OregonWaveEnergy TRUST

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Cumulative Impacts of Wave Energy In Oregon

Existing Environmental Character, Trends, and Pressures

Prepared by
Aquatera Ltd
In partnership with Parametrix
In collaboration with Powertech and European Marine Energy Centre
On behalf of Oregon Wave Energy Trust

This work was funded by the Oregon Wave Energy Trust (OWET). OWET was funded in part with Oregon State Lottery Funds administered by the Oregon Business Development Department. It is one of six Oregon Innovation Council initiatives supporting job creation and long-term economic growth.

Oregon Wave Energy Trust (OWET) is a nonprofit public-private partnership funded by the Oregon Innovation Council. Its mission is to support the responsible development of wave energy in Oregon. OWET emphasizes an inclusive, collaborative model to ensure that Oregon maintains its competitive advantage and maximizes the economic development and environmental potential of this emerging industry. Our work includes stakeholder outreach and education, policy development, environmental assessment, applied research and market development.

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For information about this project, please contact Gareth Davies at Aquatera Ltd:

Phone: (011-44)1856 850 088
Fax: (011-44)1856 850 089
Email: office@aquatera.co.uk

About Oregon Wave Energy Trust

The Oregon Wave Energy Trust – (OWET) - with members from fishing and environmental groups, industry and government - is a nonprofit public-private partnership funded by the Oregon Innovation Council in 2007. Its mission is to serve as a connector for all stakeholders involved in wave energy project development - from research and development to early stage community engagement and final deployment and energy generation - positioning Oregon as the North America leader in this nascent industry and delivering its full economic and environmental potential for the state. OWET's goal is to have ocean wave energy producing 2 megawatts of power - enough to power about 800 homes - by 2010 and 500 megawatts of power by 2025.

Contents

List of Figures

List of Tables

1 Introduction

The fundamental aim of the Oregon Wave Energy Trust's (OWET's) cumulative effects framework is to provide an enduring set of information, presented in an effective way to inform substantial decisions about the future and ongoing management of wave energy developments in the context of the existing and future situation. At the core of the framework is an electronic tool which enables people to establish possible future scenarios on the basis of judgments about the type and intensity of impacts that may arise. Underpinning this core function are sets of data about the environmental sensitivities, technical factors, and activities that are and could take place in Oregon.

The data sets used in the current framework represent data sets that were freely available at the time this framework was developed. Ultimately, the data sets within the framework would represent all available information of interest to the user. This report collates supporting information on a comprehensive list of environmental sensitivities relevant to potential users of the framework.

This report discusses the status and trends in various physical, biological, social and economic factors that may be sensitive to the development of wave energy (sensitivities). It also addresses technical factors which would not be impacted directly or indirectly by wave energy projects, but which could impinge upon the prospects for their successful operation. In addition, the report describes the status and trends and associated pressures of those activities that are currently impacting that environment, such as fishing, shipping, recreation, and conservation. In the analysis of cumulative effects, these existing activities provide a baseline upon which the potential impacts and benefits of wave energy development are superimposed to provide a complete understanding of what development scenarios will mean for the natural and human communities along the Coast.

The data that are currently available for the framework are not yet complete; there are some areas where primary data still need to be gathered. There are other areas where the current status can be described but there is no knowledge about trends. There are still other areas where some understanding about status and trends may exist, based upon localized study, but as yet there are no available data sets relating to the particular parameter. Table 1.1 below lists the technical factors and environmental sensitivities potentially influencing / influenced by the development of wave energy and indicates the level of information obtained for this phase. Environmental factors for which no information has been gathered in this phase are not included in this current report.

This document should be seen a living document. As new and improved information becomes available and known then it can be added to this catalog. The importance of creating an overall structure for this document now is that the electronic framework tool draws upon the content of this report to provide background for the data sets it presents. Establishing a fixed architecture at this stage means that any updates can be incorporated into the RADMAPP framework tool with minimal work. However, if with experience it is found that additional or different information needs to be presented, this can still be achieved.

The structure of the report follows that covered elsewhere in this project. Environmental sensitivities are broken down into 5 distinct areas:

- Physical
- Ecological
- Conservation
- Social
- Economic

For each topic covered in this report the following information has been provided:

Description – defines the topic, its relevance to wave energy development, and the types of data that would be considered for use in the framework.

Status and Trends –presents information about the current status in Oregon, and describes any known trends over time.

Data sets –lists any data sets related to the topic that were found and used in the framework

Categorization –presents key metadata associated with these data sets and provides details on the categories used to describe the various sensitivity factors specific to each of the data sets. The categories are used in the modeling framework to determine a level of weighting for a given interaction.

Maps – rasterized maps of the study area included for any data sets used in the framework

Pressures – for existing ocean use activities, considers where existing pressures are arising due to interactions between these activities and the receiving environment, as well as pressures and opportunities arising due to changes associated with natural cycles or due to climate change.

This current report is backed up by some further data reports as outlined below:

- Original data catalogue
- Vector data atlas

Table 1.1 Comprehensive list of environmental and technical factors related to development of wave energy, level of information obtained, and whether data sets have been included in the cumulative effects framework

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
Physical environment					
Atmosphere	Air quality		Non-attainment areas		Category not of primary interest; trends information not sourced; data sets not used
	Carbon footprint	X			Data sets not found
Marine	Water quality	X	Water temperature/ salinity		Category not of primary interest; data set not used
	Wave climate	X	Coastal wave height	X	Technical factor. Data sufficient for coastal technologies only.
	Currents	N/A	Current velocity	-	Technical factor. Data considered insufficient due to minimal number of sampling points
	Mixing areas and fronts	X			Trends data related to Columbia River only. Data sets not found.
	Seabed quality				Category not of primary interest; information not sourced
	Sediment dynamics	N/A	Seabed type	X	Technical factor -- no trend information
		N/A	Sediment depth	X	Technical factor -- no trend information
	Water depth	N/A	Bathymetry	X	Technical factor -- no trend information
	Seabed morphology	N/A	Seabed morphology	X	Technical factor -- no trend information
	Offshore geology	N/A	Bedrock type	X	Technical factor -- no trend information
Coastal	Coastal erosion		Risk of coastal erosion	X	Status/trends information not sourced.
	Coastal deposition				No information sourced
	Coastline morphology				No information sourced
	Coastal type				No information sourced
Terrestrial	Soil quality				Category not of primary interest; information not sourced
	Land morphology	N/A	Elevation	X	Technical factor -- no trend information

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
	Onshore Geology	N/A	Geology	-	Category not of primary interest; information not sourced
	Land stability				Category not of primary interest; information not sourced
Freshwater	Aquatic water quality				Category not of primary interest; information not sourced
	Water body type	N/A	Water bodies	X	Technical factor -- no trend information
	Water flow dynamics				Category not of primary interest; information not sourced
Ecological environment					
Marine	Seabed communities	X	Benthic trawl invertebrates	-	No trend information found; data set considered insufficient
			Kelp	X	
	Plankton	X	Chlorophyll a levels	X	Index of phytoplankton biomass
	Fish	X			Data sets not available
	Seabirds	X			Data sets for foraging seabirds not available
	Marine mammals	X	Blue whale sightings	-	Data considered insufficient
			Gray whale sightings	-	Data considered insufficient
	Marine reptiles	X			Data sets not found
Coastal	Birds	X	Shoreline seabird colonies	X	
			Island seabird colonies	X	
			Seabird points	-	Duplicates colony information
	Marine mammals	X	Steller Sea Lion rookeries	X	
	Coastal communities	X			Data sets not found
Terrestrial	Terrestrial communities				Category not of primary interest; information not sourced
	Birds				Category not of primary interest; information not sourced

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
	Mammals				Category not of primary interest; information not sourced
	Reptiles and Amphibians				Category not of primary interest; information not sourced
	Freshwater communities				Category not of primary interest; information not sourced
	Freshwater fish				Category not of primary interest; information not sourced
	Reptiles and Amphibians				Category not of primary interest; information not sourced
Conservation Areas and Protected Species					
Marine	Marine archaeological sites	X			Data sets exist but not freely found
	Marine historical sites	X	Wrecks	X	
	Marine cultural sites				Data sets not found
	Marine scenic and recreational sites	N/A			Data sets not found
	Protected marine habitats	X	Rocky Reef EFH	X	
		X	Groundfish EFH	X	
		X	State marine managed areas	X	
		X	Marine Reserves	X	Data set for adopted reserves only used
	Protected marine species	X			Data on species locations not available
Coastal	Planning zones	X	Oregon Coastal Management Zone	X	
	Coastal archaeological sites	X			Data sets exist but not freely found
	Coastal historical sites	X			Category not of primary interest; data sets not sourced
	Coastal cultural sites				Data sets not found
	Coastal scenic and recreational sites	N/A	State Parks	X	
	Protected coastal habitats	X	Steller Sea Lion critical habitat	X	
		X	Snowy Plover critical habitat	X	

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
		X	National Wildlife Refuges	X	
	Protected coastal species	X			Data on species locations not available
Terrestrial	Terrestrial archaeological sites				Data sets exist but not freely available
	Terrestrial historical sites				Category not of primary interest; data sets not sourced
	Terrestrial cultural sites				Data sets not found
	Terrestrial scenic and recreational sites	N/A	State Parks	X	
	Protected terrestrial habitats	X	Tidal wetlands	X	
		X	Marbled Murrelet critical habitat	X	
	Protected terrestrial species	X			Data on species locations not available
Social environment					
	Cities	N/A	Distance from coastal settlement	X	Technical factor -- no trend information
	Population size	X	Population of coastal communities	X	
			Distance based on population size	X	Technical factor -- no trend information
	Community facilities	X			Data sets not sourced
	Community wealth	X	Poverty rates	X	
	Education and skills	X			Data sets not sourced
	Labor Market	X	Employment in Construction/ Manufacturing/ Professional/ Management of companies/ Fishing	X	
		N/A	Distance based on Employment in Construction/ Manufacturing/ Professional/ Management of companies/ Fishing	X	

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
		X	Employment in Wholesale trade/ Retail trade/ Transportation and warehousing/ Information/ Finance/ Education	-	Category not of primary interest; data sets not used
	Unemployment rate	X	Unemployment rate	X	
		N/A	Distance based on unemployment	X	Technical factor -- no trend information
	Income	X	Per capita income	X	
	Diversity	X			Category not of primary interest; data sets not sourced
	Regional Population	X			Category not of primary interest; data sets not sourced
	Recreation	X	Beach access	X	Technical factor
	Visual amenity		Coastal viewsheds	X	Status/trends information not sourced.
	Areas of cultural identity				Information not sourced
	Marine safety and security				Information not sourced
	Energy supply and use	X			Data sets not sourced
	Social consequences of climate change	X			Data sets not sourced
	Public opinion	X			Data sets not found
Economic environment					
	Fishing industry	X	Groundfish harvest	X	
	Aquaculture	X			Data sets not found.
	Marine freight shipping	X	Tow lanes	X	
			Inshore traffic zones	X	
			Clear navigable waterways	-	Data considered insufficient
	Tourism	X	Employment in arts and entertainment	X	No direct data on tourism found.
	Scientific research	X			Data sets not found.

	Environmental factor	Status/Trends information?	Data sets found	Included in framework?	Comments
	Marine Renewables sector	X	Wave energy preliminary permit sites	X	
	Oil and gas industry	X			Data sets not found.
	Aggregate and mineral extraction				Information not found
	Military	X			Data sets not found.
	Dredging	X	Dredge disposal sites	X	
	Outfalls				Information not sourced
	Waste disposal				Information not sourced
	Cables and pipelines	X	Subsea telecom cables	X	
	Industrial/ Manufacturing	X			Data sets not found.
	Agriculture	X	Land use zoning: Agriculture	X	Data set indicates zoning not actual use
	Forestry	X	Land use zoning: Forestry	X	Data set indicates zoning not actual use
	Ports	X	Oregon Ports	-	Data deemed insufficient
			Distance from ports	-	Technical factor -- no trend information
	Supply bases	N/A	Distance from supply bases	X	Technical factor -- no trend information
	Support vessels				Information not sourced
	Grid infrastructure	N/A	Distance from electrical grid	X	Technical factor -- no trend information
	Industrial support facilities				Information not sourced
	Transport		Road networks	-	Category not of primary interest; data sets not used
			Rail networks	-	Category not of primary interest; data sets not used
	Cumulative GDP	X			Data sets not sourced

2 The Physical Environment

2.1 Introduction

For this cumulative effects framework, the physical environment is considered to include aspects of air, climate, water, seabed, coastline, land, and freshwater. Many aspects of the physical environment are relatively static, such as geology, water depth, and seabed type, but are important technical factors to consider in the development of wave energy. Other aspects of the physical environment may be sensitive to changes, either temporary or long-term, as a result of the development of wave energy. Potential physical environment sensitivities and technical factors described in this section are listed below in Table 2.1.

Table 2.1 Sensitivities of the Physical Environment

Category	Sensitivity/Technical Factor
Atmospheric Character	Air quality
	Carbon footprint
Sea Water Character	Water quality
	Wave climate
	Seawater Currents
	Mixing areas and fronts
Seabed Character	Sediment dynamics
	Water depth
	Seabed morphology
	Offshore geology
Coastline character	Coastal erosion
Land Character	Land morphology
	Onshore geology
Freshwater character	Water body types

2.2 Atmospheric character

The atmosphere itself has often been poorly considered within impact assessments. The consequence of atmospheric conditions have been considered in more detail and certainly around some types of industrial site air quality issues have been, and can be, critical. Within the cumulative effects framework we have thus far considered two areas of sensitivity, local air quality and broader-scale carbon footprint.

2.2.1 Air Quality

Description

The key emissions that contribute to air quality have been well established and described for many years. They include combustion products such as nitrogen and sulfur oxides (NO_x, SO_x) and particulates. They include non-combusted and vented gases such as carbon monoxide, methane, volatile organic compounds (VOCs). They also include transformed gases such as low level ozone. Finally this category was also used to encompass physical emissions such as noise and light, along side the chemical emissions outlined previously.

An initial review of possible sensitivities ruled this category to be of secondary interest since the level of emissions from the activities themselves was anticipated to be relatively low and therefore of secondary relevance. In the longer term the production of renewable energy may have secondary effects by replacing existing oil-based fuel use with emissions-free electricity.

Status and Trends

Air quality at the Coast is generally not of concern. In Oregon, major sources of air pollution include motor vehicles and smoke from woodstoves, fireplaces, and open burning. Forest fires are a natural source of air pollution in the summer time. In the winter time, inversions in inland valleys can lead to localized poor air quality (State of Oregon Department of Environmental Quality, 2009).

Data sets

No suitable data sets for air quality measures across the study area were sourced during phase 1 of this study. The most likely sources of data would be sampling data from urban and reference sampling stations and modeled data from national air quality management programs, and data sets were located on non-attainment areas in the United States. However, these data were considered too broad to be useful for this study.

An alternative to measured concentrations of air quality factors would be to use existing health based air quality guidelines as a set of targets and to establish the relationship between the decay of impacts away from the source and the concentrations needed to protect populations. So long as these thresholds are not exceeded then no problems should be encountered.

2.2.2 Carbon footprint

Description

The term carbon footprint is used to describe "the total set of greenhouse gases (GHG) emissions caused by an organization, event or product" (Wiedmann and Minx 2008). For the framework, this sensitivity describes the contributions to greenhouse gas emissions in Oregon. The trends in greenhouse gas emissions influence the rate of climate change, which has potential impacts on other sensitivities such as wave climate and coastal erosion.

Renewables such as wave energy can produce carbon-free energy that can displace conventional hydrocarbon-based generation. This should reduce emissions of GHG. Wave energy is seen as a possible mechanism for reducing this form of global impact.

Status and Trends

Oregon's greenhouse gas (GHG) emissions in 2004 were 67.5 million metric tons of carbon dioxide equivalent ($MMTCO_2e$), about one percent of GHG emissions for the United States as a whole. From 1990 to 2004, GHG emissions in Oregon increased 22 percent compared to a 16 percent increase for the United States. The vast majority of Oregon's greenhouse gas emissions (86 percent) came from carbon dioxide (CO_2). The primary source of CO_2 pollution came from burning fossil fuels, such as coal at power plants serving the state, gasoline, diesel, and natural gas. Assuming no change from current practices, the Oregon Department of Energy predicts that Oregon's GHG emissions will grow by 30 million metric tons of CO_2e, or 55 percent, from 1990 to 2020 (State of Oregon Department of Environmental Quality, 2009; The Governor's Climate Change Integration Group, 2008)

Data sets

No datasets on the existing carbon footprint were available. This factor could be best described by considering the locations of existing hydrocarbon-based generation plants and reducing the associated emissions by a value equivalent to the amount of wave energy generated.

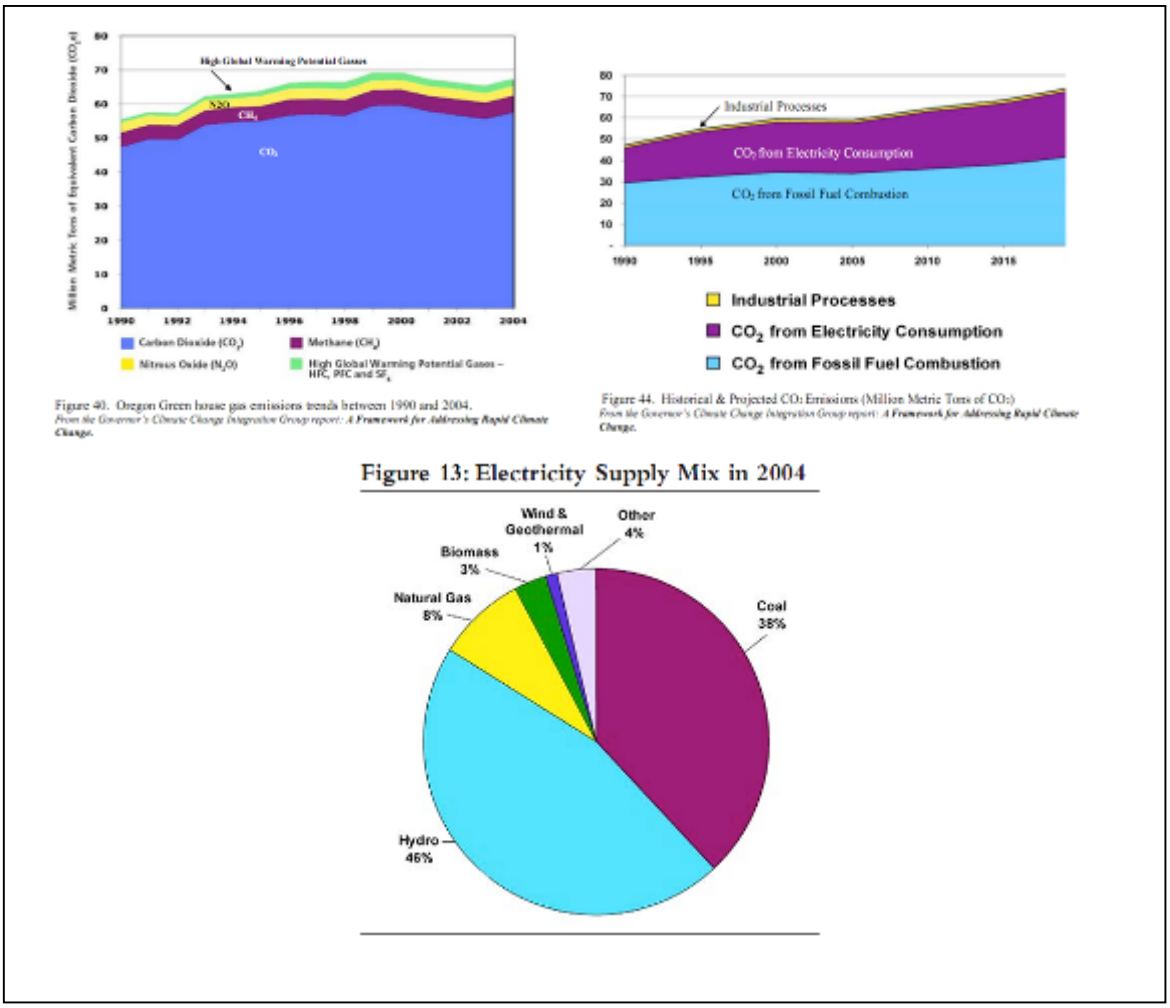


Figure 2.1 Trends in Greenhouse Gas emissions in Oregon
(From: The Governor's Climate Change Integration Group, 2008)

2.3 Sea water character

The seas along the Oregon Coast are relatively uniform compared to many other coastal areas. Factors which characterize the character of sea with regards to possible impacts from wave energy developments include:

- Water quality
- Wave climate
- Currents
- Mixing areas and fronts

These parameters are all technical factors which will in some ways influence the development of wave energy projects. Some of these factors also may be affected by wave energy projects, for example, the wave climate in an area may be affected by a wave energy development. Each of these topics is addressed in the following sub sections.

2.3.1 Water quality

Description

Seawater in offshore areas on the Oregon Coast is generally of high quality, with localized water quality challenges around areas with agricultural runoff. Factors that may reduce the quality of area of sea include presence of toxic contaminants, excess nutrients, increased turbidity, high ambient noise levels, elevated light levels, ambient temperature, and lowered dissolved oxygen.

It is considered unlikely that wave energy developments will influence water quality parameters. The most likely areas of influence are considered to be turbidity associated with construction activities, leaching of any antifouling and corrosion protection materials and the enhancement of oxygen depleted areas through reducing wave induced mixing.

Status and Trends

"Dead zones" occur in areas of the ocean where marine life suffocates as a result of insufficient dissolved oxygen, a condition known as hypoxia. Since 2002, hypoxic waters have appeared and recurred during the summer along the coastal fringes of the Northern California Current Large Marine Ecosystem (off Oregon and Washington). Hypoxia is closely linked to shifting wind patterns and changing ocean conditions. According to oceanographic data over 50 years, these events were completely unprecedented prior to 2002, but are becoming increasingly common during the summertime (PISCO, 2009).

No information on status and trends of other aspects of water quality was available. Information on the location of domestic sewage and industrial outfalls along the Coast would inform this topic.

Data sets

No comprehensive data sets were found for this broad array of water quality parameters. Local beach observation data is available from the Oregon Beach Monitoring Program. This program measures levels of pollutants that are dangerous to human health and is primarily targeted at protecting ocean recreation (Oregon Coastal Atlas).

2.3.2 Wave climate

Description

This topic addresses the distribution and character of waves in the ocean, which would obviously be impacted by wave energy development as well as being a technical factor. Waves can be defined by their height, length, period, direction, entrained power. Any area of sea is likely to be subject to both wind-blown, locally-generated waves and swell type, remotely-generated waves. There can often also be more than one swell source leading to complex wave interference patterns. The energy of the waves is dissipated through drag on shallow seabeds, breaking of waves in shallow water and crashing of the waves onto the shore or beach.

Status and Trends

Ongoing research by Oregon State University and the Department of Geology and Mineral Industries indicates the Pacific Northwest Coast has experienced increasingly intense winter storms and higher wave heights over the last 25 years. Wave heights measured several miles off the Coast during the early years of measurements averaged about three meters. In recent years, that average has substantially increased to four meters. During major storms waves have increased in height the order of 11 meters in 1975 to 15 meters now. There is no consensus on why storms have been getting stronger. While some scientists believe global warming may play a role, others suggest a recurring pattern based on similar conditions occurring in the late 19th century (Salem-News.com, 2006).

Data sets

Coastal wave heights. The best available set of data that was found related to coastal wave heights averaged over the year. The average height varied from 0 m to 3 m. This data set is suitable when considering the impacts and/or suitability of coastal wave devices.

No data were available for offshore wave, which is important for analyzing the impacts and/or suitability of nearshore and offshore wave devices.

Categorization

Dataset name:	Coastal wave height
Dataset description:	Annual mean significant wave height
Dataset source:	U.S. Geological Survey
Range:	0 – 3 meters

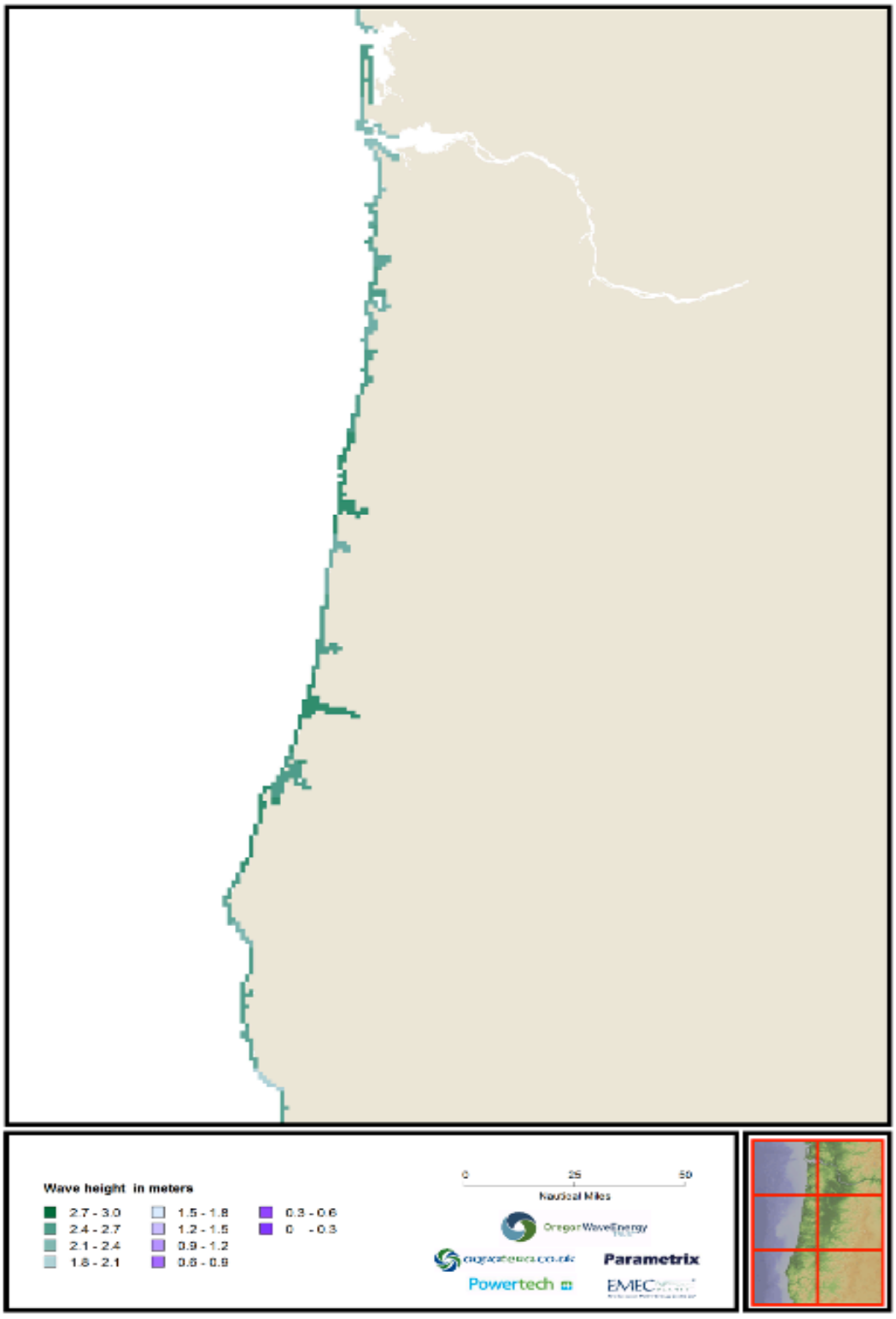


Figure 2.2 Raster map showing wave height in meters.

2.3.3 Seawater currents

Description

Currents affecting the Oregon continental shelf include oscillatory tidal currents, wind-induced currents and longer term oceanic circulation currents. These currents may operate along similar vectors leading to a combined enhanced velocity or may operate opposite each other leading to reduced levels of movement. Some aspects of currents are potentially sensitive to impacts from wave energy development, while others are technical factors.

It is considered very unlikely that wave energy devices will have an effect on the distribution and intensity of offshore currents. Near shore devices may have a more direct effect. Currents may however be a technical limit for devices from a design standpoint.

Status and Trends

Tidal currents should be predictable over long timescales. Oceanic currents are also usually very predictable; however, the Oregon seaboard is influenced by El Niño events which can alter oceanic circulation patterns. El Niño may also influence weather patterns which in turn will affect wind driven currents. Climatic changes due to global warming, along with possible shifts in oceanic circulation patterns may make currents less predictable in the future and alter the patterns compared to those experienced previously.

Data sets

One coarse set of shelf currents speeds was found, but the number of sampling points was minimal. The data were therefore not considered adequate for the project.

2.3.4 Mixing Areas and Fronts

Description

Frontal areas arise where vertically mixed waters meet stratified waters. These can occur most likely during the summer months when reduced wave action and solar warming can lead to stratification in deeper waters. The low levels of tidal currents may increase the tendency for stratification to occur relatively near to the shore.

Frontal areas are usually important for biological productivity and wave energy farms have the possibility of reducing wave energy fluxes reaching any downstream frontal areas. This could lead the frontal area to mitigate seawards, in turn moving prime foraging areas for fish, birds and sea mammals. This can influence the energetics of foraging strategies for species.

Status and Trends

The Columbia River has a great influence on the surface water conditions of the Pacific Ocean of the Pacific Northwest in all seasons. In early summer, the Columbia River creates a plume of lower-salinity water that can be traced 400 miles south to Cape Mendocino. The boundary between the Columbia River plume and surrounding ocean water is highly variable and biologically productive. Many species of fish, seabirds, and marine mammals follow these nutrient-rich "fronts" or boundaries during the summer months. In the winter, freshwater from rain and snowmelt runoff is driven by winter storms and the Davidson Current northward and shoreward along the Washington coastline. During this time, Columbia River freshwater can dominate the estuarine environments of Willapa Bay and Grays Harbor and is detectable inside the Straits of Juan de Fuca and northward along Vancouver Island (Department of Land Conservation and Development, 2008; Wise, Rinella, & Rinella, 2007).

Data sets

No data on the locations of frontal areas were found. A rule of thumb relationship between water depth and typical wave heights has been used to define likely frontal areas in the UK with good success.

2.4 Seabed character

Factors which characterize the character of the seabed with regards to possible impacts from wave energy developments include:

- seabed quality
- sediment dynamics
- water depth
- seabed morphology
- geology

Those topics for which information has been obtained are addressed in the following sub sections.

2.4.1 Sediment dynamics

Description

Sediment dynamics covers the movement of sediments around on the seabed including sandbank, sand waves, scour, erosion and deposition. Sediment dynamics includes characteristics of the seabed such as the type of sediment and the depth. It can be both a sensitivity that could be affected by wave energy, as well as a technical factor influencing where wave energy is developed. Taking wave energy out of the system may influence sedimentary processes in the shadow of any devices. Localized scour may occur around larger, bottom based structures.

Status and Trends

There are few data available on status and trends of ocean sediments outside of the Columbia River cell. Data were obtained for the cumulative effects framework on sediment type and thickness, but there no information on trends could be found. Although there is substantial new research on near shore processes by the state Department of Geology and Mineral Industries, the findings are not available yet.

Some information was available on the trends in sediment dynamics for the Columbia River. The long-term sediment budget for the Mouth of the Columbia River (MCR) indicates that approximately 4.4 M cubic yards of sediment are transported to the continental shelf north of the MCR on an annual basis. Because of dam installation in the last 50 years, sediment transport by Columbia River to the estuary/ocean has decreased substantially (Department of Land Conservation and Development, 2008; Wise, Rinella, & Rinella, 2007).

Data sets

Seabed type and sediment depth.

Categorization

Dataset name:	Seabed type
Dataset description:	Surficial Geologic Habitat maps for the Washington and Oregon continental margins
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	No data
	Boulder
	Cobble
	Gravel
	Mud
	Rock
	Sand
	Shell

Dataset name:	Sediment depth
Dataset description:	Total Sediment Thickness of the World's Oceans & Marginal Seas
Dataset source:	National Oceanic and Atmospheric Administration (NOAA), National Geophysical Data Center (NGDC)
Range:	0-2032 m

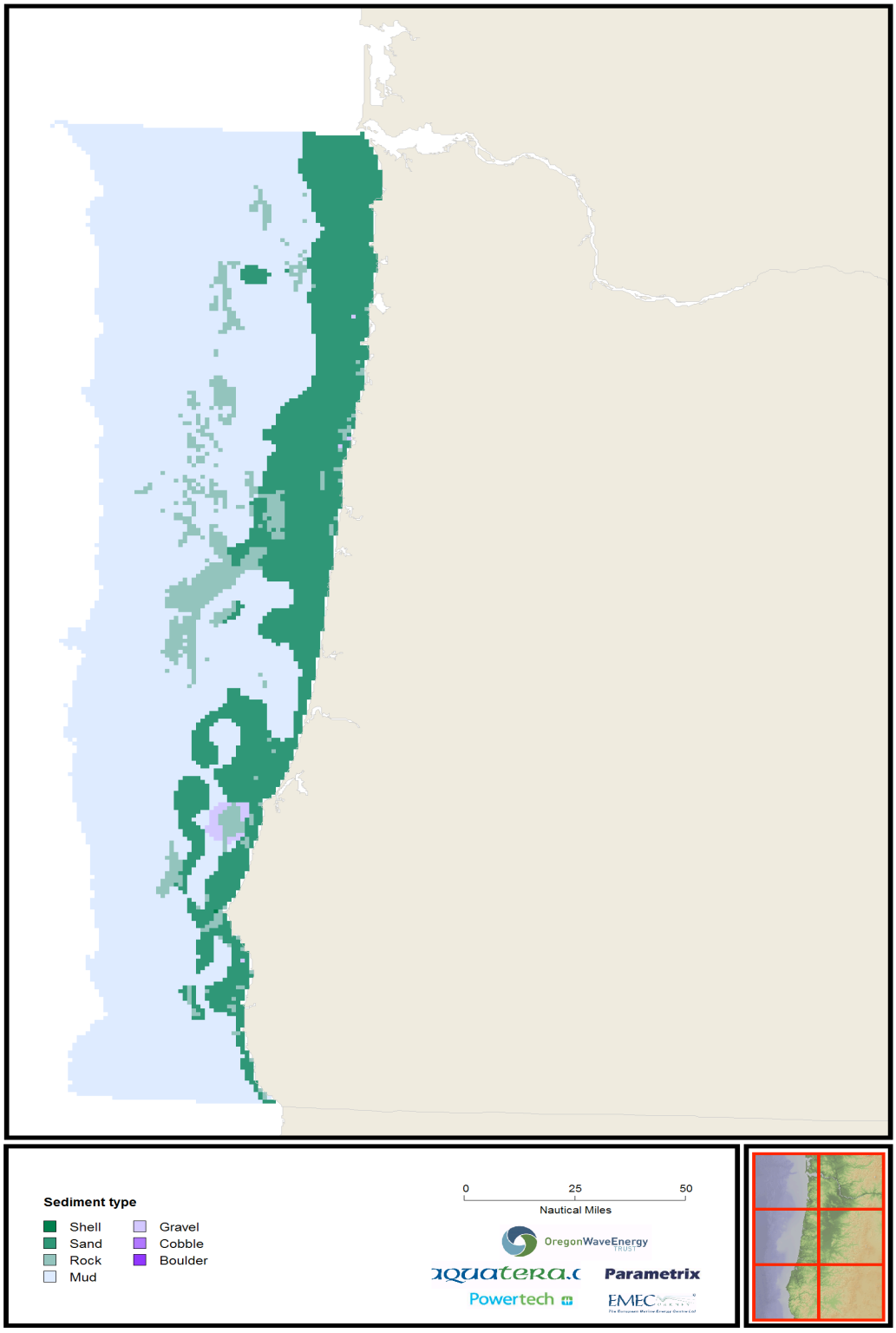


Figure 2.3 Raster map showing seabed type

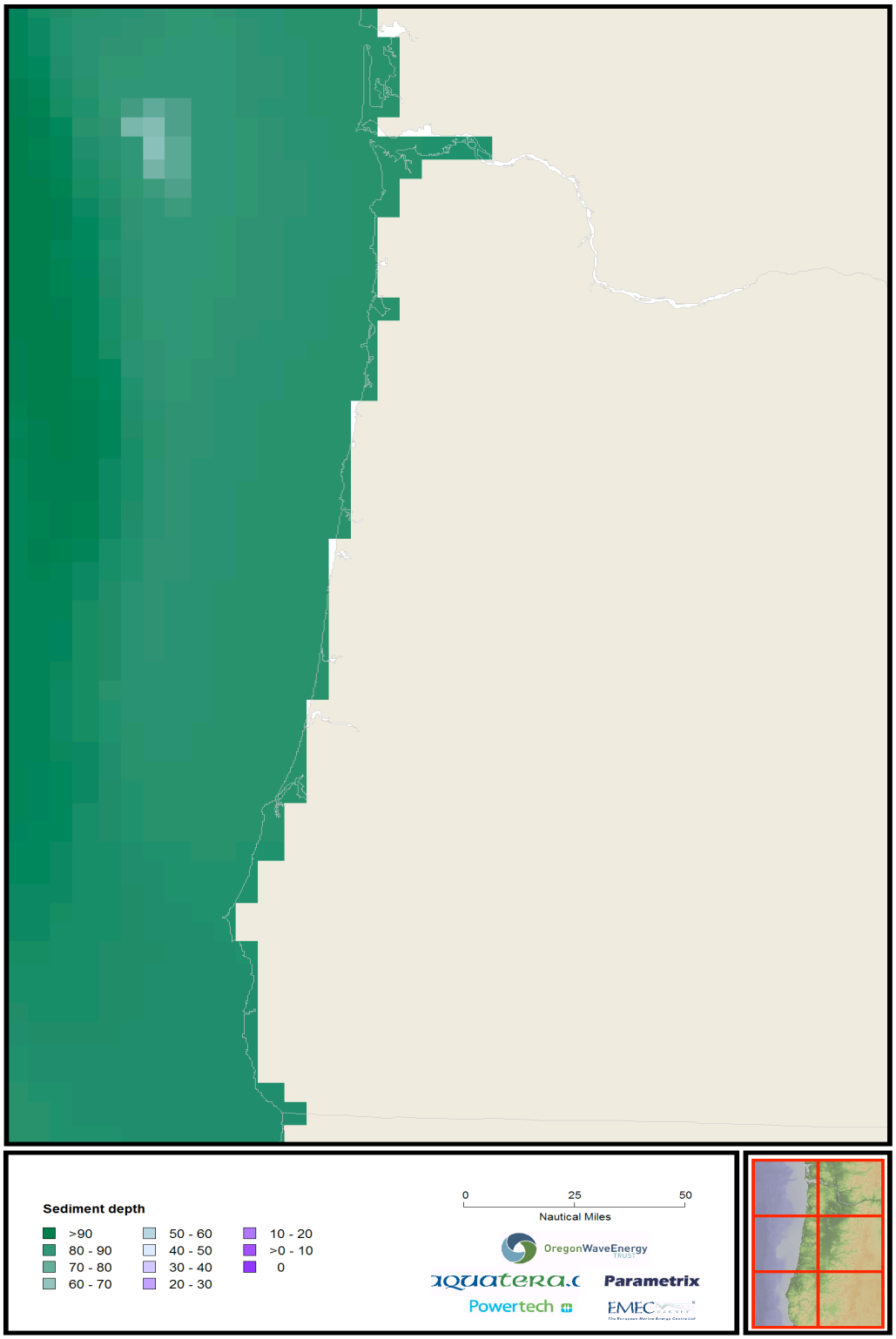


Figure 2.4 Raster map showing sediment depth

2.4.2 Water Depth

Description

Water depth, also referred to as bathymetry, is considered to be a technical factor potentially influencing wave energy development. Depth currently limits certain wave technologies. Similarly certain fishing or other ocean uses are also depth limited. The bathymetry helps understand where these different activities are possible and not possible.

Status and Trends

Not applicable.

Data sets

Bathymetry. This is a combined data set with elevation, thus negative numbers indicate the water depth below sea level while positive number indicate height above sea level.

Categorization

Dataset name:	Bathymetry
Dataset description:	Digital elevation model. Includes both positive and negative heights
Dataset source:	National Oceanic and Atmospheric Administration (NOAA), National Geophysical Data Center (NGDC)
Range:	-3200 to 4200 meters

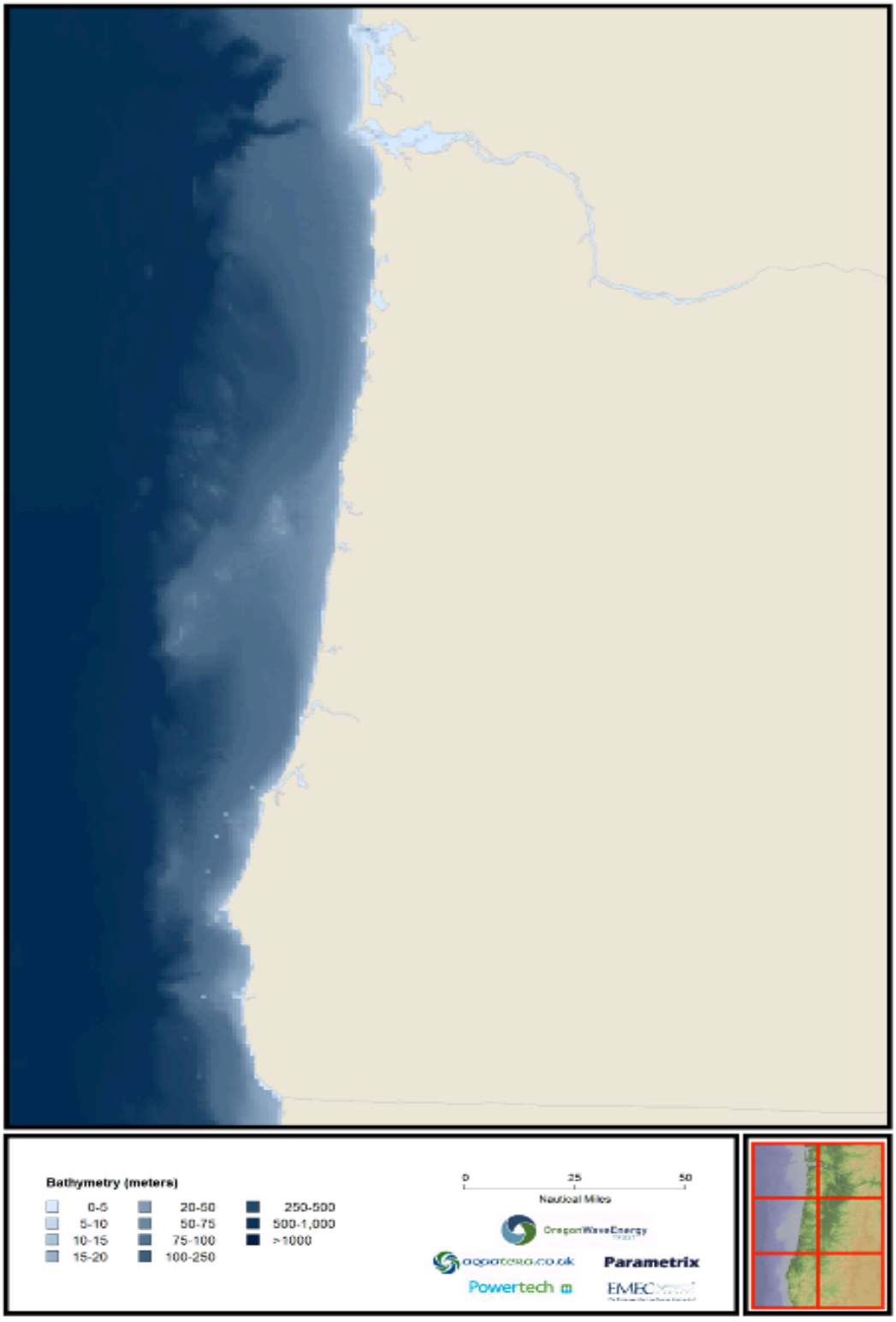


Figure 2.5 Raster map showing water depth

2.4.3 Seabed morphology

Description
Seabed morphology refers to the physical shape of the seabed, such as whether there are ridges, fracture zones, or fan facies. The morphology of the seabed will influence where wave energy developments are placed, and as such is considered to be a technical factor.

Status and Trends
Not applicable.

Data sets
Seabed morphology.

Categorization

Dataset name:	Seabed morphology
Dataset description:	Geologic interpretation of the Geologic LO-Range Inclined Asdic (GLORIA) data for the U.S. Pacific Coast
Dataset source:	U.S. Geological Survey
Categories:	Continental margins
	Sediment, fan facies
	Sediment, channeled
	Sediment-fan facies with large bedforms
	Basement fracture zone
	Basement ridge with thick sediment cover

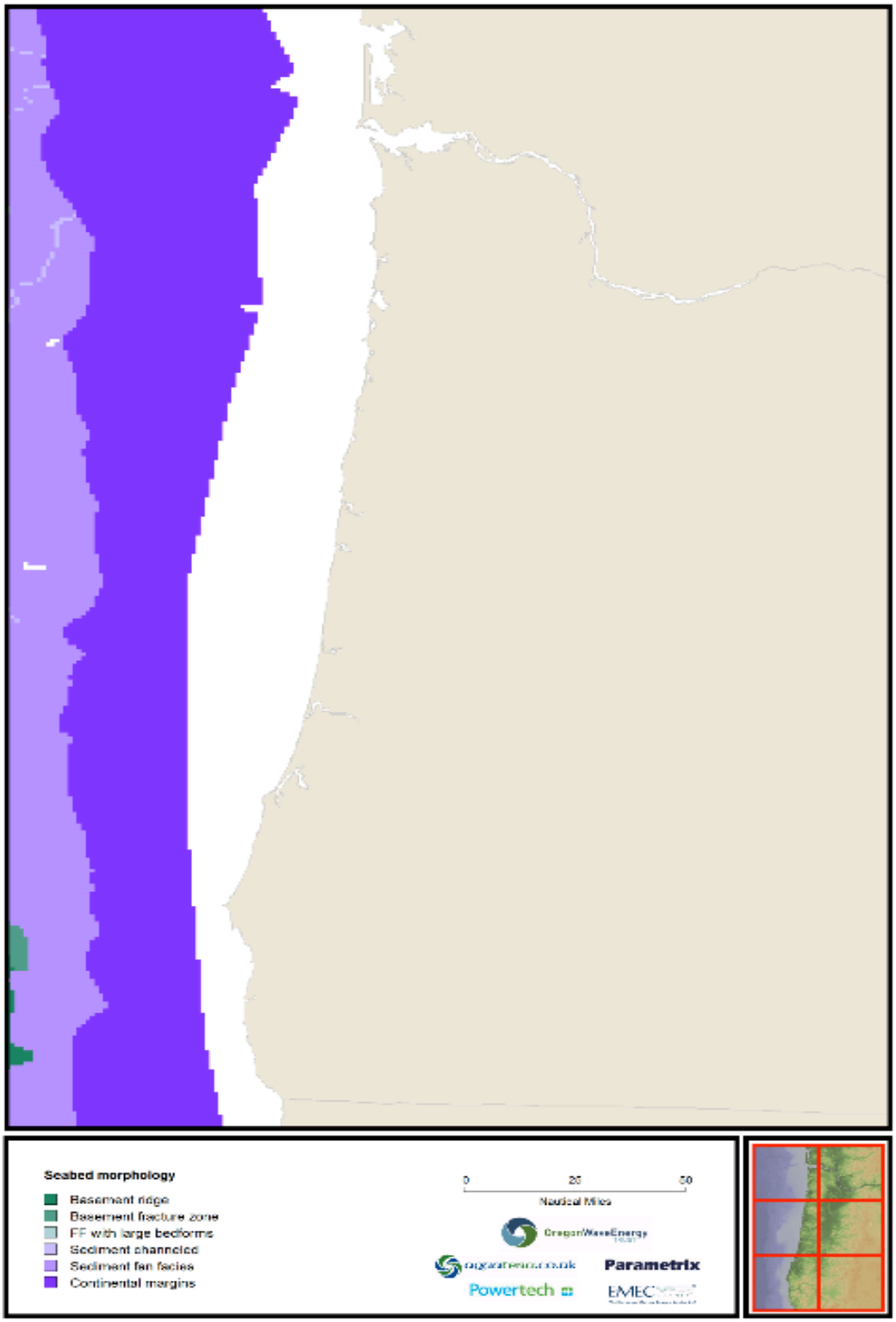


Figure 2.6 Raster map showing seabed morphology

2.4.4 Offshore Geology

Description
The geology of the seabed will influence placement of wave energy devices. Devices requiring any form of rock-bolt anchoring, or piling will need to consider the bedrock type.

Status and Trends
Not applicable.

Data sets
Bedrock type

Categorization

Dataset name:	Bedrock type
Dataset description:	Geological data of the ocean floor off Oregon and the adjacent continental margin
Dataset source:	Aquatera digitization of map from the State of Oregon Department of Geology and Mineral Industries
Categories:	Beyond continental margin
	Mudstone
	Siltstone
	Siliceous clay stone
	Mudstones, siltstones & clay stones
	Sedimentary

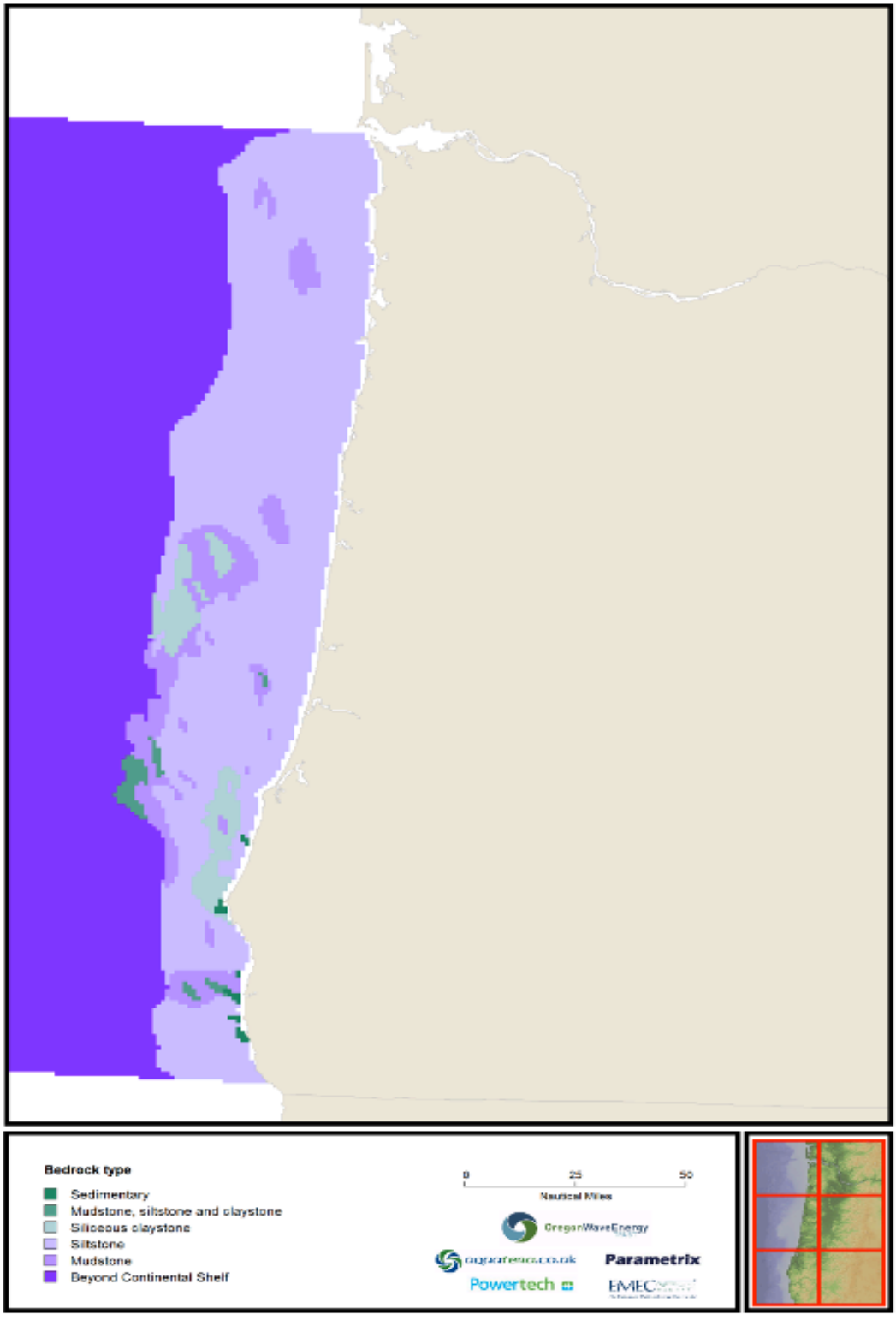


Figure 2.7 Raster map showing offshore geology: Bedrock Type

2.5 Coastline character

Factors which characterize the character of the coastline with regards to possible impacts from wave energy developments include:

- Coastal erosion and deposition
- Coastal morphology
- Coastal type

Coastal erosion is the only topic for which information was sourced for the framework. This topic is addressed in more detail below.

2.5.1 Coastal erosion

Description

The erosive potential of the shoreline may be sensitive to the placement of wave energy structures which can impact patterns of erosion and accretion due to their physical presence as well as operational impacts from energy attenuation.

Status and Trends

No information was gathered on status and trends of this sensitivity.

Data sets

Risk of coastal erosion

The data set was taken from a National Assessment of Coastal Vulnerability to Sea-Level Rise. One of the data sets used to determine the Coastal Vulnerability Index (CVI) was the shoreline erosion/accretion (m/yr). Depending on the levels of erosion/accretion, each coastal cell was assigned a category of Very Low, Low, Moderate, High, or Very High.

Categorization

Dataset name:	Risk of coastal erosion
Dataset description:	Part of a dataset describing the Coastal Vulnerability Index of the US Pacific coast
Dataset source:	
Categories:	No data
	Very Low (>2.0 m/yr)
	Low (1.0-2.0 m/yr)
	Moderate(-1.0 - +1.0 m/yr) (stable)
	High (-1.1 - -2.0 m/yr) (erosion)
	Very High (<2.0 m/yr)

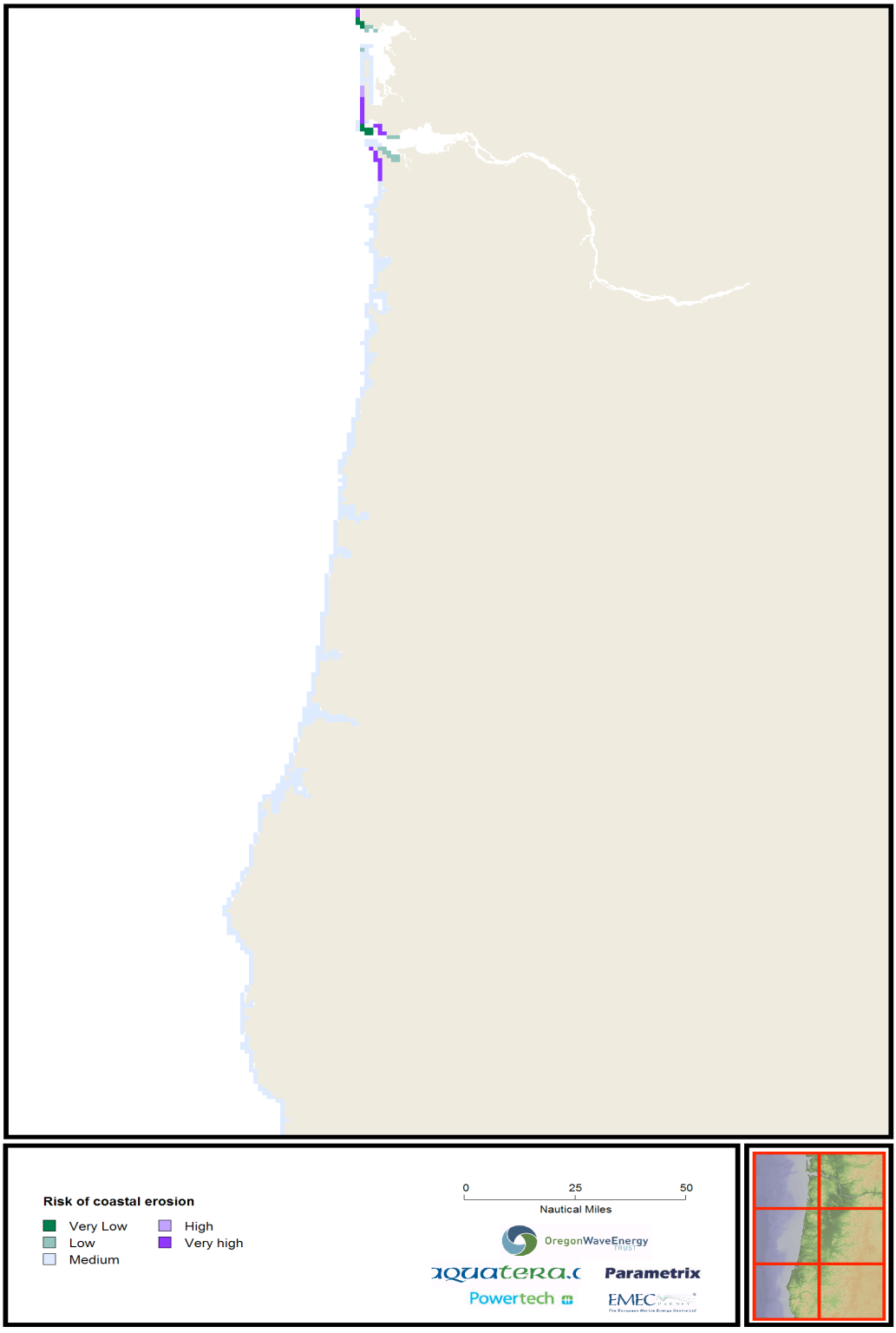


Figure 2.8 Raster map showing risk of coastal erosion

2.6 Land character

Land character is most likely to be related to the land-based aspects of wave energy development, for example, landing points and substations. Factors which characterize the character of the land with regards to possible impacts from wave energy developments include:

- Soil quality
- Land morphology
- Geology
- Land stability

Information on land morphology and onshore geology was considered for this framework, and these technical factors are described in more detail below.

2.6.1 Land morphology

Description
Land height may influence locations and routes for onshore infrastructure such as cables and substations.

Status and Trends
Not applicable.

Data sets
Elevation

Categorization

Dataset name:	Elevation
Dataset description:	Digital elevation model. Includes both positive and negative heights
Dataset source:	National Oceanic and Atmospheric Administration (NOAA), National Geophysical Data Center (NGDC)
Range:	-3200 to 4200 meters

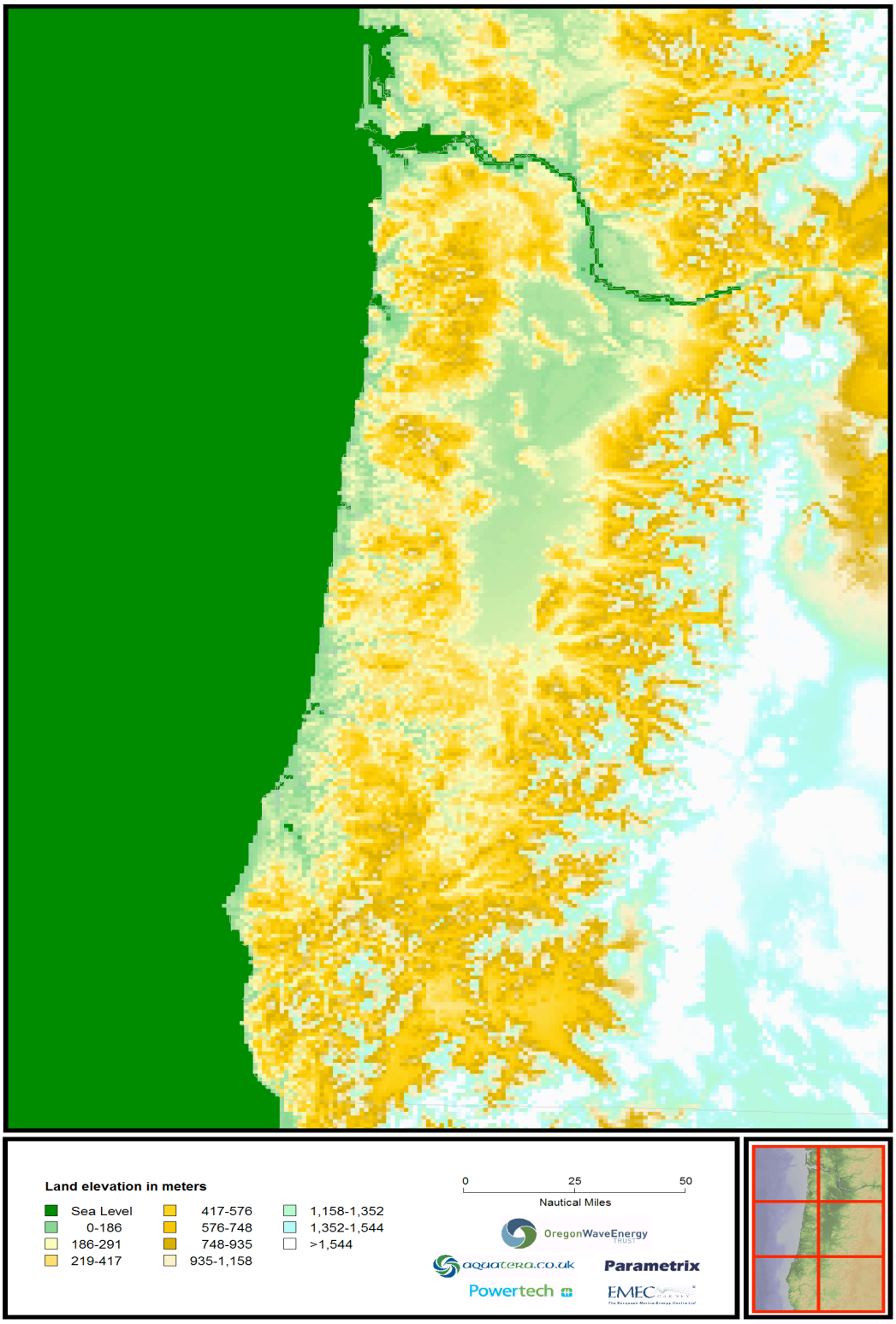


Figure 2.9 Raster map showing elevation

2.6.2 Onshore Geology

Description
As with elevation, onshore geology may influence locations and routes for onshore infrastructure such as cables and substations. However, as this was not considered to be of primary importance, the available data sets were not used for the framework.

Status and Trends
Not applicable.

Data sets
Geology.

2.7 Freshwater character

Factors which characterize the character of freshwater with regards to possible impacts from wave energy developments include:

- Fresh water quality
- Water body types
- Water flow dynamics

Only water body types were considered to be of primary importance for this phase of the framework.

2.7.1 Water body types

Description
This technical factor describes the location of streams, rivers, ponds, lakes, etc. These landscape features will influence the location of onshore facilities such as landfalls and substations.

Status and Trends
Not applicable

Data sets
Water bodies

Categorization

Dataset name:	Water bodies
Dataset description:	Water body data for the Oregon Framework Hydrography data and the standard system used to identify the state's surface water
Dataset source:	Pacific Northwest Hydrography Framework
Categories:	No water body
	Reservoir
	Marsh/Wetland
	Falls
	Dams
	Streams/Rivers
	Ditch/Canal
	Lake/Pond
	Impoundments
	Flats

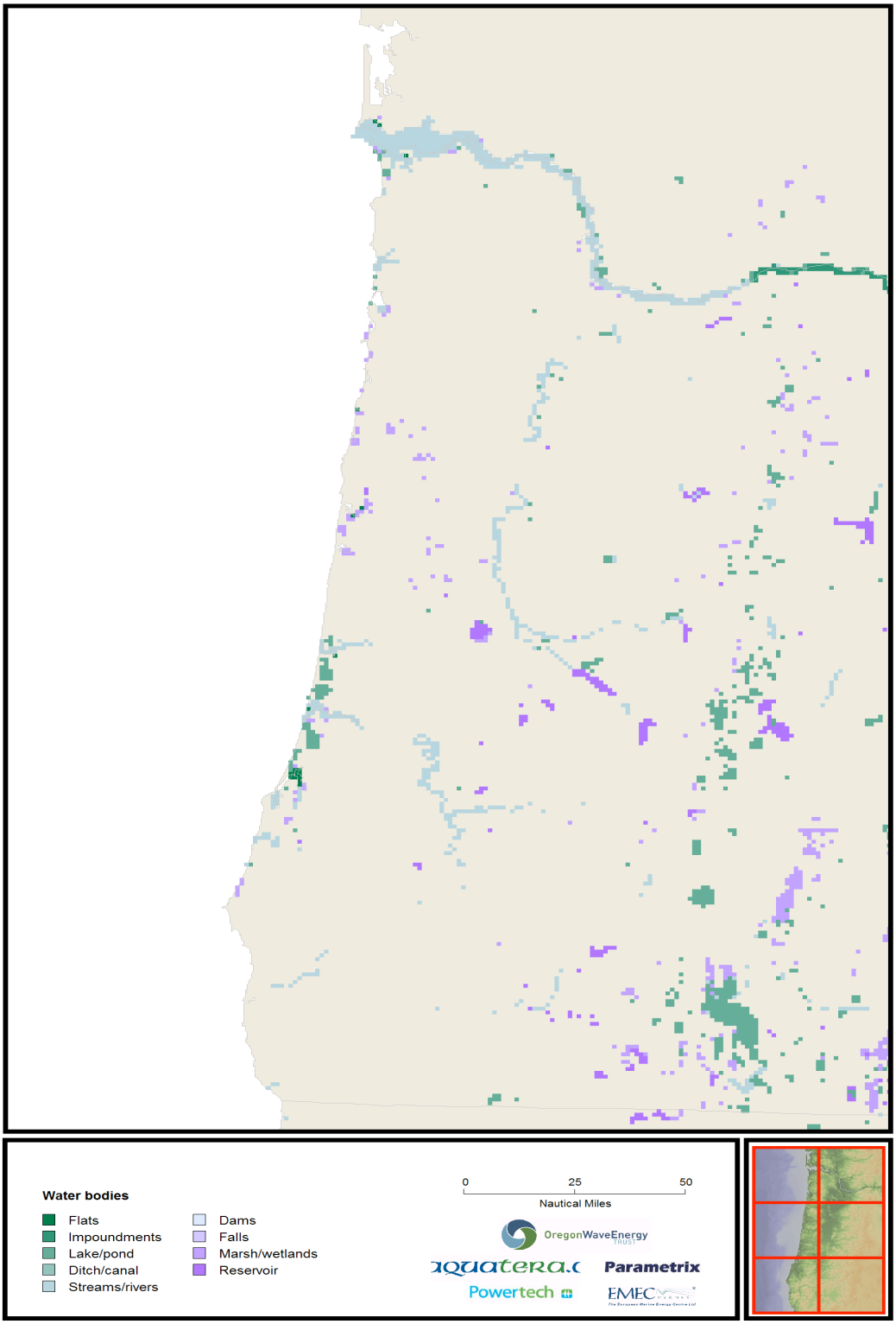


Figure 2.10 Raster map showing water bodies

3 The Ecological Environment

3.1 Introduction

Ecological systems in the marine, coastal, and terrestrial environments in Oregon are likely to be affected by the development of wave energy, from the energy conversion devices and moorings at sea, to the cables, substations, and overhead lines that transport the energy onto land. Within the marine environment, potential biological sensitivities include seabed communities (invertebrates, kelp, etc.), plankton, fish, marine mammals, sea turtles, and seabirds. Within the coastal environment, shorebirds and nesting seabirds may be affected by wave energy, as could communities occupying rocky shores, sandy shores, and estuaries. Terrestrial and freshwater ecosystems may also be affected by the development of wave energy; however, these were not considered for this phase of the framework.

Table 3.1 Sensitivities of the Ecological Environment

Category	Sensitivity
Marine Ecosystems	Seabed communities
	Plankton
	Fish
	Seabirds
	Marine mammals
	Sea turtles
Coastal Ecosystems	Birds
	Seals and sea lions
	Coastal communities

3.2 Marine ecosystems

The marine environment off the Coast of Oregon contains 4 recognized zones: a near shore zone; the middle and outer continental shelf; the pelagic zone; the benthic and demersal zone. The varieties of organisms inhabiting these zones that may be affected by wave energy development include:

- seabed communities
- plankton
- fish
- seabirds
- sea turtles
- marine mammals

Each of these sensitivities is described in more detail below.

3.2.1 Seabed communities

Description

Seabed communities include the flora and fauna which live in, on, or around the seabed such as vegetation including kelp, invertebrates such as echinoderms and crustaceans, and the fouling community, which attaches to structures.

Status and Trends

Kelp beds in Oregon generally form on rocky substrates in water depths of between 5 and 20 meters, with some extending to 25 meter depth. Most kelp beds in Oregon consist of bull kelp (*Nereocystis luetkeana*), a fast-growing plant that produces a large biomass of plant material every year. Bull kelp beds grow rapidly in spring and summer, but during the winter, storms dislodge most of the plants, leaving little or no surface canopy. There is also considerable interannual variation in the size of kelp beds, depending on the combinations of physical and biological variables that affect plant growth.

Kelp beds are biologically rich environments supporting a diverse array of fish species as well as providing habitat for seabirds and marine mammals. Kelp beds alter habitat characteristics of the reef by providing vertical habitat structure that otherwise would not exist, and that provides cover and settling areas for juvenile and adult fish and invertebrates and cover and feeding areas for seabirds and marine mammals.

Kelp beds are relatively rare habitats in Oregon's near shore, covering less than one percent of the near shore area. Approximately 92 percent of the state's kelp beds occur along the strip of Coast from Cape Arago south. Although there are other rocky reefs in the appropriate depth range, many never, or rarely, support kelp beds. Factors that may limit kelp on these reefs include too much wave and storm exposure, locally high turbidity, seasonal sand burial of the reef, sand scour of the rocks, exposure to nutrient-rich waters, distance from other sources of kelp, predation (e.g., sea urchins) and competition for rock surface available for attachment (Mackay, April 14, 2006).

No information was available on status and trends of other aspects of the seabed community.

Data sets

Kelp.
A data set on benthic trawl invertebrates was found but the data were not considered adequate to include in the framework. No other data sets related to the seabed community were found.

Categorization

Dataset name:	Kelp
Dataset description:	Oregon coastwide inventory of canopy kelp
Dataset source:	Oregon Coastal Atlas
Categories:	Areas of no kelp observations
	Areas of kelp observations

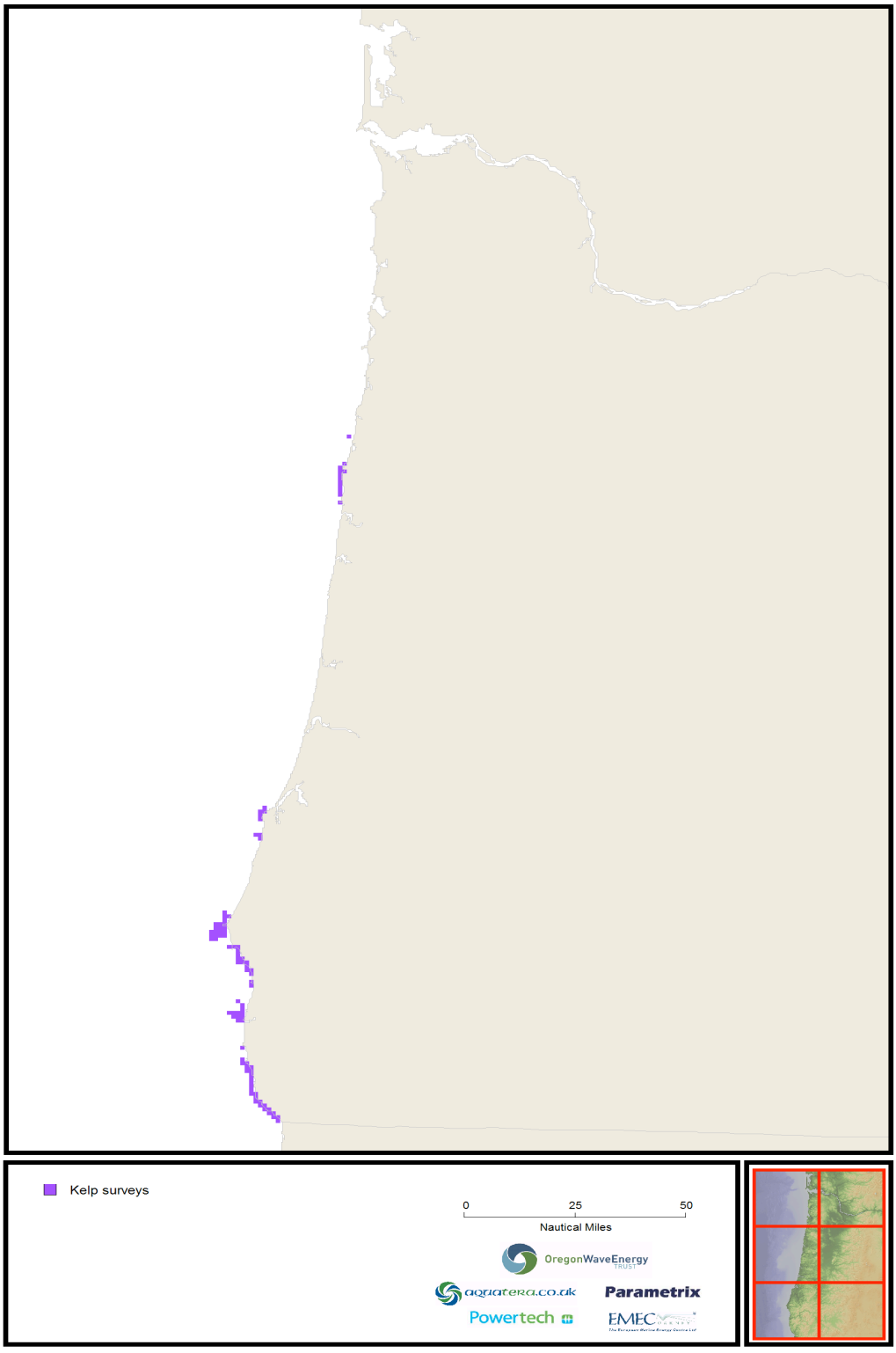


Figure 3.1 Raster map showing kelp surveys

3.2.2 Plankton

Description

Plankton refer to all of the drifting organisms inhabiting the pelagic zone. Plankton include microscopic organisms, fish fry and other larvae, as well as much larger organisms such as jellyfish. There are several categories of plankton, including phytoplankton, zooplankton, and neustonic plankton.

Status and Trends

Phytoplankton biomass is highest closest to shore during upwelling events, generally in mid to late summer. Copepod abundance is high out to 100m depth and declines beyond that point. Krill are most abundant in water depths of 200 to 800m (Boehlert et al. 2008).

Plankton in the North California Current (NCC) are highly influenced by the Pacific Decadal Oscillation (PDO) and El Nino/Southern Oscillation (ENSO). Scientists with the Northwest Fisheries Science Center use a specific type of plankton, copepods, as ecological indicators of the type of water being transported into the NCC. For example, the presence of subtropical species off Oregon indicates transport of subtropical water into the NCC. Likewise, the presence of coastal, subarctic species indicates transport of coastal, subarctic waters. Generally, species diversity of copepods is lower during the summer months and higher during winter months as a result of seasonally varying circulation patterns of coastal currents (Northwest Fisheries Science Center, 2009).

Data sets

Chlorophyll a levels. The level of Chlorophyll a is an index of phytoplankton biomass.

Categorization

Dataset name:	Chlorophyll a levels
Dataset description:	Climatologies of monthly means for sea surface chlorophyll on a 0.32º latitude by 0.32º longitude grid
Dataset source:	PaCOOS West Coast Habitat Server
Categories:	>0 – 1 mg/m^3
	>1 mg/m^3

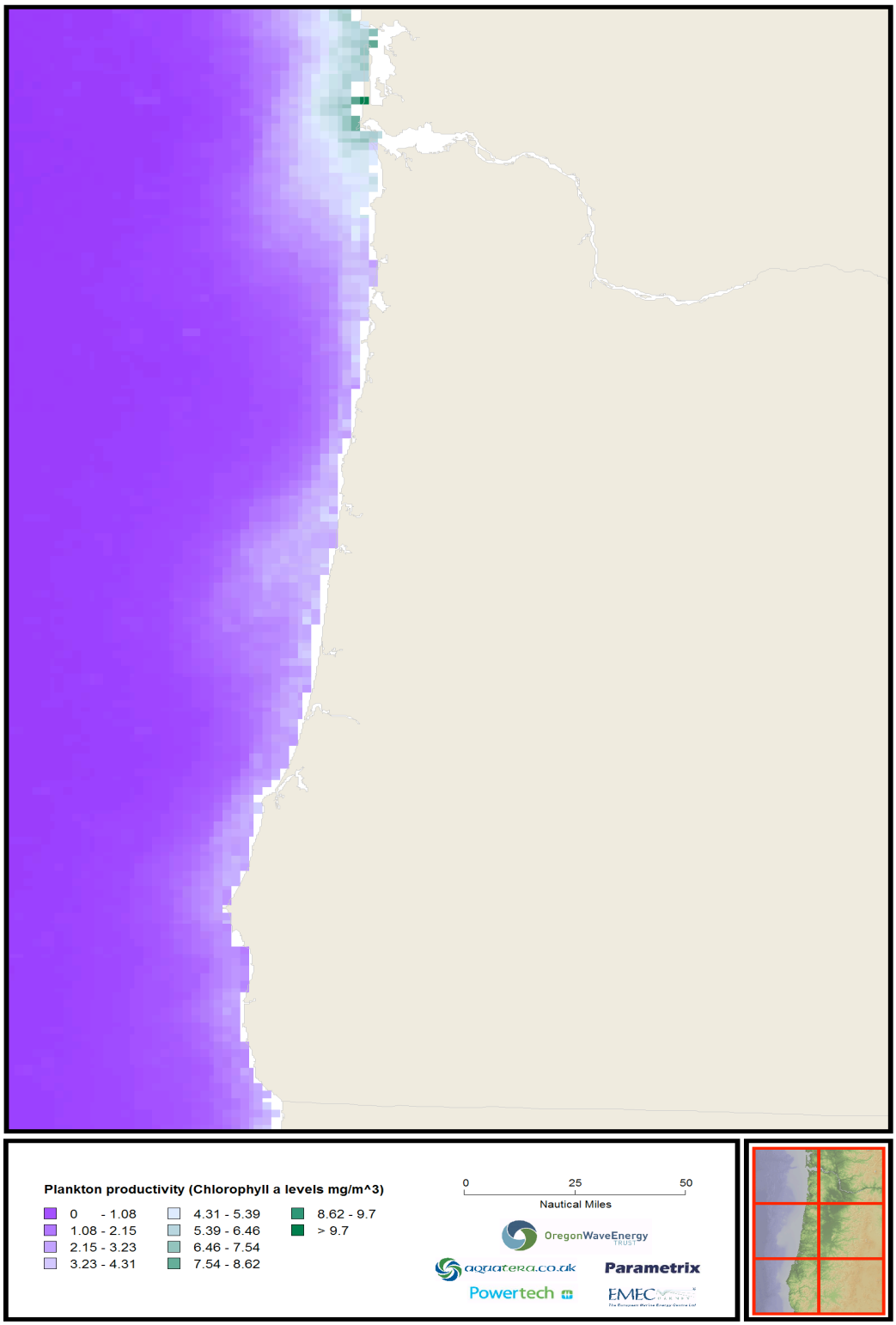


Figure 3.2 Raster map showing plankton productivity

3.2.3 Fish

Description

Marine fish are categorized by pelagic (within the water column) and demersal (bottom-dwelling) species assemblages. Anadromous fish may be either pelagic or demersal depending on the life stage and consist of migratory fishes which breed in freshwater but live most of their lives at sea. Fish may be affected by development of wave energy through a variety of mechanisims. For example, they may be attracted to devices, certain types of devices may create a risk of entrainment for small individuals, the presence of devices may affect movement patterns, etc.

Status and Trends

The status of anadromous fish is a prominent concern in the Pacific Northwest. A number of populations of salmonids have been declining. Oregon Department of Fish and Wildlife manages the state's native fish species. In their Native Fish Status Report (Oregon Department of Fish and Wildlfe, 2005), ODFW assesses the status of 33 anadromous fish runs in Oregon. Of these, they consider 8 salmonid runs to be extinct, 11 salmonid runs to be currently at risk, 7 runs to be vulnerable or potentially at risk, and 7 runs not currently at risk (Table 3.2). Of the non-salmonids, three species are at risk, two runs are potentially at risk, and four runs are not considered to be at risk (Oregon Department of Fish and Wildlfe, 2005).

Of 22 runs in Oregon considered for listing under the Endangered Species Act (ESA), 15 salmonid runs have been listed as either Threatened or Endangered, and one species is designated a "Species of Concern." Listed species are shown in Table 4.2. The listing of several salmon stocks as threatened or endangered under the ESA coincides with a prolonged period of poor ocean conditions that began in the early 1990s. The impact of El Niño events on survival of Coho Salmon is well documented. For example, the cool PDO years of 1947–1976 coincided with high returns of Chinook and Coho Salmon to Oregon rivers. Conversely, during the warm PDO cycle that followed (1977 – 1998), salmon numbers declined steadily (Northwest Fisheries Science Center, 2009; Northwest Fisheries Science Center, 2009).

The National Marine Fisheries Service considers the following non-salmonid species to be "Species of Concern" although they have not been officially designated as Threatened or Endangered. According to Natureserve, there is evidence of declining populations of pinto abalone, but evidence of declines in other species is uncertain (NatureServe, 2009).

- Green sturgeon, Northern DPS
- Cowcod
- Pacific Hake
- Pinto abalone

Table 3.2 Status of native anadromous fish runs, according to ODFW
(From: Oregon Department of Fish and Wildlfe, 2005)

Extinct species	*Species at risk*	*Vulnerable or potentially at risk*	*Not at risk*
Salmonids			
• Interior Columbia coho • Klamath coho • Upper snake spring Chinook • Upper Klamath spring Chinook • Lower Columbia chum • Mid Columbia sockeye • Snake River sockeye • Upper snake summer steelhead	• Lower Columbia coho • Lower Columbia fall Chinook • Coastal Chinook – spring run • Lower Columbia spring Chinook • Willamette spring Chinook • Lower snake spring Chinook • Coastal chum • Lower Columbia winter steelhead • Lower Columbia summer steelhead • Mid Columbia summer steelhead • Klamath summer steelhead	• Mid Columbia fall Chinook • Snake River Fall Chinook • Rogue spring Chinook • Mid Columbia spring Chinook • Coastal winter steelhead • Willamette winter steelhead • Coastal summer steelhead	• Coastal coho • Rogue coho • Coastal fall Chinook • Rogue fall Chinook • Rogue winter steelhead • Rogue summer steelhead • Lower snake summer steelhead
Non-salmonids			
	• Oregon Chub • Pacific lamprey • Western brook lamprey • Eulachon	• Lower Columbia coastal cutthroat • Green sturgeon	• Oregon coastal cutthroat • Southern Oregon coastal cutthroat • Willamette coastal cutthroat • Oregon white sturgeon

Data sets

No data sets on the distribution of fish were available for cumulative effects framework. Data sets related to protected habitats for listed species are included and are described in more detail in Section 4.0 Conservation.

3.2.4 Seabirds

Description

Seabirds which forage at sea or migrate at sea are included in this category. Nesting seabirds are included in Coastal Ecosystems. Seabirds at sea may be impacted by the presence of lights associated with wave energy facilities, oil or chemical spillage, and potentially collision with wave energy devices or moorings.

Status and Trends

Within the U.S., the U.S. Fish and Wildlife Service (USFWS) is the principal federal agency responsible for the protection and management of migratory birds, including seabirds. The agency has produced a Seabird Conservation Plan for the Pacific Region, which identifies the USFWS's priorities for seabird management, monitoring, research, outreach, and planning. The status and trends of seabirds in Oregon as summarized in this document is shown in Table 3.3 (US Fish and Wildlife Service , 2005). Some species are declining, others are increasing, others are stable, and for some species, there is not enough information to determine the population trend.

Table 3.3 Trends in seabird populations in the Pacific region

Species	Current Status
Increasing	
Double-Crested Cormorant	Widespread
Caspian Tern	Apparently secure; largest colony in Oregon
Increasing/stable	
Ring-Billed Gull	Abundant
California Gull	Abundant
Western Gull	Endemic to west
Stable	
Pelagic Cormorant	Stable
Common Murre	Abundant; core of breeding population in OR
Declining	
Brandt's Cormorant	Endemic to West Coast
Cassin's Auklet	Abundant and widespread
Tufted Puffin	Abundant, esp. in BC and north
Unknown	
Fork-Tailed Storm Petrel	Widely distributed throughout North Pacific
Leach's Storm Petrel	Widespread
Pigeon Guillemot	Endemic to North Pacific
Rhinoceros Auklet	Abundant

Common Murres are of particular importance in Oregon since 66 percent of the breeding population occurs along the Oregon Coast. In addition, the largest colony of Caspian Terns in the world occurs on East Sand Island in the Columbia River, comprising 70% of the Pacific coastal population.

There are currently two seabirds that occur in Oregon that are listed under the ESA, the Short-Tailed Albatross, and the Marbled Murrelet. The Brown Pelican was recently determined to be recovered and was subsequently delisted. Although they do not breed in Oregon and occur only as a transient here at this time, historically Short-Tailed Albatrosses were common year-round off the western coast of North America (NatureServe, 2009).

The Marbled Murrelet is listed as threatened under the ESA. It is a small seabird that nests on mossy platforms of mature trees in coastal forests. Population trends are considered to be severely to very rapidly declining (decline of 50% to >70%). On the southern coast of Washington, north coast of Oregon, and in California south of Humboldt County, Marbled Murrelets are rare or uncommon where they once were common or abundant in the early 1900s (NatureServe, 2009). Murrelet declines are connected to loss of breeding habitat. However, the Marbled Murrelet also faces threats in its marine environment including oil spills, and bycatch in gillnets (US Fish and Wildlife Service, 2009; US Fish and Wildlife Service , 2005).

Data sets

No data sets were found related to the distribution of foraging seabirds. See Coastal Ecosystems for datasets relating to nesting seabirds.

3.2.5 Marine Mammals

Description

Marine mammals that occur off the Oregon Coast include various species of cetaceans, seals, and sea lions. Seal and sea lion haul outs and rookeries are covered under the Coastal Ecosystems section. Sea otters, an Endangered species, formerly occurred off the Oregon Coast, but were extirpated over 100 years ago due to trapping.

Marine mammals may be at risk of collision or entanglement with marine energy moorings. Their sensitivity to sounds may lead to impacts during device installation or decommissioning. In addition, some marine mammals may be attracted to devices if the devices act as Fish Attractants and concentrate potential prey.

Status and Trends

NOAA Fisheries monitors and conserves marine mammals through implementation of the ESA and the Marine Mammal Protection Act. At least twenty-nine different species of marine mammals occur in Oregon Coast waters, including many whales, dolphins, and porpoises, all of which are afforded protection under the MMPA (Table 4.3). Of these, eight species are also protected under the ESA (see Table 4.2).

NOAA Fisheries has produced stock assessment reports for marine mammals. According to these reports, the status and trends of marine mammals that occur off the coast of Oregon is shown in Table 3.4 (NOAA Fisheries, Various years). There are three marine mammals with increasing population trends, one with a stable trend, one with a variable trend, and several species for which the population trend is unknown.

Table 3.4 Status and trends of marine mammals that occur in Oregon.

Species	Current Status	Trends
Cetaceans		
Dall's Porpoise	Not listed	Unknown; natural variability
Pacific white-sided dolphin	Not listed	Unknown; natural variability
Risso's dolphin	Not listed	Unknown; natural variability
Bottlenose dolphin	Not listed	Unknown; natural variability
Striped dolphin	Not listed	Unknown; natural variability
Short-beaked common dolphin	Not listed	Unknown; natural variability
Long-beaked common dolphin	Not listed	Unknown; natural variability
Harbor Porpoise	Not listed	Unknown
Northern right-whale dolphin	Not listed	No evidence of trends
Gray Whale	Recovered (delisted in 1994)	Increasing
Killer Whale	Endangered - Depleted	Variable
Humpback whale	Endangered	Increasing

Blue Whale	Endangered	No evidence of increase
Fin Whale	Endangered	No evidence of pop. trend
Sei whale	Endangered	Uncertain
Sperm whale	Endangered	Uncertain
Short-finned pilot whale	Not listed	Unknown; natural variability
Baird's beaked whale	Not listed	Unknown; natural variability
Mesoplodont beaked whales	Not listed	Unknown; natural variability
Cuvier's beaked whale	Not listed	Unknown; natural variability
Pygmy sperm whale	Not listed	Unknown; natural variability
Dwarf sperm whale	Not listed	Unknown; natural variability
Minke whale	Unknown	Unknown
Seals, sea lions, and sea otters		
Steller sea lion	Threatened	Increasing
California sea lion	Not listed	Stable
Harbor Seal	Not listed	Stable
Sea otter	Endangered (Extirpated from OR)	Unknown

Gray Whale

Although considered to be recovered and no longer listed under the Federal ESA, the Gray Whale is still listed as Endangered by the State of Oregon.

Most of the Eastern North Pacific stock of the Gray Whale spends the summer feeding in the northern Bering and Chukchi Seas. In the fall, the entire population migrates south along the coast of North America to their breeding and calving areas off the coast of Baja California, Mexico, where calves are born from early January to mid-February. From mid-February to May, Gray Whales can be seen travelling northward with newborn calves along the West Coast, utilizing the nearshore environment. Some Gray Whales have been reported feeding in waters off of Oregon during the summer,

Gray Whales are bottom feeders, and suck sediment and the "benthic" amphipods that are their prey from the sea floor.

Commercial whaling severely depleted both the eastern and western populations between the mid-1800s and early 1900s. A ban on commercial hunting beginning in the mid-1930s provided protection for this species. In 1994, the Eastern North Pacific stock of Gray Whales was removed from the ESA list, based on evidence that they were no longer in danger of extinction throughout all or a significant portion of their range and had recovered to near their estimated original population size. In 1999, the population was estimated at 26,600 individuals, and rising at 2.5% annually. The most recent abundance estimates are based on counts made during the 1997/98, 2000/01, and 2001/02 southbound migrations, and range from about 18,000-30,000 animals. NOAA Fisheries continues to monitor the abundance of the stock, especially as it approaches its carrying capacity.

Gray Whales are considered to be particularly vulnerable to impacts from commercial or industrial development or local catastrophic events because of the eastern stock's annual migration along the populated coastline of the western United States, and their concentration in limited winter and summer areas. Current threats include collisions with vessels, entanglement in fishing gear, habitat degradation, disturbance from ecotourism and whale watching, and disturbance from low-frequency noise (NOAA Fisheries Office of Protected Resources, 2007).

Data sets

Blue and Gray whale sightings. These sightings data have not been included in the framework at this time as the quality of the data sets is being evaluated.

3.2.6 Sea turtles

Description

Four species of sea turtle are occasionally sighted off the coast of Oregon. Of these, two are more likely to be found, the leatherback turtle and the loggerhead turtle.

Sea turtles may be at risk of entanglement in mooring lines of wave energy devices.

Status and Trends

Sightings and strandings of these sea turtles are very rare, and there are no breeding beaches in the Northwest Region (NOAA, 2009). The four species that are occasionally sighted off the coast of Oregon are all listed under the ESA (Table 4.2).

Leatherback sea turtles forage widely in temperate waters. Recent studies have documented trans- Pacific migrations of leatherback sea turtles between the western tropical Pacific and the California Current. Though generally considered a pelagic species, it is becoming evident that leatherbacks aggregate in productive coastal areas to forage on preferred jellyfish prey. Their presence in the California Current is highly seasonal. Along the Pacific Coast of North America leatherbacks exploit large aggregations of jellyfish during the summer and fall months. The principal Oregon/Washington foraging area is the nearshore area between Cape Flattery, Washington to Winchester Bay, Oregon. The greatest densities of a primary prey species *C. fuscescens* occur north of Cape Blanco, Oregon and in shallow inner shelf waters.

Conservation: The National Marine Fisheries Service (NMFS) is proposing to revise the current critical habitat for the leatherback sea turtle (*Dermochelys coriacea*) by designating additional areas within the Pacific Ocean. One of the additional areas proposed for designation is the nearshore area from Cape Flattery, Washington, to Umpqua River (Winchester Bay), Oregon and offshore to a line approximating the 2000 meter isobath. This area is the principal Oregon/Washington foraging area and includes important habitat associated with Heceta Bank, Oregon.

Data sets

No data available for the cumulative effects framework.

3.3 Coastal ecosystems

The coastal ecosystem includes communities inhabiting rocky shores, sandy shores, and estuaries, as well as shorebirds, nesting seabirds, and breeding and haul-out sites for seals and sea lions. Each of these sensitivities is described in more detail in the following sections.

3.3.1 Birds

Description
Birds using the coastal environment include shorebirds as well as seabirds nesting on rocks and cliffs. Shorebirds may be impacted by any changes to the wave climate at the shore. Shorebirds and seabirds may be susceptible to disturbance from installation and decommissioning of wave energy devices, particularly those near the shore.

Status and Trends
The status and trends of seabirds was discussed in the previous section.

The Snowy Plover is a shorebird that has been listed as threatened under the Federal Endangered Species Act since 1993. Populations have declined 10-30%, associated with changes in habitat availability. Historically found along the entire Oregon Coast, Snowy Plovers are today limited to just a handful of nesting sites. The main threats to the ground nesting Snowy Plover include habitat loss due to encroachment of invasive European Beach Grass, predation by wild and domestic animals, and disturbance from human activity. Although the overall breeding population trend is still down from historical numbers, the period from 1994 to present has shown a slight increase (US Fish and Wildlife Service, 2006).

Although not currently listed under the ESA, the Black Oystercatcher is a U.S. Fish and Wildlife Service "Species of Concern" because of its small population size, restricted range, and threats to habitat from human and natural factors that may potentially limit its long-term viability (US Fish and Wildlife Service, 2009).

Data sets
Island seabird colonies; shoreline seabird colonies

Categorization

Dataset name:	Shoreline seabird colonies
Dataset description:	Seabird colony locations along the Oregon Coast, with additional 1nm buffer
Dataset source:	Oregon Coastal Atlas
Categories:	Outside seabird colony shoreline segments and buffers
	Seabird colony shoreline segments
	Seabird colony shoreline segments (1nm buffer)

Dataset name:	Island seabird colonies
Dataset description:	This data set depicts groups of offshore rocks and islands that comprise a single censused seabird colony, with additional 1nm buffer
Dataset source:	Oregon Coastal Atlas
Categories:	Outside seabird Island colony and buffer
	Seabird Island colony
	Seabird Island colony (1nm buffer)

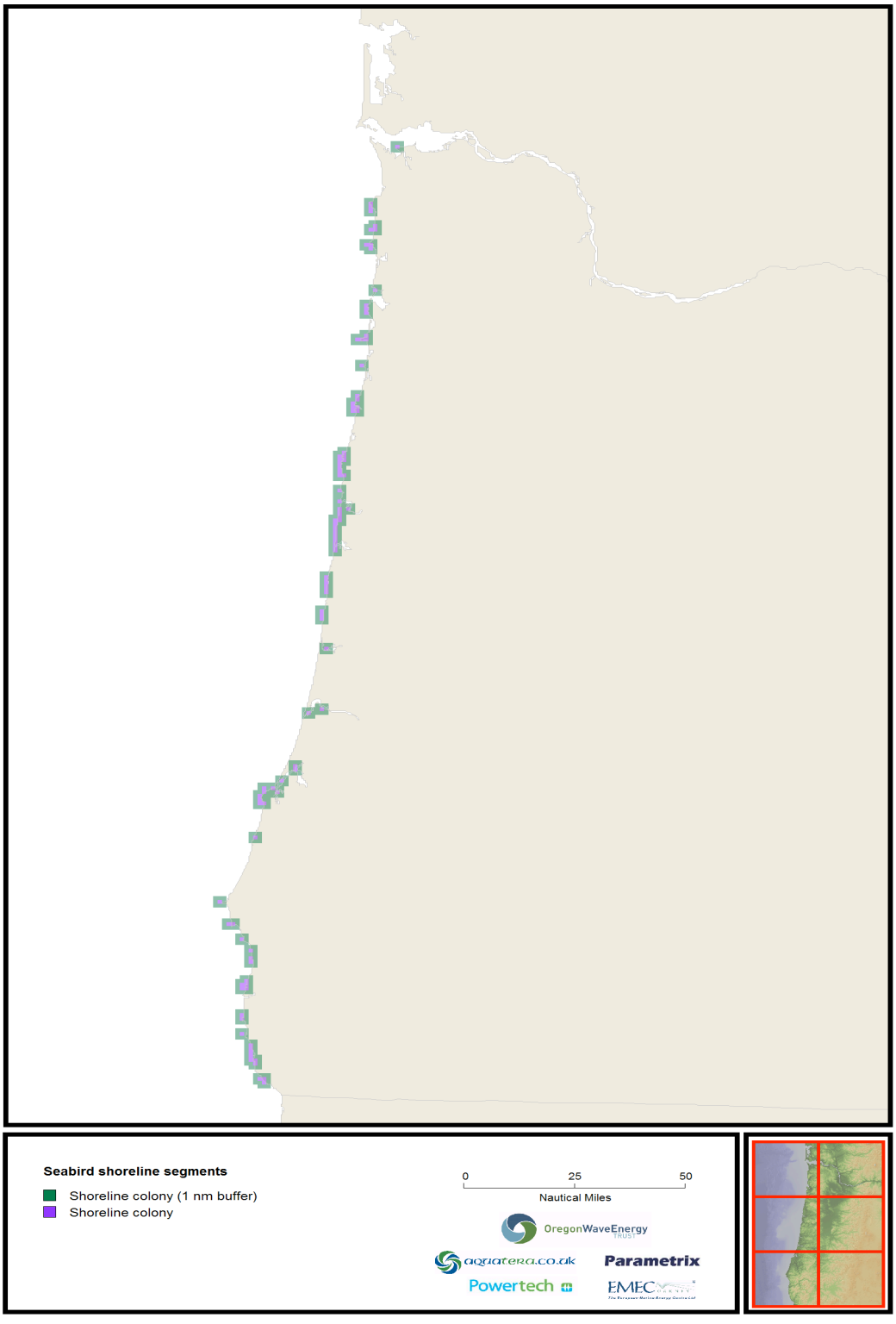


Figure 3.3 Seabirds: Raster map showing shoreline seabird colonies

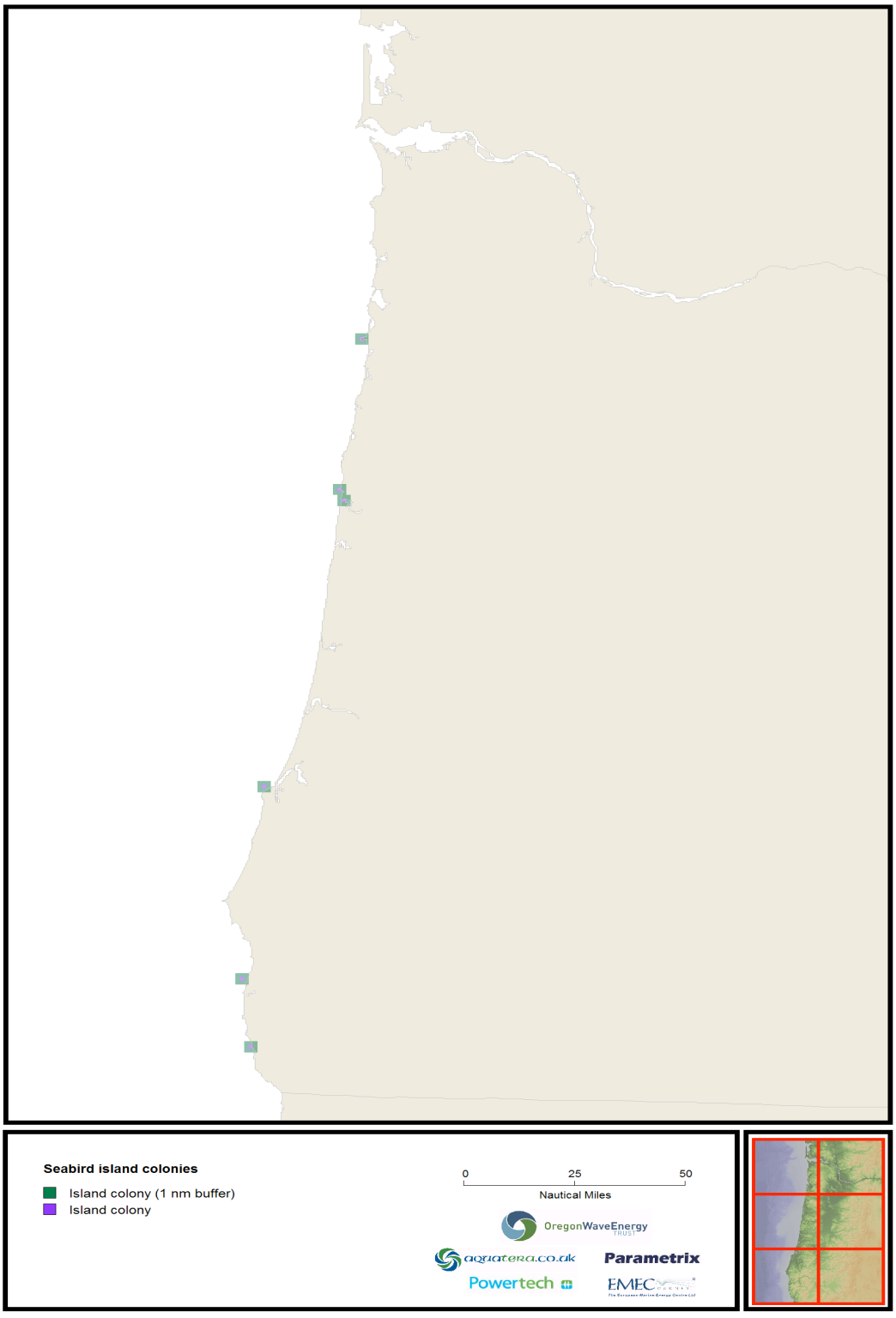


Figure 3.4 Seabirds: Raster map showing island seabird colonies

3.3.2 Seals and Sea Lions

Description

Harbor seals, Steller Sea Lions and California Sea Lions have breeding colonies and haul out sites on the coast and offshore islands.

Recreational activities such as walking/hiking, wildlife viewing, boating near rocky shore areas and scientific research all can disturb wildlife. Such disturbances may result in short-term or permanent abandonment of eggs or young by adults, changes in foraging or other behaviors and greater susceptibility to predators (Oregon Department of Fisheries and Wildlife, 2006).

Seals are at risk of boat strikes, oil spill exposure, chemical contaminants, and power plant entrainment (NOAA Fisheries Office of Protected Resources, n.d.). Incidental catch and entanglement in fishing gear, such as gillnets are threats, but estimated levels of fishery-related mortality are low. Algal blooms also have been linked to Sea Lion mortalities (NOAA Fisheries Office of Protected Resources, n.d.).

Status and Trends

All three species of pinnipeds are important predators in the marine ecosystem. Populations of California Sea Lions and Harbor Seals appear to be increasing.

California Sea Lions prefer sandy beaches for haul out sites, and may haul out on marina docks as well as jetties and buoys. The population has been increasing since at least 1975, and is believed to be approaching the carrying capacity of its environment (NOAA Fisheries Office of Protected Resources, n.d.).

Harbor Seals use rocks, reefs, and beaches as haul out and pupping sites. Harbor Seal populations in Oregon and Washington are at or approaching their carrying capacity (NOAA Fisheries Office of Protected Resources, n.d.).

Steller Sea Lions use of beaches (gravel, rocky or sand), ledges, and rocky reefs as haul out sites and as rookeries. They forage near shore and pelagic waters and may travel long distances in a season. Steller Sea Lions feed primarily at night on a wide variety of marine prey and their diet may vary seasonally depending on the abundance and distribution of prey (NOAA Fisheries Office of Protected Resources, n.d.).

The species was listed under the Endangered Species Act (ESA) in 1990 following substantial population declines. Recent population surveys suggest that the Eastern population is stable or increasing in the northern part of its range (Southeast Alaskan and British Columbia), but declining elsewhere (NOAA Fisheries Office of Protected Resources, n.d.).

All marine mammals are protected under the Marine Mammal Protection Act (Section 4.3.4). Critical habitat has been defined for Steller Sea Lions and includes a 20 nautical mile buffer around all major haul-outs and rookeries, as well as associated terrestrial, air and aquatic zones, and three large offshore foraging areas (50 CFR 226.202 on Aug. 27, 1993).

Data sets

Stellar Sea Lion rookeries

Categorization

Dataset name:	Steller Sea Lion rookeries
Dataset description:	Point layer of Steller Sea Lion rookery locations in Oregon, USA, with additional 1nm buffer
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside Stellar Sea Lion rookery
	Stellar Sea Lion rookery
	Stellar Sea Lion rookery (1nm buffer)

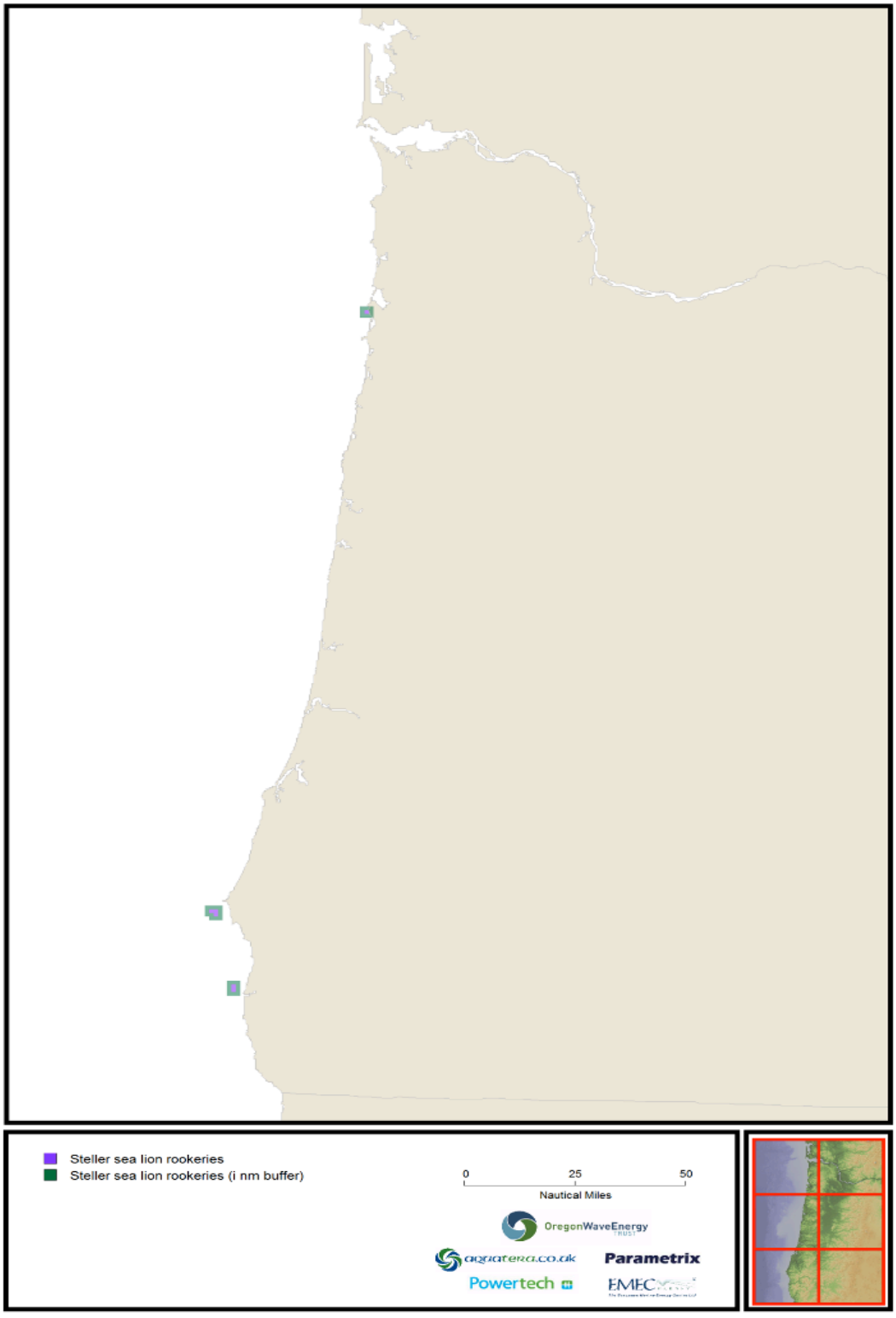


Figure 3.5 Raster map showing Steller Sea Lion rookeries

3.3.3 Coastal communities

Description

Coastal communities include the flora and fauna associated with rocky shores, sandy shores, and estuaries. They may be impacted by changes to the wave regime or coastal processes that may result from employment of wave energy devices.

Status and Trends

Rocky shore

There are approximately 82 linear miles of rocky shore habitat along the Oregon Coast. Rocky intertidal habitats have highly diverse biological communities, which include algae and other marine plants, attached and mobile invertebrates, fish, marine mammals, and sea birds. These communities are at risk of trampling and habitat loss due to heavy human use, which has been increasing. The harvest of mussels and piddocks also may result in the alteration of habitats and communities (Oregon Department of Fisheries and Wildlife, 2006).

Sandy shore

Sandy beaches make up approximately two-thirds of the Oregon coastline. The movement of sand makes sandy beaches largely unsuitable for many plants. The fauna of sandy beaches includes foraging fish and birds and invertebrates that burrow in the sand. Dominant groups are insects and some crustaceans in the upper intertidal zone, and crustaceans, mollusks and diverse worm taxa in the mid and lower intertidal zones (Oregon Department of Fisheries and Wildlife, 2006). There have been increasing beach closures in Oregon due to outbreaks of *Pseudonitzschia*, a diatom producing Domoic acid.

Estuaries

Estuaries occur where freshwater rivers meet the salty waters of the ocean and consist of a marine section at the river mouth, bays and side channel sloughs, and a riverine portion extending as far up as the tidal influence . Estuaries are often characterized by zones of vegetation influenced by variation in salinity, tidal inundation, and soils. Estuaries are complex, productive habitats critical for many fish and wildlife species, including salmon, crabs and other shellfish, marine mammals and seabirds. Major bays in Oregon include the Alsea, Coos, Nehalem, Nestucca, Netarts, Siletz, Tillamook, Yaquina, and Youngs Bays (Oregon Department of Fish and Wildlife, 2006). Estuary habitat has been decreasing in amount and quality due to development, changing hydrological regimes, degraded water quality as a result of stormwater runoff and agricultural runoff, changing complexity due to removal of woody debris, and introduction of invasive species (Oregon Department of Fish and Wildlife, 2006).

Estuaries are one of the most vulnerable habitats for invasives due to ship traffic and release of ballast water. For example, common cordgrass is an invasive grass that has been documented in two Oregon estuaries. Its impacts include reduction in mud flat habitats, disruption of nutrient flows, changing the beach profile and water circulation through trapping sediments, and displacement of native plants and animals. Species such as the European Green Crab and the New Zealand Mud Snail have been found in Oregon waters, likely introduced through ballast water. Available information indicates that extremely large invasive species problems are occurring in marine coastal systems of Oregon and are being overlooked. To date, no efforts to assess invasive species impacts have been attempted. (Oregon Department of Fisheries and Wildlife, 2006).

Data sets

No data sets were found for coastal communities.

3.4 Terrestrial & freshwater ecosystems

The terrestrial and freshwater ecosystems also may be impacted by wave energy development. Terrestrial communities, birds, mammals, reptiles and amphibians are all potentially impacted by the development of onshore structures which support wave energy such as substations and grid infrastructure. It was determined that these ecosystems were not of primary interest at this time, and a review of these ecosystems is beyond the scope of this report. However the framework is able to deal with these issues if and when they become necessary.

4 Conservation

4.1 Introduction

Conservation describes the statutory protection of habitats and species as well as other resources of cultural, historic, or aesthetic value, such as historic sites and scenic corridors. Some conservation is at a federal level, such as the Endangered Species Act, Marine Mammal Protection Act, or National Wildlife Refuges. Other conservation is at a state or local level, such as Marine Reserves and State Parks. For the purposes of the cumulative effects framework, conservation focuses on areas which have been designated for the protected of certain resources.

Due to its statutory nature, it is unlikely that wave energy projects would be allowed to have direct impacts on conservation; however, it is conceivable that some indirect impacts may occur. Although areas designated for conservation may have some sensitivity to wave energy development, conservation is also important as an activity that has existing impacts on the environment.

Conservation is considered to be a benefit to those values it is protecting. This is reflected in the framework to the extent that data were available. Conservation may also benefit other values or species than the ones it is specifically designed to protect; for example, National Wildlife Refuges designed to protect birds may also benefit shoreline and seabed communities as well as providing value for recreational activities such as wildlife watching. On the other hand, conservation may have negative social or economic impacts if protections limit the types of activities that can occur in a protected area.

An explanation of existing pressures arising from conservation activities is included in the descriptions below.

Table 4.1 Characterization of Conservation

Category	Sensitivity
Social conservation	Oregon Coastal Management Zone
	Marine , coastal, and terrestrial archaeological sites
	Marine , coastal, and terrestrial historical sites
	Marine , coastal, and terrestrial cultural sites
	Marine , coastal, and terrestrial scenic and recreational sites
Ecological conservation	Protected marine habitats
	Protected coastal habitats
	Protected terrestrial habitats
	Protected marine, coastal and terrestrial species

4.2 Social Conservation

Social conservation refers to the protection of specific archaeological, historical, and cultural resources as well as the designation of areas for scenic and recreational values. Descriptions of areas designated for social conservation of marine, coastal and terrestrial environments are given in the following sections.

4.2.1 Oregon Coastal Management Zone

Description

Oregon's Coastal Management Zone was established in 1971 and extends from Washington to California, three nautical miles seaward encompassing the Territorial Sea, and inland to the crest of the Coast Range, including almost all watersheds that drain to the Pacific Ocean.

Within this zone, goals guide how development occurs on the Oregon Coast, such as specifying which coastal estuaries can be developed for ports and which estuaries must stay in a natural state. Within the Coastal Management Zone, the focus is on the conservation of long-term values, benefits and natural resources of the ocean by giving clear priority to the proper management and protection of renewable resources over nonrenewable resources; and encouraging ocean resources development which is environmentally sound and economically beneficial to adjacent local governments and to the state.

Status and Trends

Oregon's Coastal Management Zone was established in 1971.

Data sets

Oregon Coastal Management Zone

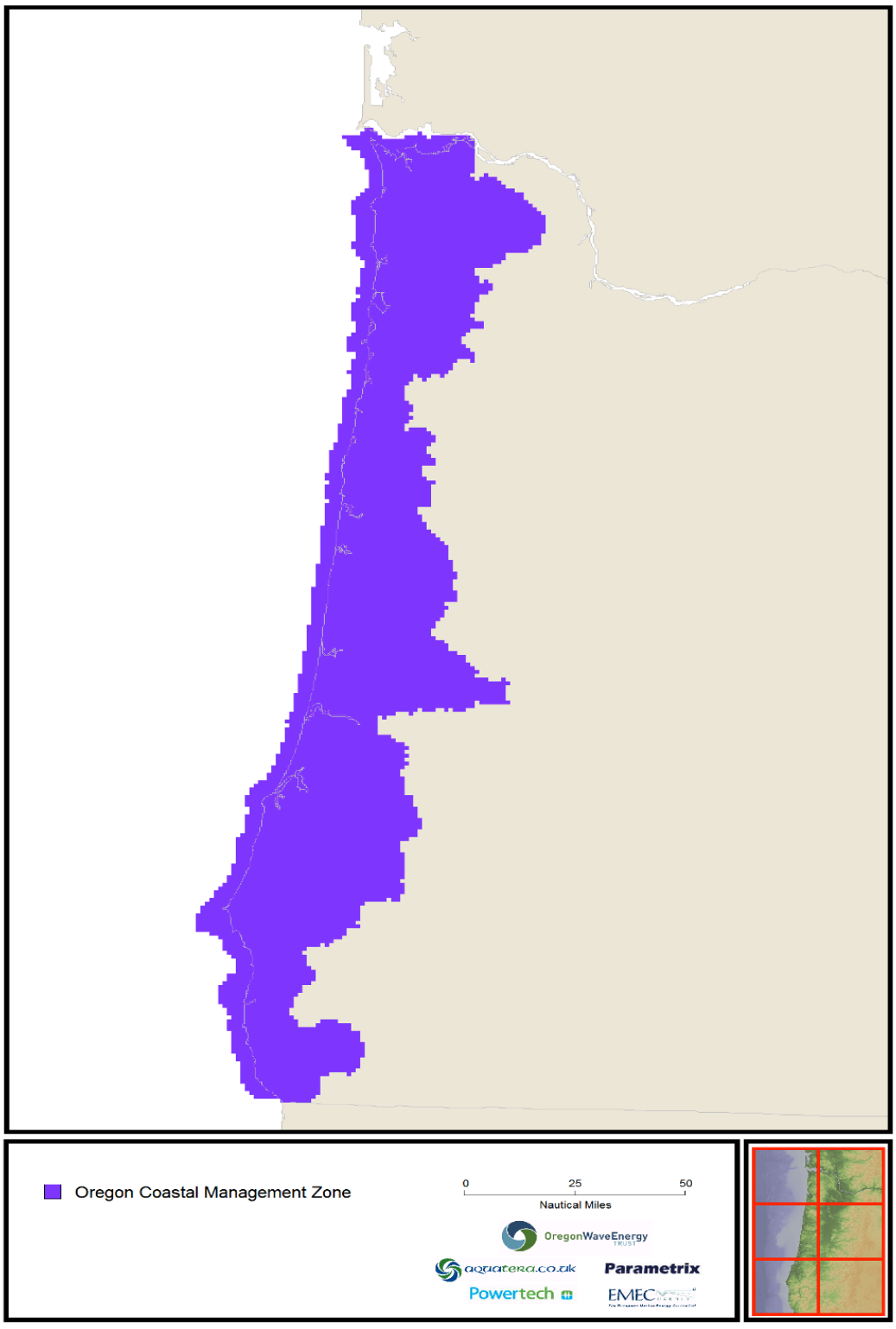


Figure 4.1 Raster map showing Oregon Coastal Management Zone

4.2.2 Marine, coastal, and terrestrial archaeological sites

Description

There are hundreds of archaeological sites on the Oregon Coast listed in the National Register. Archaeological sites can be both prehistoric and historic and include shell middens, villages, lithic sites, burial sites, fishing structures, rock art, shipwrecks, temporary campsites, homesteads, etc.

Status and Trends

More sites are added to the database each year as research continues. In 1997, 89 Native American archaeological sites of the Oregon Coast were added to the National Register of Historic Places as part of ongoing research at the University of Oregon (Moss 2008).

Data sets

Data on listed archaeological sites were not freely available for this framework. According to their website, the State Historic Preservation Office (SHPO) is creating an integrated "Archaeological Inventory Database"--a computerized database that will consist of digitized maps of known cultural resources and previous archaeological surveys; scanned archaeological site forms and survey reports; a bibliographic database; General Land Office (GLO) survey maps; and orthographic photo maps." (Oregon Parks and Recreation Dept, 2009).

4.2.3 Marine, coastal, and terrestrial historical sites

Description

There is one National Historic Park (Lewis and Clark National Historic Park) consisting of 12 sites on a 40-mile stretch of the Coast between Cannon Beach, Oregon and Long Beach, Washington.

Outside of the National Historic Park, there are hundreds or thousands of designated historic sites on the Coast, which include shipwrecks. Historic sites are defined chronologically with the arrival of Europeans in the New World and at least 50 years of age. Historic sites may be archaeological and non-archaeological.

> "Historic archaeological sites are the *remains of sites no longer in use or maintained*, *and must have a clearly defined archaeological potential (i.e., associated artifacts, features, ecological evidence)*.
> Historic non-archaeological sites consist of *property types such as buildings, sites, structures, objects, and districts that in general are still used* or *maintained*. "
> (State Historic Preservation Office, 2009)

Status and Trends

Status and trend information is available specific to shipwrecks. Approximately 2,000 ships have sunk, stranded, or disappeared at the mouth of the Columbia River since the first recorded maritime casualty in 1792.

Some shipwrecks are completely buried in Oregon's beaches, becoming temporarily visible after severe storms. In 2007, five shipwrecks formerly buried in Oregon's beaches reappeared, including the *Acme,* wrecked in 1924 near Brandon, the *Bella,* sunk in 1905 near Florence, the *Emily Reed,* sunk in 1908 near Rockaway, the *George L. Olson,* run aground in 1944 near Coos Bay, and an unidentified wreck near the Umpqua River. In 2008, 2 cannon reappeared near Arch Cape, possibly from the 1846 wreck of the USS Shark (National Park Service, 2009).

Figure 4.2 One of two cannon recovered in 2008 near Nehalem Bay State Park and presumed to be from the 1846 wreck of the USS Shark. (Oregon State Parks)
(From: http://www.nps.gov/archeology/SITES/stateSubmerged/Oregon.htm)

Data sets

Wrecks. Data on other historic sites was not obtained for this framework, but may be available through the National Register of Historic Places or the State Historic Preservation Office (SHPO).

Categorization

Dataset name:	Wrecks
Dataset description:	Submerged wrecks and obstructions in Oregon coastal waters
Dataset source:	Oregon State University
Categories:	No wreck
	Wreck

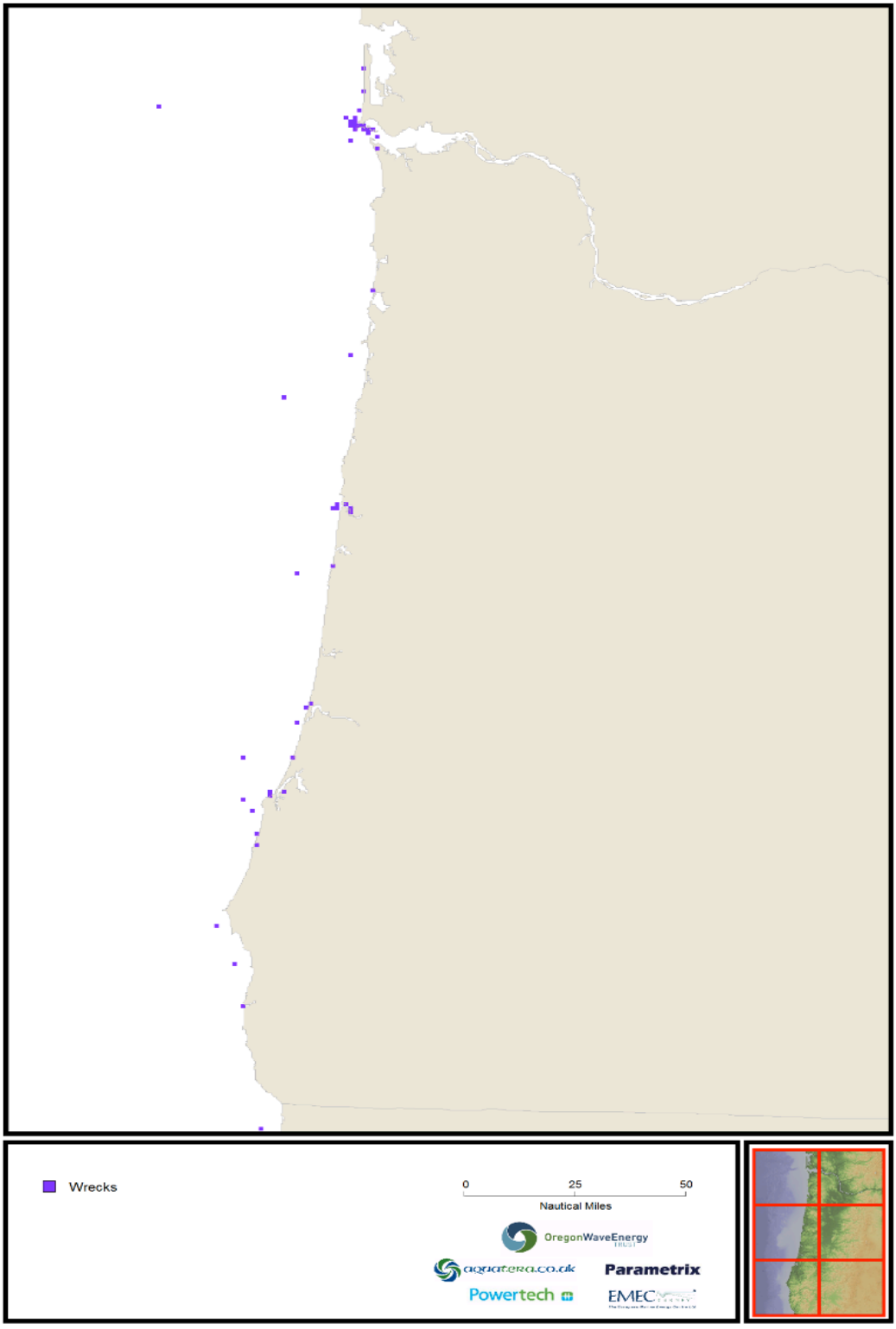


Figure 4.3 Raster map showing Marine Conservation: Wrecks

4.2.4 Marine, coastal and terrestrial recreational sites and scenic areas

Description

These areas include state recreation areas and scenic areas such as state parks, scenic areas and natural areas, as well as National Recreation Areas. There are 85 state parks, recreation areas, natural areas, scenic viewpoints, and scenic corridors designated on the Oregon Coast. In addition, there is one National Recreation Area, the Oregon Dunes National Recreation Area near Florence.

Status and Trends

No information on status or trends of recreational sites and scenic areas was obtained for this framework.

Data sets

State parks. Data were not obtained for the National Recreation Area.

Categorization

Dataset name:	State Parks*
Dataset description:	
Dataset source:	Oregon Geospatial Enterprise Office Spatial Data Library
Categories:	Outside State Park areas
	State natural area
	State park
	State recreation area
	State recreation site
	State scenic corridor
	State scenic viewpoint
	State scenic waterway
	State trail
	Willamette River Greenway
	Designation unknown

*State Parks buffers dataset is also available which describes a 1nm buffer around each of these categories (1-9)

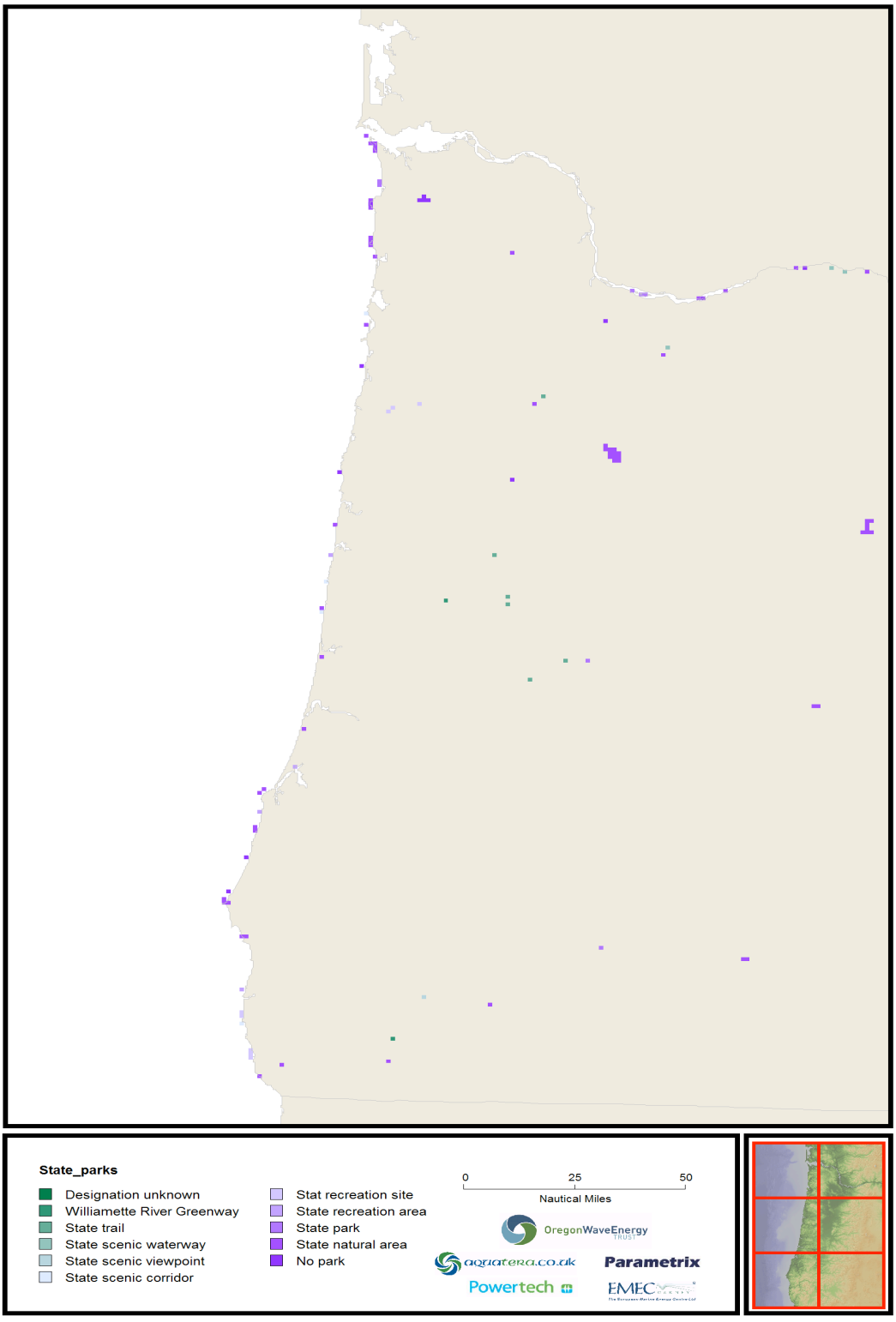


Figure 4.4 Raster map showing Oregon State Parks

4.2.5 Ecological Conservation

Ecological conservation refers to the protection of habitats and species. A description of any areas or species designated for ecological conservation in the marine, coastal and terrestrial environment is given below.

4.2.6 Protected marine habitats

Description

There are several different conservation classifications in the marine environment of Oregon. In addition to areas managed for protected species, there are State Marine Managed Areas which include marine gardens, habitat refuges, and research reserves; and State Marine Reserves and Marine Protected Areas.

In the marine environment, ESA-protected species are managed through the designation of critical habitat and certain restrictions on activities within these areas. All harvested fish species are also managed under the Fishery Conservation and Management Act (Magnuson-Stevens Act) which designates Essential Fish Habitat (EFH). EFH is designated for a number of species off the Oregon Coast, but most of the study area for wave energy is wholly included in these. Salmonid critical habitat protections are currently only in freshwater systems. The groundfish EFH includes most of the offshore areas, but some specific ocean floor features are protected with gear restrictions. These areas are included in the analysis.

Essential Fish Habitat

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), is responsible for the management and conservation of fisheries of the United States. The MSA requires that regional management councils describe Essential Fish Habitat (EFH) in their fishery management plans, that they minimize impacts on EFH from fishing activities, and that they and other federal agencies consult with the National Marine Fisheries Service about activities that might harm EFH. The Pacific Fishery Management Council has defined EFH for groundfish, coastal pelagic fish species, salmon and highly migratory species. These designations are described below (Pacific Fisheries Management Council, 2008).

Groundfish: all areas from the high tide line (and parts of estuaries) to 3,500 meters in depth.

Coastal pelagic species: based on a specific temperature range that applies to all marine and estuary waters from the West Coast shoreline (and estuaries) to the limits of the EEZ.

Salmon: in estuarine and marine areas, extends from the shoreline to the 200-mile limit of the EEZ and beyond.

Highly migratory species: defined by temperature ranges, salinity, oxygen levels, currents, shelf edges, and seamounts.

Critical Habitat

The Endangered Species Act (ESA) requires the designation of critical habitat for listed species when “prudent and determinable.” Critical habitat includes geographic areas that contain the physical or biological features that are essential to the conservation of the species and may need special management or protection. Critical habitat designations affect only Federal agency actions or federally funded or permitted activities. Federal agencies are required to avoid “destruction” or adverse modification” of designated critical habitat (NOAA Fisheries, Unknown Date).

State Marine Managed Areas

Oregon Department of Fisheries and Wildlife (ODFW) have established 18 marine conservation areas with different levels of protection (Didier, 1998). Seven of these areas are marine

gardens, a specially protected area in which it is illegal to collect any marine invertebrate (except single mussels for bait). Two areas are shellfish reserves, closed to the take of clams. There is one habitat refuge, a specially protected area needed to maintain the health of the rocky shore ecosystem and closed to the take of marine fish, shellfish and all marine invertebrates. There are seven research reserves which are used for scientific study or research: two subtidal research reserves and one intertidal research reserve closed to the take of shellfish and marine invertebrates, except via scientific take permits, and four additional intertidal research reserves, which allow take of abalone, clams, Dungeness crab, red rock crab, mussels, piddocks, scallops and shrimp. For the purposes of the scoring matrix in the model, these areas have been treated as a single unit under "State Marine Managed Areas".

Marine Reserves

Out of 20 sites proposed by the public for consideration as Marine Reserves in Oregon, two Marine Reserves have recently been established off the Oregon Coast – Otter Rock off Depoe Bay and Redfish Rocks off Port Orford. Redfish Rocks is split into a Marine Reserve and a Marine Protected Area. The Marine Reserves are closed to fishing, while some fishing is allowed in the Protected Area. Four other potential reserves at Cape Falcon south of Cannon Beach, Cascade Head near Lincoln City, Cape Perpetua near Yachats, and Cape Arago-Seven Devils area, south of Coos Bay will be evaluated as potential Marine Reserves in the future. Marine Reserves, already established in Washington and California, are designed to protect the marine resources in an area of the sea from removal or disturbance, except as necessary for monitoring or research (Department of Land Conservation and Development).

Status and Trends

The establishment of Marine Reserves is a recent development, with the first two reserves adopted in 2009. There are proposals for additional Marine Reserves that will be considered in the future.

There are currently no critical habitat designations in the marine environment offshore of Oregon. However, the National Marine Fisheries Service (NMFS) is proposing to revise the current critical habitat for the leatherback sea turtle (Dermochelys coriacea) by designating additional areas within the Pacific Ocean. One of the additional areas proposed for designation is the nearshore area from Cape Flattery, Washington, to Umpqua River (Winchester Bay), Oregon and offshore to a line approximating the 2000 meter isobath. This area is the principal Oregon/Washington foraging area and includes important habitat associated with Heceta Bank, Oregon. This proposed designation includes much of the study area for wave energy. (NMFS, 75 FR 319).

The two Primary Constituent Elements of proposed leatherback critical habitat in marine waters off the U.S. West Coast are: (1) Occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (Chrysaora, Aurelia, Phacellophora, and Cyanea) of sufficient condition, distribution, diversity, and abundance to support individual as well as population growth, reproduction, and development; and (2) Migratory pathway conditions to allow for safe and timely passage and access to/from/within high use foraging areas. It has been determined that fishing gear or vessel traffic are not potential threats to passage and only permanent or long-term structures that alter the habitat would be considered as having potential effects on passage.

Pressures

Protection of marine habitats benefits the species that use them. Other species may also benefit. For example, National Wildlife Refuges designed to protect birds may also benefit shoreline and seabed communities. In addition, a positive economic impact can result from attracting tourism activities such as wildlife watching and photography.

Restrictions on boating, fishing and take of shellfish and other invertebrates may have a negative economic impact, although these activities can occur in other parts of the sea. The long-term effect of the conservation is expected to be positive as a result of increased fish stocks due to the protective measures.

Data sets

Rocky Reef Essential Fish Habitat, Groundfish Essential Fish Habitat (prohibition of fishing gear type); State Marine Managed Areas; Marine Reserves

Categorization

Dataset name:	Rocky Reef EFH
Dataset description:	Rocky reef essential fish habitats
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside Rocky Reef EFH area
	Rocky Reef EFH

Dataset name:	Groundfish EFH (Essential Fish Habitat)
Dataset description:	Areas prohibited from fishing exploitation using specific gear types
Dataset source:	PaCOOS West Coast Habitat Server
Categories:	Outside groundfish essential fish habitat
	Bottom contact gear
	Bottom contact gear or other gear deployed deeper than 500-fm
	Bottom trawl gear
	Bottom trawl gear other than demersal seine
	Unlisted

Dataset name:	State Marine Managed Areas
Dataset description:	Summary layer consisting of the individual research reserves, marine gardens, and habitat refuge present in Oregon's Territorial Sea
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside State marine managed areas
	State marine managed areas

Dataset name:	Marine Reserves
Dataset description:	Boundaries of the Otter Rock and Red Fish Rock Marine Reserves
Dataset source:	Oregon Marine Reserves
Categories:	Outside Marine reserves
	Marine reserves

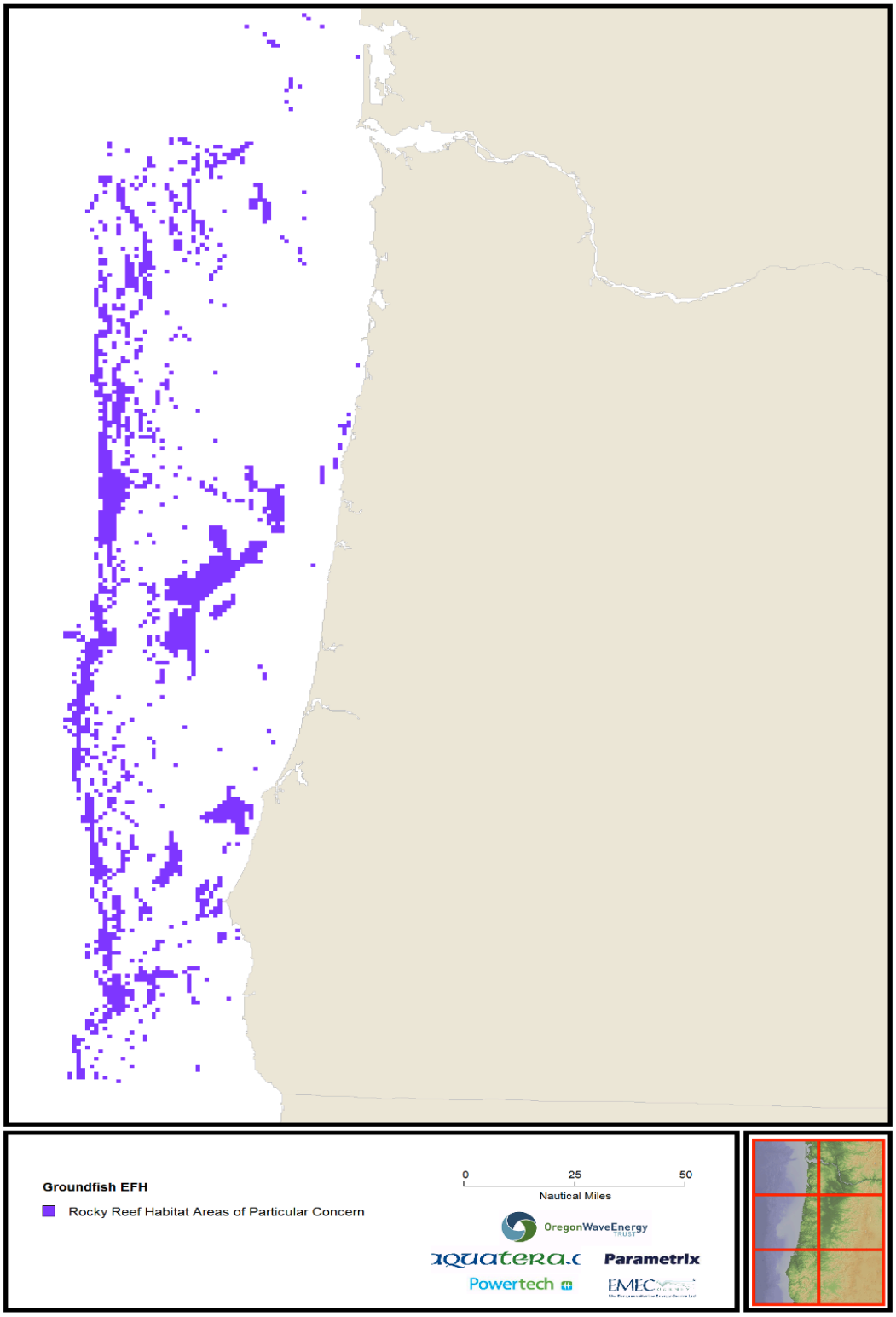


Figure 4.5 Raster map showing Groundfish Essential Fish Habitat: Rocky Reef Habitat Areas

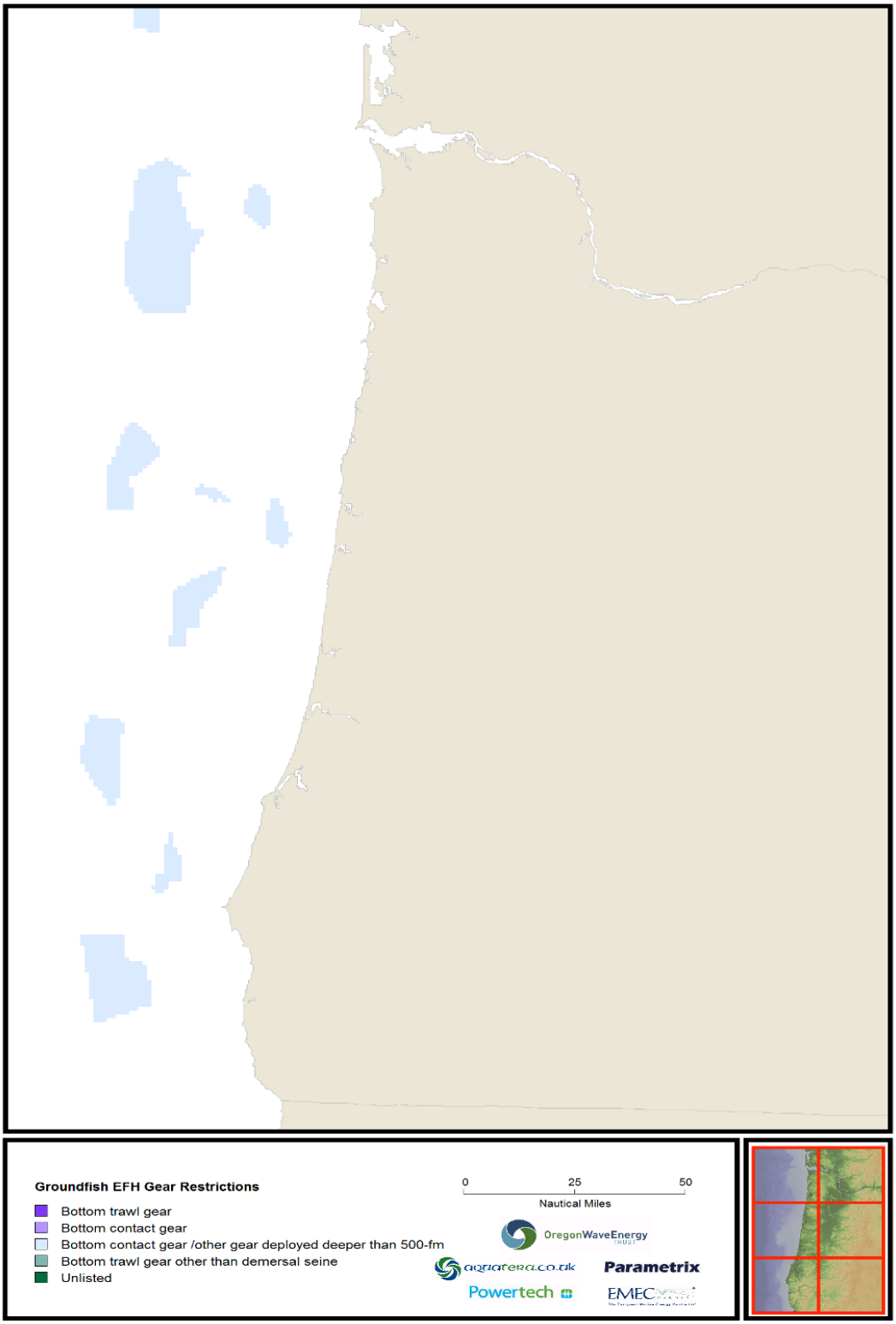


Figure 4.6 Raster map showing Groundfish Essential Fish Habitats: Gear Restrictions

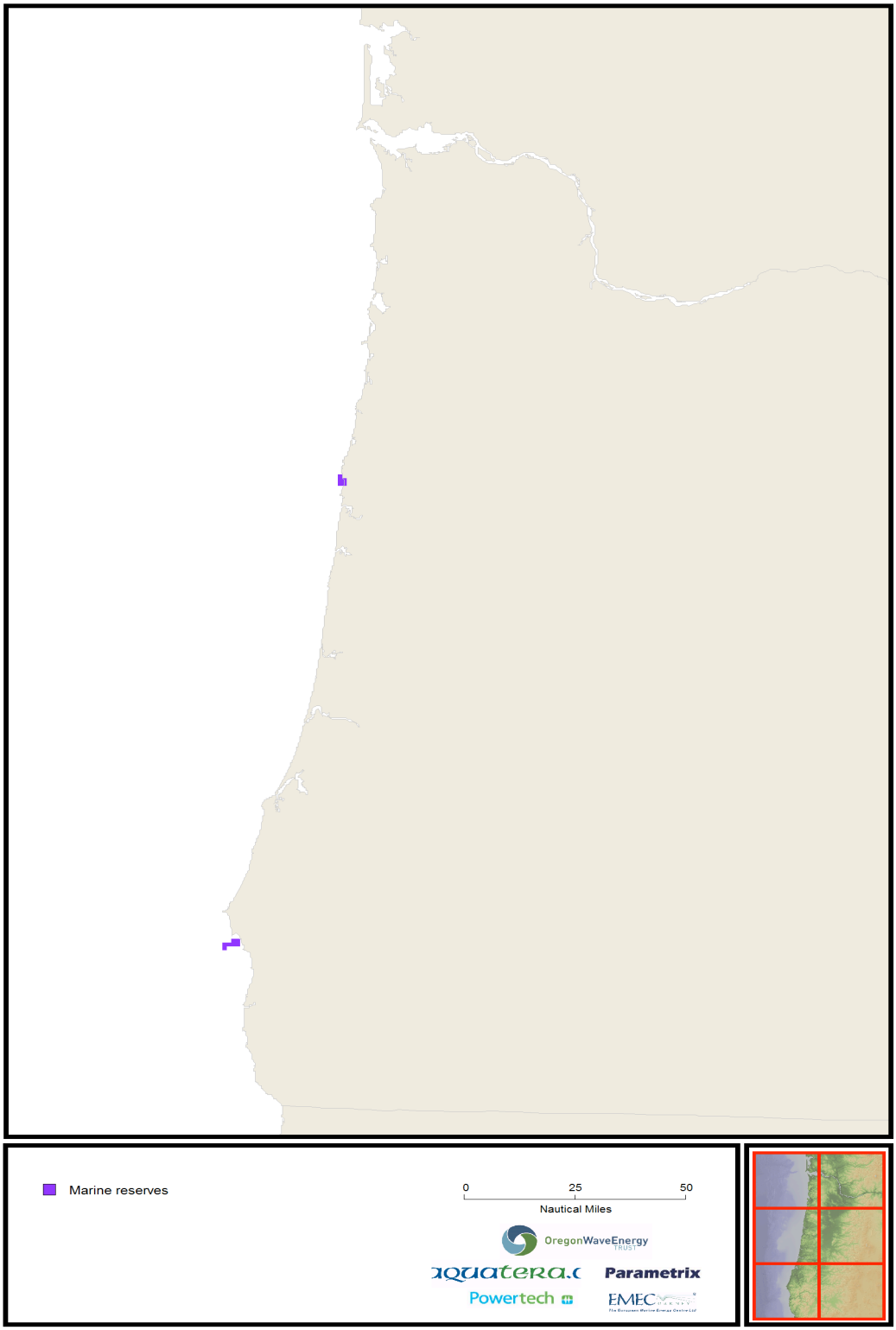


Figure 4.7 Raster map showing Oregon Marine Reserves

4.2.7 Protected coastal habitats

Description

There are several different conservation classifications in the coastal environment of Oregon. The framework currently includes National Wildlife Refuges and critical habitats for snowy plovers and Steller sea lions.

National Wildlife Refuges

The primary purpose of National Wildlife Refuges (NWR) is for the conservation, management, and restoration of fish, wildlife and plant resources and their habitat. Three marine refuges (Oregon Islands, Three Arch Rocks, Cape Meares) protect coastal rocks, reefs, islands and headland areas supporting important seabird nesting colonies. Over a million seabirds, including common murres, tufted puffins, cormorants, and storm-petrels nest on these refuges, while coastal rocks provide breeding and haul-out sites for Steller and California sea lions and harbor seals. Boats are prohibited within 500 feet of the Oregon Islands Refuge at all times, and within 500 feet of Three Arch Rocks during the seabird nesting seasons (US Fish and Wildlife Service, 2009).

Critical Habitat

The Endangered Species Act (ESA) requires the designation of "critical habitat" for listed species when "prudent and determinable." Critical habitat includes geographic areas that contain the physical or biological features that are essential to the conservation of the species and may need special management or protection. Critical habitat designations affect only Federal agency actions or federally funded or permitted activities. Federal agencies are required to avoid "destruction" or adverse modification" of designated critical habitat (NOAA Fisheries, Unknown Date).

Status and Trends

Snowy Plover Critical Habitat

There are 2,147 acres (868 ha) in 7 areas along the Oregon Coast designated as critical habitat for the Western Snowy Plover. These habitats consist of sandy beaches or mud flats where plovers nest and forage and that were occupied by snowy plovers at the time of listing in 1993 (US Fish and Wildlife Service 2005).

Steller Sea Lion Critical Habitat

In Oregon, two major Steller Sea Lion rookeries at Long Brown & Seal Rocks and Pyramid Rock are designated as critical habitat for the Steller Sea Lion. This critical habitat includes an air zone extending 3,000 feet (0.9 km) above rookery areas as well as an aquatic zone extending 3,000 feet (0.9 kin) seaward.

Pressures

Protection of marine and coastal habitats benefits the species that use them, particularly seabirds and sea lions. Other species may also benefit. For example, National Wildlife Refuges designed to protect birds may also benefit shoreline and seabed communities. In addition, a positive economic impact can result from attracting tourism activities such as wildlife watching and photography.

Protection of coastal habitats for Snowy Plovers and Stellers Sea Lion benefits these species, while creating pressure on the social and economic environments due to restrictions on activities that can take place in these areas.

Data sets

National Wildlife Refuges; Snowy Plover Critical Habitat; Steller Sea Lion Critical Habitat

Categorization

Dataset name:	Steller Sea Lion Critical Habitat
Dataset description:	Designated critical habitats for Steller Sea Lions in Oregon
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside Steller Sea Lion Critical habitat
	Steller Sea Lion Critical habitat
	Steller Sea Lion Critical habitat 1nm buffer
	Steller Sea Lion Critical habitat 2nm buffer

Dataset name:	Snowy Plover Critical Habitat
Dataset description:	Designated critical habitats for Western Snowy Plovers in Oregon
Dataset source:	PaCOOS West Coast Habitat Server
Categories:	Outside Snowy Plover Critical Habitat
	Snowy Plover Critical Habitat

Dataset name:	National Wildlife Refuges
Dataset description:	National Wildlife Refuges are federal lands managed by the U.S. Fish and Wildlife Service (USFWS)
Dataset source:	Oregon Marine Reserves
Categories:	Outside National Wildlife Refuges
	National Wildlife Refuges

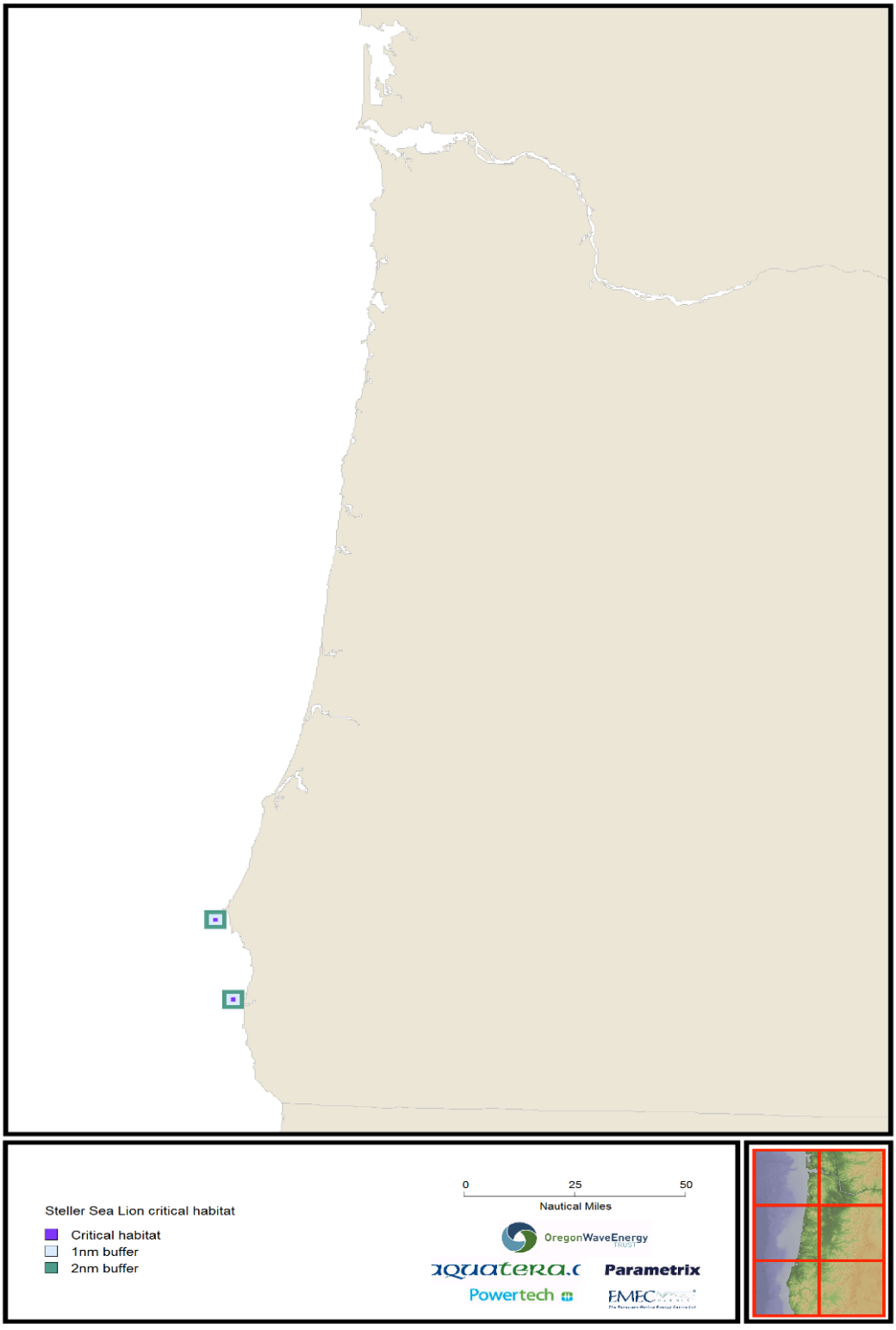
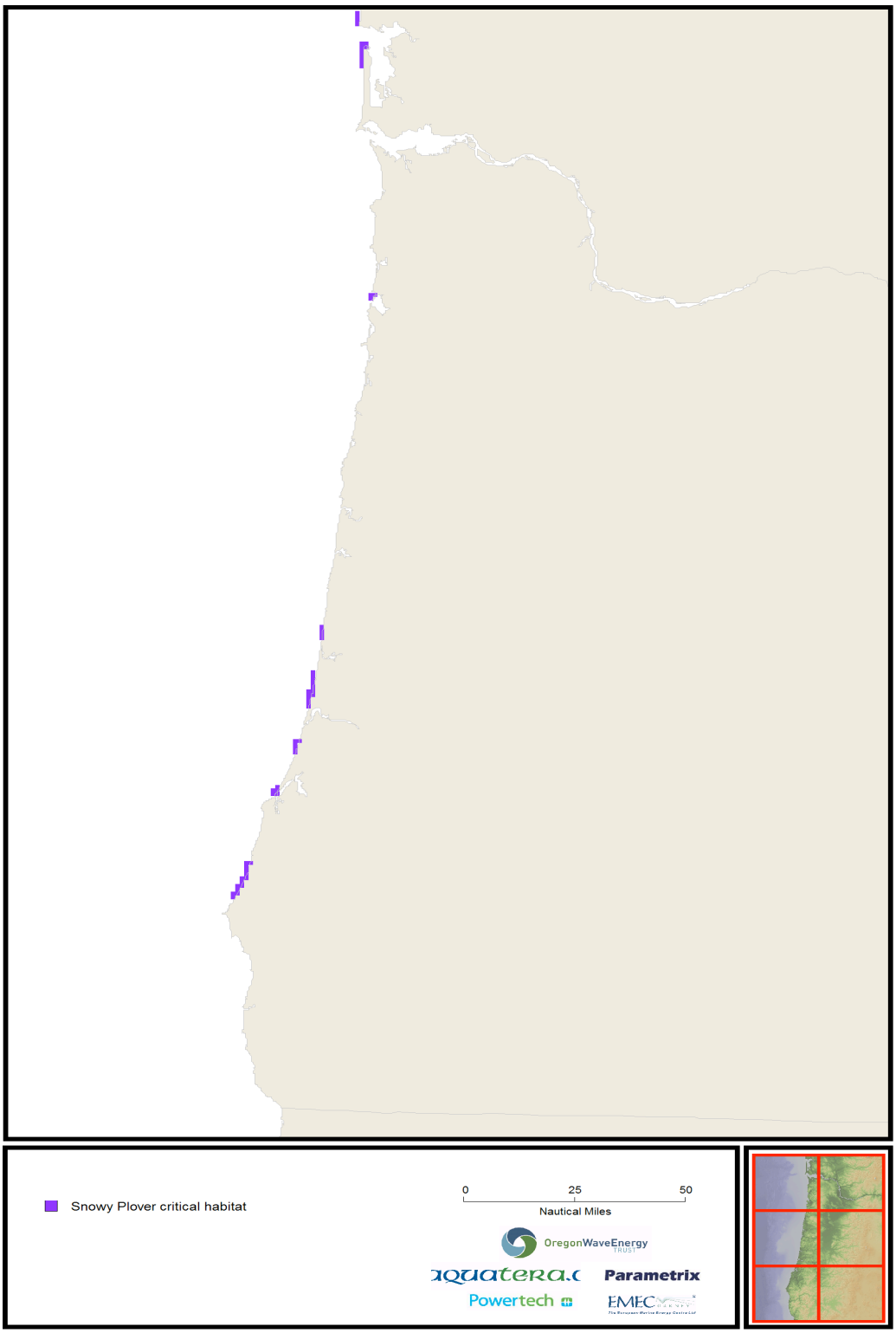


Figure 4.8 Raster map showing Steller Sea Lion Critical Habitat



Raster map showing Snowy Plover Critical Habitat

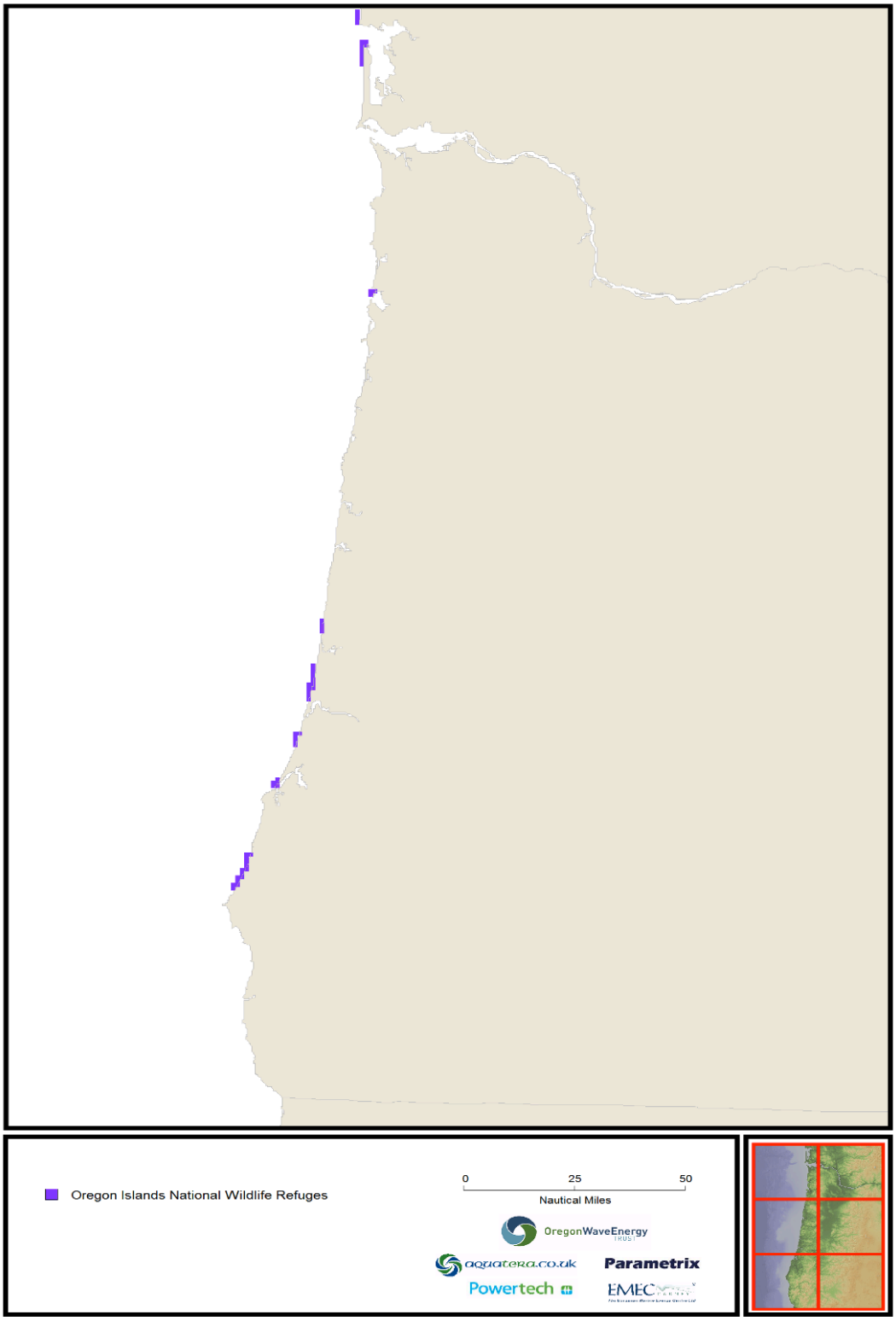


Figure 4.9 Raster map showing location of Oregon Islands National Wildlife Refuge

4.2.8 Protected terrestrial habitats

Description

Terrestrial conservation outside of the coastal zone includes National Wildlife Refuges, a National Estuarine Reserve, a Biosphere Reserve, critical habitat for Marbled Murrelets and Northern Spotted Owls, and regulations for tidal wetlands.

National Wildlife Refuges

The primary purpose of National Wildlife Refuges (NWR) is for the conservation, management, and restoration of fish, wildlife and plant resources and their habitat. In addition to the marine NWR, three estuarine NWR (Nestucca Bay, Siletz Bay, Bandon Marsh) preserve saltmarsh, brackish marsh, riparian wetlands and wooded uplands. Wildlife of these refuges includes waterfowl, shorebirds, raptors, small mammals, amphibians and anadromous fish (US Fish and Wildlife Service, 2009).

National Estuarine Reserve

South Slough is a National Estuarine Research Reserve near Coos Bay, encompassing a mixture of open water channels, tidal and freshwater wetlands, riparian areas, and forested uplands. The purpose of the reserve is to actively support and coordinate research, education, and stewardship programs which serve to enhance a scientific and public understanding of estuaries and contribute to improved estuarine management (State of Oregon, n.d.).

Biosphere Reserve

Cascade Head includes a headland and estuary north of Lincoln City, and is a UNESCO MAB Biosphere Reserve managed by The Nature Conservancy. Ecosystems represented in the biosphere reserve include two major prairie headlands, the Salmon River estuary, and productive Sitka spruce-western hemlock and Douglas Fir forests. Spotted Owl, Marbled Murrelet, Coho Salmon and Oregon Silverspot Butterfly are four federally listed endangered species that occur in the biosphere reserve (UNESCO, 2005).

Critical Habitat

The Endangered Species Act (ESA) requires the designation of critical habitat for listed species when “prudent and determinable.” Critical habitat includes geographic areas that contain the physical or biological features that are essential to the conservation of the species and may need special management or protection. Critical habitat designations affect only Federal agency actions or federally funded or permitted activities. Federal agencies are required to avoid “destruction” or adverse modification” of designated critical habitat (NOAA Fisheries, Unknown Date).

Status and Trends

Marbled Murrelet Critical Habitat

Critical habitat has been designated for this species that includes forested areas containing trees with large limbs. Destruction and adverse modification of critical habitat is not permitted.

Tidal Wetlands

Wetlands form where water persists at or near the land surface for extended periods. In Oregon, coastal wetlands are a small percentage of the wetland area of Oregon. Tidally-influenced wetlands include estuarine wetlands, which consist of tideflats, eelgrass bed, and salt marshes. These wetlands have developed in the near the mouths of Oregon's coastal rivers and cover

about 55,600 acres. In addition, there are about 10,000 acres of tidal fresh marsh, mostly in the Columbia River estuary.

Since the late 1700s, wetland acreage has decreased by more than one-third, mostly owing to conversion of wetlands to agricultural uses by diking, draining, or both. Estuarine marshes were amongst the wetland types experiencing the greatest losses. Although losses of estuarine wetlands have slowed since the mid-1900's, and more than 90 percent of remaining estuarine wetlands are protected, conversion of tidal land to urban use is still occurring. (U.S. Geological Survey, 2000).

No information on the status and trends of other terrestrial conservation was obtained.

Data sets

Tidal wetlands; Marbled Murrelet critical habitat
No other data sets were obtained for terrestrial conservation.

Categorization

Marbled murrelets:

Dataset name:	Marbled Murrelet Critical Habitat
Dataset description:	Lands designated as critical habitats for Marbled Murrelets
Dataset source:	PaCOOS West Coast Habitat Server
Categories:	Outside Marbled Murrelet Critical Habitat
	Marbled Murrelet Critical Habitat

Tidal wetlands:

Dataset name:	Tidal Wetlands
Dataset description:	Oregon's coastal watershed's known tidal wetlands and areas of interest for tidal wetland restoration, based on interpretation of historic and present remote sensing data
Dataset source:	Oregon Coastal Atlas
Categories:	Outside Tidal Wetlands areas
	Unknown
	Fill
	Marine-sourced high wetland
	Marine-sourced low wetland
	Non-tidal wetland
	Potential tidal forested wetland
	Restoration consideration area
	River sourced tidal wetland
	Unconsolidated
	Upland

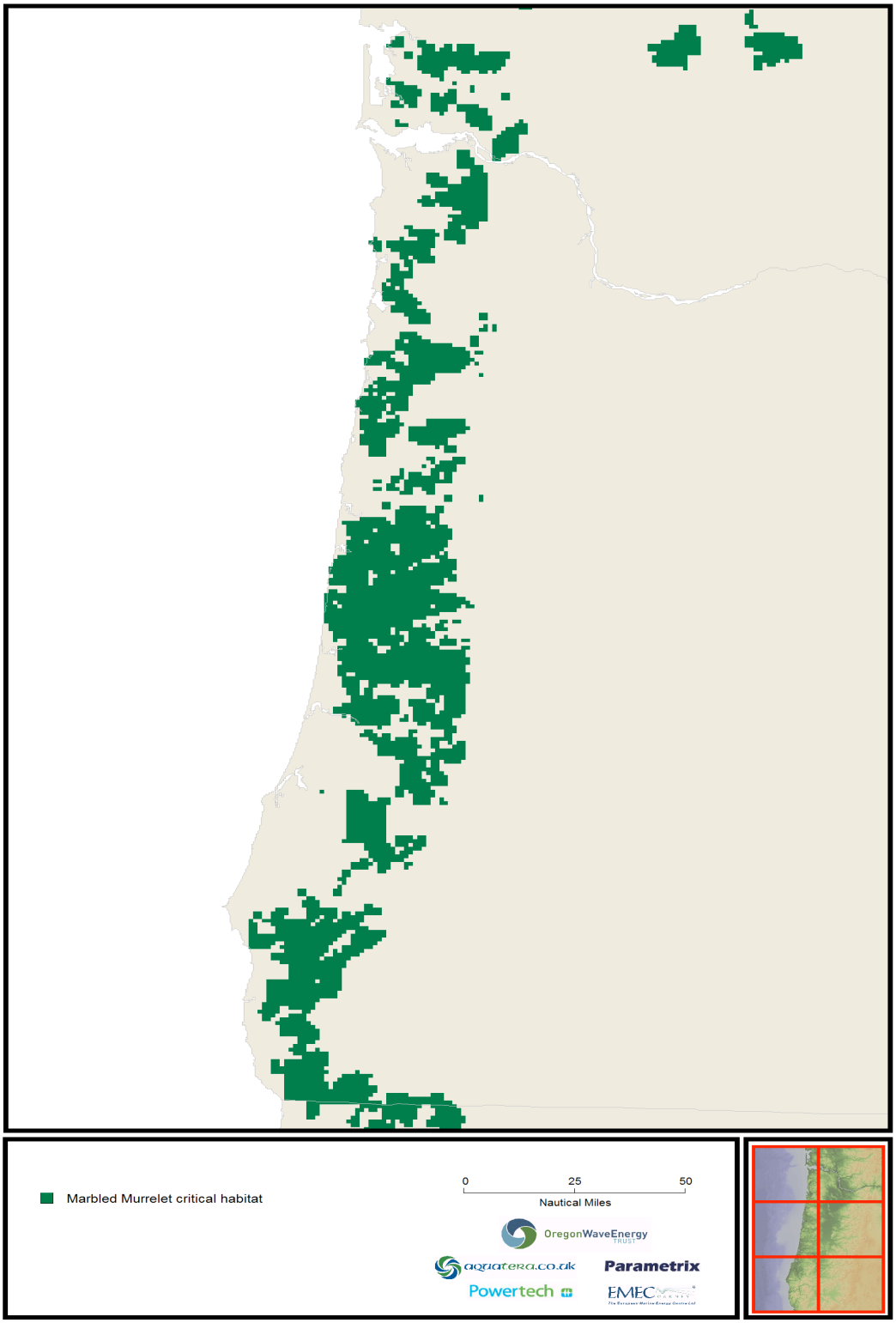


Figure 4.10 Raster map showing Marbled Murrelet Critical Habitat

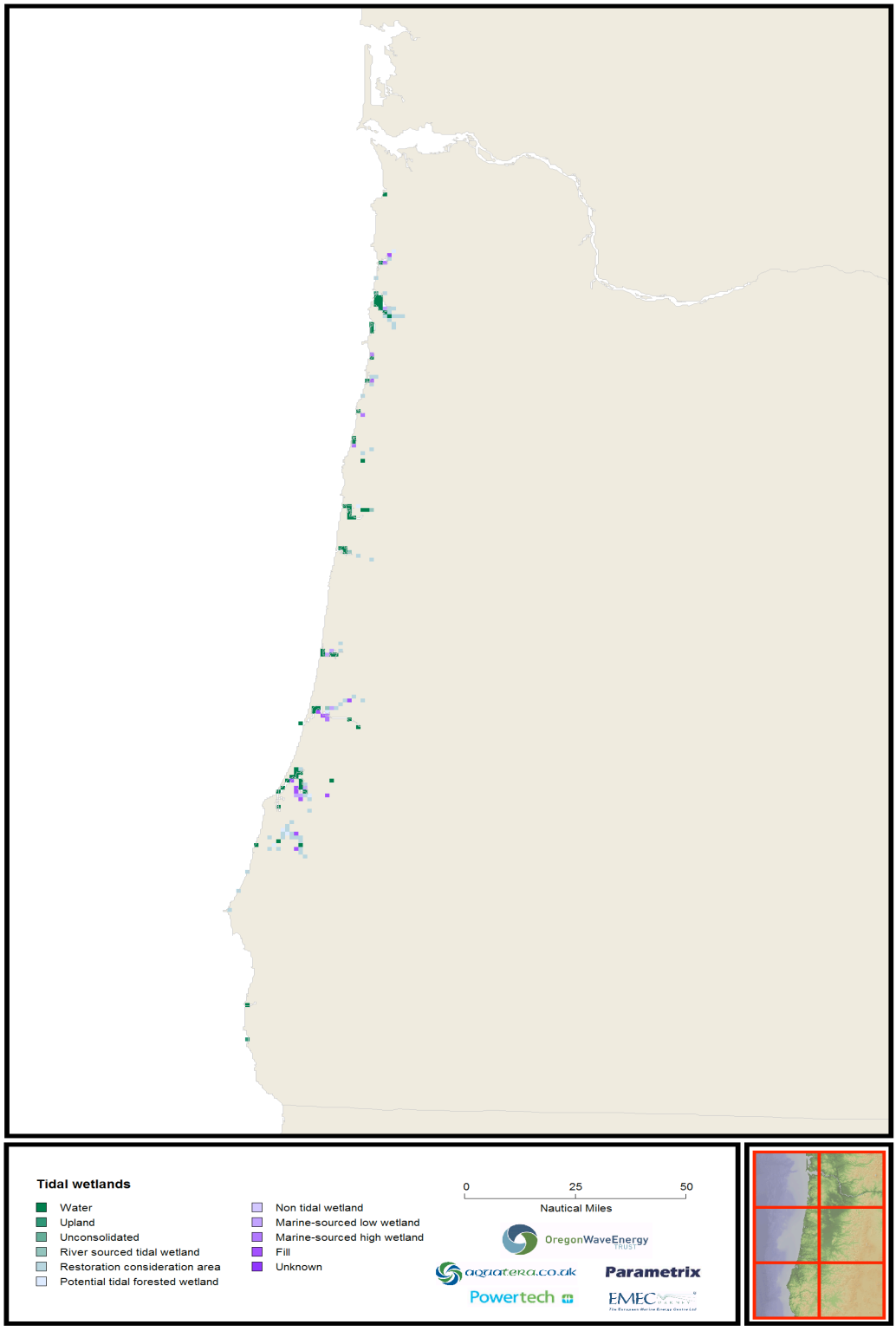


Figure 4.11 Raster map showing tidal wetlands

4.2.9 Protected species

Description

There are several laws which protect at-risk species at both the federal and the state level. Federal laws include the Endangered Species Act (ESA), the Marine Mammal Protection Act (MMPA), the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and the Migratory Bird Treaty Act (MBTA). There is also a state Endangered Species Act for Oregon. Status and trends of species listed below are discussed under Ecological Environment, Section 3.0.

Endangered Species Act (ESA)

The Fish and Wildlife Service in the Department of the Interior (FWS) and NOAA- Fisheries in the Department of Commerce share responsibility for administration of the Endangered Species Act. Under the ESA, species may be listed as either endangered or threatened. "Endangered" means a species is in danger of extinction throughout all or a significant portion of its range, while "threatened" means a species is likely to become endangered within the foreseeable future. The ESA protects endangered and threatened species and their habitats by prohibiting the "take" of listed animals. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in any such conduct." Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioural patterns, including breeding, feeding, or sheltering (NOAA Fisheries, Unknown Date; NOAA Fisheries, Unknown Date).

There are 30 species that occur in Oregon, or could occur off the coast of Oregon, that are currently listed under the Federal ESA: 15 fish runs, 3 birds, 8 marine mammals and 4 reptiles (Table 4.2).

Table 4.2 Marine and coastal species protected under the ESA

ESA-listed fish runs	ESA-listed marine mammals	ESA-listed marine or coastal birds	ESA-listed sea turtles
Lower Columbia River Chinook (T)[1]	Southern Resident Killer Whale (E)	Marbled murrelet (T)	Leatherback Sea Turtle (E)
Upper Columbia River spring-run Chinook (E)	Blue Whale (E)	Snowy plover (T)	Green Sea Turtle (E)
Snake River fall-run Chinook (T)	Fin Whale (E)	Brown pelican (R)	Olive Ridley Sea Turtle (E)
Snake River spring/summer run Chinook (T)	Sei Whale (E)	Black Oystercatcher (SOC)	Loggerhead Sea Turtle (T)
Upper Willamette River Chinook (T)	Sperm Whale (E)		
Columbia River chum (T)	Humpback Whale (E)		
Lower Columbia River coho (T)	Steller Sea Lion (T)		
Oregon Coast coho (T)			
Southern Oregon & Northern California Coasts coho (T)			
Snake River sockeye (E)			
Snake River Basin steelhead (T)			
Upper Columbia River steelhead (T)			

Middle Columbia River steelhead (T)		
Lower Columbia River steelhead (T)		
Upper Willamette River steelhead (T)		
Oregon Coast steelhead (SOC)		
Pacific Eulachon (smelt) (P)		
Green sturgeon (Southern DPS) (T)		

[1] E= endangered; T=threatened; P= proposed; SOC= Species of Concern; R= Recovered

Marine Mammal Protection Act (MMPA)

All marine mammals are protected under the MMPA. The MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S. Take is defined as "harass, hunt, capture, kill or collect, or attempt to harass, hunt, capture, kill or collect." Congress passed the MMPA in 1972 (NOAA Fisheries, Unknown date).

Table 4.3 Marine Mammals occurring off the Oregon Coast protected under the MMPA

Whales	Porpoises and Dolphins	Seals and Sea Lions
• Northern Pacific Right Whale • Blue Whale • Fin Whale • Sei Whale • Minke Whale • Humpback Whale • Gray Whale • Sperm Whale • Dwarf Sperm Whale • Pygmy Sperm Whale • Baird's Beaked Whale • Cuvier's Beaked Whale • Hubb's Beaked Whale • Stejneger's Beaked Whale	• Harbor Porpoise • Dall's Porpoise • Striped Dolphin • Saddleback Dolphin. • Pacific White-sided Dolphin • Risso's Dolphin • False Killer Whale • Short-finned Pilot Whale • Northern Right Whale Dolphin • Killer Whale	• California Sea Lion • Steller Sea Lion • Northern Fur Seal • Harbor Seal • Northern Elephant Seal

The Magnuson-Stevens Fishery Conservation and Management Act (MSA)

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), is responsible for the management and conservation of fisheries of the United States. One tool for conservation of at-risk fisheries is the designation of Essential Fish Habitat (EFH), described in Section 4.2.6.

Migratory Bird Treaty Act (MBTA)

Many seabirds occurring in Oregon are also protected by the Migratory Bird Treaty Act. This act implements various treaties and conventions between the U.S. and Canada, Japan, Mexico and the former Soviet Union for the protection of migratory birds. Under the Act, taking, killing or possessing migratory birds is unlawful (US Fish and Wildlife Service, Unknown).

Status and Trends

Not applicable.

Data sets

No species-specific data sets were available for this framework.

5 The Social Environment

5.1 Introduction

The social environment as defined for this framework includes characteristics of people and where they live, amenities and services that contribute to their quality of life, and wider-ranging values and policies affecting society such as energy supply and use. Equity and distributional measures are also important to understand the opportunities for communities that need economic development. Therefore, a complete understanding of wave energy potential must take into account the possibility for successful wave energy development to take advantage of infrastructure, workforces or other assets that can expedite or improve industry development that are also part of the social environment.

Table 5.1 Sensitivities of the Social Environment

Category	Sensitivity
Communities	Cities
	Population size
	Community facilities
	Community wealth
Population and demographics	Education and skills
	Labor Market
	Unemployment
	Income
	Diversity
	Population size
Quality of life	Recreation
	Visual amenity
Social policy and values	Energy supply
	Energy use
	Public opinion

5.2 Communities

Communities include characteristics of where people live along the Coast, including where cities are located, the size of the population, what community facilities are available, and the status of the wealth of those communities.

5.2.1 Cities

Description
This is a technical factor, describing the settlement pattern on the Coast and location of towns and cities.

Status and Trends
The Oregon Coast is sparsely populated, but communities are located all along the Coast from Astoria in the north to Brookings in the south.

Data sets
Distance from coastal communities

Categorization

Dataset name:	Distance from coastal community
Dataset description:	Dataset showing distances from coastal communities as straight line distances
Dataset source:	Aquatera
Categories:	City limits of coastal community
	0-1nm from coastal community
	1-2nm from coastal community
	2-3nm from coastal community
	3-4nm from coastal community
	4-5nm from coastal community
	5-7.5nm from coastal community
	7.5-10nm from coastal community
	10-15nm from coastal community
	15-20nm from coastal community
	20-50nm from coastal community
	> 50nm from coastal community

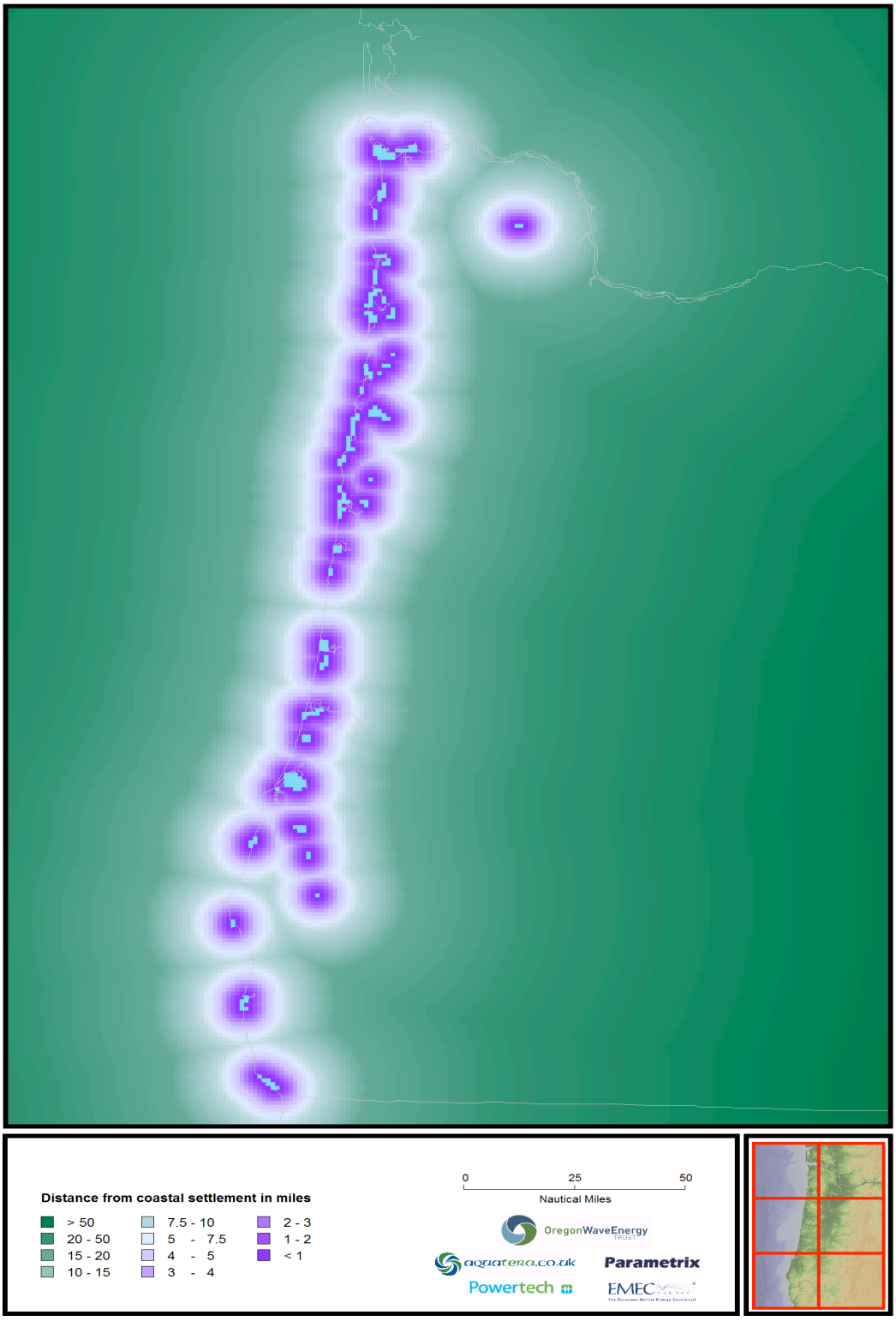


Figure 5.1 Raster map showing distance from coastal communities

5.2.2 Population Size

Description
Number of residents in each community.

Status and Trends
The Oregon Coast is sparsely populated, with a density of fewer than 9 persons per square mile. A large majority of coastal residents lives near the coastline or in narrow coastal river valleys. The five most populated coastal communities are Coos Bay (15,374 residents), Astoria (9,813), North Bend (9,544), Newport (9,532), and Lincoln City (7,437) (Oregon Department of Fisheries and Wildlife, 2006; US Census Bureau, 2009). Other prominent coastal communities include Seaside, Tillamook, Florence, Reedsport, Bandon, Gold Beach, and Brookings. There are numerous small towns scattered along the Coast between these population centers.

Data sets
Population of coastal communities

Categorization

Dataset name:	Population of coastal communities
Dataset description:	Head of population within each coastal community
Dataset source:	United States Census Bureau
Categories:	>0 – 500 people
	500 – 1000 people
	1000 – 2000 people
	2000 – 3000 people
	3000 - 4000 people
	4000 – 5000 people
	5000 – 7500 people
	>7500 people
	Outside city limits

Dataset name:	Distance based on population size
Dataset description:	Dataset utilizing population levels to produce spatial description of the benefits of proximity to population centers based on population size
Dataset source:	Aquatera
Categories:	No benefit
	Very low benefit
	Low benefit
	Moderate benefit
	High benefit
	Very high benefit

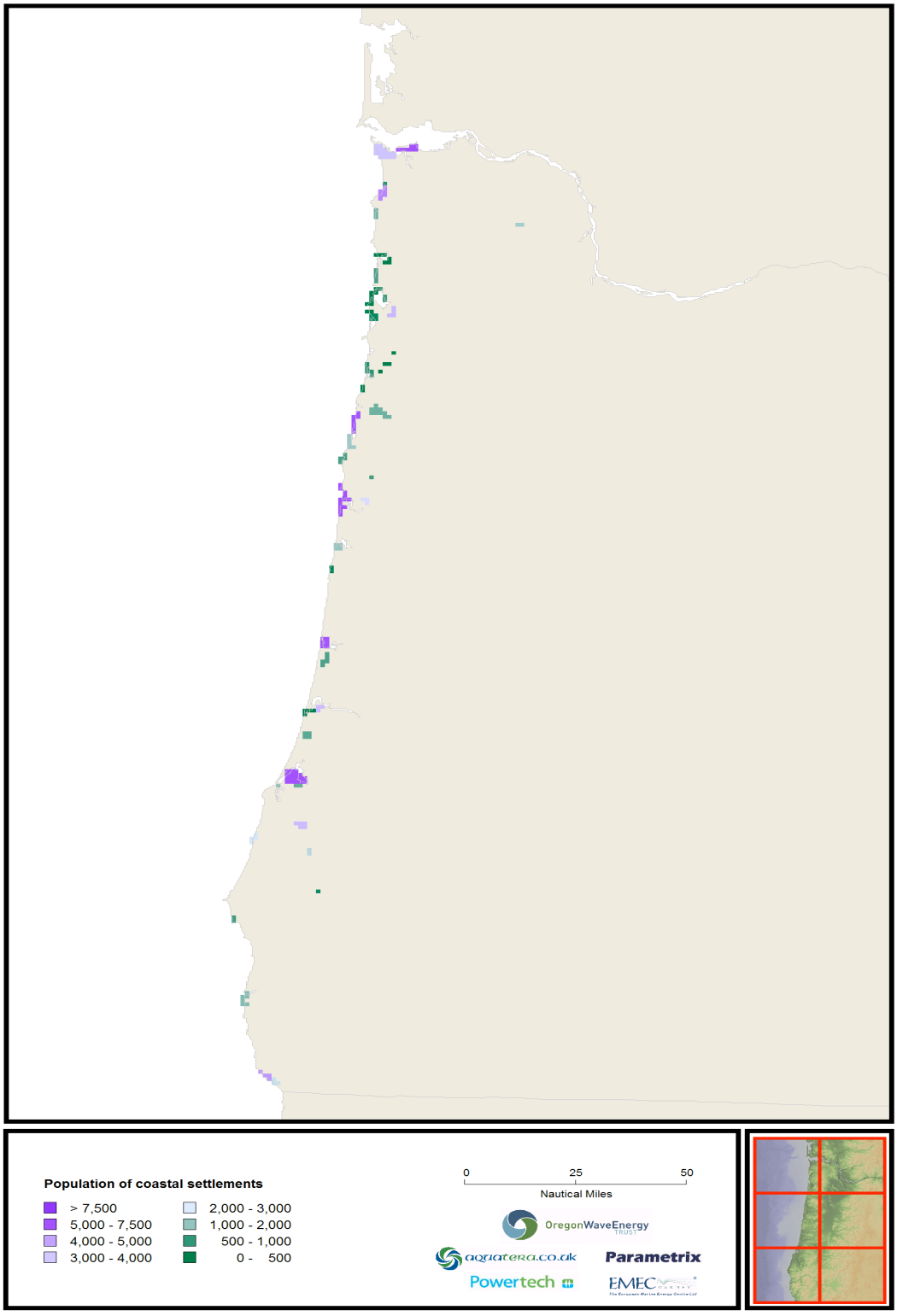


Figure 5.2 Raster map showing population of coastal communities

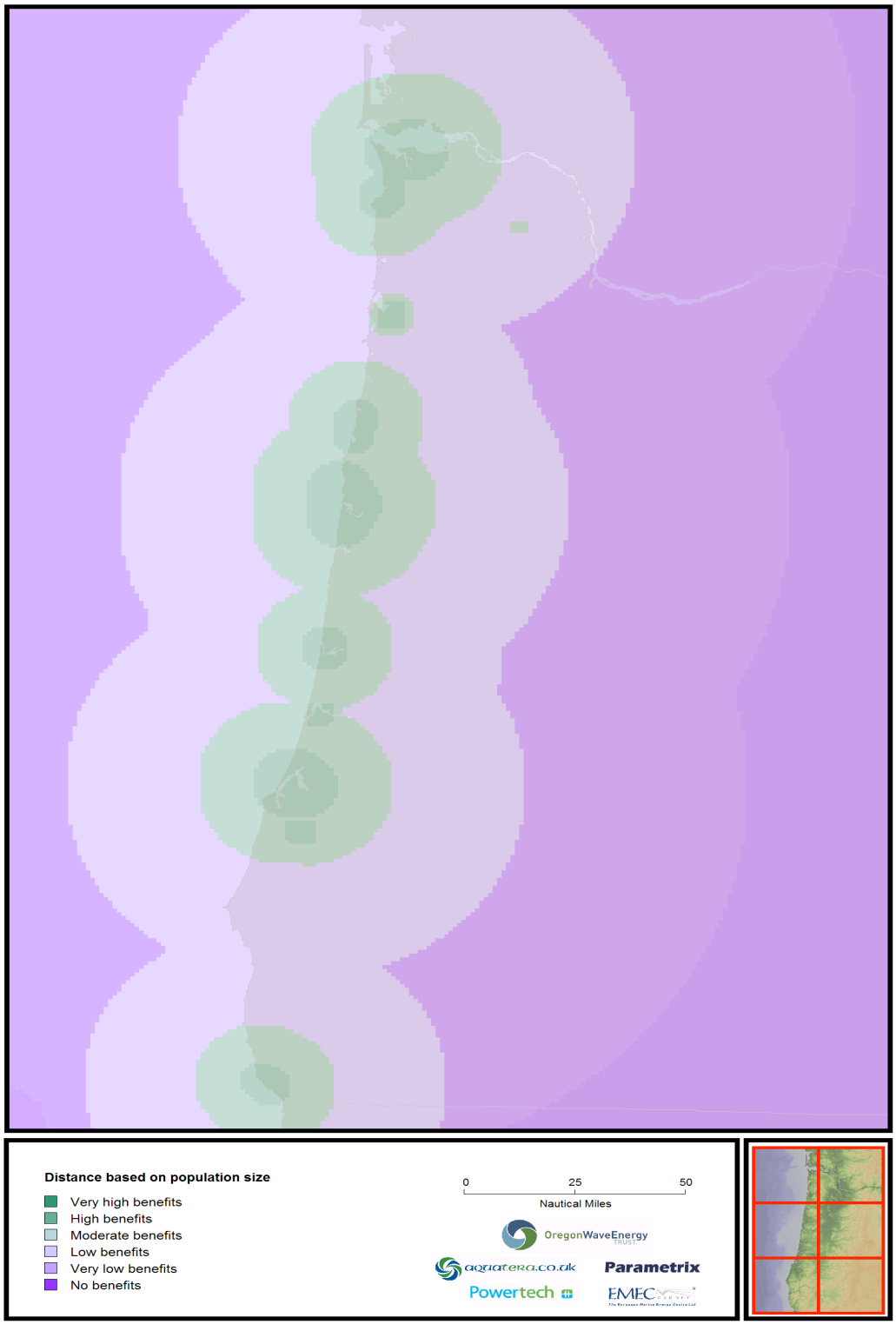


Figure 5.3 Raster map showing distance from coastal communities based on population size

5.2.3 Community facilities

Description

'Community facilities' refers to the availability of public-use facilities within a community, such as swimming pools, community centers, performance venues, etc.

Status and Trends

For most coastal communities, there was little change in community facilities from 1990 to 2000. However, there was a trend for an increasing number of religious organizations and a decreasing number of community and civic organizations in this decade (Oregon Communities Reporter).

Data sets

No data were available for this sensitivity. Measures of “community capacity” are available which include numbers of facilities and organizations in an area; however these data were not obtained for the framework.

5.2.4 Community Wealth

Description
A description of the prosperity of a community, as indicated by variables such as poverty rates and wage levels.

Status and Trends
The coastal region's economic conditions are poorer than the State averages. The median household income in coastal counties is less than in the state as a whole. Reflecting the older population, the percentage of households with retirement income is higher on the Coast than in the State as a whole. The Coast also has a higher percentage of its population living below the poverty level. The poverty rate in Oregon was relatively low at 13% in 2008, with an increasing trend from 2000. The rate was somewhat higher in coastal counties.

From 1997 to 2007, average wage levels increased across the state as a whole, and this was mirrored in trends at the county level, with Coos County experiencing less of an increase than the state as a whole, and Tillamook County experiencing a higher increase than the state as a whole (US Census Bureau, 2009; Oregon State University, Unknown date; Oregon Regional Economic Analysis Project, 2009).

Data sets
Poverty rates

Categorization

Dataset name:	Poverty rates
Dataset description:	Percent of Oregon State population living in poverty within the relevant coastal community
Dataset source:	United States Census Bureau
Categories:	0-0.03%
	0.03-0.06%
	0.06-0.09%
	0.09-0.12%
	0.12-0.15%
	0.15-0.18%
	0.18-0.21%
	0.21-0.24%
	0.24-0.28%
	>0.28%

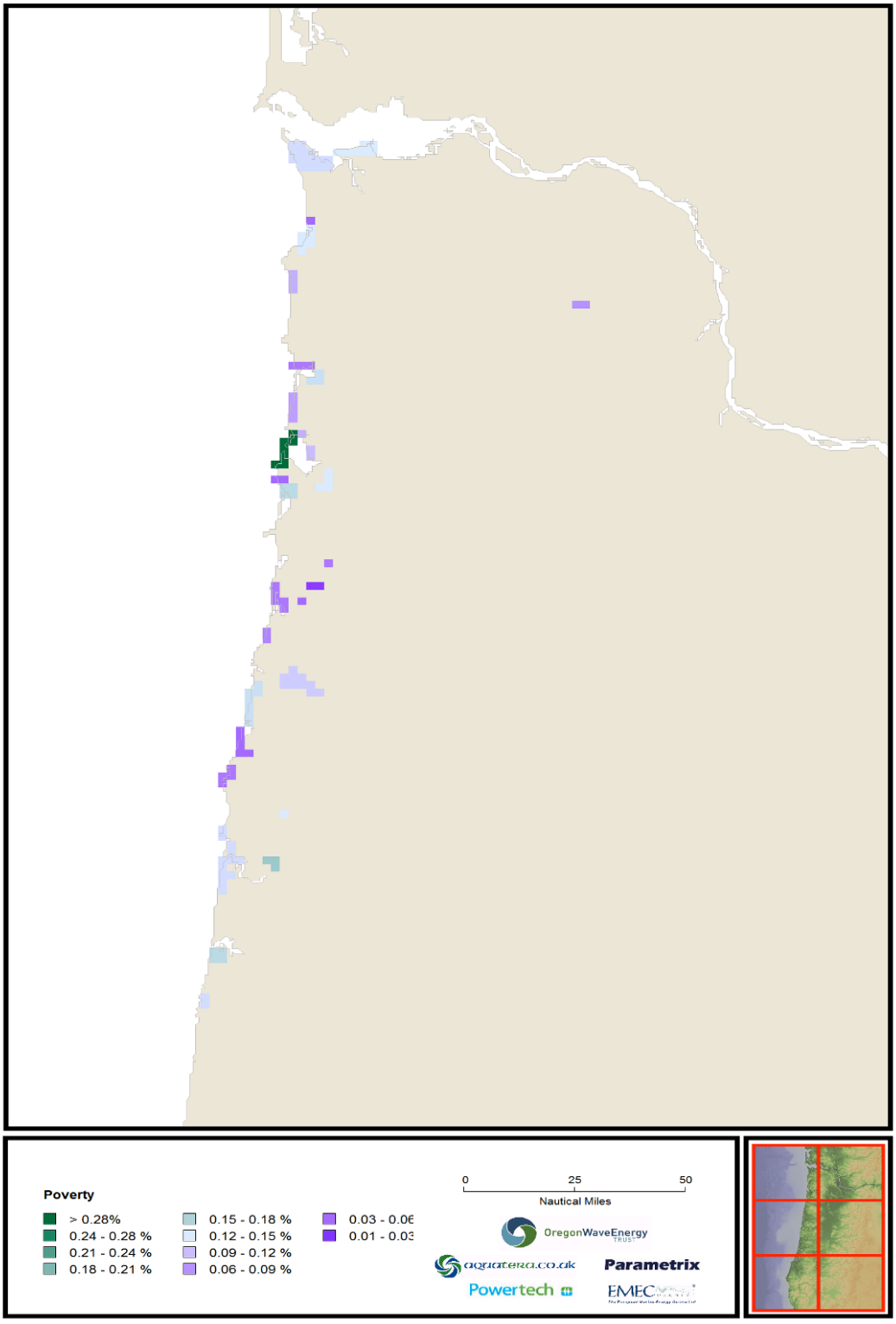


Figure 5.4 Raster map showing poverty rates

5.3 Population and demographics

This section describes characteristics of the population, including the following:

- education and skills
- employment sectors
- unemployment rate
- income
- diversity
- regional population size

Trends for each of these characteristics for the coastal population and Oregon population are described in more detail below.

5.3.1 Education and skills

Description

This variable refers to the level of education of the population and the skills available in the workforce. Communities with the appropriate workforces and skills are better suited to provide labor and services to develop wave energy sites.

Status and Trends

While across the state, high school drop out rates have been decreasing, the drop-out rate has actually increased in Clatsop and Coos Counties. The percentage of adults with a high school education and with a 4-year degree or greater has increased in all coastal counties as well as across the state as a whole (Table 5.2; Oregon Communities Reporter).

Table 5.2 Education trends in Oregon 1990-2005

Measure	1990	2000	2005
High School Drop-out rate	N/A	5.25%	4.10%
Percentage of Adults with High School Education or Greater	81.48%	85.13%	N/A
Percentage of Adults with 4-year Degree or Greater	20.60%	25.08%	N/A
Percentage of Children who Enter School Ready to Learn	N/A	66.50%	79.80%

Data sets

Some data are available on education trends; however no data sets were obtained for this sensitivity for the framework. No data were available on workforce skills, but see Labor Market following.

5.3.2 Labor Market

Description

Labor market refers to the industries and occupations in which people are employed, which is an indication of the skills that are available in communities. Communities with the appropriate workforces and skills are better suited to provide labor and services to develop wave energy sites.

Status and Trends

The coastal region of Oregon is a rural environment with a resource-based economy. Historically, timber, fishing and agriculture have been important industries on the Coast. Although there are a greater number of people employed in natural resource-based jobs on the Coast than in the state as a whole, this percentage has been decreasing. While employment in agriculture, forestry, fishing and manufacturing decreased from 1970 to 2000, employment in service trades has increased, reflecting the increased importance of tourism on the Coast (Davis & Radtke, March 2006). Other important industries on the Coast include water and marine cargo handling, boat building, paper and paperboard mills, the marine biology research and teaching facilities in Coos Bay and Newport, and, and employment in Curry County by the California State prison over the border. The Oregon Employment Department has noted that manufacturing skills may need to be improved to retain or grow manufacturing opportunities in Oregon (Oregon Employment Department, 2008).

Table 5.3 and Table 5.4 show occupational employment rates and industry employment rates by sector for coastal counties compared to the State as a whole.

Table 5.3 2000 occupation employment rates by county, and trends 1990-2000.*

Industrial sector	Coastal Counties										Oregon	
	Clatsop		Tillamook		Lincoln		Coos		Curry			
Managerial, professional, etc.	26%	↑	27%	↑	27%	↑	28%	↑	27%	↑	33%	↑
Service	21%	↑	17%	↑	22%	↑	19%	↑	20%	↑	15%	↑
Sales & Office	24%	↑	22%	↓	27%	↑	24%	↓	25%	↓	26%	↓
Farming, fishing, forestry	3%	↓	6%	↓	3%	↓	3%	↓	4%	↓	1%	↓
Construction, extraction, maintenance	11%	↓	10%	↓	10%	↔	10%	↓	11%	↓	9%	↓
Production and transport	13%	↓	17%	↑	10%	↓	14%	↓	14%	↓	14%	↓

*2000 data from Oregon Communities Reporter

Table 5.4 Industry employment rates by county and state, showing trend from 1990-2000.*

Industrial sector	Coastal Counties					Oregon
	Clatsop	Tillamook	Lincoln	Coos	Curry	
Agriculture, forestry, fishing, mining	4% ↔	11%↓	4%↓	6%↓	7%↓	3%↓
Construction	8%↑	8%↑	8%↑	7%↑	8%↑	7%↑
Manufacturing	9%↓	13%↓	6%↓	8%↓	7%↓	14%↓
Wholesale trade	2%↓	2%↓	2%↓	2%↓	1%↓	4%↓
Retail	15%↓	12%↓	15%↓	13%↓	15%↓	12%↓
Transport and utilities	4%↓	5%↓	4%↓	5%↓	4%↓	4%↓
Information	2%	2%	2%	1%	3%	2%
Finance, insurance, real estate	4% ↔	3% ↔	5% ↔	4% ↔	4%↓	6% ↔
Professional, science, management, administration	5%↑	6%↑	6%↑	6%↑	7%↑	9%↑
Education and health and social services	19% ↔	16%↓	16%↓	23%↑	18%↑	19% ↔
Arts, entertainment, recreation, accommodation	15%↑	10%↑	20%↑	9%↑	14%↑	8%↑
Other services	4% ↔	4%↑	4%↓	6%↓	5%↓	5%↓
Public administration	5%↓	4%↑	5% ↔	6%↓	7% ↔	4% ↔

%↔ = no change
%↑ = increasing trend
%↓ = decreasing trend
% = no information

*2000 data from Oregon Communities Reporter

Data sets

Employment in construction; manufacturing; professional, scientific and technical services; management and fishing; distance based on construction; manufacturing; professional, scientific and technical services; management and fishing

Categorization

Dataset name:	Employment in Construction / Manufacturing / Professional / Management of companies / Fishing
Dataset description:	Percentage of Oregon State population employed in the respective sector within each coastal community
Dataset source:	United States Census Bureau
Categories:	Very Low (>0-0.03%)
	Low (0.003-0.03%)
	Medium (0.03 – 0.27%)
	High (>0.27 – 0.297%)
	Very high (>0.297%)

Dataset name:	Distance based on employment in Construction / Manufacturing / Professional / Management of companies / Fishing
Dataset description:	Dataset utilizing levels of employment in respective sectors to produce spatial description of the benefits of proximity to population centers based on employment type. Categories are a function of the size of the settlement and the distance from it, so no or little benefit is derived from being close or distance from small settlements, but high benefits are assumed when located close to a settlement with a larger population.
Dataset source:	Aquatera
Categories:	No benefit
	Very low benefit
	Low benefit
	Moderate benefit
	High benefit
	Very high benefit

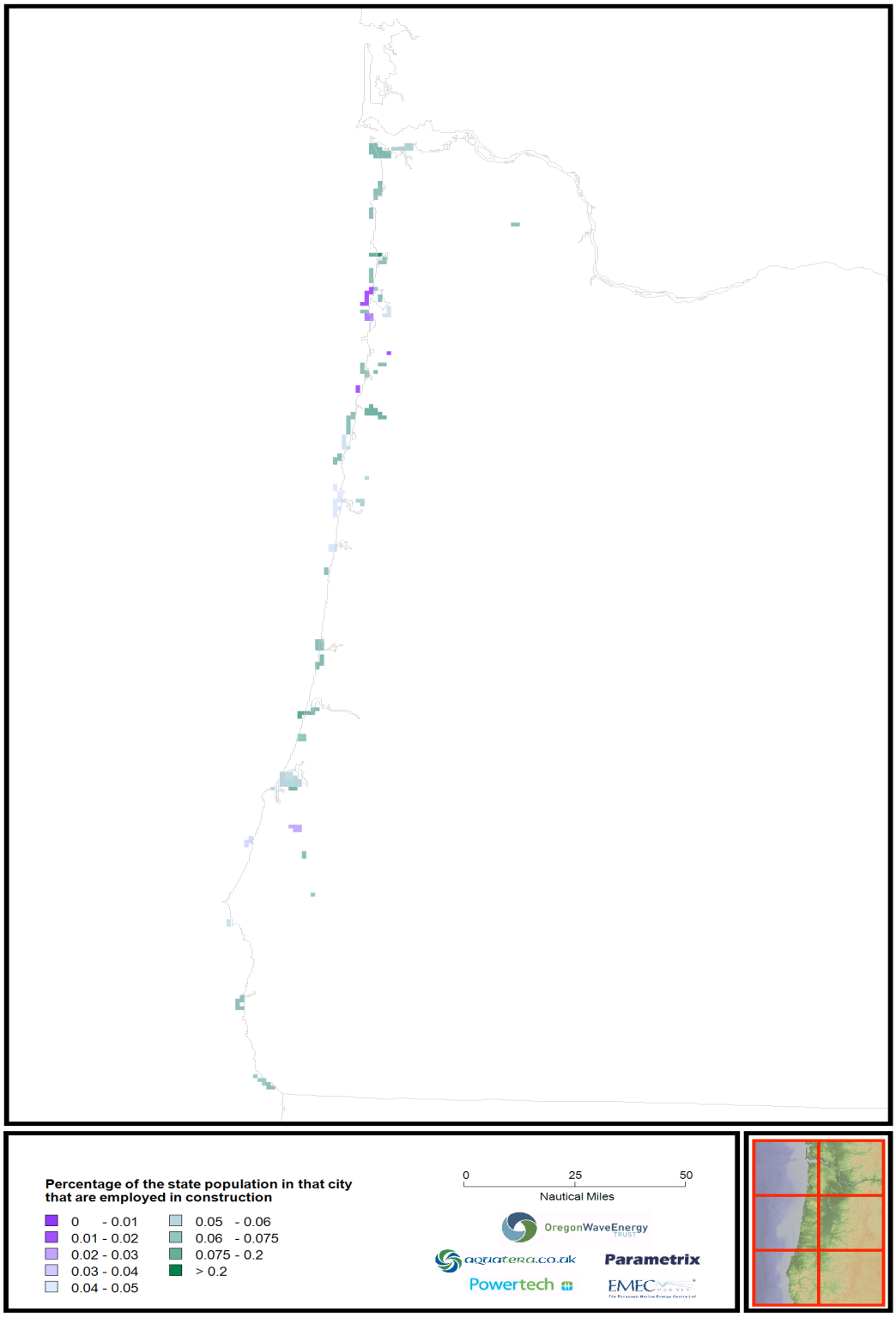


Figure 5.5 Raster map showing employment in construction

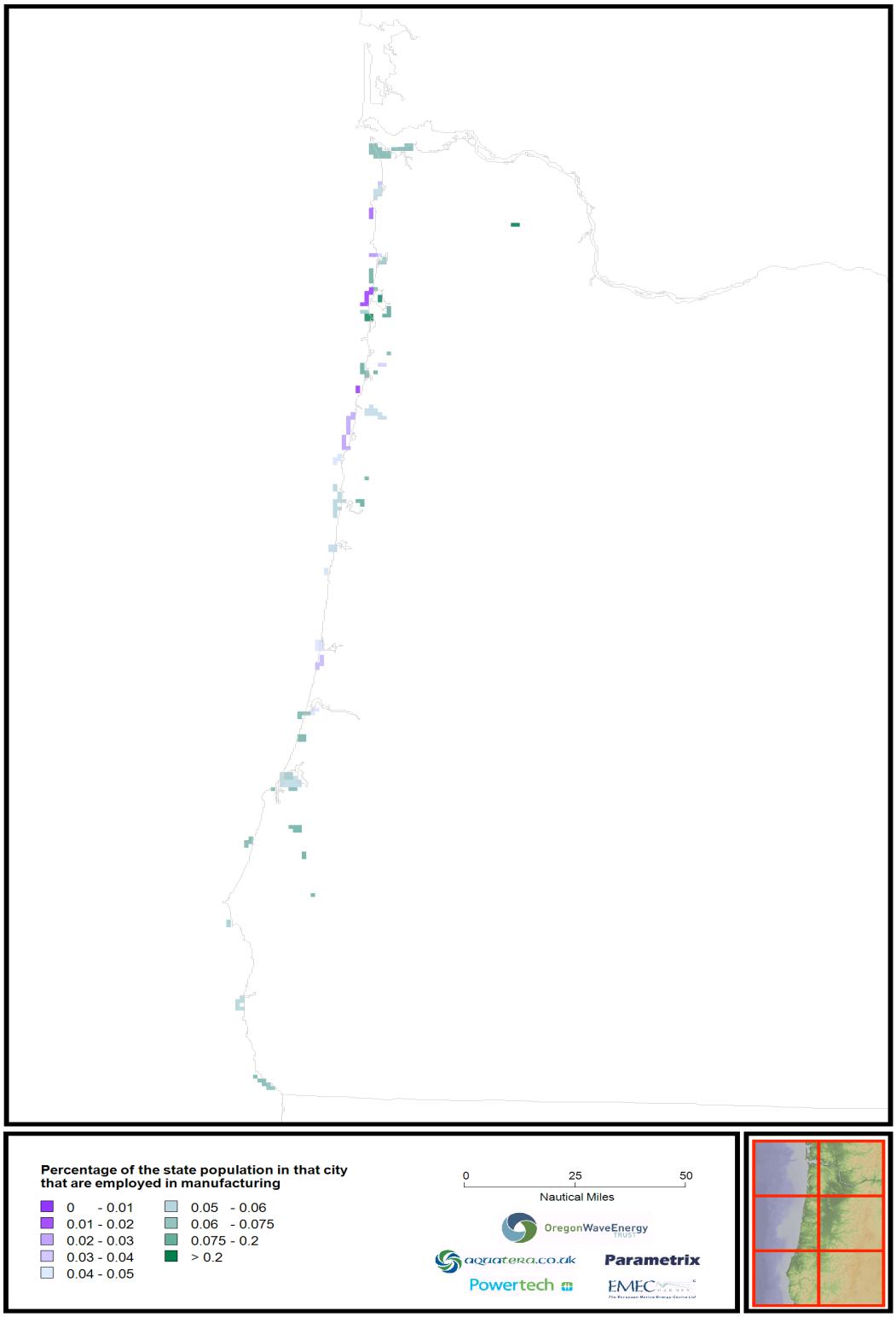
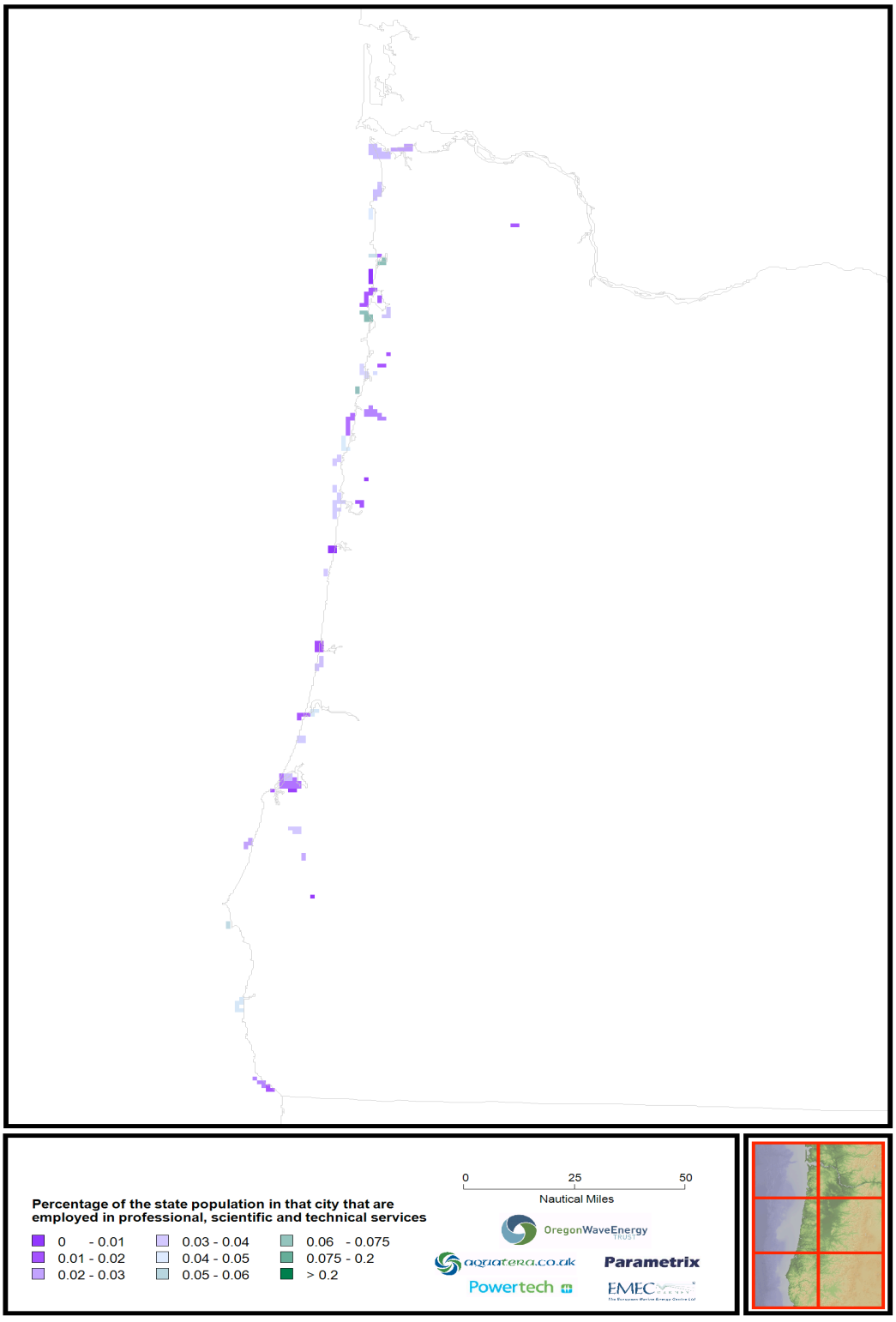


Figure 5.6 Raster map showing employment in manufacturing



Raster map showing employment in professional, scientific, and technical occupations

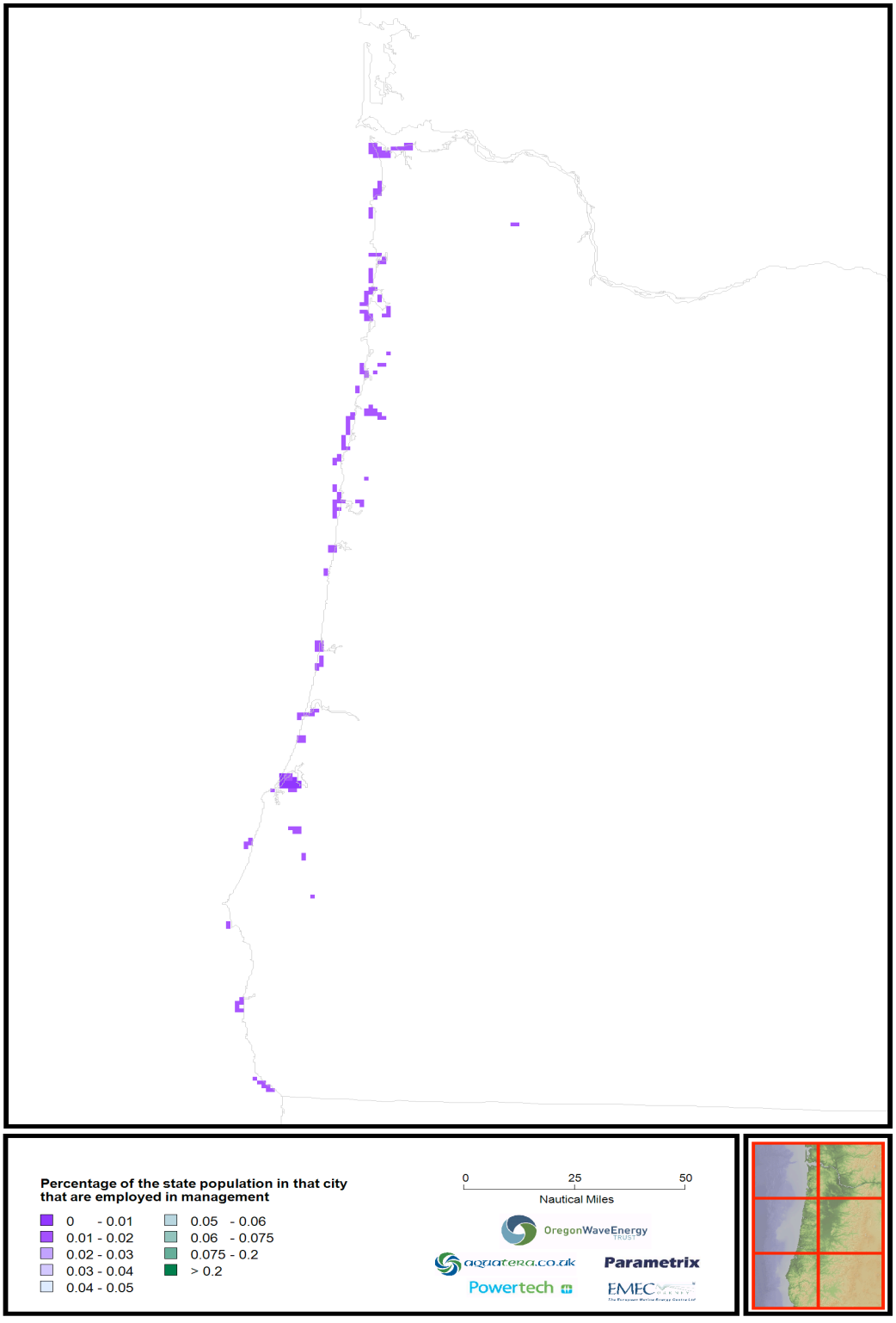


Figure 5.7 Raster map showing employment in management of companies

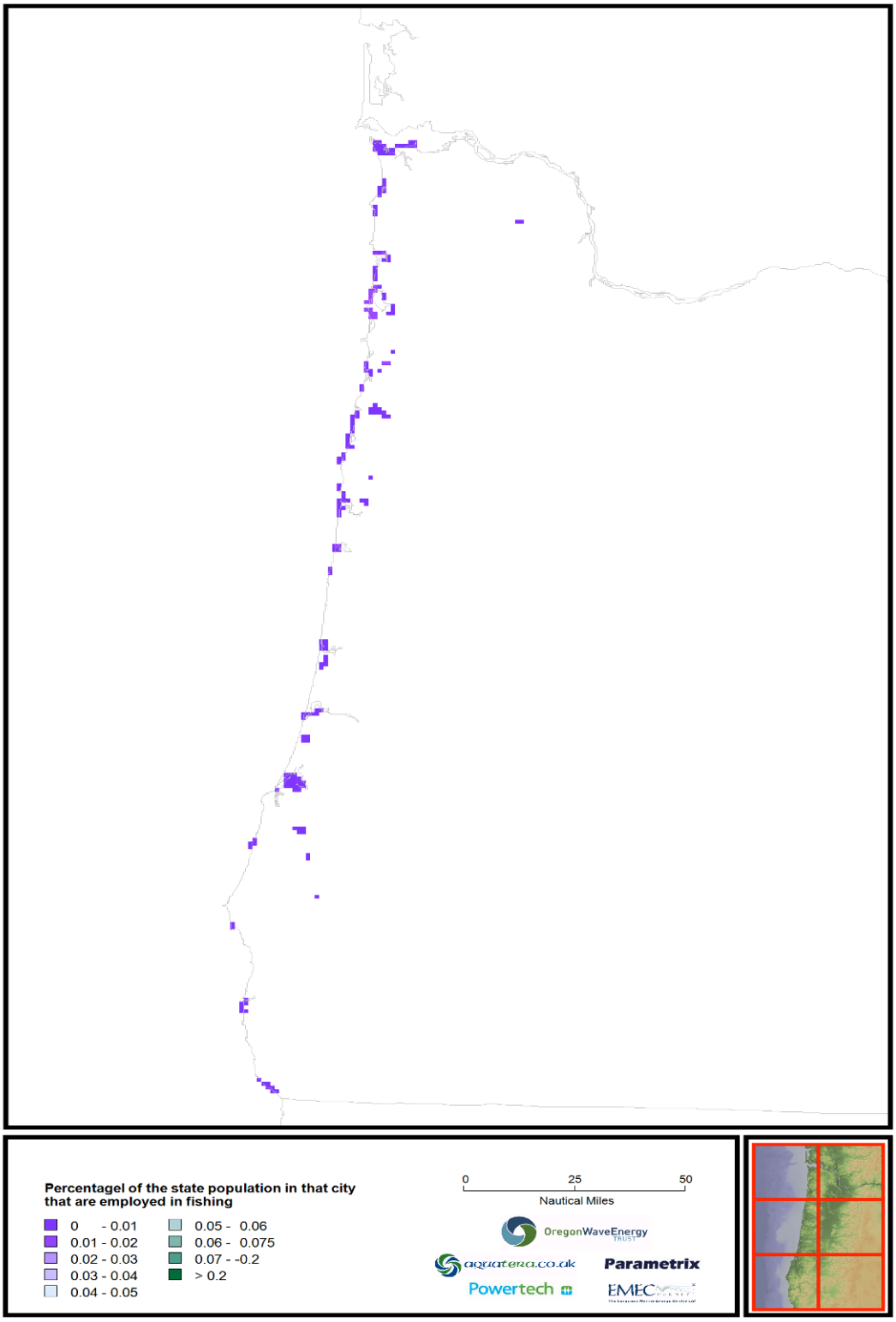


Figure 5.8 Raster map showing employment in fishing

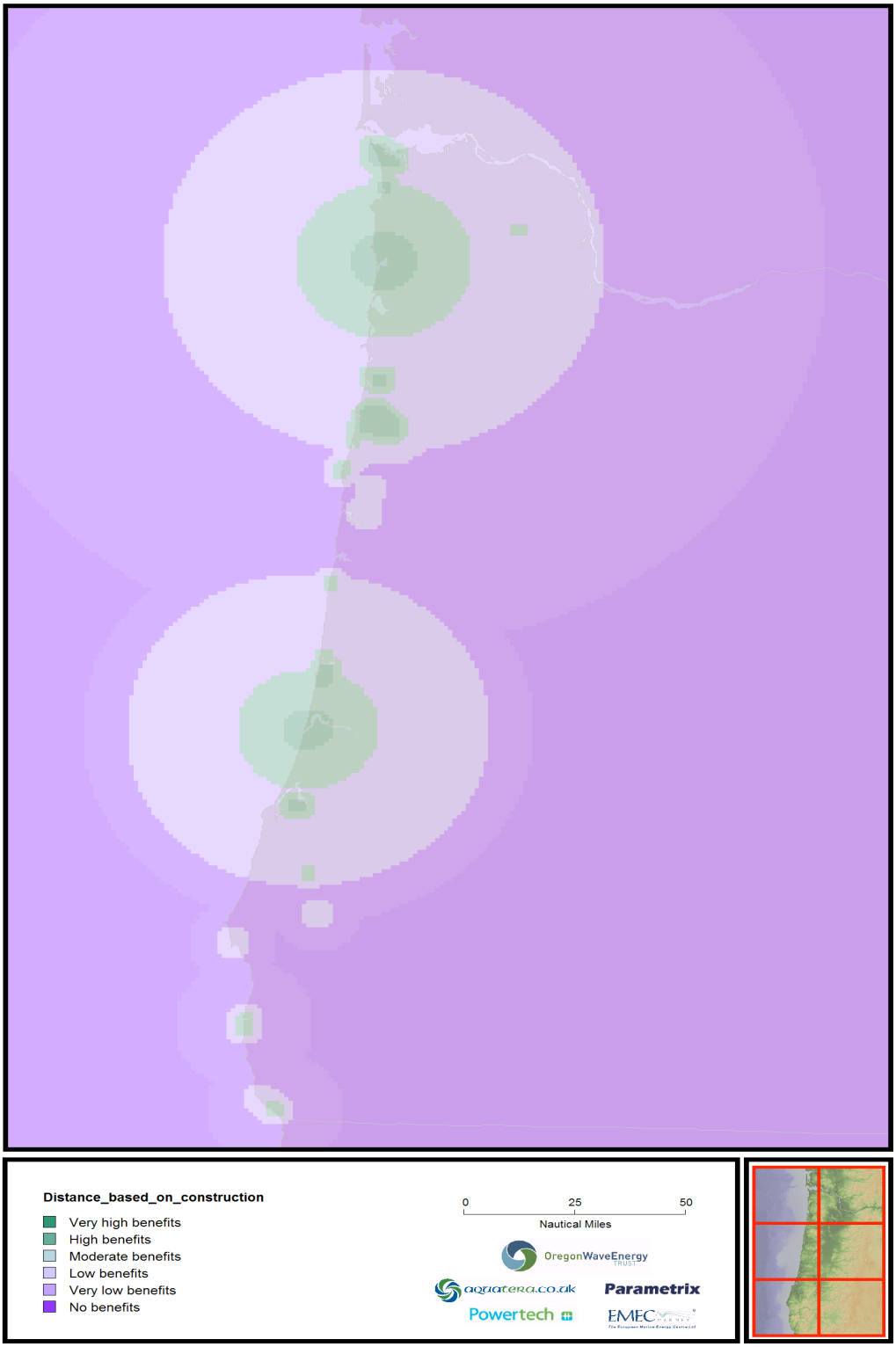


Figure 5.9 Raster map showing benefits based on distance from employment in construction

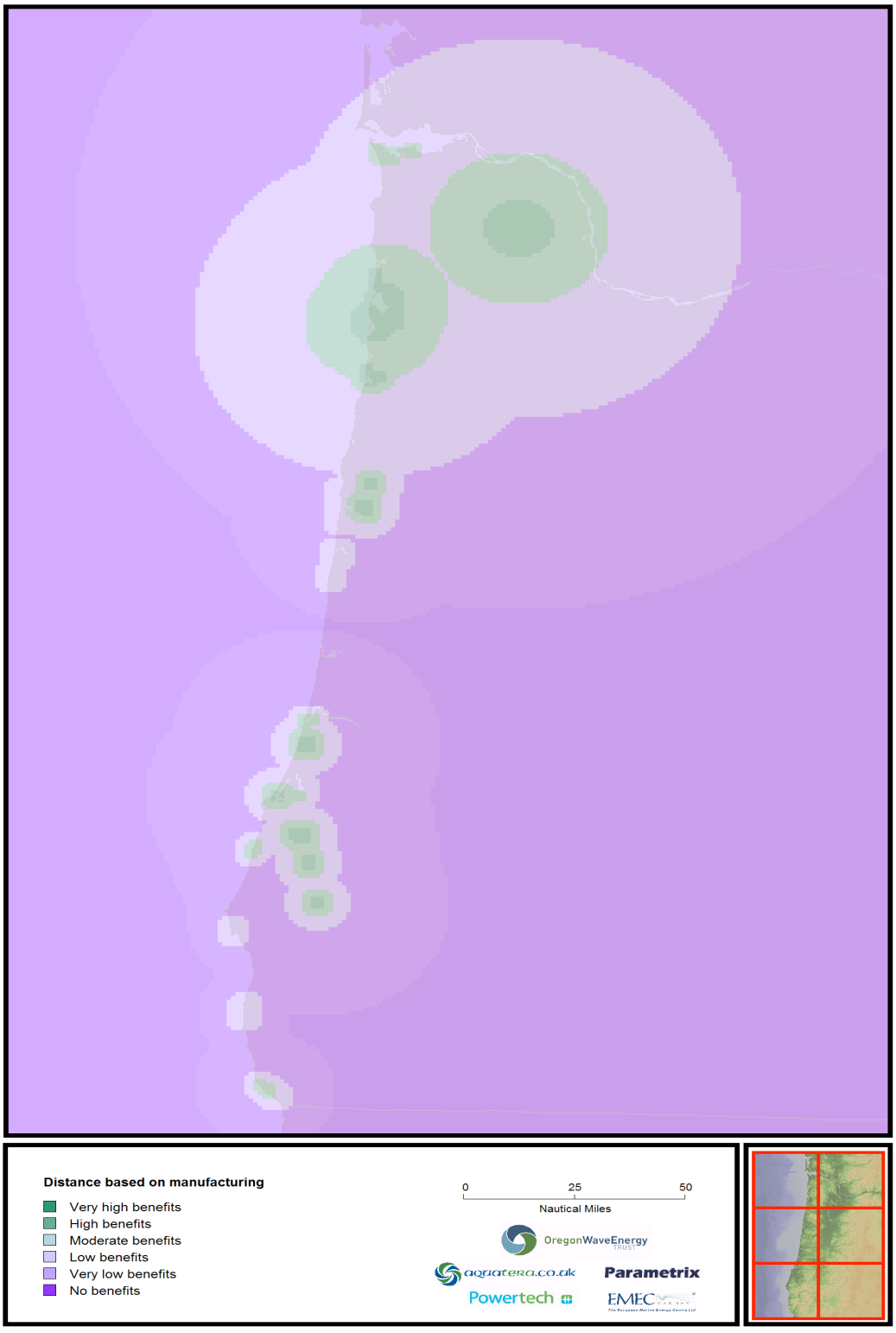


Figure 5.10 Raster map showing benefits based on distance from employment in manufacturing

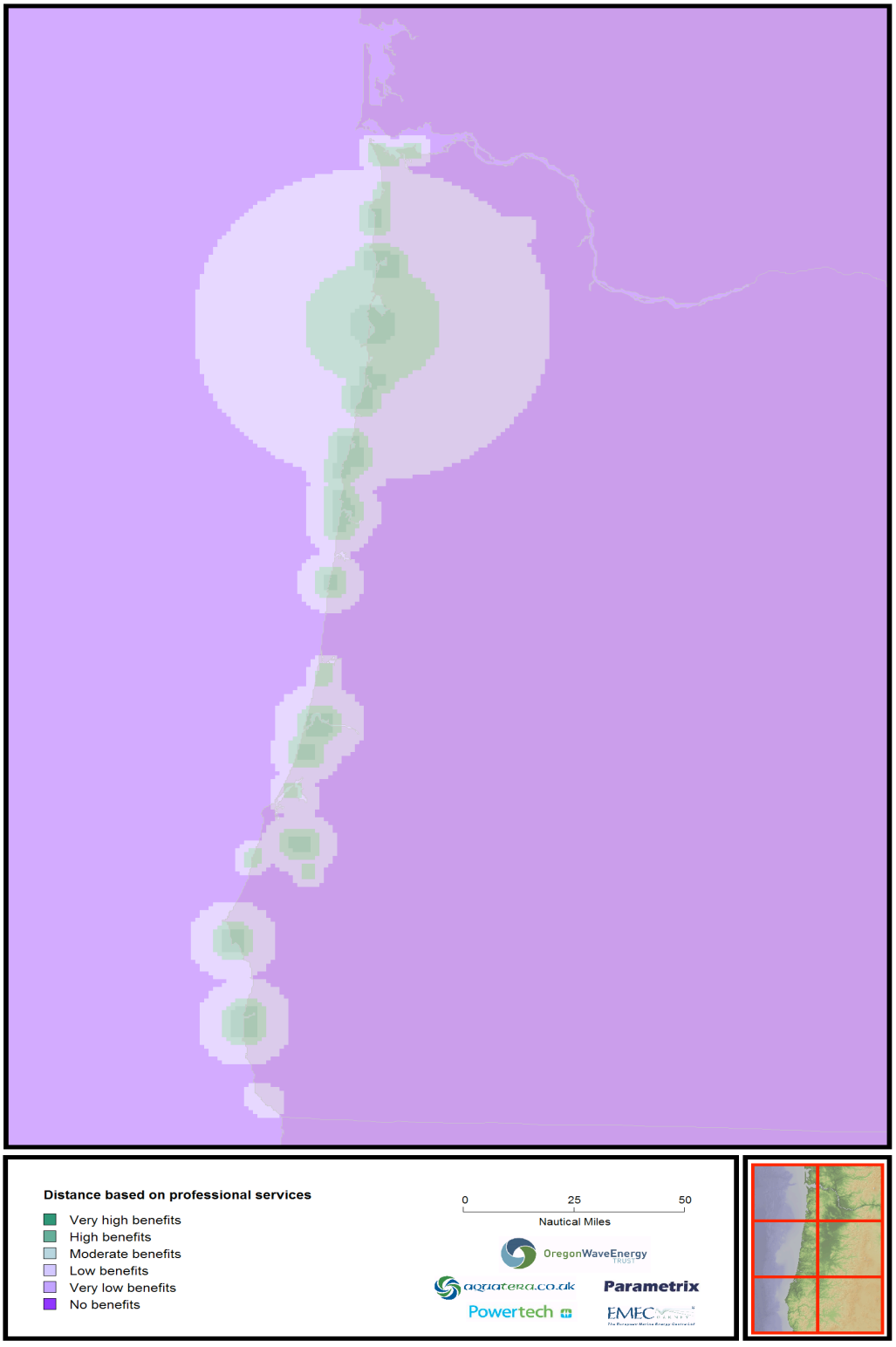


Figure 5.11 Raster map showing benefits based on distance from employment in professional, scientific, and technical services

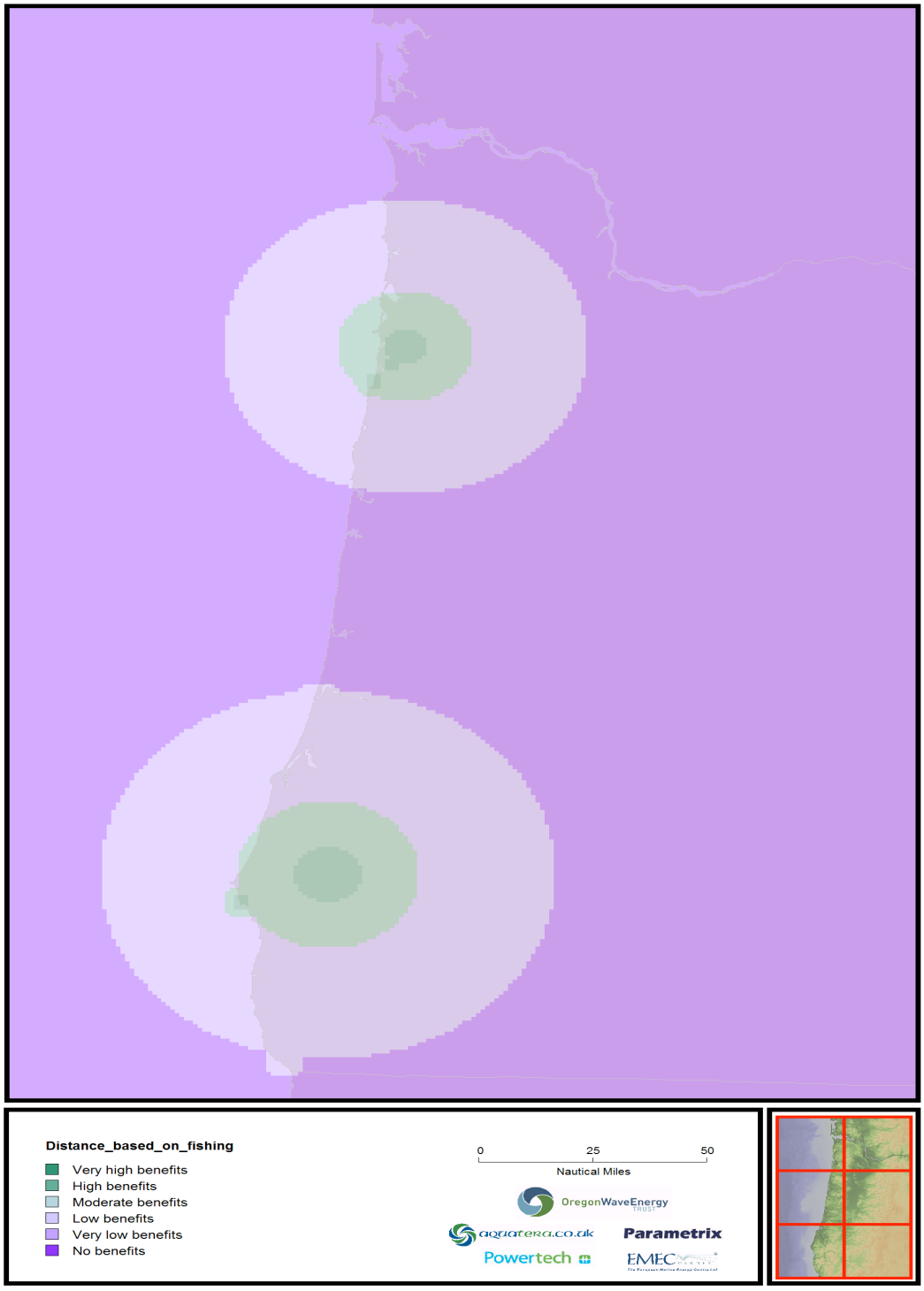


Figure 5.12 Raster map showing benefits based on distance from employment in fishing

5.3.3 Unemployment rate

Description
The rate of unemployment is an indicator of community prosperity, as well as a measure of potential workforce availability.

Status and Trends
The unemployment rate in coastal counties in Oregon over the last 20 years (1990-2004) has ranged from 6% to 9%, generally exceeding that of the state as a whole. The unemployment rate has generally been lowest in Tillamook County and highest in Coos County (Oregon Department of Fisheries and Wildlife, 2006). In March 2009, the rate of unemployment in Oregon was greater than 12% compared to 8.5% nationwide, and was one of the highest rates in the nation (Oregon State University, Unknown date; Read, 2009; Local Area Employment Statistics). At the conclusion of 2009, unemployment rates in coastal counties ranged from 9.5% to 15.9% with unemployment in southern counties highest (Oregon Labor Market Information System [OLMIS] , 2009).

Data sets
Unemployment rate by city

Categorization

Dataset name:	Unemployment rate
Dataset description:	Percentage of Oregon State population unemployed within the relevant coastal community
Dataset source:	United States Census Bureau
Categories:	0-0.01 %
	0.01-0.02 %
	0.02-0.03 %
	0.03-0.04 %
	0.04-0.05 %
	0.05-0.06 %
	0.06-0.07 %
	0.07-0.08 %
	0.08-0.09 %
	>0.09 %
	Outside city limits

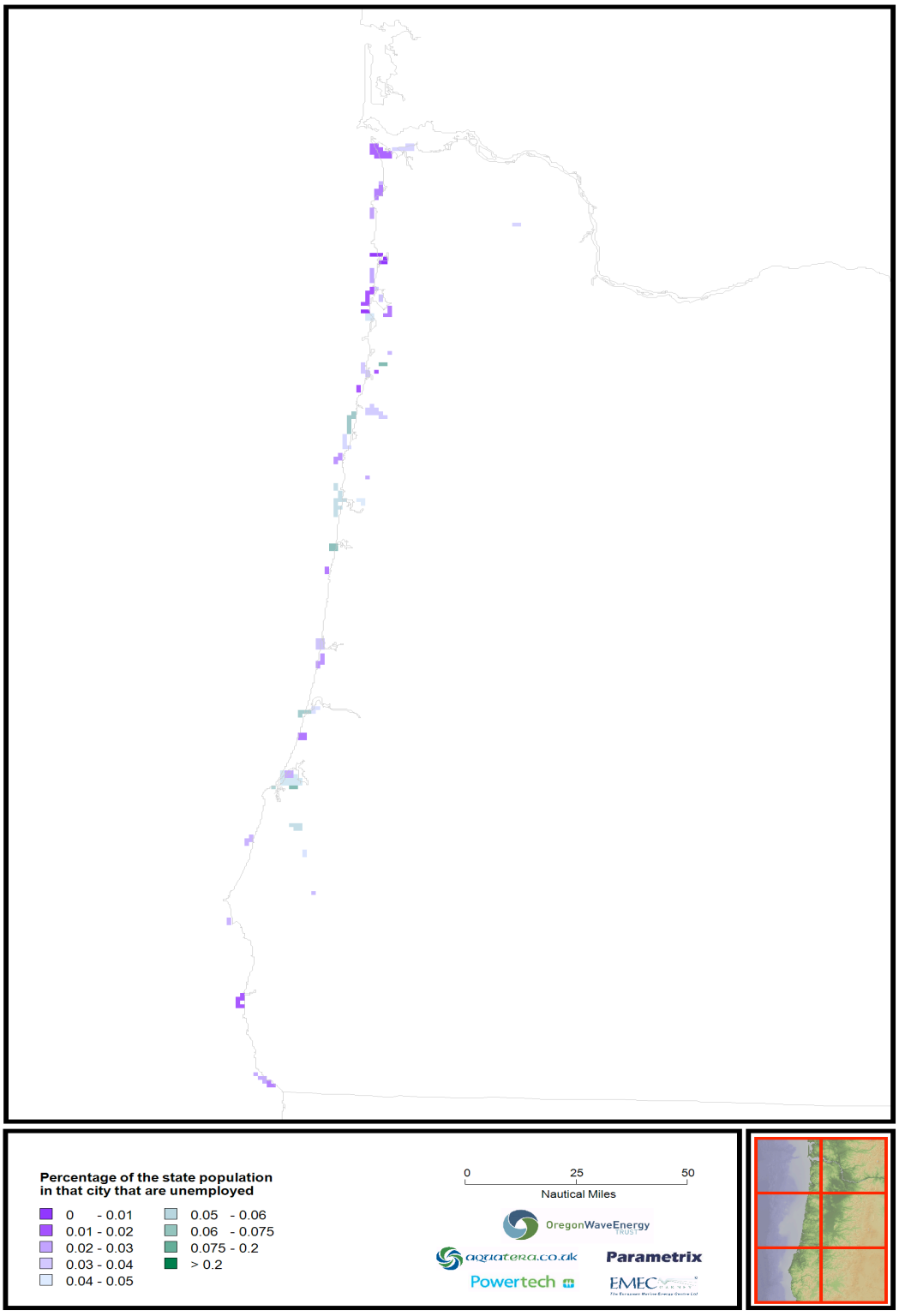


Figure 5.13 Raster map showing unemployment rate

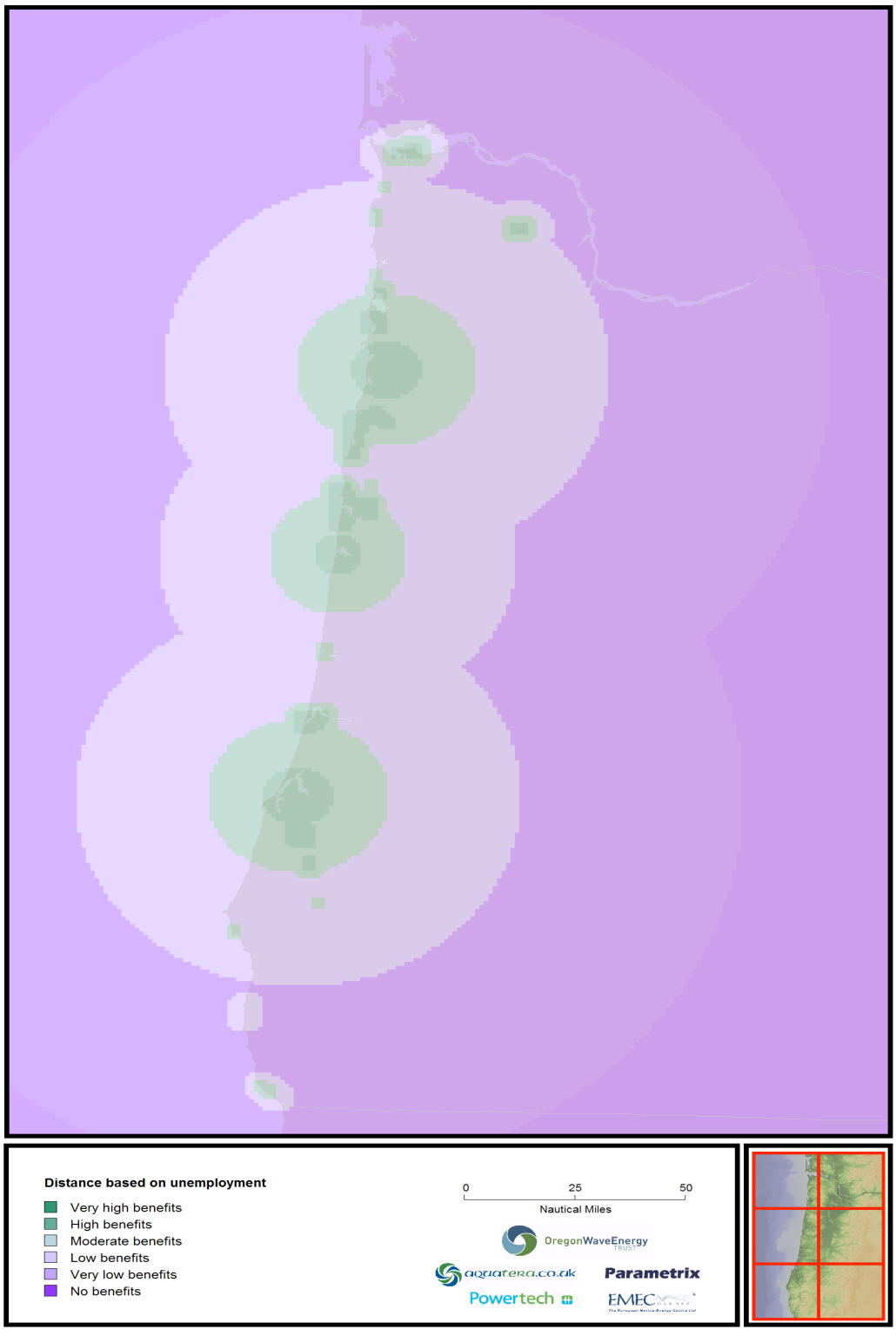


Figure 5.14 Raster map showing benefits based on distance from unemployment

5.3.4 Income

Description

We looked at the variable of personal per capita income as an indicator of trends in individual wealth. The wave energy industry has the potential to bring highly-skilled, high paying jobs to communities, which could impact the trends in personal income.

Status and Trends

Per capita personal income, as a percentage of US per capita personal income, increased in Oregon from 92% to 94% from 1990 to 2005. In coastal counties, this percentage is lower than the State as a whole, ranging from 78% in Coos and Curry Counties to 82% in Lincoln County. In the 15 years from 1990 to 2005, the percentage decreased in most coastal counties, with the exception of Lincoln and Tillamook Counties, where per capita income as a percentage of US per capita personal income increased during that time (Oregon Communities Reporter).

Data sets

Per capita income

Categorization

Dataset name:	Per capita income
Dataset description:	Average income per head of population within each of the coastal communities
Dataset source:	United States Census Bureau
Categories:	Outside city limits
	Per capita income >0 - $20 000
	Per capita income >$20 000- $30 000
	Per capita income >$30 000

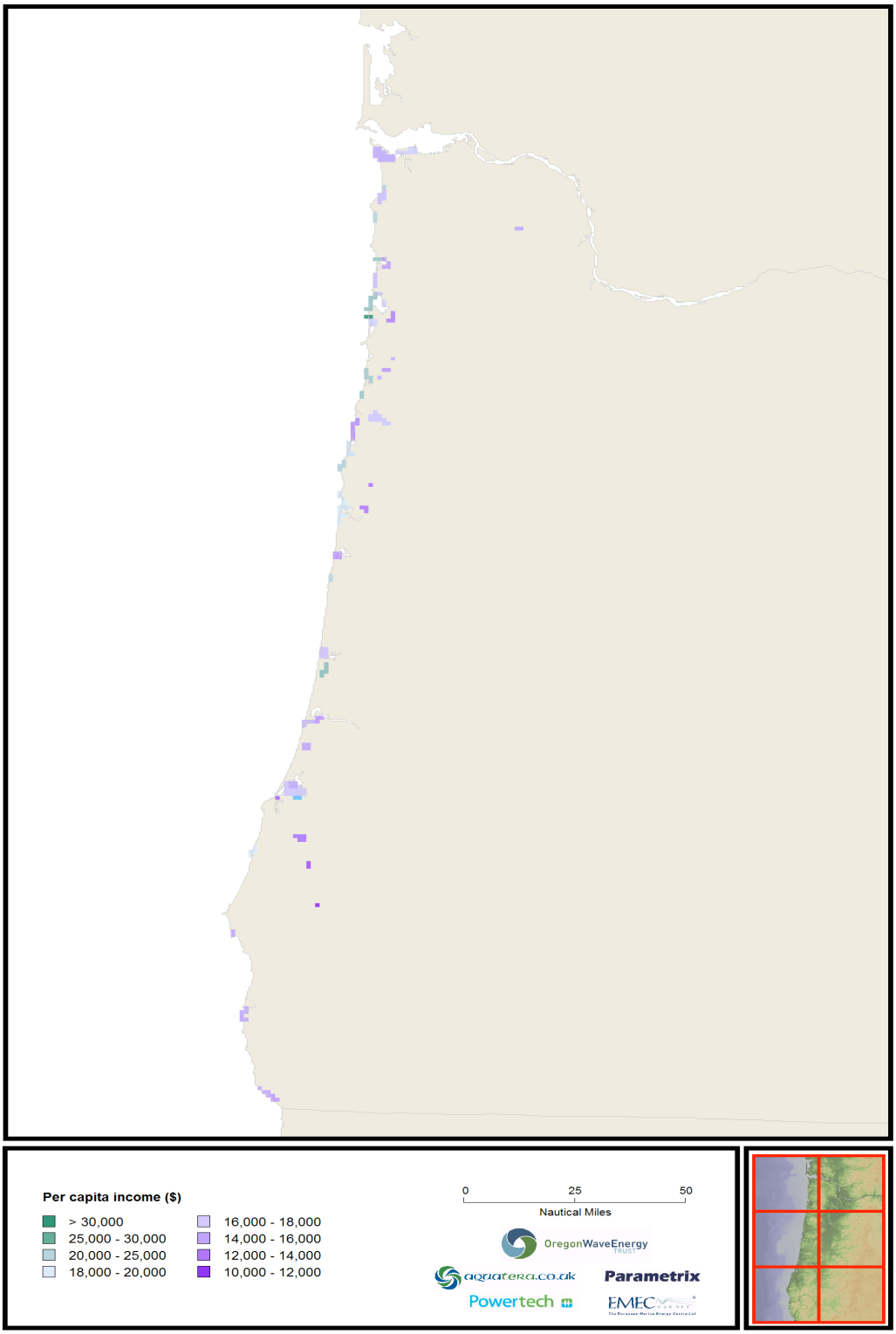


Figure 5.15 Per capita income

5.3.5 Diversity

Description

Community diversity may be indicated by variables such as age, education, family structure, and race and ethnicity. Some of these factors may provide an indicator of the potential work force in an area.

Status and Trends

The median age for coastal counties is older than for the state as a whole (Oregon State University, n.d.). There is a higher proportion of retirement-age persons living on the Coast compared to the rest of Oregon. Demographic changes are similar across the coastal counties, and retirees comprise the majority of population growth (Oregon Department of Fisheries and Wildlife, 2006). Younger residents move outside their coastal communities after graduation and simultaneously, retired individuals are moving to the Coast, creating a skewed age distribution.

Data sets

No data sets measuring community diversity were obtained for this framework.

5.3.6 Regional Population

Description

Numbers of people living in the coastal region. This sensitivity is at a broader scale than 5.2.2 “Population size” related to communities, and since it describes the coastal region, is comparable in scale to the other characteristics described in this section.

Status and Trends

Approximately 225,000 people live full-time on the Oregon Coast, about 6.5% of the State's total population (Oregon Coastal Management Program, 2008; US Census Bureau, 2009). Population levels are rising, both at the state level and in coastal counties. From 1969 to 2008, the population of Oregon increased 81.2%, compared to the national increase of 49.7% during that time. Although most of that increase was in metropolitan areas, coastal counties also saw population increases during that time, although the growth was generally slower than the State as a whole, ranging from 14.3% in Coos County to 78% in Lincoln County. In particular, Lincoln, coastal Lane, and Curry County have experienced significant population growth, similar to the State’s rate, while population growth in Coos County has been much slower. The decade of greatest growth was the 70’s, with the 90’s also seeing high annual growth rates. In the most recent decade from 2000 to 2008, Oregon’s population increased by 10.8%. Coastal counties increased less, ranging from just 1.1% in Coos County to 5% in Clatsop County (US Census Bureau, 2009; Oregon Regional Economic Analysis Project, 2009).

Data sets

No data sets specific to the population of the state or the coastal region were obtained for this framework.

5.4 Quality of Life

In addition to characteristics of places and the people who live there, the social environment includes amenities that contribute to the quality of life in an area, such as recreational opportunities and visual amenities.

Each of these is described in more detail in the sections below.

5.4.1 Recreation

Description

The Oregon Coast is a varied setting comprised of beaches and headlands, estuaries, streams and rivers, and mountain forests, offering a wide variety of outdoor recreation opportunities. Recreational activities may be primarily marine, coastal, or terrestrial, and may be active, such as fishing or hiking, or passive. Some marine recreational activities, such as surfing, are reliant on the wave regime, while many other recreational activities are not. Sites designated specifically for recreation, such as State Parks, were described under Social Conservation, Section 4.2.4.

Status and Trends

There are a large number of public (state, federal, city and county) recreation areas along the Oregon coastline including parks, campgrounds, recreational and historic areas, public forests, etc. Recreational activities include active pursuits such as boating, sailing, surfing, diving, and cycling as well as more passive pursuits such as sightseeing, wildlife observation, and photography. Passive recreational activities tend to be more prominent on the North Coast, whereas the South Coast draws more active recreationists. These activities form the basis for the important economic contributions of tourism (Oregon Coastal Management Program, 2008; Oregon State University, n.d.).

State park recreational planning has identified a growing demand for recreational opportunities on the Coast. This includes camping, hiking and scenic viewing opportunities. This demand is related to the aging population that includes more users looking for passive or non-consumptive recreational opportunities (Oregon Department of Parks and Recreation, 2003).

A research project is underway through the Surfrider Foundation. The project is developing a spatially explicit dataset that measures the types and levels of non-consumptive recreational activities on the Oregon Coast. The study will include a relative valuing of areas to understand the distribution of activities and their importance.

Data sets

Beach access. No other data sets characterizing recreation were obtained for this framework.

Categorization

Dataset name:	Beach Access
Dataset description:	Locations of beach access points along the Oregon coastline, highlighting points where ramps access is available
Dataset source:	Oregon Geospatial Enterprise Office, GEO Spatial Data Library
Categories:	No Beach Access
	Beach Access with ramp
	Beach Access without ramp

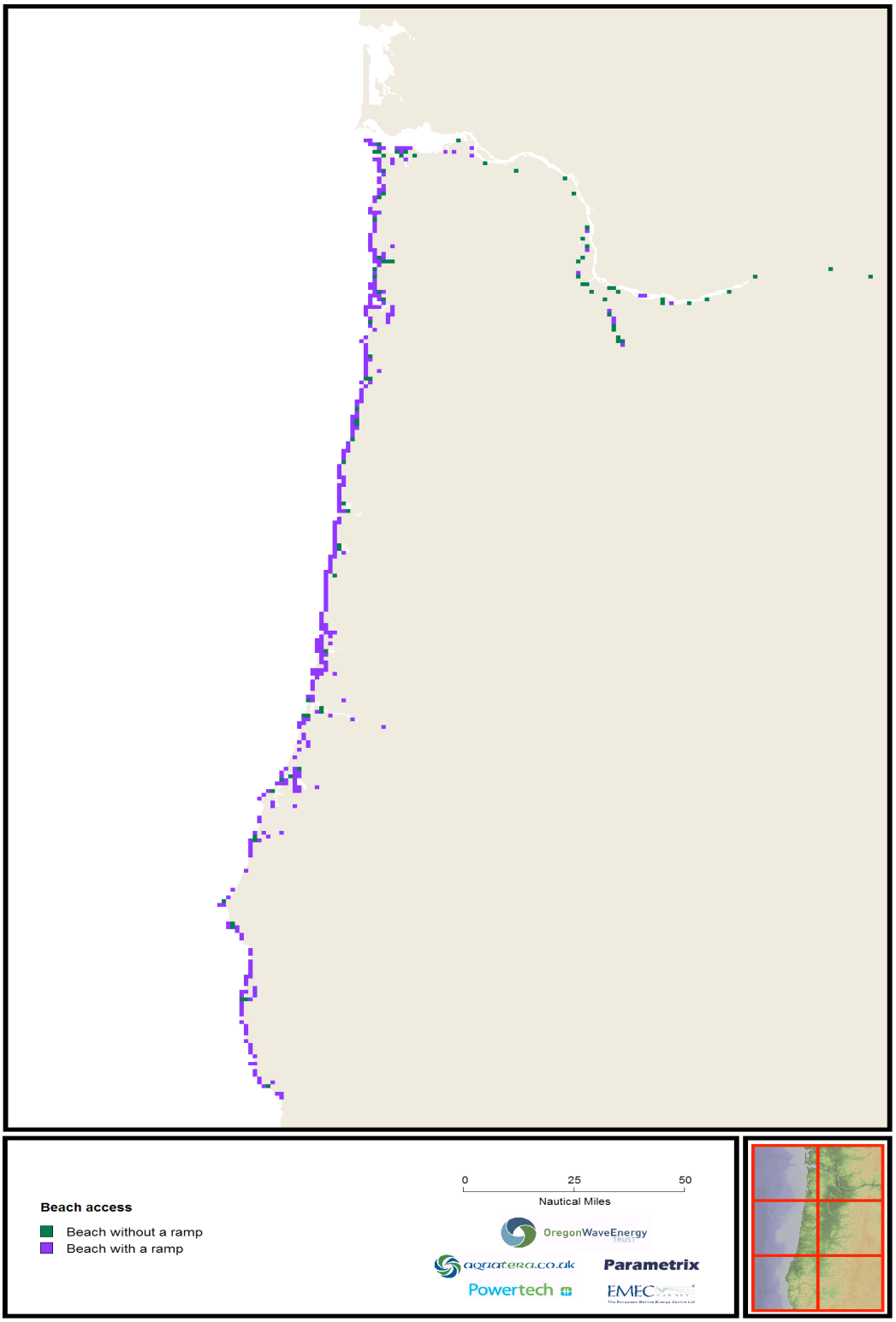


Figure 5.16 Raster map showing beach access

5.4.2 Visual amenity

Description
This sensitivity refers to visual amenities such as scenic areas and viewpoints.

Status and Trends
No information on the status and trends for this sensitivity was obtained for this report.

Data sets
Coastal viewsheds

Categorization

Dataset name:	Coastal viewsheds
Dataset description:	Dataset showing areas that are visible from designated coastal viewpoints and recordings of the distance from the viewpoint
Dataset source:	Aquatera
Categories:	Viewpoints
	Outside of viewshed
	>0 – 5 miles from viewpoint
	>5 – 10 miles from viewpoint
	>10 – 20 miles from viewpoint
	>20 miles from viewpoint

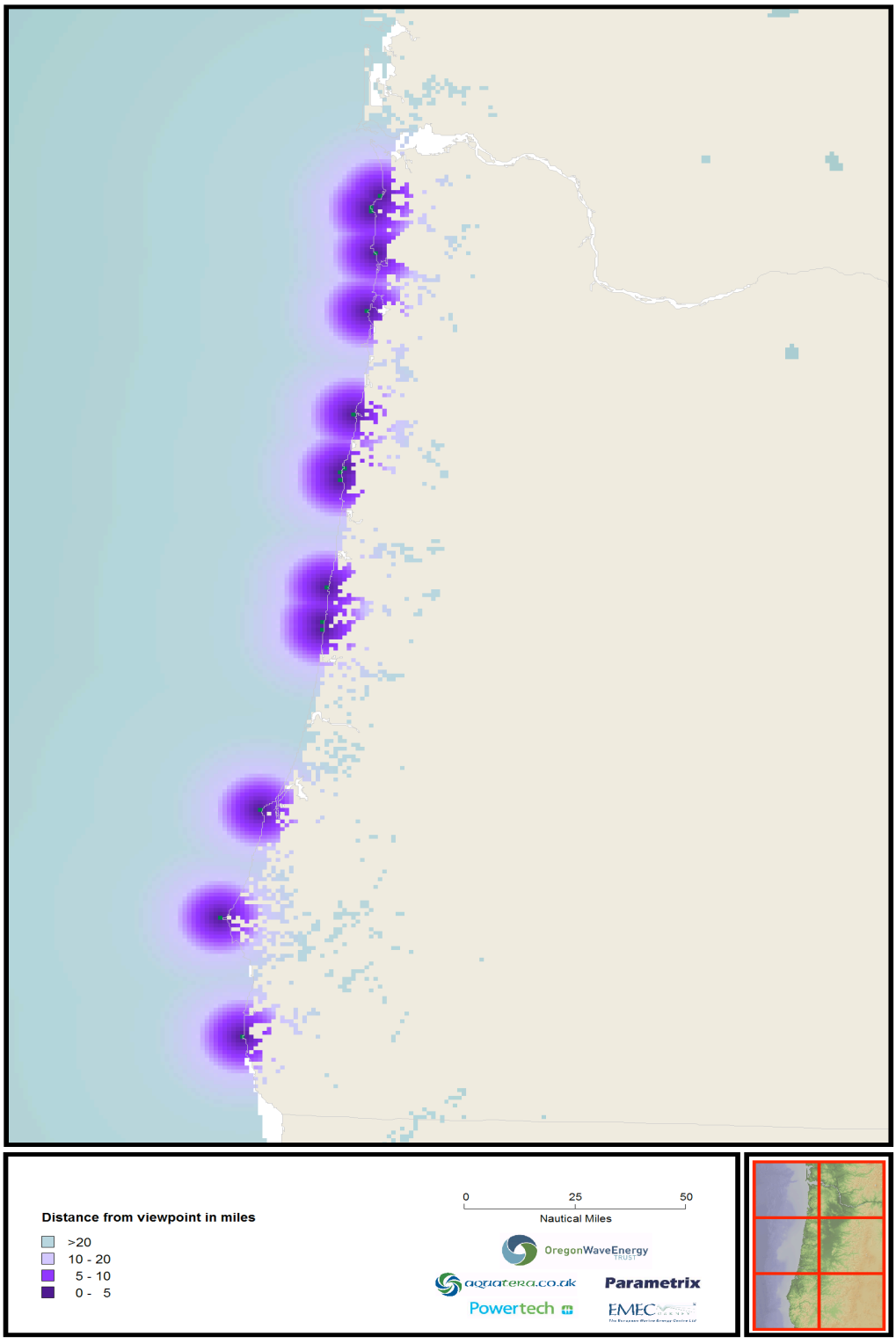


Figure 5.17 Raster map showing coastal viewsheds

5.5 Social policy and values

Social policies and values includes those potentially related to development of a wave energy industry, such as energy supply and energy use. Public opinion of energy issues, such as wave energy development, is also included in this category. These sensitivities are described in more detail in the sections below.

5.5.1 Energy supply and use

Description

This category refers to the values of society related to the security of energy supply (i.e. reliance on imported fuel); and safeguarding energy supply (i.e. how domestic energy supplies are consumed). It also includes current patterns of energy use in Oregon and policies related to reduction of CO_2 .

Energy production and management is guided regionally by the Northwest Power and Conservation Council (NPCC). The Council is a multi-state compact that plans for regional power requirements and manages the environmental impacts of the federal hydroelectric system operations. The council monitors power requirements and forecasts trends for the region.

Wave energy will be competing in the market with other energy supplies. The pattern of generation from wave may or may not be linked to energy demand/use. Provision of renewable energy will only benefit the green house gas issue if it displaces existing capacity, not if it merely services increased demand.

Status and Trends

The Northwest has historically had a higher rate of residential electrical heating leading energy usage to peak in the winter. However, this is changing as air conditioning has become more common in the Northwest leading to a summer peak to develop. The region's hydroelectric system has historically been a power exporter to California to meet its summer peak demands. The region's low cost hydroelectric power attracted the development of aluminium smelters that compose almost half of the industrial load; however these industries have slowed greatly and have an uncertain future. Future power demands for the region come primarily from residential and commercial sectors, and the proposed means to meet this load is primarily through conservation measures, which are seen as the most cost effective option (Northwest Power Conservation Council, 2009).

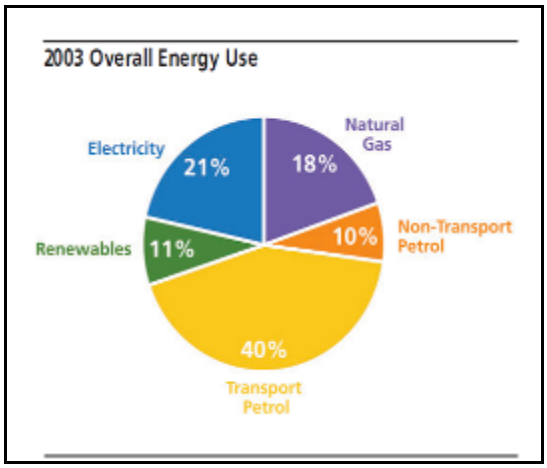
In 2003, 40 percent of Oregon's energy use was for transportation (Figure 5.18), which was also the primary cause of CO_2 emissions. Figure 5.18 also shows that electricity was 21 percent of Oregon's energy use in 2003. The primary electricity generator in Oregon is hydroelectric power, followed by coal. Oregonians spend nearly $10 billion on energy annually (Oregon Department of Energy, March 2008).

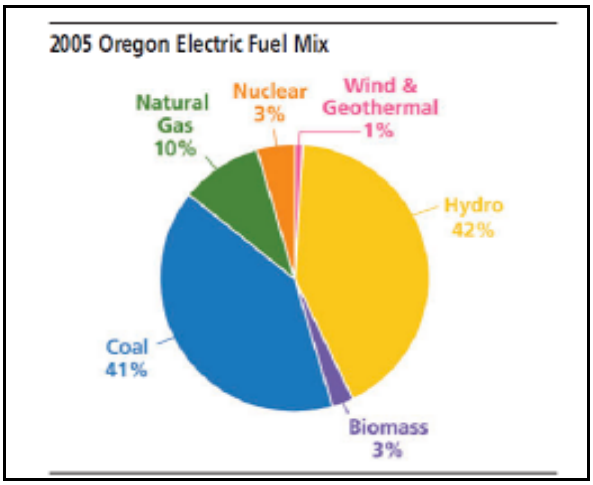
Pressures

As Oregon's population continues to increase, the demand for electricity will also continue to increase, putting pressure on the current electricity generators to meet the increasing demand.

Data sets

No data sets were obtained for this sensitivity for the framework





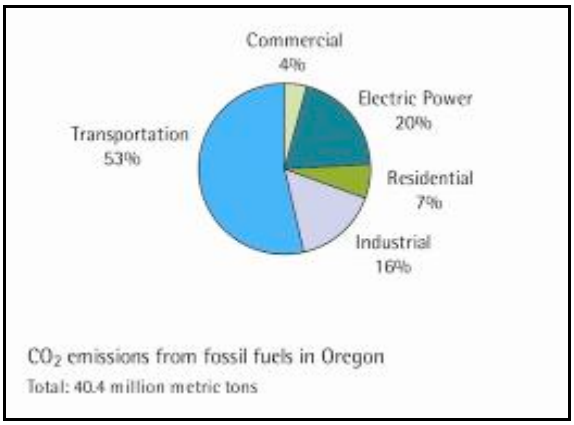


Figure 5.18 Energy use in Oregon
(a) Oregon's overall energy use 2003 (from Oregon Department of Energy March 2008);
(b) Where Oregon gets its electricity 2005 (from Oregon Department of Energy March 2008);
(c) CO_2 emissions from fossil fuels in Oregon (from Sightline Institute 2003: http://www.sightline.org/maps/charts/Climate-EmBySector)

5.5.2 Public opinion of wave energy

Description

Harvest of energy from waves is a relatively new environmental issue in Oregon. The profile of this emerging technology has been raised in recent years as the Department of Land Conservation and Development formed a Wave Energy Working Group in 2006, and the Oregon Wave Energy Trust was founded in 2007. As opinions change through time as a result of education and experience, it is important to have an indicator of what the opinions are at various points in time and space. Public opinion of wave energy could influence the acceptability of permit applications as well as the ease of negotiations with other ocean users.

Status and Trends

Researchers at Oregon State University have conducted a study of the opinion of Oregonians to wave energy development. Although a majority of respondents were generally positive about wave energy, many had reservations or didn't know enough about it to form an opinion. Opinions differed depending on whether people were more interested in jobs, energy, fishing rights, the environment or other issues. Most respondents were supportive of a slow approach to the new industry that includes careful research and testing before significant use (OSU News and Communication Services, 2009).

Data sets

No datasets were available for this sensitivity.

6 The Economic Environment

6.1 Introduction

The economic environment potentially affected by the development of wave energy consists of the activities driving community wealth, primarily of coastal communities, and the facilities and infrastructure that support these activities (Table 6.1). These activities include marine and coastal based industries; other sea uses; as well as coastal land uses. A list of the economic activities and facilities included in the cumulative effects framework is given in Table 6.1. One measure of the economic activity, the Gross Domestic Product, or GDP, is also included. The Oregon Coastal Zone Management Association (OCZMA) completed a comprehensive study on the Oregon Coast's economy in 2006 (Davis & Radtke, March 2006). This report provides more detail on many of the activities and sensitivities listed in Table 6.1.

Existing ocean use activities and their interactions with the environment are an important consideration in analysis of cumulative effects. These activities may have either positive or negative impacts on the environment, or both. A description of existing pressures arising from these activities is included in the descriptions below.

Table 6.1 Activities and sensitivities of the Economic Environment

Category	Sensitivity
Marine and Coastal-based Industries	Fishing
	Aquaculture
	Marine freight shipping
	Tourism
	Scientific research
	Marine Renewables
	Oil and gas
Other sea uses	Military
	Dredging
	Cables and Pipelines
Other land uses	Industrial/Manufacturing
	Agriculture
	Forestry
Support facilities and infrastructure	Ports
	Supply bases
	Grid infrastructure
	Industrial support facilities
	Transport
Economic activity	Cumulative GDP

6.2 Marine and Coastal-based Industries

The major industries on the Oregon Coast include timber, tourism, fishing, agriculture, and shipping. Historically, coastal economies have relied on resource-based jobs; however, opportunities in these areas generally have been declining in recent years. There is considerable variation in sources of income among coastal counties. For example, Tillamook County has a large economic base from agriculture production, Lincoln County relies on tourism and marine resources, and timber production is important to Coos and Clatsop Counties.

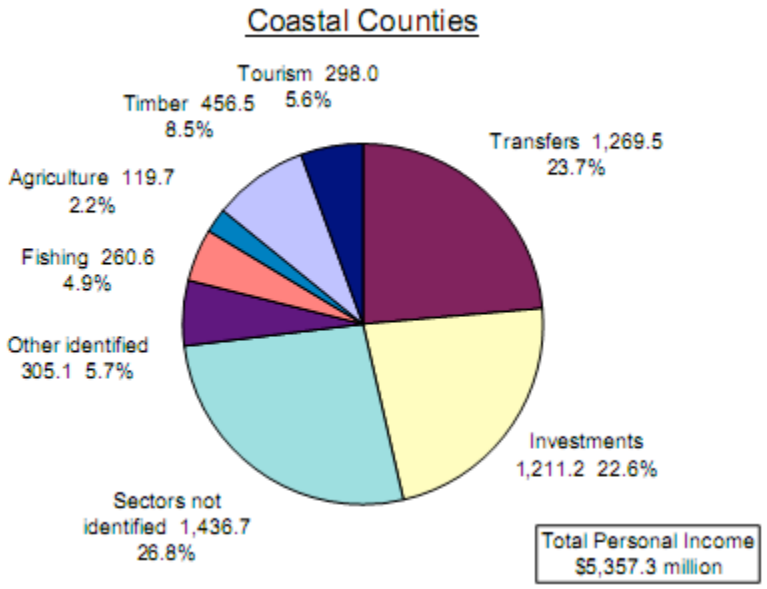


Figure 6.1 Share of total personal income sources for identified sectors in 2003. (from Davis and Radtke 2006).

6.2.2 Fishing

Description

Fishing is an intrinsic part of Oregon's heritage and economy. In particular, commercial fishing is a source for jobs and income on the Oregon Coast. Recreational fishing is also a source of income for the Coast. As a prime tourism attraction, it contributes to the economy in a different way.

Status and Trends

Fisheries Catch

Trends in fisheries catch have been variable depending on the species (Table 6.2). The Oregon Department of Fish and Wildlife (ODFW) produced a status report on Oregon Marine Fisheries in 2000. This document characterizes trends in various fisheries for various periods of time up to 2000 (Oregon Department of Fisheries and Wildlife Marine Resources Program, 2001).

Table 6.2 Status and trends in Oregon fisheries as of 2000*

Fishery	Current Status	Trends
Groundfish	Severely depressed	Declining since 1980's
Whiting	High volume	Variable; increasing since 1980's
Albacore	Averaging 6 million pounds in last decade	Variable
Pink Shrimp	Considered healthy	Variable; evidence of "fishing down"
Dungeness Crab	Considered healthy	Variable
Sea Urchins	Low volume	Decreasing since 1990's
Bay and Razor Clams, Oysters	10-year average 94,500 pounds	Variable
Ocean Salmon	Very low	Declining
Marine Recreational Finfish		Increasing

*Oregon Department of Fisheries and Wildlife Marine Resources Program, 2001

Commercial fishing

The commercial fishing industry in Oregon involves harvest of nearshore species particularly salmon, crab, shrimp, tuna, groundfish, whiting, and sardines. In addition, distant water fisheries are an important component of the commercial fishing industry and include vessels owned by Oregon residents that travel to or are located at ocean fishing areas too far away to be landed in Oregon.

Commercial fishing is an important part of the coastal economy, providing coastal residents with 9,368 jobs (Oregon State University, n.d.) and contributing $259 million (M) to coastal communities in total personal income in 2006, about 8 percent of all earned income on the Coast (Davis & Radtke, March 2006). A total of 963 vessels with an Oregon home-port made 20.4 thousand deliveries in the State in 2006. The busiest ports in 2006 were at Astoria and Newport, with 34% and 22% of the home-port vessels, respectively. In addition to home-port vessels, there are several large seafood processors and fish meal plants in the Astoria area and Newport also has several active processors. Many vessels participating solely in distant water fisheries use Newport for moorage, provisioning, and repairs (Davis & Radtke, March 2006). Distant water fisheries provided about $162 million in total revenue to coastal communities in 2006 (Davis & Radtke, March 2006; The Research Group, 2007).

Declines in catches of widow rockfish, yellowtail rockfish, canary rockfish, dover sole, thornyheads, and sablefish have resulted in a decline in the groundfish fishery since the 1980s. Ocean salmon is another declining ocean fishery. In response to declines in the salmon fishery, fish processors began handling Pacific whiting in the early 90's. That species has become a large contributor to fishery landings. Finfish catch has been increasing while albacore, Pink shrimp, Dungeness crab, and clams have varied over time. These changes in the fisheries over the last 30 years have led to a shift in the Oregon fishing industry from low-volume and high-value species, such as salmon, to high-volume and low-value species, such as Pacific whiting and sardines. In 2006, about 71 percent of the volume landed was Pacific whiting and sardines, but these high volume species only comprised about 12 percent by landed value. The Dungeness crab fishery had the highest landed value in 2006 with 38% total onshore economic contribution (Davis & Radtke, March 2006).

According to Davis and Radtke (Davis & Radtke, March 2006), there are three developments affecting the commercial fishing industry:

- Increasing global supplies of fish products resulting in a decrease in ex-vessel prices for salmon, shrimp, and crab from 1991 through 2003.
- Declining availability of salmon and rockfish due to threatened and endangered species listings and curtailment of allowable harvest due to overfishing.
- Expansion of aquaculture affecting prices for fish products

Recreational Fishing

Most recreational fishing harvests salmon, Groundfish, Dungeness crab, albacore tuna, and halibut. Recreational vessels are either charter boats operated by licensed skippers, or privately owned vessels. Charter boats operate year around with most business from May to September.

Newport is an important marine recreational fishing base, and recreational charter boat fishing was most prevalent here in 2005, as well as in the nearby port of Depoe Bay and in Garibaldi. Private boat recreational fishing activity is also important in Newport, although there is more private boat activity in Brookings and Charleston. Current data shows that thousands of recreational vessels operate out of Newport and Depoe Bay annually, adding to the revenue generated by the commercial fishing industry (Fisherman Involved in Natural Energy Committee (FINE), 2008).

In Lincoln County, coho salmon were traditionally the mainstay of the ocean recreational fishery until the 1980's when harvest limits were imposed by regulators. Many vessels began to target Chinook salmon, groundfish, halibut and albacore tuna, using different gear. In recent years, some charter boat operators and private vessels have begun dropping crab pots on the way to fishing grounds (Fisherman Involved in Natural Energy Committee (FINE), 2008).

Recreational fishing is also an important economic driver for the Oregon Coast, although the economic significance varies between salmon and non-salmon fishing, and ocean and lower estuary fishing. Non-salmon, estuary fishing comprised one-third of the total economic contribution of $26.5 M for marine recreational fishing in 2006. The Lower Columbia River is an especially important area for lower-estuary fishing. It generated $2.4 million in 2006. Ocean, non-salmon fishing is a busier fishery than salmon fishing, with approximately 86.3 thousand fishing days in 2006 compared to 62.3 thousand ocean salmon-fishing (The Research Group, 2007).

Pressures

In addition to the positive benefits that commercial fishing confers to the coastal economy, the industry represents an existing pressure on the biological environment through harvest of fish, which, in addition to affecting fish populations, affects populations of seabirds and sea mammals that forage on them. The presence of fishing vessels also presents a risk of disturbance to seabirds and mammals and risk of collision with sea mammals. Certain types of fishing gear can impact the benthic community and certain types of vegetation such as kelp.

Other pressures created by the fishing industry include shared space with other sea users such as freight shipping.

Data sets

Groundfish harvest

Categorization

Dataset name:	Groundfish harvest
Dataset description:	Groundfish catch data in kg/sq m
Dataset source:	PaCOOS West Coast Habitat Server
Categories:	0 tonnes/km2
	>0-5 tonnes/km2
	>5-50 tonnes/km2
	>50-100 tonnes/km2
	>100-150 tonnes/km2
	>150-200 tonnes/km2
	>200 tonnes/km2

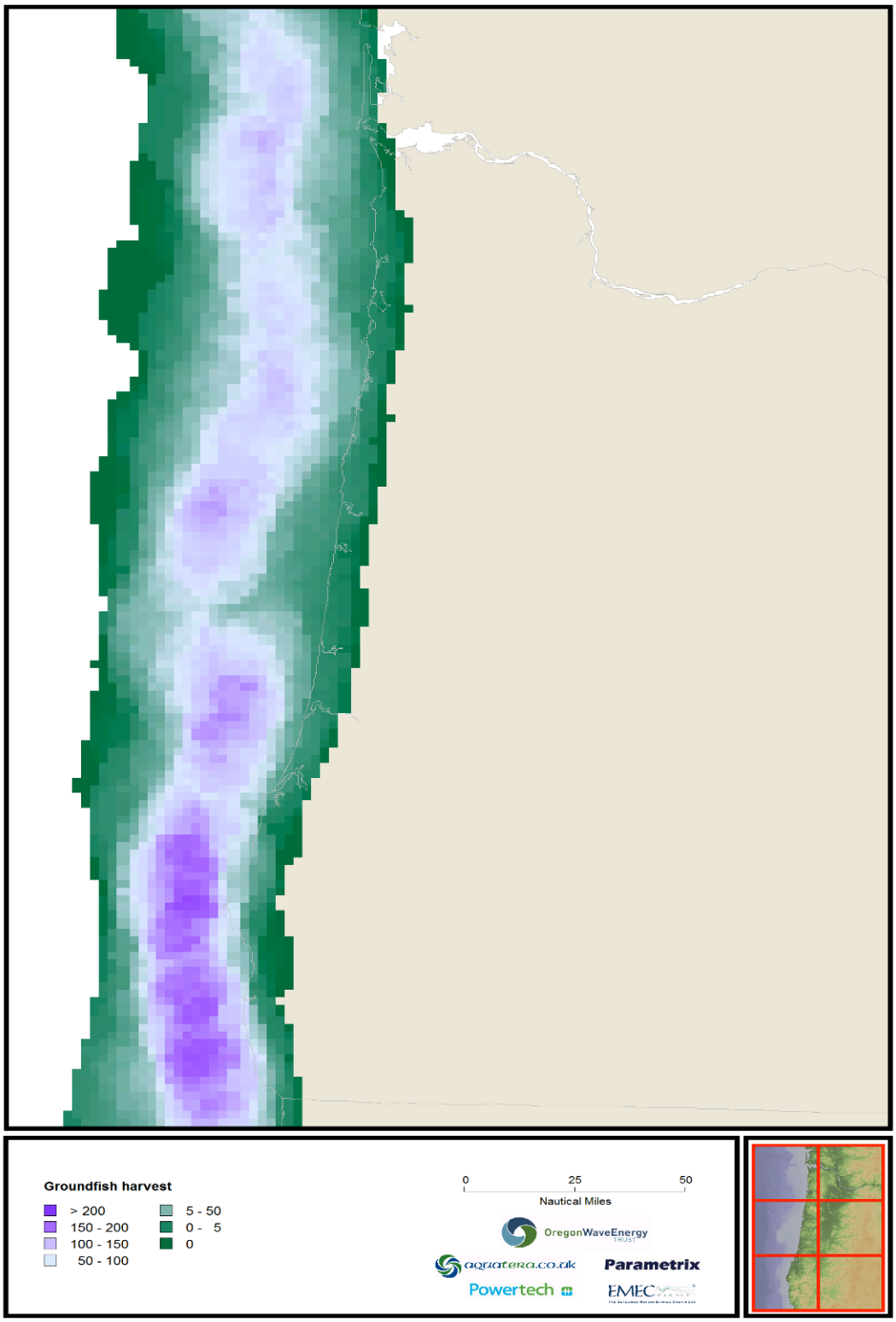


Figure 6.2 Raster map showing fishing: groundfish harvest

6.2.3 Aquaculture

Description
Some commercial cultivation of finfish and shellfish does occur in Oregon; however, it is currently at a fairly small scale.

Status and Trends
Commercial aquaculture along the Oregon Coast currently consists of the cultivation of oysters and mussels. Although there have been finfish farms in the past, there are currently no finfish farms along the Oregon Coast. Oysters are cultivated in Coos Bay, Winchester Bay, Yaquina Bay, Tillamook Bay, and Netarts Bay while mussels are grown only on the Umpqua estuary, near Winchester Bay. Salmon aquaculture has taken place along the Coast in Coos Bay and Yaquina Bay, but no salmon farming facilities are currently operational. In 2003, Oregon produced 6.286 million pounds of oysters, valued at $4.715 million. (Oberrecht, Unknown publication date).

Pressures
Though not a large industry, aquaculture does benefit the coastal economy. There are some potential impacts on ecological resources, especially the potential for pollution due to waste products and pesticides, and the potential impacts on estuarine communities from introduction of invasive species.

Data sets
No data were available for aquaculture for the cumulative effects framework.

6.2.4 Marine freight shipping

Description
Freight shipping involves the import and export of goods by ship to and from Oregon's ports. Portland ranks third among port districts operating on the Pacific Coast in terms of tonnage shipped (Loy, Allan, Buckley, & Meacham, 2001).

Status and Trends
In 2007, 31 million tons of cargo were shipped through Portland along the Columbia River, and 1.9 million tons were shipped through Coos Bay. Leading products shipped though Oregon's ports included grains, petroleum products, and forest products. Portland is the largest wheat exporting port in the US. Forest products are the leading commodities shipped through Coos Bay as well as through other smaller deep-draft ports on the Oregon Coast and Columbia River (Loy, Allan, Buckley, & Meacham, 2001; Waterborne Commerce Statistics Center, 2009).

Large cargo ships generally stay a minimum distance of 25 nautical miles offshore, except when they are coming into port (Hagerman, Bedard, & Previsic, 2004).

In the 1970's, an agreement between ocean-going tugs and commercial crabbers in Washington, Oregon and California was brokered in order to address the problems of tugs being fouled by crab pots, and crabbers losing gear to tugs. The agreement provides navigable towboat and barge lanes through the crabbing grounds between Cape Flattery and San Francisco (SeaGrant Washington 2008).

Pressures
Marine freight shipping has obvious economic benefits to port communities. Other existing impacts from shipping include the shared use of marine space with fisheries and recreation, and the risk of collision with sea mammals and potential disturbance to nesting seabirds.

Oil spills have not been very common off the Oregon Coast, but contamination due to accidental events is an existing risk. In 1999, the freighter New Carissa ran aground near Coos Bay, leaking 70,000 gallons of fuel oil (Seattle Post-Intelligencer, 2002). Such accidental events impact marine life, as well as shoreline habitats and species, including areas set aside for conservation of species and habitats.

Data sets
Towlanes, inshore traffic zones; clear navigable waterways (not used in framework)

Categorization

Dataset name:	Tow lanes
Dataset description:	Mutually agreed upon tow lane areas as agreed by Tow boat operators and Northwest Crab Fishermen
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Land
	Year round
	Summer only
	Advisory
	Advisory out to 100 fthms
	Open sea
	Out to 100 fthms

Dataset name:	Inshore traffic zones
Dataset description:	
Dataset source:	
Categories:	Outside inshore traffic zone area
	Inshore traffic zone area

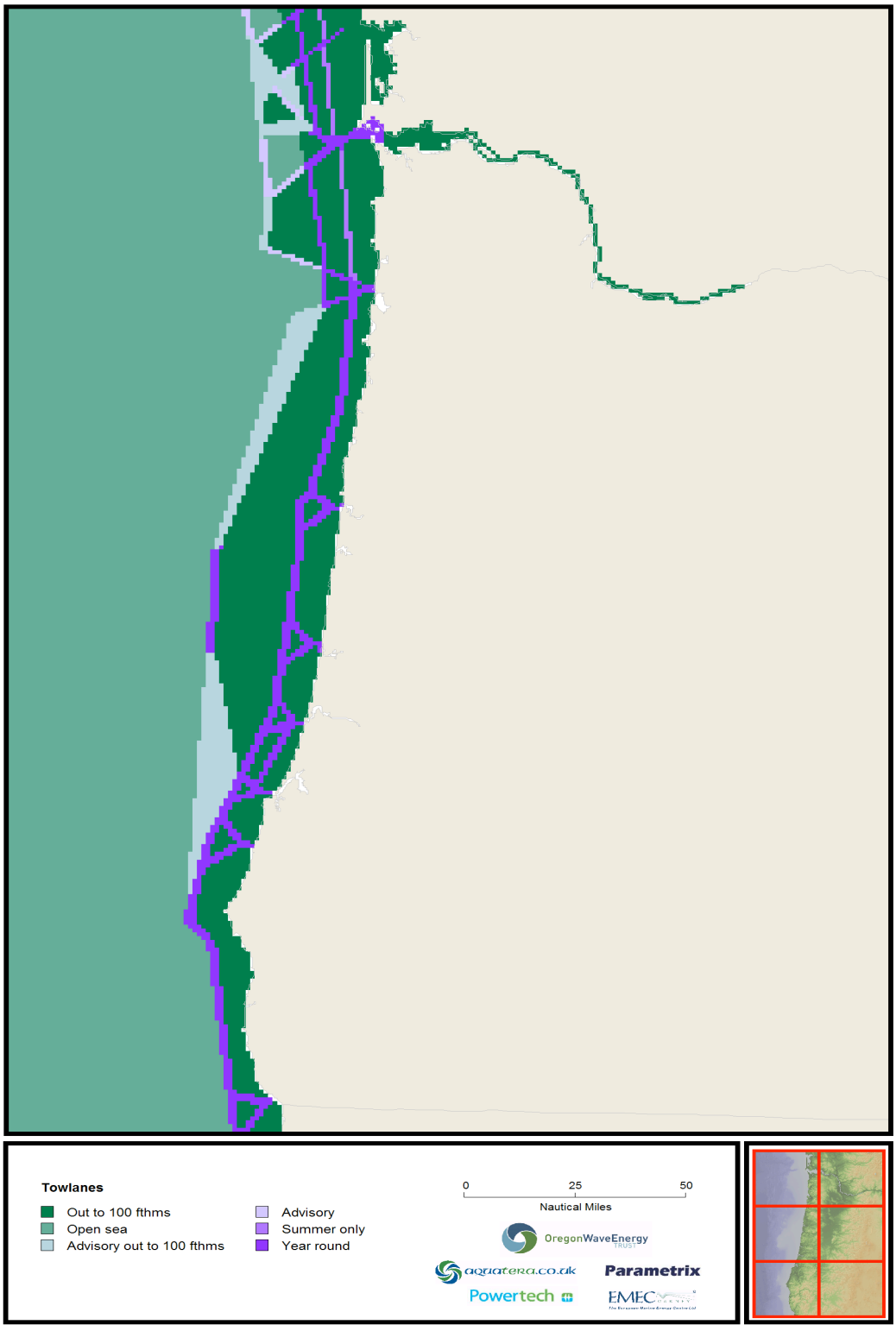


Figure 6.3 Raster map showing marine shipping: towlanes

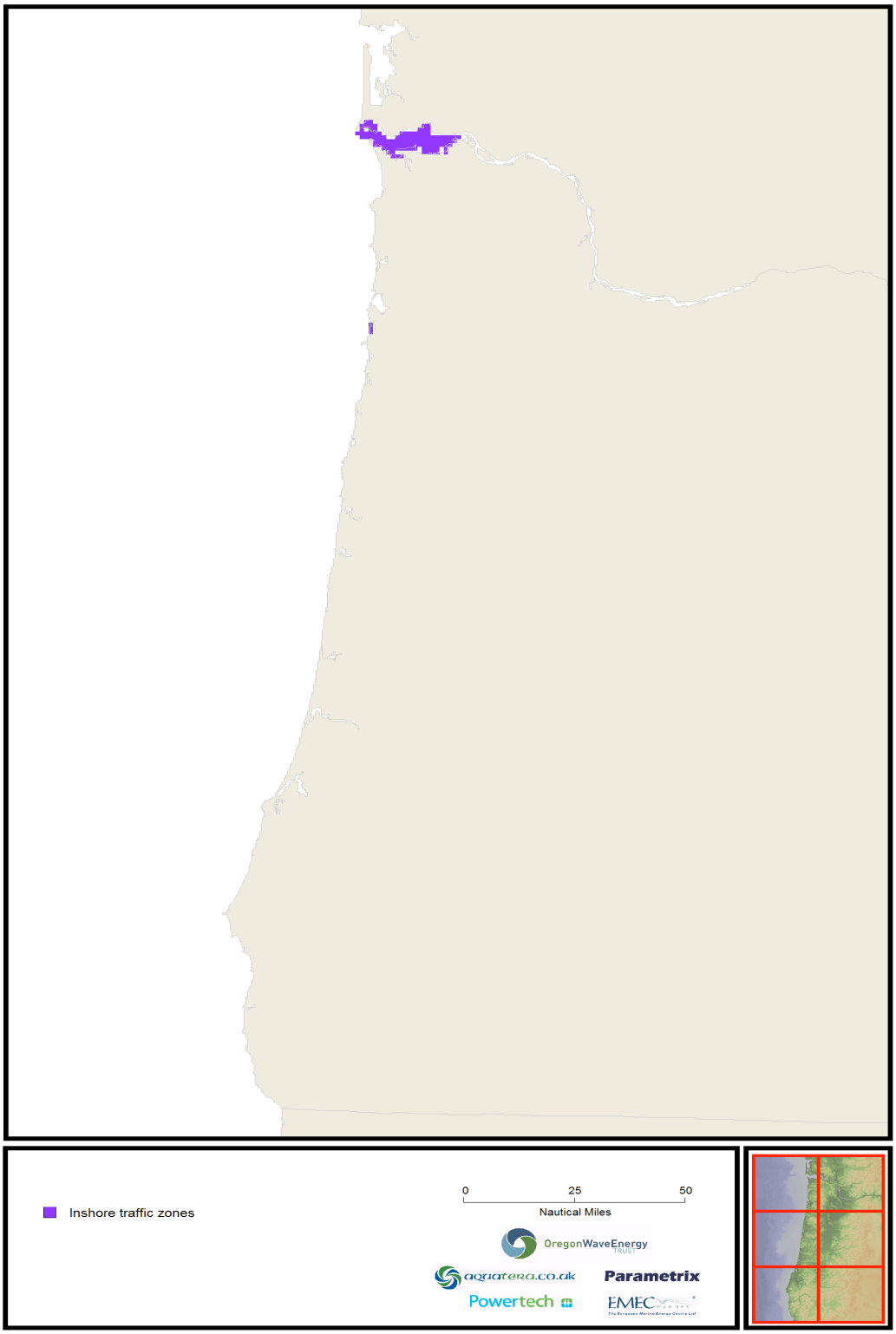


Figure 6.4 Raster map showing marine shipping: inshore traffic zones

6.2.5 Tourism

Description
Tourism is an important economic contributor to coastal economies through visitor spending on food, lodging, recreation, attractions, and guest services.

Status and Trends
Tourism is one of the six major industries defined for coastal economies and provides residents with approximately 10,800 jobs. Employment in this sector has been increasing dramatically in coastal counties in the last decade, for example from 2% of employment in Lincoln County in 1990 to over 20% by 2000. The highest tourism-related employment is in regions closest to metropolitan areas such as Clatsop and Lincoln County (Davis & Radtke, March 2006). The tourism industry provides a higher percentage of jobs in all coastal counties in comparison to the State as a whole. Tourism's contribution to the coastal economy is increasing, and providing diversification to coastal economies. In 2004, tourism generated $514.4 M for coastal communities. However, tourism only makes up 4.6% of the coast's total revenue. Although tourism provides coastal residents with jobs, a large proportion of these jobs do not pay wages sufficient to support a household (Davis & Radtke, March 2006; Oregon State University, n.d.).

Pressures
Tourism provides benefits to coastal economies. Although tourism has the potential for negative ecological impacts, through use fossil fuels, for example, or disturbance of wildlife (e.g. whale watching, tide-pooling), there currently are no data to assess this.

Data sets
Employment in tourism was used as a surrogate for identifying tourism sites This data set has been used due to a lack of specific tourism data available at the time. The data shows the percentage of the total Oregon state population employed in arts, entertainment, accommodations and food services in each of the coastal communities. This data set gives an idea of how each coastal community is geared towards tourism. However, the data set is lacking in providing an idea of the actual tourism services offered and the specific loactions of the services, especially away from the coastal towns and cities.

Categorization

Dataset name:	Employment in tourism
Dataset description:	Percentage of the state population in that city that are employed in Arts, entertainment, accommodations and food services
Dataset source:	United States Census Bureau
Categories:	Outside city limits
	Very high (>0.297%)
	High (>0.27 – 0.297%)
	Medium (0.03 – 0.27%)
	Low (0.003-0.03%)
	Very Low (0-0.03%)

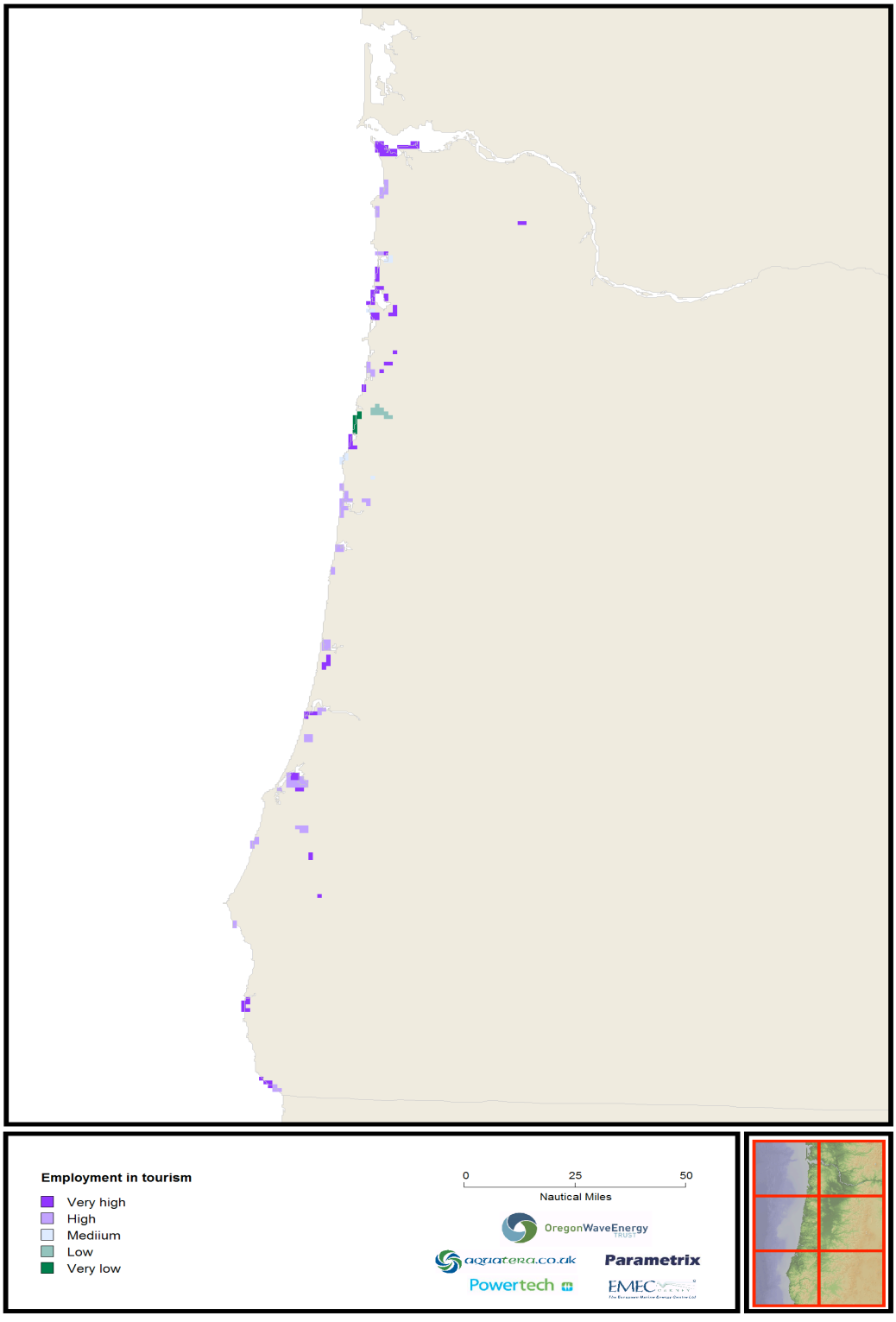


Figure 6.5 Raster map showing tourism-based communities

6.2.6 Scientific Research

Description

The Oregon Coast is an important regional center for marine and oceanographic research. The Hatfield Marine Science Center (HMSC) is located in Newport. There are also marine biology research and teaching facilities in Coos Bay.

Status and Trends

The HMSC is a base for oceanographic research in Newport. Several federal and state agencies are also located at HMSC, including the United States Department of Agriculture (USDA); the Environmental Protection Agency (EPA); the Oregon Department of Fisheries and Wildlife (ODFW); the National Oceanic and Atmospheric Administration (NOAA); the National Marine Fisheries Service (NMFS); the Alaska Fisheries Science Center; the Northwest Fisheries Science Center; and the NOAA Office of Oceanic and Atmospheric Research; and the United States Fish and Wildlife Service (USFWS). With a combined budget in excess of $37M, the HMSC also plays an important economic role on the Oregon Coast.

NOAA recently decided to locate its Marine Operations Center-Pacific in Newport, beginning in 2011. The NOAA Marine Operations Center-Pacific is comprised of approximately 175 employees, including more than 110 officers and crew assigned to the four NOAA ships.

The Oregon Institute of Marine Biology, a branch of the University of Oregon, is located in Coos Bay.

Data sets

No data available for the framework.

6.2.7 Marine Renewables

Description

Marine renewable energy, wave, tidal and offshore wind, is a developing industry on the Pacific Northwest Coast.

Status and Trends

According to the Pacific Fisheries Management Council (PFMC), the following offshore energy projects are being considered in Oregon:

1. Coos County:
   Coos Bay OPT Wave Park: Proposing 200-400 buoys in 3-6 rows parallel to the beach, 25-40 fm deep. Currently 1 mile wide by 5 miles long; eventually smaller. 2.5 miles from shore. Submitted permit application in March 2008.
2. Douglas County:
   Winchester Bay: one jetty-based structure powered by wave-driven air currents. Submitted permit application in May 2008.
   Reedsport OPT Wave Park: 10 buoys at depth of 205-225 feet with a 0.25 sq. mi. Footprint.
3. Lincoln County:
   Newport OPT Wave Park: 200-400 buoys, in 3-6 rows parallel to the beach. 3.5 miles wide by 5 miles long, eventually as little as 0.4 miles by 3.1 miles, 20-35 fm, up to 6 miles offshore. Waiting for preliminary permit.
4. Tillamook County:
   Oregon Coastal Wave Energy Project (Green Wave): 20-180mW buoys. Preliminary permit issued in May 2008.

There are several proposals for offshore energy projects in Washington and California. In Washington, the majority of proposals are in the Puget Sound area, but there is one plan for Willipa Bay for 1-3 tidal energy turbines in estuarine habitat. There are four proposals in Humboldt County in northern California as well. Activity in this sector should be increasing over the next decade; however, there is not currently an existing pressure associated with this industry.

Data sets

Wave energy preliminary permit sites

Categorization

Dataset name:	Wave energy preliminary permit sites
Dataset description:	Preliminary permit sites for wave energy development
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside preliminary permit site
	Preliminary permit site

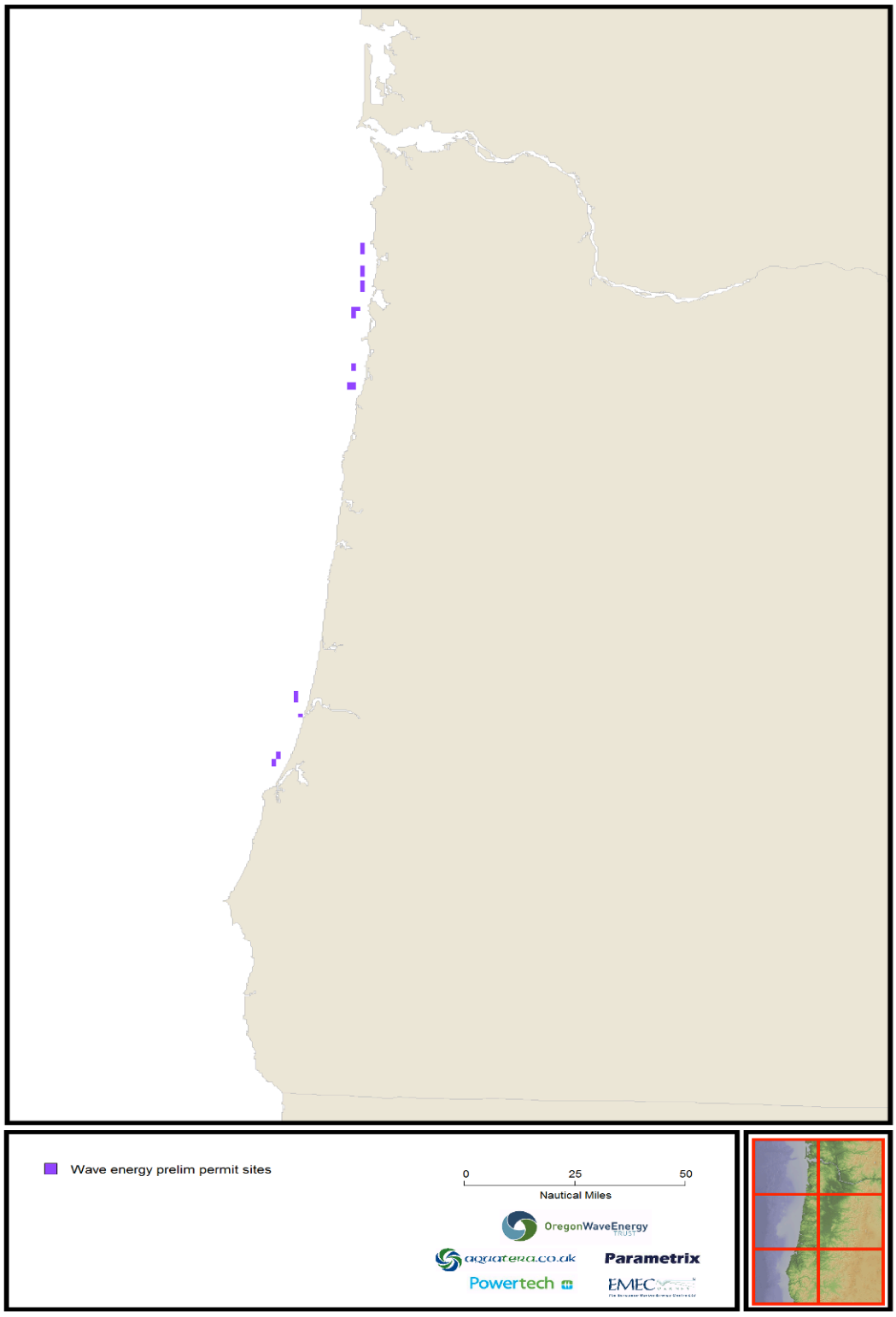


Figure 6.6 Raster map showing wave energy preliminary permit sites

6.2.8 Oil and Gas

Description
There is currently no offshore oil and gas industry in Oregon.

Status and Trends
Some limited exploration for fossil fuels has taken place offshore Oregon, and some natural gas has been found; however no commercial fields have been discovered ((Loy, Allan, Buckley, & Meacham, 2001). There are 3 current proposals for Liquefied Natural Gas (LNG) terminals: One utilizing the Port of Coos Bay, and 2 utilizing the Columbia River (Energy Facility Siting, 2008).

A three-year moratorium on oil and natural gas exploration and production in Oregon state waters recently expired. A number of environmental groups are requesting that the state legislature reinstitute the moratorium or impose a permanent ban on oil and gas exploration and production activities.

Data sets
No data available for the framework.

6.3 Other sea uses

Other sea uses includes sea-based activities that maybe impacted by, or have an impact on, wave energy developments, including

- Military
- Dredging and dredge disposal
- Outfalls
- Waste disposal
- Subsea cables and pipelines

For each of these where information was sourced, the relevance of each of these to wave energy is described in more detail below.

6.3.1 Military

Description
This includes Army, Navy, Air Force, and Marine bases and activity areas.

Status and Trends
There are two military Warning Areas, W-570 and W-93, located off the coast of Oregon, used routinely by aviation, surface and subsurface assets. These are off-shore areas used for joint air/surface operations such as missile firings, air-to-surface bombing, air-to-air firing, combat tactics, intercepts, aerial refueling, instrument training, aerobatics, and formation flight training. These areas also are part of a complex that is a designated ASW range for coordinated ASW operations, sonobouys, practice depth charges and smoke markers (GlobalSecurity.org, 2005).

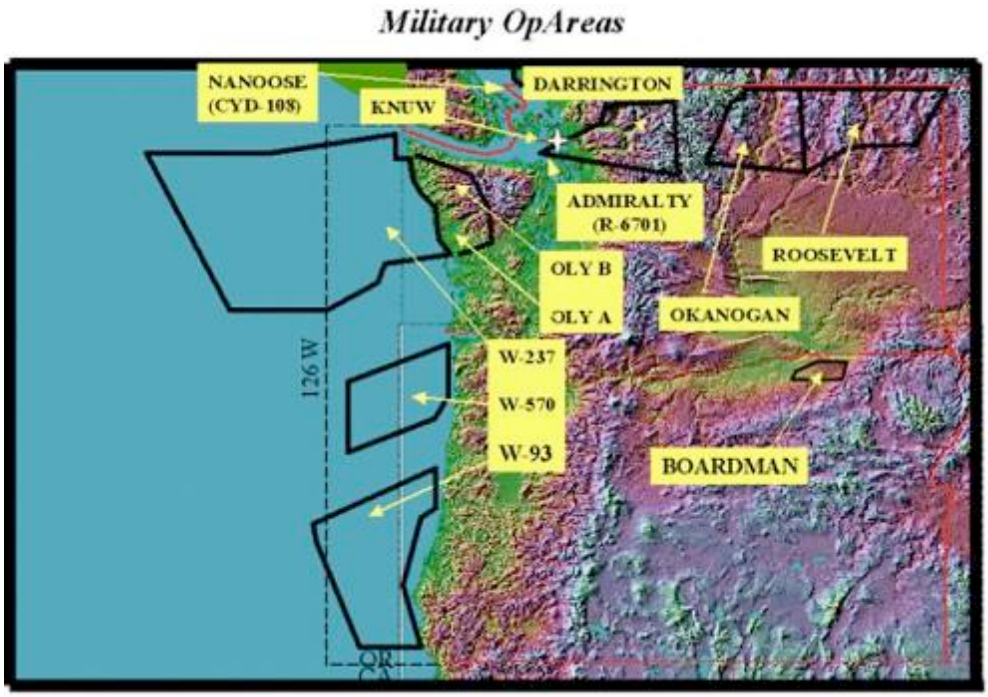


Figure 6.7 Military Operations areas off the Oregon Coast.

Data Sets
No data sets were found for the framework.

6.3.2 Dredging and Dredge Disposal

Description

Dredging occurs at major ports in order to maintain safe shipping channels.
Ocean disposal involves transporting dredge material offshore on a barge or in a hopper dredge to be dumped in open ocean waters. The US EPA regulates the permitting of such sites.

Status and Trends

The entrances to the deep-water ports at Astoria, Newport and Charleston are dredged regularly to maintain safe shipping channels. Dredging to deepen the 103.5-mile Columbia River channel between Astoria and Portland began in 2005 and is ongoing. The mouth of the Columbia River (MCR) from the Pacific Ocean to River Mile (RM) +3 in the estuary is also regularly dredged. The Army Corps of Engineers (USACE) typically removes between 4 million to 5 million cubic yards of sand and sediment from the 6-mile length of the project each year (US Army Corps of Engineers, 2009).

EPA-permitted dredge disposal sites are designated outside several of Oregon's important ports, including the Columbia River entrance, Tillamook Bay, Depoe Bay, Yaquina Bay and Coos Bay (Hagerman, Bedard, & Previsic, 2004).

The dredge spoils from the Columbia River deepening project are primarily deposited at upland sites for beneficial uses. Dredged material from the MCR project is placed at approved in-water disposal areas where the dredged material provides some benefits, such as offsetting erosion, and where conflicts with other uses are minimized. (US Army Corps of Engineers, 2009).

Pressures

As a maintenance activity, dredging provides benefits to shipping by keeping clear navigable waterways, and it provides nominal benefit in terms of employment. Dredging itself is has potential impacts on the seabed and benthic community, although there are currently no data available to assess this. There are potential negative impacts on plankton productivity and fish populations in the dredged areas as a result of loss of benthic habitat. In addition, temporarily increased turbidity may have a short-term impact on foraging by seabirds and sea mammals in those areas.

Disposal of dredge material at sea is another pressure with the potential for smothering plankton, shellfish, and other marine life and negatively impacting habitat quality for fish. Presumably, approved disposal sites avoid sensitive areas and designated conservation areas.

Data sets

Dredge disposal sites

Categorization

Dataset name:	Dredge disposal sites
Dataset description:	Ocean dredged material disposal sites along the Oregon Coast
Dataset source:	Oregon Department of Land Conservation & Development
Categories:	Outside disposal site
	Disposal site

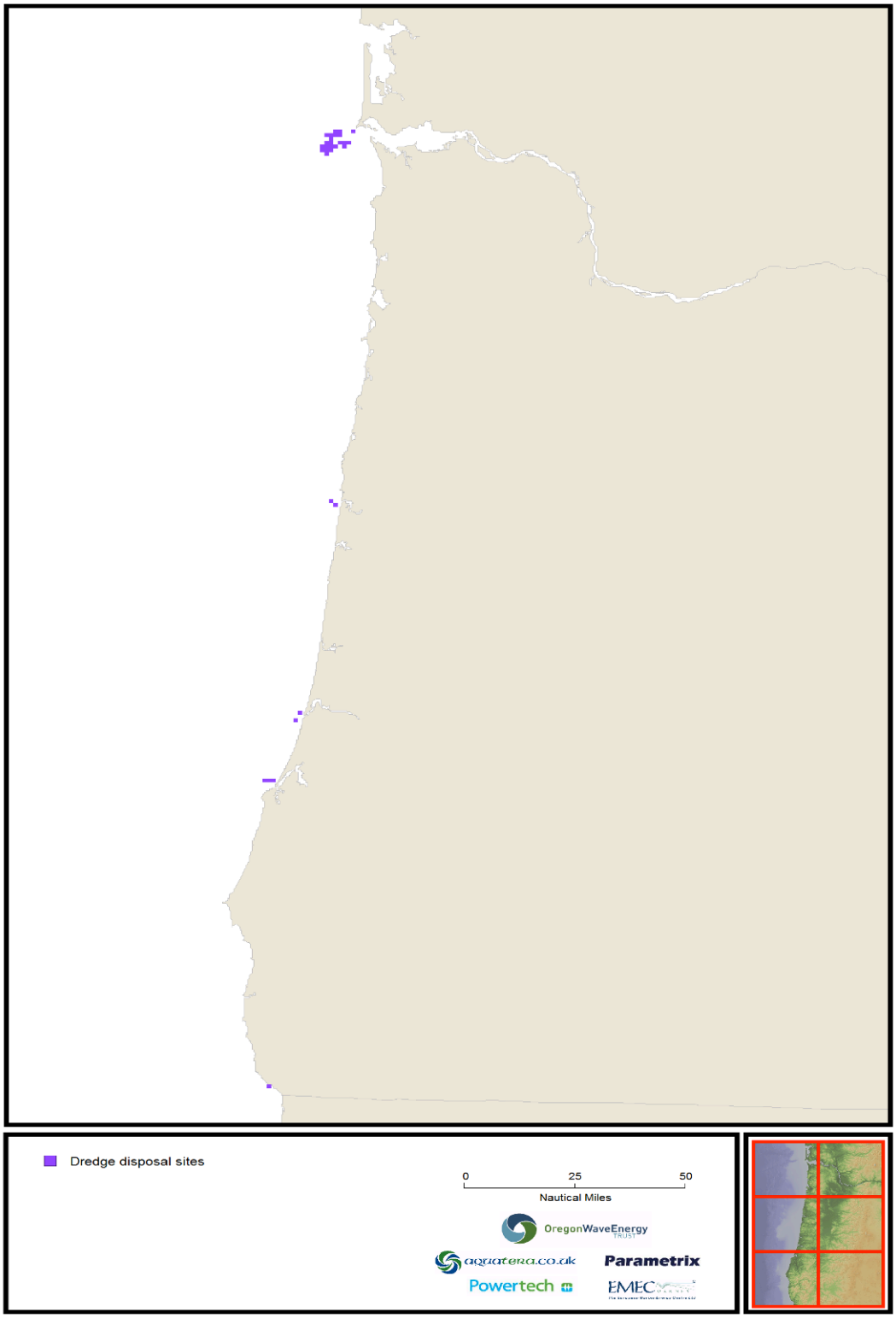

Dredge disposal sites
0
25
50
Nautical Miles
OregonWaveEnergy
aquatera.co.uk
Parametrix
Powertech
EMEC

Figure 6.8 Raster map showing dredge disposal areas

6.3.3 Cables and pipelines

Description

Includes subsea location and landfalls for fiber optic cables, telecommunications cables, oil and gas pipelines.

Status and Trends

Five different undersea telecommunications cables are landed just north of Tillamook Bay, as shown in Figure 6.9 and four cables are landed north of Bandon, just south of Coos Bay, as shown in Figure 6.10 (Hagerman, Bedard, & Previsic, 2004). An additional cable operated by PT Cable, Inc., lands just south of Tillamook Bay.

The five North Coast cables in Figure 6.9 are covered by the Oregon Fishermen's Undersea Cable Committee Agreement which describes and delineates shared use of ocean space. The PT Cable subsea cable relies on enforcement of legal penalties to prevent damage (Hagerman, Bedard, & Previsic, 2004). For the South Coast cables, AT&T has established a fund for enhancing fisheries affected by two of the cables laid through prime commercial fishing grounds (Hagerman, Bedard, & Previsic, 2004).

Pressures

Subsea cables and landfalls will have restricted areas, which may impact fishing. There may be a small impact on employment associated with operation and maintenance of telecommuni-cations cables at landfalls. If existing cables need to be repaired or replaced, there would be some temporary impacts such as sediment disturbance, turbidity, and loss of beach access.

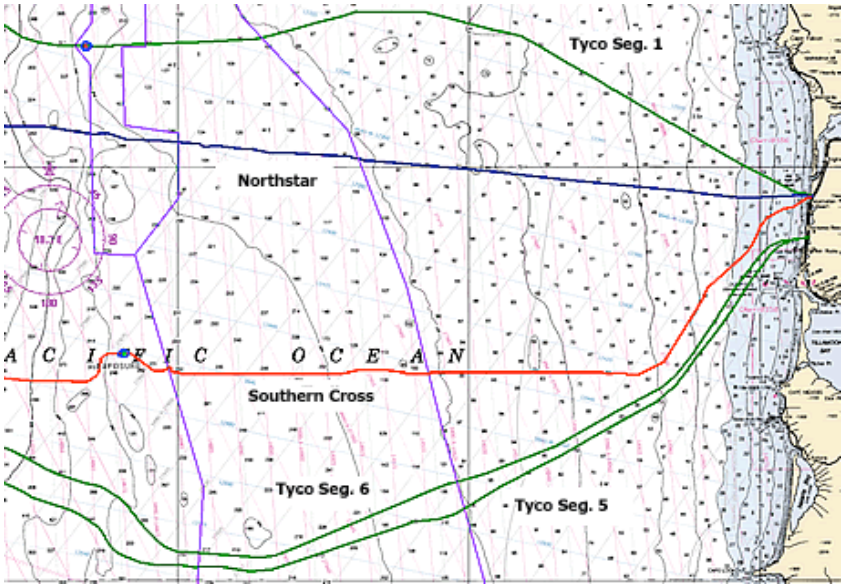


Figure 6.9 Undersea cables, Oregon North Coast
(from Hagerman et al. 2004)

Data sets

Subsea telecom cables

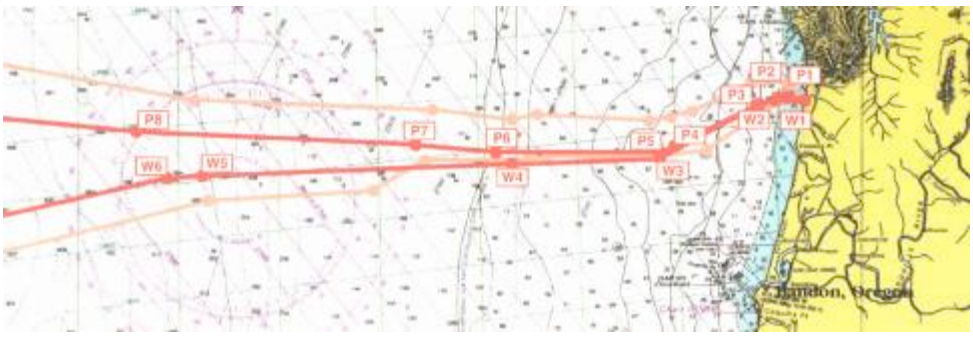


Figure 6.10 Undersea cables, Oregon South Coast
(from Hagerman et al. 2004)

Categorization

Dataset name:	Subsea telecom cables and onshore grid
Dataset description:	Locations of subsea telecommunication cables and onshore electrical grid infrastructure
Dataset source:	Oregon Fisherman's Cable Committee & Unknown
Categories:	Area with neither Onshore electrical grid network or Subsea telecommunications cables
	Onshore electrical grid network
	Subsea telecommunications cables

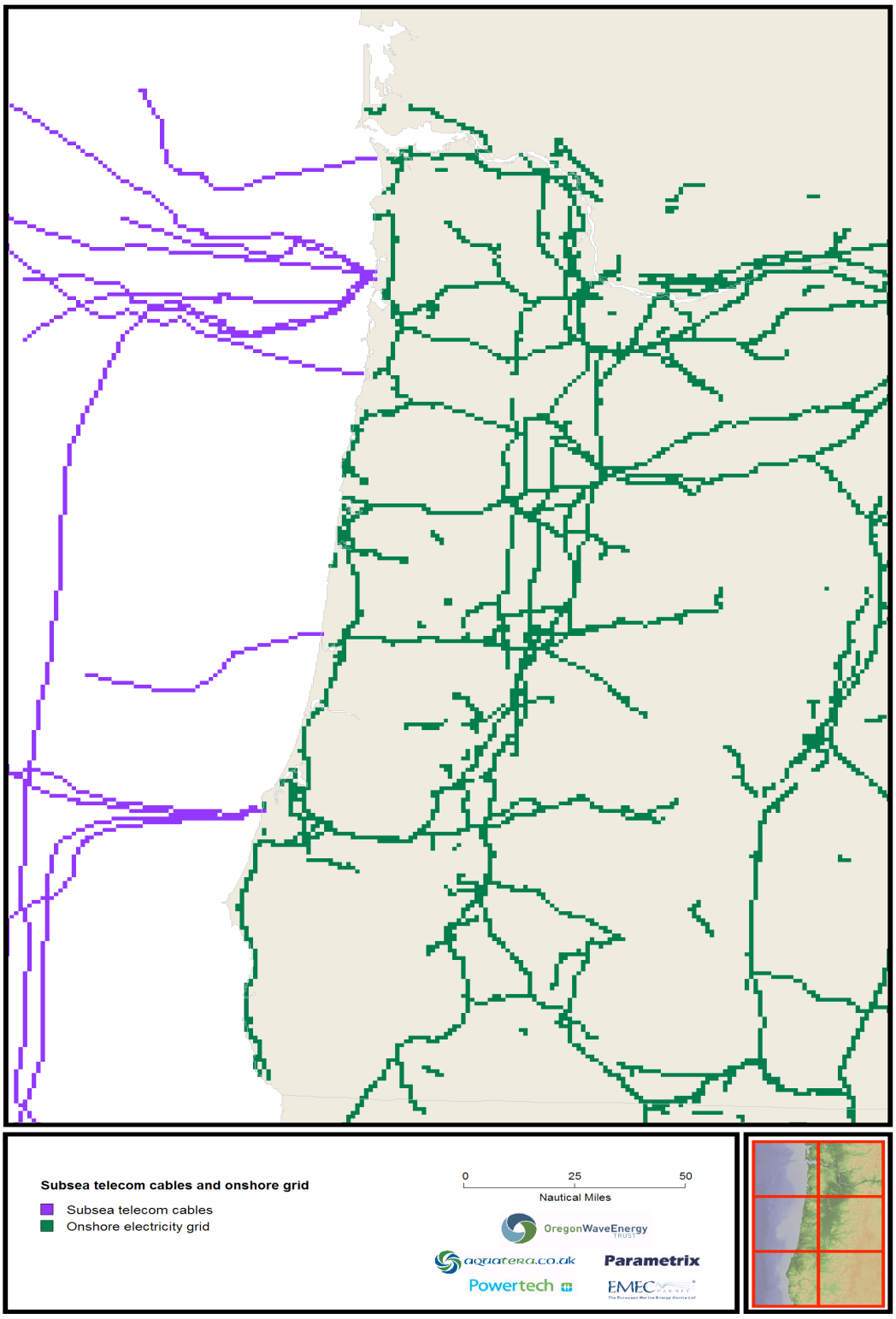


Figure 6.11 Raster map showing subsea telecommunications cables and onshore grid

6.4 Other land uses

Other land uses includes terrestrial-based economic activities such as manufacturing, agriculture, and forestry/timber. As mentioned previously, two of the major industries on the Oregon Coast are timber and agriculture.

6.4.1 Industrial/Manufacturing

Description
Much of the manufacturing located on the Coast is related to the Agriculture and Forestry/Timber sectors, such as paperboard mills. The existence of zoning or infrastructure for manufacturing is seen as positive to the development of wave energy off the Oregon Coast.

Status and Trends
In 2000, manufacturing was one of the highest employment sectors in the state, employing 14% of the workforce. Although manufacturing in the lumber, wood, paper and furniture sector has represented about one quarter of the total manufacturing employment in the state, these types of manufacturing have been in decline in the state since 1980. An industry that has been growing in Oregon since the 1990's is the manufacturing of electric and instruments, which was the second largest contributor to total manufacturing employment in 1998 at about 20% of total manufacturing employment. Manufacturing in Oregon also includes apparel and textiles and chemical and pharmaceutical manufacturing, food, transportation, and printing and publishing. On the Coast, dairy and seafood plants are the predominant manufacturing industries (Loy, Allan, Buckley, & Meacham, 2001; Oregon State University, Unknown date).

Since 2000, Oregon has experienced two recessions including the current downturn. These economic events have contributed to a generally slow job growth rate and an increasing unemployment rate state-wide. At the same time, jobs have been shifting from manufacturing and to construction and service based industries. Manufacturing jobs in the last decade have declined 9%. Education, health services, construction, hospitality and financial services have all grown quickly over the same period of time. The manufacturing sector has transitioned over the past half century from wood products to higher skill and value products. Though manufacturing jobs have declined, a modest increase is forecasted for the state. Additionally, a large number of retirements are anticipated in the manufacturing sector. Potentially, this will generate a high demand for skilled workers in manufacturing (Workforce and Economic Research Division of the Oregon Employment Department, 2008).

Pressures
Manufacturing provides jobs and income for communities. The decline in manufacturing jobs has affected coastal communities through increased unemployment, and changes in personal income. Aside from its influence on coastal economies, there are potential effects from manufacturing on water quality through discharges and on visual amenities through the presence of manufacturing plants in viewsheds.

Data sets
No data sets that adequately described these activities were found for the framework.

6.4.2 Agriculture

Description

The agriculture sector represented 2.2% of total personal income for coastal counties in 2003. Agriculture was most important in Tillamook County, where is comprised 13.1% of total personal income.

Status and Trends

Twenty-eight percent of the land in Oregon is in farmland. West of the Cascades, farms produce a variety of high-value crops, concentrated in the Willamette Valley and along the Columbia River. Some of the crops produced in coastal counties include vegetables crops, hay, cranberries, Christmas trees, holly, horticultural crops, and other forest products, such as mushrooms (Davis & Radtke, March 2006). Agriculture is particularly strong in Tillamook County where sales of animal products (dairy) exceed sales from crops.

Agriculture is an important part of the coastal economy, particularly in Tillamook County. In 2003, agricultural production and primary processing generated $120 million in total personal income in coastal communities. (Davis & Radtke, March 2006; Loy, Allan, Buckley, & Meacham, 2001).

Pressures

Some agricultural uses impact habitat for anadromous fishes as well as water quality downstream, where impacts may be concentrated in estuaries.

Data sets

Land Use Zoning: Agriculture. This dataset describes where land is zoned for agriculture, but does not necessarily indicate all areas where agriculture is the current land use.

Categorization

Dataset name:	Land use zoning
Dataset description:	This layer is the land cover/land use layer data compiled for the Oregon Gap Analysis Project
Dataset source:	Oregon Geospatial Enterprise Office Spatial Data Library
Categories:	Agriculture
	Coastal
	Forestry
	Indian Reservation
	Mixed agriculture and rural residential
	Natural Resources
	Park and Recreation
	Public facility
	Rural
	Urban
	Water

6.4.3 Forestry

Description

The timber sector represented 8.5% of total personal income for coastal counties in 2003. Timber was most important in Tillamook and Clatsop counties, where is comprised 12.0% and 11.5% of total personal income, respectively (Davis & Radtke, March 2006).

Status and Trends

On the Coast, 80 percent of the land area is productive forestland, and forestry is an important sector of the coastal economy (Davis & Radtke, March 2006). Currently, the majority of timber harvested comes from private commercial and non-industrial landowners, rather than public landowners such as the US Forest Service. In 2003, the timber industry (including all timber grown, harvested, and processed in coastal counties), generated an estimated $457 million in personal income, with Coos and Clatsop counties generating the largest portion of this (Davis & Radtke, March 2006).Total annual harvest of timber has fallen drastically since the mid-1980's. Because there are a higher proportion of jobs in forestry in coastal areas than in the rest of the state, thus these areas have been affected more by the downturn in the timber industry (Loy, Allan, Buckley, & Meacham, 2001).

Pressures

Fluctuations in the timber industry represent an existing pressure on coastal economies, particularly in terms of revenue and employment. Forestry activities also have an influence on wildlife habitat, providing habitat for some species, and reducing habitat suitability for other species. Forestry has the potential to impact marbled murrelet critical habitat which is located in designated areas of forest. Forestry activities can also influence hydrology which can impact tidal wetlands. Forests provide recreational opportunities, but the forest industry does not have a particular influence on recreational amenities.

Data sets

Land Use Zoning: Forestry . This dataset describes where land is zoned for forestry, but does not necessarily indicate all areas where forestry is the current land use.

Categorization

Dataset name:	Land use zoning
Dataset description:	This layer is the land cover/land use layer data compiled for the Oregon Gap Analysis Project
Dataset source:	Oregon Geospatial Enterprise Office Spatial Data Library
Categories:	Agriculture
	Coastal
	Forestry
	Indian Reservation
	Mixed agriculture and rural residential
	Natural Resources
	Park and Recreation
	Public facility
	Rural
	Urban
	Water

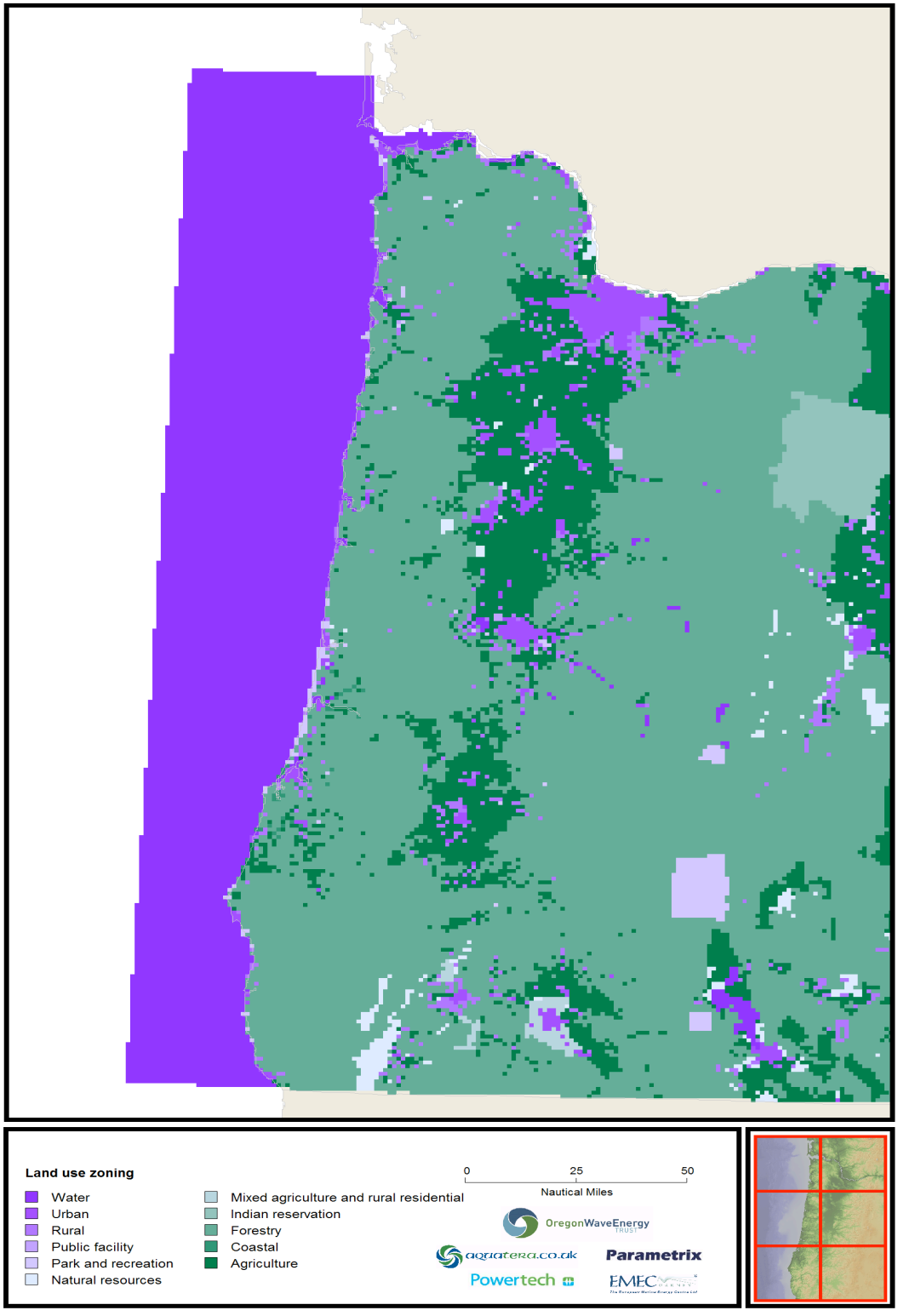


Figure 6.12 Raster map showing Oregon land use zoning

6.5 Support Facilities and infrastructure

Support facilities and infrastructure include those amenities and services that could potentially support a wave energy industry, such as ports, supply bases, support vessels, industrial support facilities, grid infrastructure and transport. These factors are described in more detail in the sections below.

6.5.1 Ports

Description

There are a total of fifteen ports and harbors on the Oregon Coast, eight of which support commercial fishing vessels. Large ports including the Oregon International Port of Coos Bay, the Port of Newport, and the Port of Astoria, host international shipping and regional-scale fishing fleets. Compared to Oregon's smaller ports, Astoria, Newport and Charleston have well-developed infrastructure, and their entrances are dredged regularly to maintain safe shipping channels.

Status and Trends

The Port of Astoria is the first deep-draft port available upon entering the Columbia River, and is located at rivermile 13 from the Pacific Ocean (Loy, Allan, Buckley, & Meacham, 2001). The Port of Portland is located 100 miles upriver along the Columbia River navigation channel. Coos Bay is the largest coastal deep-draft harbor between San Francisco Bay and Puget Sound and is the second busiest maritime commerce center in Oregon. It is 15 miles long with a channel depth of 37 feet (Port of Coos Bay, 2006). The port of Newport is a traditional exporter and importer of forest products. The deep draft ship portion of the Terminal has been closed and unusable for cargo or other traffic since 2001 because of environmental and safety hazards. The commercial fishing dock has been under restricted use as well because of its deteriorating condition (Newport International Terminal). The harbor at Newport serves as a major center of oceanographic research with the Hatfield Marine Science Center (HMSC) and related facilities operated by Oregon State University (OSU) and federal agencies like the Environmental Protection Agency (EPA) and the National Oceanic & Atmospheric Administration (NOAA). The entrance to this port is dredged to 40 feet. Smaller shallow-draft ports largely serve the needs of the recreational boating community (Oregon's Coastal Ports).

Data sets

No data sets were used in this phase of the framework.

6.5.2 Supply bases

Description
It was assumed for this version of the framework that the primary supply base would be located along the Columbia River.

Status and Trends
No information on the status and trends of this amenity was obtained for the cumulative effects framework.

Data sets
Distance from supply chain

Categorization

Dataset name:	Distance from supply chain
Dataset description:	Dataset showing distances from supply chain. Route taken is restricted to either only travelling by sea, or only travelling by land
Dataset source:	Aquatera
Categories:	Supply base
	0-1nm from supply base
	1-2nm from supply base
	2-3nm from supply base
	3-4nm from supply base
	4-5nm from supply base
	5-7.5nm from supply base
	7.5-10nm from supply base
	10-15nm from supply base
	15-20nm from supply base
	20-50nm from supply base
	> 50nm from supply base

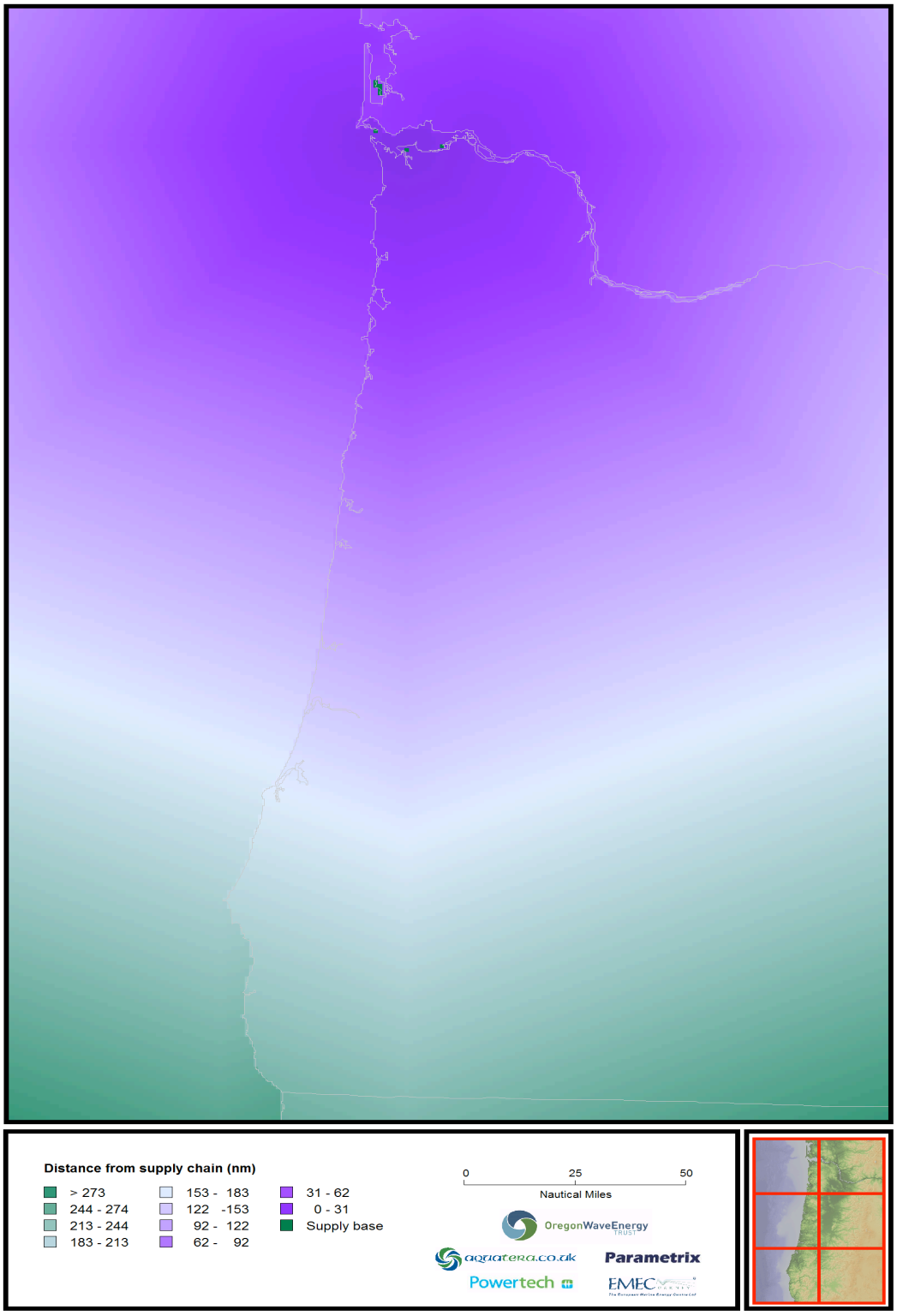


Figure 6.13 Raster map showing distance from supply chain

6.5.3 Grid infrastructure

Description
Location of transmission and distribution lines and onshore and offshore substations

Status and Trends
Not applicable.

Data sets
Onshore grid; distance from onshore electrical grid

Categorization

Dataset name:	Distance from onshore electrical grid
Dataset description:	Dataset showing distances from electrical grid based on straight line distances
Dataset source:	Aquatera
Categories:	Grid
	0-1nm from grid
	1-2nm from grid
	2-3nm from grid
	3-4nm from grid
	4-5nm from grid
	5-7.5nm from grid
	7.5-10nm from grid
	10-15nm from grid
	15-20nm from grid
	20-50nm from grid
	> 50nm from grid

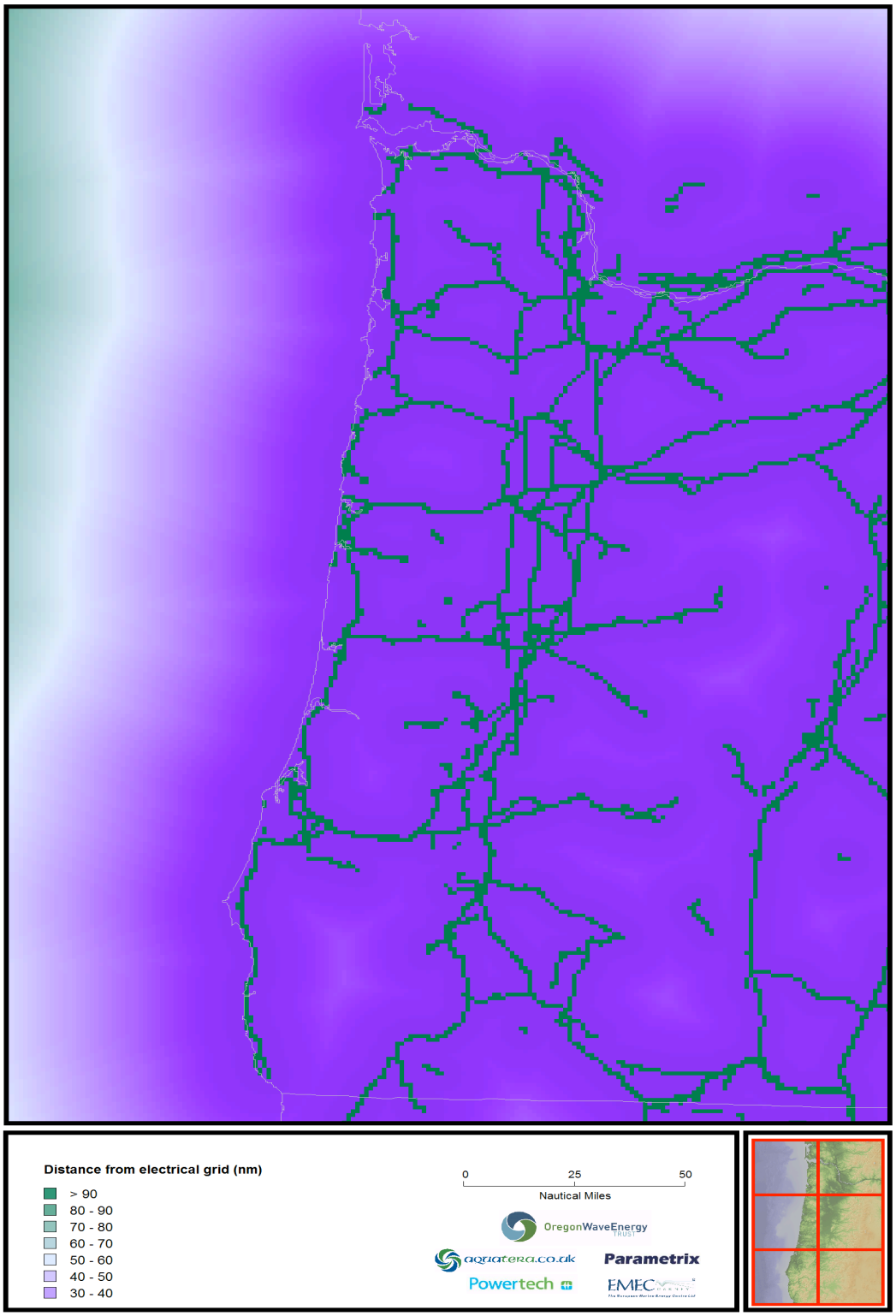


Figure 6.14 Raster map showing distance from electrical grid

6.5.4 Transport

Description
The location of existing rail, roads and airports.

Status and Trends
Not applicable.

Data sets
Although data on the location of roads, rails, and distance from roads and distance from rail are available, these were not considered of primary interest at this phase of the framework, and they are not included in the framework.

6.6 Economic activity

Description

Economic activity as measured by the gross domestic product (GDP), or measure of the market value of all final goods and services made within Oregon in a year.

Status and Trends

In 2007, Oregon generated $158.2 billion in GDP, of which 88% was generated by the private industries. The largest single contributor to the private sector GDP was manufacturing, which had an annualized growth rate of 10.7% between 2003 and 2007. Roughly 59% of Oregon's private sector GDP between 2003 and 2007 was generated by the following five industries:

- Manufacturing
- Real estate and rental and leasing
- Health care and social assistance
- Wholesale trade
- Retail trade

Although Oregon's GDP per capita is lower than other West Coast states and the US as a whole, Oregon's private sector, annualized GDP growth from 2003 to 2007 exceeded the growth rates of those areas over the same period. Since 2001, Oregon's share of manufacturing in private sector GDP has increased, while manufacturing has experienced a decline in other West Coast states and the United States (Bureau of Economic Analysis 2009).

Data sets

No data were obtained for the framework.

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