW likely requires further developments in design technology and production processes. An NREL study noted that cost reductions may be needed to be cost-competitive with fixed-bottom offshore wind (Shields et al, 2022).

FIGURE 5-13 Ocean Sentinel mobile ocean test berth for non-grid-connected WECs at the PacWave North wave energy test site..
SOURCE: Photo credit committee member Annette von Jouanne.

TABLE 5-2 Summary of Six Main Tidal Energy Converter Device Archetypes

Device Archetype	Configuration	Optimal Conditions
Axial-flow turbines	Multiple blades attached to rotor. Can be deployed as single or multiple units on a base.	Water depths depend on turbine size. Can operate in systems with tidal and unidirectional flow.
Cross-flow turbines	Floating, semi submerged, or submerged with mooring line(s) and bottom anchor(s).	When oriented horizontally, channelized flow with predictable direction. When oriented vertically, direction agnostic. Can operate in systems with tidal and unidirectional flow.
Oscillating hydrofoil	Fixed to sediment bed with one or multiple foils oriented perpendicular to flow direction.	Strong tidal oscillations
Tidal kite	Submerged generating unit with cable affixed to sediment bed.	Can be optimized to meet range of tidal conditions
Archimedes screw	Helix screw oriented in line with flow attached to floating platform.	Water depths are dependent on turbine size. Can operate in systems with both tidal and unidirectional flow
Vortex-induced vibration	Spherical or tubular units attached to generator.	Can be affixed to pilings or other submerged structures in turbulent areas. Can be direction agnostic depending on shape

SOURCE: Modified from SB605 Report, Aspen Environmental Group.

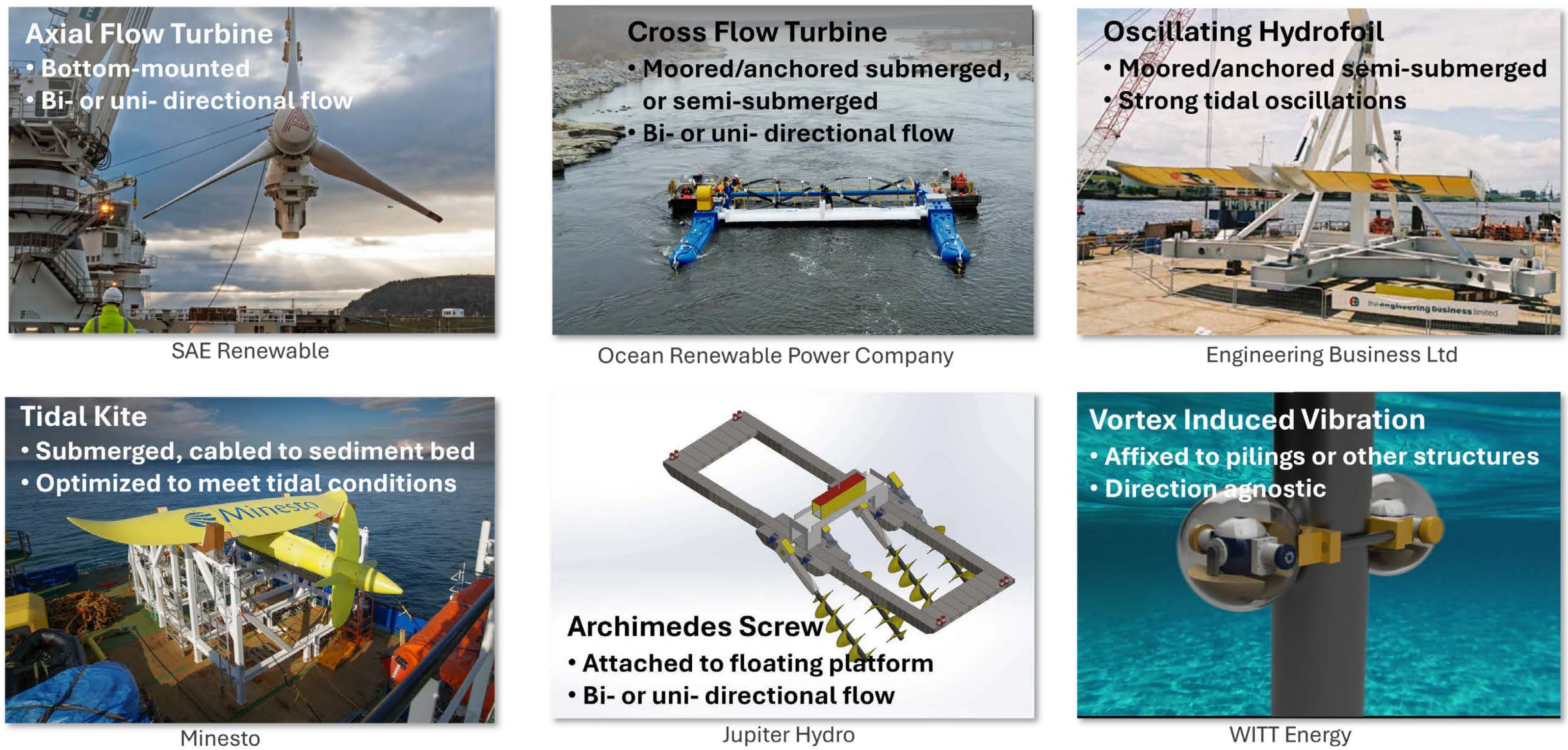

FIGURE 5-14 Examples of the six main tidal energy converter archetypes including the configurations, optimal conditions, and device name or developer.
SOURCE: Top row: SAE Renewables (left), Ocean Renewable Power Company (center), Engineering Business Ltd (right); Bottom row: Minesto (left), Jupiter Hydro (center), WITT Energy (right)

Expansion of offshore wind technologies and project development could positively influence the development of wave and tidal energy (deCastro et al., 2024). Compared to offshore wind, the wave and tidal systems are generally smaller and closer to shore (i.e., many will be within state waters), supporting niche and specific applications, and thus would be more visible and in proximity to nearshore activities such as maritime traffic. Also, there are still multiple design archetypes for both wave and tidal energy converters, each with varying benefits and impacts. Standardization of wave and tidal energy converters will likely occur with continued technological development and maturity of the industry.

Conclusion 5-1: Due to the diversity and nascent stage of wave and tidal technologies, it is not possible to determine specific impacts. As wave and tidal energy technologies mature and standardize, permitting agencies will need to review the potential impacts of these technologies.

Technology readiness level (TRL) measures the commercial readiness of technology on a scale of 1-9 (see Figure 5-15). For example, TRL 7 is a system prototype demonstration in an operational environment, TRL 8 indicates that the technology has been successfully tested and demonstrated in its final form under expected conditions, and TRL 9 signifies that the technology has been successfully proven through actual operations in its intended environment. The TRL of fixed-bottom offshore wind is relatively high (7–9) in the demonstration to proven system range (see Figure 5-16; Constant et al., 2024). FOW TRLs is in the medium-high range (7–8; Constant et al., 2024). Wave energy TRLs are for the most part lower (between 5 and 7) than for offshore wind and tidal energy as most deployments are restricted to pilot and demonstration projects. A primary reason for the lower TRL of wave energy devices is that wave energy technologies have not converged to a standardized WEC design. While tidal TRLs are generally around 6-8, Verdant Power's Roosevelt Island Tidal Energy project in the East River in New York City, the first U.S. grid-connected tidal installation, was successfully decommissioned in 2021 having achieved TRL 9 (Verdant Power, n.d.).

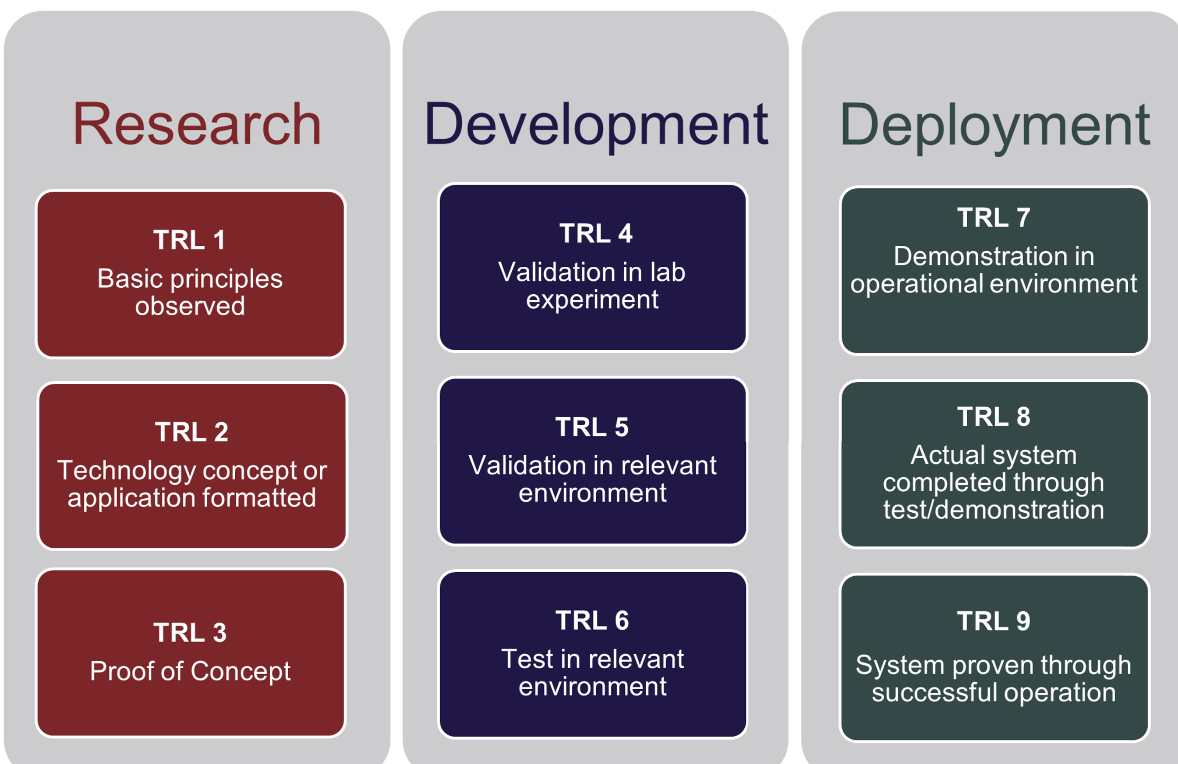

FIGURE 5-15 Technology Readiness Levels

BOX 5-1
Capacity Factors

Capacity factor (CF) is a performance indicator defined as the average power output of a device in a given resource environment relative to the actual maximum output power of the device throughout the year (EIA, n.d.): For a technology like natural gas it is mostly a function of use, but for technologies like offshore wind it is mostly reflective of the variable energy availability of the resource and is very site specific.

$$CF = \frac{\text{Average Power Out}}{\text{Maximum Power Output}}$$

The power of the wind is proportional to the swept area of the blades and the cube of the wind speed. Thus, even small differences in wind speed make large differences in the power of the wind. In addition, the relationship between power and swept area drives the use of longer blades. Each wind turbine model has its own power curve (power output at a given wind speed), including a cut-in speed (when the blades begin to rotate and produce power at a minimum wind speed), maximum production (equal to its power) at a given wind speed and maintained until its cutoff wind speed (when the wind turbine shuts off power production and feathers its blades to protect itself from damage). Winds at increasing altitudes are generally greater and less turbulent giving impetus to higher hub heights. NREL reports U.S. offshore wind CFs of around 45–50% (fixed-bottom) and around 40–46 percent (floating; Fuchs, et al., 2024) compared to onshore wind of around 26–50 percent (NREL, 2024). This is due in part to a reduction in topographic complexity and ground effects. Also, for comparison, NREL reports solar panel CFs in the range of about 12–22 percent (NREL, 2022), and CFs for WECs for various coastal environments have been reported in the range of around 10–40 percent (Rusu and Onea, 2018). Tidal CFs have been reported in the range of 20–35 percent; lower in part due to the 12.5-hour cycle of the tides (Ocean Energy Council, n.d.).

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6

Offshore Renewable Energy Planning Process

The planning process for ORE project development is overseen at both the federal and state levels. The process encompasses analysis of potential ORE development areas from site selection and assessment through operation with opportunities for public engagement. An important aspect of ORE planning includes broad marine spatial planning (MSP) which encompasses different and sometimes competing uses of the ocean, often overlapping with the identified areas for ORE project development. This chapter first addresses the offshore wind planning process at the federal level and then outlines processes in California, Oregon, and Washington. Next is a discussion of state-level MSP planning efforts. Finally, we conclude the chapter with consideration of interactions between local communities, users of the marine environment, stakeholder groups, and the agencies responsible for planning ORE projects.

FEDERAL OFFSHORE RENEWABLE ENERGY REGULATIONS

Regulation of offshore wind energy development in federal waters is primarily overseen by two bureaus within the U.S. Department of the Interior (DOI)—BOEM and BSEE. Unlike federal land management agencies such as the Fish and Wildlife Service, the National Park Service, the Bureau of Land Management, and the Forest Service, BOEM and BSEE were not established by an act of Congress or granted a broad planning mandate by Congress. Rather, BOEM and BSEE, on behalf of DOI, implement laws governing energy and mineral development on the OCS without regard to a wider mission to manage the ocean commons or regional management plans. They are among a number of federal agencies that manage different aspects of ocean waters including NOAA (fisheries and protected species), the Coast Guard (navigational safety), USACE (navigational safety, obstruction to navigation, and integrity of structures), and the Department of Defense (DOD), which, for example, manages areas of the ocean used in its own operations.

Federal lands and waters begin 3 NM offshore most states and territories, including California, Oregon, and Washington, except for Monterey Bay where a straight baseline is drawn across the bay beginning federal waters further than 3 NM from shore. The waters shoreward of 3 NM are state waters and, under the Submerged Lands Act,[1] states have the right to manage, lease, develop and use the lands and natural resources (living and nonliving) within these waters. However, even in state waters, the federal government retains rights, including national

[1] Submerged Lands Act, 43 U.S.C. §§ 1301–1315.

defense, international affairs, navigation regulation, and commerce regulation (e.g., over water pollution). It is important to note that jurisdiction and control of water power was not transferred to the states. The Submerged Lands Act "does not include water power, or the use of water for the production of power."[2]

For offshore wind energy development in those state waters not included within overlapping federal jurisdictions such as DOD areas or national marine sanctuaries, the adjacent state would be the lead agency. For example, Rhode Island was the lead for the United States's first offshore wind power project, the Block Island Offshore Wind Power Project (BIOWP). Projects in state waters are still required to obtain federal permits,[3] consider federal interests (e.g., endangered species and marine mammal protection acts), and evaluate environmental effects, with USACE generally the lead federal agency. Although the federal government retained all rights to waterpower in state waters, it effectively relinquished rights related to wind power under the Submerged Lands Act, so that any rents, royalties, or other payments would flow to the applicable state.

To manage energy resources on offshore federal lands and waters, Congress adopted the Outer Continental Shelf Lands Act of 1953 (OCSLA),[4] with the primary regulatory focus of oil and gas development and to a lesser extent minerals mining, such as sand for beach replenishment. In 2005 Congress adopted the Energy Policy Act of 2005,[5] which modified the OCSLA and authorized DOI to also lease ocean areas for "alternative energy," including offshore wind, tidal, wave and current energy.[6] However, regulations governing those alternative energy uses were not adopted until 2009.

Although the United States is not a party to the UN Convention on the Law of the Sea (UNCLOS), it has stated that it considers much of UNCLOS to reflect customary international law and to be binding on the United States. In 1983 President Ronald Reagan issued Proclamation 5030, establishing an EEZ from 12 NM out to 200 NM from the U.S. coast[7] and claiming the sovereign rights and jurisdiction over the EEZ that UNCLOS accords, which include energy. Under UNCLOS, each country also has a continental shelf maritime zone which by agreement extends at least 200 NM from the coast, although a country can seek a determination that it has a longer (extended) continental shelf if its continental shelf extends further than 200 NM geomorphologically (see Figure 1-1). Ports and coastal adjacent waters such as rivers, bays, and wetlands are considered inland waters.

Offshore Renewable Energy Processes

BOEM's regulation of alternative uses of the OCS is divided into six phases: (1) planning and analysis; (2) leasing; (3) site assessment; (4) construction; (5) operations and (6) decommissioning, with BOEM overseeing the first three and BSEE the latter three (Figure 6-1).

Offshore wind energy project construction and operation may have effects on vessel navigation and fishing. OCSLA requires that any activity carried out under a lease, easement, or right-of-way be carried out in a manner that provides for "prevention of interference with reasonable uses (as determined by the Secretary) of the EEZ, the high seas, and the territorial seas."[8] Given the early stage of development of offshore wind energy projects off the West Coast, thoughtful planning, siting, and evaluation can avoid, mitigate or lessen the burdens those effects place on navigation and fishing. Other potential impacts (ecological and environmental) will be identifiable only after floating offshore wind projects are constructed and put into operation. Well-developed monitoring plans are necessary to adaptively manage or mitigate such impacts. Next, we focus on BOEM's processes and the first three stages of development. What follows is a description of what might be typical, but the process may vary given the nascent state of the industry. Additionally, BOEM's process continues to evolve based on lessons learned from previous offshore wind projects; these are discussed in the Existing BOEM Activities section later in this Chapter.

[2] Submerged Lands Act, 43 U.S.C. § 1301(e)
[3] For example, Rivers and Harbors Act of 1899 Section 10 permit, 33 U.S.C. § 403; 33 CFR Part 322
[4] Outer Continental Shelf Lands Act of 1953, 43 U.S.C. §§ 1331 et seq.
[5] H.R.6, 109th Congress
[6] 43 U.S.C. § 1337
[7] The first 12 NM comprise the sovereign maritime zone, known as the territorial sea.
[8] 43 USC § 1337(p)(4)(I)

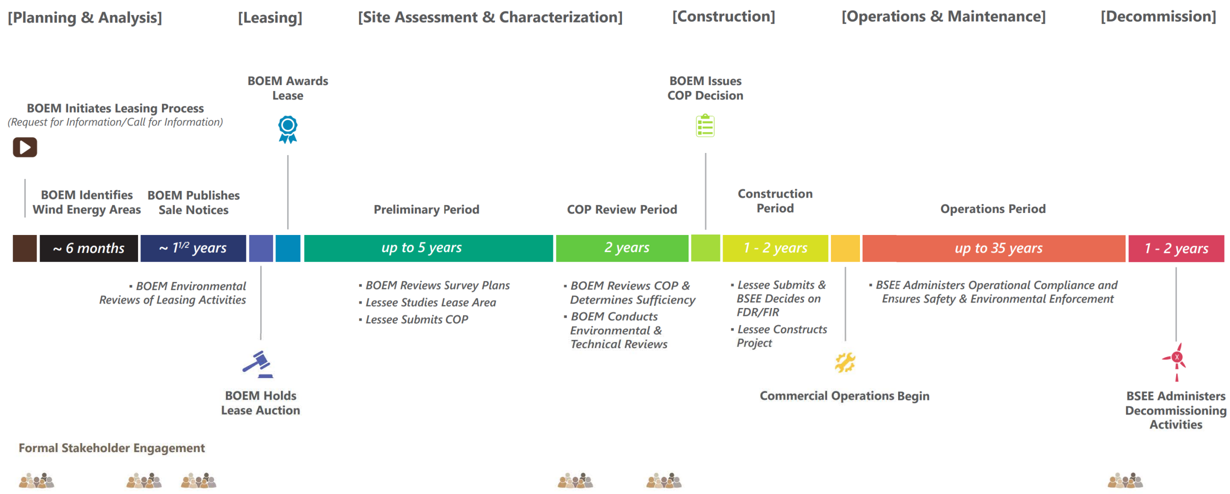

FIGURE 6-1 BOEM and BSEE regulatory states and timeline.
NOTE: BOEM = Bureau of Ocean Energy Management; BSEE = Bureau of Safety and Environmental Enforcement; COP = construction and operations plan; FDR/FIR = Facility Design Reports/Fabrication and Installation Reports.
SOURCE: BOEM, n.d.-a.

Planning and Analysis Phase

The planning and analysis phase is usually initiated by BOEM through a state-focused task force meeting or series of meetings focused on planning for leasing of ocean space off that state. BOEM will then issue a request for developer interest (RFI) and designate a large potential developable area off the coast (the "RFI area"). An interested developer will inform BOEM of its interest and indicate where within the RFI area it may be interested. Based on developer interest, spatial analysis[9], and public comment, BOEM will typically reduce the RFI area, then publish a draft Call Area. The draft call area may be modified further based on additional input leading to the final Call Area. At that point, BOEM announces a call for information and nominations, which invites both public comment and developer nominations of areas of interest within the Call Area. After consideration of that input, BOEM announces a draft WEA. Based on further engagement and comments, BOEM publishes a final WEA, which concludes the planning and analysis phase.

Leasing Phase

The Energy Policy Act (2005), which provides BOEM with authority over offshore wind energy development, amended OCSLA, which, as noted earlier, is primarily focused on oil and gas development on the OCS. There are, however, differences between markets for oil and gas and those for electricity. For example, while oil can be sold into many markets and its wholesale price is linked to global prices, grid-connected offshore wind generated electricity is sold into state and regional markets, and its development tends to follow state electricity policies. With the present framework, potential offshore developers compete to pay the largest upfront payment rather than competing to deliver electricity at the lowest price while optimizing for a combination of other project attributes (such as community benefits, economic development, time to project operation, engagement plan).

Once a WEA (which BOEM typically divides into two or more potential lease areas) is designated, the leasing phase commences with BOEM's publication of a Proposed Sale Notice inviting further comment. BOEM also commences an environmental assessment under the NEPA to evaluate the effects of site characterization activities (e.g., geophysical and geotechnical activities before construction), though this is not for full development or turbine

[9] Spatial analysis can include use of a spatial suitability model such as NOAA's NCCOS model. See Chapter 7 for further discussion of using the NCCOS model during site selection.

installation. After considering the environmental assessment, BOEM will either issue a Finding of No Significant Impact, which would be typical for these kinds of more limited activities (as opposed to the intended future act of placing a wind turbine and associated infrastructure in the ocean), or if the impacts may be significant, it undertakes a full EIS. For leases offshore California and Oregon, BOEM issued a Finding of No Significant Impact for the investigation activities allowed under the leases proposed off those states. Under OCSLA, BOEM is also required to provide the public with notice and an opportunity for comment on the proposed lease.[10]

After assessing the impacts of site characterization activities, BOEM would next issue a final sale notice. BOEM then holds an auction among qualified (developer) bidders, with bidding occurring separately and concurrently on each lease area within a WEA. For each lease area, BOEM announces a provisional winner—that entity tendering the highest bid. Winning bids have varied greatly depending on timing of the auction, location, state and federal government support, and market conditions, from less than $1 million to more than $1 billion. Two lease areas off Texas failed to receive any bids in an auction held in 2023 (Sheppard Mullin Richeter & Hampton LLP, 2023). The four New York Bight lease areas raised a cumulative $4.4 billion, while the only West Coast leases awarded—the five off California—raised $757 million (DOI, 2022b; DOI, 2022a). With the exception of any monies that have been earmarked for bidding credits (as described in the Final Sale Notice), that bid money flows to the Federal Treasury, along with rents paid to lease the ocean space, and operating fees that would be generated if a project became operational.

Under section 388 of Energy Policy Act of 2005, Congress provided that if the nearest offshore wind turbine was within 3 NM of the federal–state line (or effectively 6 NM from the West Coast states), 27 percent of the revenues from upfront payments, rents, and royalties that would otherwise flow to the federal government would flow to the adjacent coastal state; however, if more than one state was within 15 mi of the geographic center of the wind project, the 27 percent would be shared equitably.[11] The apparent congressional intent is to share offshore wind revenues with the coastal states, but this has not occurred because no offshore wind power projects have been sited in federal waters within six mi of a coastal state.

There is even broader sharing of oil and gas revenues with adjacent coastal states in the Gulf. The Gulf of Mexico Energy Security Act provides revenues to the Gulf-producing states and the Land & Water Conservation Fund to advance coastal restoration. More recently, perhaps given the absence of state revenue sharing, BOEM has allowed offshore wind developers to receive bidding credits to the extent a winning developer provides community benefits in accordance with the terms of the final sale notice and lease. After formalities, the lease is executed by BOEM and the winning developer.

Site Assessment Phase

The developer who holds a lease is required to submit a Site Assessment Plan (SAP), and upon BOEM approval, undertakes site assessment activities. These activities include environmental, cultural, and visual assessments, as well as geotechnical and geophysical surveys to inform the siting of wind turbines, cables, and offshore wind power substations or offshore converter stations. Community engagement is an important component of SAP activities, including engagement with Tribal Governments, States, fishing interests, local coastal residents and governments, and others who may have an interest or rights that may be affected by development. At the conclusion of assessment activities, the developer submits a Construction and Operations Plan (COP) to BOEM, and if sufficient, BOEM undertakes environmental review under NEPA and technical review. The COP is required to be submitted within five years of lease issuance, though an extension may be granted.

As part of the NEPA process, BOEM, as the lead federal agency, consults with other federal agencies including Coast Guard, USACE, DOD, Federal Aviation Administration (FAA), NOAA, National Park Service, Fish and Wildlife Service, and the Environmental Protection Agency on navigation, defense, endangered species, marine mammals, essential fish habitat, migratory birds, visual effects on historic structures and national seashores, and air quality. Other statutes also have their own consultation requirements such as the Endangered Species Act. BOEM

[10] 43 USC § 1337 (p)(4)(K)
[11] *Id*. at pinpoint to first cite to 43 U.S.C. § 4337

also consults with state and Tribal historic preservation officers on cultural effects as mandated by the NHPA.[12] BOEM is required to consult with Tribal governments more generally given their sovereignty, the government-to-government relationship between federally recognized Tribes and the federal government, and treaty rights. Pursuant to the Submerged Lands Act, states have the right to manage the first 3 NMs off their coast. Also, BOEM is required to consult with states, given that they must decide whether to certify (or to condition certification on certain requirements) the project as being consistent with a state's federally approved coastal zone management plan under the Coastal Zone Management Act (CZMA).[13] BOEM is also required to share a draft environmental analysis, typically a draft EIS, with the public for written and oral comment.

To conclude the NEPA process, BOEM first publishes the final EIS and response to comments, and then after a minimum of 30 days issues a record of decision. Although far-reaching in many respects, NEPA, which was adopted by Congress in 1969, provides limited engagement with the public compared to what members of the public may be used to with local development decisions. Before commencement of an EIS, the lead agency, in this case BOEM, will seek comment on the scope of the EIS. It will be returned to the public after completing the draft EIS, and request written and oral comments. While BOEM typically make a short public presentation to kick off an opportunity to submit written comment on the draft EIS, the interaction is effectively one-way, with the public making comments, rather than a two-way dialogue with questions and answers. Only when the final EIS is issued does BOEM respond in writing. This falls somewhere between informing the public and consulting with it as compared to involving, collaborating, or empowering the public (IAP2 2025; Arnstein, 1969).

BOEM's NEPA reviews have been undertaken project by project; however, before approving the first COP (Vineyard Wind 1), BOEM decided to prepare a supplemental EIS that was effectively a cumulative impacts analysis that considered the effect of developing 22 GW of offshore wind power off the Northeast and Mid-Atlantic coasts.

After issuing a NEPA record of decision for a project, BOEM will then decide whether to approve that project's COP. For COP approval, BOEM looks to the considerations set out in subsection 8(p)(4) of OCSLA, and its regulations at 30 CFR 585.102(a). Of most relevance to this report, BOEM must ensure that a project will provide for safety, protection of the environment, conservation of OCS natural resources, protection of correlative rights, and prevention of interference with reasonable uses of the territorial sea, EEZ, or high seas. BOEM must also provide "consideration" of leases, easements or rights-of-way on the OCS and of other uses of the ocean or seabed, "including use for a fishery, a sea lane, a potential site of a deepwater port, or navigation" and a fair return to the United States.[14]

After COP approval, oversight of a project shifts to BSEE, which oversees project construction, including foundation, turbine, inter-array and export cable, and transformer installation. Once the project is commissioned, BSEE oversees operation and at some point, typically at least 20 years after operation has commenced, will oversee decommissioning. The leases issued off California have an initial term of 38 years.

Existing BOEM Activities

BOEM has designated numerous WEAs off the East Coast from South Carolina to Maine and has approved 12 COPs. One commercial project is fully operational, South Fork Wind which supplies energy to Long Island, while several projects are under construction including Coastal Virginia Offshore Wind, Vineyard Wind I (Massachusetts), Revolution Wind (Rhode Island and Connecticut), and Sunrise Wind and Empire Wind (New York). Although BOEM nominally has an Atlantic Region, it is situated in BOEM's main office in Sterling, Virginia, and renewable energy development is managed by BOEM's Office of Renewable Energy Management. This lack of actual boots on the ground for renewable energy development contrasts with BOEM's long-held strategy for offshore oil and gas.

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[12] 54 U.S.C. §§ 300101 et seq
[13] 33 U.S.C. §§ 1451 et seq
[14] 43 USC § 1337 (p)(4)(J)

BOEM activity has only recently commenced on the West Coast, given different technology requirements described in Chapter 5. To date, floating foundations have been deployed in a few locations off Europe with the projects at a demonstration scale (one to a handful of turbines in an array) rather than at large commercial scale. California planning began in 2016 after Trident Winds tendered an unsolicited request for a commercial lease. In late 2022, BOEM announced the winners of five lease areas, two of which are in the North Coast (Humboldt) WEA and three of which are in the Central Coast (Morro Bay) WEA. BOEM published a final sale notice related to lease areas off Coos Bay and Brookings, Oregon, in August 2024 but postponed those WEA auctions a month later due to insufficient bidder interest and a request from the Oregon governor to postpone the sale. Tribal governments and the commercial and recreational fishing sectors also opposed the Coos Bay lease areas. Despite at least two unsolicited lease requests submitted for federal waters offshore Washington, federal planning off Washington State has yet to commence in earnest, though state maritime planning activities that could guide future developments have been undertaken.

Lessons Learned from Previous Offshore Wind Activities

While no commercial-scale ORE projects have been implemented off the West Coast, lessons can be learned from offshore wind development along the East Coast, particularly in the areas of project design, MSP, environmental review, engagement, commercial fishing, and bidding credits. The next sections will discuss the lessons learned and resulting changes made by BOEM during the California leasing process.

Project Design

BOEM's 2018 draft "design envelope" guidance allowed a developer to propose a "reasonable range of project [component] designs"—for example, in turbine capacity, numbers, height, foundation types, cable size, voltage and routing (BOEM, 2018). With the design envelope, the environmental analysis evaluates the greatest potential impact of each component. This flexibility was needed in a fast-changing turbine market with long periods between project design and financial closure. BOEM published a "Representative Project Design Envelope for Floating Offshore Wind Energy: A Focus on the California 2023 Federal Leases" as part of the draft programmatic EIS in November of 2024 (Cooperman et al., 2024).

Marine Spatial Planning

Efforts to advance MSP in the mid-Atlantic and Northeast brought together states and Tribal governments in the region and federal agencies that have interests in the ocean to agree on regional ocean plans (National Ocean Council, 2016; BOEM, 2016). MSP development also helped to build relationships between individuals representing different states, Tribes, and federal agencies, which can facilitate future coordination on complex offshore siting and development. These efforts also led to regional data portals, which provide BOEM, developers, states, local governments, and civil society with access to data to better understand siting considerations (MARCO, n.d.; Northeast Ocean Data, n.d.). Similar regional data portals are under development for Oregon and California (West Coast Ocean Data Portal and BOEM, n.d.; California Offshore Wind Energy Gateway, n.d.). As an example, the state of Oregon, with several partners, developed the OROWindMap, a publicly available online mapping service (West Coast Ocean Data Portal and BOEM, n.d.). This database provides information on biological data (such as bird, fish, etc. species location and surveys), human related data (fishing locations, existing offshore energy locations, etc.), and physical data (bathymetry, etc.) as required in the Data Gathering and Engagement Plan for Offshore Wind Energy in Oregon (West Coast Ocean Data Portal and BOEM, n.d.).

Environmental Review

Strong environmental review can help identify potential impacts and related mitigation measures and can serve to build trust. It also is less likely to be subject to a successful legal challenge due to environmental concerns.

Engagement

BOEM's engagement processes on the East Coast evolved over time from being mostly static affairs to more interactive approaches (Bennett, 2025). These approaches could include informal information sessions, town halls, and open houses. More on the issue of social engagement is presented at the end of this chapter in the Community Engagement section.

Commercial Fishing

BOEM gained a greater appreciation for the issues involved in the relationship between offshore wind power development and commercial fishing. In January 2025, BOEM issued "Guidelines for Providing Information for Mitigation of Impacts to Commercial and For-Hire Recreational Fisheries. BOEM describes the guidance this way:

> This comprehensive final guidance, informed by extensive public input, establishes clear processes for the offshore wind industry to address potential disruptions to fisheries. It ensures consistency and promotes fair treatment of fishermen, regardless of their home or landing port. The guidance emphasizes early engagement and transparency with fishing communities, encouraging lessees to document interactions. Recommendations in the guidance address design considerations, safety protocols, and financial compensation processes. Compensation measures extend through construction, early operations, and decommissioning, ensuring comprehensive coverage for affected fisheries. (BOEM, n.d.-c)

Additional guidance related to floating offshore wind will be developed in the future; additional discussion of engagement with commercial fishing is presented at the end of the chapter in the Community Engagement section.

Draft Wind Energy Areas

Before designating the Oregon WEA, BOEM identified two draft WEAs (BOEM, 2023). This step enhanced the role of the state and the public in WEA selection by providing further review between the announcement of the Oregon Call Areas and the designation of the Oregon WEAs. This included engagement opportunities on more specific potential locations for siting offshore wind turbines. As part of this process, BOEM scheduled an intergovernmental task force meeting and public meetings and took public comments for 60 days.

Bidding Credits

In early 2023 BOEM published general rules on the use of "bidding credits" in auction processes.[15] The notice for a sale will describe how bidding credits are handled for a given lease sale. In short, a developer gets credit against its bid to use the funds for public benefits, recognizing that offshore wind power development is not without community burdens and that burdens and benefits are not distributed evenly. The regulations are set out at 30 CFR § 585.216. The California leases allowed the successful bidder to claim up to 30 percent in bid credits (BOEM, n.d.-b):

- A 20 percent bidding credit to support FOW industry workforce training programs or develop a domestic supply chain for the FOW industry
- A 5 percent bidding credit to establish a lease area use community benefit agreement (CBA) with one or more communities, stakeholder groups, or Tribal entities who are expected to be impacted either by the actual location of the lease area, or because they use resources harvested from the location of the lease area
- A 5 percent bidding credit to establish a general CBA with one or more communities, Tribes, or stakeholder groups that are expected to be affected from lease development that are not otherwise addressed by the lease area use CBA. This could include potential impacts on the marine, coastal, and/or human environment (such as impacts on visual or cultural resources).

[15] 30 CFR Part 585

Siting, Licensing, and Permitting Wave and Tidal Projects

Water power was not included in the natural resources transferred to states under the Submerged Lands Act, and BOEM has no jurisdiction in state waters. If a wave or tidal project is sited within 3 NM of the coast, and will be grid-connected, FERC would be the lead agency under the Federal Power Act.[16] If the wave or tidal project is not grid-connected, a FERC license would not be required, resulting in the USACE being the lead federal agency under Section 10 of the Rivers and Harbors Act of 1899,[17] addressing obstructions in the navigable waters and Section 404 of the Clean Water Act,[18] addressing the discharge of dredge and fill materials. When a wave and tidal project is to be located in federal waters, a developer would also be required to obtain a lease from BOEM.

STATE-LEVEL PLANNING

California

Electricity demand within California is expected to increase by around 76 percent by 2045, relative to 2022 demand (CCST, 2025). This is due in large part to increased electrification (e.g. increased number of data centers, increase in electric vehicle usage, and other large loads), and population growth. In parallel with this increase in demand, California has ambitious targets for emissions reductions, and hence a growing need for renewable energy. In 2022 the California Energy Commission issued targets for offshore wind of 2 to 5 GW by 2030, and 25 GW by 2045 (CEC, 2022).

The California Renewables Portfolio Standard required electrical utilities to source 33 percent of energy from renewable sources by 2020, with this figure increasing to 60 percent by 2030. The state also has committed to sourcing all electricity from renewable sources by 2045 (CEC, n.d.). Wind and utility solar already provide substantial components of California's electricity, supplying 6.5 percent and 19.2 percent in 2023, respectively (CCST, 2025).

Decommissioning of the Diablo Canyon nuclear facility by 2030 will reduce the availability of emission-free electricity and also provide transmission grid connection opportunities on the Californian Central Coast. Diablo Canyon currently supplies around 6 percent of California's electricity generation (CCST, 2025). Note that further extensions to the operational period for Diablo Canyon may be authorized.

Applications within California State Waters

The California State Lands Commission is the lead decision agency for offshore energy applications within state waters. The assessment process for new applications is outlined in Figure 6-2. Though this process is designed for offshore wind applications, a similar process would apply to most marine hydrokinetic energy projects. For marine energy projects that are integrated into federally-managed coastal structures such as breakwaters and jetties, the USACE will lead assessment of potential impacts on navigational safety. Details of the process and decisions for the proposed CADEMO project, which was put on hold in August 2024, show the substantial complexity of each stage in the process (CSLC, n.d.).

Offshore Energy Permitting (AB 525)

Assembly Bill 525 is legislation passed by California in 2021 calling for the California Energy Commission to develop a permitting roadmap for offshore wind. The Offshore Wind Energy Strategic Plan (CEC, 2024a) was published in June 2024 in three volumes and addresses

- Identification of suitable sea space for offshore wind development
- Identification of impacts on coastal resources, fisheries, Native American and Indigenous peoples, underserved communities and national defense, along with strategies to address those impacts

[16] 16 U.S.C. §§ 791a et seq
[17] 33 U.S.C. § 403
[18] 33 U.S.C. § 1344

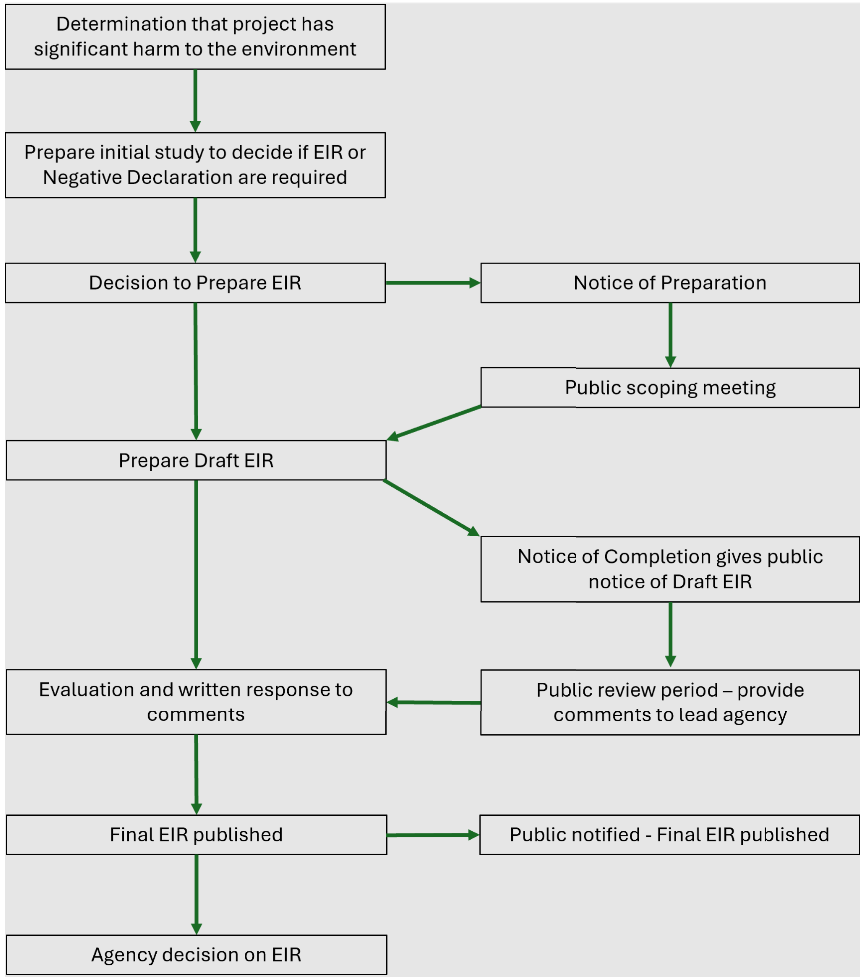

FIGURE 6-2 California Environmental Review Process for Offshore Wind Applications
SOURCE: Modified from California Environmental Quality Act Process Flow Chart, 14 CA ADC Div. 6 Ch. 3 Appendix A.

- Economic and workforce development
- Infrastructure, including port space and transmission lines
- Permitting process

The final report was built from a phased project plan, the feasible maximum capacity of California offshore wind resources, assessing the economic benefits and workforce development needs, and determining the options for the permitting roadmap to emphasize a coordinated, comprehensive and efficient process.

The roadmap notes that offshore wind development in California will occur primarily in federal waters under BOEM authority and that the state may coordinate with the BOEM process through the roadmap. California AB 525 requires that, as part of the roadmap development and communication, opportunities for meaningful input are provided to agencies, Tribes, and stakeholders. With regards to fisheries, a series of virtual and in-place meetings were held to solicit input regarding potential impacts on commercial and recreational fishing as well as identification of suitable sea space for offshore wind development. Consultations with Tribes were carried out throughout the process via letters to all California tribes to solicit consultation, phone calls and emails to tribes with ancestral boundaries near proposed WEAs, and twice-monthly meetings with an inter-Tribal working group.

Measures suggested to address Tribal impacts according to the roadmap include:

- Conducting ongoing, meaningful consultations and collaboration
- Encouraging developers to contract with tribes for ongoing cultural and environmental monitoring
- Encouraging, with BOEM, developers to agree to CBA with tribes
- Exploring opportunities to include Tribes in "adaptive management of offshore wind"

For fisheries, the study recommends:

- Using the latest fishing data from all sources to conduct data analysis of fishing effort and value metrics to inform decision making
- Continuing the California Offshore Wind Fisheries Working Group to develop a statewide strategy to address impacts and prioritize fisheries
- Working with Tribes, agencies, and other stakeholders to integrate efforts related to impact mitigation

The study looked at various models for the permitting approach, and the recommended roadmap stresses the need for a coordinated, comprehensive, and efficient process that is based on a model previously used in California called a renewable energy action team (REAT). Because permitting a large-scale project such as an offshore wind array will involve interactions with numerous public and private organizations, and potentially take years to accomplish, a coordinated approach (in this case via a REAT) would provide similar benefits for development of ORE on the West Coast.

With a REAT, dedicated staff from various agencies are brought together to integrate the required permitting activities and to serve as the primary contact point for Tribes and other interested persons. It is important that the REAT has clear decision-making authority within the agencies, and its members will ideally have been part of other REATs so that they can implement lessons learned from other efforts. With respect to offshore wind, BOEM and California have worked through an Intergovernmental Renewable Energy Task Force since 2016.

California Senate Bill 605

Two technical reports developed to support California Senate Bill 605 (2023) provide details of the potential benefits, impacts, and siting considerations for wave and tidal energy in waters off California. Technoeconomic factors of current wave and tidal energy converter designs resulted in the analysis being constrained to water depths of 200 m or less (CEC, 2024b). The Phase 1 report "Wave and Tidal Energy: Evaluation of Feasibility, Costs, and Benefits" evaluated feasibility of marine hydrokinetic energy development in California and identified classes of costs and benefits associated with those activities.

The California Senate Bill 605 Phase 2 report "Sea Space Analysis for Wave and Tidal Energy" applied MSP techniques to identify areas that were supportive of, and those less suitable for, marine energy development off the Californian coast. This report also outlines monitoring and evaluation considerations for future developments (CEC, 2025).

Oregon

HB 3630 directed the Oregon Department of Energy to develop a comprehensive state energy strategy addressing areas such as reliability, affordability, and greenhouse gas emission targets (ODOE, 2025). Among those targets are an 80percent reduction in economy-wide emissions by 2050 and a 100 percent reduction for major electricity providers by 2040.

The strategy development process (ODOE, 2024) includes identification of decarbonization pathways through input from Tribes, state advisory and working groups, state agency representatives and interagency groups, and public comment to develop scenarios that will allow the state to meet these targets. The technical study was then built around a "Reference Scenario" prioritizing efficiency and electrification. This reference scenario was used as a baseline to compare alternative scenarios with different mixes of technologies and fuels. Once defined, the scenarios are evaluated via a modeling approach to calculate the state's energy needs and identify the lowest cost means of generating electricity within the clean energy targets. The final document detailing the strategy was due in November 2025.

In March 2023, the Oregon Department of Energy published the Transformational Integrated Greenhouse Gas Emissions Reduction study to evaluate actions needed to achieve the Oregon target of 45 percent reduction in greenhouse gas emissions (compared to 1990 levels) by 2035 (ODOE, 2023). The study evaluated two options for meeting the targets: electrification (focused solely on electrification of power demand) and hybrid (combining electrification with alternative fuels). Using a modeling tool that incorporates energy, emissions, and finances, the study determined net benefits and health benefits of these two scenarios. The calculations showed a cumulative net benefit of roughly $47 billion for either scenario by 2050. The cumulative health benefits from meeting the decarbonization targets were calculated as about $75 billion for either scenario by 2050 (ODOE, 2023).

Oregon publishes a biennial energy report with the latest version issued in 2024. Based on this report, in 2022 Oregon imported 32 percent of its electricity, with the remaining 64 percent generated in state via solar, hydro, wind, geothermal, natural gas, biomass, and petroleum (ODOE, 2024). Lawrence Livermore National Lab data from 2022 shows that 96 percent of Oregon's in-state electricity came from three sources: natural gas (49 percent), hydro (37 percent), and wind (10 percent) (LLNL, 2025).

HB 4080[19] requires the Oregon Department of Land Conservation and Development to develop an Offshore Wind Roadmap that defines standards to consider in the processes related to offshore wind energy development and approval. The standards defined in the Offshore Wind Roadmap must support

(a) Effective stakeholder engagement;
(b) Local and regional coastal communities;
(c) The creation of economic opportunities and sustainment of existing local and regional economies;
(d) The creation of an offshore wind energy workforce that is local, trained, housed, and equitable;
(e) Protection of Tribal cultural and archaeological resources, culturally significant viewsheds and other interests of Indian Tribes;
(f) Protection of the environment and marine species; and
(g) Achievement of state energy and climate policy objectives, including energy resource diversity, reliability, and resilience of state and regional energy systems.

As of the time of this writing, the Oregon Offshore Wind Roadmap is still under development.

Washington

Washington has enacted the Clean Energy Transformation Act[20] pursuant to defining clean energy targets for the state. Washington is committed to a carbon-free electricity supply by 2045. The Climate Commitment Act[21] requires the state's largest greenhouse gas emitters to purchase allowances for these emissions on a quarterly basis. These allowances are freely tradeable and are an effort to incentivize the reduction of emissions.

The 2021Washington State Energy Strategy seeks to balance three goals: competitive energy prices, increasing competitiveness, and reducing greenhouse gas emissions (WSDC, 2020). As part of developing their strategy, Washington created an advisory committee consisting of legislators, officials, civic organizations, businesses and public interest advocates. The state also sought broader input through public engagement efforts. A macroeconomic model, PI+, developed and maintained by Regional Economic Models, Inc., was used to examine how decarbonization targets could be reached under various scenarios such as rapid electrification and behavioral changes compared to a "business-as-usual" scenario.

[19] HB 4080, 82nd Oregon Legislative Assembly, 2024
[20] SB 5116, State of Washington 66th Legislature, 2019
[21] SB 526, State of Washington 67th Legislature, 2021

Part of this strategy adds 4 GW of offshore wind to the state's electricity portfolio between 2040 and 2050 (Gridworks, 2024). While it was recognized as early as 2023 that offshore wind is not currently cost-competitive with onshore wind or solar, this option is still being explored, particularly since onshore wind and solar resources are primarily out-of-state and require expansion of transmission capacity (Gridworks, 2024).

The development of in-state resources is important for economic development but must be balanced with commitments to upholding Tribal sovereignty and protecting the interests of communities where this development occurs. Estimates have indicated that the power generation opportunities from strong winter wind fields offshore can supply all of Washington's winter power needs. Offshore wind also has the relative advantage of shorter transmission pathways to consumers. Washington does not have any explicit policy regarding offshore wind development or interactions with the federal government or private developers (Gridworks, 2024).

Per the Washington State Energy Strategy, 16 percent of greenhouse gas emissions in 2018 were from electricity generation (WSDC, 2020). The state targets to reduce emissions from all sources by 45 percent by 2030. Because the base year for comparison is 1990, and emissions have risen since then, this 2030 goal represents a 53 percent reduction from 2018 levels. The Washington State Energy Strategy did not calculate net benefits of decarbonization, but notes that these will be calculated and published as part of a future report.

From 2022 data developed by the Lawrence Livermore National Lab, 86 percent of Washington's in-state electricity came from three sources: hydropower (49 percent), nuclear (19 percent) and natural gas (19 percent). 5 percent came from wind (LLNL, 2025). The WSES assumes that there is no room for growth in hydropower and that wind and solar will be needed to meet the additional future energy demands. Note that much of this supply will be imported: in one scenario 36 percent of 2050 electricity production would come from Montana and Wyoming-based wind. The state's assumptions are that until 2040, solar and wind production in state and federal offshore waters will be minimal. By 2050, the state's models include 6 GW of new transmission from Montana and 5 GW from Idaho.

Depending on the modeling assumptions used, the state estimates that the 2050 electricity mix will still heavily depend on hydropower, but less than current levels (WSDC, 2020). There will be a shift to solar and wind (both onshore and offshore) some of which will be in-state, with a portion imported from neighboring states. Overall gas-fired production will be somewhat reduced, and nuclear power will be phased out as the sole in-state power plant is shut down by 2040.

The Washington State Energy Strategy highlights that a key part of meeting decarbonization targets is developing greater interconnection among "the 11 Western states" highlighting that a regional approach is needed as opposed to a state-by-state approach.

STATE MARINE SPATIAL PLANNING AND MARINE COASTAL ZONE MANAGEMENT

The CZMA was adopted in 1972 with the goal of encouraging state planning for management of the coastal zone. It differs from other federal environmental laws in that state participation is voluntary (although currently all coastal states participate in the program other than Alaska, which withdrew in 2011) and states may craft their state plan as they wish in terms of structure, approach, and what to include. States are encouraged to participate through federal financial support and the consistency requirements set out in CZMA. CZMA also encourages the creation of special area management plans. The Rhode Island special area management plan for offshore wind power development, which led to the BIOWP, is an example. Importantly, CZMA does not authorize federally recognized coastal Tribes to be treated in a manner similar to states. As a result, Tribes whose lands border the ocean may not create Tribal coastal zone management plans to ensure floating offshore wind power projects are developed in accordance with enforceable Tribal coastal zone policies.[22]

Under the CZMA, a state's coastal zone is defined by outer limits of the Submerged Lands Act, which for California, Oregon, and Washington is usually 3 NM, the adjacent shorelands, and inland as far as necessary to control the shorelands, which may be Highway 1 or another major roadway. The coastal zone excludes lands held

[22] Unlike states, coastal Tribal governments were also not authorized by the Submerged Lands Act to manage the natural resources within 3 NM of the coast.

in trust by the federal government, including Tribal lands, lands within a national park, wildlife refuges, national forests, public land management systems, and military lands.

A state management plan identifies its boundaries and the enforceable policies (laws and regulations) behind it, and must, define permissible and prioritized uses, designate areas of concern, include an energy planning process, allow reasonable uses that have regional benefits, and provide for public participation. Importantly, the trigger is not for an action to take place within the boundaries of a defined state coastal zone, but rather whether the action affects "any land or water use or natural resources of the coastal zone of that state."[23]

California, through its Coastal Commission, Oregon, through its Department of Land Conservation and Development, and Washington, through its Department of Ecology, maintain coastal zone management programs. In addition, Oregon developed a Marine Renewable Energy Geographic Location Description to provide boundaries (following the 500 ft depth contour) where marine renewable energy projects automatically be subject to the federal consistency review of licenses for offshore wind or wave power generation facility development and underwater cables that service power generation (ODLCD Coastal Management Program, 2015).

Federal consistency requirements for potential ORE deployment come into play primarily in two ways. First, the issuance of a federal lease is considered a federal agency action.[24] Thus, when BOEM issues an offshore wind power or a marine renewable energy lease in federal waters, BOEM is required to certify no later than 90 days before holding a lease sale that its lease action is consistent with affected state management plans to the "maximum extent practicable." A state then has 60 days to either concur, conditionally concur, or object. Second, when BOEM issues a license or permit such as approving a COP, the applicant (developer) is required to make a certification that its activity is consistent with legally binding, and hence, enforceable, portions of a state's plan with regard to any "reasonably foreseeable"[25] effects on land, water, and natural resources. A state may object, concur, or place conditions on its concurrence; but if the state fails to act within six months, concurrence is presumed. If the state objects, the state license or permit cannot be issued unless the secretary of commerce overrides the objection.

Oregon was called on to make a CZMA consistency determination for marine renewables (a 307(c)(3) license applicant) and offshore wind leasing (a 307(c)(1) BOEM). In early 2020, Oregon conditionally concurred in Oregon State University's CZMA certification related to its application for a FERC license to operate the 20 MW PacWave hydrokinetic test facility. In July 2024 Oregon issued a conditional concurrence regarding a potential lease and associated easements for offshore wind power off southern Oregon (Coos Bay and Brookings). At that time, however, BOEM chose not to move forward with leasing. California issued CZMA consistency determinations for offshore wind power leasing in WEAs off Morro Bay and Humboldt in 2022. In each case, BOEM made a request for consistency determination, and California conditionally concurred.

DATA NEEDS FOR OFFSHORE RENEWABLE ENERGY SITE SELECTION

In selecting sites for ORE, several key factors must be balanced. The first is the availability of the energy resources (wind, wave, tide), based on historical weather patterns and the physics of wind and wave energy. This aspect is relatively well understood via resource characterization studies conducted by national laboratories within the Department of Energy and others.

The second key factor is the ability to extract ORE at a competitive price, which is governed by technoeconomic properties of the turbine or energy converter, and the ability to get the devices to the necessary locations. This requires an understanding of the port infrastructure necessary for construction and operation. Once the energy has been generated it must be transported to where it is needed, requiring an understanding of the capacity and limitations of the existing grid network. As most of the available energy is located a long distance away from major population centers, this requires substantial modeling and investment.

It is also necessary to understand what human and ecological systems could be affected by ORE development. This requires both information about existing spatial and temporal use patterns, and information about potential

[23] 16 U.S.C. § 1457 (c)(3)
[24] 307(c)(1), 16 U.S.C. § 1457
[25] 15 CFR §930.11

conflicts and interactions. Data may be quantitative (such as sampling, monitoring, reporting, survey responses) or qualitative (including interviews, focus groups, traditional narratives and oral histories). Thoughtful integration of these diverse sources of data and attempts to bridge traditional (Indigenous), local (fishermen), and science-based knowledge, while challenging, will be facilitated by thoughtfully designing collaborative processes to foster co-production of knowledge (Huntington et al., 2011; Alexander, et al., 2019; Berkes, et al., 2007).

Identification of conflicts (or potential for colocation opportunities) with other marine uses is the final component of site assessment but can be the most complex. This is due both to limited baseline information about some existing uses and the lack of previous projects from which physical and biological impact information can be sourced. Each of these data needs is addressed in the following subsections.

Resource Characterization

For wind energy, the turbine technology is well developed, and different developers compete for the right to develop in WEAs with known wind speeds and water depths. For hydrokinetic energy, the location of the ideal resource requires more detailed site- and device-specific analysis, due to the range of technologies and complex wave and current interactions with bathymetric contours and offshore geography. Each device will have an optimal set of operating conditions (e.g. water depth, wave height) and developers will seek to locate their devices in locations that most closely match their ability to generate power at different wave heights and periods or current velocities. Seasonality in wave heights and directionality of the waves will have different impacts on different devices, depending on their ability to self-align to the incoming energy and perform across the range of wave heights and periods.

Wind Energy Resource

The Pacific Northwest National Laboratory and NREL estimate that development of offshore wind on the U.S. West Coast may contribute up to 33 GW by 2050 (Douville et al., 2025). The West Coast Offshore Wind Transmission Study identified an area 10–50 mi off the coast of Northern California and southern Oregon as the most promising for offshore wind development. This area covers approximately 9,265 sq mi and has consistent winds in the 9.5–10 m/s range (approximately 22 mi per hour) at hub height, which is ideal for large wind turbines (Douville et al., 2025). Although winds are typically stronger with greater distance from the shore, this study restricted their analysis to identifying areas with depths of no more than 1,300 m, as mooring and cable infrastructure deployment become more complex and costly with depth.

Wave Energy Resource

NREL conducts resource characterization via sampling and modeling activities, and the energetic resource for wave and tidal energy is relatively well understood. The Marine Energy Atlas provides interactive maps of these resources for the entire country. The Phase 2 of the California Senate Bill 605 report provides more detailed information for the Californian coast, restricted to areas with a water depth of 200 m or less (CEC, 2025). This depth was selected because it is approximately twice the depth of existing wave power test facilities in Oregon and Hawaii, to allow for advances in mooring technology and reductions in the levelized cost of energy. This report included overall analysis of wave and tidal energy resources and spatial layers representing other marine uses, such as marine protected areas, defense operational and historical use areas, shipwrecks, navigational pathways, and areas of importance for commercial fishing, recreational angling, and aquaculture. This analysis also considered conflicts and colocation opportunities but did not weight layer importance or interactions in considering suitability of sites. It was also technology agnostic, meaning that it identified areas of highest available energy that were unconstrained by other marine uses. Due to limitations in the available data for energy closest to shore (in water depths of less than 50 m), which may be the best locations for wave energy, there may be additional areas worthy of further investigation that were not identified in the report. The report also outlines environmental monitoring and evaluation processes that should be incorporated into any permit for deployment of wave and tidal energy off the West Coast.

Port Infrastructure

In developing ORE, the location of key ports for construction and maintenance operations is critical. The size and scale of floating platforms and turbine components limit their construction and assembly to large port locations, as they are too large and heavy to be transported or assembled without access to deep water. Approximately $11.7 billion in investment is necessary to facilitate port development for offshore wind in California alone (Lim, 2025). Further discussion of port development related to ORE development can be found in Chapter 7.

Transmission Infrastructure

Delivering the energy to locations where it is needed most is a critical factor. Inter-array cables, transmission cables and, depending on the size of the project, one to three offshore substations will be necessary to bring offshore energy to land. From there it must be transmitted to where the energy resources are required. The demand for energy is based on patterns of development and population centers. For grid-connected devices or arrays, the ability to locate or develop a suitable connection point is critical. At the time of writing, this is relevant to offshore wind, but less so for wave energy, where devices are typically on the scale of hundreds of kilowatts. For distributed applications with relatively small generation capacities, it is necessary to locate as close as possible to the demand, to reduce transmission costs and losses. Transmission grid studies have been undertaken for California, identifying necessary upgrades and limitations of the electricity network.

Existing Marine Uses

To date, most planning has relied upon desktop planning exercises that identify potential use conflicts from existing spatial information. This process works well where the alternative marine use has well defined spatial extents and there is a clear conflict that requires total exclusion of renewable energy. For example, it would not be appropriate or practical to locate turbines or energy converters in shipping lanes or fairways identified in the PAC-PARS (see Chapter 2), nor would it be appropriate to add new cable transmission routes through marine protected areas. Desktop planning exercises are less appropriate where the spatial extent of the alternative use is not (or cannot be) clearly delineated, or where the potential interaction between that use and renewable energy infrastructure is unknown or uncertain. For example, the impacts of mooring, noise, inter-array cables, and transmission cables on migratory marine mammals will require monitoring and adaptive management.

There is limited publicly available information with regard to the location and importance of recreational fishing activity. This information is obtainable only via dedicated surveys, which are conducted infrequently and do not include detailed information about where people fish. Limited information is available about commercial fishing in fisheries with a small number of participants (where the release of this information would result in confidentiality issues), or those where vessels are not required to use vessel tracking technologies. Cell phone mobility data may provide one means of more effectively tracking fishing activity in these sectors, but it would face substantial confidentiality and privacy obstacles and concerns.

By their nature, smaller commercial uses (e.g., locally important commercial and recreational fisheries) and nonmarket uses (recreation, cultural uses) will be more likely to have spatial data deficiencies, meaning that they may not be adequately considered in spatial planning exercises. This can lead to large impacts on small communities and industry sectors that may already be socially and economically vulnerable. The Community Engagement section provides additional information on this topic.

Impacts of Offshore Renewable Energy

Human Use Impacts

While freedom of navigation will remain within wind projects, there will likely be *de facto* limitations on some activities including commercial vessel navigation and the use of certain kinds of fishing gear given the size of vessels and gear, the presence of dynamic inter-array cables, and the distances between wind turbines. With careful siting these conflicts can be avoided or minimized, but they may have locally relevant impacts on commercial and recreational fishing, and port users. There may also be acute and chronic impacts associated with construction and operation of both offshore installations, and their shoreside connection and service points. More details on human use impacts is included in the Community Engagement section below.

Ecological impacts

The 2025 GAO report identified a range of potential ecological impacts of ORE

- Collision, entrainment, impingement, and entrapment
- Underwater noise
- Electromagnetic fields
- Changes in habitats
- Entanglement (primary and secondary)
- Changes in oceanographic systems and processes
- Displacement
- Water quality.

Floating wind and marine energy are relatively new technologies and have not been tested at scale in the conditions and environments found off the U.S. West Coast. Pilot stage projects are designed to provide information both about real-world energy production and the environmental impacts of deploying these technologies. The Phase 2 report for California Senate Bill 605 provides an overview of monitoring and evaluation of best practices for wave and tidal energy, and many of the suggested studies are also relevant for offshore wind.

In addition to uncertainty about the potential impacts of ORE, there may be limitations in the baseline data about the use of marine areas by potentially sensitive and/or protected species. For example, migratory patterns of seabirds, marine mammals and commercially and recreationally important fish stocks are not fully understood.

The CADEMO project, as proposed, would have allowed for monitoring of environmental impacts of a small array of four floating wind platforms and turbines off the coast of Central California. That project was put on hold in August of 2024.

PacWave South in Oregon provides a grid-connected test facility for wave energy devices on the West Coast, which is pre-permitted for most devices and reduces the complexity of deployments. This provides an opportunity for many types of devices to reduce the costs of field testing, which is a critical component of advancing through the higher TRLs and ultimately to achieve commercial deployment, and lower levelized cost of energy.

COMMUNITY ENGAGEMENT

Renewable energy is often framed as an optimal and sustainable option to provide variation in methods of electricity generation, although its development and operation are not without social dynamics. Social scientists have long analyzed large-scale renewable energy development under the framework of "social acceptance" (Wüstenhagen et al., 2007), which considers market, socio-political, and community acceptance (Figure 6-3).

Research on community acceptance of offshore wind power, discussed below, relies on a longer-term understanding of the prerequisites to community acceptance. Participation processes that rely on one-way communication may not allow for meaningful participation, resulting in the public not feeling heard, or even feeling disrespected (Innes and Booher, 2004). A critical issue is often who controls information and whether those that do are trusted (Innes and Booher, 2004). More broadly, considering increasing social distrust (Kasperson et al., 1992) of science and institutions, more collaborative approaches than have typically been employed in federal energy permitting processes may be beneficial (Kasperson and Ram, 2011). Collaborative approaches seek to move beyond the one-way flow of information, envisioning face-to-face dialogue with interested parties communicating with and influencing one another, and building consensus (Innes and Booher, 2004; Ansel and Gash, 2008; Innes, 1996). Also, integrating traditional and local knowledge, citizen science, and joint fact-finding along with both formal

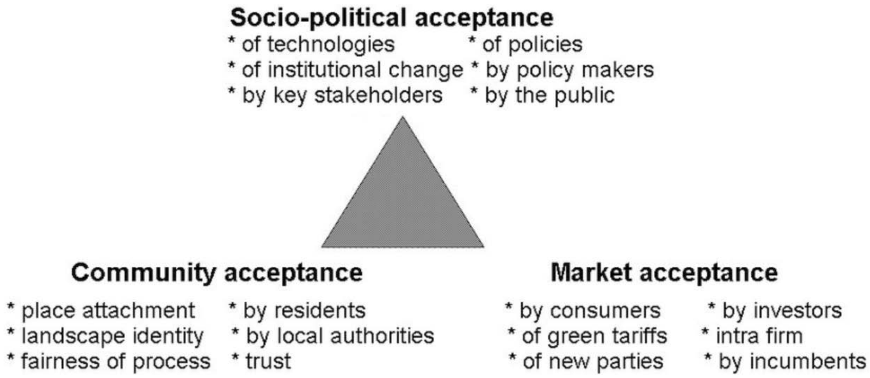

FIGURE 6-3 Social Acceptance Dimensions
SOURCE: Wolsink, 2012.

and informal participation opportunities can facilitate meaningful participation (Smythe and McCann, 2018). The benefits of collaborative approaches are many: networks are built, as is intellectual, social and political capital; learning takes place; individuals can come to recognize that other opinions are legitimate; and trust is fostered (Innes and Booher, 2004; Ansell and Gash, 2008). In the end, better processes may be a prerequisite to community acceptance.

Turning to offshore wind power, fixed-bottom offshore wind power development recently has had difficulty in U.S. markets given supply chain and inflation woes in the face of previously negotiated fixed-price power purchase contracts leading to project cancellations. The industry also has seen a reversal in political support at the federal level, from the Biden administration's goal of 30 GW by 2030, to the second Trump administration requiring a review of the government's leasing and permitting practices on their first day in office. President Trump temporarily withdrew all areas of the OCS from future offshore wind leasing, and issued stop work orders or sought to have previously issued COPs and permits that are being contested in court by third-parties remanded to BOEM for review and potential modification or denial. However, state support for offshore wind power remains strong in several coastal states, including California, Maryland, Massachusetts, New York, Rhode Island, and Virginia.

Community acceptance has garnered significant scholarly attention, though most research has considered either land-based or fixed-bottom offshore wind power development. Regarding U.S. offshore wind power, much of the published social science research has focused on hypothetical offshore wind power projects or projects that had not yet been constructed at the time of the study, with the exceptions being research related to the BIOWP. The BIOWP has several atypical attributes, though, so research findings may not be generalizable. Specifically, the BIOWP is a demonstration-scale project composed of five wind turbines rather than commercial scale; it is located in state waters, so BOEM was not involved; it benefited from a state MSP effort in support of project development; it is located approximately 16 NM from the mainland coast of Rhode Island; but it is located within 3 NM of an island that supports a large summer tourism economy and a small year-round population (whereas commercial-scale projects can be expected to be located approximately 10 NM or further from shore); and the project as a whole includes a separate cable that connects the island to the land-based grid, which replaced diesel generators on the island.

More generally, there have been efforts to understand the *social* gap—that is, the gap between levels of general support for a given renewable energy technology and the percentage of proposed projects that are successfully developed—and the *individual* gap between levels of general support and levels of local project support, which are often lower (Bell et al., 2005). Scholars suggest that opposition to local projects is better seen as place-protective action rather than "not in my backyard" attitudes (Devine-Wright 2005, 2009), where for many coastal residents their support or opposition may be affected by whether they consider the local project to be in or out of place in the ocean and coastal environment (Russell et al., 2020). Closely related to the issue of sense of place is the visual effect of offshore wind turbines on coastal residents and tourists, with wind projects being viewed negatively and as a source of anger by some, and positively and as a source of pride by others (Russell and Firestone, 2022; Russell et al., 2020; Parsons et al., 2020; Krueger et al., 2011). Concerns surrounding offshore wind power impacts on tourism, recreational uses, fishing communities, fishery economies, and wildlife abound (Smythe et al., 2021; Smythe et al., 2020; Parsons et al., 2020), which may also reflect underlying values and beliefs (Bidwell, 2017).

The scholarly evaluation of offshore wind power project attitudes has recently drawn on what is referred to as energy justice (Jenkins, et al., 2016). Energy justice simply considers whether the process leading to project development has been fair, whether persons with an interest have been engaged in that process, and whether the outcome (the balance of benefits and burdens) is fair to affected users.

From the elucidation of the BOEM process above, it is apparent that BOEM provides many opportunities for public comment, but from surveys, interviews, and focus groups of coastal interests, it appears that the public is either disconnected from those opportunities or considers the substance of those opportunities to be wanting. Indeed, the literature suggests the public perceives BOEM as primarily being engaged in "box-checking", where money is "power" and locals are marginalized (Smythe et al., 2025, 6, Table 2).

A lack of publicly available scientific data, along with mis- and dis-information, has also challenged members of the public who are trying to distinguish facts from fiction, confounding perceptions of justice (Korein et al., 2025). Offshore wind power mis- and dis-information has been found to be "pervasive," particularly with regard to the effect of offshore wind power development on marine mammals, which multiple government agencies have stated is not a significant from a scientific perspective (DOE, 2023). Slevin et al. (2025) focuses on offshore wind power obstruction, and details complex networks that include commercial fishing interests that spread offshore wind misinformation. However, in the broader context, Howley et al. (2025) examined perceptions of ten sources of misinformation, finding that social media and elected officials were seen as the most prevalent sources of misinformation, with offshore wind developers and the commercial fishing industry grouped among moderate sources and Tribes as the least prevalent source. This is consistent with earlier findings of a deficit of trust in, and openness and transparency of, government decision-makers and project developers (Dwyer and Bidwell, 2019; Smythe et al., 2025). Among the recommendations to mitigate misinformation are trust and relationship building and acknowledging gaps in knowledge and information and uncertainties (Howley et al., 2025).

Regarding the operational (since 2019) BIOWP, although it garnered substantial support among Block Island residents, the process that led to the project's development was described as a "done deal" and "not above board" (Firestone, et al., 2020). Given these findings, perhaps not surprisingly, local support for U.S. offshore wind and perceptions of process fairness have been found to be correlated (Firestone, et al., 2020).

Commercial and recreational fishermen may face distinct obstacles to engagement. Their interests are diffuse, and they come to any table or discussion with divergent interests. Some target mobile species and others sessile,[26] and within those broad categories, different species require the use of different gear and may be impacted in distinct ways (Haggett et al., 2020). The GAO (2025), in its recent study, was able to discern neither how BOEM ensured that commercial fishing interests were included in its planning processes nor how it informed those commercial fishing interests how their input would be incorporated.

With commercial fishermen, face-to-face and personal interactions may be required for engagement to be meaningful (GAO, 2025). Fishery liaisons are typically employed by developers. These liaisons, along with organizations like the Responsible Offshore Development Alliance, can help to enhance capacity and to mitigate distrust and concerns over power imbalances (GAO, 2025).

BOEM is legally required to consult Tribal governments, and specifically Tribal historic preservation officers under the NHPA and under the principle of sovereign government to sovereign government relationships between the United States and federally recognized Tribes. As part of its study, the GAO (2025) interviewed 22 Tribal governments and Tribal organizations and found that BOEM had not engaged meaningfully with Tribal governments. Although there had been some consultation, the GAO (2025) concluded that when it received Tribal concerns, BOEM did "not consistently demonstrate efforts to consider or address these concerns." The GAO (2025) noted that BOEM had recently adopted a Tribal Engagement Strategy but given its recent adoption, the GAO was uncertain how BOEM would implement that strategy in practice. In an unpublished master's analytical paper, Garcia (2021) details interviews with representatives from five East Coast Tribal governments and one Tribal government

[26] Sessile refers to immobile species that are attached to a surface, e.g. oysters

organization, along with representatives of BOEM, two states, three developers and other government agencies such as National Park Service, NOAA, and Environmental Protection Agency. These other government agencies had significantly more experience with Tribal consultation and engagement than BOEM, and the paper found that rather than engaging in government-to-government consultation with Tribal governments, BOEM was shifting its legal responsibility to developers. One interesting recommendation from the paper was that BOEM broadly trains staff and leadership to enhance understanding of the Tribal constitutional structure, history and cross-cultural communication (Garcia, 2021). In a recent master's thesis, Suarez (2025) co-designed a research project with the Yurok Tribe concerning Tribal sovereignty in the ocean and the development of offshore wind power. A centerpiece of the research was the interview of thirteen individuals, at least nine of whom identified as indigenous. The interviewees underscored the importance of federal, state and Tribal sovereigns coming to a common understanding of Tribal sovereignty offshore. BOEM's failure to engage meaningfully with Tribal governments also has been exacerbated by Tribal capacity deficiencies (GAO, 2025). As noted by BOEM to GAO, and as emphasized in this chapter, under OCSLA all offshore wind power revenues from developers (auction bonus bid payments, rents and royalties) are deposited in the Federal Treasury, leaving BOEM without funds. Additionally, BOEM does not have authority under the OCSLA to provide support to Tribal governments that could build and enhance technical and human capacity, which could allow them to more meaningfully engage with BOEM and developers. Given that, the GAO (2025) concluded that congressional action is required for BOEM to provide adequate support.

A conundrum presented by offshore wind power is that there may be local impacts while the benefits in terms of clean air and climate mitigation and revenues are much more diffuse. BOEM has sought to address this issue within the constraints of OCSLA by providing bidding credits as part of lease auctions. State legislative bodies have opportunities to mandate local benefits through legislation that authorizes their state to consider contracts to purchase offshore wind energy. Likewise, state utility regulators can condition the acceptance of any contract on the provision of local benefits. States like Massachusetts have also conditioned CZMA concurrence on financial support to address impacts on the commercial fishing sector.

Offshore wind power development may generate benefits in the form of shoreside economic development (manufacturing and port re-development) and related tax revenue, jobs (including those directly related to site investigation, construction and operation), and infrastructure improvements (grid, internet and roads). Although these benefits may be substantial, they also may not be distributed in the same areas or among the industries experiencing burdens. For example, in California, wind projects are proposed to be developed off Central Coast communities while economic development related to wind turbine staging and deployment (and likely any related manufacturing) and associated jobs to facilitate the Central Coast development are expected to be in Southern California near the port of Long Beach.

This imbalance between local burdens and local benefits may in part be addressed through what are broadly referred to as community benefit mechanisms. Community benefit mechanisms include job creation, economic development, and monetary payments to support community goals such as local tax relief, community programs, or community infrastructure. Offshore wind power development presents some particular challenges given that the primary portion of the development is in federal waters outside of local control and zoning, typically creating boundaries as to who is a community of interest. Offshore wind can also be comprised of projects under separate control, such as the expansion of the Port of Los Angeles/Long Beach to accommodate offshore wind power development on the central California coast (Bingham, et al., 2025; NREL, 2023; Tyler, et al., 2022). Offshore wind power community benefit mechanisms may take the form of host community agreements (for those communities hosting project infrastructure such as cable landing), good neighbor agreements (e.g., to respond to visual impacts), project labor agreements, and CBAs to advance community goals and programs (e.g., coastal resiliency). From interviews in the Northeast, Smythe and colleagues (2025) found that offshore wind community benefit mechanisms can be a form of recognition, if they are fairly negotiated and the benefits are properly allocated, otherwise they can be perceived as bribes or handouts, and insufficient.

In the offshore wind context, there also have been "agreements" focused on compensating commercial fishermen for potential loss of revenue and livelihood that may result from offshore wind power development. BOEM has supported this through its recent issuance of fishery mitigation guidance as detailed below (2022). Also, there has been one Tribal benefit agreement with a developer to date. Importantly, Tribal benefit agreements must be considered through the lens of Tribal sovereignty, treaty rights such as fishing rights, and potential desires for co-management of natural and cultural resources of concern to Tribal nations. Similarly, the CADEMO project signed a community benefits agreement with the federally recognized Santa Ynez band of Chumash Indians in 2023 (DOE, n.d.) before the project was put on hold in 2024.

Further, while demonstration projects like BIOWP have garnered support, it remains to be seen how large-scale commercial development will be viewed. On the one hand, coastal residents have indicated that if their local project was the first of many similar projects, they would tend to be more supportive of the local project. This was true even of the notorious Cape Wind Project that was proposed to be developed off Cape Cod, Massachusetts, but ultimately failed after more than a decade of controversy (Firestone and Kempton, 2007). On the other hand, while residents of Block Island and coastal Rhode Island evinced support for commercial-scale development near BIOWP, levels of support dropped if a project was being built to provide energy to neighboring Massachusetts, and even more so to neighboring New York state (Bidwell et al., 2022). These findings highlight the potential for regional issues to underly perceptions of distributional unfairness.

The adjacent ocean areas off the West Coast states of California, Oregon, and Washington do not overlap like the waters off the Northeast and mid-Atlantic states, and the West Coast states have for the most part long coastlines running north to south. Still, at the margins, a wind power project could be developed off the coast of one state to support energy sales under contract to another (e.g., development off Brookings, Oregon, which is located near the Oregon–California border) or could be viewed as providing energy to more removed urban residents and businesses rather than to coastal residents and economies. Concerns over visual impacts, tourism and property values are concerns regarding local burdens while benefits from offshore wind power development are more diffuse.

Burdens may be particularly pronounced on commercial fishers as well as on workers in the commercial fishing supply chain (fish processors and distributors, though some also process and distribute fish caught by other nations). In a study of commercial fishing and offshore wind power development in the UK focusing on coexistence, many respondents reported that they had been displaced, that spatial competition had increased, that they had to travel greater distances to fish, and that had been negatively affected financially (Szostek et al., 2025). The GAO (2025) had underscored concerns over loss of access. In the UK, although some fishers received compensation, they expressed "frustration in the amount of money received or inequity of payments between individuals or fleet sectors," shedding further light on the distributional complexities (GAO, 2025). As the GAO (2025) noted, more profoundly, fishing communities may experience cultural changes if fishing becomes less viable as an occupation; these cultural changes include impacts on families who have multigenerational links to fishing. And as commercial fishers can originate in different ports to fish in overlapping areas at sea, there also can be impacts to what are referred to as "communities at sea" (St. Martin and Olson, 2017).

Potential or realized impacts to income or to gear due to interactions with wind turbine cable arrays or mooring lines suggest a role for fishery compensation schemes, which are presently not mandated in law. Considering the lack of legally mandated compensation, and facing fishing industry concerns regarding losses, BOEM (2022) issued fishery compensation mitigation guidelines. An East Coast consortium of 11 states is likewise trying to address these concerns through the establishment of a regional fishery compensatory fund; in November 2024 they selected a team to assist them in developing a standardized claims process (SIOW, n.d.). To date, when compensation has been provided, it has occurred on a project-by-project basis and has been driven as much by developers as by governments, which may explain some of the equity concerns detailed in research studies. Issues of fishery compensation are also ripe for consideration in the Tribal context, and those issues are even more pronounced given that Tribal fishing is governed by treaty rights. In contrast, there is no general commercial right to fish in the ocean. California Senate Bill 286[27] requires the development of a statewide strategy "for ensuring that offshore wind energy projects avoid and minimize impacts to ocean fisheries to the maximum extent possible, avoid, minimize, and mitigate impacts to fishing and fisheries in a manner that prioritizes fishery productivity, viability, and long-term resilience, and fairly and reasonably compensate persons engaged in the commercial and recreational fishing industries and Tribal fisheries for economic impacts to ocean fisheries resulting from offshore wind energy

[27] SB 286, Offshore Wind Energy Projects, 2023

projects." The California Offshore Wind Energy Fisheries Working Group, at the time of this writing, continues its work on developing the Statewide Strategy.

In contrast, studies of wave and tidal energy have been sparse. In a recent study of attitudes toward wave energy in the states of Washington, Oregon, and California and the Canadian province of British Columbia, researchers found that a majority had positive attitudes, but a full quarter did not have enough knowledge of the technology to express an opinion (Stelmach et al., 2023). In an early mail survey, Stefanovich (2009) found that while almost a quarter of coastal respondents required more information before they could answer a question about their attitude toward wave development off Oregon, 59 percent had positive attitudes compared to just 6 percent with negative attitudes.

Finally, a recently published review article by Boudet and colleagues (2025) that focuses on extensive public literature on renewable energy projects, with emphasis on offshore wind power, examines project siting. They distinguish *effective siting practices*—those that include "inclusive, expansive and immersive communication" and participatory assessments of project effects," are flexible and transparent, and where local perspectives are given voice and treated as important inputs that help to shape siting—from *ineffective practices*—those that are box-checking, operate on a "decide-announce-defend" model, and where local perspectives are discounted relative to expert ones or simply not incorporated (Boudet et al., 2025, Box 2). They conclude that projects will need to focus on building trust, responding to public concerns rather than dismissing those concerns, and being realistic about the time required to address potential community effects.

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7

Effects and Benefits of Offshore Renewable Energy

This chapter describes potential interactions with ORE development across commercial, Tribal, and recreational fishing, shipping, other maritime activities, and Coast Guard operations related to commercial fishing vessels. It builds upon the previous chapters, which described the current and potential future state of maritime activities, shipping, fisheries, and Coast Guard operations. Both benefits from and burdens caused by ORE development, as well as possible mitigation strategies, are explored. The chapter concludes with recommendations.

OFFSHORE RENEWABLE ENERGY AND FISHERIES INTERACTIONS

Effects on the California Current Ecosystem

An area of concern around FOW development is the impact projects may have on oceanographic processes, such as upwelling and primary production along the West Coast. Wind turbines extract wind energy from the atmosphere, cause wind wake effects (see Chapter 5), and thereby inherently affect wind-driven upwelling and circulation. The magnitude of these effects, and effects on the ecosystem, including fish and fisheries, merit continued study (Jacox, 2025; Raghukumar et al., 2023). As discussed in Chapter 3, the CCE is highly dynamic, and much of the primary production that supports fisheries relies on upwelling of cold, nutrient-rich waters. To date there are no operational FOW projects of similar size to those proposed offshore California, which have the potential to install at least 4.6 GW of capacity in the Humbolt and Morro Bay lease areas. The effects of large capacity FOW arrays on ocean dynamics, including coastal upwelling, have not been measured.

However, results from recent modeling studies, that consider the effects of energy generation from up to 8 GW of installed capacity off California, indicate that while FOW could have significant local effects on upwelling, both positive and negative, there would likely be minimal net impact to upwelling measured across a wind lease area (Jacox, 2025; Raghukumar et al., 2023). Further modeling has suggested lesser effects on nutrient supply to surface waters and primary production (Jacox, 2025). These studies suggest that while ORE installations yield local effects, these changes would be dispersed and not significant given the considerable natural variability and changing ocean conditions at the level of FOW installation modeled. California's strategic plan to install 25 GW of FOW capacity by 2045 would exceed current modeling considerations.

Conclusion 7-1: Current modeling (that considers up to 8 GW of installed floating offshore wind capacity) indicates upwelling, nutrient supply, and productivity may be affected locally, but impacts likely will not be significant for the U.S. waters off the West Coast more broadly, particularly when compared to natural variability and the changes associated with climate change. However, ongoing monitoring and updated modeling is needed to confirm whether and how upwelling, nutrient supply, and productivity may be affected in the future.

The environmental effects of ORE are addressed in a compilation of educational briefs as part of the U.S. Offshore Wind Synthesis of Environmental Effects Research project (SEER, 2022) and reviews (Farr et al., 2021, Harris et al., 2025). Subjects include bats and birds, vessel collision, entanglement, underwater noise, fish ecology, electromagnetic fields, and benthic disturbance.

Effects of ORE on the movement of fish (e.g., tuna) or marine mammals (e.g., gray and humpback whales) on the U.S. West Coast are unknown. Limited data exist for the effects of ORE on marine species in waters off the United Kingdom where the effects have been found to be negative (UNEEP-WCMC, 2024). Similarities may be drawn between possible marine mammal habitat disruption from ORE development on the West Coast and the habitat compression seen during the 2014–2016 northeast Pacific marine heatwave where some whales moved closer to shore. The 2014–2016 habitat compression increased interaction between marine mammals and Dungeness crab fishing gear, impacting the fishery (Santora et al., 2020), but to date no studies have examined possible marine mammal habitat compression from ORE development. Demersal fish, such as hake, are less likely to be affected by ORE development.

While marine birds are not a focus of this study, they have been an important consideration in the development of ORE elsewhere in the world and are likely to be important in its development on the U.S. West Coast, particularly for endangered species or those covered by international migratory bird treaties. Several studies have documented the distribution and abundance of marine birds off the U.S. West Coast in the context of ORE (Leirness et al., 2021, Wallach et al., 2025). New methods are being used to study the vertical distribution of marine birds near offshore wind turbines (Schneider et al., 2024). Most marine birds are found below the swept area of the rotors of wind turbines, with only 8 percent of birds above 10 m at any given time (Wallach et al., 2025). Certain species such as the sooty shearwater, which migrates higher above the sea surface to make use of the higher wind speeds, are expected to be exceptions to the 10 m standard. The opportunity exists to alter the operation of wind turbines during periods of high exposure to marine birds or bats.

Electrical transmission cables that connect FOW arrays to shore create EMFs which may affect some species of marine organisms (SEER, 2022). Creci and colleagues (2022) found no effect of EMFs on sand eel larvae, whereas Guillebon and colleagues (2025) found that EMFs affect some behaviors of larval cod and haddock. Female shore crabs were found to respond strongly to EMFs via altered behavior such as lingering near cables and attraction to high-EMF zones (James et al., 2025). The same study also highlighted possible disruption to crab population dynamics relating to "migration, mating, and larval release" (James et al., 2025). However, due to their local occurrence, EMFs are likely to be less of a concern for ORE development than other environmental effects.

Research shows that marine mammals are at a low risk of primary entanglement with FOW mooring lines and inter-array cables, and at unknown risk of secondary entanglement with fishing gear that may become caught on mooring lines and inter-array cables or tertiary entanglement when already entangled and caught on mooring lines and inter-array cables (SEER 2022, Farr et al., 2021, Harris et al., 2025). It appears that primary entanglement is not a significant concern for ORE because mooring and transmission cables are sufficiently large to be detected and avoided by marine organisms. More data is needed to fully understand the likelihood of secondary and tertiary entanglement. There could also be risks of marine mammals striking the FOW platforms, anchors, or inter-array cables, but the committee found no literature addressing this topic.

ORE will create noise in the environment during all stages, from site investigation through decommissioning, but particularly during installation. Nonoperational noise (e.g., from pile driving) will be quieter and at greater depth for floating wind turbines than for bottom-mounted wind turbines like those on the East Coast, while operational noise is similar for floating and fixed wind turbines, with the exception that the floating wind turbines produce transient noise associated with their moorings at high wind speeds (Risch et al., 2023). Operational noise has been measured near FOW turbines associated with two projects in Scotland: Kincardine which has five turbines, each operating at 9.5 MW, and Hywind with five turbines, each operating at 6 MW (Risch et al., 2023). For a 15 m/s wind speed, underwater operational noise exceeded ambient noise up to 4 km away from the array center. During this assessment, porpoises were observed to avoid the arrays. Harbor porpoises have also been observed to avoid tidal turbines (Gillespie et al., 2021, Palmer et al., 2021).

Fishing Within or Near Offshore Renewable Energy Sites (Commercial and Recreational)

As noted in Chapter 5, FOW platforms are a newer technology with few operational arrays on a global scale as of 2025. Of the projects that do exist, none are in water depths comparable to the lease areas off California, at 500–1,300 m. According to a report released in 2024 by NREL, fishery-specific interactions will depend on the floating structures and their respective layouts (i.e., spar, semi-submersible, or tension-leg platform; Cooperman et al., 2024). Important considerations will include the watch circle radius (100–350 m), the peak displacement of the floating hull from its installed location, seabed contact area (up to 75 acres), the extent of the mooring system at the sea floor, and inter-array cables connecting turbines and substations that will likely sit about 60 m below the surface. Additionally, every lease would be expected to have between two and eight buried export cables delivering energy from the offshore substation or converter station to shore. Details for California FOW projects, including platform type, anchor systems, inter-array cable connection, and export cable arrangement have not been decided.

Without an operational FOW project in water depths such as those in the lease areas off California, we are left to make informed assumptions about the ability to fish in and around an ORE site. Some studies anticipate that mooring structures and inter-array cables will have the largest impact on fishing methods that rely on mobile gear, due to various obstacles such as navigation challenges and risk of entanglement (Haberlin et al., 2022). Commercial vessels using gear such as trap and trawl fisheries, groundfish longline, or purse seining would likely be more affected than those participating in surface fisheries.

De facto exclusion of certain fishing activities in and around ORE installations should reduce fishing mortality in those areas, particularly for the gear types that would be precluded from operating in and around the installations. However, fishermen displaced from an area may leave the fishery or move to different fishing grounds, which may result in gear compaction, crowding and impacts to fishermen and fishing communities outside of the lease site. To the extent ORE installations act as fish aggregating devices, like the ones observed with bottom-mounted turbines, they could also keep fish from being available to commercial fisheries. The net effect on fish mortality on a larger scale is uncertain but likely small.

A 2022 study by the National Academy of Sciences, Engineering, and Medicine found that offshore wind projects can interfere with a ship's navigational radar, which is used to avoid collisions, posing challenges for safe maritime navigation. This has raised concerns about potential exclusions from or increases in premiums for insurance coverage for commercial and recreational fishermen, and operators of commercial fishing vessels (Marvasti and Werner, 2024).

Conclusion 7-2: Offshore renewable energy projects could result in an area that is effectively closed to most commercial fishing, which might, depending on the fishery, reduce catch or the amount of fish available to be caught (e.g., species with high site fidelity) or increase fish stock recruitment and abundance.

Wave and tidal energy projects would likely also restrict fishing activity. The California Energy Commission's SB 605 Draft Consultant Report on Sea Space Analysis considered suitable depths for wave energy converters to potentially extend to a maximum depth of 200 m (CEC, 2025). Many fisheries such as the purse seine fisheries for CPS, including squid, operate in waters potentially suitable for wave energy projects off California and are greatly affected by wind and current. According to presentations received by the Committee, that fishing activity likely would not be feasible within a wave or tidal energy project that had components either on the surface or the sea floor (Henkel, 2025). This functional closure could extend up to a mile around the facility for some fisheries, depending on their operational needs, wind and current patterns.

Conclusion 7-3: The expected ratings of individual wave and tidal devices is in the kW range, with arrays in the MW level involving single to tens of devices, i.e., orders of magnitude less than wind arrays, and such arrays are likely to be placed much closer to shore than offshore wind turbines. As such:

Wave and tidal device impacts on fishing, communities and shipping will be near shore compared to wind, and meaningful engagement is likely to be critical,
Spatial and temporal conflicts within ports used for construction and operation will be lower than for offshore wind turbine assembly and transportation,
Spatial interactions with nearshore fishing activities (Tribal, commercial and recreational) may be substantial, and
Wave and tidal energy are expected to serve local applications rather than grid scale, thus requiring U.S. Army Corps of Engineers or state approval, vs. grid connection approval through Federal Energy Regulatory Commission.

Finally, dependent on the location of where the offshore wind array cables come ashore, there could be temporary impacts on recreational surf-based fishermen or near shore fisheries such as those who fish from kayaks. For example, on the East Coast U.S. Wind's cables are proposed to come ashore beneath 3Rs beach in Delaware Seashore State Park resulting in a one-time off-season recreational fishery closure (DNREC, 2024).

Tribal Fishing Impacted by Offshore Renewable Energy Development

Tribal fishing occurs along the West Coast in places that are both culturally and resource significant. With minimal uncertainty, ORE development would likely impact Tribal fishing, so Tribal collaboration and consultation is needed to assess those possible impacts, both direct and indirect. The development could cause fishermen

BOX 7-1
East Coast Recreational Anglers, Perceptions of ORE, Post-Construction

Studies have been conducted on the U.S. East Coast to collect recreational anglers' impressions of their fishing experiences in and around offshore wind turbines. There are limitations to applying the findings of these studies to West Coast recreational anglers due to differences in array types (floating vs. fixed), array sizes (demonstration projects vs commercial scale), the distance of wind arrays from shore, and relative ocean depth of the study locations. However, the studies do provide some understanding of anglers' thoughts. Two studies analyzed the same surveys and interviews of recreational saltwater anglers from New York, Connecticut, Rhode Island, and Massachusetts. Survey participants were collected from the National Saltwater Angler Registry and resulted in 199 completed surveys (a response rate of 9%) with participants having a combined average of 28 years' fishing experience.

There was a general perception among survey respondents that the wind turbines had a small, net-positive impact on catch. Interviewees confirmed that those who fish at and around the project believe there had been fish aggregation at the turbines, enhancing catch, increasing species diversity, and providing more "trophy fish" (Bidwell et al., 2023). Anglers described the turbines as "growing food" for fish with "seaweed, barnacles, and everything growing on the legs" (Smythe et al., 2021).

The papers analyzed anglers' motivation for being on the water, with the survey providing interviewees with seven options. Of the seven, "to be outdoors" ranked the highest, with a mean of 4.51 on a 5-point scale, while contrastingly "to catch fish" ranked behind "to experience natural beauty" (second) and "for relaxation" (third), with an average of 4.21. Table 2 in Smythe et al (2021) provides a full list of responses.

As a note, as it relates to the issues of natural beauty, there was a slightly negative response to the visual aspects of the project among angler survey respondents (Bidwell et al., 2023).

and fisheries to be displaced from fishing locations or require fishermen to change gear types to accommodate the presence of ORE projects and ancillary components. The same development could result in fish aggregation, which could reduce species diversity as fishing practices target the aggregated species. In addition to direct impacts to fishermen and fisheries, the presence of ORE along the coast could cause Tribal fishermen to experience changes in their available catch or fishing locations, increased fishing activity within the Tribal usual and accustomed areas by displaced non-Tribal vessels, or changes in gear type options if marine mammal migration patterns or movement corridors are altered due to ORE platforms, electrical service platforms, cables, and anchorages.

Tribal fishing is an usufructuary right, meaning it is the legal right of Indians to hunt, fish, and gather from the land. In United States v. Washington,[1] the Supreme Court ruled that the treaties between the United States and certain Tribes in the Pacific Northwest include reserved right to fish and include the right to have the fish habitat protected from human-caused degradation. It is possible that ORE development would impact the Tribal usufructuary right by disrupting the habitat that fish rely on. As a result, Tribes that have adjudicated treaty fishing rights could articulate the impacts from ORE projects under the above ruling, United States v. Washington, and for the Columbia River Tribes, United States v. Oregon, the Belloni Decision (see Chapter 3). For those Tribes in particular, as well as other affected Tribes, proposed ORE projects should be clearly presented in advance of construction to provide time and opportunity for both the federal government and Tribes to reasonably ascertain potential impacts on fish habitat, and any underlying usufructuary right to take fish.

Beyond the mentioned impacts on Tribal fisheries and a Tribe's capacity to secure fish, many Tribes experience spiritual and cultural ties to the marine environment and species that come from it (NOAA Fisheries, n.d.). Tribes have relied on species such as salmon, halibut, lamprey for "thousands of years for use for Tribal religious/cultural ceremonies, subsistence, and commerce" (NOAA Fisheries, n.d.). Because of these ties, certain areas suitable for ORE development may be considered traditional cultural properties which are properties subject to the NHPA (DOI, 1992). Under the NHPA, projects seeking permitting would be required to include a process to identify and mitigate project effects as they relate to historical and cultural resources. ORE projects should undergo an evaluation for potential impacts on spiritual and cultural interests. An example of traditional cultural properties considerations for the offshore marine environment is when all of Nantucket Sound was recognized as a TCP because of its cultural significance to the Wampanoag Tribes in 2010 (DOI, 2010).

Conclusion 7- 4: Tribal fishing is likely to be impacted by ORE development; therefore, tribal collaboration and consultation is needed early in the project planning and evaluation process to assess possible impacts and mitigation methods.

Harbor Access, Marina Space, and Landing Obstructions

The California Offshore Wind Draft Programmatic EIS identifies possible staging and integration ports along the coast, including the Port of Humboldt, Port of Long Beach, and the Port of Los Angeles (BOEM, 2024). Many of these ports would require additional funding and development to accommodate large-scale wind projects. For example, the Port of Long Beach's plans for the Pier Wind Project would create space for the assembly of wind turbines on the shoreside that could then be towed offshore to sites as far as central and northern California (Plezia, 2025).

Each of the ports mentioned above are important to California's commercial and recreational fishing communities, who are dependent both on the infrastructure at the docks and on dockside and land-based support businesses. In response to California Assembly Bill 525, the PFMC provided information on how the development of offshore wind could impact both small ports and the fisheries they accommodate (PFMC, 2024). Its concerns relate to limited space and crowding in fully developed harbors, because berths and other harbor spaces accommodate both local fishermen and coastal-traveling vessels. The lack of available space and continuous operation of these harbors at full capacity could lead to potential safety issues during bad weather, as they would no longer be able to operate as harbors of refuge.

[1] United States v. Washington, 384 F. Supp. 312 (1974)

Beyond spatial competition within harbors, the PFMC raised concerns about environmental conditions and harbor access limitations for fisheries. Elevations in turbidity or pollution as a result of harbor enhancements or ORE developments could have local effects on the harbor ecosystem. During deployment of turbines and other wind elements, harbor entrances may be closed to all vessel activity, including fishing vessels and pleasure crafts, for the duration of the event (Plezia, 2025; Lim, 2025). Fishermen based in Eureka, California have been told they should expect closures of the entrance to Humboldt Bay, due to the narrowness of the harbor entrance and size of an assembled turbine, when turbines are being towed out to the lease sites during construction, and when turbines are being towed in and out of port for maintenance activities.

Impacts on Fisheries Management

ORE areas may affect the management of fisheries in various ways. Firstly, the behavior, distribution, abundance and productivity of fish may change in response to ORE installations due to factors such as wind turbine platforms acting as fish aggregation devices (Jech et al., 2023). Second, changes in behavior, distribution, abundance, or production of fish may affect fishing locations or catch and effort levels. Third, lease areas and their infrastructure may inhibit surveying, disrupting long running fishery independent surveys utilized in management decisions (Lipsky et al., 2024; see Table 3-1 and Figure 3-2).

Models developed using historical fishery and fishery independent data could be impacted leading to less accurate predictions in fish stocks. Under the precautionary approach utilized in the fishery management process,[2] the higher the degree of uncertainty in a stock assessment, the more precaution is incorporated into catch targets and limits. Cumulatively, such effects may justify consideration of adaptive management, including new or revised observation methods, models and rules. In 2024 NMFS developed *The West Coast Offshore Wind Energy Strategic Science Plan* identifying areas more research is needed to understand the effects of FOW turbines on West Coast fish, fisheries, and fish habitats. The plan emphasizes that the deep waters off the U.S. West Coast will require technology that is not yet deployed at large commercial scales anywhere around the world. To understand potential future effects research activities are needed to explore habitat impacts, physiological and physical effects, species abundance and distribution, socioeconomic impacts to fisheries and fishing communities, ecosystem and climate interactions, and impacts to NOAA's NMFS scientific surveys (NMFS, 2024).

Conclusion 7-5: There is a need for additional data and research to understand and assess the potential impacts from offshore renewable energy development on the distribution, abundance, and production of fish and how those changes may affect Tribes, fisheries, and fishing communities.

In 2022 NOAA and BOEM developed the *NOAA Fisheries and BOEM Federal Survey Mitigation Strategy–Northeast U.S. Region* to mitigate impacts from ORE development in the Northeast on NOAA Fisheries Surveys. This strategy was in response to major adverse impacts to fisheries surveys identified by NOAA during the environmental review for Vineyard Wind 1 project in 2021 (Hare et al., 2022). NOAA experimented with autonomous research vessels supporting stock assessments in areas, like WEAs, that are increasingly difficult to access or sample using traditional shipboard survey methods (NF Staff, 2025).

Conclusion 7-6: The installation of offshore renewable energy projects will likely prevent the National Oceanic and Atmospheric Administration from conducting fish surveys, particularly those that use trawl gear or have fixed survey stations that overlap with ORE sites, and gathering other relevant datasets using traditional methods, so it will need to modify survey plans or identify new ways of assessing fish stocks to inform catch limits.

[2] 50 CFR 600.350(d)(3)(ii)

Impacts on Fishery Treaties

In 1981, the United States and Canada signed the Treaty between the Government of Canada and the Government of the United States of America on Pacific Albacore Tuna Vessels and Port Privileges.[3] Historically, the treaty has benefited Canadian harvesters by allowing them access to the U.S. EEZ to harvest albacore and benefitted U.S. harvesters by allowing them access to Canadian ports for maintenance projects and other purposes.

FOW projects off the West Coast are planned in depth that overlap with important fishing grounds and habitats for North Pacific albacore. As more leases are auctioned, and more important fishing grounds are potentially lost, one of the primary benefits of the treaty to Canadian harvesters will be diminished. U.S. fishery participants report Canadian harvesters are already asking questions about the scope and scale of potential developments and possible implications to the albacore fishery.[4] This could result in either termination or amendment of the Treaty in terms that are less favorable to U.S. harvesters.

Use of Spatial Suitability Model for Identification of Call Areas

In May of 2025, the DOI's Solicitor issued a memorandum withdrawing Solicitor's Opinion M-37067 and reinstating M-37059. This memorandum provides the Solicitor's interpretation of 43 USC 1337, leases, easements, and rights-of-way on the outer Continental Shelf, and states that when evaluating proposals for new activities that could conflict with existing uses, preference should be for activities that "[err] on the side of less interference rather than more interference" (DOI, 2025). As it relates to ORE, the proper siting of energy facilities is an example of a method that can result in less interference with existing uses, such as fishing and vessel transit.

To help identify areas of opportunity for aquaculture development, NOAA's NCCOS developed "whole-ecosystem and regional-scale spatial suitability models" for the U.S. Gulf of Mexico and Southern California Bight (NCCOS, n.d.). Following their success, NCCOS has since partnered with BOEM to draft a WEA siting for the Oregon call areas, using a similar spatial suitability model, in support of designating final WEAs in Oregon (See Chapter 3; Carlton et al, 2023).

The Oregon suitability model incorporated dozens of data layers representing major ocean characteristics from government agencies, universities, non-government agencies. These layers were used to develop five distinct submodels: constraints, industry and operations, fisheries, wind, and natural resources. The layers and submodels were then weighted accordingly to help identify conflicting interests to determine areas most suitable for development.

One limitation to that suitability model was that it was restricted to the call areas and did not take a holistic view of Oregon's entire EEZ. Additionally, concerns were raised regarding the types of fisheries data that were included, a lack of transparency around the weighting of data layers, and insufficient engagement with ocean users and Tribes who may be impacted by ORE (PFMC, 2023).

Conclusion 7-7: Spatial suitability models that are not artificially constrained in the geographic space, incorporate all available data and produce straightforward and transparent outputs, engage interested parties, and provide sensitivity analyses on the weights selected, would increase the likelihood of siting ORE facilities in a manner that prevents interference with reasonable uses.

Conclusion 7-8: In identifying call areas, BOEM did not adequately consider or account for current or future ocean uses, including commercial, recreational, and Tribal fisheries and the habitats they depend on, such as through a broader, transparent process that included spatial suitability modeling on a regional scale.

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[3] Treaty between the Government of Canada and the Government of the United States of America on Pacific Coast Albacore Tuna Vessels and Port Privileges, May 26, 1981, S. Treaty Doc No. 97-13.

[4] Communication between U.S. albacore fishers and Canadian albacore fisheries

EFFECTS OF OFFSHORE RENEWABLE ENERGY ON MARITIME ACTIVITY AND SHIPPING

Port Interactions

ORE activities are expected to require port facilities that can support 3 general types of activities:

1. Manufacturing and fabrication (M&F) of components, including those for platforms, nacelles, towers, and blades
2. Staging and integration (S&I), including assembly of foundations, and integration of wind turbines and foundations ready to be towed to site
3. Operations and maintenance (O&M) throughout the life of the project, involving transporting personnel and equipment to the site for maintenance and inspections

The planning of these activities and assessment of port infrastructure assumes that S&I activities will take place in a port or other sheltered area, rather than in the open ocean, and only fully assembled foundations with wind turbine generators attached will be towed to their final locations from the port facilities.

As part of the strategic planning for future development, California authorized, via Assembly Bill 525, a study of ports in the state and their readiness to accommodate ORE activities. The limiting factor for ORE development was ports that can support the S&I phase of FOW projects. The Port of Humboldt, Port of Los Angeles, and Port of Long Beach are the only ports with existing harbors suitable for integration activities. Plans at these ports to create large areas (hundreds of acres each) devoted to S&I and M&F activities (referred to as a marshalling port) would provide sufficient S&I capacity to allow the state to meet its 2045 offshore wind energy development goal of 25 GW (CEC, 2024). The California Energy Commission, as required by Assembly Bill 3,[5] is currently developing a second-phase plan for seaport readiness for offshore wind development which is due by December 31, 2026.

The Assembly Bill 525 Port Readiness Plan notes that although it is not necessary for all M&F activities to take place within the state, home-basing all M&F activities would maximize the in-state economic benefits of FOW development (Lim and Trowbridge et al., 2023). It is estimated that with the planned development at the ports mentioned above and additional capacity at the Port of San Diego, the state would have the ability to support all M&F activities and reach its 2045 targets.

O&M sites have the most flexibility since the requirements are focused on sufficient berthing for vessels rather than developing new acreage for heavy manufacturing and construction. To meet the 25 GW target, the study estimates that 9 to 16 berths will need to be developed (Lim and Trowbridge et al, 2023). The locations of these berths will be dependent on operational considerations more than port facility capabilities.

Even in ports where new infrastructure is planned to accommodate some of the ORE activities envisioned, other port users may be displaced or restricted, either permanently or during a particular phase of ORE development. For example, when floating turbines are towed to site, access to the port may be restricted to ensure safety of the operations and limit risk of damage to the turbines and vessels (Plezia, 2025). When inspection campaigns are undertaken for a wind project, an increase in vessel traffic from O&M sites could limit access for other traffic such as fishermen.

Shipping and Coast Guard Maritime Geospatial Planning Considerations

The marine transportation system is vital to the U.S. economy, and the Coast Guard's PARS are an important MSP effort to preserve vital commercial and navigational uses. Port access route studies will be a critical element of future maritime activity siting decisions, because of the important information about shipping and maritime activity they gather. The Coast Guard's MSP practices regarding maritime commerce and Tribes have been successful at de-confliction of competing waterway uses. This is likely due to a clear procedural doctrine and local units that hold recurring forums for continuous engagement with the maritime community. Expanding MSP pro-

[5] Assembly Bill 3, Zbur, Chapter 314, Statutes of 2023.

cedures to include considerations such as those for cable permitting and licensing and other related maritime uses can leverage the advantages from the Coast Guard's process.

As discussed in Chapter 2, the Coast Guard's PAC-PARS recommended fairways to accommodate shipping activity. Although the use of fairways is voluntary, a vast majority of vessels have historically conformed to the recommended lanes. During the PAC-PARS, the Coast Guard involved Federal and State agencies, maritime community representatives, environmental groups, Tribes, and commercial and recreational fisherman from inception through formal consultation. During the Committee's open sessions, representatives from the Tribes and commercial fishing communities expressed satisfaction with how the PAC-PARS study was conducted.

Conclusion 7- 9: The Pacific Area Port Access Route Study was conducted using an inclusive and effective process, and the Coast Guard followed a clear procedural process of continuous engagement beginning at the inception of the study effort.

When the PAC-PARS results and associated recommendations are finalized, they will establish clear, defined shipping lanes along the West Coast. These will be very important as new maritime activities make siting decisions. Without clear, defined shipping lanes, new maritime projects could create a maze for commercial ships, much like in the Gulf of Mexico. On the West Coast, the PAC-PARS was finished after WEAs on the West Coast were identified, causing portions of the shipping lanes to be modified to account for ORE development. This stresses the need to consider navigation early in the ORE development process, especially given the projected increases in the volume of commercial shipping.

Conclusion 7- 10: The timely enactment of the Pacific Area Port Access Route Study recommended fairways will promote waterway safety and help inform future studies assessing the competing uses of waters off the West Coast.

The scope of this study is limited to the U.S. West Coast, so the committee did not make any formal recommendations for other parts of the United States. However, given the importance of identifying shipping lanes before new maritime development begins, it will be important for the Coast Guard to conduct port access route studies for other federal waters before maritime activity sites are selected for ORE or other new projects, such as subsea mining. New port access route studies may be appropriate for areas around Alaska, Hawaii, Puerto Rico, the U.S. Virgin Islands, Guam, American Samoa, and the Commonwealth of the Northern Marianas Islands.

Transit Corridors Through Offshore Renewable Energy Projects

Academic studies, government guidance, and developer navigation risk assessments consistently frame the question of transits by avoiding the assumption that vessels must be excluded from ORE arrays. Instead, developers, permitting agencies, and regulators characterize vessel traffic and operational scenarios specific to the development area; quantify and compare risk with and without the ORE project; and decide whether in-array transit, dedicated transit corridors, or routing measures (e.g., precautionary areas, traffic lanes, areas to be avoided) are warranted (Maritime and Coastguard Agency, 2023; USCG 2024). Transit corridors are justified to mitigate navigational risk when they reduce one or more of the following: (1) allision or collision risk (ship–turbine or ship–ship), especially under degraded visibility, heavy weather, or high traffic complexity (Milin, 2025); (2) traffic compression effects created when multiple projects "stack" and squeeze ships into fewer safe routes, raising encounter rates (Milin, 2025); or (3) emergency response constraints (SAR access, towing, maneuvering room) and navigational system performance issues (notably radar/clutter and situational awareness) (NASEM, 2022). The Coast Guard emphasizes mariner lookout, small craft/commercial towing vessel/ORE support vessel traffic, cable awareness, and anchoring avoidance inside ORE arrays as the primary factors determining the safety of "through-transit" (USCG, 2024).

In fixed-bottom ORE arrays, the obstacle field is geometrically stable: turbines are fixed points; the main navigational issues are spacing, visibility or radar effects, traffic density, and emergency maneuvering room (Milin, 2025; Maritime and Coastguard Agency, 2023). Transit corridors in these circumstances address high baseline traffic density and constrained sea room; multiple adjacent projects creating pinch points; safety-of-navigation concerns under worst-case scenarios (e.g. drift, grounding, allision); or the need to preserve established approaches or fairways and predictable routing. FOW arrays differ in that developers, permitting agencies, and regulators cannot evaluate transit through the array by ORE turbine spacing alone, because floating systems add moving, extended subsurface infrastructure that changes the hazard profile (NASH Maritime and, Osprey CSL, 2024). FOW platforms have mooring lines and cables extending outside the visible turbine location creating a snagging risk. Further, FOW turbines motion includes pitch, yaw, heave, surge, and sway affects radar returns and vessels navigating in or near FOW arrays. Similar to fixed-bottom ORE projects, adjacent lease areas can create cumulative vessel traffic pinch points.

In 2022 BOEM awarded five lease areas off California covering 583 sq mi with an expected minimum capacity of 4.6 GW. The PAC-PARS characterized commercial fishing vessel and commercial towing vessel density in the existing lease areas off California as low or low to medium. Neither BOEM's Pacific offshore wind leases nor the final environmental assessments for the Humboldt and Morro Bay WEAs concluded that dedicated vessel transit corridors through the WEAs were required. Instead, BOEM relied on existing and proposed Coast Guard routing measures (PAC-PARS fairways) and project-level navigation safety risk assessments to manage navigational risk. Where multiple adjacent ORE leases exist, however, they could create a barrier to through transits. And achieving California's goal of installing 25 GW of offshore wind power generation by 2045 may require many additional WEAs and over 3,000 sq mi dedicated to offshore wind arrays. Concerns have been raised about the ability to safely transit through these extensive arrays of wind platforms.

Conclusion 7- 11: If the offshore energy goals established by the West Coast states come to fruition, thousands of square miles of offshore waters will be dedicated to wind installations. Further analysis and engagement with interested persons are needed to ascertain whether transit corridors through and between lease sites are justified.

Search and Rescue and Coast Guard Interactions

This section focuses on the interaction of FOW platforms with Coast Guard operations because wind technology is the most suited and advanced ORE technology for commercial scale projects. Other ORE technologies, such as tidal and wave energy projects, would have different interactions with Coast Guard operations. Because FOW platforms can be places of refuge for mariners in distress, and because accidents and security demands will occur on those platforms, Coast Guard operations will require close-quarters navigation around them and may involve docking to them. FOW arrays are anticipated to interact with navigation safety and Coast Guard operations in four important ways:

(1) Surface vessel navigation,
(2) Aviation operations,
(3) Search planning tools, and
(4) Demand for Coast Guard operations.

These four interactions yield a variety of likely burdens, possible mitigation strategies, and benefits to navigation safety and Coast Guard operations.

Surface Vessel Navigation

Coast Guards cutters, boats, and aircraft will inevitably have to perform missions inside FOW arrays. FOW arrays present obstructions to formerly open ocean space and could cause restricted maneuverability of Coast Guard assets operating within and near them. Coast Guard cutter and small boat crews will have to take precautions to reduce the risk of allisions with platforms, potentially including enhancing navigation watches (USCG, 2020) while operating in the vicinity of FOW projects. Coast Guard towing, cutter-boat launch and recovery, and helicopter launch and recovery require specific wind/wave geometry to avoid collisions. The ability to align with that geometry inside the array will be constrained by the space available between platforms (Harrison, 2025). In addition, FOW projects can be configured differently from one lease area to the next, requiring area-specific navigation precautions, familiarity with multiple emergency response plans, and recurring crew training/familiarization regimes (Pedersen and Ahsan, 2020). In these situations, Coast Guard units must use operational risk management to determine unacceptable risk and appropriate mitigation (USCG, 2018) for all operations, including those that would take them in or near FOW arrays.

The mooring system catenaries and any inter-array cables likely do not present a subsurface hazard to Coast Guard surface navigation and operations under most environmental conditions. This is the case in Gulf of Mexico operations around floating offshore production platforms with catenary mooring systems, where the primary concern appears to focus on vessels over 100 ft in length, towing vessels,[6] and fishing vessel trawls (ABSG Consulting Inc., 2015).

Offshore wind turbines affect marine vessel radar in different ways based on a variety of circumstances. The most common impact is radar display clutter from an increase in strong, reflected energy off the turbine, which can lead to complications in navigation decision making (DOE, 2023; Ling et al., 2013; NASEM, 2022). Installing improved radar signal processing equipment (NASEM, 2022) would lessen radar scatter from turbines and mitigate the impact on navigation. In Navigation and Vessel Inspection Circular 03-23 the Coast Guard requires that each corner platform on the edges of an array adjacent to a fairway, or used to identify a designated vessel transit route through the array, be identified by a properly encoded AIS Message, providing additional mitigation for radar clutter and possible positional confusion (USCG, 2023).

The proliferation of industrial internet of things (IIoT) sensors onboard offshore wind platforms may create radio frequence spectrum management challenges that require systematic consideration. Industry analyses document offshore wind projects scaling from hundreds to thousands of wireless sensors supporting supervisory control and data acquisition systems, structural health monitoring, predictive maintenance, and real-time operational data transmission, while simultaneously deploying multiple wireless communication technologies (George, n.d.). A previous National Academies report on marine vessel radar (NASEM, 2022) found electromagnetic interference phenomenology, spectrum management challenges, and the need for comprehensive electromagnetic compatibility assessment. The 2022 report suggested further analysis of RF spectrum management considerations may be necessary given the proliferation of IIoT wireless networks. The U.S. established the interagency Wind Turbine Radar Interference Mitigation Working Group involving the Departments of Defense, Energy, Homeland Security, FAA, NOAA, and BOEM to coordinate research and mitigation activities for wind turbine electromagnetic interference such as the IIoT proliferation and radio frequency spectrum management issue.

Lighting and marking of offshore wind platforms fall under multiple regulatory authorities. Aviation obstruction lighting requirements for structures within 12 NM of shore are established by FAA,[7] and extended by BOEM permitting guidelines to structures beyond 12 NM of shore. The Coast Guard has authority over marking structures and obstructions that pose a hazard to safe navigation of vessels.[8] BOEM (2021) summarizes guidance for lighting, markings, sound signals, and AIS transponders on offshore wind platforms, and the agency considers these factors when approving a SAP, COP, or general activities plan from a lessee. The arrays will also be required to follow Coast Guard Private Aids to Navigation rules (USCG, 2023). BOEM evaluates the safety and impact of proposed lighting and marking in consultation with the FAA and Coast Guard to reduce the risk that lighting creates more dangerous situations. To help identify outer edges of arrays, corner platforms and others at significant locations along the boundary will be marked with different lights than interior, internal platforms (USCG, 2023). In addition to lighting, the Coast Guard has recommended each platform in an array be marked with its unique alphanumeric character, a NOAA-charted designator, enabling quick recognition and reference (USCG, 2023).

Rules for lighting during construction, wet-storage, and installation vary slightly from those above; during the construction phase of offshore wind turbines, the FAA requires temporary steady-burning red lights once structures

[6] 33 CFR § 147.2, and 147.801 through § 147.813
[7] 14 CFR part 77
[8] 33 CFR part 64

reach 200 ft in height, and developers cannot use a Notice to Airmen to justify delaying lighting installation (FAA, 2015). The Coast Guard requires quick-flashing yellow obstruction lights visible at 5 NM on temporary structures, requiring notification but not a full Private Aids to Navigation permit until final installation (BOEM, 2021). These distinct requirements reflect the transition from temporary obstruction marking to permanent marine and aviation infrastructure integration (BOEM, 2021).

BOEM and the Coast Guard have recommended array configuration factors to mitigate the navigation, operations, and training/familiarization burdens. The Coast Guard recommends each wind array be configured in a grid pattern of straight rows and columns with two or more lines of orientation. The grid pattern proposed by the Coast Guard allows mariners to transit through the array on a single course heading. The Coast Guard also recommends an ideal spacing for SAR within an offshore wind array of at least 1 NM between turbines, although this is largely based on helicopter safety considerations. The ORE industry is likely to use remotely operated subsurface vehicles for various functions, including platform, catenary, electrical cable, and mooring inspection. Coast Guard subsurface operations are, by contrast, limited at present. Unmanned, autonomous surface vessel technology is developing rapidly (Matos et al, 2017), but is not likely at sufficient technological readiness level for at-scale use for Coast Guard missions in offshore wind energy arrays. Should the Coast Guard become more involved in maritime security or energy security roles, it may have to increase subsurface operations, requiring close coordination with remotely operated subsurface vehicle operators and operations centers, as in the Gulf of Mexico.

Low-Altitude Aviation Operations

As with cutters and small boats, Coast Guard helicopters will inevitably enter offshore wind energy platform arrays at low altitude for reconnaissance, visual, and surface-search radar searching, hoist-based swimmer deployment, and victim rescue/recovery. Towers and blades can present air collision hazards, obstruct radar signals, and create down-wind wake effects while they are in motion (discussed in Chapter 5). Turbulence from downwind wake effects of operational wind turbines would impede air navigation, hover and hoist operations (Jackson, 2025). As a result, Coast Guard operational risk management will likely prohibit low-altitude air operations in the immediate area until turbines are shut down, requiring a well-refined emergency shutdown procedure coordinated between the Coast Guard and offshore wind energy platform array operators.

When turbine rotation is secured, hover and hoist operations immediately adjacent to the towers still present a risk of air collision and hoist-cable entanglement, but these risks are managed with operational and environmental parameter controls, as evidenced by regular maintenance and medevac hoists from the top of nacelles in other areas. Nevertheless, risk mitigation measures likely suggest moving a vessel away from the base of a platform before hoisting, particularly in adverse weather. Low-altitude air operations have not been unduly impeded, in early operations, in and around European and East Coast offshore wind energy platform arrays, but they do require extensive air crew familiarization and training due to the differences in configuration, prevailing weather, and operators with whom the crew must cooperate. Experience from rescues in European offshore wind energy arrays suggests that while the use of helicopters in SAR remains indispensable, it is best paired with a surface rescue boat response (Brown, 2005).

BOEM (2023) will review offshore wind energy platform lighting during the permitting process. Lighting is designed to increase navigation safety in and around FOW arrays, but it presents a risk of air navigation light confusion (such as confusing these lights with vessel lights) and of night-vision-goggle-enabled flight “blinding” for air crews at close range to lights (FAA, 2009). BOEM, in consultation with FAA and DOD, is considering the use of aircraft detection lighting systems, sensor-based systems that automatically turn on and off obstruction lights, or similar technologies that will minimize impacts from lighting (FAA, n.d.). This risk is commensurate with the risk of night-vision-goggle-enabled flight around Gulf of Mexico offshore platforms and Atlantic fixed OWE platforms. At present the Coast Guard is not pursuing an intermittent detection-based system for marine navigation lights like aviation aircraft detection lighting systems, raising the opportunity for future research on the need for such a system to protect night-vision-goggle-enabled flight or surface operations.

In 2021, the Coast Guard, BOEM, Atlantic Shores Offshore Wind LLC and others convened for a SAR Risk Assessment Workshop to review potential SAR hazards and discuss mitigation methods (BOEM, 2024a).

Recommended mitigation measures from this workshop included VHF direction finding equipment to help pilots navigate into arrays, emergency response procedures for turbine shutdown and rescue, high-resolution thermal or infrared detection systems, training regimes, making offshore wind energy platform lights compatible with night-vision-goggles, passive monitoring of offshore wind energy maintenance personnel location and status, limiting vessel access to offshore wind energy platform arrays during heavy weather, standard communication protocols for emergency situations, limiting aircraft operations in offshore wind energy arrays, limiting the total time any single aircraft spends in the array during SAR or other operations for Crew Resources Management purposes, creating dedicated helicopter corridors, training pilots for offshore wind energy platform helipads, using substation helipads as safe havens for Coast Guard helicopters, and stationing weather instruments in the wind array to provide real-time environmental condition data (BOEM, 2024a).

Offshore wind array operators appear to be considering air-based medevac, maintenance, and resupply operations, which would involve hoists from the nacelle of secured turbines (Helicopter Express, n.d.), and use of helicopter pads on a floating platform in or on the edge of the array. The Coast Guard will still need to ensure that its asset modernization, particularly for the helicopter fleet, has sufficient capacity and capability to perform SAR operations for fishing vessels and other vessels operating in and around the ORE installations, considering the services provided by the operators.

Conclusion 7- 12: The Coast Guard and BOEM have implemented various measures to enhance safety in and around offshore wind arrays including establishment of standards for lighting, marking, and installation of AIS transponders on platforms. They have also made recommendations for array configuration and minimum spacing between turbines.

This collaborative effort should continue, taking into consideration the unique aspects of the proposed West Coast projects (for example, floating platforms in deeper waters further offshore) and evolving technologies.

SAR Planning

Coast Guard SAROPS software (discussed in Chapter 4) cannot currently model specific drift obstructions, such as FOW platforms, which will generate inaccurate drift models as if the array was not there. In addition to inaccurate probabilities of where the object may have drifted, SAROPS may also output search patterns that take a vessel or aircraft directly through or over the array. There appears to be a gap in sensitivity analysis research on SAROPS drifts, given the very localized effects on wind and currents around specific OWE platforms. Where uncertainty exists during a search, Coast Guard crews deploy self-locating data marker buoys to transmit real-time data to SAROPS. To address this, the Coast Guard has sponsored two multiyear efforts to modify ocean and meteorological models to include wind turbines, to collect data to validate this modeling, to further assess wind turbine interference in high-frequency (HF) radar, and to refine radar interference mitigation strategies.[9] These projects are ongoing, and findings have not been finalized or released.

Shore-based HF radar is one of several sources of environmental data used to create accurate drift predictions and search patterns; while not currently in full use on the West Coast, future shore-based HF radar would experience significant radar shadow seaward of the FOW platforms nearest to shore. To mitigate these limitations FOW operators could install HF radar, acoustic doppler current profilers, or other sensors to provide real-time wind and sea-state measurements. OWE array operators could realize significant cost savings and efficiency increases using sensors and remotely operated technology not only for maintenance but also for environmental sensing. But any new sensor data stream comes with considerable variation in data quality and compatibility that must be taken into consideration before use by Coast Guard in SAROPS. NOAA also recognizes that cooperation, not competition, with private sector best serves the public interest. NOAA considers private sector data capabilities, opening questions of wider use of OWE array data.

[9] Communications to the committee from USCG, September 2025.

Demand for Coast Guard Operations

The presence of OWE industry maintenance personnel at FOW arrays would be an increase in personnel working in the maritime environment. Their presence offshore presents a predictable increase in air medevac for industrial accidents, falls (including into the water), and emergencies arising from natural causes. The industry intends to use contract helicopter capacity for its employees, but evidence from European offshore wind projects suggests the Coast Guard air medevac will still be required for high-acuity cases and for those cases occurring either in heavy weather or when contract resources are overwhelmed with simultaneous demands. As part of their rescue response capabilities, operators would need to consider the medical equipment and crew expertise and training needed to respond to high-acuity cases, a capability the Coast Guard does not normally provide. Additionally, high-acuity cases require careful planning and coordination between Coast Guard and contract assets responding to the emergency.

The OWE industry will employ significantly more Coast Guard–inspected vessels during assembly and installation phases, will maintain additional crew and service vessels during the operations phase, and may require safety zones during port transits in the installation phase and offshore while attaching to moorings. The Coast Guard can account for these incremental workload increases using its Sector staffing model but would need to give special attention to the cognitive workload increases on watch standers, including both monitoring and responding to increased human activity offshore and interactions with new stakeholders including OWE command centers.

Response time is critical for falls overboard or from OWE platforms into the cold waters of the Pacific, given the limited functional and survival times in cold water. Crews working on ORE are required to wear specific safety and survival gear, which increases survivability and identification to SAR assets. Diverting service and crew support vessels that are present in the OWE array will frequently result in arrival on scene more quickly than dispatching shore-based Coast Guard boats, cutters, or aircraft. Also, OWE array operators are equipping their vessels and contracting aircraft with capability relevant to assisting in Coast Guard operational missions, most directly SAR. Additional actions, such as requiring OWE personnel to wear personal locator beacons or similar emergency location and alert devices while working offshore would help to minimize response time during industrial accidents, falls, and medical emergencies.

Conclusion 7- 13: Although Coast Guard air medivac will be required for high acuity cases in special circumstances, the Coast Guard does not normally have the equipment, expertise and training to medically respond to high-acuity cases. Additionally, the distance between current OWE areas and Coast Guard rescue assets will normally result in response times that exceed cold water functional and survival times.

It is difficult to anticipate which activities will be displaced from the OWE lease areas into new areas, and what new human activity—for example, offshore recreational fishing excursions will be drawn to the ORE platform arrays. FOW arrays may displace some human activity to new areas outside the arrays, and the degree of displacement is difficult to predict except for bottom-trawl and other bottom-tending commercial fishing activities. Beyond monitoring for increased demand for service in the OWE array, the Coast Guard episodically studies maritime activity outside the OWE array area as part of the port access route studies and in waterway analysis.

RECOMMENDATIONS

As described in Chapter 6, commercial-scale ORE development in U.S. waters was slowed considerably with the issuance of Donald Trump's January 20, 2025, presidential memorandum, "Temporary Withdrawal of All Areas on the Outer Continental Shelf from Offshore Wind Leasing and Review of the Federal Government's Leasing and Permitting Practices for Wind Projects." Acting on the directive in that memorandum, several federal agencies paused the issuance of wind energy authorizations. The January 20 memorandum was followed by Executive Order 14315, "Ending Market Distorting Subsidies for Unreliable, Foreign-Controlled Energy Sources," on July 7, 2025, and the implementing of Secretary of the Interior Order 3437, "Ending Preferential Treatment for Unreliable, Foreign-Controlled Energy Sources in Department Decision Making," on July 29, 2025. In accordance with these directives, on July 30, 2025, BOEM rescinded all designated, and unleased, WEAs on the U.S. OCS,[10] effectively removing the designation of federal waters previously targeted for offshore wind development. On December 8, 2025, a federal judge found the federal agency actions that indefinitely paused authorizations were unlawful and vacated those actions.[11]

While the timeline for ORE development in U.S. waters remains uncertain, there are steps that can be taken to prepare for the possible future implementation of ORE on the West Coast. The following recommendations were created to capture best practices. The recommendations are organized based on topic area, similar to the order of sections presented in this chapter, and are intended to

- better inform decision-makers about the potential effects of offshore development on Tribal, commercial, and recreational fisheries,
- improve the offshore site selection and development process, and
- enhance the quality and durability of the outcomes.

Chapter 3 contains a discussion of shifting fish stocks and modeling efforts to understand how changing ocean conditions may affect species distributions (Conclusions 3-2 and 3-3). Previously, in this chapter the report discusses efforts to understand the interactions between FOW and upwelling, nutrient supply and primary productivity (Conclusion 7-1). Other considerations of interactions between ORE and fishing activity include how fisheries and fish stocks could be affected by a potential for reduced fishing activity within WEAs (Conclusion 7-2).

Recommendation 7-1: National Oceanic and Atmospheric Administration's National Marine Fisheries Service should identify research and data needs to better understand the potential effects (e.g., on upwelling, nutrient levels, productivity, species distributions) of offshore renewable energy development on the broader California Current Large Marine Ecosystem and West Coast fisheries and fill identified gaps as resources allow.

Some studies have begun to model the effect of ORE development in California lease areas on upwelling (Raghukumar et al., 2023) and primary production (Jacox, 2025). Similar studies off of Oregon and Washington could provide a better understanding of the effects on upwelling and primary production before ORE planning continues. Additionally, a better understanding of shifting fish distribution in response to changing ocean conditions could provide a clearer picture of how fisheries will be affected by the placement of FOW arrays.

Engagement with the federal government's regulatory system creates a burden on Tribal resources and personnel. Many Tribes do not have the personnel, resources, or technical capacity to engage in the BOEM planning process in the timeline required, which often includes reviewing technical and legal documents, in addition to Consultation (see Chapter 6 and 7 and Conclusion 7-4)

Recommendation 7-2: Congress should designate funding or resources to support consultation and collaboration by Tribes and other engagement by Tribes who do not have resources to meaningfully engage in the Bureau of Ocean Energy Management process.

Federal agencies are required to conduct Consultations with federally recognized Tribes, but agencies such as BOEM that have not routinely engaged in this process are often unfamiliar with the requirement and the burden falls to Tribal members to educate or re-educate agency representatives about the process (Yrad et al., 2025).

The engagement process and dialogue during PAC-PARS conducted by the Coast Guard with fishing communities, Tribes, and stakeholders followed a comprehensive plan and resulted in community support for the recommended fairways (see Chapter 2, Conclusion 2-1, and Conclusion 7-9). At specific phases of the ORE planning process the lead federal agency, BOEM seeks public comments or input (see Chapter 6). In the Community

[10] 90 FR 37386
[11] State of New York v. Trump, Civil Action No. 1:25-cv-11221 (D Mass. December 8, 2025).

Engagement section of Chapter 6, the report discusses engagement during the planning process for the California and Oregon WEAs and highlights a 2025 GAO report that found Tribes felt a lack of meaningful engagement. Engaging with Tribes, fishing communities and other local users can help account for current and future uses of proposed WEAs (Conclusion 7-8).

Recommendation 7-3 Lead federal agencies for offshore renewable energy projects (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers) should meaningfully engage and establish a dialogue with states, Tribes, fishing and coastal communities, other ocean users, and interested persons to exchange and integrate local knowledge while gaining a mutual understanding of the needs and concerns of all users.

Effective engagement with states, Tribes, fishing communities, and other ocean users cannot happen as one-way communication; it must be a dialogue that continues throughout the ORE development process. The engagement processes should move beyond seeking written and oral comments to include meaningful consultation, interviewing, surveying, focus groups, informal conversation and discussion, open houses and information fairs, workshops, and the use of trained and experienced facilitators. Beginning engagement before call areas are established can contribute to community support and make the process more meaningful.

Installation of ORE platforms will add structures to the marine environment, coastal and nearshore for hydrokinetic energy and offshore for FOW. The exact interactions between the marine environment and these structures are not known. Inference from fixed-bottom arrays, analysis of global FOW arrays, and modeling studies on the environmental effects of FOW can provide some information on environmental effects. However, real time data from the West Coast can provide information on how ORE may affect the distribution, abundance and production of fish in the CCE to better understand potential benefits and impacts (Conclusion 7-5).

Recommendation 7-4: Lead federal agencies, (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers), in collaboration with National Oceanic and Atmospheric Administration and state agencies, should require offshore renewable energy projects to develop and implement scientifically robust long-term environmental monitoring plans for leased sites that ensure comparability across sites and results in publicly accessible data. Monitoring plans should include elements that are designed at a regional level and use standardized, comparable methods across sites.

In addition to continuing long-standing surveys for fish stock assessment, ORE projects have the potential to provide routine, real-time data on the environment in and around arrays to better understand changing ocean conditions (Conclusion 3-3). Development of long-term monitoring plans can help inform environmental effects of future ORE developments and could feed into data streams that support Coast Guard SAR planning and operations.

NOAA's NMFS conducts several repeat surveys along the West Coast (Table 3-1 and Figure 3-1), some of which overlap with California WEAs. Many surveys have continued for decades, and one, the CalCOFI survey, dates to 1949. These surveys provide critical information on fish stocks for fisheries management decisions. FOW lease areas in California and past proposed WEAs in Oregon could interrupt these surveys as currently conducted. Disrupting these surveys without mitigation strategies for collecting necessary data can impact management decisions (Conclusion 7-6).

Recommendation 7-5: National Oceanic and Atmospheric Administration National Marine Fisheries Service, in conjunction with lead federal agencies for offshore renewable energy projects (e.g., Bureau of Ocean Energy Management, Federal Energy Regulatory Commission, U.S. Army Corps of Engineers), should develop a Federal Survey Mitigation Implementation Strategy for the Pacific U.S. Region. The mitigation strategy would minimize disruptions to long-running datasets that are used for stock assessments and other fishery management decisions.

A similar Federal Survey Mitigation Implementation Strategy has been developed for the Northeast U.S. Region, but accounts for fixed-bottom offshore wind facilities. Developing a West Coast NOAA survey mitigation strategy to mitigate the disruptions to long-running data sets that provide critical information about fish stocks and fisheries management is important to minimize impacts on fishing and the health of fish stocks.

Determining uses of offshore maritime space often requires a variety of data sources and an understanding of how different uses can interact in the same space. Adoption of a spatial suitability model early in the ORE siting process can identify conflicting use areas, such as BOEM's use of NOAA's NCCOS model. Using a suitability model early in the ORE planning process, incorporating multiple data sources, and engaging with the various ocean users to validate model results can lead to more informed siting decisions (see Chapter 6 and Conclusions 7-7 and 7-8).

Recommendation 7-6: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, in consultation and collaboration with other applicable federal agencies, states, and Tribes, should conduct a marine geospatial assessment, including a spatial suitability model, for the West Coast. This assessment would be used to evaluate the competing uses, and assess the risks, mitigations, costs, and benefits of the different uses.

In addition to conducting early engagement, a robust process for evaluating and comparing competing maritime uses will lead to more informed decisions about where to propose ORE projects. Engagement across federal agencies, states, and Tribes will ensure that more complete data sets are included in a spatial suitability model, such as the NCCOS model. Also, input from these entities can help provide context and weight to various data layers while evaluating the different uses. A sample framework developed by the committee to help assess competing maritime uses can be found in Appendix B.

The Coast Guard completed PAC-PARS for the West Coast, including an analysis of means to deconflict current competing waterway uses due to the quickly evolving demand for the use of coastal waters. The Coast Guard wanted to determine if new or modified vessel routing measures were needed to ensure the safety of navigation along the West Coast. Collection of vessel traffic data along with input from key stakeholders, Tribal governments, and the public informed the analysis of existing and potential future use of waterways off the West Coast. The PAC-PARS resulted in recommendations for implementation of several fairways along the West Coast (see Figure 2-12, Conclusion 2-1, and Conclusion 7-10).

Recommendation 7-7: The Coast Guard should expedite enactment of Pacific Area Port Access Route Study fairways for the U.S. West Coast.

The PAC-PARS found that there was need for fairways and access routes into and out of ports along the West Coast to accommodate existing and future waterway uses and safe and reliable shipping routes. Throughout the study the Coast Guard engaged with local communities, conducted Tribal consultation, and considered common transit routes along the West Coast to garner broad support for the fairways (Conclusion 7-9).

The five lease areas off California cover a combined 583 sq mi over two sites (Humbolt Bay and Morro Bay WEAs), with an expected minimum capacity of 4.6 GW. California has a clean energy goal of 45 GW of installed offshore wind power capacity by 2045, which may require additional lease areas covering over 3,000 sq mi. Transit corridors providing safe passage between or through wind arrays may become necessary as larger areas offshore are developed with FOW arrays (see Transit Corridors through Offshore Renewable Energy Projects section and Conclusion 7-11).

Recommendation 7-8: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, should engage the Coast Guard and other applicable federal agencies; commercial, Tribal and recreational fishermen; and maritime stakeholders to study whether transit corridors through or between offshore wind lease sites are needed to allow for safe passage for fishing, vessel traffic, and Coast Guard operations.

In addition to the recommendations by BOEM and the Coast Guard for lessees to configure offshore wind turbines in straight rows and columns with a minimum of 1 NM between turbines, transit corridors can alleviate additional burdens on vessels trying to transit to or from the offshore side of the array. Similar lanes have been proposed for East Coast offshore wind projects, in part, to allow fishing vessels to safely transit to and from fishing grounds on the offshore side of wind arrays. Creation of transit corridors could also reduce transit time for Coast Guard assets responding to SAR cases.

Throughout planning and design of offshore wind arrays on the U.S. East Coast the Coast Guard, BOEM and BSEE cooperated to develop guidelines for lighting and marking of ORE structures and spacing between individual offshore wind turbines. FOW turbines planned for use along the West Coast will be tethered to the sea floor by anchors and likely be larger than fixed bottom turbines on the East Coast. Coast Guard SAR assets (surface and aviation) and other vessels will operate in and around FOW arrays. Measures such as lighting, marking requirements, array configuration, and sensors for minimizing navigational impacts will reduce the risk to navigational safety around offshore wind arrays (see Search and Rescue and Coast Guard Interaction Section and Conclusion 7-12).

Recommendation 7-9: The Coast Guard, Bureau of Ocean Energy Management, and Bureau of Safety and Environmental Enforcement should continue adding, refining, and standardizing measures for offshore renewable energy projects in order to mitigate the risk to Coast Guard operations, including surface, subsurface, air, cyber and command-and-control operations.

Continued close collaboration between the Coast Guard, BOEM, and BSEE will help to ensure safe navigation and vessel operation in and around West Coast ORE projects. Additionally, the opportunity to install sensors on wind turbines can enhance domain awareness, minimize navigation risks, and better coordinate emergency procedures.

An increased number of personnel will work offshore during the construction and operation of FOW arrays in areas leased off the West Coast. Additionally, once built, the FOW structures may impact safe navigation. Increased numbers of personnel and impediments to safe navigation can increase the potential for SAR and response by Coast Guard assets. The current lease areas off California are located on the offshore side of main shipping routes, mitigating some navigational safety risk, while putting the facilities farther from Coast Guard response assets. The Coast Guard will need to coordinate with lessees in order to prevent and minimize risk and reduce response time to cases in and around FOW arrays (see Search and Rescue and Coast Guard Interaction Section and Conclusion 7-13).

Recommendation 7-10: Bureau of Ocean Energy Management, the lead federal agency for offshore wind development, should require offshore renewable energy area lessees to provide services for 24/7 vessel and aircraft search and rescue response capabilities to support their personnel and assets. Additionally, the Coast Guard should establish planning and coordination procedures with operators to facilitate search and rescue response.

One way to alleviate the burdens on the Coast Guard and decrease response time for accidents in and around FOW arrays is to require surface or air assets on scene in each wind lease area. As part of their rescue response capabilities, operators would need to consider medical equipment and crew expertise and training needed to respond to high-acuity cases, a capability the Coast Guard does not normally provide. The Coast Guard will still be required to have sufficient capacity and capability to perform SAR operations for fishing vessels and other vessels operating in and around the FOW projects.

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Appendix A

Committee Biographies

Michele K. Conrad (*Co-Chair*) is the principal consultant and strategist for Oceanbeat Consulting. Conrad has over 25 years of experience working with west coast tribes, commercial and recreational fishers, conservation organizations, and interested members of the public to manage sustainable fisheries, protect ocean resources, and evaluate and develop policies and management procedures. Previously, she represented the State of Washington as the primary designee on the Pacific Fishery Management Council (PFMC) for 15 years while she worked for the Washington Department of Fish and Wildlife as the Intergovernmental Ocean Policy Manager and Regional Director for the Coastal Region. During her career she managed Pacific halibut, whiting, groundfish, Dungeness crab, albacore tuna, and sardine fisheries. Currently she co-chairs the PFMC's Ecosystem Advisory Subpanel, serves on the Washington Coastal Marine Advisory Council, and participates in the Pacific Halibut and Sablefish Management Strategy Evaluation processes. Conrad received a B.S. in environmental science from The Evergreen State College.

Conrad has provided consulting services for Ocean Conservancy on fisheries management policies and practices since 2021. In February 2023 Ocean Conservancy made a public statement regarding offshore wind development.

R. Keith Michel (*Co-Chair*) is former President of Webb Institute and former President and Board Chairman of Herbert Engineering Corp. In his forty years employed as a naval architect, he has worked on the design and construction oversight of containerships, bulk carriers, tankers, and liquified natural gas carriers. His work includes developing methodologies for assessing oil spills from tankers and advising the International Maritime Organization and U.S. Coast Guard on these issues. He was lead engineer on marine risk assessments related to shipping on the West Coast of the United States and Canada. He was awarded the Society of Naval Architecture (SNAME) David Taylor Medal for contributions to the field of naval architecture, is a SNAME fellow, a member of the National Academy of Engineering, and was elected President Emeritus of Webb Institute. Michel received a B.S. in naval architecture and marine engineering from Webb Institute of Naval Architecture. He previously served as chair of the Transportation Research Board's Marine Board from 2002-2004 and chaired National Academies committees on Offshore Windfarm Worker Safety and Risk of Vessel Accidents and Spills in the Aleutian Islands.

Dave Anning is the founder of Osprey Economics, and was previously a Senior Consulting Economist with Integral Consulting Inc. He has over 15 years of experience in consulting, academia, government research support, and as a board member of a coastal non-government organization. Anning's expertise includes the management of coastal and marine environments, ranging from work with Tribal governments and the fishing sector to renewable energy developers and regulators. His work addresses topics such as climate vulnerability and adaptation, coastal resilience, offshore wind and marine renewable energy, natural resource damage assessment, and environmental and social impact assessment. His project experience includes assisting with marine spatial planning for wave and tidal energy in California, and estimation of the economic benefits of navigational dredging projects on boating, scuba diving, whale watching, commercial fishing, and recreational angling in Australia. Anning received a B.S. degree from the University of Queensland with majors in marine biology and anatomy, a Graduate Diploma of economics from the University of New England, a M.E.M in environmental tourism from the University of Queensland, and a Ph.D. in geography from the University of New South Wales.

Anning is currently providing pro bono technical advisory services for Monterey Bay Fisheries Trusts on a vulnerability assessment of key fish species. He has provided consulting services to Wave Swell Energy LLC.

Diana Bob is an attorney with Native Law PLLC in Bellingham, Washington and is an enrolled member of the Lummi Nation. Bob's legal practice is focused on generally applicable environmental laws, Federal Indian law, cultural resources laws, Indian water rights, treaty reserved rights, and real property matters. Prior to establishing Native Law PLLC, she was an attorney with Tribal governments, a private law firm, and Washington's civil legal aid firm. Bob currently serves as an appointee on the Washington State Attorney General's Truth and Reconciliation Tribal Advisory Committee. In addition, she has held several leadership positions for the Washington State Bar Association's Indian Law Section and is a frequent CLE presenter on Indian and Environmental law topics. Bob received a B.A. from Pitzer College and a J.D. from Lewis & Clark Law School with a certificate in environmental law.

Bob was employed by Canopy Offshore Wind LLC in 2024 to provide limited legal services regarding Federal Indian Law. As an enrolled member of the Lummi Nation, a signatory of the 1855 Treaty of Point Elliot she holds a reserved right to fish in usual and accustomed places.

David Checkley is Emeritus Professor of Oceanography at the University of California, San Diego, Scripps Institution of Oceanography. His expertise is in biological and fisheries oceanography, including zooplankton and small pelagic fish, the effects of climate thereon, and the development of oceanographic instrumentation. Previously, he directed the Cooperative Institute for Marine Ecosystems and Climate and the California Cooperative Oceanic Fisheries Investigations, co-Chaired the international Small Pelagic Fish and Climate Change program, and was Editor-in-Chief of Fisheries Oceanography. Checkley's career has included work for the Department for Agriculture and Fisheries for Scotland and for the University of Alaska, University of Texas, North Carolina State University, and the University of California, San Diego, Scripps Institution of Oceanography. He received B.S. degrees in oceanography and zoology from the University of Washington and a Ph.D. in oceanography from the University of California, San Diego, Scripps Institution of Oceanography.

Michael Conroy is a Principal of West Coast Fisheries Consultants, a small boutique company working with commercial and recreational fisheries along the West Coast of the United States, where his primary focus is on legal aspects of fisheries management and policy. His expertise is in legislative and regulatory processes relating to fisheries management on both the federal level and in various states. Throughout his career he has worked to ensure commercial and recreational fisheries concerns and future shifts in fish stocks are considered in decision making processes and has explored ways fisheries and offshore renewable energy can co-exist. Prior roles include West Coast director for the Responsible Offshore Development Alliance, commercial passenger carrying vessel operator in southern California, and operator of commercial fishing vessels that targeted several state and federally managed species. He is Co-chair of the Pacific Fishery Management Council's Marine Planning Committee, and Vice Chair of the Council's Highly Migratory Species Advisory Subpanel. He also serves on the California Offshore Wind Energy Fisheries Working Group. Conroy received a B.B.A. from the University of San Diego and a J.D. and M.B.A from Santa Clara University.

Conroy serves as a consultant to the American Albacore Fishing Association on fisheries management and marketing related issues. He was employed by Responsible Offshore Development alliance from 2022-2023, which has made public comments about offshore wind development. He serves in an uncompensated position on the California Offshore Wind Energy Fisheries Working Group.

Jeremy Firestone is a Professor Emeritus at the University of Delaware (UD) in the School of Marine Science and Policy. His research focuses on understanding public attitudes toward, and human behavior regarding, renewable energy technology, particularly offshore wind power, using survey research and semi-structured interviews. Other research foci include Indigenous rights, marine spatial planning, and ocean and coastal law and governance. Firestone was a co-founder and previously served as Director of UD's interdisciplinary Center for Research in Wind. Prior to his doctoral studies, he was an Assistant Regional Counsel for the U.S. Environmental Protection Agency and an Assistant Attorney General for the State of Michigan. Firestone serves on the Mid-Atlantic Fishery Management Council's Ecosystem and Ocean Advisory Panel. He received a B.S in cellular and molecular biology, a J.D. from the University of Michigan, and a Ph.D. in public policy analysis from the University of North Carolina. Firestone is a member of the National Academies Committee on Offshore Science and Assessment.

Firestone served in an uncompensated position as the Director of First State Marine Wind, LLC (FSMW), a jointly owned company between a privately held, 100% UD owned company (Blue Hen Wind, Inc.), and Siemens Gamesa Renewable Energy until 2022. FSMW's sole asset is a 2MW onshore wind turbine adjacent to UD's coastal campus which is used for research and supplies energy to the campus and the Lewes, DE community. He has also made numerous public statements regarding offshore wind development.

Stephen Joner is a professional consultant for the Makah Tribe's Fisheries Management program. He has been with the Makah Tribe's Fisheries Management program for more than forty years in positions including Biologist, Fisheries Director, and Chief Biologist. His work with the Tribe has included developing and managing the Makah hatchery program for chinook, coho, and sockeye salmon, managing the Makah salmon troll and gillnet fisheries, and developing and managing the Makah groundfish and halibut fisheries, including the Pacific hake (whiting) fishery. Joner represents the Tribe's interests at the state, regional, and international levels, currently serving as a U.S. commissioner on the United States - Canada Pacific Hake Joint Management Committee and is active in the Pacific Fishery Management Council, serving on the Marine Planning Committee and on the Groundfish Advisory Panel. He represents the Tribe on the Olympic National Marine Sanctuary Intergovernmental Policy Council. He previously served on the federal Marine Fish Advisory Committee. Following six years of military service, Joner received a B.S. in fisheries science from the University of Washington. Joner is a member of the National Academies of Sciences, Engineering, and Medicine's Committee on Offshore Wind Energy and Fisheries.

Joner is employed by the Makah Indian Tribe who have made statements about offshore wind energy development.

Rebecca Lewison is an applied conservation ecologist and professor at San Diego State University and is the co-director of the Institute of Ecological Monitoring and Management. Her research is aimed at improving and expanding the science of conservation in the context of climate resilience: presenting new paradigms for ocean and land use management, oceanscape and landscape connectivity, and developing new applications for in situ biological data, remotely sensed data, and climate models. In marine systems, this research has led national efforts in support of dynamic ocean management, strengthening integrative and application-ready approaches to oceanscape analyses. Lewison's recent research activities highlight her commitment to science innovation through both interdisciplinary and transdisciplinary approaches. Lewison received a B.S. from Vassar College and a Ph.D. in ecology from the University of California, Davis.

Lewison co-authored the article "Integrating Oceans into Climate Policy: Any Green New Deal Needs a Splash of Blue" in Conservation Letters in 2020 that discussed how oceans fit into climate policy that discusses marine renewable energy.

Brian Penoyer is a senior associate (non-resident) at the Center for Strategic and International Studies. Previously he served in the U.S. Coast Guard (USCG) and retired as a Rear Admiral. While in the USCG he served as the Director of the Coast Guard Talent Management Transformation, Assistant Commandant for Human Resources, the Commander of the Eleventh Coast Guard District responsible for operations along the Pacific rim of North America, Commander of the Coast Guard Force Readiness Command, and the Commander of the Fourteenth Coast Guard District responsible for operations in the Central Pacific. Penoyer is a commercial vessel inspector, investigating officer, and experienced maritime incident responder who has served and responded to a variety of incidents including Deepwater Horizon, Hurricane Katrina, and Hurricane Sandy. His research interests include digital and talent management transformation, climate change and security, and emerging threats to global maritime governance and security. He is a life member of the U.S. Naval Institute and has been appointed to the Advisory Board for the University of Chicago Harris School of Public Policy Cyber Policy Initiative. Penoyer received a B.A. in political science from the University of Chicago, an M.P.P. in environmental policy from the University of Maryland, and an M.A. in national security and strategic studies from the Naval War College.

Tracy Phillips served for 25 years in the U.S. Coast Guard and retired as a Captain as the Chief of the Prevention Division of the Coast Guard's Eighth District. Her previous roles included Chief of the Tank Vessel & Offshore Division for the Coast Guard's Marine Safety Center in Washington, DC, Chief of the Inspection Division for Sector San Francisco, and Prevention Department Head for Sector New Orleans. Phillips is a current member of the Society of Naval Architects and Marine Engineers and has chaired a formal Coast Guard investigation regarding the capsizing of a liftboat. Her work has included managing commercial vessel inspections and investigations, issuing maritime policy and guidance, executing key decisions to control vessel navigation and to open/close traffic on the Mississippi River. Philips' first Coast Guard assignment was on a buoy tender based in San Francisco, where she navigated the ship up and down the West Coast of the United States. She received a B.S. in marine and environmental science from the U.S. Coast Guard Academy, and an M.S. in mechanical engineering, and M.Eng in concurrent marine design from the University of Michigan. Phillips served as a member of the National Academies Committee on Improving the Efficiency and Effectiveness of the Coast Guard Certificate of Compliance Examination Program for Liquefied Gas Carriers.

Robert Sheppard is a Senior Consultant with Spire Engineering Services LLC. He has over 30 years of experience in structural engineering with a focus on assessment and repair of offshore structures and structural integrity management. His experience covers both fixed and floating offshore systems and includes inspection activities, repairs and modifications, and operations. Sheppard has been actively involved in the development of offshore standards including integrity management recommended practices for the American Petroleum Institute and the International Organization for Standardization (API RP 2SIM and RP 2FSIM, ISO 19901-9), and the American Clean Power offshore wind recommended practices for fixed and floating installations (OCRP-1 and OCRP-2). He has worked on projects for the Minerals Management Service (now the Bureau of Safety and Environmental Enforcement), addressing hurricane impacts and offshore wind inspection guidelines. Sheppard is a registered civil engineer in California and Texas. He received a B.S. in civil engineering from Rice University and an M.S. in structural engineering from the University of California, Berkeley. Sheppard previously served as a member of the National Academies committees on Offshore Windfarm Worker Safety, Offshore Wind Energy Turbine Structural and Operating Safety, and Review and Update of BSEE Offshore Oil and Gas Operations Inspection Program.

Annette von Jouanne is an Energy Systems professor in the Department of Electrical & Computer Engineering at Baylor University and the Director and Founder of the Baylor Energy & Renewable Systems Laboratory. Von Jouanne's research specializes in power electronics and power systems, renewables with a focus on wave energy, advanced inverters using wide bandgap SiC and GaN systems, electric motor-drive systems including application issues, electric and hybrid vehicles and sustainable transportation systems. Previously von Jouanne was a professor in the School of Electrical Engineering and Computer Science at Oregon State University where she initiated the Wave Energy Program and helped develop the Northwest National Marine Renewable Energy Center. She is a registered professional engineer. Von Jouanne received a B.S. in electrical engineering and M.S. in electrical engineering/power systems from Southern Illinois University and a Ph.D. in electrical engineering/power electronics from Texas A&M University in 1995.

Appendix B

Sample Framework for Siting New Offshore Renewable Energy Projects

The committee prepared a framework as an example of how to evaluate proposed sites for new renewable energy marine projects. This framework is designed to identify the *current and future* maritime and associated community interests and competing maritime uses that may be impacted by the project and proposed location; assess the level of usage for each interest; assess the burdens, and benefits; use the information to prioritize interests, and then decide whether to retain, revise or relocate the site for the marine project. The goal of this proposed framework is to consider and account for the various maritime and community interests, without excluding interests, and to find the least impact to those interests, based on the best available information at the time of the decision. This proposed framework is designed to be flexible and adaptable, to accommodate new information and new activities while considering cumulative impacts as multiple projects are assessed. It focuses on maritime activities and topics addressed in this report.

SAMPLE USE OF THE FRAMEWORK

The proposed set of questions are guidelines designed to engage the various maritime users and interested community groups that would interact with the proposed location. This list does not include all possible maritime uses that are, or could be, operating in the proposed project location, but focuses on those address in this report. There may be additional maritime or community interests that should be included on this list in the future. A "yes" answer to any of the maritime interest questions *does not* mean that the project cannot use the proposed location. A "yes" answer means that the maritime interest should be engaged in the planning process. A "yes" answer also means that additional questions are needed to assess the level of usage, along with the risks, burdens, and benefits.

Questions about the future uses are included to help understand and incorporate how changing ocean conditions may impact the uses at a proposed location. The answers and discussion around these questions should be based not on speculation but instead on available documentation at the time of the evaluation. They may help to identify areas where scientific research or modeling is needed to better understand future shifts in fish stocks for example.

Tribal Interests:

Has a federal or state recognized Indian Tribe ever fished in the proposed location?

Does a federal or state recognized Indian Tribe currently fish in the proposed location?
Does a federally recognized Indian Tribe have a treaty right for usual and accustomed fishing rights in the proposed location?
Does a federal or state recognized Indian Tribe expect to fish in the proposed location in the future, due to shifting fish habitats?
Would the proposed location of a maritime project cause non-Treaty fisherman to impose on Indian Tribes treaty fishing rights?

Has a non-recognized Native American community ever fished in the proposed location?
Does a non-recognized Native American community currently fish in the proposed location?
Does a non-recognized Native American community expect to fish in the proposed location in the future, due to shifting fish habitats?

Does the proposed location include an area of cultural heritage or significant meaning to an Indian Tribe(s)?
Do culturally important aquatic species or organisms for a federal or state recognized Indian Tribe live in or pass through any part of the proposed location?
Does a federal or state recognized Indian Tribe expect culturally important aquatic species or organisms live in or pass through any part of the proposed location in the future due to shifting habitats?

Fishing Interests:

While considering fishing interest consider type of species targeted, gear type used, and value of the fishery.
Do commercial fishermen currently operate in the proposed location?
Do commercial fishermen expect to fish in the proposed location in the future, due to shifting fish habitats?

Do recreational fishermen currently operate in the proposed location?
Do recreational fishermen expect to fish in the proposed location in the future, due to shifting fish habitats?

Do fishermen from another country operate in the proposed location under an International Treaty?
Do fishermen from another country expect to fish in the proposed location in the future, due to shifting fish habitats?

Environmental/Ecological Interests:

Does the proposed location include any part of a national marine sanctuary?
Is a national marine sanctuary planned for the proposed location?
Does the proposed location include any other marine protected areas?

Is the proposed location the only known site for an aquatic species or organism?
Could the proposed location become the only known site in the future due to shifting habitats?

Does the proposed location include ecologically sensitive areas or critical habitats for fish? Could the proposed location become an ecologically sensitive area or critical habitat for fish due to shifting stocks?

Is any part of the proposed location used as critical habitat by aquatic species or birds? Could the proposed location become a critical habitat in the future, due to shifting habitats?

Are any part of the proposed location biologically important areas for threatened or endangered species or marine mammals?

Could the proposed location become biologically important areas for threatened or endangered species or marine mammals due to shifting habitats?

Is an aquaculture project in the proposed location?
Is an aquaculture project planned for the proposed location?

Shipping Interests:

Does an established commercial vessel maritime traffic route or International Maritime Organization–defined recommended route/fairway cross the proposed location?
Is a commercial vessel maritime traffic route or International Maritime Organization–defined recommended route/fairway planned for the proposed location?

Is the proposed location in the path of an approach to a port or harbor?
Is an approach to a port or harbor planned for the proposed location?

Is the proposed location in a traffic separation scheme or precautionary area?
Is a traffic separation scheme or precautionary area planned for the proposed location?

Do recreational vessels transit across the proposed location?
Do recreational vessels expect to transit across the proposed location in the future?

Do races, regattas or parades ever cross the proposed location?
Are races, regattas or parades planned for the proposed location?

Is an anchorage in the proposed location?
Is an anchorage planned for the proposed location?

Are any existing aids to navigation (federal or private) in the proposed location?
Are aids to navigation planned for the proposed location?

Historical Interests:

Are shipwrecks, cultural sites, or sites of historical importance in the proposed location?

Energy Interests:

Is an oil or gas platform within the proposed location?
Is an oil or gas platform planned for the proposed location?

Is an offshore wind project in the proposed location?
Is an offshore wind project planned for the proposed location?

Is a hydrokinetic project in the proposed location?
Is a hydrokinetic project planned for the proposed location?

Is another type of energy project in the proposed location?
Is another type of energy project planned for the proposed location?

Does a pipeline cross the proposed location?
Is a pipeline planned for the proposed location?

Does an electrical transmission line cross the proposed location?
Is an electrical transmission line planned for the proposed location?

Military Interests:

Is a military range, operations or training area in the proposed location?
Is a military range, operations or training area planned for the proposed location?
Are former military training or disposal areas, or areas with unexploded ordinance in the proposed location?

Aviation Interests:

Is the proposed location used for space launch or recovery?
Are there plans to use the location for space launch or recovery in the future?

Does a space launch path cross over the proposed location?
Is a space launch path planned for the proposed location?

Other Interests:

Does a subsea communications/fiber optic cable cross the proposed location?
Is a subsea communications/fiber optic cable planned for the proposed location?

Is a mining operation in the proposed location?
Is a mining operation planned for the proposed location?

Is a disposal area in the proposed location?
Is a disposal area planned for the proposed location?

The questions above should help to identify the maritime and community interests that will have a stake in the discussions about the proposed location for the project. For each maritime activity, assess the level of usage of the proposed location. In other words, how much does the maritime interest use the proposed location, and how important is the proposed location in relation to other locations? The usage does not need to be quantified as an exact number but instead should be evaluated on a relative scale. A variety of participants in the marine activities above should help answer usage questions. For example, some fisheries participants stay in a more localized area where others fish in a broader area.

Usage Level and Importance Assessment (for an interest that moves):

How often does the maritime interest use the proposed location?
Never
Rarely (a few times a year)
Sometimes (or occasionally)
Moderately (about half of the time)
Very often
All the time (almost every day)

How many other locations are available for the maritime interest to use or to conduct the specified activity?
None
A few
Some
Quite a few
Many

How important is the proposed location to the maritime interest (relative to other locations)?
Not important at all
Slightly important
Fairly important
Important
Very important
Essential

It is also important to note if the proposed location is the only location in which a specific activity can occur.

Level of Importance and Interference Assessment (for an interest with fixed infrastructure):

How much does the maritime interest rely on the infrastructure in the proposed location?
Rarely (a few times a year)
Sometimes (or occasionally)
Moderately (about half of the time)
Very often
All the time (almost every day)

How much would the project interfere with the infrastructure in the proposed location?
Not at all
A little
Some
Quite a bit
A great deal

How costly would it be to move the maritime interest's existing infrastructure?
Not at all
A little
Some
Quite a bit
Extremely

Once the level of usage and importance is assessed, identify the risks and costs and benefits for each maritime interest. In other words, what risks would there be to the maritime interest if the project was conducted in the proposed location? What would be the costs to the maritime interest if the project was conducted in the proposed location? What would be the benefits for the maritime interest?

This step is not meant to compare maritime interests that are already operating in a particular location assuming that if there are multiple interests already operating in one location, then they have already found ways to lower their risks to an acceptable level.

This step is designed as an initial top-level screening, not an in-depth formal risk assessment. It can be completed relatively quickly as a project or activity is considering multiple sites for future operations.

Risks:

If the project is placed in the proposed location, would the maritime activity be at risk for:

- a loss of life?
- personnel injury?
- environmental pollution?
- injury or loss of life for aquatic species or birds?
- economic loss to community?

What is the likelihood of the risk occurring, and to what extent?

Burdens:

If the project is placed in the proposed location, what would be the burdens on the maritime activity? Who, or what groups and communities would the burden fall upon? Is there tourism near the proposed location that could be affected? Would the project impact the local community? Would the project impact a non-local community (i.e. a non-local port that would need to support the project)? Would the project impact ocean preservation? Would the project affect the local climate? How would the burdens be allocated?

Benefits:

If the project is placed in the proposed location, what would be the benefits to the maritime activity? Who or what groups and communities would benefit from the activity? Would the project create new jobs in the community? Would the project benefit clean energy goals or other societal impacts? Would there be economic benefits to local communities? How would the benefits be allocated?

After assessing the risks, burdens, and benefits for each interest, assess the risks for the project itself. In other words, what risks does the proposed location pose to the project?

Project/Activity Assessment:

What is the typical current speed and direction on the surface of the proposed location?
What is the maximum expected current speed and direction on the surface of the proposed location?

What is the typical current speed and direction just above the seabed of the proposed location?
What is the maximum expected current speed and direction just above the seabed of the proposed location?

What is the typical tidal range in the proposed location?
What are the maximum expected high and low tides in the proposed location?

What is the typical wave height and period within the proposed location?
What is the maximum expected wave height within the proposed location?

What is the typical wind speed and direction at the surface of the water in the proposed location?
What is the maximum expected wind speed and direction at the surface of the water in the proposed location?

What is the typical wind speed and direction at the uppermost height of the project/activity?
What is the maximum expected wind speed and direction at the uppermost height of the project/activity?

Once all of the maritime interests are identified and all of the questions above are answered, compare the proposed location for the project with the maritime interests. This comparison should look at all of the maritime interests at the same time, along with the information about level of usage, risks, costs, and benefits.

Ideally, the information would show that the project can be placed in the proposed location without serious impacts and risks to the maritime interests. However, if that is not the case, then the information can be used to identify which activities or interests should take precedence in the proposed location. Once the priorities are identified for the proposed location, then decisions can be made about retaining, revising, or relocating the site.