AGENDA ITEM 15
MAY 20-21, 2021-LCDC MEETING
ATTACHMENT A

STATE OF OREGON
GEOGRAPHIC LOCATION DESCRIPTION

Analysis of Reasonably Foreseeable Effects of Federal Actions Related to Marine Renewable Energy Projects on Resources and Uses Occurring within the Federal Waters of the Oregon Ocean Stewardship Area.

Oregon Department of Land Conservation and Development
Coastal Management Program

(March 20, 2015)

This document, pursuant to 15 C.F.R. § 930.53, describes a geographic area in federal waters where certain federal license or permit activities, under 15 C.F.R. Part 930, Subpart D, and Outer Continental Shelf (OCS) authorizations, under 15 C.F.R. Part 930, Subpart E, will be subject to review by the Oregon Coastal Management Program (OCMP) under the Coastal Zone Management Act (CZMA) Federal Consistency Provision. The OCMP is seeking federal consistency review over certain federal actions listed below, taking place in the federal waters within a part of the Oregon Ocean Stewardship Area (OSA), as described in Oregon's Statewide Planning Goal 19 Ocean Resources. That area will be delineated as the Geographic Location Description and will hereafter be referred to as the GLD. The document consists of the following parts: (I) a description of the specific geographic location within federal waters to which it applies, including a brief description of the types of marine renewable energy uses that are anticipated; (II) a list of federal license or permit activities and OCS authorizations related to marine renewable energy development that will be subject to OCMP review when the federal action or activity that is being proposed is located within the geographic area; and (III) an analysis of the reasonably foreseeable effects the activity may have on specific marine resources and uses within Oregon's coastal zone.

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I. Geographic Location Description

This section provides a description of the specific geographic location within federal waters to which it applies, including a brief description of the types of marine renewable energy uses that are anticipated and a map of the boundary.

A. Delineation of the GLD Boundary

Oregon's GLD for federal waters is within the area defined in Oregon Statewide Planning Goal 19 Ocean Resources as the Oregon Ocean Stewardship Area. The Ocean Stewardship Area is delineated and described in the Oregon Ocean Resources Management Plan, and the state's management goals and policy interests for this area are enumerated in Part One of the Territorial Sea Plan. Specifically, the GLD is a polygon starting from the seaward limit of Oregon state jurisdiction at 3 nautical miles (nm) from the shoreline, and extending seaward to a boundary line along the outer continental shelf which approximates the 500 fathom bathymetric contour. (*See* Figure 1 below for a map of the GLD) The OCMP has on file a list of geographic coordinates that form the GLD boundary line, and can make these available on a project by project basis.

The OCMP has chosen the 500 fathom (fm) contour to delineate the GLD to account for the distribution of marine resources and uses important to the state; the potential that marine renewable energy development impacts to those resources and uses would result in reasonably foreseeable effects to these coastal uses or resources (where the coastal effects could occur within and outside the state's coastal zone), and; the maximum likely depth of future marine renewable energy development.

The final boundary depth contour represents a combination of these factors in consideration of the following factors.

1) General ocean ecology – There are well established classification schemes for ocean ecological zones (FGDC 2012). The mesopelagic zone extends from a depth of 200m down to 1000m, and the 500 fm which has been chosen as the GLD boundary, is a logical break from an ecological standpoint.

2) Key fish species – The area from the shore to 500 fm encompasses the primary distribution of nearly all demersal fish species important to Oregon (Figure 1a, b, c). Of the deeper water species, sablefish is the most important within the GLD, because it is the most economically valuable species in Oregon's groundfish fishery. The 500 fm contour encompasses most of this species' distribution. (Figure 1c, Figure 2). Figure 2 also depicts similar examples for other groundfish species.

3) Fisheries – The groundfish fishery uses the continental shelf and upper slope. Taken together, the trawl and fixed gear fisheries have most of their effort on the upper slope (Figures 3 and 4). While these fisheries can extend out to 700 fm, most of the fisheries occur inside of 500 fm. (Figure 4).

4) Biogenic Habitat – Important coral and sponge biogenic habitat occurs on the upper slope. These areas provide important habitat for groundfish species. Figure 5 indicates that several important areas occur between 300 and 500 fm.

5) Seabirds and mammals – Several seabird species are most abundant at the shelf break (Guy, et al. 2013; Nur, et al. 2010). As an example, Figure 6 depicts the distribution of black footed albatross. Many whale species also forage along the shelf break, and are similarly abundant along the upper slope.

6) Physical Constraints on Development – Ocean energy technology is evolving rapidly and it is impossible to anticipate what factors will physically constrain project location with respect to seafloor characteristics and the distance to shore, electrical substations and service ports. While the steep gradient of the continental slope may limit development in some areas, much of the upper slope off Oregon has a very gentle incline.

B. Description of Marine Renewable Energy Technologies

Oregon has been engaged in planning for marine renewable energy development since 2008. During that period, technology development has evolved; however, financial and business constraints have dampened expectations of commercial scale projects, shifting the focus toward small-scale and pilot projects. Oregon's Territorial Sea Plan is designed to address marine renewable energy development from a neutral perspective, not predicated or favoring any specific type of technology. The assumption is that a variety of technologies may evolve, each designed to take advantage of a specific range of physical and oceanographic properties in terms of wave patterns, ocean depth and seafloor bottom type. For the purposes of this document, any current or future renewable energy technologies that produce energy using the hydrokinetic, water column pressure, wind, or hydrothermal properties of the marine environment will be categorized as marine renewable energy (MRE) development.

The seafloor within the GLD area is generally characterized by a rapidly deepening bathymetry. Current MRE technologies, other than wind, are more suitable for development within the state's territorial sea and the narrow band several miles wide just beyond the state-federal boundary, where devices would produce power more efficiently and the deployment and operating costs would be lower. This area is generally more suitable to MRE technology types such as the point absorbers and attenuators both of which rely on the vertical motion of wave action to produce power. Other MRE technologies such as the oscillating water column, wave surge converters, and overtopping devices are generally more suitable for the shallower depths of Oregon's territorial sea, and are less likely to be sited in the GLD area.

Oregon will have the distinct advantage of being the home of the Pacific Marine Energy Center (PMEC) South Energy Test Site (SETS) located in Newport, where MRE developers will have a facility to deploy their devices for research and development. PMEC SETS will be located within an area about 6 nm miles from shore, will be grid connected, and will offer MRE developers some advantages in terms of the availability of baseline environmental data, monitoring capacity and an established process for obtaining permit authorizations. The types of MRE devices to be deployed at PMEC will be the precursors to those that may eventually be sited elsewhere with similar physical and logistical attributes, within the federal waters off

Oregon. However, it is likely that MRE development in the federal waters will be confined to the smaller-scale testing and development supported by PMEC for the near term. Should that occur as anticipated, the data and information gained from PMEC will enhance the state's ability to assess the potential impacts from similar developments elsewhere.

Recent studies have found that though the wave energy potential of the Oregon coast is substantial and could be exploited with current technologies, the MRE industry is still many years away from large scale, commercial developments. J. Klure, et. al. 2013)

Offshore wind power development in the Pacific Northwest has an abundant potential power resource, technological advancements applicable to the Pacific Northwest, and industry and financial support. First, the marine wind resources are substantially stronger and more uniform than the winds are over the land mass, meaning that ocean based turbines have the potential to produce more power than their terrestrial wind development counterparts. This is confirmed by the maps and information provided by the National Renewable Energy Laboratory's (NREL) which can be found on their MapSearch website, and by the U.S. Department of Energy (DOE), who has published wind resource assessment maps at their Resource Assessment & Characterization webpage. The availability of strong and persistent wind power, coupled with the fact that the turbines being built for deployment in the marine environment are much larger and more efficient that the land-based versions, whose size is constrained by transportation and siting limitations, provides a distinct advantage for ocean-based wind power facilities.

The greater power production potential and close proximity to power grid facilities and markets of coastal communities has lead developers worldwide to pursue offshore wind energy development opportunities. In addition, marine-based wind turbine technology is far more mature and advanced than the other MRE technologies, and platforms for siting wind turbines in depths equal to those on Oregon's continental shelf are currently in development using designs already employed by the oil and gas platforms worldwide. For example, Principle Power's WindFloat Project, which is planned to be sited approximately 16 miles offshore from Coos Bay, is designed to deploy five grid connected floating platforms, each with a 6 MW turbine, anchored in 400-500 meter water depth. Both the platform and turbines to be used for this project have already been successfully deployed in Europe. Platforms of this type are capable of being anchored at greater depths and are currently being built for testing off of Norway. The GLD was predicated on the likelihood that commercial scale wind energy development will occur earlier than MRE in Oregon, and that the boundary needed to encompass the area farther offshore where deep ocean wind platform development could be sited.

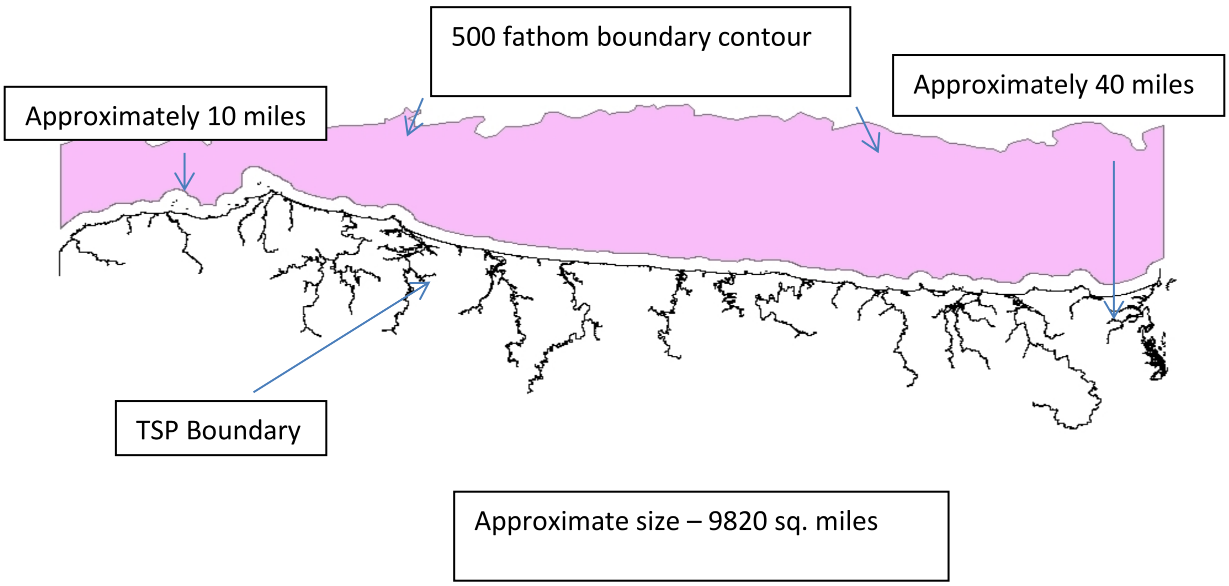
Citations

Wave Energy Utility Integration Advanced Resource Characterization and Integration Costs and Issues. J. Klure, K. Dragoon, J. King and G. Reikard for Oregon Wave Energy Trust 2013

Marine and Hydrokinetics. Alejando Moreno and Hoyt Battey, U.S. Department of Energy Water Power Program, Presentation to CESA 2010.

The Potential of Wave Power in the United States. Marko Previsic et. al. A report for the U.S. Department of Energy Wind and Water Technologies Program. Washington D.C. 2012

Figure 1. Geographic Location Description Boundary Map



II. List of Federal License or Permit Activities (15 C.F.R. Part 930, Subpart D), and Outer Continental Shelf (OCS) Authorizations (15 C.F.R. Part 930, Subpart E) Subject to OCMP CZMA Review in the GLD

A. Thresholds:

Federal consistency review of the licenses and permits listed below is *only* sought for the following type of projects proposed for the GLD. The following thresholds apply to all of the licenses and permits listed subsequently in this document:

- Any offshore wind or wave power generation facilities or structures(s), of a permanent nature, regardless of size or number.
- Underwater cables to service power generating facilities;
- Research and monitoring devices such as LIDAR, Met towers or wave energy measurement instruments with a deployment window of 5 years or greater.

B. Federal License or Permit Activities and OCS Authorizations

1) Department of Defense, Army Corps of Engineers:

a. Section 10 of the River and Harbors Act (33 U.S.C. 403). Prohibits the unauthorized obstruction or alteration of any navigable water of the United States resulting from the construction of any structure in or over any navigable water of the United States, the excavating from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters.

b. Section 4(f) of the Outer Continental Shelf Lands Act of 1953 as amended (43U.S.C. 1333(e)). (See 33 CFR Part 322) Prevents obstructions to navigation in navigable waters of the United States including artificial islands, installations, and other devices located on the seabed, to the seaward limit of the outer continental shelf.

2) Department of Energy, Federal Energy Regulatory Commission:

a. Sections 3 (11), 4 (e) and 15 of the Federal Power Act (16 U.S.C. 796 (11), 797, and 808). Licenses, renewals, and amendments to licenses for non-Federal hydroelectric projects and primary transmission lines.

b. Section 202 (b) of the Federal Power Act (16 U.S.C. 824 (a) (b)). Orders for interconnection of electric transmission facilities.

3) Environmental Protection Agency:

a. Sections 401, 402, 403, 405, and 318 of the Federal Water Pollution Control Act of 1972 (“Clean Water Act”) (33 U.S.C. 1341, 1342, 1343, and 1328). National Pollution Discharge Elimination System (NPDES) permits and other permits for Federal installations, discharges in contiguous zones and waters, sludge runoff and aquaculture permits.

4) Department of the Interior, Bureau of Ocean Energy Management:

a. Permits to drill, rights-of-use, rights-of-way, and easements for construction and maintenance of pipelines, gathering and flow lines and associated structures pursuant to 43 U.S.C. 1334, explorations and development plans, and any other permits or authorizations granted for activities described in detail in OCS exploration, development, and production plans.

b. Issuance or approval of leases, permits, easements, rights-of-way, exploration plans, development plans, production plans, and other authorizations, as appropriate, pursuant to the Outer Continental Shelf Lands Act (43 U.S.C. 1331 et. seq.) as amended by the Energy Policy Act of 2005 (42 U.S.C. 15801 et. seq.) for the construction, operation, maintenance and/or support activities related to OCS energy development. BOEM OCS Development Regulations - 30 CFR 585.

5) U.S. Coast Guard:

a. Determination of Approval of Private Aids to Navigation under 33 CFR Parts 62 and 66.

III. Analysis of Effects on Coastal Resources and Uses for Listed Activities

A. Definition of coastal effects

Pursuant to 15 C.F.R. Part 930, a federal action is subject to federal consistency review if the action will affect a state's coastal uses or resources. As stated in 15 C.F.R. § 930.11(g), "[t]he term 'effect on any coastal use or resource' means any reasonably foreseeable effect on any coastal use or resource resulting from a Federal agency activity or federal license or permit activity." Effects on coastal uses and resources include those that are both direct as well as indirect such as secondary and cumulative effects. This document represents an analysis of the reasonably foreseeable effects on Oregon's coastal resources and uses of listed federal license or permit activities under 15 C.F.R. Part 930, Subparts D and E that may be proposed in the federal waters of the Oregon Ocean Stewardship Area, as delineated by the GLD. This analysis is not site specific, nor is it at the scale or level of detail that would typically be applied at the project level. It is a general analysis of the reasonably foreseeable effects that may occur, and that should be the subject of further consideration during the regulatory review process associated with marine renewable energy projects.

B. Description of the Oregon coastal zone and Outer Continental Shelf

Oregon's coastal waters include the waters out to 3 nm as measured from mean lower low water from the ocean shoreline (*see* Figure 1 above). Natural resources such as fish and marine mammals regularly migrate between these state and federal waters, and many human uses, including commercial and recreational fishing, shipping and passenger transportation, and scientific research similarly occur in both the state and federal waters within the area. The management of Oregon's coastal zone, as part of this extensive marine ecosystem, needs to consider uses and activities taking place in adjacent federal waters. This area is referred to in the Oregon Ocean Resources Management Act,[1] and is described in Oregon's Ocean Resources Management Plan and in Statewide Planning Goal 19 for Ocean Resources as the Oregon Ocean Stewardship Area. This integrated ecosystem perspective is reflected in the description of the foreseeable effects to uses or resources of Oregon's coastal zone below.

A comprehensive characterization of ocean resources and uses has been documented in the Oregon Ocean Resources Management Plan (1991) and, with spatial detail, in the Oregon Territorial Sea Plan (2013 as amended). An inventory of marine uses and resources has been incorporated into the Territorial Sea Plan (TSP), delineating the distribution and concentration of a wide variety of biological resources and habitat areas, as well as the spatial footprint of specific marine resource uses. The data and information that is available in the TSP marine resource and use inventory extends beyond the state's territorial sea into the outer continental shelf, and would be relevant to an assessment to determine whether any of the particular marine resources and uses may be impacted by a specific new use of an area.

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[1] ORS 196.415 (3) The fluid, dynamic nature of the ocean and the migration of many of its living resources beyond state boundaries extend the ocean management interests of this state beyond the three geographic mile territorial sea currently managed by the state pursuant to the federal Submerged Lands Act.

C. Coastal Resources and Uses Characterization

The Oregon Ocean Resource Management Plan and the Territorial Sea Plan include a comprehensive analysis of Oregon's offshore waters, including both state waters and adjacent federal waters. The OCMP is seeking federal consistency review over listed federal actions taking place in the federal waters within a portion of the Oregon Ocean Stewardship Area referred to as the Geographic Location Description (GLD).

The primary uses and resources of concern to the OCMP are those that ensure the functional integrity of the marine ecosystem and the continued use of the area for commercial and recreational fishing and other uses. Areas needed to ensure the preservation and use of important marine resources and uses include:

- Areas important to the biological viability of commercial and recreational fisheries;
- Areas necessary for the survival of threatened and endangered species;
- Areas that are ecologically significant to maintaining ecosystem structure, biological productivity and biological diversity;
- Areas that are essential to the life history or behaviors of marine organisms;
- Biological communities that are especially vulnerable because of the size, composition or location in relation to the impacts of the proposed activities;
- Biological communities that are unique or of limited range within the region
- Areas important to fisheries including those that important on a seasonal basis, to individual ports or particular fleets, or of particularly high value species.
- Habitat areas that support food or prey species important to the sustaining the commercial and recreational fisheries.
- Beneficial uses such as navigation, recreation, scientific research, cable corridors, and aesthetic enjoyment including ocean shore view-sheds.

The Oregon Ocean Stewardship Area GLD comprises the portion of the outer continental shelf slope out to the 500 fathom bathymetric depth contour. This area is a rich, environmentally sensitive marine ecosystem with an abundance of natural resources and beneficial uses. The description and analysis below outlines the linkage between specific marine resources and uses that are distributed or located within the federal waters and Oregon's coastal zone. The analysis is presented in two major sections:

- Marine Resource Uses
- Ecology/Natural Resources.

As noted above in Section II., concerning the nature and types of MRE and wind energy developments that are likely to occur within the GLD, there are many uncertainties and unknowns related to the size, location, configurations and eventual footprints for future development. Perhaps as important are the various methods and timing of deployment, installation and maintenance that will be used for different projects. In addition, over time, the number, proximity and cumulative effects of projects would contribute to any analysis of the potential impacts MRE and wind energy projects might have on certain resources and uses. Lacking the type of specific operating or development plans that provide project specific detailed data and information and enable site specific impact analysis, the generic impact analysis below is based on a general understanding of the current technologies and their development.

D. Marine Resource Uses

This section provides an analysis of coastal effects for human uses that occur within the GLD. The analysis includes a description of certain human uses in the GLD, how these uses are linked to the state's Coastal Zone Management Program, and what exposure these uses have to reasonable foreseeable effects from renewable ocean energy development. This section includes the following subsections:

1) Commercial and Recreational Fishing
2) Submarine Cables
3) Navigation
4) Aesthetic (Visual) Resources
5) Scientific Research

The coastal effects analysis in each subsection below is organized to provide information as follows:

A. Resource use occurring off Oregon: What the use is and where it occurs.
B. State interest in the resource use.
C. Reasonably Foreseeable Effects on the resource use: What the reasonably foreseeable effects are from ocean renewable energy development and, specifically, the reasonably foreseeable effects on uses and resources of Oregon's coastal zone (i.e. coastal effects)?

These analyses form the basis for a rationale, with respect to human use resources, for the need to establish the GLD.

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1) Commercial and Recreational Fishing

This section characterizes the fisheries that occur within the GLD (Part a.), then explains how fisheries are linked to the state's Coastal Zone (Part b.), and concludes by describing the potentially reasonably foreseeable MRE impacts on fisheries (Part c.).

a. Fisheries Occurring off Oregon

There are approximately 33 commercial (Table 1) and recreational (Table 2) fisheries that occur off Oregon, including ephemeral fisheries that operate cyclically or under large climatic events (e.g., El Niño). Among the fisheries listed, sixteen occur in state waters only, and seventeen occupy depth ranges that overlap both state and federal waters. The federal waters components of these seventeen fisheries occur within the GLD, and only these fisheries are considered in the analysis below. Maps A-1 through A-5 show the distribution of some of the major commercial fisheries with respect to the GLD. Fish caught and landed in Oregon commercial fisheries are distributed to domestic markets and exported worldwide.

Oregon fishing fleets, and the thirteen coastal port communities that depend on them, are vulnerable to energy development impacts due to the inherent characteristics of the fleet. Gear configurations, vessel size, fishing strategies, and fishing locations are all linked to fishery success or failure. Alteration of these characteristics can lead to relatively substantial economic impacts, as there are no, or very few, alternatives that maintain the current diversity and productivity of the Oregon fisheries fleet.

Multiple, overlapping fishing areas occur in the GLD, and fishing locations vary depending on the species pursued and the gear that is used. For example, the trawl fishery occurs from shore to 700 fathoms (Map A-1), while the Dungeness crab fishery occurs from the shore to 120 fathoms (Map A-5). All areas of the GLD are fished by one or more fisheries; there are no spatial gaps between fishing areas. Additionally, fishing effort is not uniform throughout the GLD, as any given species, gear and fishing strategy has particular hotspots, some of which are consistent from year to year and some of which vary in location from one year to the next.

A diversity of fishing gear types are used to pursue the multiple, overlapping commercial and recreational fisheries within the GLD. Commercial gear types commonly used off Oregon fall into two categories: fixed (passive) gear or mobile (active) fishing gear. Fixed gear includes crab or fish pots and traps, longline gear, and some other types of hook and line gear. The Dungeness crab fishery, some groundfish fisheries, and halibut fisheries use these gear types. Mobile gear that is most commonly used off Oregon includes trawl gear, troll gear and purse seines. The trawl fishery actively tows nets to pursue species throughout the water column, including benthic and pelagic groundfish and pink shrimp. Boat sizes in Oregon fisheries vary widely depending on port size, infrastructure availability, and draft depth, in addition to the fisheries being pursued and the gear types used. The largest fishing vessels occur in deep draft ports that have extensive marine infrastructure (i.e., Astoria, Newport, and Coos Bay). Smaller commercial vessels are able to access the shallow draft ports on the Oregon coast and serve to diversify the fishing fleet.

The Oregon recreational fishery within the GLD primarily targets salmon, halibut, groundfish and tuna using hook and line gear. The Oregon recreational fishing fleet consists of both charter boats and private sport boats. All of Oregon's coastal ports serve recreational fishing vessels.

b. State Interest in Offshore Fisheries

Oregon has interest in optimizing and maintaining fisheries-related economic benefits, in addition to the management responsibility associated with fisheries resources that occur within the GLD. Both economic and policy aspects of Oregon fisheries are subject to the enforceable policies of the state's Coastal Zone Management Program.

b.1. Economic Importance

Offshore fisheries are an integral component of both state and local economies (The Research Group 2014a). Oregon commercial fisheries have been estimated to generate $353 million in 2013 (The Research Group 2014b). Recreational fisheries also contribute substantially to coastal Oregon economies and generated $49.5 million in 2012 (The Research Group 2013b). The two most valuable commercial fisheries off of Oregon are Dungeness crab (total economic contribution in 2013 of $110 million) and groundfish trawl fisheries (total contribution in 2013 of $108 million; The Research Group 2014b).

Oregon's coastal zone primarily consists of rural areas with small communities. This region has a relatively small economic base which is poorly-diversified and highly dependent on natural resources. Small port communities offer limited economic opportunities and fisheries dependence is high. For example, commercial fisheries comprise 10% of total personal income earnings in Lincoln County, and up to 20% of annual earned income in other coastal counties (Davis 2014; The Research Group 2014b).

Port characteristics vary markedly depending on community size, vessel accessibility, infrastructure availability, the number of fisheries pursued, and the degree dependence on these fisheries. Each of these communities has varying degrees fishery dependence and socio-economic vulnerability to negative effects on fisheries. Many small ports rely on specific fisheries and are economically vulnerable due lack of fishery diversification, geographically restricted resource availability, port size and available processing infrastructure. For example, in a federal analysis examining major West Coast ports, Astoria, Newport and Brookings are considered economically vulnerable due to high commercial groundfish fishery engagement and dependence (PFMC and NMFS 2014). However, this analysis did not encompass the numerous smaller port communities that comprise the Oregon coast, some of which are more economically vulnerable to changes in fisheries than the major ports. The West Coast commercial groundfish disaster in 2000 exemplified Oregon port community dependence on fisheries. Overfishing, low fish productivity, and regulatory decisions, led to the West Coast groundfish fishery crash and Congress appropriated nearly $7.5 million over two years to assist resource dependent communities and individuals impacted by the disaster (OCZMA 2002; Upton 2010). Since the commercial groundfish fishery occurs primarily in the GLD, this action illustrates that a reduction to fisheries in the GLD can have a real and nationally-recognized effects on Oregon's coastal zone.

Oregon's commercial fishing fleet consists of many independent small businesses that are individually vulnerable to activities that may impact their business, and often cannot adapt in the same ways as larger businesses. Their continued viability depends on operating at high efficiency by maximizing catch per unit effort while minimizing costs such as fuel. The continued economic contribution of the fisheries to Oregon's coast depends on maintaining that efficiency. Economic impacts can result from actions that affect either the catch per unit effort or cost side of the fishing businesses. Actions that reduce overall catch would certainly have negative economic consequences to fishing businesses and the Oregon coast. However, even more subtle impacts that don't affect overall fleet catch, but reduce operational efficiency such as removing fishing areas from access, increased travel distances, or shifting fishing effort to increase crowding and competition among boats, can also impact the individual fishing businesses and thus the Oregon coastal economy. The Oregon fishing fleet is vulnerable to negative impacts that can result from offshore actions that reduce fishery catch or efficiency. Because of the high degree of the regional community dependence on fisheries, negative effects on the fishing fleet can have a disproportionally large impact to the already-fragile Oregon coastal economy.

b.2. Regulatory Importance

The Coastal Zone Management Act of 1972, the Coastal Zone Act Reauthorization Amendments of 1990, the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (MSA; 16 USC 1801-1882) and the Outer Continental Shelf Lands Act of 1978, recognize the interest of coastal states in the management of ocean resources in federal waters and provide for state participation in ocean resources management decisions. Oregon fully participates in these federal and federal-state programs. In addition, the Oregon Food Fish Management Policy (ORS 506.109) requires economic optimization and preservation of the commercial and recreational fisheries and Oregon's Fisheries Conservation Zone policy (ORS 506.755) conveys the state's interest in marine resources and fisheries in the area from shore to 50 miles offshore. Both of these Oregon statutes are enforceable policies within the state's coastal management program.

The Endangered Species Act (ESA; 16 USC 1531-1544) is one of the primary laws used to protect fish, wildlife and flora within the United States. ESA listed fish species that have biological ranges that overlap with fisheries pursued in the GLD include Green Sturgeon (T), Eulachon (T), Chinook Salmon (9 ESUs listed, T and E), Chum Salmon (2 ESUs listed, T), Coho Salmon (4 ESUs listed, T and E), Sockeye Salmon (2 ESUs listed, T and E), Steelhead Trout (11 DPSs listed, T and E) (ODFW 2014, NOAA 2014). Among these species, Chinook Salmon (2 ESUs, T) and Coho Salmon (E) are also listed under the Oregon ESA (ORS 496.171-192). Oregon's ESA statute is an enforceable policy within the state's Coastal Zone Management Program. Oregon has interest in threatened, endangered, or otherwise sensitive species in the GLD either due to conservation measures in state regulations, or when impacts to federally managed species in the GLD negatively affect Oregon's ocean resources and economy.

The Oregon Territorial Sea Plan (TSP) contains specific policies for state ocean management that have been adopted as enforceable policies under the Coastal Zone Management Act. Policies addressing fisheries require Oregon state agencies protect areas important to fisheries, including commercial, charter, and recreational fisheries, along with fishery-dependent ports. The enforceable policies of the TSP are applicable to those federal actions that affect Oregon's coastal zone and are subject to the federal consistency requirements of the federal Coastal Zone

Management Act. Recently, the TSP was amended to include provisions for siting, development, operation, and decommissioning of renewable energy facilities within the territorial sea. The amended TSP includes standards that must be considered in determining adverse impacts to fisheries when siting renewable energy facilities. This includes minimizing fisheries displacement, travel distance to alternative fishing grounds, the consolidation of fishing effort, economic losses to fishery sectors and port communities resulting from fishing area reduction, and disproportionate impacts to one community. These specific policies were established with recognition that examining potential impacts to fisheries is not simply a matter of determining whether or not total fleet catch would be affected. Instead, the policies require that the state examine impacts at multiple scales (boat, sector, port, state) and examine nuances of impacts that can result from displacement, with the intent of providing a mechanism for the state to ensure the impacts are minimized and coastal effects avoided.

Oregon has interest in optimizing and maintaining economic benefits associated with both commercial and recreational fishing industries that occur within the GLD. Many fisheries span the depth range between state and federal waters, including the entire depth range of the GLD, and are thus subject to the enforceable policies of the state's Coastal Zone Management Program. Because of their economic importance, all of these fisheries, and the associated species, are of direct interest to the state. Activities that affect fisheries in federal waters for Oregon's fishing fleet have a direct link to state interests with respect to the enforceable policies of the state's Coastal Zone Management Program.

c. Reasonably Foreseeable Effects of Ocean Renewable Energy Development to Fisheries

There is potential for MRE development to displace fisheries that have been identified as highly productive and important resources to the state of Oregon. This effect may be detrimental to the value of those fisheries, both from a individual perspective, as well as an economic resource of interest to coastal communities and the state. Oregon's Coastal Program defines an adverse effect on fisheries as, "a significant reduction in the access of commercial and recreational fishers to an area spatially delineated as an area important to a single fishing sector, multiple combined sectors, or to the fishing community of a particular port (DLCD, TSP Part 5 Appendix C, 2013 [page 42])". Drawing on the discussion in the above sections and on specific examples of current and potential future impacts due to fisheries displacement, this section presents arguments that MRE development in the GLD can result in reasonably foreseeable coastal effects to Oregon.

The most direct potential effect of MRE development on fisheries is the spatial conflict resulting from overlapping footprints of device placement and fisheries access, and the potential associated economic losses to state and local economies. There is virtually no area within the GLD that is not fished; therefore, some level of spatial conflict will occur with all new developments. The potential for space-use conflicts related to renewable energy development impacts on fisheries have been well documented (MMS 2007; BERR 2008; BOEM 2012; Perry et al. 2012; BOEM 2013).

MRE development could result in a de facto closure of an area to fisheries involving one or more gear types. A de facto closure occurs when the presence of the development renders it impractical, unsafe, or costly to operate a fishing gear type in the vicinity of the development. De facto closures are contingent on gear types and fishing strategies, and may disproportionately impact certain fisheries (e.g., trawl), vessel sizes or communities (e.g., geographically isolated with high dependence on a single fishery; BERR 2008).

Areas made inaccessible to fishing due to obstructions (e.g., floating devices, anchors or cables) are often much larger than the footprint of the obstruction itself. For example, operating trawl gear adjacent to a deep water obstruction could require a buffer of up to a few miles in order to allow an adequate distance for trawl net retrieval prior to encountering the obstruction, or up to about a ½ mile wide buffer on each side to attempt to tow around. Therefore, even a small obstruction requires a buffer on all sides, resulting in a de facto spatial closure that is potentially several miles long for trawl gear (pers. Comm. Scott McMullen, Oregon Fishermen's Cable Commission 2015).

Although completed ocean renewable energy development has yet to occur in Oregon, experience from emerging development and analogous examples from other types of development have specific relevance to analyzing fishery effects of MRE development. Two offshore energy projects have been initiated off of Oregon: one wave energy project (OPT) and one wind energy project (WindFloat). Both of these are either planned or sited in productive fishing grounds and represent de facto spatial closures. The wave energy project never came to fruition; however, a subsurface anchor was in place for an extended period off of Reedsport, Oregon. Commercial crab fishers set their gear well away for the anchor due to safety and liability concerns with gear entanglement, representing the removal of substantially more area from productive fishing grounds than occupied by the footprint of the anchor. While crab fishermen that formerly fished the site moved to other areas, the shift resulted in increased competition for a limited resource, thus reducing profitability of the affected fishers. The wave energy project was in state waters, but if it was a mile farther offshore in federal waters (the depth range where future wave energy projects are likely to site), the effect would have been the same. In May 2013, Principal Power proposed a WindFloat project off of Coos Bay, located in a productive fishing area for the mid-water trawl fleet. Once built, this project will result in a de facto closure to a productive midwater trawling location. Based on ten years (2000-2010) of historical fishing data, a segment of the Pacific whiting fleet documented a catch of 60,023 metric tons of Pacific whiting in and around the proposed WindFloat development site (United Catcher Boats 2014). Pacific whiting ex-vessel prices ranged from \$0.05/pound to \$0.11/pound during that timeframe. This equates to a potential loss of approximately \$6.6 to 14.6 million from the proposed site in one decade from one segment of the Pacific whiting fleet.

Telecommunication and science cables are analogous examples of both actual and de facto spatial closures. Exposed, unburied cables are a hazard to fishing operations and fishermen have made specific agreements with cable companies to avoid these areas in exchange for mitigation actions such as release from liability and guaranteed gear replacement. Buffer size around exposed cables or scientific research equipment varies depending on the depth fishing occurs, with deeper depths requiring larger buffers. Depths shallower than 300 fathoms have a buffer of approximately 0.25 square miles surrounding each point of exposed cable. Depths greater than 300 fathoms necessitate a larger buffer of approximately 0.64 square miles surrounding each point of exposed cable. (Scott McMullen, personal communication 2015). Furthermore, in cases where the obstruction includes devices in the water column (e.g., equipment associated with science cables), midwater trawl gear retrieval can take multiple miles depending on the depth that is fished and current direction and speed. This results in a de facto spatial closure that is up to several miles wide around one point of the obstruction.

The distance between obstructions can also become a spatial closure if the proximity is too close for trawling to successfully occur. An analogous example of this occurs off of Wiskey Run, where adjacent partially exposed lengths of fiber optic cable are too close together to allow for trawl net deployment and retrieval, creating a de facto closure between the cables (Scott McMullen, personal communication 2015). Offshore wave and wind energy development off of Oregon will likely consist of numerous anchored devices spaced at a distance that will preclude use of trawl and other gear types between devices, creating large de facto spatial closures.

Fishery displacement effects that will result from MRE development can result in reasonably foreseeable coastal effects to Oregon. There is virtually no area within the GLD that is not currently fished by Oregon's commercial or recreational fleets. The displacement of these fisheries will be larger than the MRE spatial footprint alone due to buffer zones and de facto closures. Upon displacement, these fisheries are unable to simply shift elsewhere and still maintain an equal level of economic viability. All profitable fishing areas within the GLD are currently occupied, and shifting effort results in more competition for a finite resource in a limited geographic area. Because of the high degree of the coastal community dependence on fisheries, negative effects on the fishing fleet can have a disproportionally large impact to the Oregon coastal economy.

Recognizing the importance of fisheries, enforceable policies within Oregon's Coastal Program have been established to provide a mechanism for the state to examine all aspects of potential fishery impacts to ensure that potential negative effects are minimized and significant coastal effects are avoided. Although offshore MRE development has yet to occur off of Oregon, experience drawn from analogous developments (e.g., fiber optic cables), and both past attempts and planned future MRE developments demonstrates potential effects on fisheries resulting for the displacement of fishing effort. As is evidenced by the potential multimillion dollar impact that the WindFloat project alone may have on the Pacific whiting fishery, there is a reasonably foreseeable effect from MRE development on commercial and recreational fishing resources, and that this effect may be detrimental to an economic resource of interest to coastal communities and the state of Oregon.

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Table 1. Commercial fisheries occurring off of Oregon

Fishery	Target Species	Depth Range (fathoms)	State Water Fishery	Federal Water Fishery	Value[a/] (millions of $)	Volum (milli of Lb
Crab	Dungeness crab	1-120	X	X	35.5	15.5
Shrimp	Pink shrimp	30-160	X	X	16.2	35.3
Highly Migratory Species	Albacore, minor tuna species	40-700+	X	X	13.5	9.9
Coastal Pelagic Species	sardine	15-700	X	X	5.7	52.5
Salmon	Chinook and coho salmon	1-200	X	X	5.8	2.2
Halibut	Pacific halibut	18-300	X	X	0.9	0.2
Fixed Gear (groundfish)	Sablefish, lingcod, Pacific halibut	25-650	X	X	8.7	3.0
Bottom Trawl (groundfish)	Sablefish, shelf/slope rockfish and shelf flatfish species	5-700	X	X	26.3	30.7
Midwater Trawl	Pacific whiting	25-300	X	X	9.3	90.6
Hagfish	Pacific hagfish	40-600	X	X	1.0	1.5
Squid	Market and Humboldt squid	< 40	X	X	b/	b/
Nearshore rockfish	Black and blue rockfish, cabezon, greenling, lingcod, nearshore rockfish complex	1-30	X	X	1.0	0.7
Prawn	Spot prawn	60-170	X	X	0.1	< 0.
Urchin	Red Urchin		X		0.3	0.6
Razor Clams	Razor Clams	Shoreline	X		0.1	< 0.
Ghost Shrimp		Estuaries	X		c/	c/
Mussels	California mussel	Shoreline	X		c/	c/
Dive Clams	Gaper clam, heart cockle, butter clam, littleneck clam	0-1	X		0.1	0.2
Herring	Pacific Herring (roe)	Estuaries	X		d/	d/
Coonstripe shrimp	Coonstripe shrimp	1-33	X		e/	e/

a/ Five year, annual average (2008-2012) of ex-vessel value, unless otherwise noted
b/ Squid is an ephemeral fishery and typically occurs on a decadal cycle. Peak years were 1983-85 (average = $0.2 million and 1.0 million pounds)
c/ No estimates available for these commercial fisheries and species
d/ Targeted roe herring fishery has not occurred since 2003.
e/ Targeted coonstripe shrimp fishery has not occurred since 2007.

Table 2. Recreational fisheries occurring off Oregon

Fishery	Target Species	Depth Range (fathoms)	State Water Fishery	Federal Water Fishery	Effort (# of Trips)[a/]	Volume (# of Fish)[a/]
Crab	Dungeness crab, minor crab species	1-30	X		115,531 b/	624,393 b/
Groundfish - from boats	Black and blue rockfish, lingcod, greenling, cabezon, quillback, minor rockfish species	1-100	X	X	73,000	1,638,406
Groundfish - from shore	same as above	estuaries and shoreline	X		80,000 c/	77,692 c/
Halibut	Pacific halibut	10-170	X	X	16,700	56,000
Salmon	Chinook and coho salmon	1-200	X	X	284,300	154,900
Highly Migratory Species	Albacore tuna, minor tuna species	>40	X	X	11,000	196,700
Razor Clams	Razor Clams	Shoreline	X		92,400	1,168,200
Ghost Shrimp		Estuaries	X		d/	d/
Mussels	California mussel	Shoreline	X		d/	d/
Bay clams	Gaper clam, heart cockle, butter clam, littleneck clam	Estuaries	X		44,152	699,281
Herring	Pacific herring	Estuaries	X		d/	69,836 c/
Surf Perch - from boats	Several surf perch species	1-30	X		39,158	48,400
Surf Perch - from shore	Several surf perch species	Estuaries and Shoreline	X		d/	150,068 c/

a/ Five year, annual average (2008-2012), unless otherwise noted
b/Annual average for 2008-2011
c/Annual average for 2000-2004
d/ No estimates available for these recreational fisheries and species

2) Submarine Cables

A. Submarine cables off the Oregon coast:

Submarine cable facilities and installation is a complex multi-national activity that is highly regulated and monitored under various international conventions and treaties governing their siting and protection. There are currently 9 separate submarine fiber optic cables that cross Oregon's seafloor and land at four different locations on the Oregon coast. Some cables are joined offshore and come onshore through a single connection. Many cable facilities are developed and owned by consortiums of private companies, and in some cases nationally owned entities, that share the cable capacity. These ownerships may be sold or transferred without any change to the state or federal authorizations for their use. The routes and landing locations for these cables are available on Oregon MarineMap, and a copy of that map is included in the map inventory as (B).

Table 3. Submarine Cable Facilities in Oregon

Cable	Facility Location and County	Route
TPC-5	Bandon – Coos	California
TPC-5	Bandon – Coos	Asia
China US (CHUS)	Bandon – Coos	China - California
Alaska Oregon Network AKORN	Florence – Lane	Asia
North Star	Nedonna – Tillamook	Alaska
Trans Pacific Express TPE	Nedonna – Tillamook	Asia
TATA – TGN – Trans Pacific	Nedoona – Tillamook	Japan – CA
Southern Cross	Nedonna – Tillamook	Australia-NZ- HI
Hawaiki	Pacific City – Tillamook	Australia-NZ- HI

B. State interest in submarine cable use:

Submarine fiber optic cables carry the vast majority of the telecommunications signals being transmitted between and within the continental U.S., between continents and islands of the Pacific basin and around the world, including telephone, internet, and other digital signals. Submarine cable reliability and security is high, as compared to other methods such as satellites, and the total carrying capacity of submarine cables is in the terabits per second versus megabits for satellites. The typical multi-terabit, transoceanic submarine cable system costs several hundred million dollars to construct, and the loss of use for any single cable is measured in the millions of dollars per day. The cost and usefulness of submarine cable systems make them highly valuable to the economies and countries they service.

Oregon has identified the submarine cables as a beneficial use of the seafloor that the state protects when siting marine renewable energy projects. Based on the policies and procedures required under Part Four of the Oregon Territorial Sea Plan, all cable routes must be established through an agreement between the cable company and an organization representing the commercial fishing interests, specifically the trawl fishers, who traditionally use the area through which the cable is to be laid. That agreement will encompass the area within the territorial sea but also extends through the federal waters and the GLD.

C. Reasonably Foreseeable Effects of MRE development on submarine cables:
Constructing and maintaining a marine renewable energy or wind facility in close proximity to a submarine cable may create a risk of damaging or hindering the use of the cable. The environmental impacts of cable installations are well- studied and monitored routinely with evidence indicating that cable burials may affect marine life in a narrow corridor, but that the disturbance is temporary and recolonization by marine organisms soon follow. There are still concerns regarding the local effects of electromagnetic forces on some species, though shielding seems to insulate that affect. However, there continue to be numerous instances, in other areas around the world, of fishing gear damaging cables or becoming entangled with seafloor cables.

The Oregon Territorial Sea Plan Part Four: Telecommunication Cables, Pipelines, and Other Utilities, provides policies and procedures to govern the siting of submarine cables,These policies were applied after the deployment of transoceanic fiber optic cables within Oregon's seafloor began to expand rapidly in the 1990's, causing space use conflicts with commercial trawlers. Space use conflicts between cable operators and the fishing community have not occurred in Oregon since, because the agreements required by Part Four are in place to prevent such conflict. The cable industry representative appointed by the Oregon Land Conservation and Development Commission to the Territorial Sea Plan Advisory Committee provided testimony to the commission and to the Ocean Policy Advisory Council during the TSP amendment process, to ensure that their facilities were included in the plan and that standards were in place to protect them. Further, cable ship operators testified as to the need to provide a buffer around the cable corridors so that the maintenance vessels would have safe access to cables for repair or replacement. Those same procedures ensure that MRE cables within the territorial sea will avoid conflicts. However, that presumption can't be extended to federal waters. Cables are often connected to bundled cable systems deployed on a north-south axis offshore along the Oregon coast in federal waters. There is a potential for space use conflicts with these cables, especially during the development stage of an MRE.

Citations

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3) Navigation

A. **<u>Navigation occurring off Oregon</u>**:

The section on navigation concerns the maintenance of reliable, safe and efficient routes for the commercial vessel traffic emanating from coastal ports. Ports activity is fundamental to the economic health of the state, not to mention the port communities themselves. Ports play the primary role in the conduct of domestic and global trade, which generates economic output for thousands of businesses located throughout Oregon. A recent study by the Brookings Institute concluded that the greater Portland Metro Region ranks 28 out of the top 100 metros across the U.S. in the value of goods traded with $140 billion in total trade. Oregon was among few areas in the U.S. with an international trade share higher than 10 percent (13.6 percent for Oregon).

Oregon's deep draft ports (Portland, St. Helens, Astoria, Newport and Coos Bay) handled approximately19.4 million tons of cargo valued at $15.9 billion in 2012 (Exhibit 3-1). Foreign trade accounted for approximately 87 percent of the total tonnage and 86 percent of the cargo value, with the remainder comprised of domestic trade with other states, primarily Washington and California but also to a lesser extent Hawaii and Alaska.

The North Coast ports (Port of Astoria, Port of Alsea, Port of Garibaldi, Port of Nehalem Port of Newport, Port of Tillamook, Port of Toledo and Port of Siuslaw) continue to rely on commercial fishing and forestry and logging, but as these traditional sources of port activity have been curtailed, the North Coast ports are expanding into general manufacturing, seafood processing, energy and recreational and tourism activities. From RV parks to whale watching to chartered fishing, the ports are exploring ways to expand beyond the former resource based economic uses. Marine science and marine education at the Port of Newport have contributed significantly to the local economy. While the Columbia River is the navigational channel for the Port of Portland, it also serves the Ports of St. Helens, Cascade Locks, Hood River, The Dalles, Arlington, Morrow, and Umatilla.

Oregon's South Coast ports (Port of Bandon, Port of Bookings Harbor, Port of Coos Bay, Port of Coquille, Port of Port Orford, Port of Umpqua/Salmon Harbor) play a key role in diversifying the regional economy by providing land/buildings for industrial and business activities and attracting tourism and recreation. A map of the vessel traffic emanating from Oregon's ports is included in the map inventory as #.

B. State interest in navigation:

Oregon coastal ports, home to fishing fleets, marinas and recreational facilities, are critical to the economic survival of their communities. International trade, recreational boating and commercial fishing are vital to the economic health of coastal port communities. A recent U.S. Army Corps of Engineers study of the economic impacts of recreational use of 18 Oregon shallow draft ports indicates that these ports generate, with multiplier effects, $94.3 million in sales, $35.9 million in income and 1,542 jobs. Commercial fishing remains the primary economic base for the coastal port communities. A 2010 NMFS study Oregon ranked Oregon seventh with 201M pounds, valued at $104.6M. Four Oregon ports made NOAA's Top 30 fish landings list. Port of Astoria was 13th in the nation with 100.9M valued at $30.5M. Newport was 19th, with 57.0M pounds valued at $30.6M. Coos Bay-Charleston ranked 26th at 31.0M pounds with $24.0M in value.

C. Reasonably foreseeable effects of MRE development on navigation:

Constructing and maintaining a marine renewable energy or wind facility in close proximity to a major shipping lane may create a risk of hindering the safe use of the navigational channel or shipping lane or cause vessels to use alternate routes that are more costly. During the Oregon Territorial Sea Plan amendment process, the Columbia River Bar Pilots Association provided a presentation and testimony regarding the Pilot Safety area at the mouth of the Columbia River. This area, and those for the Yaquina and Coos Bay channels are delineated under ORS 776 as areas wherein navigational safety is strictly controlled due to the high volume of large commercial merchant ships, barges, fishing vessels, and other craft. The Lower Columbia Region Harbor Safety Committee, made up of ports, merchant shipping operators, bar pilots, and the USCG, discussed the need to ensure that a navigational safety corridor extending seaward of the Columbia River channel, be considered when planning for future marine renewable energy projects. Vessel operators and bar pilots also pointed out that the new federal regulations requiring vessels to use low sulfur diesel fuels diminishes propulsion, slowing large vessels and requiring them to need larger turning radius when maneuvering to enter the channel or during rough seas. The Territorial Sea Plan and and others policies identify navigation as a beneficial use of the territorial sea and provide policies for ensuring that other new uses do not conflict with the use. A Memorandum of Understanding between FERC and the USCG for Hydrokinetic Projects was signed in 2013 to address the process for ensuring that MRE projects would be sited in a manner that does not compromise navigational safety. That agreement acknowledges the development of a MRE projects within or in close proximity to major vessel traffic lanes may pose a risk to the continued safe and efficient use of those areas by commercial vessels.

Citations

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4) Aesthetic (Visual) Resources

A. Resource use occurring off Oregon:

The scenic and aesthetic enjoyment of the Oregon coast is of vital economic and cultural importance to Oregon and is the primary contributor to the character of the coastal region and its communities. (Swedeen, Batker, Radtke, Boumans and Willer, 2008) (Needham, Cramer and Perry, 2013) The linear coastal margin offers views of the extensive expanses of Oregon's diverse open ocean seascape populated by headlands, islands and rocks land-water interface. This aesthetic resource has made the Oregon Coast an internationally recognized tourist destination with more than 20 million visits the state's coastal parks occurring each year (OPRD, 2011). Oregon's coastline is also unique in that it has over 70 state parks running along the highway, providing "public access and resource protection in a way that is unrivaled by any other U.S. coastline park system (CH2MHill, 1997)." Scenic enjoyment is the third most commonly stated primary recreational activity that visitors say they engage in at Oregon's coastal beaches (Shelby and Tokarczyk, 2002).

In addition, the Oregon Coast highway (Pacific Coast Scenic Byway) has been federally recognized by the National Scenic Byways program, established by Congress and administered by the U.S. Department of Transportation's Federal Highway Administration. The highway has a series of viewpoints overlooking unique ocean vistas built into it at various points. In addition to being one of the first Scenic Byways in the country, it has also been designated an "All American Road," which recognizes US 101 as possessing "multiple intrinsic qualities that are nationally significant and have one-of-a-kind features that do not exist elsewhere." The complete inventory of maps for the 144 scenic ocean viewsheds delineated and incorporated into the Territorial Sea Plan Part Five, is available on Oregon MarineMap. A map of these locations is included in the map inventory as (D).

B. State interest in the resource use:

One of the national policies that the federal Coastal Zone Management Act (CZMA) seeks to promote is the preservation and protection of aesthetic values and aesthetic coastal features. (16 U.S.C. §§ 1452(2), 1452(2)(F), and regulations implementing the CZMA define coastal effects to include effects to coastal uses including the "scenic and aesthetic enjoyment" of coastal resources (15 C.F.R. § 930.11(b). Oregon's Statewide Planning Goal 19 applies this policy by requiring state agencies to "protect and encourage the beneficial uses of ocean resources such as…aesthetic enjoyment." Cities and counties reiterated their interest in protecting aesthetic resources in the Territorial Sea Plan, specifically regulating the impacts of MRE under Part Five. The DLCD, in conjunction with Oregon Parks and Recreation Department (OPRD), conducted a comprehensive coastwide assessment of ocean viewsheds through the application of a visual resource inventory methodology for 142 ocean viewshed locations. The analysis created the maps, categorization and a specific set of standards to assess the impact of MRE projects within the territorial sea on each viewshed location.

The Oregon Ocean Shore Management Plan (OSMP) and Oregon TSP are both approved by the Federal Energy Regulatory Commission (FERC) as comprehensive plans under Section 10(a)(2)(A) of the Federal Power Act. In the approval of the OSMP, FERC notes that the OPRD "may identify important 'scenic features' that should be protected from development or other impacts for their scenic value (OPRD, 2005)."

Table 4. Visual Resource Inventory Viewshed Locations

1. Fort Stevens State Park, South Jetty
2. Fort Stevens State Park, Peter Iredale
3. Delaura Beach
4. Sunset Beach SP Fort to Sea Trail
5. Sunset Beach
5. Del Ray Beach State Park
6. Gearhart Beach Access
7. Seaside 12th Avenue Beach Access
8. The Cove, Seaside
9. Ecola State Park, Tillamook Head Trail
10. Ecola Point Viewpoint
11. View Point Terrace, Cannon Beach
12. Tolovana Beach State Park
13. Arcadia Beach State Park
14. Hug Point State Park
15. Leech Avenue, Arch Cape
16. Cove Beach
17. Oswald West State Park, Cape Falcon
18. Oswald West State Park, Day-Use
19. Oswald West State Park, HWY Lookout
20. Manzanita
21. Nehalem Bay State Park, Day Use
22. Manhattan Beach State Park
23. Rockaway Beach
24. Twin Rocks, State Natural Site
25. Barview Co. Park, Tillamook R. N. Jetty
26. Bay Ocean (Cape Meares)
27. Cape Meares Scenic Viewpoint, Cove
28. Cape Meares Lighthouse
29. Cape Meares Scenic Viewpoint, South
30. Oceanside Beach State
31. Symons Scenic Viewpoint, Access trail
32. Cape Lookout State Park, Headland N.
33. Cape Lookout State Park, Headland S.
34. Tierra del Mar
35. Cape Kiwanda, McPhillips Beach Access
36. Pacific City, Beach Access
37. Bob Straub State Park, Day Use Area
38. Winema Wayfinding
39. Proposal Rock, Neskowin
40. Cascade Head
41. Roads End State Park, N.
42. Roads End State Park, S.
43. Lincoln City 21st Street
44. D River State Park
45. Canyon Drive, Lincoln City
46. Nelscott Parking Lot
47. Pointe Park/Beach Ave, Siletz River
48. Gleneden Beach State Park
49. Fishing Rock State Park
50. Fogarty Creek State Park
51. Boiler Bay State Scenic Viewpoint
52. Depoe Bay Whale Watching Center
53. Rocky Creek State Scenic Viewpoint
54. Otter Crest (Cape Foulweather)
55. Devil's Punchbowl
56. Beverly Beach State Park
57. Moolack Beach
58. Yaquina Head (BLM), Lighthouse
59. Yaquina Head (BLM), South View
60. Agate Beach State Park
61. Nye Beach
62. Yaquina Bay State Park, N.
63. South Beach State Park, Day Use
64. Thiel Creek
65. Lost Creek State Park
66. Ona Beach State Park
67. Seal Rock State Park, View N.
68. Seal Rock State Park, View S.
69. Driftwood Beach State Park
70. Governor Patterson State Park
71. Beachside State Park, Day-use
72. San Marine State Wayside
73. Perch Street, Historic 804 Trail Beach
74. Smelt Sands State Park
75. Yachats State Park
76. Yachats Ocean Rd, State Access
77. Cape Perpetua - Rock Shelter

78. Neptune State Park, Cummins Cr.
79. Neptune State Park, Strawberry Hill
80. Neptune State Park, Bob Cr.
81. Stonefield Beach State Park
82. Tokatee Klootchman, Day Use Area
83. Muriel O. Ponsler Memorial Viewpoint
84. Carl G. Washburne State Park
85. Heceta Head Lighthouse
86. Heceta Head - ODOT Viewpoint
87. Sutton Overlook, Dunes View
88. Florence, Siuslaw River North Jetty
89. Siuslaw South Jetty
90. Siltcoos, Beach Access
91. Sparrow Park Road (USFS)
92. Umpqua Overlook (ODOT)
93. Umpqua Lighthouse State Park
94. Horsfall Viewpoint (USFS)
95. Bastendorff Beach
96. Yoakam Point, State Natural Site
97. Sunset Bay State Park
98. Shore Acres Observation Shelter
99. Shore Acres, Simpson Reef Overlook
100. Cape Arago State Park, North Cove
101. Cape Arago Middle Cove
102. Cape Arago State Park, South Cove
103. Seven Devils State
104. Whiskey Run Viewpoint
105. Bullards Beach State Park
106. Bandon Beach Loop Trail Bridge
107. Coquille Point (USFWS)
108. Face Rock State Scenic Viewpoint
109. Bandon, China Creek Access
110. New River Overlook Trail (BLM)
111. Floras Lake, Blacklock Point
112. Cape Blanco State Park, View North
113. Cape Blanco State Park, View South
114. Paradise Point State Recreation Site
115. Tseriadun State Recreation Area
116. Port Orford Heads State Park
117. Port Orford Heads SP, Nellie's Cove
118. Port of Port Orford
119. Battle Rock Wayside
120. Humbug Mountain State Park
121. Arizona Beach State Recreation Site
122. Sisters Rock, State Natural Area
123. Ophir Rest Area
124. Otter Point State Recreation Site
125. Gold Beach, Rogue River North Jetty
126. Gold Beach, Visitor Center
127. Buena Vista Ocean Wayside
128. Cape Sebastian State Scenic View North
129. Cape Sebastian State Scenic View South
130. Pistol River State Scenic Viewpoint
131. Samuel H. Boardman SP Arch Rock
132. Boardman SP, Natural Bridges
133. Samuel H. Boardman SP, Indian Sands
134. Samuel H. Boardman SP House Rock
135. Samuel H. Boardman SP Cape Ferrello
136. Harris Beach State Park Day-Use Area
137. Harris Beach State Park, South Beach
138. Chetco Point - End of Point
139. Chetco Point - End of Paved Trail
140. Brookings, Chetco River South Jetty
141. McVay Rock State Recreation Site
142. Crissey Field State Recreation Site

The description of each site, its aesthetic values, characteristics and photo images are contained in the Oregon Territorial Sea Plan Visual Resource Inventory.

C. Reasonably Foreseeable Effects on the resource use:

According to a study for the Argonne National Laboratory, the potential visual impacts that development of offshore wind facilities may have on coastal lands has emerged as a major concern in the United States and Europe. The study finds that "[t]he visual impacts to seascapes associated with offshore wind facilities are without precedent; the facilities are very large, with structures of enormous height having colors and a geometry that contrast strongly with natural seascapes. The synchronized sweeping movement of the massive blades during the day and the synchronized flashing of the lighting at night contribute to the facilities' visibility over very long distances."

Most MRE developments will be partially if not entirely visible on the ocean surface. Wind turbines are currently being built for deployment in the ocean that will exceed 600 feet above sea surface at the tip of the blade. When deployed in arrays, and lighted for navigational safety, MRE technologies have the potential to create a significant visual effect on a seascape that is now mostly populated by offshore rocks and islands interspersed with passing vessels. The Argonne study finds that observations of existing offshore wind facilities in the United Kingdom showed that the offshore developments may be visible at distances of 26 mi (42 km) in daytime and 24 mi (39 km) in nighttime views, and may be a major focus of visual attention at distances of up to 10 mi (16 km).

There is reasonably foreseeable potential for MRE, and specifically offshore wind turbine development, to have a visual impact on viewsheds that have been identified as unique and special aesthetic resources to the state of Oregon. This effect may be detrimental to the value of those viewsheds, both from a cultural and personal aesthetic perspective, as well as an economic resource of interest to coastal communities and the state.

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5) Scientific Research

A. Scientific Research Occurring off Oregon

There is a long, well-established, history of marine research off the Oregon coast, providing decades of invaluable biological, atmospheric, geologic, and hydrographic information that is vital to the state economy, in addition to the safety and well-being of residents and coastal infrastructure. In addition, local economies are enhanced via several well-known research institutes and universities on the Oregon coast. It is important to continue to provide for the research institutes, research-related infrastructure and long-term sampling regimes, and to prevent overlap between research areas and potential offshore energy facilities.

Spatial analysis of marine research activity conducted for the Oregon GLD shows that the highest densities of research are found near coastal communities and ecologically important areas. Furthermore, many transect lines, cables and arrays, extend from the nearshore environment to offshore waters. Oceanographic moorings are distributed throughout the Oregon GLD, in both nearshore and offshore waters. Many moorings are interconnected systems, creating a line of data collection points at varying depths. The following section highlights the variety of research projects and infrastructure that occur off Oregon, along with associated marine research institutes that supports offshore efforts.

Fixed station moorings and research transects extend from the nearshore environment to approximately 300 nautical miles offshore. There are seventy-seven underwater platforms off the Oregon coast, and these devices include nodes for connecting cables and other subsurface infrastructure. Additionally, there are forty-one permanent transect lines off the coast of Oregon (Sherman 2012), some of which provide invaluable, and substantial long-term historical datasets.

Oregon is home to three marine research institutions, along with the National Oceanic Atmospheric Administration's Marine Operations Center, Pacific (MOC-P) research fleet. Thousands of scientists visit and participate with institutions and programs such as Center for Coastal Margin Observation and Prediction (CMOP), Hatfield Marine Science Center (HMSC) and the Oregon Institute of Marine Biology (OIMB) to make use of scientific resources available, as well as to experience innovative research techniques, and to easily access offshore research areas. HMSC and CMOP are partnerships of multiple educational entities, industries, along with federal and state agencies. Scientific research is concentrated near coastal communities, with Newport having the highest concentration of projects, followed by Port Orford, and Charleston (Sherman 2012). This proximity to ports is important because ports provide infrastructure and access to the offshore environment.

HMSC, located in Newport, is Oregon State University's marine campus for research, education, and outreach, and is also home to OSU and NOAA's marine research fleet. Multiple state and federal government agencies are co-located at HMSC, including the Oregon Department of Fish and Wildlife, US Fish and Wildlife Service, NOAA, the Environmental Protection Agency. HMSC has been in existence nearly five decades and is a major economic driver on the central Oregon coast, employing over 300 staff with a total annual research and operating budget of nearly $50 million. Additionally, HMSC is co-located adjacent to NOAA's MOC-P research fleet. The facility was completed in 2010 and cost $30 million, and created approximately 175 jobs. OIMB, located in Charleston, is the marine science station of the University of Oregon, and has been conducting marine research since 1924. CMOP is National Science Foundation funded, large multi-institutional partnership with Oregon Health & Science University, Oregon State University, and the University of Washington.

B. State Interest in Offshore Scientific Research

Scientific research that occurs outside of Territorial Sea waters are tied to the state of Oregon interests, providing decades of invaluable biological, atmospheric, geologic, and hydrographic information that is vital to the state economy, in addition to the safety and well-being of residents and coastal infrastructure. Scientific research contributes millions to state and local economies, and may be linked to state interests primarily through a spatial connection, as a high degree of research occurs between state and federal waters. Many research transects or arrays span the depth range between state and federal waters, and are thus subject to the enforceable policies of the state's Coastal Zone Management Program.

Marine research is conducted in many capacities, including permanent, offshore sampling points, or moorings, in addition to systematic sampling transects along the coast (e.g., multi-year, sampling lines and arrays). There are a minimum of 58 research transect lines (cruise, underwater glider, research), 39 buoys/moorings, and two underwater cables that are part of the Ocean Observing Initiative system within the proposed GLD. The bouys and moored monitoring devices are connected to shore through a data cable system that passes through the state's territorial sea and are connected to several onshore data distribution facilities. The purpose of various research programs are broad, and the intent of this document is not to describe every use, but instead to highlight key areas of research. Fixed station buoys or moorings extend from the nearshore environment to approximately 275 nautical miles offshore. The data collected by fixed station infrastructure serve a wide breadth of purposes including: tsunami prediction, tracking the dynamics of hypoxia and ocean acidification, in addition to tracking other parameters that drive the California Current Ecosystem. Furthermore, the OOI operates seven, networked, offshore buoys that measure physical, geological and biological variables on the ocean floor. The OOI also operates three fixed platform sites at 25, 80 and 600 m depth, with the 80 and 600 m sites cabled, supporting surface moorings, water column profilers and benthic boundary layer sensors, supplemented by six gliders. This research tracks parameters such as, chlorophyll, dissolved organic matter, current drift, dissolved oxygen and backscatter data.

Oregon has identified the submarine research cables as a beneficial use of the seafloor that the state protects when siting marine renewable energy projects. Based on the policies and procedures required under Part Four of the Oregon Territorial Sea Plan, all cable routes must be established through an agreement between the cable company and an organization representing the commercial fishing interests, specifically the trawl fishers, who traditionally use the area through which the cable is to be laid. That agreement will encompass the area within the territorial sea but also extends through the federal waters and the GLD.

Oregon has a history of long-term, offshore scientific research, which is of interest to the state as these datasets provide long-term oceanic monitoring information For example, the Newport Hydrographic Line has been used to examine various components of the offshore environment for over five decades. The Oregon, California, Washington Line Ecosystem Survey (ORCAWALE) is a large transect grid that has been in existence for multiple decades. It extends from shore out to approximately 300 nautical miles, with the primary objective to collect data for estimating the abundance of cetacean and bird populations along the U.S. West Coast and for a better understanding of habitat distribution. Some sampling points have been in existence for nearly three decades, such as the International Pacific Halibut Commission's annual survey. The IPHC halibut survey extends from Alaska to California and is important to evaluate the viability and sustainability of halibut populations.

Scientific research is also an emerging, yet significant, economic driver on the Oregon coast. The institutions, oceanic research fleets, and offshore research-related infrastructure provide valuable economic assets to the state. For example, in Lincoln County, home to HMSC, marine science has become a substantial economic contributor for this coastal community. In Lincoln County, marine science alone generates $62 million in earnings annually and accounts for nearly 4% of the county's personal income (Davis 2014). Although there is little research-related, economic data available in other parts of the state, it should be noted that marine science is an emerging, albeit significant economic contributor.

C. Reasonably Foreseeable Effects of MRE Development to Scientific Research

Reasonably foreseeable effects of ocean energy development on scientific research is primarily related to the potential for spatial conflict resulting from overlapping footprints of device placement and research access, and can be classified into two broad categories based on the effects on research infrastructure, and on sampling regimes:

1. Infrastructure conflicts, including submarine research cables
2. Displacement or Alteration of long-term sampling transects

The most direct effect on scientific research pertains to conflicts resulting from overlapping footprints of device placement and research infrastructure, which include fixed moorings, buoys, underwater platforms and/or submarine cables. The second effect on scientific research results in the potential alteration of long-term, multi-decadal sampling regimes.

The addition of renewable energy device floats, cables, anchoring and mooring systems, along with the energy-generating devices themselves provide physical structure where none currently exists, and serve to increase infrastructure or gear conflicts, and to alter accessibility to researchers. The Oregon Territorial Sea Plan policies and procedures that govern the siting of submarine cables were established to ensure the safe operation and maintenance of the cables specifically with respect to the potential conflicting use of the cable corridor by the commercial fishing vessels. However, most of the research infrastructure cables are widely deployed in federal water along the outer continental shelf, often in circuitous configurations connecting the various seafloor mounted monitoring devices. It can be assumed that the development of a MRE or wind project over or within the safe operational area required by vessels to maintain a cable may pose a similar risk to the continued use and maintenance of an existing submarine cable. There is a potential for MRE developments to have an effect upon devices that measure oceanographic conditions such as ambient sound, current flow, or other physical properties. For example, an Oregon State University researcher recently provided comments to the BOEM at a public workshop for the proposed Windfloat Project, expressing concern that the turbines may cause a shadowing effect on an offshore radar system that scans the area.

Research infrastructure displacement, damage or entanglement has the potential to increase costs to the academic or research community due to increased resource consumption, along with the actual cost of infrastructure relocation (e.g., cost to move fixed research devices, or increased fuel use and travel time to research grounds in order to avoid a development site). Furthermore, long-term research programs provide invaluable datasets that track changes to the oceanic environment on decadal time scales. Alteration of these research sampling areas or infrastructure may diminish the ability to make comparisons between historical and current biological, atmospheric, geologic, and hydrographic trends. It should be noted that renewable energy siting may theoretically increase research efforts related to ocean energy, but this increase may not mitigate the alteration of invaluable, long-term sampling arrays or sampling sites. Ultimately, all of these impacts are of direct interest to the state and this section summarizes potential reasonably foreseeable effects on scientific research.

Much scientific research and associated infrastructure, in the form of research arrays, underwater platforms, moorings, or buoy lines, spans the depth ranges between state and federal waters, and are thus subject to the enforceable policies of the state's Coastal Zone Management Program. Many of these have specific site-use authority under state or federal permitting or leasing programs. Any of the impacts to this scientific research infrastructure described above constitute reasonably foreseeable impacts to Oregon's coastal zone.

Citations

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IV. Marine Ecology/Natural Resources

This section characterizes natural resources within the GLD, how these resources are linked to the state's Coastal Zone, and what exposure these resources have to the potential impacts from renewable ocean energy. The potential impacts of MRE on the resources in this section are of concern to Oregon. However, there is not yet adequate data and information about the impacts of MRE on these resources to substantiate the "reasonably foreseeable effects analysis" necessary for 15 CFR Section 930.53. Though this information is descriptive, rather than analytic, it is being included in the GLD to document the state's continuing interest in how important resources and uses may be affected, and to ensure that they are considered when the siting and authorizing of MRE projects is conducted.

Following an explanatory introduction are four subsections addressing separate categories of marine ecological resources:

1) Fish and Selected Invertebrates;
2) Birds;
3) Marine Mammals; and
4) Ocean Habitat.

The four species/habitat subsections are each organized to address the following questions:

a. Species and habitats occurring off of Oregon: Which species and habitats occur off Oregon, and where?
b. State interest in offshore species and habitats: Which species and habitats outside of Territorial Sea waters is the state most concerned about, and what are the linkages between habitats or species within the GLD to state of Oregon interests with respect to the enforceable policies of the state's Coastal Zone Management Program?
c. The potential for certain impacts associated with MRE development to contribute to effects on species and habitatsof concern to Oregon.,

These species or habitats may be linked to state interests for one or more of three general reasons:

1. ecological connection between state and federal waters,
2. conservation or management policy connection,
3. human use connection (e.g., fish harvested in federal waters and landed in the state)

For purposes of this analysis, an adverse effect on an ecological resource is defined as degradation in ecosystem function or integrity (including but not limited to direct habitat damage, burial of habitat, habitat erosion, reduction in biological diversity) or degradation of living marine organisms (including but not limited to abundance, individual growth, density, species diversity, species behavior) (DLCD, TSP Part 5, 2013 [page 17]) The state is concerned that there may be effects that are small or temporary in the context of a single project, but that may result in cumulative effects over time. For example, short-term construction or maintenance effects may become chronic impacts when many developments are built and operated in close proximity over a longer time frame. The assumption is that the monitoring and adaptive management plans that would be required as conditions of any federal authorizations will be designed to identify and measure any cumulative impacts, and that certain best management practices and mitigation measures will be applied to prevent such occurrences.

This analysis takes the approach of examining identifiable components of potential future projects that may impact resources (stressors) with respect to the resources that may be affected by the project (receptors). This stressor-receptor approach is well established and has been recently applied in ocean renewable energy analysis (Boehlert and Gill 2010; Klure, et al. 2012). Types of marine renewable energy development stressors that may affect resources described in Part III. of each subsection include (Boehlert and Gill 2010; Klure, et al. 2012):

- Physical presences of device (includes above-water and below-water structure, anchoring and mooring components, and electric cable infrastructure
- Moving devices (includes moving components of device)
- Energy removal
- Chemical release (includes spills during installation and maintenance, leaching of paint)
- Acoustic effects
- Electromagnetic field (EMF) effects
- Lighting

There is a growing body of literature reviewing potential ocean renewable energy effects on marine natural resources (e.g., COWRIE citations, Boehlert and Gill 2010; Klure, et al. 2012; others). Rather than reiterating the extensive details concerning the effects provided in existing literature, this analysis provides brief summaries of the effects for each resource type and lists examples of species or habitats that may be affected. The analysis then draws final conclusions about whether or not adverse impacts experienced primarily in federal waters translate to reasonably foreseeable effects to uses or resources of Oregon's coastal zone (i.e., coastal effects).

A. Fish and Invertebrates

This subsection analyzes resources and potential ocean renewable energy effects within the GLD with respect to marine fish and a subset of marine invertebrates. The analysis endeavors to include all fish species that occur off of Oregon from the shore to the outer depth limit of the GLD, including both marine and anadromous species. This section also includes a subset of marine invertebrates, focusing on those regularly harvested in commercial or sport fisheries. The "Ocean Habitat" section of this GLD document documents other marine invertebrate species.

a. Fish and Selected Invertebrates Occurring off of Oregon

Approximately 516 species of fish occur off of Oregon from the shore to 500 fm, excluding occasional occurrences of open-ocean, pelagic or very deep sea species (Appendix, Table A). In addition, 7 species of invertebrates occur off of Oregon that are important to Oregon fisheries (Appendix, Table B). The distribution by depth for many of the species is shown in Figure 1. Of the total species listed, considering adult stages only, 36 species occur solely in the GLD area, 43 occur solely within state waters, and 221 occupy depth ranges that overlap both state and federal waters. Most of the remaining species are deepwater species that occur in federal waters, but have insufficient data to determine their full depth range. The majority of species that will be considered further in this analysis include species whose depth distribution overlaps with the GLD. In addition, this analysis includes some species that occur solely in state waters (inshore of the GLD) if they have a clear link to activities or species that occur within the GLD. Maps F-1 through F-4 provide some examples of the distribution of key fish species with respect to the boundaries of the GLD.

b. State Interest in Offshore Species

This section addresses specific species that are regulated under enforceable policies of the state's Coastal Zone Management Program, and that occur both within and Oregon's Territorial Sea and the GLD area. The state's interest is related to one or more of three general reasons:

1. ecological connection between state and federal waters,
2. conservation or management policy connection,
3. fishery connection (e.g., fish harvested in federal waters, landed in the state)

b.1. Ecological Factors

Species distribution, life history, or food web relationships can draw connections between state and federal waters, and justify a state interest in these species. Many fish and invertebrate species populations span the depth range across state and federal waters.. Of the species considered in this section, 221 occur both in state and federal waters as adults (Appendix, Table B). For this reason, all of these species are of direct interest to the state.

Many species off of Oregon exhibit seasonal or longer time scale movements between state and federal waters due to feeding or spawning migrations, shifts in depth during development, or movement for other reasons. Anadromous species, along with other fish species, are found in both state and federal ocean waters off of Oregon and return to Oregon's rivers, streams, or bays to spawn. The salmonid species are best known for this life history trait. Other examples of anadromous species that are found in waters of the GLD include Green Sturgeon, White Sturgeon, Pacific Lamprey, River Lamprey, Longfin Smelt, Eulachon, American Shad, Striped Bass, and Threespine Stickleback. While not considered an anadromous species, Pacific Herring spawn in some of Oregon's estuaries, but spend much of their time in GLD waters.

Several species that occupy the GLD move into shallow nearshore state waters to spawn. For example, Lingcod lay eggs in shallow nearshore rocky reef environments and the males guard the egg nests until the young hatch (McCain, et al. 2005). Other species such as Spiny Dogfish move to shallow water to release young (McCain, et al. 2005). Most of the adult populations of these species occupy GLD waters, with Lingcod populations extending to 475 m (260 fm) and Spiny Dogfish to 1,236 m (676 fm) (McCain, et al. 2005). Several species move seasonally between the inner and outer shelf/slope, alternating between their primary spawning areas and primary feeding areas. Portions of those populations cross between state and federal waters. Many of the flatfish species off of Oregon, such as Dover Sole, Petrale Sole, Rex Sole, and Rock Sole move from winter spawning areas in deeper water to summer feeding areas in shallower waters (McCain, et al. 2005). In addition to flatfish, other species such as Pacific Cod show a similar seasonal pattern. In contrast, species such as Sand Sole and Starry Flounder spawn in shallow neashore waters or estuaries in winter and move to deeper summer feeding grounds

(McCain, et al. 2005). Dungeness crab also exhibit seasonal onshore-offshore movements between state and federal waters. Appendix, Table B indicates species whose populations commonly shift across the state-federal boundary.

Many species off of Oregon settle as juveniles in nearshore ocean or estuarine waters and move offshore to deeper shelf waters or the continental slope as they grow. This ontogenetic shift from primarily state waters to primarily federal waters is well-documented in many of the rockfish species. Examples include Blue, Canary, Copper, Darkblotched, Greenspotted, Greenstriped, Quillback, Redstripe, Rosy, Squarespot, Widow, Yelloweye, and Yellowtail Rockfish (McCain, et al. 2005). In addition to rockfish, Lingcod, Spiny Dogfish, several flatfish species display this life history trait. Of the invertebrate species considered in this document, Dungeness crab is notable in displaying this trait. Juveniles settle in estuarine and shallow ocean nursery areas, primarily in state waters, and the adult population spreads to deeper waters, including both state and federal waters. Market squid will also spawn in nearshore shallow waters while adults occur in both state and federal waters. Appendix Table B indicates species which display this life history trait.

Virtually all species of interest to the state are linked to species in federal waters through food web relationships. It is beyond the scope of this analysis to attempt to describe all of the possible food web relationships in the ocean off of Oregon. As a general example, numerous forage fish species such as Pacific Sardine, Pacific Herring, Northern Anchovy, Pacific Mackerel, Pacific Sand Lance, and many smelt species, exist in federal waters and provide food for species of state interest. In addition, larval and juvenile forms of many fish and invertebrate species in federal waters are consumed by species of state interest.

There are numerous other ecological processes that provide connections between state and federal waters such as larval transport, primary production, ocean circulation processes (e.g. upwelling), nutrient and carbon cycling, sediment transport, and phenomena such as hypoxia and ocean acidification. Rather than documenting these processes in detail, this descriptioncites these physical processes in order to further substantiate e and support the state's interest in waters of the GLD.

b.2. Conservation and Management Policy Factors
Oregon has interest in threatened, endangered, or otherwise sensitive species in the GLD either directly due to conservation measures in state regulations, or indirectly when impacts to federally-managed species in the GLD negatively affect Oregon's ocean resources and uses. Fish species that occur within the GLD, that are on the state and federal endangered species list include Green Sturgeon (T), Eulachon (T), Chinook Salmon (9 ESUs listed, T and E), Chum Salmon (2 ESUs listed, T), Coho Salmon (4 ESUs listed, T and E), Sockeye Salmon (2 ESUs listed, T and E), Steelhead Trout (11 DPSs listed, T and E) (ODFW 2014, NOAA 2014). Oregon's threatened and endangered wildlife statute is an enforceable policy within the state's Coastal Zone Management Program.

The federal Groundfish Fishery Management Plan lists seven groundfish species as overfished, including Yelloweye Rockfish, Pacific Ocean Perch, Petrale Sole, Darkblotched Rockfish, Canary Rockfish, Bocaccio, and Cowcod (PFMC 2014). The overfished and threatened and endangered species are of conservation concern to the state because their populations are vulnerable and they often constrain fisheries that interact with them. Any impacts to those species outside of the fishery context, such as from an ocean energy development, could serve to further constrain and reduce the Oregon's fishery access to these and co-occurring species. Anything that affects Oregon fishing fleet access to fish in federal waters, other than a short-term inconvenience, impacts state interests with respect to the enforceable policies of the state's Coastal Zone Management Program (see the Commercial and Recreational Fishing chapter of this GLD document for further information). Similarly, some species that are not listed as overfished still constrain mixed-stock fisheries because their populations can only support limited catch quotas. These constraining species can vary from year to year depending on their population status. In 2014 constraining species include Sablefish, Rougheye Rockfish, Shortraker Rockfish, China Rockfish and Spiny Dogfish, and any impacts to them outside of the fisheries context could serve to further reduce the state's fishery access.

In addition to the conservation issues described above, the state of Oregon has developed a Nearshore Conservation Strategy as part of their overall state conservation strategy which identifies 34 marine fish species of conservation concern to the state. The Nearshore Strategy refers to these species as "Strategy Species", and many of these occur in both state and federal waters. Any long-term effects on these species from renewable ocean energy development in federal waters is therefore a concern to the state.

Appendix, Table B indicates species with a conservation or management policy connection as discussed in this section.

b.3 Fishery Factors

Oregon fisheries catch many fish and invertebrate species in federal waters of the GLD, as well as state waters, and land them in Oregon. Oregon coastal economies depend on these fisheries and, by extension, on healthy populations of the harvested fish and invertebrate species. The state is concerned with any activities that could impact these species either directly or indirectly that may reduce the populations and therefore curtail catch. Appendix Table B lists the top 30 commercial and top 20 recreational fish species in terms of catch and value, as examples of fishery species that are of direct interest to the state. In addition to affecting fish populations, activities in the federal waters of the GLD can also impact fishing operations due to space-use conflicts, navigation closures, or restrictions on fishing gear. Please refer to the "Commercial and Recreational Fishing" chapter of this GLD document for a description of these potential impacts and further information on fisheries.

b.4. Summary of Potential Fish and Invertebrate Species of Concern

Appendix, Table B summarizes fish and invertebrate species based on the above discussion, and highlights the species linked to Oregon's interests with respect to ocean renewable energy activities in the federal waters of the GLD. A species is potentially linked to Oregon's interest if one or more of the following criteria are met:

- The species' adult population occurs in both state and federal waters,

- The species' adult population occurs in federal waters, and it is within the top 30 fishery species (either commercial or recreational, by value or catch, respectfully)
- The species' adult population occurs in federal waters, and it has juvenile stages in state waters.
- The species' adult population occurs in federal waters, and it is a prey source for species in state waters
- The species' adult population occurs in federal waters, and it has a particular conservation concern to the state (T&E, overfished, or constraining species)
- The species' adult population occurs in state waters only, and it feeds on prey species that occur in federal waters

Many of the species listed meet more than one of the criteria listed above (Appendix Table B).

c. Potential Impacts of MRE to Fish and Selected Invertebrates
This section summarizes potential reasonable foreseeable effects on fish and invertebrate species from the following categories of potential stressors form ocean renewable energy development:

1. Physical presences of device (includes above-water and below-water structure, anchoring and mooring components, and electric cable infrastructure)
2. Moving devices (includes moving components of device)
3. Energy removal
4. Chemical release (includes spills during installation and maintenance, leaching of paint)
5. Acoustic effects
6. Electromagnetic field (EMF) effects
7. Lighting

Potential impacts from renewable ocean energy development are described for each stressor, followed by a summary of how these impacts affect uses or resources of Oregon's coastal zone (i.e., coastal effects).

c.1. Physical Presence of Devices- Summary of Effects
The ocean renewable energy structure, moorings, and electrical transmission infrastructure involve some alteration of the pelagic and benthic habitat in and near their location. Structures on the water surface or in the water column will likely act as fish aggregation devices and attract species of pelagic fish such as Albacore Tuna and several shark species (Boehlert and Gill 2010; Klure, et al. 2012; Nelson, et al. 2008). In addition, fouling organisms that will settle on the subsurface structure will likely attract other species in response to the additional surface structure created by the fouling organisms and the presence of additional food resources. The devices' anchoring systems alter benthic habitat by providing hard physical structure on otherwise soft-bottom environments, creating an artificial reef effect. This will attract demersal species such as rockfishes and may displace species such as many of the flatfish species and Dungeness crab. In addition, the presence of anchors or other structure on or near the sea floor will cause down-current changes in the sedimentary environment due to scouring or accretion, which can alter habitat characteristics and benthic prey resources.

These habitat changes have the following effects on fish and selected invertebrates:

- Alter species composition at the site,
- Attract concentrations of predators that could prey on species not otherwise exposed to similar concentrations of predators
- Attract fish and mobile invertebrates away from their previous locations, which, in turn could limit fishery catch in those areas
- Decrease habitat of species that were previously located at the site, which could alter species composition at the site (Boehlert and Gill 2010; Klure, et al. 2012).

Fish aggregation effects of the devices can increase fish abundance at the ocean energy site. However, however fishing around the devices may be closed or limited to certain types of fishing in order to prevent commercial fishing gear,nets and pots from becoming entangled with the cables and other parts of the development and for navigational safety. This may reduce fish availability to fisheries operating in the surrounding areas. In addition the aggregation of predators at the ocean energy site can serve to reduce the abundance of species that may be important to fisheries. These
Increase predation that can result from aggregation of predators can cause direct mortality fish species of conservation concern, such as ESA-listed or overfished species. Examples include the listed salmonid stocks, Eulachon, and juvenile Yelloweye Rockfish. These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Impacts to these species in federal waters may also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above

c.2. Moving Devices – Summary of Effects
The movement or other mechanical actions of devices in the water can have impacts on fish or invertebrates beyond those caused by the physical presence of the device. Devices that have moving parts in the water could impact fish by direct contact damage or, if pressure differentials are created, through barotrauma effects. The potential for this type of impact would depend on the size of the moving parts, characteristics of the motion (speed, movement distance, frequency, etc.) and position in the water column.

Some devices move water in and out of chambers or other internal structures, relying on water pressure or other action to generate electricity. If the pathway of water movement into the device is not screened, fish may be entrained and subjected to direct physical damage, abrasion, or, if there are significant pressure changes, various types of barotrauma effects. Where the intake is screened, fish and invertebrate species or life history stages unable to out-swim the intake currents could be impinged on the screen (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008). The susceptibility of various species to these potential impacts would depend on the location of the device and the location of the water intake with respect to position in the water column. For example, if the water intake is on a device floating on the surface, pelagic species and life history stages would be most vulnerable to impact, especially those that are likely to be attracted to the device for shelter. Examples include pelagic species such as

Pacific Herring, or species with pelagic larval stages that settle on hard substrate, such as newly-settling rockfish.

Devices that operate using an overtopping of ocean water, depending on their design, could pose a stranding hazard to fish species or life history stages near the surface of the water (Klure, et al. 2012).

Entrainment and other effects described above could cause direct mortality fish species of conservation concern, such as juvenile stages of ESA listed salmonid stocks. These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Impacts to these species in federal waters may also impact Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above.

c.3. Energy Removal-Summary of Effects

Energy removal refers to a reduction in wave action that may occur shoreward of wave energy devices, especially if development, either individually or cumulatively, is very large-scale. This can change the sediment transport and habitat characteristics of shallow water and shoreline environments in the wave-shadow of devices (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008). Most of the shallow water and shoreline areas are in state waters, however in some areas such as the Clatsop plains, the slope is more gradual and the shallow bathymetry extends into federal waters . The potential for energy removal and anchoring systems to impact sediment transport and deposition is currently one of the effects of concern at the Pacific Marine Energy Center site south of Newport.

Potential effects on fish and invertebrates would be indirect, including changes in habitat structure and benthic prey communities. Fish and invertebrate species most susceptible to this type of effect would include shallow-water benthic species and juvenile life history stages. Many of the rockfish and flatfish species depend on the shallow water habitats as nursery areas. In addition, rocky intertidal areas which provide habitat for numerous fish and invertebrates, including early life history stages of deeper-water fishes, could be affected. Changes in sedimentation patterns at the mouths of small estuarine systems that support migratory salmonids could impede salmon movement to and from the ocean (Nelson, et al. 2008).

If development reaches a large enough scale to affect shoreline and shallow-water habitats in state waters, the nursery functions of these habitats to rocky species such as rockfishes and lingcod, or sandy species, such as Dungeness crab or several flatfish species could be compromised. Reduction in juvenile stages of commercially important species can contribute to reduce commercial fishery landings or increase the cost for catching fish.

Changes in shoreline or shallow-water habitat in state waters could affect the prey base of ESA listed Green Sturgeon or juvenile stages of salmonids. Any impact to these species in state waters impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above.

c.4. Chemical Exposure - Summary of Effects

Potential chemical exposure of organisms and the surrounding environment can result from leaching or chipping of anti-fouling paints or other coatings on the devices, and spills or leaks of chemicals that may occur during construction, operations, or maintenance (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008). The chemicals can originate from the devices or vessels servicing the devices. There is extensive literature on potential chemical effects in the marine environment from various substances. Recent studies link the potential for chemical pollution from MRE to adversely effect a variety of marine species. (Shield and Payne eds. 2014) (Kramer, Previsic, Nelson and Woo, 2010). Larval or other early stages of many fish and invertebrate species are especially vulnerable to even small concentrations of certain chemicals in the pelagic environment. Benthic fishes and invertebrates, and their prey, can experience chronic effects from chemical exposure from paint chips or spilled materials that sink to the seafloor and can persist in benthic environment under the devices. This is especially true of materials that can slough off the devices during periodic and on-going maintenance. Klure, et al. (2012) found that ocean stakeholders are very concerned about release and accumulation of toxic chemicals. In addition, estuaries are particularly sensitive to leaching, spills, or discharges that can occur while building, storing, maintaining, or staging ocean energy devices or from the vessels installing or servicing the devices.

Chemical pollution can cause direct mortality on fishery species, reducing the potential catch of a fishery or increasing the fishing effort required to achieve a desired catch. Additionally, a pollution event can cause a closure of fisheries in the affected area until the fish or shellfish are safe for human consumption. Even when fish and shellfish are not directly affected, pollution events often cause negative reaction by the public due to concerns about chemically-tainted fish. This can, in turn, reduce marketability of Oregon's fish and impact economies dependent on the fisheries. Any of these issues can contribute to reduce commercial fishery landings, increase the cost for catching fish, reduce fish price or otherwise impact fish marketability.

Chemical pollution can cause direct mortality or sub-lethal impacts to fish species of conservation concern, such as ESA-listed or overfished species. Examples include the listed salmonid stocks, Eulachon, Green Sturgeon, and Yelloweye Rockfish. These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Any impact to these species in federal waters also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above *c.5. Acoustic Generation – Summary of Effects*

Ocean renewable energy devices will generate noise due to moving components, operation of internal components, and action of waves or wind chop against the device. In addition, various aspects of pre-construction surveys, construction, and maintenance can be sources of in-water noise. Examples include geophysical surveys for siting device and cable route, pile driving, and noise from vessel operations. Potential acoustic effects to fish depend on the magnitude, frequency, duration, and timing of the noise, and the sensitivity of the fish species to noise impacts. Research of the potential effects from the acoustic emissions of marine renewable energy developments as well as monitoring data and other studies have demonstrated a range of potential impacts. (Copping et al. PNNL 2013 and Kramer, Presivic, Nelson and Woo, 2010)

Most fish species have hearing capability, but specific studies on hearing have only been conducted on a very small fraction of species, and there are very few studies on the effects of anthropogenic noise on fish. Thomsen, et al. (2006), Hastings and Popper (2005), Popper and Hastings (2009), and Popper et al. (2014) reviewed peer-review and grey literature on the effects of noise on fish, and Popper, et al. (2014) have proposed sound exposure guidelines for fish. Noise can affect fish behavior, communication and, in extreme cases, cause direct tissue damage resulting in immediate or delayed mortality (Thomsen, et al. 2006; Hastings and Popper 2005; Popper and Hastings (2009); Popper et al. (2014). Behavioral avoidance of noise can alter fish migration and schooling which can impact foraging, predator avoidance, or reproductive success.

All fishes have organs to detect sound and many species have swim bladders or other gas-filled structures that can detect sound pressure. The species with gas-filled structures can suffer physical damage (e.g., barotrauma) from loud, sudden sounds. For example, in the case of underwater explosions, fish with swim bladders are susceptible to barotrauma 100 times farther away from the explosion that non-swim bladder fish (Popper, et al. 2014) In some species, the gas-filled structure re-radiates sound energy to the hearing organs, given them an enhanced hearing ability. The latter species are most likely to show behavioral changes from sound (Popper, et al. 2014). The Clupeiformes, which in Oregon include Pacific Herring, American Shad, Pacific Sardine, and Northern Anchovy, fall into this category. In addition, gaddids, such as Pacific Cod, and juvenile salmon, such as Chinook Salmon, have been shown to respond to sound (Thomsen, et al. 2006; Knudsen, et al. 1997). Larval fish have similar hearing ability as adults, but there has been little research on effects of sound (Popper, et al. 2014).

Acoustic effects can cause direct mortality, hearing impairment, damage to anatomical sturcutes, or behavioral changes to fish species of conservation concern, such as many of the forage fish species (e.g., Pacific Herring, Pacific Sardine, Northern Anchovy) and ESA-listed salmonids. The behavioral changes can result in increased susceptibility to predation or disruption of feeding, reproduction, or migration (Popper, et al. 2014). These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Any impact to these species in federal waters also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above.

Where acoustic affects are large enough to cause direct or delayed fish mortality, fish abundance and availability to fisheries operating in federal waters would be reduced. Little is known about how underwater noise might affect fish behavior and the ability of the fish to be caught by fisheries. It is possible that acoustic effects could reduce fishing efficiency. These issues can contribute to reduce commercial fishery landings or increase the cost for catching fish

c.6. Electromagnetic Field Generation (EMF) – Summary of Effects

Ocean energy devices and power transmission cables will produce electromagnetic fields (EMF). While many species of fish have the ability to detect electric or magnetic fields and there are several studies showing behavioral and physiological effects of EMF, there have been few studies on specific impacts of EMF from ocean energy devices. Normandeau, et al. (2011) and Cameron and Slater (2010) reviewed scientific literature and summarized potential effects of EMF on fish. All chondricthyans, including sharks, rays, and spotted ratfish, are electrosensitive (Normandeau, et al. 2011). They use electrosensitive organs for prey detection, and some species use them for reproductive behavior and predator detection. Electric fields generated by devices or power transmission cable could affect feeding ability or behaviors of these species. Lampreys and sturgeons are also electrosensitive and potential effects of anthropogenic electric fields could be similar to those for chondrichthyans (Normandeau, et al. 2011). There is some evidence that scorpaenidae (rockfishes) and plueronectids (flatfishes) are electrosensitive (Normandeau, et al. 2011), and could experience effects from anthropogenic electric fields.

Many fish species are also sensitive to magnetic fields, but there has been little research on the effects of anthropogenic magnetic fields. Elasmobranchs (sharks and rays) use magnetic fields to orient themselves for migration and habitat use (Normandeau, et al. 2011). Salmonids and scombrids (tunas and mackerals) have been shown to use magnetic fields for orientation, navigation, and homing (Normandeau, et al. 2011). Recent studies on juvenile Chinook Salmon and other salmonid species have demonstrated the role of magnetic fields in their migratory behavior in the ocean (Putman, et al. 2013, Putman, et al. 2014; Lohmann, et al. 2008), raising concern that artificial magnetic fields can disrupt this migratory behavior. While the precise role of magnetic fields in other species' migrations is not fully know, it is conceivable that magnetic fields produced by devices or power transmission cables could also disrupt their migrations (Normandeau, et al. 2011).

EMF can cause behavioral changes to fish that may impact their feeding or other behaviors. Fishery species most likely to be affected include the salmonids and shark species. These effects can lead to reduced population sizes which would reduce commercial fishery landings or increase the cost for catching fish EMF effects, especially changes in fish navigation behaviors, can cause direct mortality or sub-lethal impacts to fish species of conservation concern, such as ESA-listed salmonids and Green Sturgeon. These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Any impact to these species in federal waters also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could cause federal fisheries agencies to tighten regulatory restrictions which can further reduce fisheries, resulting in Oregon fishery economic impacts as described in the paragraph above.

c.7. Lighting
This analysis has not identified any potential impacts on fish and selected invertebrates from lighting.

c.8. Summary
Table 5 lists the fish and selected invertebrate species within the GLD that are of interest to the state of Oregon. Of these 221 species, 83 are of particular interest because they are either commercially/recreationally important, have a particular ESA or fishery management concern, or are key forage species. In addition, more is known about the abundance, distribution, and life history of these species than many others listed in the supporting appendix tables. The description of potential impacts focused on these particularly important species. Table 5 lists these species, indicates why they are of particular interest to the state, and summarizes the range of potential impacts of ocean renewable energy development.

Table 5. Fish and Invertebrate Species

		Reason for Importance to State						Reasonably Foreseeable Effect Type					
Common Name	Scientific Name	Top 30 Commercial	Top 20 Recreational	ESA	Overfished Species	Fishery Limiting Species	Forage Fish	Physical Presence of Device	Moving Devices	Energy Removal	Chemical Effects	Acoustic Effects	EMF
Pacific Hagfish	Eptatretus stouti	x						x	x		x		
Spiny Dogfish Shark	Squalus acanthias					x		x	x	x	x		x
Longnose Skate	Raja rhina	x						x	x		x		x
other sharks and skates	20 species							x	x		x		x
White Sturgeon	Acipenser transmontanus	x						x	x		x		x
Green Sturgeon	Acipenser medirostris			x				x	x		x		x
Pacific Herring	Clupea harengus pallasi		x				x	x	x		x	x	
Pacific Sardine	Sardinops sagax	x					x	x	x		x	x	
Northern Anchovy	Engraulis mordax						x	x	x		x	x	
Chum Salmon	Oncorhynchus keta			x				x	x		x	x	x
Coho Salmon	Oncorhynchus kisutch	x	x	x				x	x		x	x	x
Sockeye Salmon/ Kokanee	Oncorhynchus nerka			x				x	x		x	x	x
Chinook Salmon	Oncorhynchus tshawytscha	x	x	x				x	x		x	x	x
Rainbow Trout/Steelhead	Oncorhynchus mykiss			x				x	x		x	x	x
Eulachon	Thaleichthys pacificus			x			x	x	x		x		
Pacific Cod	Gadus macrocephalus	x						x	x		x	x	
Pacific Whiting (Hake)	Merluccius productus	x						x	x		x		
Striped Seaperch	Embiotoca lateralis		x					x	x		x		
Pacific Sand Lance	Ammodytes hexapterus						x	x	x	x	x		
Chub Mackerel	Scomber japonicus	x					x	x	x		x		x
other forage fish	8 species						x	x	x		x		
Albacore	Thunnus alalunga	x	x					x	x		x		x
Rougheye Rockfish	Sebastes aleutianus					x		x	x		x		
Pacific Ocean Perch	Sebastes alutus	x			x			x	x		x		
Shortraker Rockfish	Sebastes borealis					x		x	x		x		
Copper Rockfish	Sebastes caurinus		x					x	x	x	x		
Darkblotched Rockfish	Sebastes crameri	x			x			x	x	x	x		
Widow Rockfish	Sebastes entomelas	x	x					x	x	x	x		
Yellowtail Rockfish	Sebastes flavidus	x	x					x	x	x	x		
Cowcod	Sebastes levis				x			x	x		x		
Quillback Rockfish	Sebastes maliger		x					x	x	x	x		
Black Rockfish	Sebastes melanops	x	x					x	x	x	x		
Vermilion Rockfish	Sebastes miniatus		x					x	x	x	x		
Blue Rockfish (Solid)	Sebastes cf. mystinus		x					x	x	x	x		
China Rockfish	Sebastes nebulosus	x	x			x		x	x	x	x		
Tiger Rockfish	Sebastes nigrocinctus		x					x	x	x	x		
Bocaccio	Sebastes paucispinis				x			x	x		x		
Canary Rockfish	Sebastes pinniger				x			x	x	x	x		
Yelloweye Rockfish	Sebastes ruberrimus				x			x	x	x	x		
Shortspine Thornyhead	Sebastolobus alascanu	x						x	x		x		
Longspine Thornyhead	Sebastolobus altivelis	x						x	x		x		
Sablefish	Anoplopoma firmbria	x	x			x		x	x		x		
Kelp Greenling	Hexagrammos decagrammus	x	x					x	x	x	x		
Lingcod	Ophidon elongatus	x	x					x	x	x	x		
Cabezon	Scorpaenichthys marmoratus	x	x					x	x	x	x		
Pacific Sanddab	Citharichthys sordidus	x	x					x	x	x	x		
Arrowtooth Flounder	Atheresthes stomias	x						x	x		x		
Petrale Sole	Eopsetta jordani	x			x			x	x	x	x		
Rex Sole	Glyptocephalus zachirus	x						x	x		x		
Pacific Halibut	Hippoglossus stenolepis	x	x					x	x		x		
Dover Sole	Microstomus pacificus	x						x	x	x	x		
English Sole	Parophrys vetulus	x						x	x	x	x		
Sand Sole	Psettichthys melanostictus	x	x					x	x	x	x		
Dungeness Crab	Cancer magister	x						x	x	x	x		x
Red Urchin	Strongylocentrotus franciscanus	x						x			x		
Pink Shrimp	Pandalus jordani	x						x			x		
Spot Shrimp	Pandalus platyceros	x						x			x		

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2) Coastal and Marine Birds

This subsection analyzes resources and potential ocean renewable energy effects within the proposed GLD with respect to marine birds and avian species that use the coastal zone and waters off Oregon. The analysis endeavors to include all bird species that occur off of Oregon from the shore to the outer depth limit of the GLD, including both seabirds and other coastal bird species that have ecological connections to the marine system.

a. Species occurring off of Oregon:

Approximately 176 species of birds occur off Oregon within the proposed GLD and adjacent state waters, including those that have been observed as vagrants or rare migrants (Appendix B, Table 1., Briggs et al. 1992, Marshall et al. 2006, Naughton et al. 2007, Adams et al. 2014, Gillson 2014, OBRC 2014). Of the total species listed, 3 species have been observed primarily within the Federal waters of the GLD, 46 species have been observed primarily within adjacent state waters or estuaries, 59 species occupy both state and federal waters, and the remaining 68 species occur primarily in estuaries or considered vagrants or rare migrants to the coastal zone (Poole 2005, Marshall et al. 2006). The majority of species that will be considered further in this analysis are species whose documented marine habitats or observed distances from shore overlap with the proposed GLD. In addition, this description includes some species that occur solely in state waters (inshore of the GLD) or on state lands if they have a clear ecological, conservation or management link or a fishery connection to the proposed GLD.

b. State interest in offshore species and habitats:

Species that occur outside of state Territorial Sea waters are linked to state of Oregon interests with respect to the enforceable policies of the state's Coastal Zone Management Program. These species may be linked to state interests for one or more of following reasons:

1. An ecological connection between state and federal waters,
    a. The species' adult population occurs in both state and federal waters,
    b. The species' adult population occurs in state waters or lands only, and relies on habitat for breeding, migration or foraging that is connected to federal waters through coastal physical processes such as sediment transport and ocean circulation (ocean beaches and rocky shorelines).
    c. The species' adult population occurs in state waters or lands only, and it feeds on prey species that occur in federal waters
2. A conservation, management or policy connection,
    a. The species' adult population occurs in federal waters, and is included on the state threatened and endangered species list, is on the state list of sensitive species, or was identified in the Oregon Conservation Strategy.
    b. The species' adult population relies on prey species that are included as strategy species in the Oregon Nearshore Strategy.
3. A fishery connection (e.g., potentially limiting of economically important state fisheries through bycatch limits)
    a. The species has a current biological opinion in place that requires a reexamination of bycatch mitigation guidelines if birds are taken as bycatch above a set threshold.
    b. The species is commonly taken in fisheries off Oregon, and therefore has the potential to become fishery limiting if populations decrease.

Table 2.c.1 summarizes bird species based on the above criteria, and highlights the species linked to Oregon's interests with respect to ocean renewable energy activities in the federal waters of the GLD. A species is potentially linked to Oregon's interest if one or more of the criteria above are met. Many bird species meet more than one of the criteria.

b.1 Ecological Factors

As outlined in the prior fish and invertebrates section of this document, bird species distribution, life history and food web relationships underpin clear ecological connections between state and federal waters, and justify a state interest in these species.

Many avian species occupy both state and federal waters, or the air space above said waters, and are thus subject to the enforceable policies of the state's Coastal Zone Management Program. Of the species considered in this section, 59 occur in both state and federal waters as adults and therefore are of direct interest to the state (See Table 2.c.1.)

Bird species that occur in both federal and state waters may move across this jurisdictional boundary for a variety of reasons. A number of species are considered “central place foragers” and forage in GLD waters while attending breeding colonies on the adjacent state lands. The number of seabirds nesting within the state of Oregon is substantial, representing about half of the seabirds breeding on the West Coast of the United States (Naughton et al. 2007). As of 2007, approximately 1.3 million seabirds of 16 different species nested on the Oregon Coast (Table 2.b.1. Naughton et al. 2007). For example, the Common Murre, an abundant breeding seabird in Oregon, nests along the entire coast of Oregon and is distributed throughout the proposed GLD (Naughton et al. 2007, Suryan et al. 2012, Adams et al. 2014). Some birds, such as the Pigeon Guillemot, have a more inshore distribution during the breeding season, when they are incubating eggs or provisioning chicks at the colony site but then move into the GLD when the breeding season ends (Naughton et al. 2007, Adams et al. 2014). Other species, such as the Sooty Shearwater, Pink-footed Shearwater, Red Phalaropes and Red-necked Phalaropes breed outside of the state of Oregon, but migrate into the GLD and the adjacent state waters during their non-breeding season (Suryan et al. 2012, Adams et al. 2014). A third group of birds may use waters within the GLD during migration, but rely on estuarine and coastal habitats in Oregon for wintering. For example, Black Brant and the Semidi island population of the Aleutian Cackling Goose pass through the GLD on the way to and from their breeding grounds in Alaska and spend their winters in Oregon coastal habitats. Oregon has a clear wildlife stewardship responsibility for all species that use habitats within the state of Oregon. The enforceable policies of Oregon’s CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species, as well as special protections in the Territorial Sea Plan, Part 5 for seabird breeding colonies as Important, Sensitive, and Unique ecological resources. Therefore, we maintain that all birds that occupy the GLD and state lands or waters for any portion of their annual cycle are of direct interest to the state.

Table 6. Seabirds breeding on the Oregon coast or in coastal forests.

Common Name	***Latin Name***	**Common Name**	***Latin Name***
Fork-tailed Storm-petrel	*Oceanodroma furcata*	Ring-billed Gull	*Larus delawarensis*
Leach’s Storm-petrel	*Oceanodroma leucorhoa*	Caspian Tern	*Hydroprogne caspia*
Double-crested Cormorant	*Phalacrocorax auritus*	Common Murre	*Uria aalge*
Brandt’s Cormorant	*Phalacrocorax penicillatus*	Pigeon Guillemot	*Cepphus columba*
Pelagic Cormorant	*Phalacrocorax pelagicus*	Cassin’s Auklet	*Ptychoramphus aleuticus*
Black Oystercatcher	*Haematopus bachmani*	Rhinoceros Auklet	*Cerorhinca monocerata*
Western Gull	*Larus occidentalis*	Tufted Puffin	*Fratercula cirrhata*
Glaucous-winged Gull	*Larus glaucescens*	Marbled Murrelet	*Brachyramphus marmoratus*

A number of species occupy only state lands or state waters adjacent to the GLD, but use habitats that are connected to the GLD through coastal physical processes. Several resident shorebirds use open beaches year round (i.e. Western Snowy Plover), and many others use Oregon's coastal beaches and estuaries as stopover habitat during migration. In particular, Western Sandpipers, Least Sandpipers, Dunlin, Sanderlings, and Whimbrels are commonly observed on sandy beaches in Oregon during migration stopovers. The location, size and quality of these stopover habitats are related to the physical processes on the continental shelf, including the area of the GLD. Wave climate, coastal currents, and upwelling and other ocean circulation processes can change sediment transport, beach elevation profiles, and nutrient transport to Oregon's beach habitats. This is also true for rocky shorelines, where Oregon birds such as Black Oystercatchers, Surfbirds, Ruddy Turnstones, and Harlequin Ducks forage on mussels, limpets and other intertidal animals that require exposed hard surfaces. Rather than documenting these processes in detail, this analysis cites these as general connections between state and federal waters that provide additional substantiation for the state's interest in waters of the proposed GLD.

Virtually all bird species of interest to the state are linked to species in federal waters through food web relationships. It is beyond the scope of this analysis to attempt to describe all of the possible food web relationships in the ocean off of Oregon. Similar to the example provided in the fish and invertebrate section above, numerous forage fish species such as Pacific Sardine, Pacific Herring, Northern Anchovy, Pacific Mackerel, Pacific Sand Lance, and many smelt species, exist in federal waters and provide food for bird species of interest to the state. In addition, larval and juvenile forms of many fish and invertebrate species in federal waters are consumed by bird species of interest to the state.

b. 2. Conservation and Management Policy Connections

Oregon has an interest in threatened, endangered, or otherwise sensitive species in the GLD either directly due to conservation measures in state regulations, or indirectly when impacts to federally-managed species in the GLD negatively affect Oregon's ocean resources and uses (see Table 2.b.2 below). Bird species that occur within the GLD and are also on the state or federal endangered species list include Brown Pelican (E), California Least Tern (E), Marbled Murrelet (T), Short-tailed Albatross (E) (USFWS 2014). Western Snowy Plover (T, federal listing of coastal population only) occurs in the state land and waters and has an ecological connection to the GLD as outlined above. The Xantus's Murrelet is a candidate for federal listing, the Tufted Puffin has been petitioned for listing, and the Black Oystercatcher has been identified as a species of concern by the U.S. Fish and Wildlife Office Oregon Field Office. These birds occur within Oregon waters and and are subject toOregon's threatened and endangered wildlife statute, which is an enforceable policy of the state's Coastal Zone Management Program.

The state has also designated sensitive species in two categories: critical (SC) and vulnerable (SV). Bird species that occur in the GLD that are listed as sensitive species include the Red-necked Grebe (SC), Fork-tailed Storm-petrel (SV), and Cassin's Auklet (SV). Birds listed as sensitive species in Oregon that have an ecological connection to the GLD include Harlequin Duck (SC), Peregrine Falcon (SV) (See table 2.b.2. below).

The Oregon Conservation Strategy and its companion document, the Oregon Nearshore Strategy, constitute Oregon's state comprehensive wildlife conservation strategy adopted under USFWS Wildlife and Sport Fish Restoration Program. These documents highlight species of particular importance to Oregon. All species that are listed as threatened, endangered or sensitive in the state of Oregon are also included as Oregon Conservation Strategy species. Other species that occur in the GLD are Oregon Conservation Strategy species as well, including Black Brant, Aleutian Cackling Goose, Dusky Canada Goose, Bufflehead, Rock Sandpiper, Tufted Puffin, Leach's Storm-petrel, and Caspian Tern (See table 2.b.3. below). Oregon Conservation strategy species that have an ecological connection to the GLD include Peregrine Falcons and Bald Eagles.

Many of the fish species listed in the Oregon Nearshore Strategy are important prey for marine birds. Seabird prey species that are identified in Oregon's Nearshore Strategy include Northern Anchovy, Surf Smelt, Eulachon, Topsmelt, Pacific Herring, Shiner Perch, Surfperch, Starry Flounder, and many juvenile rockfishes. The following seabird prey species are included on the Oregon Nearshore Strategy watch list: Pacific Sand Lance, many flatfishes, and market squid (http://www.dfw.state.or.us/mrp/nearshore/document.asp).

Table 7. State Threatened & Endangered or Species of Concern Birds.

Common Name	***Latin Name***	**State**	**Federal**
Brown Pelican	*Pelecanus occidentalis*	E	
California Least Tern	*Sterna antillarum browni*	E	E
Marbled Murrelet	*Brachyramphus marmoratus*	T	T
Short-tailed Albatross	*Phoebastria (Diomedea) albatrus*	E	E
Western Snowy Plover	*Charadrius alexandrinus nivosus*	T	T (Coastal population only)
Xantus's Murrelet	*Synthliboramphus hypoleucus*		Candidate
Black Oystercatcher	*Haematopus bachmani*		Species of Concern
Red-necked Grebe	*Podiceps grisegena*	SC	
Harlequin Duck	*Histrionicus histrionicus*	SC	
Peregrine Falcon	*Falco peregrinus anatum*	SV	
Fork-tailed Storm-petrel	*Oceanodroma furcata*	SV	
Cassin's Auklet	*Ptychoramphus aleuticus*	SV	
Rhinoceros Auklet	*Cereorhinca monocerata*	SV	
Tufted Puffin	*Fratercula cirrhata*	SV	

Table 8. Coastal Birds on Oregon Conservation strategy list:

Common Name	***Latin Name***	**State**	**Federal**	**State Heritage**
Brown Pelican	*Pelecanus occidentalis*	E		2
Black Brant	*Branta bernicula*	E		NR
Marbled Murrelet	*Brachyramphus marmoratus*	T	T	
Aleutian Cackling Goose	*Branta hutchinsii leucopareia*	T	T	1
Short-tailed Albatross	*Phoebastria (Diomedea) albatrus*	E	E	
Western Snowy Plover	*Charadrius nivosus nivosus*	T	T (Coastal population only)	2

Dusky Canada Goose	*Branta Canadensis occidentalis*			1
Buffelhead	*Bucephaela albeola*	SU		2
Rock Sandpiper	*Calidris ptilocnemis*			NR
Peregrine Falcon	*Falco Peregrinus anatum*	LE		2
Tufted Puffin	*Fratercula cirrhata*	SV		2
Black Oystercatcher	*Haematopus bachmani*	SV		4
Bald Eagle	*Haliaeetus leucocephalus*			4
Fork-tailed Storm-petrel	*Oceanodroma furcata*	SV		2
Leach's Storm-petrel	*Oceanodroma leucorhoa*			NR
Red-necked Grebe	*Podiceps grisegena*	SC		2
Caspian Tern	*Sterna caspia*			

b.3. Fishery Connection

Oregon fisheries catch many fish and invertebrate species in federal waters of the proposed GLD, as well as state waters, and land them in Oregon. Oregon's coastal economies depend on these fisheries and, by extension, on healthy populations of the harvested fish and invertebrate species. Marine birds are taken as bycatch regularly in fisheries that occur inside the GLD and the adjacent state waters (Jannot et al. 2011). Seabirds are particularly sensitive to adult mortality because they are long-lived and have delayed sexual maturation (Croxall et al. 2012). Even small increases in adult mortality from fisheries bycatch can have population scale effects on seabirds and are considered a global threat to many seabird species (Gales et al. 1998). For the Short-tailed Albatross, there is a biological opinion in place that would require a re-initiation of consultation with the USFWS if more than an average of two birds are taken in any two year period in the US West Coast groundfish fishery (USFWS 2012). Additionally, the biological opinion specifies that the number of Short-tailed Albatross takes will be estimated using the number of takes of the more common Black-footed Albatross as a proxy. There is a potential for MRE activities occurring within the GLD to have impacts on the endangered Short-tailed Albatross as well as the proxy Black-footed Albatross, which could in turn could constrain or reduce Oregon's fishery access to groundfish species.

Other seabirds caught as bycatch in the west coast groundfish fishery include Brown Pelican, Brandt's Cormorant, Common Murre, Leach's Storm-petrel, Northern Fulmar, Sooty Shearwater, Western Gull, and other unidentified seabirds (Jannot et al. 2011). Populations for these species are currently healthy, and there are no current restrictions to fisheries in place. It is reasonably foreseeable that future restrictions could be placed on bycatch for these birds if activities inside or outside the GLD have detrimental impacts on these species, with subsequent effects on fisheries that are economically important to the state. Anything that affects Oregon fishing fleet access to fish in federal waters impacts state interests with respect to the enforceable policies of the state's Coastal Zone Management Program (see the Commercial and Recreational Fishing chapter of this GLD document for further information). Therefore, the state is concerned with any activities that could impact these species either directly or indirectly that may reduce the populations and therefore potentially restrict future fisheries access to areas where these species co-occur.

d. Potential impacts on species and habitats

This section summarizes the potential impacts of renewable energy development within the GLD on bird species. We have organized this summary using the following categories of potential stressors:

1. Physical presences of device (includes above-water and below-water structure, anchoring and mooring components, and electric cable infrastructure)
2. Moving devices (includes moving components of device)
3. Energy removal
4. Chemical release (includes spills during installation and maintenance, leaching of paint)
5. Acoustic effects
6. Electromagnetic field (EMF) effects
7. Lighting

The state is most concerned about bird species which occur in the GLD, and therefore may be subject to direct impacts from activities occurring in those waters. The state is also concerned about bird species which occur only in state waters or beaches, but which have an ecological connection to the GLD. The state is less concerned about avian species which occur exclusively in estuaries or are vagrant to Oregon, despite a potential ecological connection to the waters of the GLD. Table 2.c.1 provides details on which bird species are of most concern to the state for birds that occur primarily in GLD, occur in both State and GLD waters, or occur primarily in state waters but have an ecological, management or policy connection to the GLD. The summaries of the potential impacts below provide general descriptions and a few specific examples of how these stressors could affect birds that are of interest to the state. They are not exhaustive descriptions of all birds that are subject to that stressor. Please see table 2.c.1 below for the applicable potential stressors for birds that are within the state's interest.

Table 9. Page 1 of 3. Birds in which the state has an interest that occur within or have an ecological, management or conservation connection to the GLD. The potential impacts from renewable ocean energy development in the GLD are also summarized.

				Reason for Importance to the State of Oregon											Ocean Renewable Energy					
		Geographic Location		Ecological Connection								Conservation Connection			Potential Impacts					
Common Name	Latin Name	Utilizes GLD	Utilizes primarily state waters or beaches	Occurs in State and Fed H20	Occurs Primarily in State H20	Occurs Primarily in Fed H20	Breeds in Oregon	Winter/Feeds in Oregon	Migrates through Oregon	Habitat Connected to GLD by Coastal Processes	Consumes Prey that Occurs in Federal H20	Listed on Federal or State ESA	Fishery Limiting Species	Wildlife Stewardship Responsibility	Physical Presence of Device	Moving Devices	Energy removal	Chemical Effects	Acoustic Effects	EMF
Black Brant	*Branta bernicla*	x		x				x	x					x	x	x		x	x	
Cackling Goose	*Branta hutchinsii*	x		x				x	x					x	x	x		x	x	
Canada Goose	*Branta canadensis*	x		x				x	x					x	x	x		x	x	
Tundra Swan	*Cygnus columbianus*	x		x				x	x					x	x	x		x	x	
Long-tailed Duck	*Clangula hyemalis*	x		x				x	x					x	x	x	x	x	x	
Red-throated Loon	*Gavia stellata*	x		x				x	x	x	x			x	x	x		x	x	
Pacific Loon	*Gavia pacifica*	x		x				x	x		x			x	x	x		x	x	
Common Loon	*Gavia immer*	x		x			x	x	x		x			x	x	x		x	x	
Western Grebe	*Aechmorphorus occidentalis*	x		x			x	x	x		x			x	x	x		x	x	
Clark's Grebe	*Aechmorphorus clarkii*	x		x			x	x	x		x			x	x	x		x	x	
Laysan Albatross	*Phoebastria immutabilis*	x		x				x	x		x		x	x	x	x		x	x	
Black-footed Albatross	*Phoebastria nigripes*	x		x				x	x		x		x	x	x	x		x	x	
Short-tailed Albatross	*Phoebastria albatrus*	x				x		x	x		x	x	x	x	x	x		x	x	
Northern Fulmar	*Fulmar glacialis*	x		x				x	x		x		x	x	x	x		x	x	
Hawaiian Petrel	*Pterodroma sandwichensis*	x				x					x			x	x	x		x	x	
Pink-footed Shearwater	*Puffinus creatopus*	x		x				x	x		x		x	x	x	x		x	x	
Flesh-footed Shearwater	*Puffinus carneipes*	x		x				x	x		x			x	x	x		x	x	
Buller's Shearwater	*Puffinus bulleri*	x		x				x	x		x			x	x	x		x	x	
Sooty Shearwater	*Puffinus griseus*	x		x				x	x		x		x	x	x	x		x	x	
Short-tailed Shearwater	*Puffinus tenuirostris*	x		x				x	x		x			x	x	x		x	x	
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	x		x			x	x			x			x	x	x	x	x	x	
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	x		x			x	x			x			x	x	x	x	x	x	
Brant's Cormorant	*Phalacrocorax penicillatus*	x		x			x	x	x		x		x	x	x	x		x	x	
Double-crested Cormorant	*Phalacrocorax auritus*	x		x			x	x	x		x			x	x	x	x	x	x	
Pelagic Cormorant	*Phalacrocorax pelagicus*	x		x			x	x	x		x			x	x	x	x	x	x	
Brown Pelican	*Pelecanus occidentalis*	x		x				x	x		x	x	x	x	x	x	x	x	x	
Whimbrel	*Numenius phaeopus*	x		x				x	x	x				x	x	x	x	x	x	
Sanderling	*Calidris alba*	x		x				x	x	x				x	x	x	x	x	x	
Red-necked Phalarope	*Phalaropus lobatus*	x		x					x		x			x	x	x	x	x	x	
Red Phalarope	*Phalaropus fulicarius*	x		x				x	x		x			x	x	x	x	x	x	
South Polar Skua	*Stercorarius maccormicki*	x		x					x		x			x	x	x		x	x	
Pomarine Jaeger	*Stercorarius pomarinus*	x		x					x		x			x	x	x		x	x	
Parasitic Jaeger	*Stercorarius parasiticus*	x		x					x		x			x	x	x		x	x	
Long-tailed Jaeger	*Stercorarius longicaudus*	x				x			x		x			x	x	x		x	x	
Common Murre	*Uria aalge*	x		x			x	x	x		x		x	x	x	x	x	x	x	
Pigeon Guillemot	*Cepphus columba*	x		x			x		x		x			x	x	x	x	x	x	
Marbled Murrelet	*Brachyramphus marmoratus*	x		x			x	x	x		x	x		x	x	x	x	x	x	
Scripp's Murrelet	*Synthliboramphus scrippsi*	x		x				x	x		x			x	x	x	x	x	x	
Guadalupe Murrelet	*Synthliboramphus hypoleucus*	x		x				x	x		x	x		x	x	x	x	x	x	

Table 9. Continued, page 2 of 3. Birds in which the state has an interest that occur within or have an ecological, management or conservation connection to the GLD. The potential impacts from renewable ocean energy development in the GLD are also summarized.

		Reason for Importance to the State of Oregon													Ocean Renewable Energy					
		Geographic		Ecological Connection								Conservation			Potential Impacts					
Common Name	Latin Name	Utilizes GLD	Utilizes primarily state waters or beaches	Occurs in State and Fed H20	Occurs Primarily in State H20	Occurs Primarily in Fed H20	Breeds in Oregon	Winter/Feeds in Oregon	Migrates through Oregon	Habitat Connected to GLD by Coastal Processes	Consumes Prey that Occurs in Federal H20	Listed on Federal or State ESA	Fishery Limiting Species	Wildlife Stewardship Responsibility	Physical Presence of Device	Moving Devices	Energy removal	Chemical Effects	Acoustic Effects	EMF
Ancient Murrelet	*Synthliboramphus antiquus*	x		x							x			x	x	x	x	x	x	
Cassin's Auklet	*Ptychoramphus aleuticus*	x		x			x	x	x		x			x	x	x	x	x	x	
Parakeet Auklet	*Aethia psittacula*	x		x					x		x			x	x	x	x	x	x	
Rhinocerous Auklet	*Cerorhinca monocerata*	x		x			x	x	x		x			x	x	x	x	x	x	
Horned Puffin	*Fratercula corniculata*	x		x				x	x		x			x	x	x	x	x	x	
Tufted Puffin	*Fratercula cirrhata*	x		x			x	x			x	x		x	x	x	x	x	x	
Black-legged Kittiwake	*Rissa tridactyla*	x		x				x	x		x			x	x	x		x	x	
Sabine's Gull	*Xema sabini*	x		x					x		x			x	x	x		x	x	
Bonaparte's Gull	*Chroicocephalus philidelphia*	x		x					x		x			x	x	x		x	x	
Heerman's Gull	*Larus heermanni*	x		x				x	x		x			x	x	x		x	x	
Mew Gull	*Larus canus*	x		x				x	x					x	x	x	x	x	x	
Western Gull	*Larus occidentalis*	x		x			x	x	x		x		x	x	x	x		x	x	
California Gull	*Larus californicus*	x		x			x	x	x		x			x	x	x		x	x	
Herring Gull	*Larus argentanus*	x		x				x	x		x			x	x	x		x	x	
Thayer's Gull	*Larus thayeri*	x		x				x	x		x			x	x	x		x	x	
Iceland Gull	*Larus glaucoides*	x		x							x			x	x	x		x	x	
Glaucous-winged Gull	*Larus glaucescens*	x		x			x	x	x		x			x	x	x		x	x	
Glaucous Gull	*Larus hyperboreus*	x		x				x	x		x			x	x	x		x	x	
Caspian Tern	*Hydroprogne caspia*	x		x			x		x		x			x	x	x		x	x	
Common Tern	*Sterna hirundo*	x		x					x		x			x	x	x		x	x	
Elegant Tern	*Thalasseus elegans*	x		x					x		x			x	x	x		x	x	
Harlequin Duck	*Histrionicus histrionicus*		x		x		x	x		x				x			x	x		
Surf Scoter	*Melanitta perspicillata*		x		x			x	x					x			x	x		
White-winged scoter	*Melanitta fusca*		x		x			x	x					x	x	x	x	x	x	
Black Scoter	*Melanitta americana*		x		x			x	x					x	x	x	x	x	x	
Bufflehead	*Bucephala albeola*		x		x		x	x	x					x			x	x		
Common Merganser	*Mergus merganser*		x		x		x	x	x					x			x	x		
Red-breasted Merganser	*Mergus serrator*		x		x			x	x					x			x	x		
Horned Grebe	*Podiceps auritus*		x		x		x	x						x	x	x		x	x	
Red-necked Grebe	*Podiceps grisegena*		x		x		x	x	x					x	x	x		x	x	
Osprey	*Pandion haliaetus*		x		x		x	x	x					x			x	x		

Table 9. Continued, page 3 of 3. Birds in which the state has an interest that occur within or have an ecological, management or conservation connection to the GLD. The reasonably foreseeable effects from renewable ocean energy development in the GLD are also summarized.

				Reason for Importance to the State of Oregon												Ocean Renewable Energy				
		Geographic		Ecological Connection								Conservation			Potential Impacts					
Common Name	Latin Name	Utilizes GLD	Utilizes primarily state waters or beaches	Occurs in State and Fed H20	Occurs Primarily in State H20	Occurs Primarily in Fed H20	Breeds in Oregon	Winter/Feeds in Oregon	Migrates through Oregon	Habitat Connected to GLD by Coastal Processes	Consumes Prey that Occurs in Federal H20	Listed on Federal or State ESA	Fishery Limiting Species	Wildlife Stewardship Responsibility	Physical Presence of Device	Moving Devices	Energy removal	Chemical Effects	Acoustic Effects	EMF
Bald Eagle	*Haliaeetus leucocephalus*		x		x		x	x	x					x			x	x		
Turkey Vulture	*Cathartes aura*		x		x			x	x					x				x		
Black Oystercatcher	*Haematopus bachmani*		x		x		x	x	x	x				x			x	x		
Black-bellied Plover	*Pluvialis squatarola*		x		x			x	x	x				x			x	x		
American Golden-Plover	*Pluvialis dominica*		x		x			x	x	x				x			x	x		
Pacific Golden-Plover	*Pluvialis fulva*		x		x			x	x	x				x			x	x		
Snowy Plover	*Charadrius nivosus*		x		x		x	x	x	x		x		x			x	x		
Semipalmated Plover	*Charadrius semipalmatus*		x		x		x	x	x	x				x			x	x		
Wandering Tattler	*Tringa incana*		x		x			x	x	x				x			x	x		
Willet	*Tringa semipalmata*		x		x			x	x	x				x			x	x		
Long-billed Curlew	*Numenius americanus*		x		x		x	x		x				x			x	x		
Marbled Godwit	*Limosa fedoa*		x		x			x	x	x				x			x	x		
Ruddy Turnstone	*Arenaria interpres*		x		x			x	x	x				x			x	x		
Black Turnstone	*Arenaria melanocephala*		x		x			x	x	x				x			x	x		
Surfbird	*Calidris virgata*		x		x			x	x	x				x			x	x		
Sharp-tailed Sandpiper	*Calidris acuminata*		x		x				x	x				x			x	x		
Dunlin	*Calidris alpina*		x		x			x	x	x				x			x	x		
Rock Sandpiper	*Calidris ptilocnemis*		x		x			x	x	x				x			x	x		
Least Sandpiper	*Calidris minutilla*		x		x			x	x	x				x			x	x		
Semipalmated Sandpiper	*Calidris pusilla*		x		x				x	x				x			x	x		
Western Sandpiper	*Calidris mauri*		x		x			x	x	x				x			x	x		
Short-billed Dowitcher	*Limnodromus griseus*		x		x				x	x				x				x		
Long-billed Dowitcher	*Limnodromus scolopaceus*		x		x			x	x	x				x				x		
Ring-billed Gull	*Larus delawarensis*		x		x		x	x		x				x			x	x		
Forster's Tern	*Sterna forsteri*		x		x		x		x	x				x				x		
Peregrine Falcon	*Falco peregrinus*		x		x		x	x	x		x			x			x	x		
American Crow	*Corvus brachyrhynchos*		x		x		x	x	x	x				x			x	x		
Common Raven	*Corvus corax*		x		x		x	x	x	x				x			x	x		

c.1. *Physical Presence of Devices – Summary of Effects*
The ocean renewable energy structure, moorings, and electrical transmission infrastructure all serve to alter the pelagic and benthic habitat in and near their location. It is reasonably foreseeable that birds using the air space above and the waters in areas where marine renewable energy may be developed could be subject to effects through collisions with devices and changes in spatial distribution in response to the device as well as indirect ecosystem effects.

The above-water, stationary components of ocean renewable energy devices present serious collision risks for birds (Huppop et al. 2006, Montevecchi 2006, Larsen & Guillemette 2007, Grecian et al. 2010). The risk of collision has been more thoroughly investigated for wind energy devices, and appears to vary as a function of body size, age and reproductive stage (Grecian et al. 2010). Species which are more active during crepuscular or nocturnal periods, such as Rhinoceros Auklets and many Procellariiform species, may be more vulnerable to collision because they are active during low light periods and may have reduced ability to detect above-water structures (Grecian et al. 2010). Fog, rain, and other poor weather conditions which reduce visibility are common off the Oregon coast, also appear to increase the risk of avian collision with marine energy structures at sea (Garthe & Huppop 2004, Huppop et al. 2006). The above water, stationary components of devices also could provide additional roosting locations for marine birds, although manufacturers are likely to include design components to deter roosting. Additional roosting sites have potential positive effects for birds, including increasing foraging ranges for birds that must periodically dry their plumage like cormorants (Grecian et al. 2010, Furness et al. 2012). Also, additional roosting might provide resting sites for migratory terrestrial birds that are unable to rest on the water. Both of these effects would attract birds to the ocean renewable energy devices but could also increase the likelihood of collisions (Grecian et al. 2010).

It is also foreseeable that diving birds could be impacted by the near surface, but below-water stationary components of ocean renewable energy devices, with collisions possible during periods of high turbidity and corresponding low visibility (Grecian et al. 2010). Plunge divers, for example Brown Pelicans, are potentially more vulnerable to collisions with anchoring devices, cables and mooring components immediately below the surface of the water, because they have limited avoidance ability once a dive has been initiated.

Birds are at risk of entrapment in devices with enclosed chambers that are partially exposed to the open ocean (Grecian et al. 2010). If birds are capable of entering an enclosed chamber, they could be killed by turbines, the propulsion of water, or by pressure changes within the device (Grecian et al. 2010). Although this risk is minimal and easily mitigated, it is reasonably foreseeable and could have effects on birds if developments occur at a large scale.

The stationary components of ocean renewable energy devices are also likely to accumulate marine debris, such as derelict fishing gear including nets, floats, line, and monofilament. Marine debris pose an entanglement risk for birds, and can lead to sub-lethal or lethal effects such as injury, impaired foraging ability, and drowning (Derraik 2002). If small particles are accumulated, there is the additional risk from plastic ingestion. Plastic ingestion has been shown to have deleterious effects on seabirds throughout the North Pacific, ranging from increased exposure to heavy metals and other toxic chemicals to decreased food uptake because of mechanical blockage of the digestive tract (Derraik 2002, Lavers et al. 2014). Entanglement in marine debris have been documented for 22 species of marine birds in central California, with Common Murres and Western Gulls observed most frequently (Moore et al. 2009). Seabird entanglement in derelict fishing gear has also been documented for 15 species in the Puget Sound (Good et al. 2009). These patterns of entanglement likely hold for Oregon's offshore waters as well, and all but one of the species identified in these two studies occur in both Oregon and GLD waters.

The physical presence of marine energy conversion devices has the potential to change the spatial distribution of marine birds through displacement or attraction. Most evidence suggests that birds avoid diving or flying in the areas around marine energy conversion devices, thereby changing their migration corridors or reducing the available foraging area (Desholm & Kahlert 2005, Plonczkier & Simms 2012). Depending on the scale of development, marine energy conversion devices have the potential to create extensive barriers to bird movement. At-sea wind energy developments have been shown to increase both distance travelled and energy expenditure in a sea duck, the Common Eider (*Somateria mollissima*) (Desholm & Kahlert 2005, Masden et al. 2010). However these increases were relatively small, and would only become important to bird body condition and survival if repeated many times. Therefore, birds that must navigate areas with energy developments most frequently are at highest risk for energetic impacts from distribution changes (Masden et al. 2010). If devices are sited between breeding, foraging and roosting areas changes in bird energy expenditures are reasonably foreseeable, with potential implications for individual fitness (Grecian et al. 2010). The state is especially concerned with species breeding in Oregon and foraging in the GLD, including Brant's Cormorant, Double-crested Cormorant, Common Murre, Marbled Murrelet, Cassin's Auklet, Rhinoceros Auklet, Tufted Puffin, Western Gull, and Glaucous-winged Gull.

It is also possible that the devices will act as fish aggregating devices, as described above in the fish and invertebrates section of this document, and birds may be attracted to the aggregated prey around the devices, including biofouling organisms. It is reasonably foreseeable that an altered bird community may arise in the area with marine energy conversion devices as well as in the surrounding area, including Oregon's territorial sea, because of differing species specific responses to the presence of the devices.

The physical presence of marine energy development also includes the increased ship traffic during installation, maintenance and decommissioning of devices. Alcid seabirds (murres, puffins, auklets, murrelets), scoters and loons are sensitive to boat disturbance at scales between hundreds of meters up to 1 km away (Ronconi & St Clair 2002, Schwemmer et al. 2010, Furness et al. 2012). Because vessels would transit through state waters to reach any development within the GLD, it is reasonably foreseeable that the increased vessel traffic would have disturbance effects on bird species both within the GLD and in state waters.

As analyzed in the fish and select invertebrate section of this document, there are reasonably foreseeable impacts from the physical presence of devices on potential seabird prey species such as Pacific Herring. Changes in prey communities are likely to propagate through the food web, with corresponding impacts to seabirds (Boehlert & Gill 2010). That said, it is beyond the scope of this analysis to address the broad range of possible indirect effects that the physical presence of marine energy conversion devices might have on birds. It is reasonably foreseeable that an altered prey community and corresponding ecosystem effects on seabirds may arise in the area with marine energy conversion devices as well as in the surrounding area, including Oregon's territorial sea.

c.2. *Moving Devices – Summary of Effects*
It is reasonably foreseeable that the movement or other mechanical actions of devices above or below the surface of the water could have impacts on birds beyond those caused by the physical presence of the device. Devices that have moving parts could impact birds by direct contact damage or, if pressure differentials are created, through barotrauma effects or entrapment. The potential for this type of impact would depend on the size of the moving parts, characteristics of the motion (speed, movement distance, frequency, etc.), position in the water column, and height above the surface of the water.

Birds are at high risk for collisions with above water moving parts (blades, oscillators, etc.) of ocean renewable energy devices (Garthe & Huppop 2004, Huppop et al. 2006). The collision risk is particularly acute for offshore wind energy developments, where the tips of the blades on turbines can move at very high speeds, despite a low number of rotations per minute. For example, the Siemens 6 MW floating wind turbine proposed for the WindFloat development off Coos Bay, Oregon rotates at only 5-11 rotations per minute, yet the speed at the tip of the 75 m blade is 87-193 mph. Because the speed along portions of the blade exceed that of most birds' flying speed, it is reasonably foreseeable that birds may not be able to avoid a turbine blade if they pass through the rotor swept area. The degree of collision risk, however, varies by bird morphology, flight height, and flight strategy (flapping, gliding/soaring, intermediate flap-gliding etc.), along with environmental conditions that impact a bird's ability to detect and avoid moving structures at sea.

Diving birds with high wing-loading that use active flapping flight, such as the Common Murre, generally transit at relatively low altitudes (< 10m) and may pass through the area beneath the rotor swept area unharmed but could be at risk for collision with moving components of wave energy devices that are closer to or below the water's surface (Grecian et al. 2010). Other birds that employ sustained flapping flight, such as Western Gulls and terns, can fly at higher altitudes and may be at increased risk for collision with the moving components of wind energy devices. High altitude migrants, such as shorebirds and waterfowl, also employ flapping, powered flight. These migrants fly at lower altitudes over water, which presents the possibility that they would fly low enough to overlap with the upper terminus of the rotor swept area of an offshore wind turbine. Birds that use dynamic soaring such as the Black-footed Albatross, Sooty Shearwater, and Pink-footed Shearwater do not maintain a constant altitude during directional flight. Their flight is powered by turning up into the wind and gaining altitude to access an area of higher wind speeds, then turning back with the wind and travelling down slope toward the water's surface (Weimerskirch et al. 2000). Many birds that use dynamic soaring stay close to the surface of the water, but their flight altitude peaks during high wind speeds may overlap with the rotor swept area of off shore wind turbines (Sachs et al. 2012).

As stated above, weather conditions that reduce visibility have been clearly shown to increase the risk of avian collision with marine energy structures at sea (Garthe & Huppop 2004, Huppop et al. 2006). Collisions with the moving components of ocean renewable energy devices are likely to be episodic, and may coincide with weather conditions that decrease birds detection and avoidance capabilities.

Although there is some debate, underwater collisions with moving parts of ocean energy conversion devices appears reasonably foreseeable (Furness et al. 2012). Marine birds are maneuverable underwater and it has been suggested that they could avoid contact with devices (Fraenkel 2006, Grecian et al. 2010), but the typical swimming speed of seabirds is on the order 1.5 m/s (Furness et al. 2012). If the speed of the moving parts of a device exceed the typical swimming speed of a bird species, it may be difficult for the bird to avoid a collision. Increased turbidity and reduced visibility in the underwater environment surrounding the moving parts of an ocean energy device may make it more difficult for seabirds to detect and avoid underwater moving hazards (Grecian et al. 2010, Furness et al. 2012). Similar to the increased risk from stationary components (c.1), plunge divers are at higher risk of collision with moving components of ocean renewable energy devices (Grecian et al. 2010).

Birds are at additional risk of entrapment or direct contact with moving parts of devices that use pressure differentials to drive internal turbines. These devices could be periodically or continuously exposed to the open ocean, and birds could enter under their own power or be entrained in the water entering the device. Birds are at risk for lethal interactions with turbines or from barotrauma effects from the propulsion of water within the device (Grecian et al. 2010).

c.3. *Energy Removal – Summary of Effects*

As stated in the fish and invertebrate section above, energy removal refers to a reduction in wave action that may occur shoreward of wave energy devices. This factor has the greatest potential for impact to Oregon's coastal zone development is at a very large scale. Energy removal can change sediment transport and habitat characteristics of shallow water and shoreline habitats within state waters and lands located in the wave shadow of devices (Nelson et al. 2008, Boehlert & Gill 2010). The reasonably foreseeable effects from energy removal on birds would be primarily indirect, including changes to habitat structure, and nearshore pelagic, benthic and sandy beach prey communities. Wave energy attenuators can create wave shadow behind devices, with potential impacts to sediment transport processes and could be detrimental for nursery and spawning sites for seabird prey (Grecian et al. 2010). Alternately, reduced sediment transport would increase the accumulation of organic matter, potentially increasing prey for benthic feeding seabirds such as Surf Scoters and Black Scoters. Changes in sediment transport processes could also change the foraging habitat for birds that rely on sandy beach habitats, such as Black-bellied Plover, Black Oystercatcher, Willet, Whimbrel, Long-billed Curlew, Marbled Godwit, Sanderling, Western Sandpiper, Least Sandpiper, Dunlin, Long-billed Dowitcher, Short-billed Dowitcher and the threatened Snowy Plover (Colwell & Sundeen 2000, Boehlert et al. 2008)

Effects may also include changes in water movement energy, turbulence, and changes to stratification in the nearshore coastal ocean (Boehlert & Gill 2010). It is well established that the foraging ecology of birds is tightly coupled with oceanographic conditions, with birds forming feeding aggregations at oceanographic fronts and other micro-features (Hoefer 2000, Ainley et al. 2005, Bost et al. 2009). Birds are visual predators, therefore changes in water turbidity may have impacts on birds foraging efficiency or potential reductions in food availability for birds. Surface feeding birds like phalaropes rely on small scale oceanographic processes to accumulate their small planktonic prey at surface fronts. Changes to the energetic environment within the wave shadow of marine renewable energy devices have the potential to disrupt these local oceanographic processes.

c.4. *Chemical Exposure – Summary of Effects*

Marine energy conversion devices are likely to incur similar chemical releases as other marine construction projects, including leaching or chipping of anti-fouling paints or other coatings on the devices, and spills or leaks of chemicals, hydraulic and lubricating fluids, and other oils (Boehlert & Gill 2010). Potential chemical exposure of organisms and the surrounding environment may occur during construction, operations, or maintenance (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008). The chemicals can originate from the devices or vessels servicing the devices. There is extensive literature on potential chemical effects in the marine environment from these various substances, and birds have an elevated exposure risk to oil. Oil fouls the feathers of birds that come in contact with it. Even small exposures can disrupt the waterproofing and thermoregulation function of the plumage, and have both lethal and sub-lethal effects (Burger 1997, Oka et al. 1999). Oils need not be toxic to have these detrimental effects on birds. Similar to marine mammals, direct ingestion of toxic oils during preening and grooming can cause illness or death in birds. Both chronic low level and catastrophic oil spills can have population level consequences for bird species (Votier et al. 2005). Birds that spend a large proportion of their time resting on or diving into the water are at high risk to oil exposure, which includes many of the seabirds that breed in Oregon and forage within the GLD. Birds are vulnerable to organotin exposure and other chemicals used in anti-fouling coatings, but more research is needed to determine what, if any, toxic effects are likely (Furness & Camphuysen 1997, Tasker & Furness 2003).

Ingestion of oils and other toxic chemicals can also occur when birds forage on prey that has been contaminated with chemicals. Seabirds are considered middle to upper trophic level predators, and are vulnerable to bioaccumulation of toxins. The processes of biomagnification and bioaccumulation, described in more detail in the marine mammals section of this document, lead to higher concentrations of chemicals in animals at higher trophic levels along with concomitant detrimental effects. Seabirds that forage higher on the food chain, such as pursuit diving piscivores like the Common Murre may be at higher risk than those that feed on plankton like the Cassin's Auklet. Bird species that prey on seabirds, such as Bald Eagles and Peregrine Falcons, are at even higher risk of increased exposure to toxic chemicals.

c.5. *Acoustic Generation – Summary of Effects*

As described in the fish and invertebrates section of this document, ocean renewable energy devices will generate noise. Noise will be generated in both air and water by moving components, operation of internal components, and action of waves or wind chop against the device. In addition, various aspects of pre-construction surveys, construction, and maintenance can be sources of in-water noise. Examples include geophysical surveys for siting device and cable route, pile driving, and noise from vessel operations. Potential acoustic effects to birds depend on the magnitude, frequency, duration, and timing of the noise, and the sensitivity of the bird species to noise impacts.

Birds have sensitive hearing capabilities, and are thought to hear both above and in water. The peak detection range for birds is 2 -5 kHz, and marine birds rely on hearing for communication both at breeding colonies and while foraging under water (Dooling & Therrien 2012). The physiology of bird ears have similar structures to marine mammal and sea turtle ears, suggesting potentially similar effects, but there are limited studies of the direct effects of underwater noise on birds in the marine environment (Ketten 2008). Ocean renewable energy installation activities can produce underwater noise loud enough to damage the hearing of animals within 100 m of the source, and likely to cause behavioral changes in animals much further from the source (Gill 2005). It is reasonably foreseeable that acoustic generation during installation, operation, and decommissioning of ocean renewable energy devices has the potential to cause temporary or permanent hearing damage and behavior modification for birds in the vicinity,

Another important foreseeable effect is a change to the spatial distribution of birds, specifically birds will likely avoid areas in which ocean renewable energy devices are generating noise in both air and water(Gill 2005). Birds are mobile, and therefore can move away from potentially damaging acoustic sources. Noise from human activity on land reduces bird abundances, and underwater noise reduces avian predation pressure on molluscs by waterfowl, presumably by modifying the behavior of avian predators in the area (Gill 2005). It is also foreseeable that noise from the above and below water components of marine energy developments will mask biologically significant noises in both water and air and therefore alter marine bird movements and use of the area (Grecian et al. 2010).

Siting in the vicinity of breeding colonies is also a potential concern, because breeding seabirds can be disturbed by human activities, including increased vessel traffic (Dunnet et al. 1990, Beale & Monaghan 2004, Gill 2005). A potentially positive effect is that noise in air has been suggested as a cue that increases bird avoidance of wind energy devices, which might in turn reduce the probability of bird collisions (Larsen & Guillemette 2007).

c.6. *Electromagnetic Field Generation (EMF) – Summary of Effects*
This analysis has not identified any reasonably foreseeable effects on birds from electromagnetic field generation (EMF).

c.7. *Lighting – Summary of Effects*
Many of the bird species that occur off Oregon are nocturnal or migrate at night over waters of the GLD. There is extensive documentation of artificial light sources causing changes in seabird behavior, going back well before the age of electric lighting (Maillard 1898, Montevecchi 2006). Marine birds are attracted to artificial lighting sources, and can become disoriented. Poor weather conditions and the darkness during new moon phases enhance seabirds' attraction to artificial light, which can result in birds circling the source for hours or even days (Huppop et al. 2006, Montevecchi 2006). Collisions have also been documented at many coastal and marine structures that emit intense artificial light, including lighthouses, coastal resorts, offshore oil platforms, and fishing vessels (Montevecchi 2006, Barrett et al. 2007). Procellariiform species are especially vulnerable, including several that occur within the GLD: Hawaiian Petrel, Pink-

footed Shearwater, Flesh-footed Shearwater, Buller's Shearwater, Sooty Shearwater, Short-tailed Shearwater, Fork-tailed Storm-petrel, and Leach's Storm-petrel (Reed et al. 1985, Montevecchi 2006). Disorientation and attraction to artificial light can occur in large numbers especially for young nocturnal seabirds as they depart from breeding colonies (Reed et al. 1985). The state is particularly concerned with the Fork-tailed Storm-petrel and the Leach's Storm-petrel, two species that are sensitive to artificial light, occur within the GLD and breed within Oregon.

c.8. Summary

The table 8 lists the bird species that occur within or have an ecological, management or conservation connection to the GLD. Of these 176 species that occur from shore to the boundary of the GLD, 105 are of particular interest because they spend a portion of their annual cycle within Oregon's land or waters (breeding, wintering/feeding, or migration), have a particular wildlife management (ESA, State T&E) or fisheries management concern. Table 7 lists these species, indicates why they are of particular interest to the state.

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3) Marine Mammals

This subsection analyzes the potential marine renewable energy effects within the proposed GLD with respect to marine mammal species that use the coastal zone and waters off Oregon. This section includes all marine mammals that occur in Oregon waters, from the coast to the outer depth limit of the GLD.

a. Species Occurring off of Oregon

Approximately 33 species of marine mammals occur off the Oregon Coast (Table X). Five species of pinnipeds, six species of balaenopteridae, and twenty species of odontoceti use Oregon waters as foraging grounds, migrations corridors, and breeding zones. Six of these species are considered "strategy species" by Oregon's Nearshore Strategy (Oregon Department of Fish and Wildlife 2006). Although there are no established populations of sea otters in Oregon waters, individuals have been sighted, most recently in Depoe Bay in February of 2009 (Killen 2009). As populations of sea otters in Washington and California increase, expansion into the species' former range is likely (Wilson et al. 1991). Likewise, there are no established populations of the North Pacific right whale, although individuals have been spotted as far south as California and Hawaii, allowing for the possibility of visitors along the Oregon coast as the population continues to increase (Shelden et al. 2005, Josephson et al. 2008)

Marine mammals are highly mobile animals that respond dynamically, both spatially and temporally, to variable oceanographic conditions. Therefore, it is difficult to define absolute distributional limits and boundaries of marine mammals. Based on typical distribution patterns, none of the marine mammal species in Oregon waters occur solely in the GLD (Table X). Three species occur mostly inside state and GLD waters, with an additional fourteen species that use all three zones equally (state waters, GLD waters, waters beyond the GLD). Eleven species occur in and beyond federal waters without substantial use of near shore environments. The remainder of this analysis focuses on those species that use both state and federal waters as primary habitat, and regularly occur off the Oregon coast: California sea lions (*Zalophus californianus*), harbor porpoise (*Phocoena phocoena*), and gray whales (*Estrichtius robustus*). These species are also each representative of the major groups of marine mammals (pinniped, small odontocete, and large baleen whale) and their distinct ecological patterns will be discussed. Additionally, threatened and endangered marine mammals at risk from MRE impacts are also discussed.

b. State Interest in Offshore Species

Marine mammal species that occur within the GLD remain linked to Oregon state interests through the Coastal Zone Management Program and with respect to

1) Ecological and spatial connections
2) Conservation and Management Policy Connections
3) Economic interests

b.1 Ecological connection

The spatial distribution patterns of seventeen species of marine mammals regularly cross the boundary between state and federal waters. Of these 17 species, three (California sea lions, harbor porpoises, and gray whales) are of significant management interest to Oregon because these species (1) occur frequently in Oregon waters, (2) forage in and migrate through both state and federal waters, (3) prey on commercially viable fish species, and (4) interact with human activities, most frequently mediated through tourism and fishing. Therefore, these marine mammals that use both state and federal waters are subject to policies under Oregon's Coastal Zone Management Program, which makes them of direct interest to the state.

In Oregon, California sea lions (CSLs) are a serious and costly nuisance on docks, contribute toward depleting salmon stocks, account for unwanted incidental mortality in fisheries, and are an important tourist attraction (Wright et al. 2010, NOAA 2011, Stratton 2014). Over the past four decades California sea lions have been documented with increased frequency in Oregon waters and at haul-outs along the coast (ODFW 2011a). In 2011, the population of CSLs in Washington, Oregon and California was estimated at 296,750 individuals (NOAA 2011). It is believed that this growing population is expanding their range. The CSLs in Oregon are predominantly males during the non-breeding period (Aug-May), which travel south to California to breed between June and August (NMFS 1997). CSLs show broad distribution over the continental shelf and analyses of CSL scat collected in Oregon indicate important prey include Pacific mackerel (*Scomber japonicas*), Pacific sardine (*Sardinops sagax*), Pacific hake (*Merluccius productus*), salmonids (*Oncorhynchus spp*.), and herring (*Clupea pallasi*; NMFS 1997, Riemer and Brown 1997; S. Riemer, ODFW, unpub. data). Due to these ecological and spatial patterns, CSLs are a management issue for Oregon in order to (1) minimize fisheries mortalities, (2) maintain healthy salmon stocks, and (3) balance tourism, economic benefits, and dock-user accessibility.

Ecological similarities exist between CSLs and three other species listed as 'strategy species' in the Oregon Nearshore Strategy, all of which are pinnipeds: northern elephant seal (*Mirounga angustiostris*), pacific harbor seal (*Phoca vitulina richardsi*), and Steller sea lion (*Eumetopias jubatus*). Northern elephant seals occur irregularly off Oregon throughout the year, foraging in offshore waters, and hauling out at Cape Arago to molt (Le Boeuf and Laws 1994, ODFW 2011b). Harbor seals are year round residents who mainly occur within 30 km of shore and are frequently observed in harbors. Steller sea lions are seasonally abundant in Oregon waters, with frequent sightings at haul-out sites such as the Columbia River South Jetty, Sea Lion Caves, Cascade Head, and Orford and Rogue reefs. Steller sea lions forage on Pacific Hake, salmonids, skates (*Rajidae*), Pacific lamprey (*Lampetra tridentate*), herring, rockfish (*Sebastes spp.*) and northern anchovy (Riemer et al. 2011). There are two Steller sea lion breeding rookeries in Oregon: Long Brown & Seal Rock at Orford Reef, and Pyramid Rock at Rogue Reef. The Eastern distinct population segment of Steller sea lions, of which individuals in Oregon are a part of, has successfully recovered and been delisted from the Endangered Species Act (Office of Protected Resources 2014).

Harbor porpoise are encountered year-round off the Oregon coast (Carretta et al. 2014). Harbor porpoise communicate acoustically by generating narrow band high frequency clicks. Due to the attenuation of high frequency sounds in water, harbor porpoises must remain closer to each other to communicate compared to other cetaceans (Clausen et al. 2010). Harbor porpoise are prone to entanglement, particularly in gillnets, and suffered high mortality rates in the 1990s and early 2000s (Jefferson and Curry 1994, Carretta et al. 2014). Ranging between the coast and the 110 m isobath, harbor porpoises prefer shallower waters over the continental shelf. Harbor porpoise exhibit a seasonal distribution, which is likely a function of prey distribution, and appears to be correlated with salinity, thermocline gradient, and distance to the inshore edge of the upwelling front during summer months (Tynan et al. 2005). Although typically a coastal species, harbor porpoises do extend their distribution farther offshore at Heceta Bank and at Cape Blanco where they are associated with higher chlorophyll concentrations (Tynan et al. 2005). Harbor porpoise also occur within various bays and estuaries along the Oregon coast including the Coos and Yaquina estuaries and the Columbia River mouth (Bayer 1985). Based on their near shore residency patterns within Oregon state waters and their susceptibility to fisheries bycatch, harbor porpoise are a management concern for the state.

Dall's porpoises (*Phocoenoides dalli dalli*), common dolphins (*Delphinus spp.*), and other small cetaceans (see Table 1) are also vulnerable to fisheries bycatch (Read et al. 2006, Bowles and Anderson 2012). These species prefer deeper waters than the harbor porpoise, but are similarly affected by ocean conditions and noise pollution.

Gray whales are an iconic feature of the Oregon coast, with thousands of tourists coming annually to Oregon's beautiful lookouts, headlands and beaches to spot migrating and seasonally resident gray whales. Each year, between 18,000 and 19,200 gray whales migrate north toward Alaska, and later return south toward breeding grounds near Baja California (Carretta et al. 2014, ODFW 2014). During the northbound migration, mothers are often accompanied by calves and therefore remain close to the shoreline (within 400 m) to avoid predation by killer whales (Ford and Reeves 2008). A portion of this gray whale population, known as the Pacific Coast Feeding Aggregation (PCFA) do not make the full migration from Baja California to the Bering or Chukchi seas in Alaska, but rather spend May through October feeding at various coastal locations along the Oregon coast. These gray whales feed in very close proximity to the shore line (often between 10 and 50 m from the shore), This behavior encourages easy viewing at multiple locations including Depoe Bay, Cape Blanco, Seal Rock, Cape Meares and the Umpqua lighthouse. The whales feed voraciously on dense aggregations of mysids and amphipods that are abundant in these coastal areas (Newell 2009). When feeding in these shallow muddy bottom habitats, gray whales occasionally become entangled in crabbing gear (NOAA Fisheries 2014). This not only causes economic losses for fishermen, but, if not swiftly removed, can be detrimental to the whale's health and ability to move and forage. It is critical for gray whales to have successful foraging seasons to replenish their energy stores for the upcoming migration and breeding season. Outside of this summer period, gray whales still occur along the Oregon coast as they migrate north or south, typically within 4 km of shore (Calambokidis et al. 2002, Ford and Reeves 2008, Jones and Swartz 2009). Gray whales were once opportunistically hunted for sustenance along the Oregon coast by Native American tribes (Losey and Yang 2007) and therefore Native Americans communities in Oregon may maintain cultural connections this whale population. Given the (1) coastal distribution of gray whales within Oregon state waters, (2) the ecological importance of the coastal Oregon marine ecosystem to gray whales, and (3) the economic and cultural importance of gray whales to coastal Oregon communities, the management of gray whales is an important issue to the state.

Many of the great whales (blue whales, fin whales, humpback whales, sei whales, minke whales) also migrate through Oregon waters. These whales often stop and feed in Oregon's productive coastal waters. During this time, these whales may be effected by local fisheries, tourism ventures, and noise or chemical pollution.

b.2. Conservation and Management Policy Connections

All marine mammals are protected under the United State Marine Mammal Protection Act (MMPA) of 1972. The MMPA defines 'take' as "the act of hunting, killing, captures, and/or harassment of any marine mammal; or the attempt at such." 'Harassment' is defined as "any act of pursuit, torment or annoyance which has the potential to either: a. injure a marine mammal in the wild, or b. disturb a marine mammal by causing disruption of behavioral patterns, which includes, but is not limited to, migration, breathing, nursing, breeding, feeding, or sheltering." Of the marine mammal species that occur in Oregon waters, one species is listed as threatened (sea otter), and seven species are listed as Endangered under the Endangered Species Act (ESA) of 1973 (Table X). Since their inception, the MMPA and ESA have had certain successes; namely, the delisting of the gray whale in 1994 (Office of Protected Resources 2013). Despite this proclamation, gray whales remain listed as 'endangered' under Oregon State's endangered species act. The Oregon Endangered Species Act also lists the blue whale, sei whale, fin whale, humpback whale, north Pacific right whale, and sperm whale as Endangered.

An important component of the MMPA is the definition and implementation of the Potential Biological Removal (PBR) management approach to the incidental bycatch of marine mammals in fishing activities (Wade 1998). PBR is defined by the MMPA as the maximum number of animals, not including natural mortalities that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population. The PBR level for each stock is calculated by a formula which considers population productivity rate and a recovery factor (Wade 1998). The PBR management approach prioritizes and identifies fisheries according to the degree of mortality and serious injury that occurs incidental to commercial fishing. When PBR is met or exceeded, management protocols are initiated to mitigate the threat to the stock. While PBR levels are specific to fishery bycatch mitigation, there is a potential for MRE operations to influence PBR rates for fisheries if MRE operations 'take' a marine mammal and hence lower the PBR allowance from fishing activities.

Six marine mammal species are also considered "strategy species" by Oregon's Nearshore Strategy (California sea lion, gray whale, harbor porpoise, northern elephant seal, pacific harbor seal, and Steller sea lion), which is meant to guide management decisions affecting Oregon's nearshore marine resources and direct managers' attention and resources to priority areas (Oregon Department of Fish and Wildlife 2012).

b.3 Economic Interests

Marine mammals are both a benefit and a detriment to the Oregon economy. On one hand, gray whales and California sea lions attract thousands of visitors to the coast each year for wildlife viewing opportunities. In contrast, seals, sea lions, porpoises and other cetaceans cause fisheries losses due to predation on commercially valuable stocks and gear loss due to entanglements.

The gray whale migration corridor offers a unique opportunity to view whales from shore at a close range and draws at least 645,000 visitors a year to Oregon (Runyan 2009). In 2008, approximately 1,700,000 people traveled in Oregon with the express intent of viewing wildlife. A portion of these visitors participated in 645,000 trips with the intention of viewing marine mammals, which generated $48 million in revenue for Oregon coastal communities (accounting for 4.7% of the state total $1 billion in wildlife viewing revenue; Runyan 2009). Visitors to the Oregon coast are also drawn to see sea lions that haul out at Sea Lion Caves, and on the docks in Newport and Astoria. In Newport, bay front store owners and community members established the Newport Sea Lion Docks Foundation to raise money for dock refurbishment in order to maintain sea lion presence as a tourist attraction (http://www.newportsealiondocks.com/).

Commercial and recreational fisheries are important industries on the Oregon Coast and significant economic drivers in the state (ODFW 2013). Commercial fishing revenues in 2013 were $265 million (local commercial fisheries) and $618 million (commercial fisheries including distant water fleet). In 2012, ocean recreational fisheries earned $49.5 million. Interactions with marine mammals, particularly CSLs, can lead to profit losses to these fisheries in Oregon due to gear loss from entanglements and predation on target species (e.g., salmon) (Nash et al. 2000, Wright et al. 2010, NOAA 2011).

c. Potential Impacts of MRE Development to Marine Mammals

This section summarizes potential potential impacts on marine mammals from the following categories of potential stressors form marine renewable energy development:

1. Physical presences of device (includes above-water and below-water structure, anchoring and mooring components, and electric cable infrastructure)
2. Moving devices (includes moving components of device)
3. Energy removal
4. Chemical release (includes spills during installation and maintenance, leaching of paint)
5. Acoustic effects
6. Electromagnetic field (EMF) effects
7. Lighting

Potential impacts from marine renewable energy development are described for each stressor, followed by a summary section of the potential impacts in federal waters.

c.1. Physical Presence of Devices

The installation of marine renewable energy (MRE) devices may result in changes to the local ecosystems in which they are placed. Potential ecosystem impacts can create both positive and negative repercussions for marine mammals. Positive feedback to marine mammals by MRE devices include increased foraging opportunities and haul-out platforms (pinnipeds), and a decrease in vessel traffic and competition or interaction with fisheries due to restricted space. Negative impacts of MRE devices include decreased foraging opportunities, habitat degradation through water quality changes (e.g. turbidity, pollution), and noise changes due to vessel traffic, all of which can cause displacement of marine mammals from an area where an MRE device is installed (Boehlert and Gill 2010, James 2013). Marine mammal behavior and distribution patterns are affected by boat traffic (Lusseau 2003, Bejder et al. 2006), noise (Nowacek et al. 2007, Clark et al. 2009, Jensen et al. 2009), MRE construction and operation (Snyder and Kaiser 2009), and oceanographic patterns that influence the distribution of prey (Redfern et al. 2006, Torres et al. 2008). Local changes in water quality habitat caused by MRE installation and operation that may alter the habitat for marine mammals and their prey include sediment, electromagnetic fields (EMFs), turbidity, pollution (spills), current flow, and bathymetry.

Above water platforms may be attractive to pinnipeds as haul out sites. California and Steller's sea lions are regularly seen hauled out on offshore buoys in Oregon, making it likely that MRE platforms will also be used by pinnipeds when accessible. Harbor seals may also haul out on MRE platforms depending on the distance from shore and accessibility. Haul-out sites associated with MRE devices can also pose an injury threat to pinnipeds when getting onto or off the structures as they may come in contact with exposed, moving or articulated parts.

MRE systems and certain features in particular, such as rotating blades or tethering lines, may entrap, entangle, or collide with marine mammals. Impacts from such encounters can range from minor to lethal. Marine mammals are prone to becoming entangled in fishing gear; appendages (pectoral fins and flukes) are caught and tangled in lines and nets, which could cause an individual to drown when it cannot reach the surface to breathe. When demonstration scale MREs are scaled up to an array of multiple devices it creates a field of entanglement and avoidance hazards. A tidal energy site in the Bay of Fundy, Canada, has been associated with entrapment and mortality of humpback whales (James 2013). Models have predicted significant encounter rates between marine mammals and MRE devices; these are expected to increase when water is more turbid, such as during storms (Wilson et al. 2007). Another significant hazard for some animals may be tethers between devices such as mooring cables, chains, guy-lines, power cables and the seafloor. Marine mammals must be able to detect these objects to avoid them. Avoidance becomes more complicated when several cables are used per device or multiple devices are present. Another hazard presents itself when derelict fishing gear becomes caught on lines and cables, increasing the surface area of the zone for potential entanglement (Benjamins et al. 2014).

Underwater MRE surfaces, such as platforms, cables, anchors, and pipes are likely to be colonized by invertebrates and encrusting organisms to create an artificial reef. Such an artificial reef may aggregate fish or zooplankton that may attract marine mammals for increased foraging opportunities on concentrated prey. In contrast, MREs may disturb productive benthic and pelagic prey communities for marine mammals, causing decreased foraging opportunities and possible displacing marine mammals.

Fishing effort and vessel traffic will be limited or removed within and around an MRE site. This reduction in fishing effort may release some marine mammals (pinnipeds, dolphins, and harbor porpoise) from competition with fishing vessels for prey, decrease the risk incidental mortality in fishing operations, or cause a displacement of fishing effort, competition, and bycatch risk to another region. Removal of vessel traffic (other than servicing of the MREs) will locally reduce risk of vessel strikes and acoustic masking (other than ambient sounds generated by the MRE).

The risk of vessels colliding with marine mammals may increase in an MRE area due to increased vessel activity during exploration, construction, maintenance, operation, and decommissioning of the devices. Vessel strikes to marine mammals, especially baleen whales, are a growing global problem. Actual numbers of strikes are poorly known (Laist et al. 2001). Published statistics likely underestimate events because they are unnoticed or unreported; only a proportion of carcasses are documented and stranded carcasses may show no obvious sign of a strike. The probability of a lethal injury (i.e., killed or severely injured) to a large whale is a function of vessel speed at the time of the collision (Laist et al. 2001, Vanderlaan and Taggart 2007). Other factors that could influence the number and severity of ship strikes include vessel type (size and purpose), ambient noise, weather conditions, and whale behavior (social, feeding, resting, traveling), all which influence a whale's ability to detect and then avoid approaching vessels.

Local changes in habitat, water quality and prey communities can be expected within Oregon waters with the placement of MREs. Such changes are likely to be device, site and species specific, making it difficult to anticipate if these changes will result in positive (i.e. increased foraging opportunities through fish aggregation around devices) or negative (i.e., entanglements or habitat abandonment due to increased noise) interactions. Furthermore, because the implementation of MREs around the world is in its infancy, it is difficult to draw reliable predictions based on the experience at other locations. For instance, a long-term (10 year) study of harbor porpoise occurrence patterns within a large-scale wind farm development in the Danish western Baltic Sea documented significant declines in echolocation activity of harbor porpoise compared to baseline studies, with slow rates of harbor porpoise re-establishment in the area (Teilmann and Carstensen 2012). Gradual increases since the construction of the wind farm have been attributed to either habituation of the porpoises to the wind farm or enrichment of the environment due to reduced fishing and to artificial reef effects (Teilmann and Carstensen 2012). Additionally, harbor seals and gray seals in the North Sea follow the grid layout of a wind farm grid as well as pipelines leading to offshore structures; a behavior which is thought to be associated with foraging effort (Russell et al. 2014). Gray whales are frequent benthic and mid-water foragers in Oregon's waters; therefore disturbances by MRE operations in the GLD on large-scale ecosystem dynamics (i.e., water clarity, recruitment, current flow) may impact the concentration, distribution, and predictability of their prey in state waters. Based on previous evidence, the physical presence of MREs in Oregon waters may have short-term and long-term effects on California sea lions, harbor porpoise, and gray whales.

The initial emplacement of an MRE will cause destruction of some benthic habitat, and potentially impact marine mammal foraging zones. Certain wave pressure and clamshell technology devices that are attached directly to the seafloor, when deployed in large arrays, could cover and displace a large area of benthic habitat. Energy removal effects will have indirect effects on marine mammals mediated through ecosystem and prey availability changes. As energy is removed from the area (wind, waves, current, etc.), the effects of scouring and changing currents due to blockading objects may over time cause an ecosystem to transition from one state to another (sand/mud flat to artificial reef). This impact to the structure of the local environment (sediment properties, water column stratification, etc.) may displace benthic organisms and forage fish which will cause predators to expend more energy to find new sources of food (Boehlert and Gill 2010). Marine mammals may have to adapt to potential changes in prey dynamics by adjusting distribution and foraging strategies.

It is important to note the significance of carry-over effects from any ‘take’ of a marine mammal by MRE development or operation to the Oregon fishing communities. Some marine mammal species that occur in Oregon waters (bottlenose dolphin, killer whale, short finned pilot whale, Baird’s beaked whale, Mesoplodon beaked whales, pygmy sperm whale, dwarf sperm whale, sperm whale, gray whales from the Pacific coast feeding aggregation, blue whale, sei whale, minke whale) have low (<10 individuals) PBR rates (Table X), which if surpassed will trigger a management response for the relevant fishery. Therefore, if one of these species suffer a take due to a MRE development, state fisheries may face increased regulations or fishing restrictions.

If MRE devices are sited in the GLD, the ecology, fitness, population trends, foraging habitats and migration corridors of many marine mammals that occur in Oregon state waters may be impacted. The state is especially concerned with the impacts of entanglement, vessel strikes, and ecosystem shifts (i.e., changes in prey communities, habitat degradation) for California sea lions, harbor porpoise, and the endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon’s CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, ‘takes’ of marine mammals by MRE operations may impact lucrative Oregon fishery and tourism activities

c.2. Moving Devices

Individual repetitively moving parts (e.g., turbines) may cause direct and indirect effects on marine mammals. Entanglement or collisions with MRE may cause direct effects that injure or kill animals, or cause avoidance behaviors that lead to indirect effects of changes in habitat use and distribution patterns (See Wilson et al. 2007 for full review). Such avoidance behavior can lead to increased energetic demands of foraging or migrating animals that must find suitable replacement habitat. Localized changes in current patterns and water movement (i.e. increased turbulence due to turbine blades) may also affect prey distribution in the water column, which in turn affects predators who rely on Oregon coastal prey communities to meet energy demands. California sea lions, gray whales, harbor porpoises and other marine mammals could face ecological, individual and population-level impacts due to movement of these MREs (Boehlert and Gill 2010).

All three focal species (California sea lions, harbor porpoise, gray whales), as well as the endangered baleen whales, are prone to entanglement in fishing gear, and are therefore at risk of interaction with and entanglement or collision with MREs. Furthermore, if MREs do aggregate prey, and therefore marine mammal predators, then the risk of collision and entanglement will increase. Should derelict fishing gear become caught on a moving portion of the MRE, the additional ropes and cable moving through the water column will exacerbate risk of entanglement (Benjamins et al. 2014). Foraging and naive animals may be less cognizant of moving blades or turbines, leading to unanticipated physical interactions with moving parts.

If MRE devices are sited in the GLD, there may be incidental injuries and mortalities due to collisions and entanglements of marine mammals that occur in Oregon state waters. The state is especially concerned with the individual and population level impacts on California sea lions, harbor porpoise, and the endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, 'takes' of marine mammals by MRE operations may impact lucrative Oregon fishery and tourism activities.

c.3. Energy Removal

Oregon's coastal zone would mostly see secondary effects from the motion of these MREs. Energy removal by devices in water can lead to localized changes in water movement, energy, and turbulence, affecting local stratification processes and the distribution of prey in the water column (Boehlert and Gill 2010). California sea lions (as well as all pinnipeds), harbor porpoise, and gray whales all rely on Oregon coastal prey communities to meet energy demands. Additionally, if shoreline erosion manifests due to MREs, coastal haul-out sites and rookeries for pinnipeds may be disturbed. Therefore, broad-scale changes in the distribution or composition of prey comminutes (ranging from zooplankton to larger fish) could result in ecological and population-level impacts on these marine mammal species.

If MRE devices are sited in the GLD, physical changes in water flow and sediment transport may alter the topography and prey availability for marine mammals that occur in Oregon state waters. The state is especially concerned with changes to foraging opportunities and pinnipeds haul-outs on the individual and population fitness of California sea lions, harbor porpoise, and the endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species.

c.4. Chemical effects

Chemical effects of MRE devices on the local ecosystem are most likely to occur as a result of oil and chemical spills during construction and maintenance. Chemical leaching may also occur on a smaller, yet long-term, scale as anti-bio-fouling paints or other coatings applied to devices slowly leach and degrade into the water column.

Impacts on marine mammals from chemicals in the ecosystem can have direct and acute effects, or long-term and systematic impacts (Peterson et al. 2003). An oil or chemical spill can affect prey communities, repel animals from preferred habitats, and cause skin irritations and disease. Different chemicals will have differing effects on marine mammals depending on the method of exposure. If fur has been slicked, the animal's thermoregulation capabilities may be compromised. Direct ingestion as animals attempt to groom themselves can cause illness or death. For marine mammals who must break the surface water/air interface in order to breathe, slicks or chemicals which cling to exposed skin (i.e. blowholes), as well as residual fumes, may cause breathing difficulties. Viscous fluids that coat the body for extended periods of time may also interfere with swimming ability in seals, and filtering abilities in baleen whales (Engelhardt 1983, Reijnders et al. 2009).

Long-term impacts can manifest in marine mammals through bio-accumulation of toxins. Many human produced chemicals bioaccumulate in marine mammals, meaning that animals absorb these chemicals at a rate faster than they are lost. Marine mammals are long-lived top predators that acquire the lifetime accumulation of chemicals of the animals they eat. This leads to biomagnification, whereby the concentration of chemicals increases greatly at every step in the food chain, and top predators end up with extremely high levels (Borrell 1993, Hall 2002, Law et al. 2012). Because baleen whales feed on planktonic crustaceans, and are thus situated lower in the food web, their tissue concentrations of pollutants are typically lower than toothed whales living in the same ecosystem (Tilbury et al. 2002).

The main environmental toxins that are currently a concern for populations of marine mammals are known as persistent organic pollutants (POPs) and include PCBs, PBDE's and dioxins and furans (Borrell 1993, Reijnders et al. 2009). Pollutants can also include oil-pollution derived substances, marine debris, metals, sewage-related pathogens, excessive amounts of nutrients causing environmental changes, and radionuclides.

High concentration of certain compounds in the tissues of these animals has been associated with organ anomalies, impaired reproduction and immune function, and as a consequence of the latter, with the occurrence of large die-offs among seal and cetacean species (Johnston et al. 1996, Reijnders et al. 2009). Increased exposure to pollution might manifest through high tissue pollutant concentrations in individuals, and changes in a population's biological parameters such as physiological condition and changes in reproductive or mortality rates (Reijnders 1996, Reijnders et al. 2009).

Due to the dynamic nature of the marine environment, toxic slicks and chemical spills are not static, but rather move unpredictably through ecosystems as a function of currents and tides. Therefore, large-scale or long-term chemical inputs into Oregon waters by MREs will have broad-scale impacts on marine mammal communities. Gray whales can be exposed to contaminants that have leached into the benthic substrate during their feeding activities. Bioaccumulation of anthropogenic chemicals is of particular concern in males who do not eliminate pollutants through gestation and lactation as do females (Tilbury et al. 2002). California sea lions and harbor porpoise are at higher risk of bioaccumulation of chemicals due to the higher trophic level at which they feed compared to gray whales (Hall 2002, Riemer et al. 2011).

If MRE devices are sited in the GLD, there will be an increased risk of chemical (pollutants and toxins) release into the marine ecosystem that may impact marine mammals that occur in Oregon state waters. The state is particularly concerned with the individual and population level impacts of toxin bioaccumulation on the long-lived, top trophic level predators California sea lions and harbor porpoise. The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, 'takes' of marine mammals by MRE operations may lead to reduced local population sizes and hence impact lucrative Oregon fishery and tourism activities.

c.5. Acoustic Effects

MRE devices will generate noise when they are being built, during operation, and when they are removed from the environment. Different types and frequencies of sounds can be anticipated from different device types and during different stages of development. Marine mammals rely heavily on sound to communicate and navigate the oceans. Numerous studies have demonstrated behavioral changes of marine mammals responding to exposure of anthropogenic activities (Nowacek et al. 2007). These responses have ranged from subtle short-term behavioral changes, to longer-term population level impacts (Richardson et al. 1995, Lusseau 2003, Constantine et al. 2004). Extensive research over the past two decades has resulted in general trends in observed behavioral responses to disturbance, and in 2005, the Population Consequences of Acoustic Disturbance model was developed as a framework to help determine how individual behavioral responses to noise could lead to population level responses/impacts.

When acoustic effects on marine mammals are assessed, the level of impact varies with distance from a sound source - potential injury or death when the animal is very close to the source to a broader range of behavioral disturbances when the animal is further away. One study of construction of an offshore wind farm estimated the range of potential injury for bottlenose dolphins was 100 m, with the potential range for behavioral disturbance to be out to a range of 50 km (Bailey et al. 2010). There are concerns that noises generated by MREs might have a masking effect and impede communication between individuals who rely on sound for hunting, mating, or communication. A masked area is defined as the space around a noise source in which the noise impedes detection of other sounds (i.e. communication, predators and prey, orientation and navigational). The size of a masked area will vary from species to species and individual to individual (Richardson et al. 1995). When masking causes foraging effort to outweigh benefit, or communication to be ineffective, previously productive foraging locations may be abandoned to the detriment of an animal's health. Additionally, it is unknown how quickly an individual's hearing returns to 'normal' after exposure to loud sounds. The zone of hearing loss, discomfort and injury is anticipated to be a small area close to very loud sound sources with sufficiently high sound pressures to inflict temporary or permanent damage. Different effects are anticipated between continuous low levels of sound and pulsed, non-continuous sounds (Tougaard et al. 2009).

Cetaceans are particularly vulnerable to noise disturbance. Odontocetes (toothed whales and dolphins) are considered high and mid-frequency specialists, and use passive and active acoustics for navigation, communication and foraging. Mysticetes (baleen whales) use low frequency sound for long-range communication. Therefore, noise production by MREs will have variable effects on marine mammal communities depending on the type of noise emitted and the local marine mammal species.

Harbor porpoise are high frequencies specialist cetaceans that use acoustics to communicate with conspecifics and echolocate. Therefore, anthropogenically induced high frequency noise within their range (16-140 kHz, with max sensitivity between 110-140 kHz) may disrupt communication and foraging capabilities (Kastelein et al. 2002). Harbor porpoise are of particular concern because of its high sensitivity to anthropogenic noise (Tougaard et al. 2012) and its high potential for spatial overlap with MRE devices due to their typically coastal distribution in waters less than 200 m deep. It has been determined that noise exposure above 120 dB re: 1 μPa (sound pressure level) will disturb porpoises (Southall et al. 2007). The draft NOAA guidelines on the impacts of anthropogenic noise on marine mammals (NOAA 2013) lists the onset of temporary threshold shift (TTS) of harbor porpoise to be at received levels of 195 dB_{peak} and 146 dB $SEL_{cumulative}$ (Impulsive sound) and 195 dB_{peak} and 160 dB $SEL_{cumulative}$ (Non-impulsive sound). NOAA (2013) lists the onset of permanent threshold shift (PTS) of harbor porpoise to be at received levels of 201 dB_{peak} and 161 dB $SEL_{cumulative}$ (Impulsive sound) and 201 dB_{peak} and 180 dB $SEL_{cumulative}$ (Non-impulsive sound). Other small odontocetes (e.g., dolphins) in Oregon waters are considered mid-frequency specialists with a functional hearing range of 150 Hz to 160 kHz with the onset of TTS listed to occur at received levels of 224 dB_{peak} and 172 dB $SEL_{cumulative}$ (Impulsive sound) and 224 dB_{peak} and 178 dB $SEL_{cumulative}$ (Non-impulsive sound) (NOAA 2013).

The acoustic range of gray whales is <100 Hz – 2 kHz, with the majority of calls occurring between 250-850 Hz, making them rely on low frequency sounds for communication (Dahlheim 1987). Gray whales are not acoustically active while foraging but do rely on acoustics during migration. Therefore, low frequency noise generated by MREs may disturb gray whales while migrating or possibly during foraging (e.g., avoidance of an area). Reactions of gray whales to seismic airgun noise has been documented (Malme et al. 1983). Received levels exceeding 160 dB re: 1 μPa caused migrating gray whales to avoid airgun sounds. Less profound but still statistically significant reactions occurred at much larger ranges and lower levels: the 10, 50, and 90% probabilities of gray whale avoidance reactions occurred in conditions with 164, 170, and 180 dB re: 1 μPa, respectively (Malme et al. 1983). The draft NOAA guidelines on the impacts of anthropogenic noise on marine mammals (NOAA 2013) lists the onset of TTS of baleen whales to be at received levels of 224 dB_{peak} and 172 dB $SEL_{cumulative}$ (Impulsive sound) and 224 dB_{peak} and 178 dB $SEL_{cumulative}$ (Non-impulsive sound). NOAA (2013) lists the onset of PTS of baleen whales to be at received levels of 230 dB_{peak} and 187 dB $SEL_{cumulative}$ (Impulsive sound) and 230 dB_{peak} and 198 dB $SEL_{cumulative}$ (Non-impulsive sound).

California sea lions are very social animals, and groups often rest closely packed together at favored haul-out sites on land or float together on the ocean's surface in "rafts." The audio range of CSLs is 1-30Hz (Schusterman et al. 1972) and it has been estimated that California sea lion show temporary threshold shift onset at 174 dB re: (SEL: 206 dB re: 1 μPa^2-s; sound exposure level) (Southall et al. 2007). It is believed that CSLs mainly use acoustics for communication and passive acoustics to listen for prey and predators. CSLs may suffer acoustic disturbance from MREs that produce loud mid to high frequency sounds, causing individuals to avoid the area. The draft NOAA guidelines on the impacts of anthropogenic noise on marine mammals (NOAA 2013) lists the onset of TTS of Otariid pinnipeds (including sea lions) to be at received levels of 229 dB_{peak} and 200 dB $SEL_{cumulative}$ (Impulsive sound) and 229 dB_{peak} and 206 dB $SEL_{cumulative}$ (Non-impulsive sound). NOAA (2013) lists the onset of PTS of Otariid pinnipeds (including sea lions) to be at received levels of 235 dB_{peak} and 215 dB $SEL_{cumulative}$ (Impulsive sound) and 235 dB_{peak} and 220 dB $SEL_{cumulative}$ (Non-impulsive sound).

If MRE devices are sited in the GLD, there will be increased ocean noise in the local environment that may impact the ecology, fitness, population trends, foraging habitats and migration corridors of many marine mammals that occur in Oregon state waters. The state is especially concerned with the direct (i.e., injury) and indirect (i.e., habitat displacement) impacts of noise on acoustically sensitive harbor porpoise and the endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, 'takes' and displacement of marine mammals by MRE operations may impact lucrative Oregon fishery and tourism activities.

c.6. EMF

When in operation, MREs generate electromagnetic fields (EMFs) within their associated subsea cable network and substation(s). Modeling efforts have predicted that sub-sea cables used by the offshore wind industry emit EMFs of the type and intensity that fall within the sensory range of a number of marine animals (Boehlert and Gill 2010, Gill et al. 2014). Although this field of study is young and the full impacts of EMFs on marine animals is unknown, some studies have indicated that EMF-sensitive marine animals can respond to both naturally occurring and anthropogenic EMFs in the coastal environment (Gill 2005, Gill et al. 2014). Anthropogenic EMFs may appear as prey for predators who use EMF -sensitivity for hunting, such as elasmobranchs, or disrupt the migratory patterns of species like cetaceans. Therefore, marine mammals may suffer direct effects of EMF if migration pathways are disrupted, or secondary effects if prey resources are disturbed.

If the prey of California sea lions and harbor porpoise are disturbed by EMFs emitted by MREs in Oregon, then these predators may have to expend more energy as they adapt to unexpected distribution patterns of their prey. Gray whales may use EMF naturally to migrate. If MREs disrupt these natural EMF signals, the migration pathway of approximately 19,000 gray whales along the Oregon coast may be disturbed.

If MRE devices are sited in the GLD, there will likely be changes and increases in electromagnetic fields around the sites and the cables that may impact the ecology, fitness, and migration corridors of many marine mammals that occur in Oregon state waters. The state is particularly concerned with the indirect impacts of EMF on the prey sources of California sea lions and harbor porpoise, and the migration capabilities of the endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, displacement of marine mammals by MRE operations may impact lucrative tourism activities in coastal Oregon.

c.7. Lighting

Artificial lighting causes different reactions by marine animals based on style of lighting (i.e. duration, spectrum), and the age-class and species. It can influence schooling and foraging behavior, spatial distribution, predation risk, migration and reproduction cues (Rich and Longcore 2005). While underwater light may attract marine mammals to prey sources that aggregate near lighting sources, especially at night, it is unlikely that MRE use of underwater lighting will be persistent (other than possibly during installation and maintenance). Therefore, the secondary effects on marine mammals, such as increased prey or habitat disturbance, is likely to be short-term and minor.

It is likely that individual California sea lions and harbor porpoises may be attracted by prey aggregations caused by the attraction to artificial lighting. Additionally, zooplankton are known to aggregate toward light sources during nocturnal periods (Wittmann 1977, McConnell et al. 2010), making it possible that the mysid prey of gray whales may aggregate near underwater lighting of MREs. However, due to the impermanent nature of the lighting, effects on marine mammals are unlikely to be serious (Rich and Longcore 2005), unless indirect consequences such as entanglement manifest.

If MRE devices are sited in the GLD, there may be illumination of underwater environments that may change the distribution of prey of many marine mammals that occur in Oregon state waters, causing impacts to their ecology, fitness, and foraging habitats. The state is concerned with the indirect (i.e., changes in prey distribution) impacts of underwater lighting on the zooplankton prey of endangered large baleen whales (blue whale, fin whale, humpback whale, gray whale, sei whale). The enforceable policies of Oregon's CZMP includes broad authority to develop wildlife protection programs and protect threatened and endangered species. Furthermore, displacement of marine mammals by MRE operations may impact lucrative tourism activities in coastal Oregon.

Table 10. Marine mammal species occurring in Oregon waters and potential impacts from Marine Renewable Energy (MRE) development. Population sizes, stock boundaries, and Potential Biological Removal (PBR) estimates are taken from NOAA stock assessments. Distribution is defined as (1) species that use federal waters and are potentially exposed to direct impacts at MRE sites in federal waters, (2) species that use state waters or beaches only and may respond to indirect impacts of MRE, (3) species that use estuaries only and are thus one step further removed from indirect impacts, and (4) vagrant species. Species that exhibit more than one distribution pattern are given two designations. Occurrence of species in Oregon waters is defined as regular (R), occasional (O), or uncommon (U). Temporal patterns of occurrence in Oregon waters is defined as year-round (Y), or seasonal (S). General habitat use patterns of each species are categorized as State waters (species occurs between the shoreline and the GLD), GLD (species occurs mainly in the GLD between 3nm and 500 m water depth), or offshore (species typically occurs past the offshore limits of the GLD). Species are listed as threatened (T) or endangered (E) according to the Endangered Species Act (ESA) and the State's stewardship responsibilities. Species response is limited to anticipated direct effects.

							Habitat use			Importance to State					Potential Impacts						
Common Name	Latin name	Estimated population size	Stock boundaries	Distribution	Occurrence	Temporal Pattern in GLD	State waters	GLD	Offshore	ESA	State ESA listing	PBR	Currently Fishery Limiting	Tourism	Physical presence of device	Moving device	Energy removal effects	Chemical	Acoustic	EMF	Lighting
California Sea Lion	*Zalophus californianus*	296750	CA/WA/OR	1	R	Y	X	X	X			9200	N	X	X	X		X			
Northern Fur Seal	*Callorhinus ursinus*	9968	San Miguel Island	1	R	Y		X	X			324	N		X	X		X			
Stellar Sea Lion (Eastern Stock)	*Eumetopias jubatus*	58334-72223	SEAK/BC/OR/CA	1	R	Y	X	X	X			2378	N	X	X	X		X			
Harbor Seal	*Phoca vitulina richardsi*	24732	OR/WA	1	R	Y	X	X				1343 [2]	N		X	X		X			
Northern Elephant Seal	*Mirounga angustiostris*	124000	CA breeding stock	1	R	S	X	X	X			4382	N		X	X		X			
Sea Otter	*Enhydra lutris*	0	OR w/i historical range	4	U	Y	X			T	T							X			
Harbor Porpoise	*Phocoena phocoena*	55255 [1]	NCA/OR/SWA	1	R	Y	X	X	X			577 [3]	N		X	X		X	X		
Dall's Porpoise	*Phocoenoides dalli dalli*	42000	CA/OR/WA	1	R	S	X	X	X			257	N		X	X		X	X		
Pacific White Sided Dolphin	*Lagenorhynchus obliquidens*	26930	CA/OR/WA	1	O	S		X	X			193	N		X	X		X	X		
Risso's Dolphin	*Grampus griseus*	6272	CA/OR/WA	1.4	O	S	X	X	X			39	N		X	X		X	X		
Common Bottlenose Dolphin	*Tursiops truncatus truncates*	1006	CA/OR/WA	1	U	S	X	X	X			5.5	N		X	X		X	X		
Striped Dolphin	*Stenella Coeruleoalba*	10908	CA/OR/WA	4	U	S		X	X			82	N		X	X		X	X		
Common Dolphin (short-beaked)	*Delphinus delphis delphis*	411211	CA/OR/WA	4	O	S	X	X	X			3440	N		X	X		X	X		
Common Dolphin (long beaked)	*Delphinus capensis capensis*	107016	CA	4	U	S	X	X	X			610	N		X	X		X	X		
Northern Right Whale Dolphin	*Lissodelphis borealis*	8334	CA/OR/WA	1	O	Y		X	X			48	N		X	X		X	X		
Killer Whale (Offshore)	*Orcinus orca*	240	SEAK/CA/OR/WA	1	---	---		X	X			1.6	N		X	X		X	X		
Killer Whale (Transient)	*Orcinus orca*	354	SEAK/BC/CA/OR/WA	1	R	---	X	X	X			3.5	N		X	X		X	X		
Killer Whale (Southern Resident)	*Orcinus orca*	87	SEAK/CA/OR/WA	1	U	S	X	X		E		0.14	Y		X	X		X	X		
Short finned Pilot Whale	*Globicephala macrorhynchus*	760	CA/OR/WA	4	U	S		X	X			4.6	N		X	X		X	X		

Table 10. continued

							Habitat use			Importance to State					Potential Impacts						
Common Name	Latin name	Estimated population size	Stock boundaries	Distribution	Occurrence	Temporal Pattern in GLD	State waters	GLD	Offshore	ESA	State ESA listing	PBR	Currently Fishery Limiting	Tourism	Physical presence of device	Moving device	Energy removal effects	Chemical	Acoustic	EMF	Lighting
Baird's Beaked Whale	*Berardius bairdii*	907	CA/OR/WA	4	O	---		X	X			6.2	N		X	X		X	X		
Mesoplodont Beaked Whale	*Mesoplodon spp*	1024	CA/OR/WA	4	---	---		X	X			5.8	N		X	X		X	X		
Cuvier's Beaked Whale	*Ziphius cavirostris*	2143	CA/OR/WA	4	O	---			X			13	N		X	X		X	X		
Pygmy Sperm Whale	*Kogia breviceps*	579	CA/OR/WA	4	U	---			X			2.7	N		X	X		X	X		
Dwarf Sperm Whale	*Kogia sima*	unk	CA/OR/WA	4	U	---			X			unk	N		X	X		X	X		
Sperm Whale	*Physeter macrocephalus*	971	CA/OR/WA	1	O	S		X	X	E	E	1.5	Y		X	X		X	X		
Gray Whale	*Eschrichtius robustus*	19126	SEAK/CA/OR/WA	1	R	S	X	X			E	558 [4]	N	X	X	X		X	X		
Humpback Whale	*Megaptera novaeangliae*	2043	CA/OR/WA	1	O	S	X	X	X	E	E	11.3	N		X	X		X	X		
Blue Whale	*Balaenoptera musculus*	2497	CA/OR/WA	1	O	S	X	X	X	E	E	3.1	N		X	X		X	X		
Fin Whale	*Balaenoptera physalus*	3044	CA/OR/WA	1	O	S		X	X	E	E	16	N		X	X		X	X		
Sei Whale	*Balaenoptera borealis*	126	CA/OR/WA	1.4	U	S	X	X	X	E	E	0.17	N		X	X		X	X		
Minke Whale	*Balaenoptera acutorostrata*	478	CA/OR/WA	1.4	U	S	X	X	X			2	N		X	X		X	X		
Northern Pacific Right Whale	*Eubalaena japonica*	100-200	OR w/i historical range	4	U	S	X	X	X	E	E				X	X		X	X		

[1]Northern California/Southern Oregon and Northern Oregon/Southern Washington stock population estimates added together.
[2]PBR calculated by Carretta et al (2009) due to outdated harbor seal census data.
[3]PBR unknown for Northern Oregon/Southern Washington stock of harbor porpoises, so this is an underestimate.
[4]An additional PBR of 2.8 gray whales has been calculated for the Pacific Coast Feeding Aggregation since these whales may soon be declared a separate stock.

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4) Ocean Habitat

a. Ocean Habitats Occurring off of Oregon

Numerous types of marine benthic and pelagic habitats occur within the GLD. On a broad scale, habitats within the GLD occupy two depth ranges:

- Continental shelf (shoreward boarder of the GLD to 100 fm (approx. 200 m) water depth)
- Upper slope (100 gm to seaward border of the GLD) (Map F.7)

The topography of the continental shelf and slope is not uniform. Rocky banks and submarine canyons interrupt the otherwise gently-sloping continental shelf. The continental slope is relatively steep in some areas, while in others the incline is gentle and in some cases interrupted by rises and hills. The width of the shelf off of Oregon varies from about 8 to 36 nautical miles (<1 to 32 nm within the GLD). The full width of the continental slope varies from about 13 to 55 nautical miles (2 to 29 nm within the GLD).

Benthic habitats in the GLD include both rocky and unconsolidated substrate. These general substrate categories can be broken into numerous sub-groups according to grain size, vertical relief, and other factors (Map F.7). Structure-forming invertebrate species (sponges, cold-water corals, etc.) and communities occur on many rocky and unconsolidated sediment areas of the seafloor, increasing the complexity of these habitats.

Pelagic habitats in the GLD are shaped by the spatially and temporally variable currents of the California Current system, local wind stress, seafloor and coastal topography, and the Columbia River plume, in addition to other smaller-scale oceanographic processes. The portion of the California Current Large Marine Ecosystem off of Oregon characteristically has a southward flowing current over the shelf and slope and a northward flowing undercurrent over the slope in spring and summer. In winter, the current over the shelf consists primarily of the northward flowing Davidson current. During spring and summer, southward blowing winds drive an upwelling system that brings cold, nutrient-rich, and oxygen-poor waters from depth up onto the continental shelf (Map F.8). The upwelling process is highly variable on many time scales and is generally stronger and more persistent on the south Oregon coast and more intermittent on the central and northern Oregon coast. In addition to nutrients derived from upwelling, river discharge from the Columbia River provides a major source of nutrients to the Oregon continental shelf, especially along the north coast. The upwelling and river-plume nutrients fuel high phytoplankton productivity (Map F.9) which drives an extremely productive marine ecosystem off of Oregon. Superimposed on these large-scale processes are smaller scale eddies, gyers, fronts, and other oceanographic phenomena, which together serve to create a complex, spatially and temporally dynamic pelagic ecosystem. Oceanographic processes off of Oregon have been well studied and much detailed information can be found in Landry and Hicky (1989), Hickey and Banas (2003, 2008), Hickey, et al. (2010) and many other publications.

Influences of climate change and ocean acidification are beginning to affect both benthic and pelagic habitats off of Oregon, and effects will intensify in the future. There is growing evidence that, over time, upwelling will increase in intensity, be less intermittent, and start later in the year due primarily to changes in wind patterns (Bakun 1990, Barth et al. 2007, Iles, et al. 2012).

Ocean acidification is already affecting local ecosystems in Oregon and, along with hypoxia, is expected to increase in the future (Feely, et al. 2008, Feely, et al. 2009, Bindoff et al. 2007, Chan et al. 2008). Increased ocean temperatures are also beginning to be reflected in northern expansion of species ranges (Mote and Salathe 2010, Phillips, et al. 2007, Field et al. 2007). In combination, all of these influences of climate change will place new stresses on the marine ecosystem off of Oregon. Consideration of potential impacts from ocean energy development needs to account for cumulative effects of climate-related stressors on ocean habitats and other marine resources.

b. State Interest in Ocean Habitats

Habitats that occur outside of state Territorial Sea waters are linked to state of Oregon interests with respect to the enforceable policies of the state's Coastal Zone Management Program. These habitats may be linked to state interests for one or more of three general reasons:

1. ecological factors and connections between state and federal waters,
2. conservation or management policy factors,
3. fishery factors.

b.1. Ecological Factors

Benthic and pelagic habitats within the GLD provide shelter, feeding areas, and nursery areas for fish, invertebrates, birds, and mammals that are of direct interest to the state of Oregon (see previous sections for lists and descriptions of these species). All of these species depend on the functionality of habitats within the GLD. Since Oregon has interest in conserving these species, state interest extends to ensuring that habitats within the GLD retain their ability to provide supportive functions to these species.

b.2. Conservation and Management Policy Factors

Protection of habitat functions and values represents a key component of Oregon's Coastal Management Program enforceable policies. For example the Oregon Territorial Sea Plan recognizes the need to protect habitat for the purpose of marine resource conservation, and many of its enforceable policies contain provisions to inventory, assess impacts, and protect habitat. In addition, fish and wildlife management laws that are part of the state's coastal program include habitat protection provisions for the purpose of fish and wildlife conservation. In order to meet coastal marine resource management requirements for the fish, invertebrate, bird and mammal species summarized in previous sections, the state's interest extends to all habitats used by these species, including habitats within the GLD.

Federal laws contain provisions for protecting specific habitats with in the GLD, including designated critical habitat under the Endangered Species Act and Essential Fish Habitat under the Magnuson-Stevens Fisheries Conservation and Management Act. Federally-listed threatened or endangered species that have designated critical habitat within the GLD include Green Sturgeon and Leatherback Sea Turtle. In addition a possible extension of Southern Resident Killer Whale critical habitat into ocean waters off of Oregon is currently under review by NOAA. Designated Essential Fish Habitat conservation areas within the GLD include all rocky reef environments (see rock substrate on Map F.7) and Nehalem Banks, Daisy Bank/Nelson Island, Stonewall Bank, Heceta Bank, and the Bandon High Spot. Oregon shares management responsibility for species dependent on these specific habitat areas and would realize impacts to coastal economies should these species suffer negative effects due to impacts on their habitats. Protection of these habitat areas within the GLD is therefore of direct interest to the state of Oregon.

b.3 Fishery Factors
Oregon fisheries depend on fish and invertebrate species that occur within the GLD (see previous sections on Commercial and Recreational Fisheries and Fish and Invertebrates). These fish and invertebrates, in turn, depend on benthic and pelagic habitats within the GLD. Oregon coastal economies depend on these fisheries and, by extension, on the habitats that support populations of the harvested fish and invertebrate species. The state is concerned with activities that may impact these habitats and effect the populations that depend on them.

c. Potential Impacts of Ocean Renewable Energy Development to Ocean Habitats
This section summarizes potential impacts on ocean habitats. Of the seven categories of potential stressors from ocean renewable energy development, the following three potentially impact ocean habitat:

1. Physical presences of device (includes above-water and below-water structure, anchoring and mooring components, and electric cable infrastructure)
2. Energy removal
3. Chemical release (includes spills during installation and maintenance, leaching of paint)

Potential impacts from renewable ocean energy development are described below for each stressor.

c.1. Physical Presence of Devices- Summary of Effects
The ocean renewable energy structure, moorings, and electrical transmission infrastructure all serve to alter the pelagic and benthic habitat at and near their locations. Structure on the water surface or in the water column will likely act as fish aggregation devices and attract species of pelagic fish such as Albacore Tuna and several shark species (Boehlert and Gill 2010; Klure, et al. 2012; Nelson, et al. 2008). In addition, fouling organisms that will settle on the subsurface structure will likely attract other species in response to the additional habitat surface structure created by the fouling organisms. The devices' anchoring systems alter benthic habitat by providing hard physical structure on otherwise soft-bottom environments, creating an artificial reef effect. In addition, the presence of anchors or other structure on or near the sea floor will cause down-current changes in the sedimentary habitats due to scouring or accretion, which can alter habitat characteristics and benthic prey resources.

Habitat alterations at or near the project site in federal waters can have reasonably foreseeable effects on fish, invertebrates, or fisheries that are of interest to the state. The previous sections on fisheries and fish and invertebrates discuss potential effects. Habitat impacts that reduce availability of fish can contribute to reduce commercial fishery landings or increase the cost for catching fish. Since the economy of Oregon's coastal zone is dependent on fisheries, and Oregon's CZMP has specific enforceable policies dedicated to the protection and orderly execution of fisheries, any of the impacts described above constitute reasonably foreseeable impacts to Oregon's coastal zone. Habitat impacts can also negatively affect fish species of conservation concern, such as ESA-listed or overfished species. Examples include the listed salmonid stocks, Eulachon, and juvenile Yelloweye Rockfish. These species' populations are found in both state and federal waters, and the state and federal government share management responsibility for their conservation and recovery. Any impact to these species in federal waters also impacts Oregon's conservation programs, potentially increasing the cost or time for species recovery. Additionally, impacts to the species could result in more conservative fisheries regulatory restrictions, resulting in reduced catch allowances, and ultimately leading to economic impacts (see Fisheries section).

c.2. Energy Removal - Summary of Effects

Energy removal refers to a reduction in wave action that may occur shoreward of wave energy devices, especially if development, either individually or cumulatively, is very large-scale. This can change the sediment transport and habitat characteristics of shallow water and shoreline environments in the wave-shadow of devices (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008).

The shallow water and shoreline areas are in state waters, and are therefore of direct interest to the state. Rocky shoreline areas provide viewing, educational, and harvest opportunities, and many are protected under provisions in Oregon's Coastal Zone Management Program. Sandy shoreline areas provide the center piece of Oregon's coastal recreation, and the coastal economy depends on these beaches. In addition, some of these beaches provide for razor clam fisheries, and provide habitat for shorebirds including the threatened Snowy Plover. Alteration of shoreline habitats due to changes in sediment transport would constitute a reasonably foreseeable effect on Oregon's coastal zone.

Alteration of shoreline or shallow-water habitat can also have indirect effects on fish and invertebrates, including changes in habitat structure and benthic prey communities. Fish and invertebrate species most susceptible to this type of effect would include shallow-water benthic species and juvenile life history stages (see Fish and Invertebrate section for description of impacts).

c.3. Chemical Exposure - Summary of Effects

Potential chemical exposure of organisms and the surrounding environment can result from leaching or chipping of anti-fouling paints or other coatings on the devices, and spills or leaks of chemicals that may occur during construction, operations, or maintenance (Klure, et al. 2012; Boehlert and Gill 2010; Nelson, et al. 2008). The chemicals can originate from the devices or vessels servicing the devices. There is extensive literature on potential chemical effects in the marine environment from various substances. Paint chips or spilled materials can sink to the seafloor and persist in benthic environment under the devices, or may be carried to areas distant from the project site, and impact those habitats. In addition, estuaries are particularly sensitive to leaching, spills, or discharges that can occur while building, storing, maintaining, or staging ocean energy devices or from the vessels installing or servicing the devices.

Chemical pollution of habitats within the GLD can affect fisheries, fish, invertebrates, birds and mammals, many of which are managed with conservation or use provisions of Oregon's CZMP (see previous sections for description of how fisheries, fish, invertebrates, birds, and mammals are connected to Oregon's CZMP). Additionally, Oregon has direct responsibility for addressing any habitat impacts from chemicals spilled in federal waters and transported by currents into state waters. .

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Appendix

The tables below provide a comprehensive list and supportive information related to the species of fish, selected invertebrates and birds that are of interest to the state of Oregon.

Table A. Fish and selected invertebrate species that occur off of Oregon out to 500 fm.

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Black Hagfish	*Eptatretus deani*	Coastal Cutthroat	*Oncorhynchus clarki*	Benthabella Linguidens	*Benthabella linguidens*
Pacific Hagfish	*Eptatretus stouti*	Dolly Varden	*Salvelinus malma*	Scaly Paperbone	*Scopelosaurus harryi*
Bobtail Eel	*Cyema atrum*	Rainbow Trout/Steelhead	*Oncorhynchus mykiss*	California Lizardfish	*Synodus lucioceps*
Spiny Eel	*Notacanthus chemnitzii*	Brook Trout	*Salvelinus fontenalis*	Highfin Lizardfish	*Bathysaurus mollis*
Leaflike Eel	*Thalassenchelys coheni*	Brown Trout	*Salmo trutta*	Roundnose Lanternfish	*Centrobranchus brevirostris*
Blackline Snipe Eel	*Avocettinna infans*	Atlantic Salmon	*Salmo salar*	Dogtooth Lampfish	*Ceratoscopelus townsendi*
Pale Snipe Eel	*Nemichths larseni*	California Smoothtongue	*Leuroglossus stilbius*	California Headlightfish	*Diaphus theta*
Slender Snipe Eel	*Nemichthys scolopaceus*	Robust Blacksmelt	*Psuedobathylagus milleri*	Dorsadena Yaquinae	*Dorsadena yaquinae*
Twinpored Eel	*Xenomystax atrarius*	Popeye Blacksmelt	*Bathylagus ochotensis*	Chubby Lanternfish	*Electrona risso*
Crossthroat Sawplate	*Serrivomer jesperseni*	Pacific Blacksmelt	*Bathylagus pacificus*	Sunbeam Lanternfish	*Lampadena urophaos*
Sawtooth Eel	*Serrivomer sector*	Snubnose Blacksmelt	*Bathylagus wesethi*	Lampanyctus Fernae	*Lampanyctus fernae*
Longnose Tapirfish	*Polyacanthonotus challengeri*	Javelin Spookfish	*Bathylychnops exilis*	Brokenline Lanternfish	*Lampanyctus jordani*
River Lamprey	*Lampetra ayresi*	Brownsnout Spookfish	*Dolichopteryx longipes*	Pinpoint Lampfish	*Nannobrachium regale*
Pacific Lamprey	*Lampetra tridentata*	Barreleye	*Macropinna microstoma*	Broadfin Lampfish	*Nannobrachium ritteri*
Sixgill Shark	*Hexanchus griseus*	Bonythroat	*Bathylaco nigricans*	Patchwork Lampfish	*Notoscopelus resplendens*
Sevengill Shark	*Notorynchus maculatus*	Paperjaw	*Leptochilichthys agassizii*	Giant Lampfish	*Parvilux ingens*
Thresher Shark	*Alopias vulpinus*	Narcetes Stomias	*Narcetes stomias*	California Flashlightfish	*Protomyctophum crockeri*
White Shark	*Carcharodon carcharias*	Whitebait Smelt	*Allosmerus elongatus*	Northern Flashlightfish	*Protomyctophum thompson*
Basking Shark	*Cetorhinus maximus*	Surf Smelt	*Hypomesus pretiosus*	Northern Lampfish	*Stenobrachius leucopsaris*
Shortfin Mako Shark	*Isurus oxyrinchus*	Rainbow Smelt	*Osmerus mordax*	Garnet Lanternfish	*Stenobrachius nannochir*
Salmon Shark	*Lamna ditropis*	Capelin	*Mallotus villosus*	California Lanternfish	*Symbolophorus californiens*
Brown Cat Shark	*Apristurus brunneus*	Night Smelt	*Spirinchus starksi*	Blue Lanternfish	*Tarletonbeania crenularis*
Longnose Cat Shark	*Apristurus kampae*	Longfin Smelt	*Spirinchus thaleichthys*	Taillight Lanternfish	*Tarlentonbeania taylori*
Filetail Cat Shark	*Parmaturus xaniurus*	Eulachon	*Thaleichthys pacificus*	Anotopterus Pharaoh	*Anotopterus pharaoh*
Prickly Shark	*Echinorhinus cookei*	Arctic Smelt	*Osmerus dentex*	Northern Pacific Daggertooth	*Anotopterus nikparini*
Soupfin Shark	*Galeorhinus zyopterus*	Holtbrynia Latifrons	*Holtbrynia latifrons*	Longnose Lancetfish	*Alepisaurus ferox*
Blue Shark	*Prionace glauca*	Pitted Tubeshoulder	*Maulisia argipalla*	Slender Barracudina	*Lestidiops ringens*
Leopard Shark	*Triakis semifasciata*	Pellisolus Embranchus	*Pellisolus embranchus*	Ribbon Barracudina	*Notolepsis rissoi*
Pacific Sleeper Shark	*Somniosus pacificus*	Shining Tubeshoulder	*Sagamichthys abei*	Duckbill Barracudina	*Magnisudis atlantica*
Spiny Dogfish Shark	*Squalus acanthias*	Pacific Argentine	*Argentina sialis*	Plainfin Midshipman	*Porichthys notatus*
Pacific Angel Shark	*Squatina californica*	Bluethroat Argentine	*Nansenia candida*	Northern Clingfish	*Gobiesox maeandricus*
Brown Smoothhound	*Mustelus henlei*	Stout Argentine	*Nansenia crassa*	Kelp Clingfish	*Rimicola muscarum*
Deep Sea Skate	*Bathyraja abyssicola*	California Slickhead	*Alepocephalus tenebrosus*	Arrotail	*Melanonus zugmayeri*
Pacific Electric Ray	*Torpedo californica*	Deepsea Slickhead	*Erica salmoneum*	Hundred Fathom Mora	*Physiculus rastrellinger*
Bat Ray	*Myliobatis californica*	Threadfin Slickhead	*Talismania bifurcata*	Pacific Cod	*Gadus macrocephalus*
Big Skate	*Raja binoculata*	Benttooth Bristlemouth	*Cyclothone acclinidens*	Burbot	*Lota lota*
California Skate	*Raja inornata*	Black Bristlemouth	*Cyclothone atraria*	Pacific Whiting (Hake)	*Merluccius productus*
Sandpaper Skate	*Raja kincaidi*	Tan Bristlemouth	*Cyclothone pallidae*	Pacific Tomcod	*Mircogadus proximus*
Longnose Skate	*Raja rhina*	Slender Bristlemouth	*Cyclothane pseudopallidae*	Walleye Pollock	*Theragra chalcogramma*
Starry Skate	*Raja stellulata*	Showy Bristlelouth	*Cyclothane signata*	Pacific Flatnose	*Antimora microlepis*
Black Skate	*Bathyraja trachura*	Atlantic Fangtooth	*Gonostoma atlanticum*	Slender Codling	*Halargyreus johnsonii*
Flathead Skate	*Bathyraja rosispinis*	Slender Hatchetfish	*Argyropelecus affinus*	Pacific Grenadier	*Corphaenoides acrolepis*
White Skate	*Bathyraja spinosissima*	Longspine Hatchetfish	*Argyropelecus diaphana*	Giant Grenadier	*Albatrossia pectoralis*
Roughshoulder Skate	*Raja badia*	Spurred Hatchetfish	*Argyropelecus hemigymnus*	Abyssal Grenadier	*Coryphaenoides armatus*
Spotted Ratfish	*Hydrolagus colliei*	Tropical Hatchetfish	*Argyropelecus lynchnus*	California Grenadier	*Nezumia stelgidolepis*
Diamond Stingray	*Dasyatis dipterura*	Pacific Hatchetfish	*Argyropelecus pacificus*	Shoulderspot Grenadier	*Coelorinchus scaphopsis*
Pelagic Stingray	*Dasyatis violacea*	Lowcrest Hatchetfish	*Argyropelecus sladeni*	Popeye Grenadier	*Coryphaenoides cinereus*
White Sturgeon	*Acipenser transmontanus*	Bottlelights	*Danaphos oculatus*	Filamented Grenadier	*Coryphaenoides filfer*
Green Sturgeon	*Acipenser medirostris*	Highlight Hatchetfish	*Sternoptyx pseudobscura*	Ghostly Grenadier	*Coryphaenoides leptolepis*
Threadfin Shad	*Dorosoma petensense*	Slim Lightfish	*Ichthyococcus elongatus*	Yaquina Grenadier	*Coryphaenoides yaquinae*
American Shad	*Alosa sapidissima*	Shining Loosejaw	*Aristostomias scintillans*	Spotted Cusk-Eel	*Chilara taylori*
Pacific Herring	*Clupea harengus pallasi*	Highfin Dragonfish	*Bathophilus flemingi*	Threadfin Cusk-Eel	*Dicrolene filmentosa*
Pacific Sardine	*Sardinops sagax*	Pacific Viperfish	*Chauliiodus macouni*	Holcomycteronus profundissimus	*Holcomycteronus profundissimus*
Northern Anchovy	*Engraulis mordax*	Pacific Blackdragon	*Idiacanthus antrostomus*	Paperbone Cusk-Eel	*Lamprogrammus niger*
Pink Salmon	*Oncorhynchus gorbuscha*	Idiacanthus Fasciola	*Idiacanthus fasciola*	Giant Cusk-Eel	*Spectrunculus grandis*
Chum Salmon	*Oncorhynchus keta*	Neonesthes Sp.	*Neonesthes sp.*	Red Brotula	*Brosmophycis marginata*
Coho Salmon	*Oncorhynchus kisutch*	Opistomias Mitsuii	*Opistomias mitsuii*	Rubnose Brotula	*Cataetyx rubrirostris*
Sockeye Salmon/ Kokanee	*Oncorhynchus nerka*	Loingfin Dragonfish	*Tactostoma maropus*	Barathronus Pacifica	*Barathronus pacifica*
Chinook Salmon	*Oncorhynchus tshawytscha*	Northern Pearleye	*Benthalbella dena*	Sciadonus Pedicellaris	*Sciadonus pedicellaris*

Table A. continued

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Rounded Batfish	*Zalieutes elater*	Tube-Snout	*Aulorhynchus flavidus*	Longfin Gunnel	*Pholis clemensi*
Spikehead Dreamer	*Bertella idiomorpha*	Three-Spined Stickleback	*Gasterosteus aculeatus*	Rockweed Gunnel	*Apodichthys fucorum*
Chaenophryne Longicepes	*Chaenophryne longicepes*	Bay Pipefish	*Syngnathus leptorhynchus*	Wolf-Eel	*Anarrhichthys ocellatus*
Chaenophryne Melanorhabdus	*Chaenophryne melanorhabdus*	Striped Bass	*Morone saxatilis*	Quillfish	*Ptilichthys goodei*
Oneirodes Bulbosus	*Oneirodes bulbosus*	Kelp Bass	*Paralabrax clathratus*	Giant Wrymouth	*Delopepis gigantea*
Twopose Dreamer	*Oneirodes eschrichti*	White Sea Bass	*Atractoscion nobilis*	Dwarf Wrymouth	*Lyconectes aleutensis*
Alaska Dreamer	*Oneirodes thompsoni*	Popeye Catalufa	*Pristigenys serrula*	Graveldiver	*Scytalina cerdale*
Johnson'S Black Anglerfish	*Melanocetus johnsonii*	Ocean Whitefish	*Caulolatilus princeps*	Black Swallower	*Chiasmodon niger*
Fan Fin Anglerfish	*Caulophryne jordani*	Remora	*Remora remora*	Shortnose Swallower	*Kali indica*
Northern Giant Seadevil	*Ceratius holboelli*	Whalesucker	*Remora australis*	Needlenose Swallower	*Kali normani*
Triplewart Seadevil	*Crytopsarus couesi*	Jack Mackerel	*Trachurus symmetricus*	Prowfish	*Zaprora silenus*
Whipnose Anglerfish	*Gigantactis vanhoeffeni*	Yellowtail	*Seriola lalandi*	Pacific Sand Lance	*Ammodytes hexapterus*
Twoline Eelpout	*Bothrocara brunneum*	Dolphinfish	*Coryphaena hippurus*	Arrow Goby	*Clevelandia ios*
Soft Eelpout	*Bothrocara molle*	Pilotfish	*Naucrates ductor*	Blackeye Goby	*Coryphopterus nicholsi*
Alaska Eelpout	*Bothrocara pusillum*	Pacific Pomfret	*Brama japonica*	Bay Goby	*Lepidogobius lepidus*
Cuskpout	*Derepodichthys alepidotus*	Rough Pomfret	*Taractes asper*	Skipjack Tuna	*Euthynnus pelamis*
Lycenchelys Callista	*Lycenchelys callista*	Veilfin	*Caristius macropus*	Pacific Bonita	*Sarda chiliensis*
Kamchatka Eelpout	*Lycenchelys camchatica*	White Croaker	*Genyonemus lineatus*	Chub Mackerel	*Scomber japonicus*
Snakehead Eelpout	*Embryx crotalinus*	Queenfish	*Seriphus politus*	Albacore	*Thunnus alalunga*
Shortjaw Eelpout	*Lycenchelys jordani*	North Pacific Armorhead	*Pseudopentaceros wheeleri*	Yellowfin Tuna	*Thunnus albacares*
Lycenchelys Micropora	*Lycenchelys micropora*	Pelagic Armorhead	*Pentaceros richardsoni*	Bigeye Tuna	*Thunnus obesus*
Lycenchelys Pearcyi	*Lycenchelys pearcyi*	Opaleye	*Girella nigricans*	Bluefin Tuna	*Thunnus thynnus*
Looseskin Eelpout	*Lycodapus dermatinus*	Halfmoon	*Medialuna californiensis*	Escolar	*Lepidocybium flavobrunneum*
Deepwater Eelpout	*Lycodapus endemoscotus*	Northern Ronquil	*Ronquilus jordani*	Louvar	*Luvarus imperialis*
Midwater Eelpout	*Melanostigma pammelas*	Stripedfin Ronquil	*Rathbunella hypoplecta*	Black Scabbardfish	*Aphanopus carbo*
Bigfin Eelpout	*Aprondon cortezianus*	Barred Surfperch	*Amphistichus argenteus*	Frostfish	*Benthodesmus elongatus*
Blackmouth Eelpout	*Lycodapus fierasfer*	Calico Surfperch	*Amphistichus koelzi*	Pacific Scabbardfish	*Lepidopus fitchi*
Pallid Eelpout	*Lycodapus mandibularis*	Redtail Surfperch	*Amphistichus rhodoterus*	Swordfish	*Xiphias gladius*
Shortfin Eelpout	*Lycodes brevipes*	Kelp Perch	*Brachyistius frenatus*	Striped Marlin	*Tetrapturus audax*
Black Eelpout	*Lycodes diapterus*	Shiner Perch	*Cymatogaster aggregata*	Shortbill Spearfish	*Tetrapturus angustirostris*
Wattled Eelpout	*Lycodes palearis*	Striped Seaperch	*Embiotoca lateralis*	Medusafish	*Icichthys lockingtoni*
Blackbelly Eelpout	*Lycodopsis pacifica*	Spotfin Surfperch	*Hyperprosopon anale*	Smalleye Squaretail	*Tetragonurus cuvieri*
Bearded Eelpout	*Lyconema barbatum*	Walleye Surfperch	*Hyperprosopon argenteum*	Pacific Pompano	*Peprilus simillimus*
Pacycara Bulbiceps	*Pacycara bulbiceps*	Silver Surfperch	*Hyperprosopon ellipticum*	Ragfish	*Icosteus aenigmaticus*
Pachycara Gymnimium	*Pachycara gymnimium*	White Seaperch	*Phanerodon furcatus*	Blackspotted Rockfish	*Sebastes melanostictus*
Pachycara Lepinium	*Pachycara lepinium*	Pile Perch	*Rhacophilus vacca*	Rougheye Rockfish	*Sebastes aleutianus*
Taranetzella Lyoderma	*Taranetzella lyoderma*	Sharpnose Seaperch	*Phanerodon atripes*	Pacific Ocean Perch	*Sebastes alutus*
California Flying Fish	*Cypselurus californicus*	Pacific Barracuda	*Sphyraena argentea*	Brown Rockfish	*Sebastes auriculatus*
Smallhead Flying Fish	*Cheilopogon pinnatibarbatus*	Pacific Sandfish	*Trichodon trichodon*	Aurora Rockfish	*Sebastes aurora*
Pacific Saury	*Cololabis saira*	Crevice Kelpfish	*Gibbonsia montereyensis*	Redbanded Rockfish	*Sebastes babcocki*
Rainwater Kilifish	*Lucania parva*	Striped Kelpfish	*Gibbonsia metzi*	Silvergray Rockfish	*Sebastes brevispinis*
Topsmelt	*Atherinops affinis*	Giant Kelpfish	*Heterostichus rostratus*	Shortraker Rockfish	*Sebastes borealis*
Jacksmelt	*Atherinopsis californiensis*	High Cockscomb	*Anoplarchus purpurescens*	Copper Rockfish	*Sebastes caurinus*
Opah	*Lampris guttatus*	Slender Cockscomb	*Anoplarchus purpescens*	Greenspotted Rockfish	*Sebastes chlorostictus*
King-Of-The-Salmon	*Trachipterus altivelis*	Y-Prickleback	*Allolumpenus hypochromus*	Gopher Rockfish	*Sebastes carnatus*
Tapertail Ribbonfish	*Trachipterus fukuzakii*	Monkeyface Prickleback	*Cebidichthys violaceus*	Black-And-Yellow Rockfish	*Sebastes chrysomelas*
Whiptail Ribbonfish	*Desmodema lorum*	Decorated Warbonnet	*Chirolophis decoratus*	Darkblotched Rockfish	*Sebastes crameri*
Tube-Eye	*Stylephorous chordatus*	Mosshead Warbonnet	*Chirolophis nugator*	Splitnose Rockfish	*Sebastes diploproa*
Highsnout Bigscale	*Melamphaes lugubris*	Snake Prickleback	*Lumpenus sagitta*	Greenstriped Rockfish	*Sebastes elongatus*
Little Bigscale	*Melamphaes parvus*	Ribbon Prickleback	*Phyichthys chirus*	Puget Sound Rockfish	*Sebastes emphaeus*
Crested Bigscale	*Poromitra crassiceps*	Bluebarred Prickleback	*Plechtobranchus evides*	Widow Rockfish	*Sebastes entomelas*
Longjaw Bigscale	*Scopeloberynx robustus*	Whitebarred Prickleback	*Poroclinus rothrocki*	Pink Rockfish	*Sebastes eos*
Twospine Bigscale	*Scopelogadus mizolepis bispinosus*	Black Prickleback	*Xiphister atropurpureus*	Yellowtail Rockfish	*Sebastes flavidus*
Armored Redmouth Whalefish	*Rondeletia loricata*	Rock Prickleback	*Xiphister mucosus*	Chilipepper	*Sebastes goodei*
Velvet Whalefish	*Barbourisia rufa*	Penpoint Gunnel	*Apodichthys flavidus*	Rosethorn Rockfish	*Sebastes helvomaculatus*
Pink Flabby Whalefish	*Cetostoma regani*	Crescent Gunnel	*Pholis laela*	Squarespot Rockfish	*Sebastes hobkinsi*
Gyrinomimus Sp.	*Gyrinomimus sp.*	Saddleback Gunnel	*Pholis ornata*	Shortbelly Rockfish	*Sebastes jordani*
Oxeye Oreo	*Allocyttus folletti*	Red Gunnel	*Pholis schultzi*	Cowcod	*Sebastes levis*
Longhorn Fangtooth	*Anoplogaster cornuta*	Rock Gunnel	*Xererpes fucorum*	Quillback Rockfish	*Sebastes maliger*

Table A. continued

Common Name	Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name
Black Rockfish	*Sebastes melanops*	Thorny Sculpin	*Icelus spiniger*	Bigpored Sailfish	*Paraliparis latifrons*
Blackgill Rockfish	*Sebastes melanostomus*	Spotfin Sculpin	*Icelinus tenuis*	Paraliparis Megalopus	*Paraliparis megalopus*
Vermilion Rockfish	*Sebastes miniatus*	Longfin Sculpin	*Jordania zonope*	Paraliparis Melanobranchus	*Paraliparis melanobranchus*
Blotched Blue Rockfish	*Sebastes cf. mystinus*	Pacifc Staghorn Sculpin	*Leptocottus armatus*	Bulldog Snailfish	*Paraliparis mento*
Blue Rockfish (Solid)	*Sebastes cf. mystinus*	Darkfin Sculpin	*Malacocottus zonurus*	Paraliparis Paucidens	*Paraliparis paucidens*
China Rockfish	*Sebastes nebulosus*	Blackfin Sculpin	*Malococottus kincaidi*	Paraliparis Pectoralis	*Paraliparis pectoralis*
Tiger Rockfish	*Sebastes nigrocinctus*	Sailfin Sculpin	*Nautichthys oculofasciatus*	Rosy Snailfish	*Paraliparis rosaceus*
Speckled Rockfish	*Sebastes ovalis*	Tidepool Sculpin	*Oligocottus maculosus*	Broadfin Snailfish	*Paraliparis ulochir*
Bocaccio	*Sebastes paucispinis*	Saddleback Sculpin	*Oligocottus rimensis*	Slim Snailfish	*Rhinoliparis attenuatus*
Canary Rockfish	*Sebastes pinniger*	Fluffy Sculpin	*Oligocottus snyderi*	Longnose Snailfish	*Rhinoliparis barbulifer*
Redstripe Rockfish	*Sebastes proriger*	Snubnose Sculpin	*Orthonopias triacis*	Blacktail Snailfish	*Careproctus melanurus*
Grass Rockfish	*Sebastes rastrelliger*	Thornback Sculpin	*Paricelinus hopiticus*	Tidepool Snailfish	*Liparis florae*
Yellowmouth Rockfish	*Sebastes reedi*	Slim Sculpin	*Radulinus asprellus*	Slipskin Snailfish	*Liparis fucensis*
Rosy Rockfish	*Sebastes rosaceus*	Darter Sculpin	*Radulinus boleoides*	Slimy Snailfish	*Liparis mucosus*
Yelloweye Rockfish	*Sebastes ruberrimus*	Grunt Sculpin	*Rhamphocottus richardsoni*	Showy Snailfish	*Liparis pulchellus*
Flag Rockfish	*Sebastes rubrivinctus*	Puget Sound Sculpin	*Ruscarius meanyi*	Ringtail Snailfish	*Liparis rutteri*
Bank Rockfish	*Sebastes rufus*	Cabezon	*Scorpaenichthys marmoratus*	Prickly Snailfish	*Paraliiparis deani*
Stripetail Rockfish	*Sebastes saxicola*	Manacled Sculpin	*Synchirus gilli*	Speckled Sanddab	*Citharichthys stigmaeus*
Halfbanded Rockfish	*Sebastes semicinctus*	Flabby Sculpin	*Zesticelus profundorum*	Pacific Sanddab	*Citharichthys sordidus*
Olive Rockfish	*Sebastes serranoides*	Blob Sculpin	*Psychrolutes phrictus*	Roughscale Sole	*Clidoderma asperrimum*
Semaphore Rockfish	*Sebastes melanosema*	Pacific Spiny Lumpsucker	*Eumicrotremus orbis*	Southern Rock Sole	*Pleuronectes bilineatus*
Harlequin Rockfish	*Sebastes variegatus*	Smooth Alligatorfish	*Anoplagonus inermis*	California Halibut	*Paralichthys californicus*
Pygmy Rockfish	*Sebastes wilsoni*	Kelp Poacher	*Agonomalus mozinoi*	Arrowtooth Flounder	*Atheresthes stomias*
Sharpchin Rockfish	*Sebastes zacentrus*	Northern Spearnose Poacher	*Agonopsis vulsa*	Deepsea Sole	*Embassichthys bathybius*
Shortspine Thornyhead	*Sebastolobus alascanu*	Sturgeon Poacher	*Agonus acipenserinus*	Petrale Sole	*Eopsetta jordani*
Longspine Thornyhead	*Sebastolobus altivelis*	Gray Starsnout	*Bathyagonu alascanuss*	Rex Sole	*Glyptocephalus zachirus*
Lumptail Searobin	*Prionotus stephanophrys*	Spinycheek Starsnout	*Bathyagonus infraspinatus*	Flathead Sole	*Hippoglossoides elassodon*
Sablefish	*Anoplopoma firmbria*	Blackfin Poacher	*Bathyagonus nigripinnis*	Pacific Halibut	*Hippoglossus stenolepis*
Skilfish	*Erilepis zonifer*	Bigeye Poacher	*Bathyagonus pentacanthus*	Hybrid Sole (=Forkline Sole)	*Inopsetta ischyra*
Kelp Greenling	*Hexagrammos decagrammus*	Rockhead	*Bothragonus swani*	Butter Sole	*Isopsetta isolepis*
Rock Greenling	*Hexagrammos lagocephalus*	Warty Poacher	*Occella verrucosa*	Rock Sole	*Lepidopsetta bilineata*
Whitespotted Greenling	*Hexagrammos stelleri*	Pygmy Poacher	*Odontopyxis trispinosa*	Slender Sole	*Lyopsetta exilis*
Lingcod	*Ophidon elongatus*	Tubenose Poacher	*Pallasina barbata*	Dover Sole	*Microstomus pacificus*
Painted Greenling	*Oxylebius pictus*	Pricklebreast Poacher	*Stellerina xyosterna*	English Sole	*Parophrys vetulus*
Atka Mackerel	*Pleurogrammus monopterygius*	Blacktip Poacher	*Xeneretmus latifrons*	Starry Flounder	*Platichthys stellatus*
Shortspine Combfish	*Zaniolepis frenata*	Smootheye Poacher	*Xeneretmus leiops*	C-O Sole	*Pleuronichthys coenosus*
Longspine Combfish	*Zaniolepis latipinnis*	Stripefin Poacher	*Xeneretmus ritteri*	Curlfin Sole	*Pleuronichthys decurrens*
Coralline Sculpin	*Artedins corallinus*	Bluespotted Poacher	*Xeneretmus triacanthus*	Sand Sole	*Psettichthys melanostictus*
Padded Sculpin	*Artedins fenestralis*	Acantholiparis Caecus	*Acantholiparis caecus*	Greenland Turbot	*Reinhardtius hippoglossoides*
Scalyhead Sculpin	*Artedins harringtoni*	Spiny Snailfish	*Acantholiparis opercularis*	Horneyhead Turbot	*Pleuronichthys verticalis*
Smoothhead Sculpin	*Artedins lateralis*	Blackfinned Snailfish	*Careproctus cypselurus*	California Tonguefish	*Symphurus atricauda*
Bonehead Sculpin	*Artedins notospilotus*	Careproctus Filimentosus	*Careproctus filimentosus*	Finescale Triggerfish	*Balistes polylepis*
Rosylip Sculpin	*Ascelichthys rhodorus*	Smalldisk Snailfish	*Careproctus gilberti*	Black Durgon	*Melichthys niger*
Silverspotted Sculpin	*Blepsias cirrhosus*	Threadfin Snailfish	*Careproctus longifilis*	Ocean Sunfish	*Mola mola*
Roughback Sculpin	*Chitonotus pugetensis*	Blacktail Snailfish	*Careproctus melanurus*		
Sharpnose Sculpin	*Clinocottus acuticeps*	Careproctus Microstomus	*Careproctus microstomus*	**Selected Invertebrates**	
Calico Sculpin	*Clinocottus embryum*	Oregon Snailfish	*Careproctus oregonensis*	Dungeness Crab	*Cancer magister*
Mosshead Sculpin	*Clinocottus globiceps*	Abyssal Snailfish	*Careproctus ovigerum*	Red Urchin	*Strongylocentrotus franciscanus*
Bald Sculpin	*Clinocottus recalvus*	Salmon Snailfish	*Caroproctus rastrinus*	Pink Shrimp	*Pandalus jordani*
Coastrange Sculpin	*Cottus aleuticus*	Humpback Snailfish	*Elassodiscus caudatus*	Spot Shrimp	*Pandalus platyceros*
Prickly Sculpin	*Cottus asper*	Ribbon Snailfish	*Liparis cyclops*	Squid Spp	
Buffalo Sculpin	*Enophrys bison*	Pygmy Snailfish	*Liparis nanus*	Tanner Crab	*Chinonocetes bairdi*
Red Irish Lord	*Hemilepidotus hemilepidotus*	Kelp Snailfish	*Liparis tunicatus*	Box Crab	*Lopholothodes forminatus*
Brown Irish Lord	*Hemilepidotus spinosus*	Tadpole Snailfish	*Nectoliparis pelagicus*		
Bigmouth Sculpin	*Hemitripterus bolini*	Genilolipars Ferox	*Geniloliparis ferox*		
Dusky Sculpin	*Icelinus burchami*	Bigtail Snailfish	*Osteodiscus cascadiae*		
Threadfin Sculpin	*Icelinus filamentosus*	Swellhead Snailfish	*Paraliparis cephalus*		
Fringed Sculpin	*Icelinus fimbriatus*	Red Snailfish	*Paraliparis dactylosus*		
Frogmouth Sculpin	*Icelinus oculatus*	Prickly Snailfish	*Paraliparis deani*		

Table B. Fish and selected invertebrate species occurring within the GLD. *Commercial fishery column lists the annual average (date – date) ex-vessel value for species averaging over $10,000 per year.

		Ecological Connection						Fishery Connection		Conservation Connection		
Common Name	Scientific Name	Depth range in State and Fed. Waters	Depth range in State Waterw	Depth range in Federal Waters	Seasonal Adult Movement	Ontogenic shift	Forage Fish	Commercial Value*	Top 20 Recreational Species	ESA	Overfished Species	Fishery Limiting Species
Pacific Hagfish	Eptatretus stouti	x						987,197				
Leaflike Eel	Thalassenchelys coheni	x										
Pacific Lamprey	Lampetra tridentata	x										
Sixgill Shark	Hexanchus griseus	x										
Sevengill Shark	Notorynchus maculatus	x										
Thresher Shark	Alopias vulpinus	x										
White Shark	Carcharodon carcharias	x										
Basking Shark	Cetorhinus maximus	x										
Shortfin Mako Shark	Isurus oxyrinchus	x										
Salmon Shark	Lamna ditropis	x										
Brown Cat Shark	Apristurus brunneus	x										
Soupfin Shark	Galeorhinus zyopterus	x										
Blue Shark	Prionace glauca	x										
Leopard Shark	Triakis semifasciata	x										
Pacific Sleeper Shark	Somniosus pacificus	x										
Spiny Dogfish Shark	Squalus acanthias	x			x	x		33,769				x
Pacific Angel Shark	Squatina californica	x										
Brown Smoothhound	Mustelus henlei	x										
Deep Sea Skate	Bathyraja abyssicola	x										
Pacific Electric Ray	Torpedo californica	x										
Big Skate	Raja binoculata	x										
California Skate	Raja inornata	x										
Sandpaper Skate	Raja kincaidi	x										
Longnose Skate	Raja rhina	x						411,014				
Starry Skate	Raja stellulata	x										
Spotted Ratfish	Hydrolagus colliei	x			x							
White Sturgeon	Acipenser transmontanus	x						288,351				
Green Sturgeon	Acipenser medirostris	x								x		
American Shad	Alosa sapidissima	x										
Pacific Herring	Clupea harengus pallasi	x					x		x			
Pacific Sardine	Sardinops sagax	x					x	5,666,104				
Northern Anchovy	Engraulis mordax	x					x	25,195				
Pink Salmon	Oncorhynchus gorbuscha	x										
Chum Salmon	Oncorhynchus keta	x								x		
Coho Salmon	Oncorhynchus kisutch	x						759,528	x	x		
Sockeye Salmon/ Kokanee	Oncorhynchus nerka	x								x		
Chinook Salmon	Oncorhynchus tshawytscha	x						5,035,019	x	x		
Coastal Cutthroat	Oncorhynchus clarki	x										
Dolly Varden	Salvelinus malma	x										
Rainbow Trout/Steelhead	Oncorhynchus mykiss		x					18,911		x		
California Smoothtongue	Leuroglossus stilbius	x										
Whitebait Smelt	Allosmerus elongatus	x					x					
Capelin	Mallotus villosus	x					x					
Night Smelt	Spirinchus starksi	x					x					
Longfin Smelt	Spirinchus thaleichthys	x					x					
Eulachon	Thaleichthys pacificus	x					x	17,043		x		
Arctic Smelt	Osmerus dentex	x					x					
Pacific Argentine	Argentina sialis	x					x					
California Slickhead	Alepocephalus tenebrosus	x										

Table B. continued

		Ecological Connection						Fishery Connection		Conservation Connection		
Common Name	Scientific Name	Depth range in State and Fed. Waters	Depth range in State Waterw	Depth range in Federal Waters	Seasonal Adult Movement	Ontogenic shift	Forage Fish	Commercial Value*	Top 20 Recreational Species	ESA	Overfished Species	Fishery Limiting Species
Benttooth Bristlemouth	Cyclothone acclinidens	x										
California Lizardfish	Synodus lucioceps	x										
Anotopterus Pharaoh	Anotopterus pharaoh	x										
Plainfin Midshipman	Porichthys notatus	x										
Northern Clingfish	Gobiesox maeandricus	x										
Pacific Cod	Gadus macrocephalus	x			x			188,610				
Burbot	Lota lota	x										
Pacific Whiting (Hake)	Merluccius productus	x						9,372,454				
Pacific Tomcod	Mircogadus proximus	x					x					
Walleye Pollock	Theragra chalcogramma	x										
Spotted Cusk-Eel	Chilara taylori	x										
Red Brotula	Brosmophycis marginata	x										
Blackmouth Eelpout	Lycodapus fierasfer	x										
Shortfin Eelpout	Lycodes brevipes	x										
Black Eelpout	Lycodes diapterus	x										
Wattled Eelpout	Lycodes palearis	x										
Blackbelly Eelpout	Lycodopsis pacifica	x										
Pacific Saury	Cololabis saira	x					x					
Opah	Lampris guttatus	x										
White Sea Bass	Atractoscion nobilis	x										
Popeye Catalufa	Pristigenys serrula	x										
Ocean Whitefish	Caulolatilus princeps	x										
Remora	Remora remora	x										
Whalesucker	Remora australis	x										
Jack Mackerel	Trachurus symmetricus	x					x					
Yellowtail	Seriola lalandi	x										
Pilotfish	Naucrates ductor	x										
Pacific Pomfret	Brama japonica	x										
White Croaker	Genyonemus lineatus	x										
Queenfish	Seriphus politus	x										
North Pacific Armorhead	Pseudopentaceros wheeleri	x										
Pelagic Armorhead	Pentaceros richardsoni	x										
Northern Ronquil	Ronquilus jordani	x										
Kelp Perch	Brachyistius frenatus	x										
Shiner Perch	Cymatogaster aggregata	x										
Striped Seaperch	Embiotoca lateralis	x							x			
Spotfin Surfperch	Hyperprosopon anale	x										
Walleye Surfperch	Hyperprosopon argenteum	x										
Silver Surfperch	Hyperprosopon ellipticum	x										
White Seaperch	Phanerodon furcatus	x										
Sharpnose Seaperch	Phanerodon atripes	x										
Pacific Sandfish	Trichodon trichodon	x										
Monkeyface Prickleback	Cebidichthys violaceus	x										
Decorated Warbonnet	Chirolophis decoratus	x										
Mosshead Warbonnet	Chirolophis nugator	x										
Snake Prickleback	Lumpenus sagitta	x										
Ribbon Prickleback	Phyichthys chirus	x										
Whitebarred Prickleback	Poroclinus rothrocki	x										
Crescent Gunnel	Pholis laela	x										

Table B. continued

		Ecological Connection						Fishery Connection		Conservation Connection		
Common Name	Scientific Name	Depth range in State and Fed. Waters	Depth range in State Waterw	Depth range in Federal Waters	Seasonal Adult Movement	Ontogenic shift	Forage Fish	Commercial Value*	Top 20 Recreational Species	ESA	Overfished Species	Fishery Limiting Species
Longfin Gunnel	Pholis clemensi	x										
Wolf-Eel	Anarrhichthys ocellatus	x										
Quillfish	Ptilichthys goodei	x										
Giant Wrymouth	Delopepis gigantea	x										
Dwarf Wrymouth	Lyconectes aleutensis	x										
Prowfish	Zaprora silenus	x										
Pacific Sand Lance	Ammodytes hexapterus	x					x					
Blackeye Goby	Coryphopterus nicholsi	x										
Bay Goby	Lepidogobius lepidus	x										
Skipjack Tuna	Euthynnus pelamis	x										
Pacific Bonita	Sarda chiliensis	x										
Chub Mackerel	Scomber japonicus	x					x	37,473				
Albacore	Thunnus alalunga	x						13,467,143	x			
Yellowfin Tuna	Thunnus albacares	x										
Bluefin Tuna	Thunnus thynnus	x										
Pacific Pompano	Peprilus simillimus	x										
Ragfish	Icosteus aenigmaticus	x										
Rougheye Rockfish	Sebastes aleutianus	x										x
Pacific Ocean Perch	Sebastes alutus	x						51,944			x	
Brown Rockfish	Sebastes auriculatus	x				x						
Redbanded Rockfish	Sebastes babcocki	x										
Silvergray Rockfish	Sebastes brevispinis	x										
Shortraker Rockfish	Sebastes borealis	x										x
Copper Rockfish	Sebastes caurinus	x				x			x			
Greenspotted Rockfish	Sebastes chlorostictus			x		x						
Gopher Rockfish	Sebastes carnatus	x										
Darkblotched Rockfish	Sebastes crameri	x				x		105,903			x	
Splitnose Rockfish	Sebastes diploproa			x		x						
Greenstriped Rockfish	Sebastes elongatus	x				x						
Puget Sound Rockfish	Sebastes emphaeus	x										
Widow Rockfish	Sebastes entomelas	x				x		62,538	x			
Pink Rockfish	Sebastes eos	x										
Yellowtail Rockfish	Sebastes flavidus	x				x		301,261	x			
Chilipepper	Sebastes goodei	x										
Rosethorn Rockfish	Sebastes helvomaculatus	x										
Squarespot Rockfish	Sebastes hobkinsi	x				x						
Shortbelly Rockfish	Sebastes jordani	x				x						
Cowcod	Sebastes levis	x									x	
Quillback Rockfish	Sebastes maliger	x				x		12,863	x			
Black Rockfish	Sebastes melanops	x				x		457,893	x			
Vermilion Rockfish	Sebastes miniatus	x				x			x			
Blotched Blue Rockfish	Sebastes cf. mystinus	x										
Blue Rockfish (Solid)	Sebastes cf. mystinus	x				x		11,017	x			
China Rockfish	Sebastes nebulosus	x						96,364	x			x
Tiger Rockfish	Sebastes nigrocinctus	x				x			x			
Speckled Rockfish	Sebastes ovalis	x				x						
Bocaccio	Sebastes paucispinis	x									x	
Canary Rockfish	Sebastes pinniger	x				x					x	
Redstripe Rockfish	Sebastes proriger	x				x						

Table B. continued

		Ecological Connection						Fishery Connection		Conservation Connection		
Common Name	Scientific Name	Depth range in State and Fed. Waters	Depth range in State Waterw	Depth range in Federal Waters	Seasonal Adult Movement	Ontogenic shift	Forage Fish	Commercial Value*	Top 20 Recreational Species	ESA	Overfished Species	Fishery Limiting Species
Rosy Rockfish	Sebastes rosaceus	x				x						
Yelloweye Rockfish	Sebastes ruberrimus	x				x					x	
Flag Rockfish	Sebastes rubrivinctus	x										
Bank Rockfish	Sebastes rufus	x										
Stripetail Rockfish	Sebastes saxicola	x				x						
Halfbanded Rockfish	Sebastes semicinctus	x										
Olive Rockfish	Sebastes serranoides	x										
Harlequin Rockfish	Sebastes variegatus	x										
Pygmy Rockfish	Sebastes wilsoni	x										
Sharpchin Rockfish	Sebastes zacentrus	x										
Shortspine Thornyhead	Sebastolobus alascanu	x						866,337				
Longspine Thornyhead	Sebastolobus altivelis			x				391,912				
Lumptail Searobin	Prionotus stephanophrys	x										
Sablefish	Anoplopoma firmbria	x						14,721,238	x			x
Kelp Greenling	Hexagrammos decagrammus		x					202,953	x			
Rock Greenling	Hexagrammos lagocephalus	x										
Whitespotted Greenling	Hexagrammos stelleri	x										
Lingcod	Ophidon elongatus	x			x	x		384,961	x			
Painted Greenling	Oxylebius pictus	x										
Atka Mackerel	Pleurogrammus monopterygius	x										
Shortspine Combfish	Zaniolepis frenata	x										
Longspine Combfish	Zaniolepis latipinnis	x										
Coralline Sculpin	Artedins corallinus	x										
Smoothhead Sculpin	Artedins lateralis	x										
Silverspotted Sculpin	Blepsias cirrhosus	x										
Roughback Sculpin	Chitonotus pugetensis	x										
Buffalo Sculpin	Enophrys bison	x										
Red Irish Lord	Hemilepidotus hemilepidotus	x										
Brown Irish Lord	Hemilepidotus spinosus	x										
Bigmouth Sculpin	Hemitripterus bolini	x										
Threadfin Sculpin	Icelinus filamentosus	x										
Fringed Sculpin	Icelinus fimbriatus	x										
Frogmouth Sculpin	Icelinus oculatus	x										
Spotfin Sculpin	Icelinus tenuis	x										
Longfin Sculpin	Jordania zonope	x										
Pacifc Staghorn Sculpin	Leptocottus armatus	x										
Darkfin Sculpin	Malacocottus zonurus	x										
Sailfin Sculpin	Nautichthys oculofasciatus	x										
Thornback Sculpin	Paricelinus hopiticus	x										
Slim Sculpin	Radulinus asprellus	x										
Darter Sculpin	Radulinus boleoides	x										
Grunt Sculpin	Rhamphocottus richardsoni	x										
Puget Sound Sculpin	Ruscarius meanyi	x										
Cabezon	Scorpaenichthys marmoratus	x						209,425	x			
Smooth Alligatorfish	Anoplagonus inermis	x										
Northern Spearnose Poacher	Agonopsis vulsa	x										
Sturgeon Poacher	Agonus acipenserinus	x										
Gray Starsnout	Bathyagonu alascanuss	x										
Spinycheek Starsnout	Bathyagonus infraspinatus	x										

Table B. continued

		Ecological Connection						Fishery Connection		Conservation Connection		
Common Name	Scientific Name	Depth range in State and Fed. Waters	Depth range in State Waterw	Depth range in Federal Waters	Seasonal Adult Movement	Ontogenic shift	Forage Fish	Commercial Value*	Top 20 Recreational Species	ESA	Overfished Species	Fishery Limiting Species
Blackfin Poacher	Bathyagonus nigripinnis	x										
Warty Poacher	Occella verrucosa	x										
Pygmy Poacher	Odontopyxis trispinosa	x										
Tubenose Poacher	Pallasina barbata	x										
Pricklebreast Poacher	Stellerina xyosterna	x										
Blacktip Poacher	Xeneretmus latifrons	x										
Smootheye Poacher	Xeneretmus leiops	x										
Bluespotted Poacher	Xeneretmus triacanthus	x										
Slipskin Snailfish	Liparis fucensis	x										
Showy Snailfish	Liparis pulchellus	x										
Ringtail Snailfish	Liparis rutteri	x										
Speckled Sanddab	Citharichthys stigmaeus	x										
Pacific Sanddab	Citharichthys sordidus	x			x	x		101,181	x			
California Halibut	Paralichthys californicus	x										
Arrowtooth Flounder	Atheresthes stomias	x			x			463,855				
Petrale Sole	Eopsetta jordani	x			x	x		1,892,840			x	
Rex Sole	Glyptocephalus zachirus	x			x			236,019				
Flathead Sole	Hippoglossoides elassodon	x			x	x						
Pacific Halibut	Hippoglossus stenolepis	x						884,262	x			
Butter Sole	Isopsetta isolepis	x			x							
Rock Sole	Lepidopsetta bilineata	x			x	x						
Slender Sole	Lyopsetta exilis	x										
Dover Sole	Microstomus pacificus			x	x	x		4,835,710				
English Sole	Parophrys vetulus	x				x		82,181				
Starry Flounder	Platichthys stellatus	x			x	x						
C-O Sole	Pleuronichthys coenosus	x										
Curlfin Sole	Pleuronichthys decurrens	x										
Sand Sole	Psettichthys melanostictus	x			x	x		97,608	x			
Greenland Turbot	Reinhardtius hippoglossoides	x										
Horneyhead Turbot	Pleuronichthys verticalis	x										
Selected Invertebrates												
Dungeness Crab	Cancer magister	x						35,539,225	x			
Red Urchin	Strongylocentrotus franciscanus		x					268,251				
Pink Shrimp	Pandalus jordani	x						16,210,797				
Spot Shrimp	Pandalus platyceros	x						101,368				

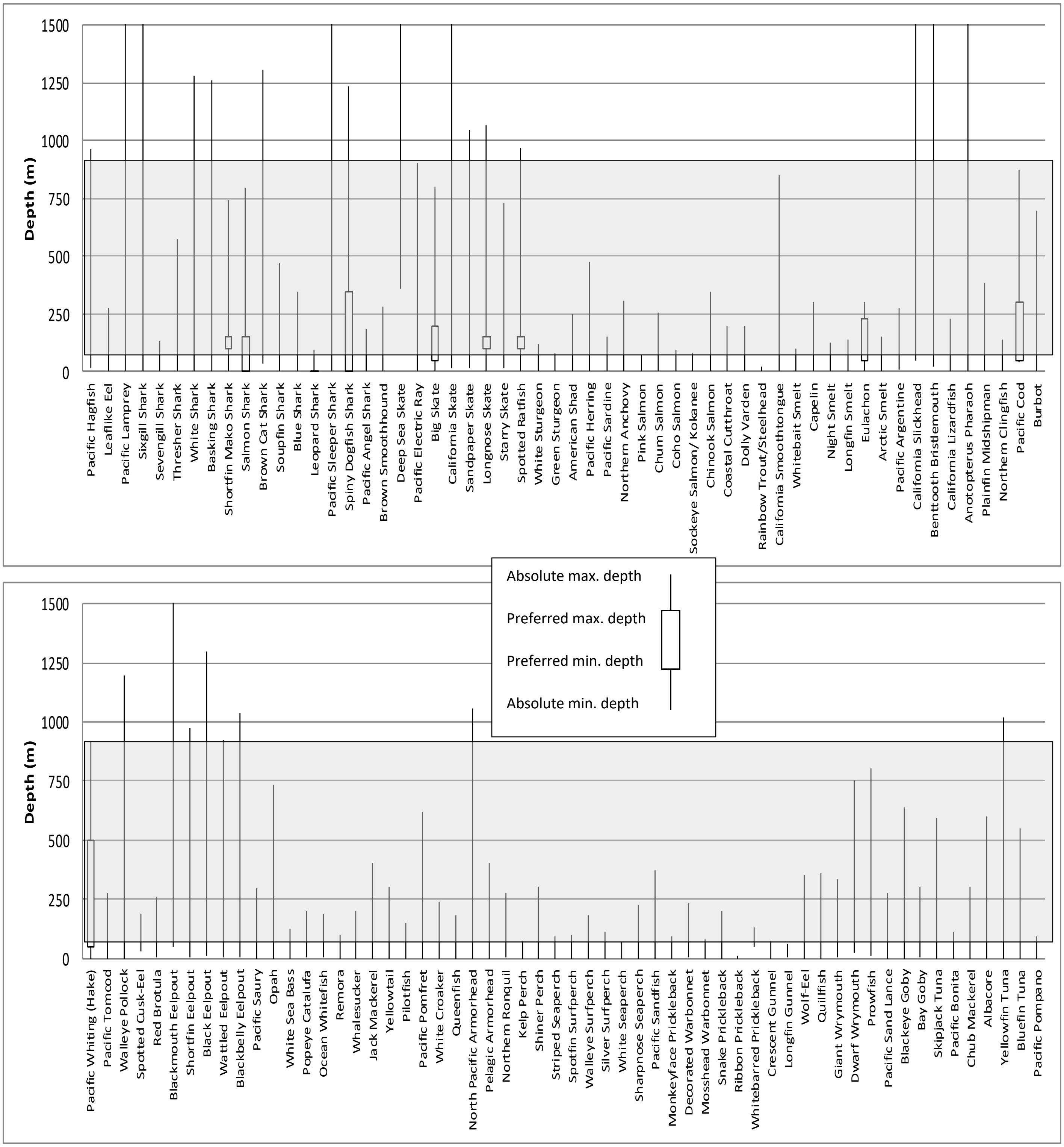


Table C. Depth distribution of fish species that occur off of Oregon. Gray box encompasses the depth range of the GLD from the Territory Sea Line (average depth 65 m) to 500 fm (914 m).

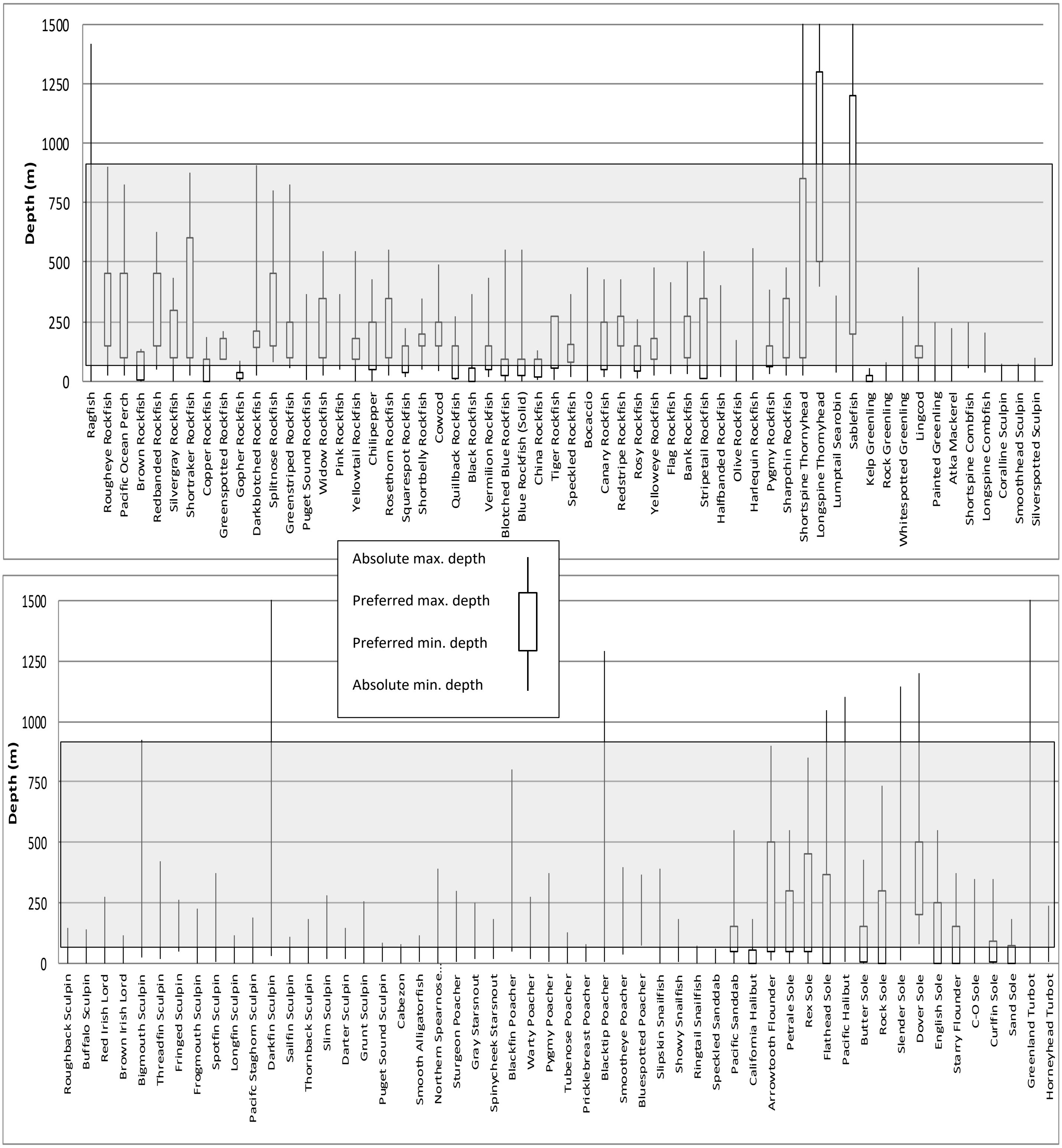


Table C. Depth distribution of fish species that occur off of Oregon (continued). Gray box encompasses the depth range of the GLD from the Territory Sea Line (average depth 65 m) to 500 fm (914 m).

Table D. Page 1 of 3. Birds species that occur off Oregon from shore to the outer boundary of the proposed GLD, including birds that occur in the waters and shorelines of estuaries.

Common Name	**Latin Name**	**Common Name**	**Latin Name**
Greater White-fronted Goose	*Anser albifrons*	Hawaiian Petrel	*Pterodroma sandwichensis*
Emperor Goose	*Chen canagica*	Cook's Petrel	*Pterodroma cookii*
Snow Goose	*Chen caerulescens*	Streaked Shearwater	*Calonectris leucomelas*
Ross's Goose	*Chen rossii*	Pink-footed Shearwater	*Puffinus creatopus*
Black Brant	*Branta bernicla*	Flesh-footed Shearwater	*Puffinus carneipes*
Cackling Goose	*Branta hutchinsii*	Great Shearwater	*Puffinus gravis*
Canada Goose	*Branta canadensis*	Wedge-tailed Shearwater	*Puffinus pacificus*
Trumpeter Swan	*Cygnus buccinator*	Buller's Shearwater	*Puffinus bulleri*
Northern Pintail	*Anas acuta*	Sooty Shearwater	*Puffinus griseus*
Green-winged Teal	*Anas crecca*	Short-tailed Shearwater	*Puffinus tenuirostris*
Greater Scaup	*Aythya marila*	Manx Shearwater	*Puffinus puffinus*
Lesser Scaup	*Aythya affinis*	Black-vented Shearwater	*Puffinus opisthomelas*
Steller's Eider	*Polysticta stelleri*	Wilson's Storm-Petrel	*Oceanites oceanicus*
King Eider	*Somateria spectabilis*	Fork-tailed Storm-Petrel	*Oceanodroma furcata*
Common Eider	*Somateria mollissima*	Ringed Storm-Petrel	*Oceanodroma hornbyi*
Harlequin Duck	*Histrionicus histrionicus*	Leach's Storm-Petrel	*Oceanodroma leucorhoa*
Surf Scoter	*Melanitta perspicillata*	Ashy Storm-Petrel	*Oceanodroma homochroa*
White-winged scoter	*Melanitta fusca*	Black Storm-Petrel	*Oceanodroma melania*
Black Scoter	*Melanitta americana*	Red-billed Tropicbird	*Phaethon aethereus*
Long-tailed Duck	*Clangula hyemalis*	Magnificent Frigatebird	*Fregata magnificens*
Bufflehead	*Bucephala albeola*	Masked Booby	*Sula dactylatra*
Common Merganser	*Mergus merganser*	Blue-footed Booby	*Sula nebouxii*
Red-breasted Merganser	*Mergus serrator*	Brown Booby	*Sula leucogaster*
Red-throated Loon	*Gavia stellata*	Brant's Cormorant	*Phalacrocorax penicillatus*
Artic Loon	*Gavia arctica*	Double-crested Cormorant	*Phalacrocorax auritus*
Pacific Loon	*Gavia pacifica*	Pelagic Cormorant	*Phalacrocorax pelagicus*
Common Loon	*Gavia immer*	American White Pelican	*Pelecanus erythrorhynchos*
Yellow-billed Loon	*Gavia adamsii*	Brown Pelican	*Pelecanus occidentalis*
Horned Grebe	*Podiceps auritus*	Great Blue Heron	*Ardea herodias*
Red-necked Grebe	*Podiceps grisegena*	Great Egret	*Ardea alba*
Eared Grebe	*Podiceps nigricollis*	Green Heron	*Butorides virescens*
Western Grebe	*Aechmorphorus occidentalis*	Osprey	*Pandion haliaetus*
Clark's Grebe	*Aechmorphorus clarkii*	Bald Eagle	*Haliaeetus leucocephalus*
Shy Albatross	*Thalassarche cauta*	Peregrine Falcon	*Falco peregrinus*
Wandering Albatross	*Diomedea exalans*	Merlin	*Falco columbarius*
Laysan Albatross	*Phoebastria immutabilis*	Turkey Vulture	*Cathartes aura*
Black-footed Albatross	*Phoebastria nigripes*	Black Oystercatcher	*Haematopus bachmani*
Short-tailed Albatross	*Phoebastria albatrus*	Black-bellied Plover	*Pluvialis squatarola*
Northern Fulmar	*Fulmar glacialis*	American Golden-Plover	*Pluvialis dominica*
Mottled Petrel	*Pterodroma inexpectata*	Pacific Golden-Plover	*Pluvialis fulva*

Table D. Continued page 2 of 3. Birds species that occur off Oregon from shore to the outer boundary of the proposed GLD, including birds that occur in the waters and shorelines of estuaries continued.

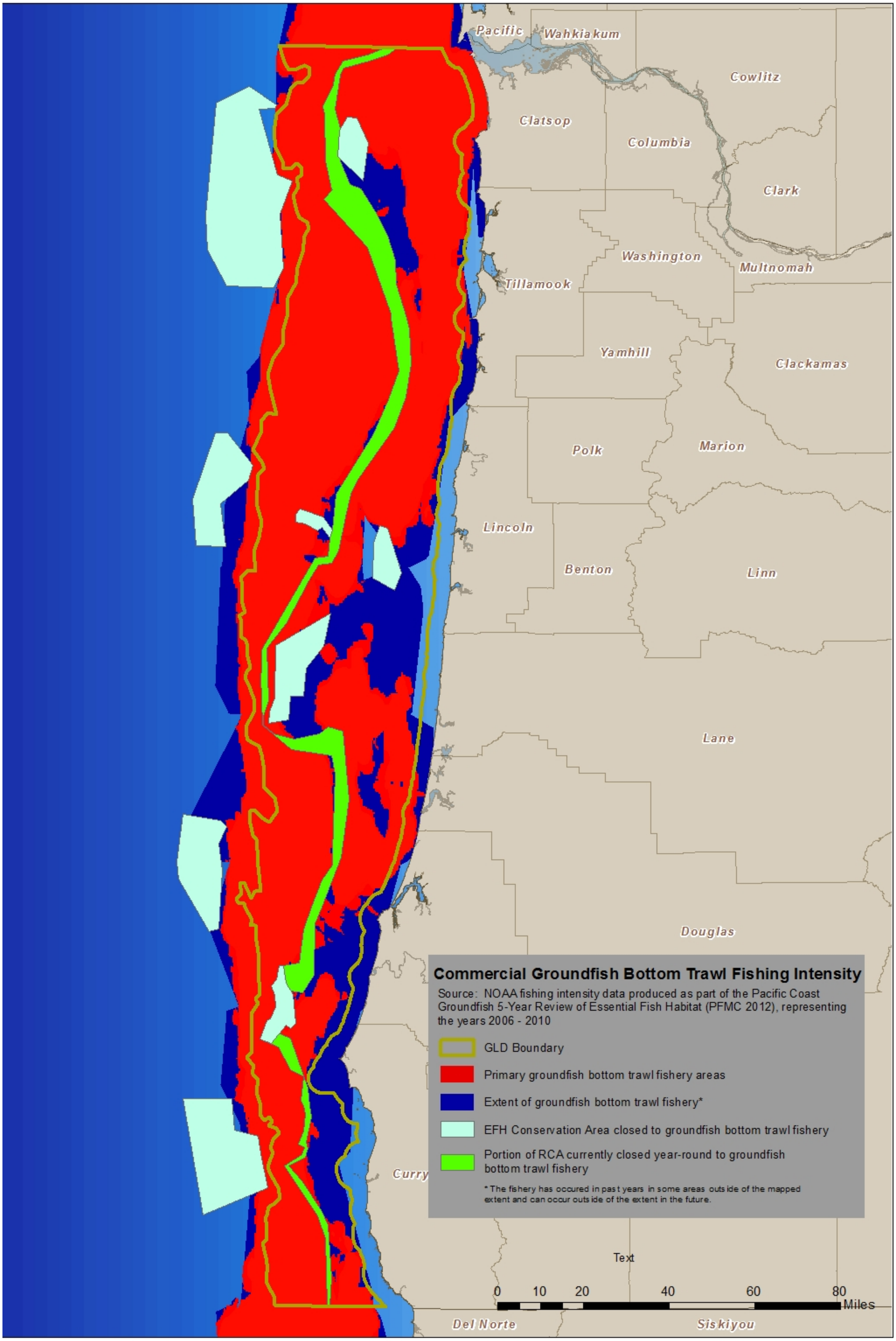
Common Name	Latin Name	Common Name	Latin Name
Snowy Plover	*Charadrius nivosus*	Semipalmated Sandpiper	*Calidris pusilla*
Wilson's Plover	*Charadrius Wilsonia*	Western Sandpiper	*Calidris mauri*
Semipalmated Plover	*Charadrius semipalmatus*	Short-billed Dowitcher	*Limnodromus griseus*
Piping Plover	*Charadrius melodus*	Long-billed Dowitcher	*Limnodromus scolopaceus*
Eurasian Dotterel	*Charadrius morinellus*	Red-necked Phalarope	*Phalaropus lobatus*
Spotted Sandpiper	*Actitis macularius*	Red Phalarope	*Phalaropus fulicarius*
Solitary Sandpiper	*Tringa solitaria*	South Polar Skua	*Stercorarius maccormicki*
Wandering Tattler	*Tringa incana*	Pomarine Jaeger	*Stercorarius pomarinus*
Spotted Redshank	*Tringa erythropus*	Parasitic Jaeger	*Stercorarius parasiticus*
Greater Yellowlegs	*Tringa melanoleuca*	Long-tailed Jaeger	*Stercorarius longicaudus*
Willet	*Tringa semipalmata*	Common Murre	*Uria aalge*
Lesser Yellowlegs	*Tringa flavipes*	Thick-billed Murre	*Uria lomvia*
Upland Sandpiper	*Bartramia longicauda*	Pigeon Guillemot	*Cepphus columba*
Whimbrel	*Numenius phaeopus*	Long-billed Murrelet	*Brachyramphus perdix*
Bristle-thighed Curlew	*Numenius tahitiensis*	Marbled Murrelet	*Brachyramphus marmoratus*
Long-billed Curlew	*Numenius americanus*	Scripp's Murrelet	*Synthliboramphus scrippsi*
Hudsonian Godwit	*Limosa haemastica*	Guadalupe Murrelet	*Synthliboramphus hypoleucus*
Bar-tailed Godwit	*Limosa lapponica*	Ancient Murrelet	*Synthliboramphus antiquus*
Marbled Godwit	*Limosa fedoa*	Cassin's Auklet	*Ptychoramphus aleuticus*
Ruddy Turnstone	*Arenaria interpres*	Parakeet Auklet	*Aethia psittacula*
Black Turnstone	*Arenaria melanocephala*	Rhinocerous Auklet	*Cerorhinca monocerata*
Great Knot	*Calidris tenuirostris*	Horned Puffin	*Fratercula corniculata*
Red Knot	*Calidris canutus*	Tufted Puffin	*Fratercula cirrhata*
Surfbird	*Calidris virgata*	Black-legged Kittiwake	*Rissa tridactyla*
Ruff	*Calidris pugnax*	Red-legged Kittiwake	*Rissa brevirostris*
Sharp-tailed Sandpiper	*Calidris acuminata*	Sabine's Gull	*Xema sabini*
Curlew Sandpiper	*Calidris ferruginea*	Bonaparte's Gull	*Chroicocephalus philidelphia*
Long-toed Stint	*Calidris subminuta*	Black-headed Gull	*Chroicocephalus ridibundus*
Red-necked Stint	*Calidris ruficollis*	Little Gull	*Hydriocoloeus minutus*
Sanderling	*Calidris alba*	Ross's Gull	*Rhodostethia rosea*
Dunlin	*Calidris alpina*	Laughing Gull	*Leucophaeus atricilla*
Rock Sandpiper	*Calidris ptilocnemis*	Franklin's Gull	*Leucophaeus pipixcan*
Baird's Sandpiper	*Calidris bairdii*	Heerman's Gull	*Larus heermanni*
Little Stint	*Calidris minuta*	Mew Gull	*Larus canus*
Least Sandpiper	*Calidris minutilla*	Ring-billed Gull	*Larus delawarensis*
White-rumped Sandpiper	*Calidris fuscicollis*	Western Gull	*Larus occidentalis*
Buff-breasted Sandpiper	*Calidris subruficollis*	California Gull	*Larus californicus*
Pectoral Sandpiper	*Calidris melanotos*	Herring Gull	*Larus argentanus*

Table D. Continued page 3 of 3. Birds species that occur off Oregon from shore to the outer boundary of the proposed GLD, including birds that occur in the waters and shorelines of estuaries continued.

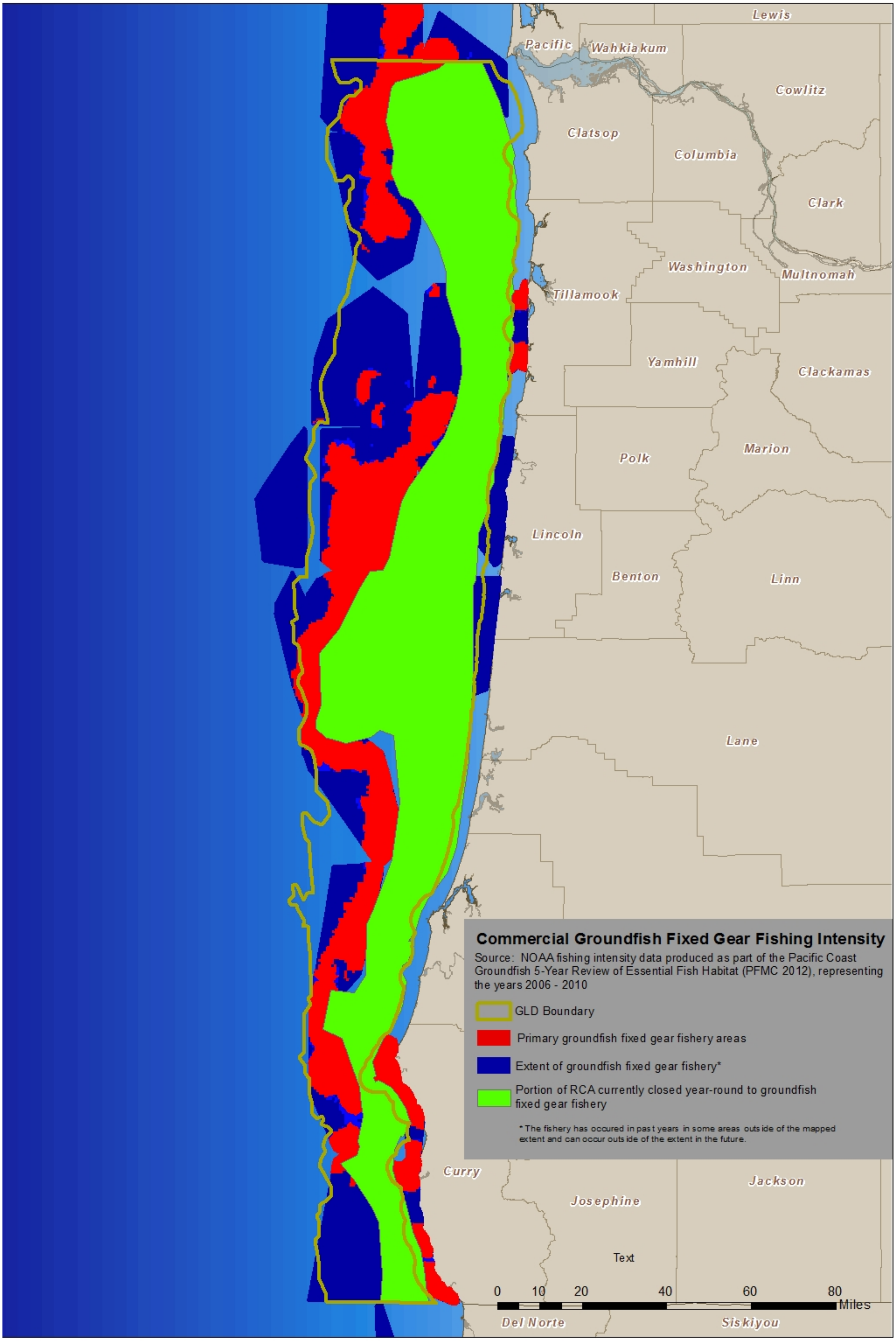
Common Name	Latin Name	
Thayer's Gull	*Larus thayeri*	
Iceland Gull	*Larus glaucoides*	
Slaty-backed Gull	*Larus schistisagus*	
Glaucous-winged Gull	*Larus glaucescens*	
Glaucous Gull	*Larus hyperboreus*	
Least Tern	*Sternula antillarum*	
Caspian Tern	*Hydroprogne caspia*	
Common Tern	*Sterna hirundo*	
Arctic Tern	*Sterna paradisaea*	
Forster's Tern	*Sterna forsteri*	
Elegant Tern	*Thalasseus elegans*	
Black Skimmer	*Rynchops niger*	
Belted Kingfisher	*Megaceryle alcyon*	
American Crow	*Corvus brachyrhynchos*	
Common Raven	*Corvus corax*	
Brewer's Blackbird	*Euphagus cyanocephalus*	
Brown-headed Cowbird	*Molothrus oryzivorus*	
European Starling	*Sturnus vulgaris*	
American Pipit	*Anthus rubescens*	
Savannah Sparrow	*Passerculus sandwichensis*	

Marine Resources and Uses
Map Inventory

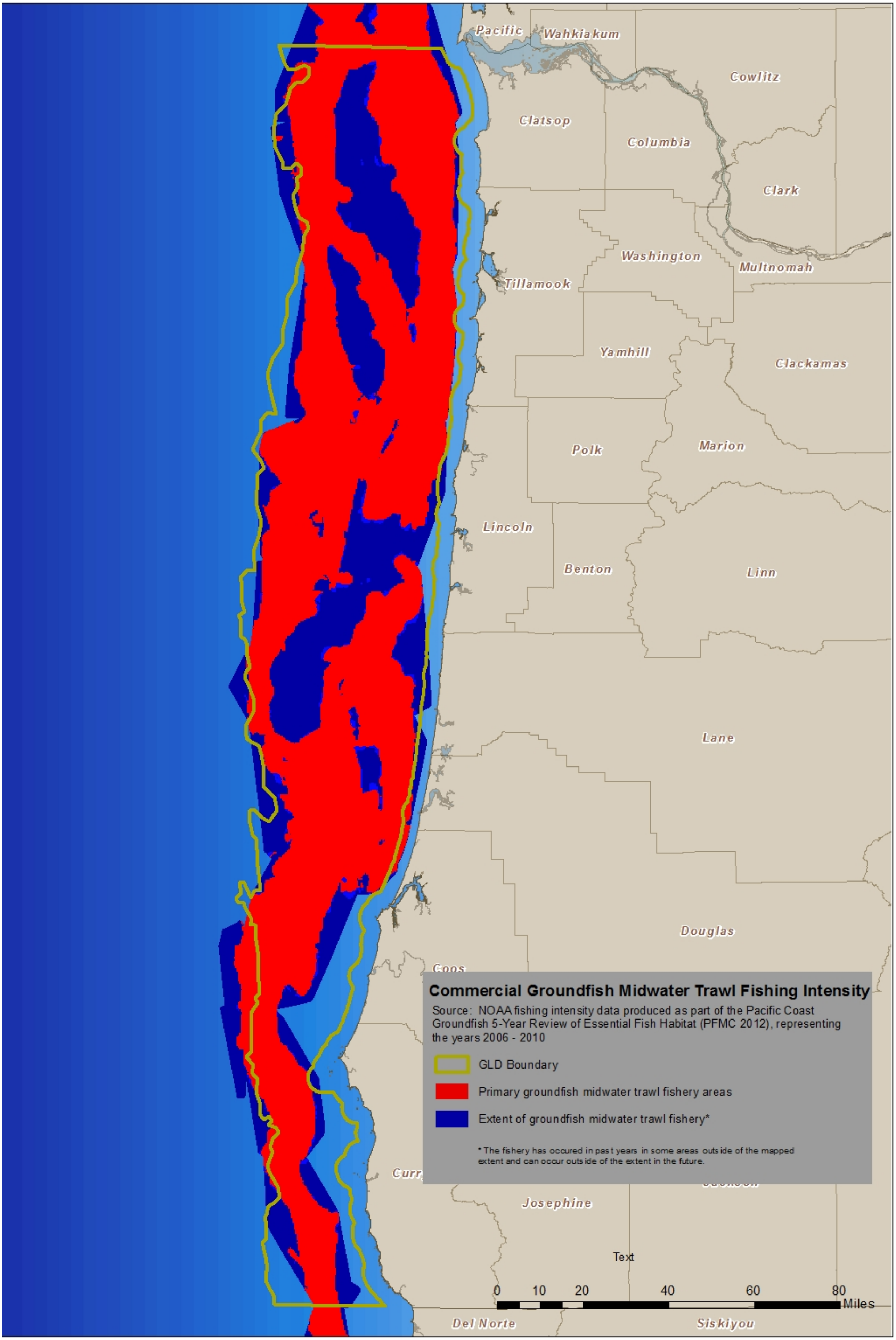
Map A-1 Fisheries - Commercial Groundfish Bottom Trawl



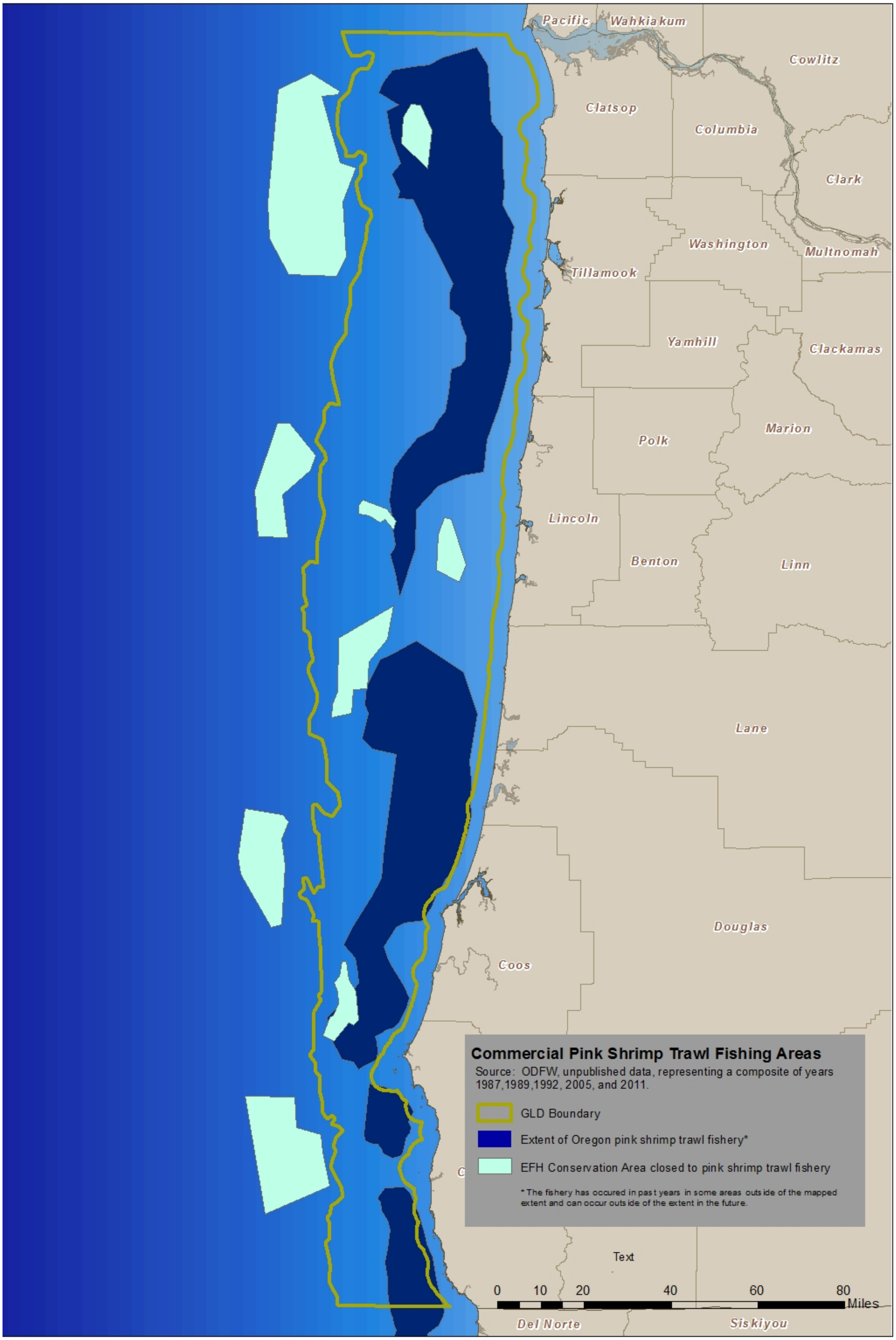
Map A-2 Fisheries - Commercial Groundfish Fixed Gear



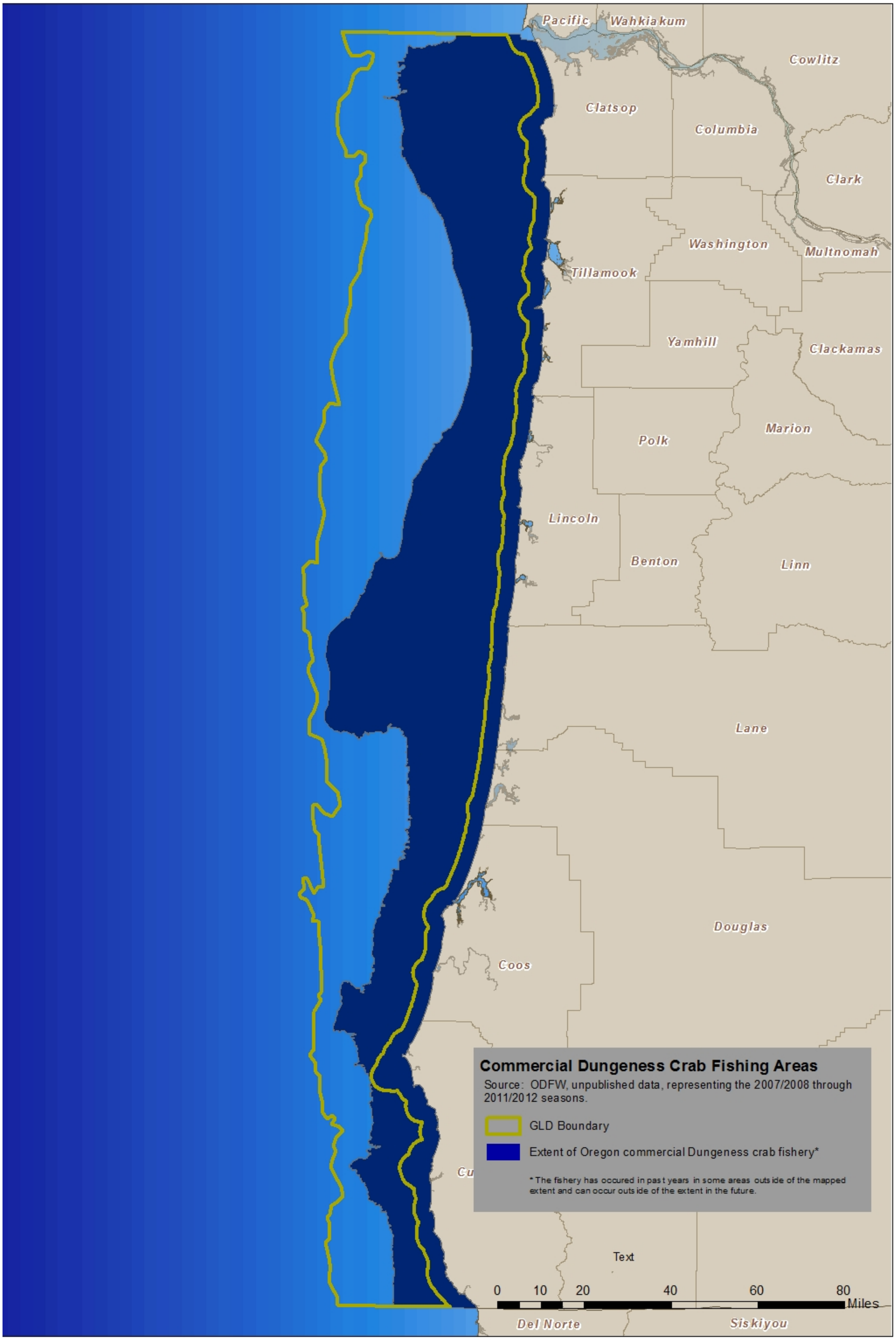
Map A-3 Fisheries - Commercial Groundfish Midwater Trawl



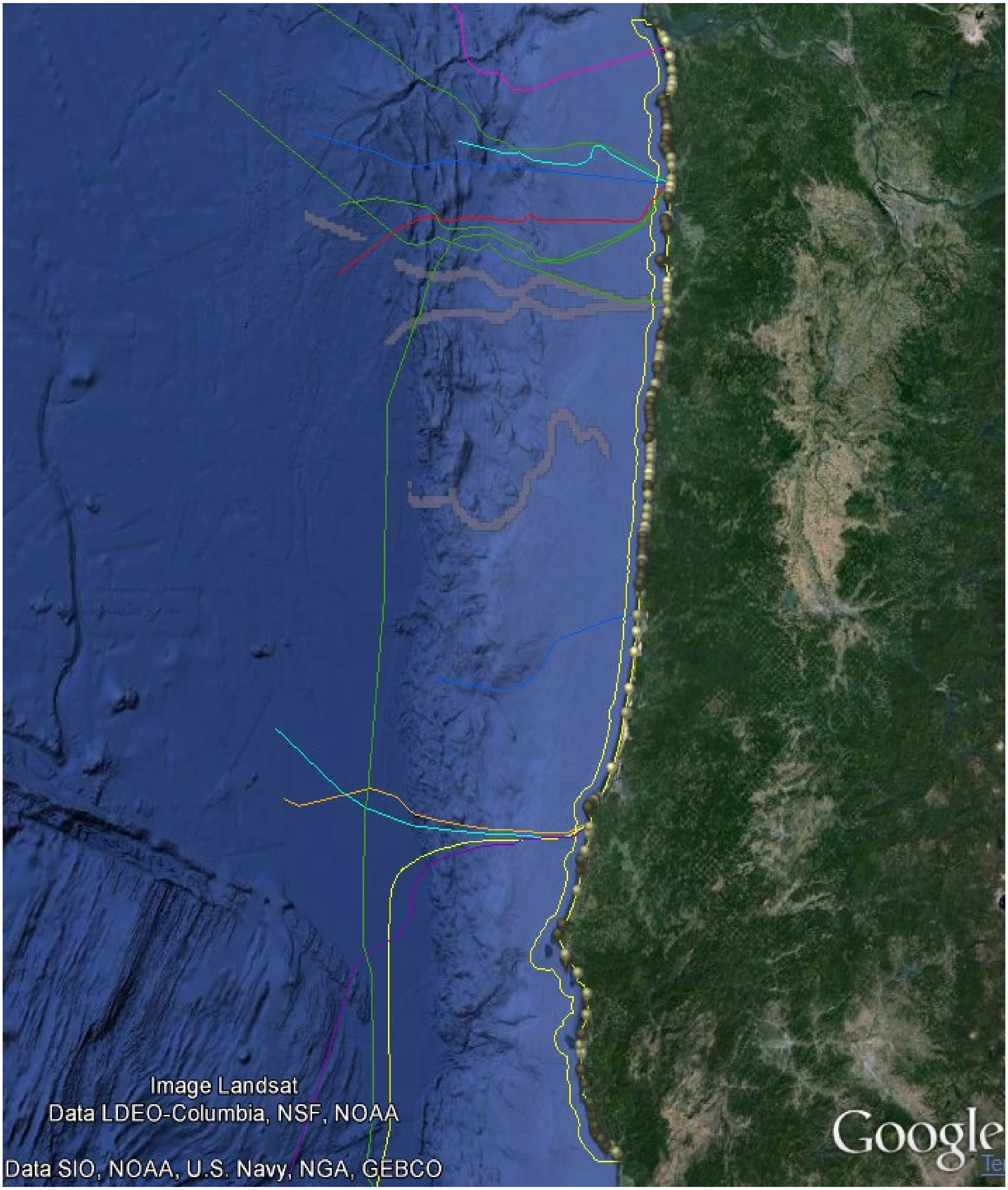
Map A-4 Fisheries - Commercial Pink Shrimp Trawl Fishery



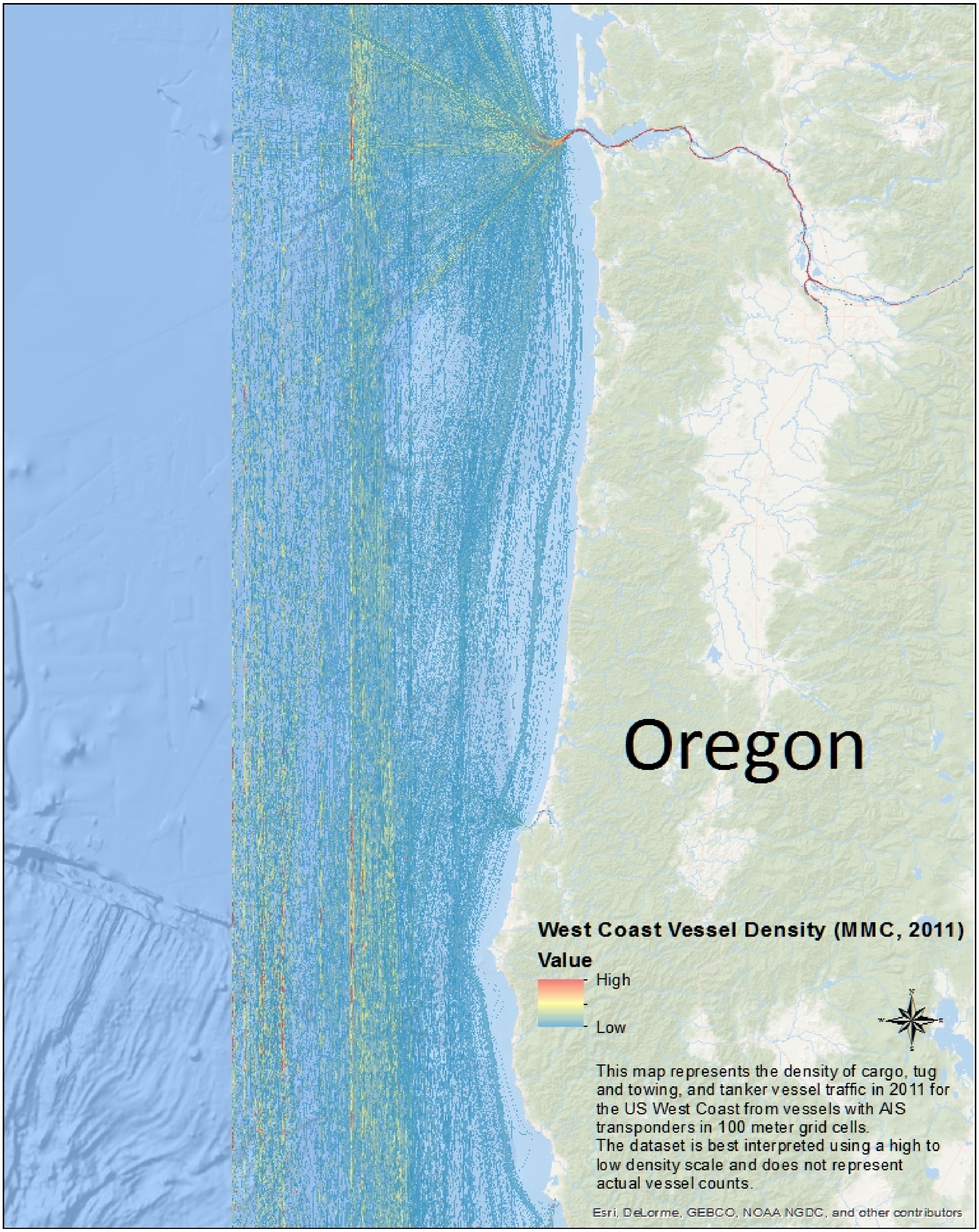
Map A-5 Fisheries - Commercial Dungeness Crab Fishery



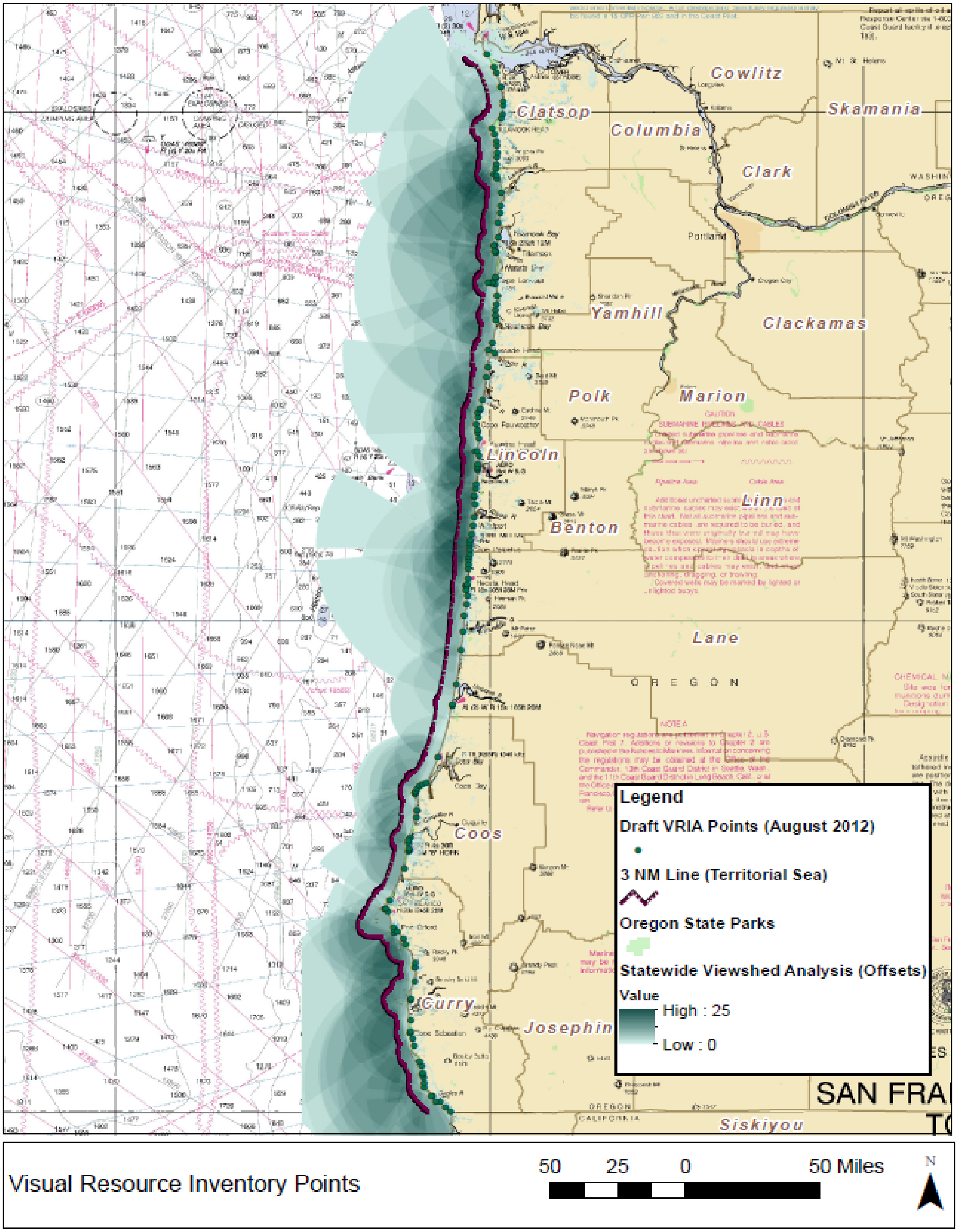
Map B – Submarine Cables



Map C- Vessel Traffic

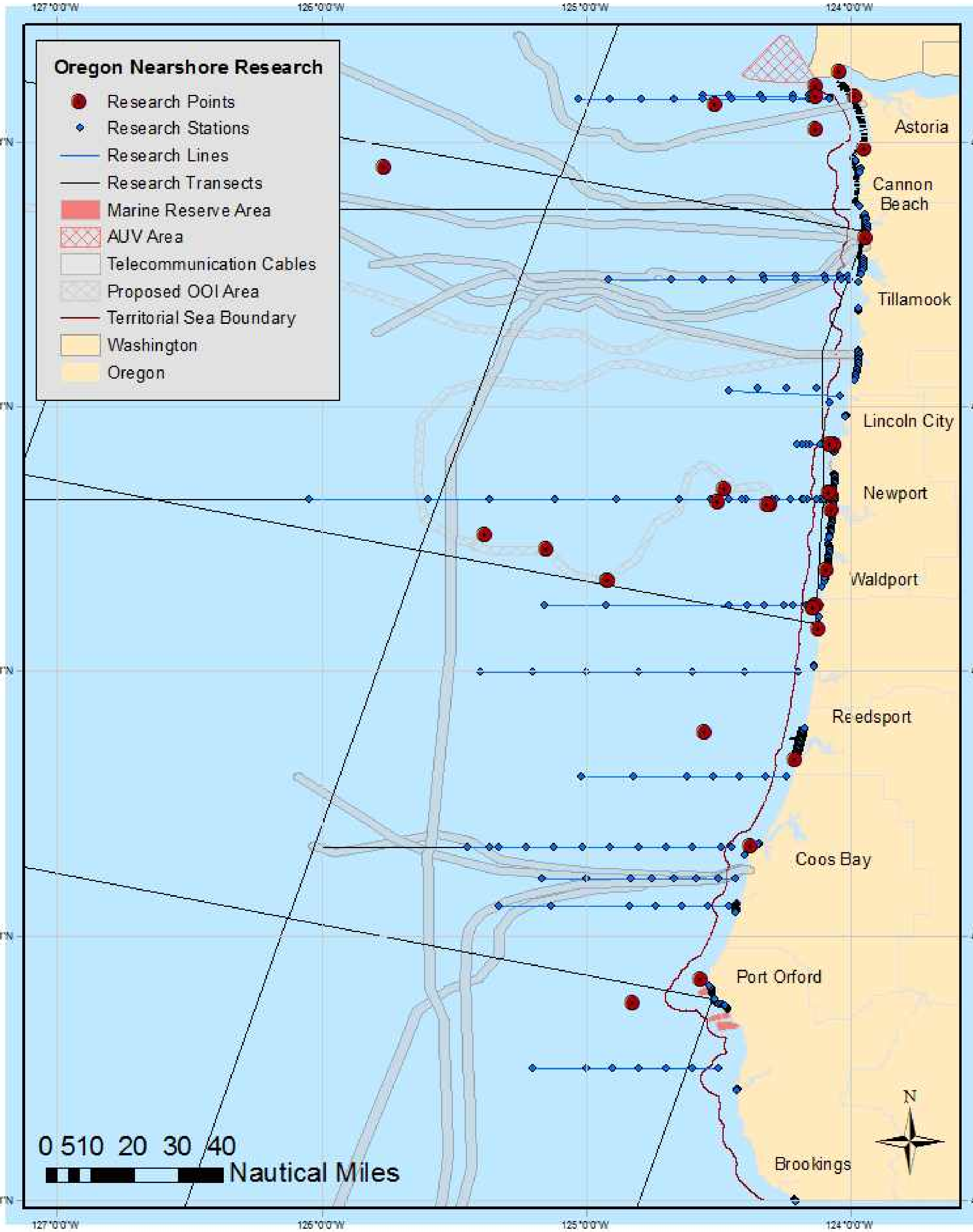


Map D: Visual Resource

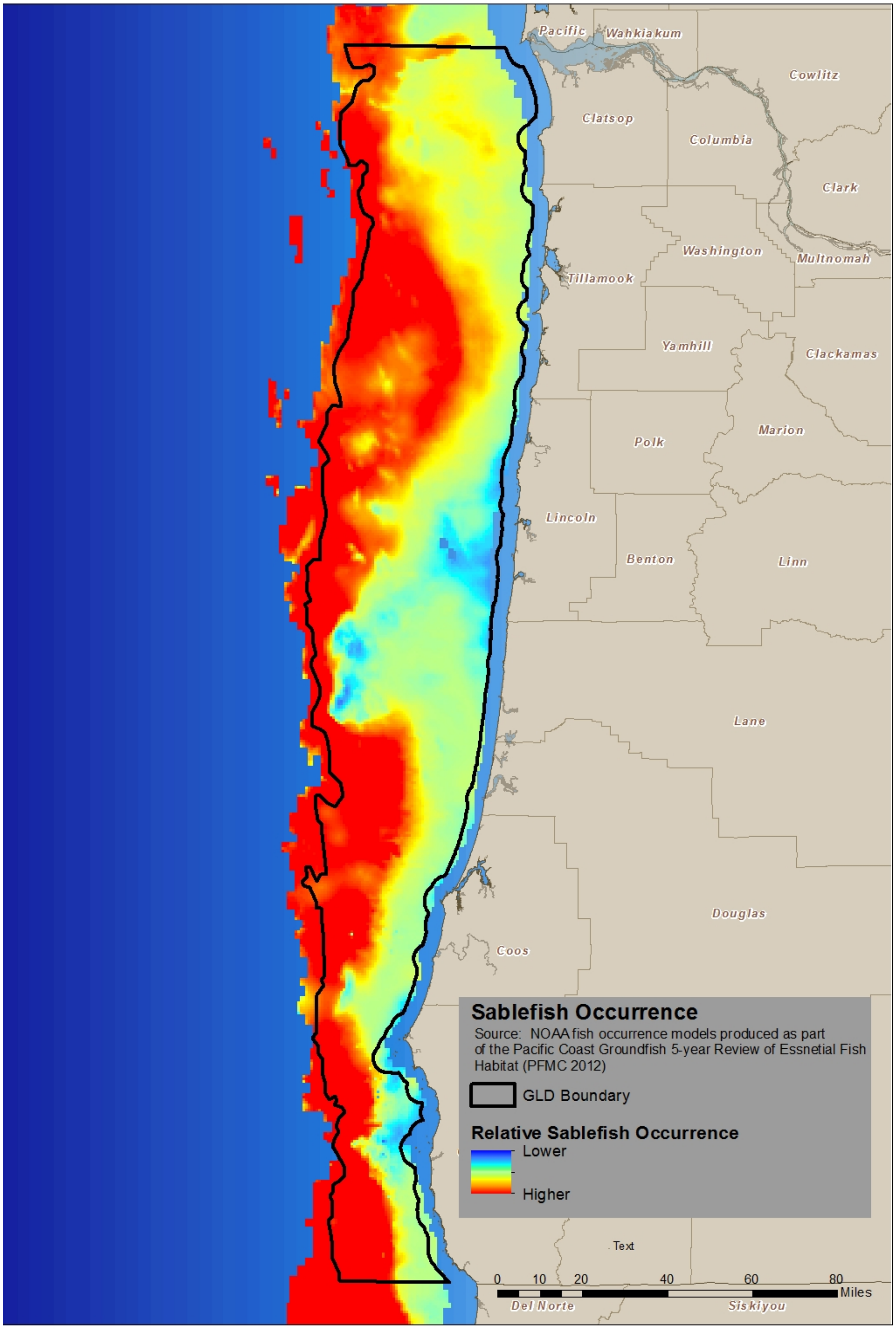


Map E - Scientific Research

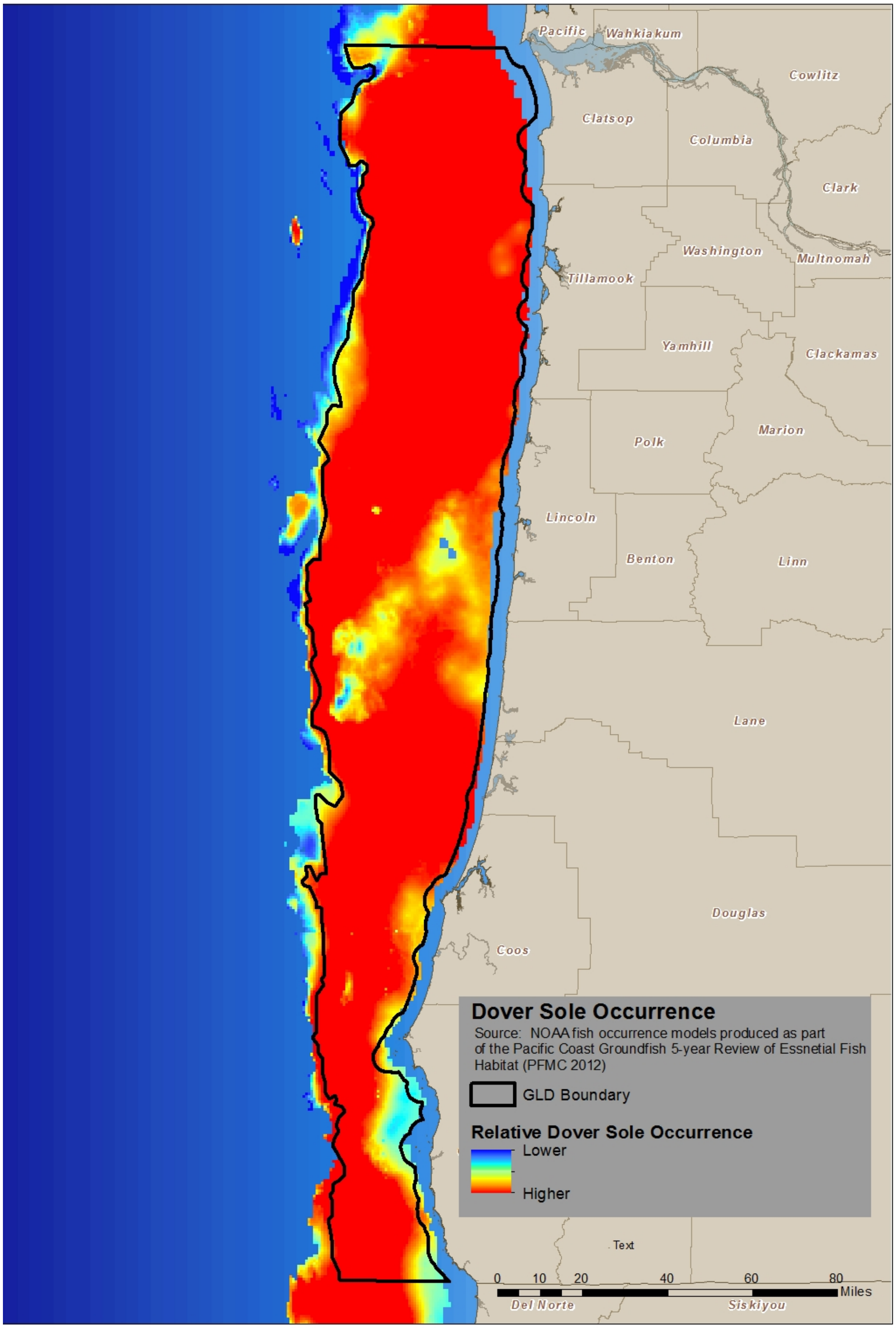
Oregon Nearshore Research Inventory Project



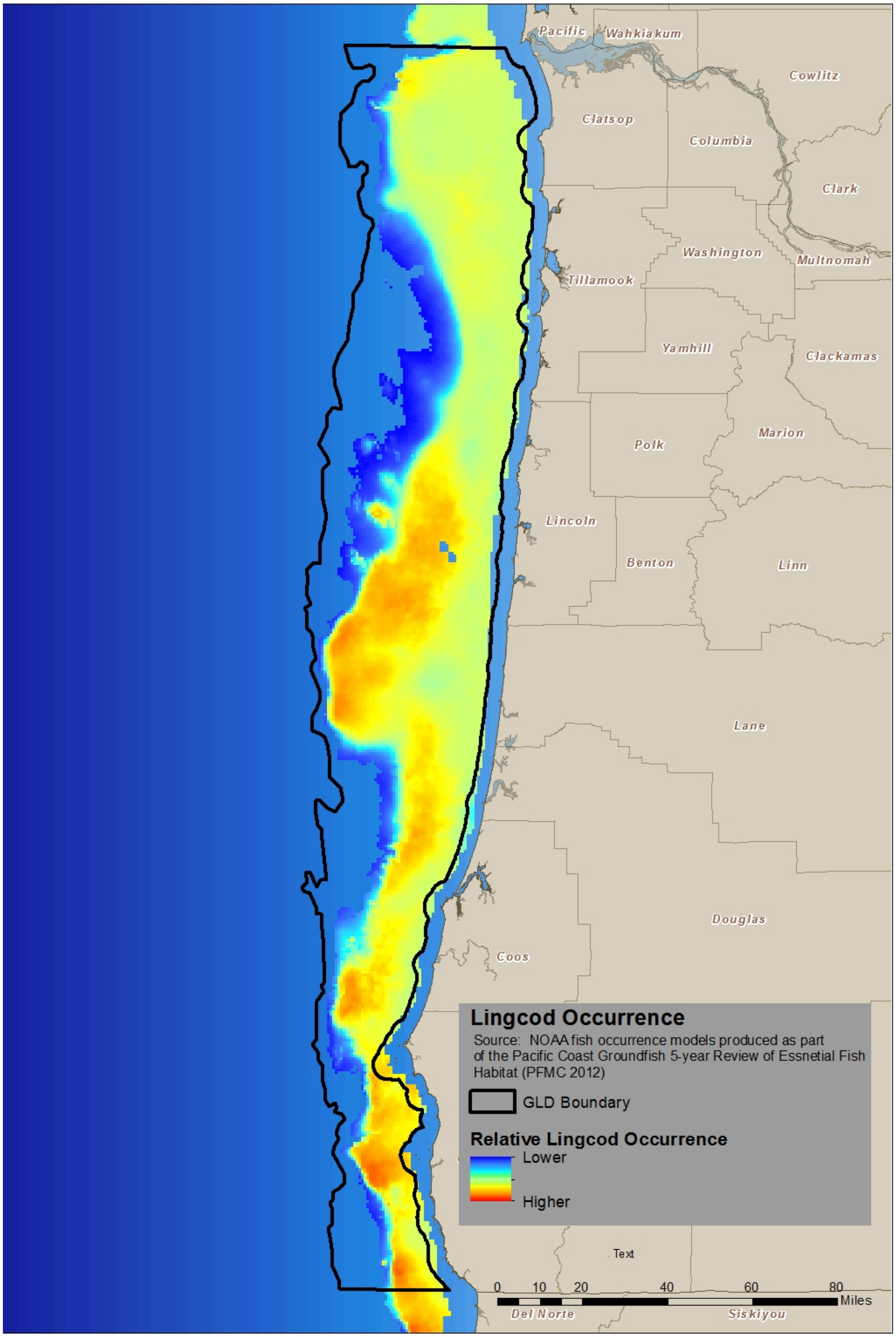
Map F1 – Sablefish Occurrence



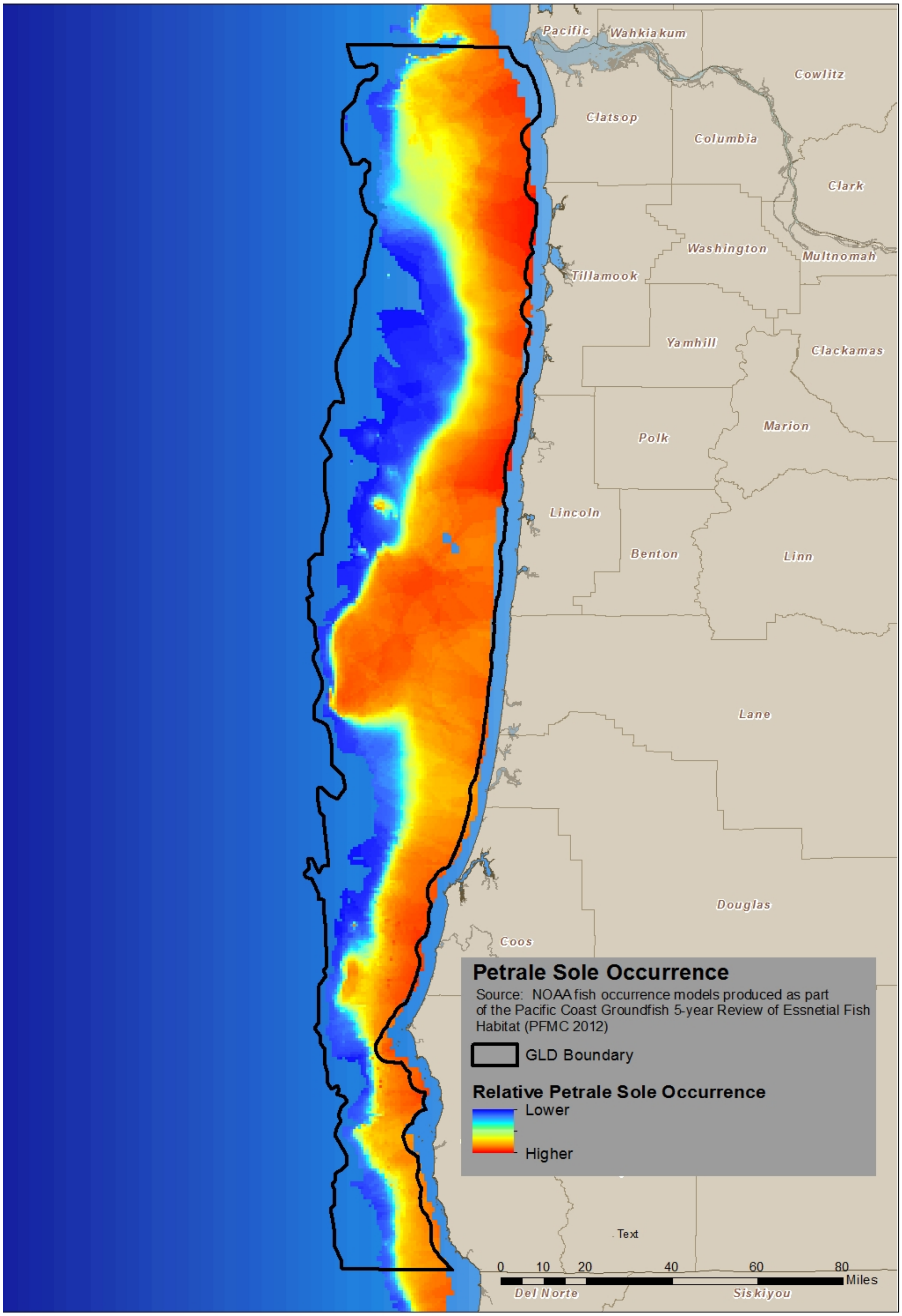
Map F2 – Dover Sole Occurrence



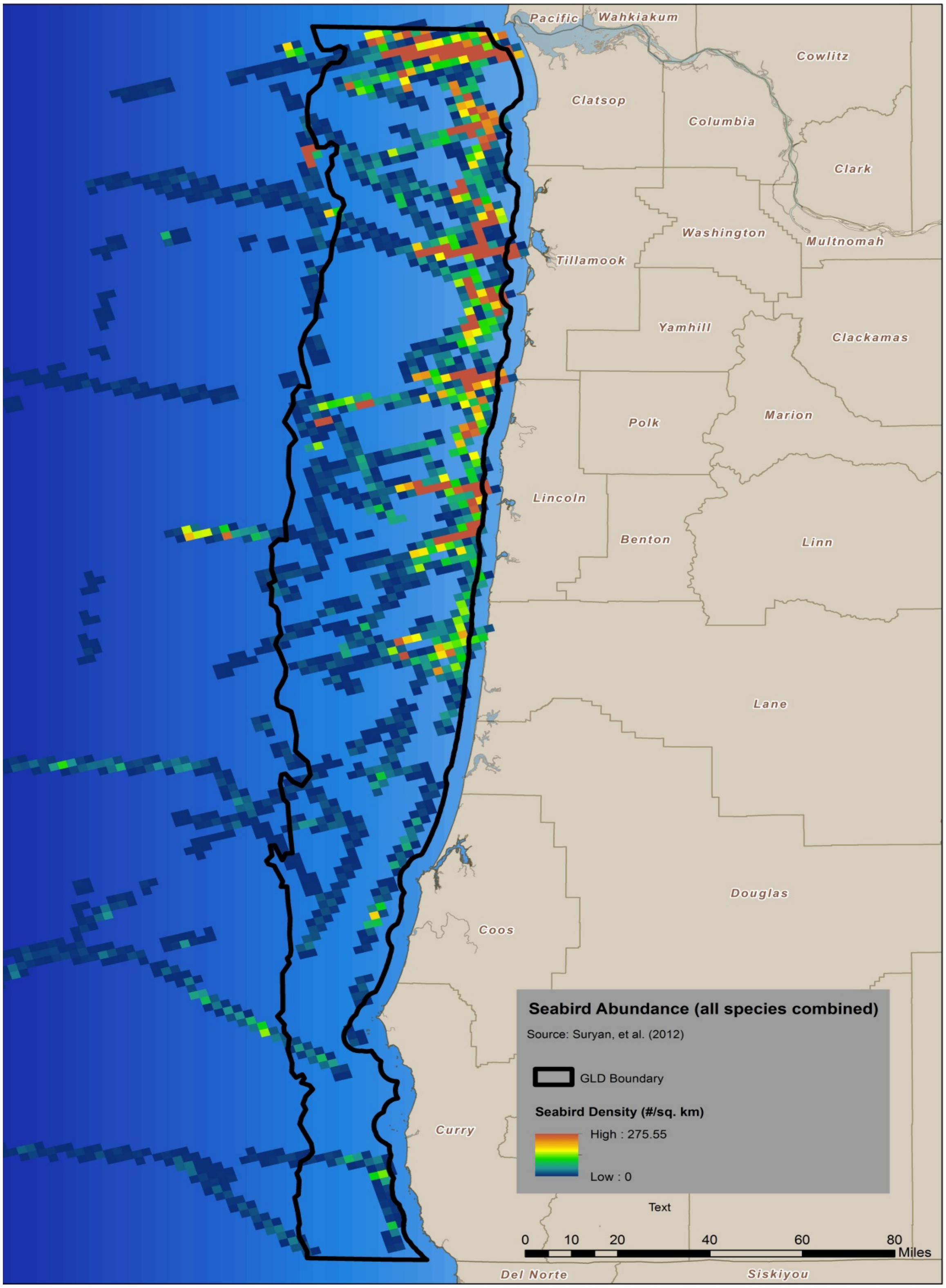
Map F3 – Lingcod Occurrence



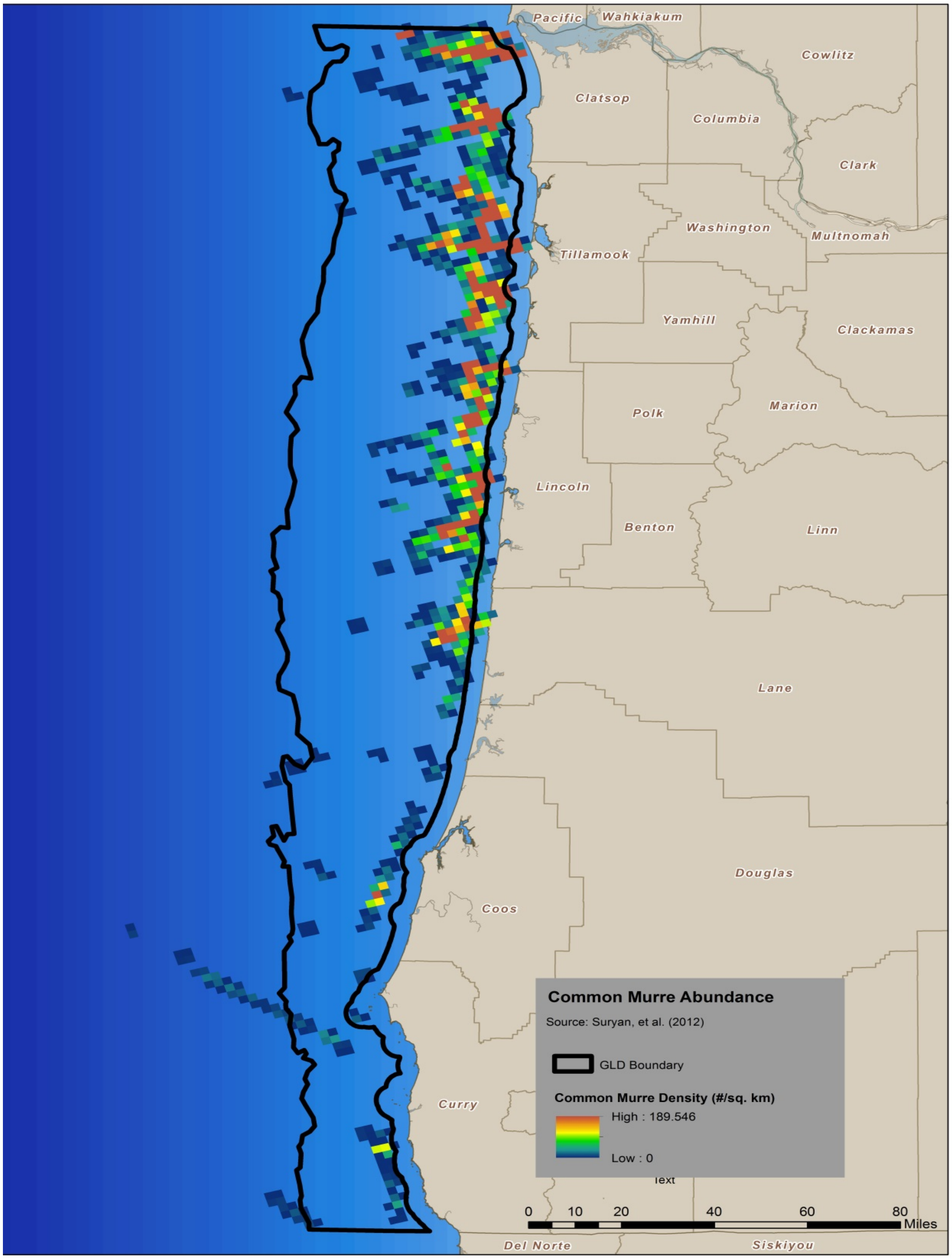
Map F4 – Petrale Sole Occurrence



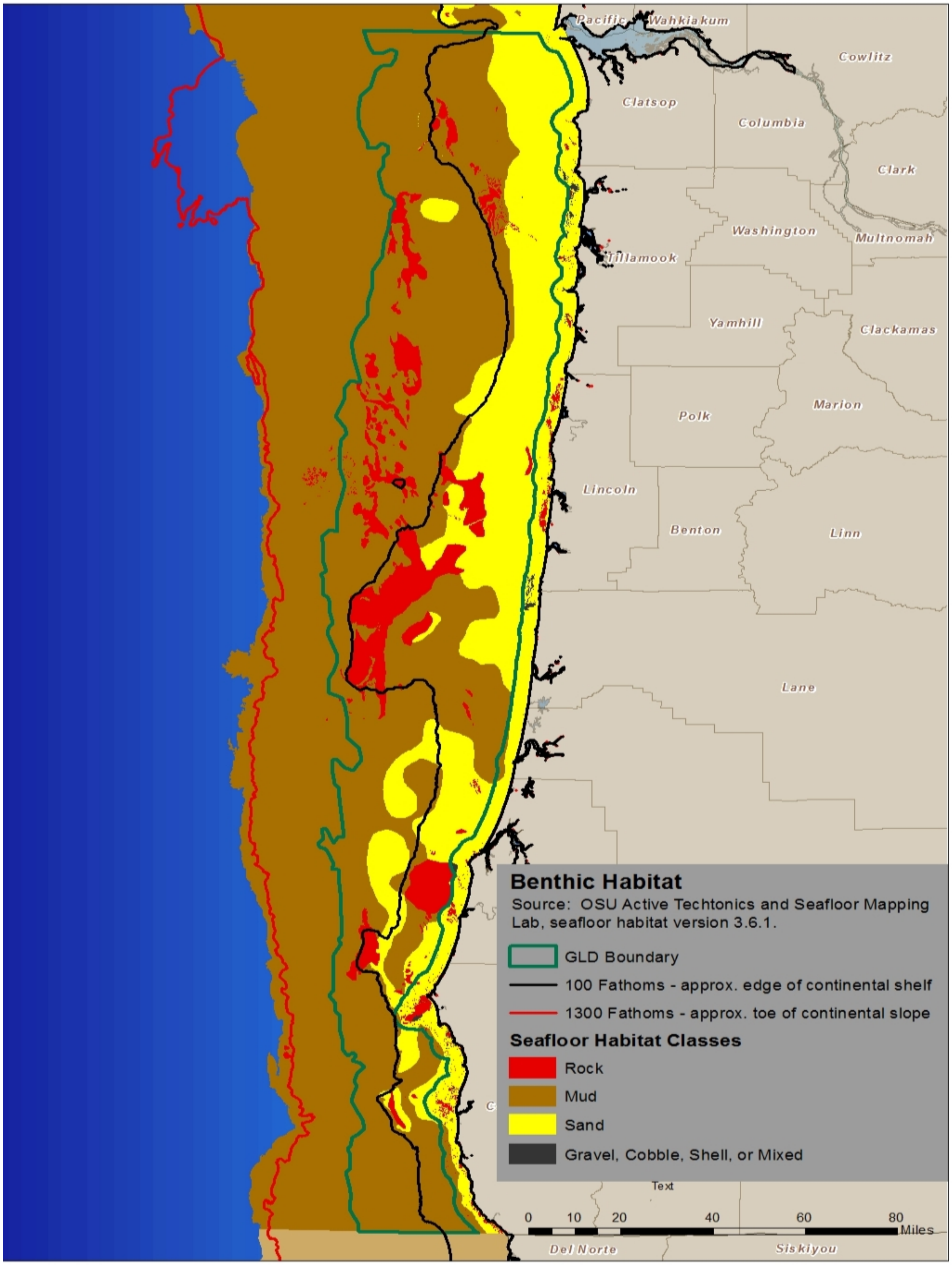
Map F5 – Seabird Occurrence



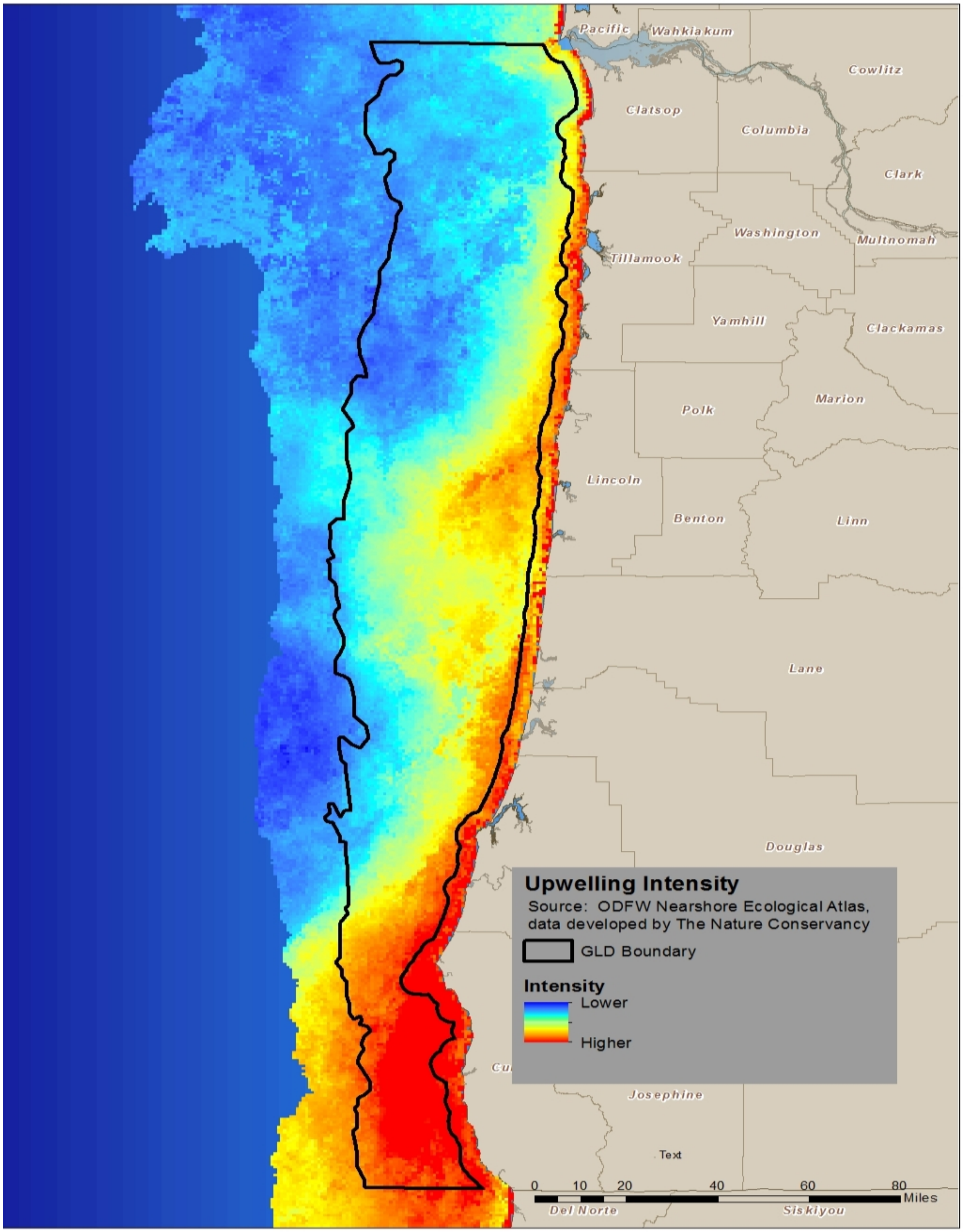
Map F-6 Common Murre Occurrence



Map F7 – Benthic Habitats



Map F8 – Upwelling Intensity



Map F9 – Chlorophyll *a* Concentration