Coastal and Nearshore Oregon:
Using and Protecting Our Natural Resources

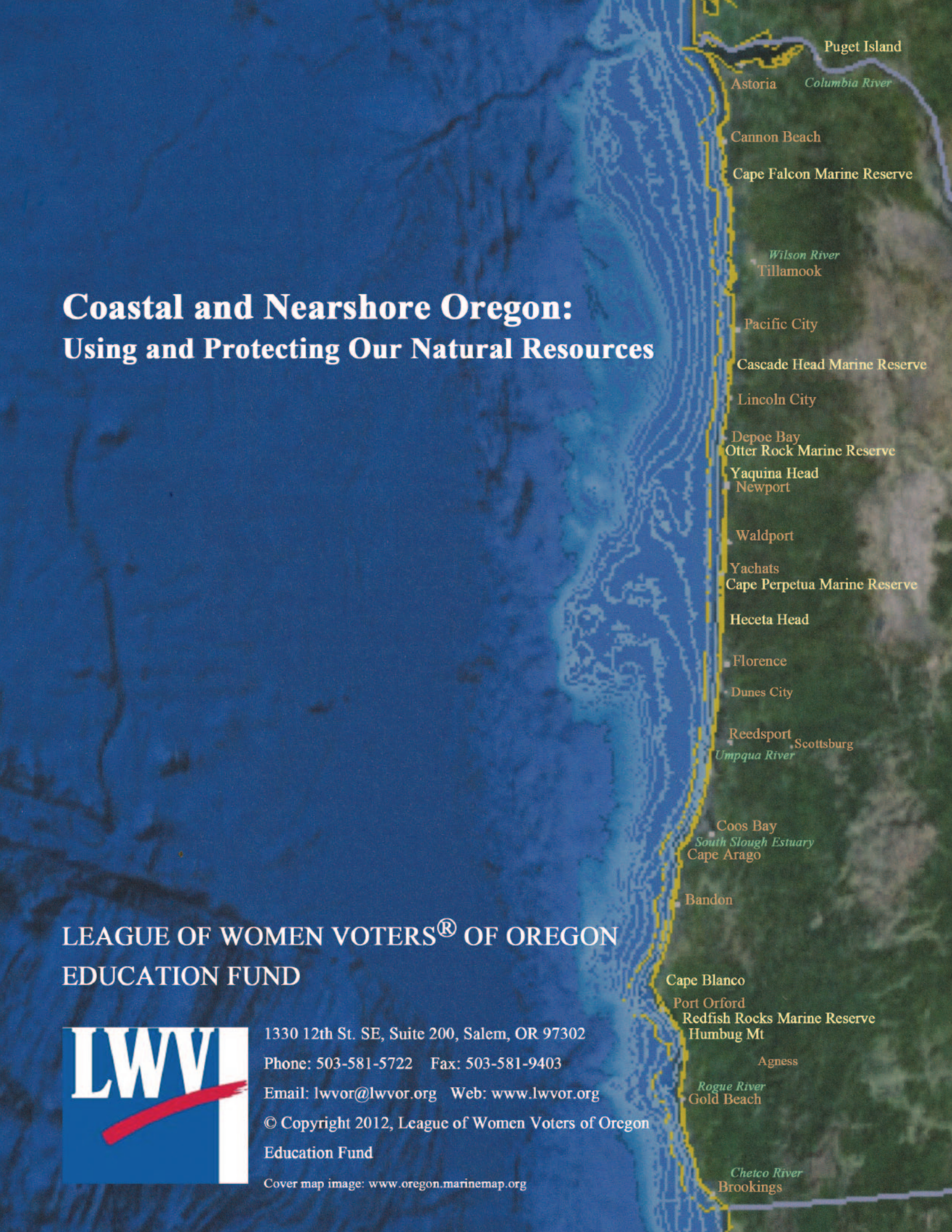

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TABLE OF CONTENTS

Page

Introduction 1
Oregon's Coastline/Oregon's Coastal Zone 1
- Map of Coastal Zone 2

Coastal Regulations 2

Characteristics of the Coastal Environment 6
- Estuaries, the water exchange zone 6
- Columbia River Plume 8
- Dead Zones 8
- Natural features, weather, seismic activity and human development 8
- The people and the economy 10
- Working waterfronts – Coastal Ports 11
- The dynamic Coast – Mapping 12

Current Natural Resource Topics 13
- Fisheries 13
- Oregon Marine Reserves and Marine Protected Areas 15
- Ocean Energy 19
- Invasive or Introduced Species 25
- Forestry 27
- Dredging 28
- Chromite Mining 31
- Ocean Acidification 32
- Nonpoint source pollution: Water Quality 32
- Trash 34
- Ocean Noise Pollution 35
- Climate Change 35

Public Involvement 37
Conclusion 38
References 38

COASTAL AND NEARSHORE OREGON:
Using and Protecting Our Natural Resources
Spring 2012

Introduction

Over 70% of the world's surface is covered in ocean; the coastlines form the transition zone between land and water. The laws and regulations for managing the natural resources of these regions must incorporate consideration of many interacting natural, economic and cultural factors.

Special regulations on federal, state and local levels govern activities within what is defined as the Coastal Zone. Since the 1970s, Oregon has worked on Coastal Zone planning. In recent years, Oregon has begun a comprehensive spatial mapping process of the coastline and the continental shelf within Oregon's territorial waters to improve policy for determining the best uses for Oregon's coastline. The understanding gleaned from mapping efforts will help Oregon plan for future economic development, protect marine organisms and habitat, manage fisheries, reduce pollution risks and ensure a strong prosperous coast.

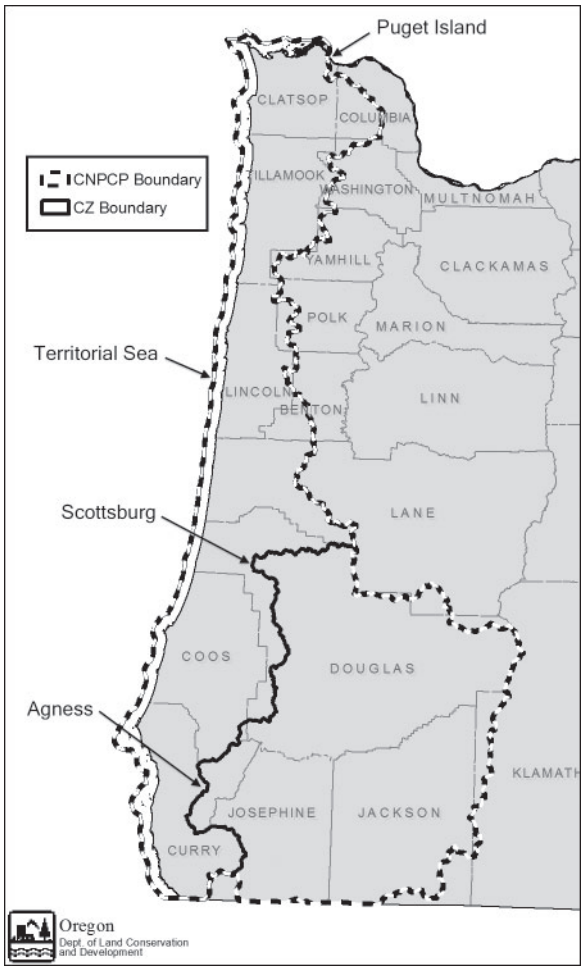
Many decisions must be made on such diverse issues as marine reserves, energy from the ocean, protection and restoration of habitat, economic improvements, earthquake and tsunami preparation and mitigation. Conflicting interests must be balanced.

In 1990, the League of Women Voters of Oregon (LWVOR) Education Fund study, *Energy, Ecology, Economics: Oregon Offshore Development Issues,* focused on offshore mining. The report is available through the LWVOR office. Since then Oregon has placed a moratorium on offshore mining along its 362-mile coastline and within Oregon's Territorial Sea that extends three nautical miles offshore. In 2010, a 10-year extension of the moratorium on offshore oil and gas development along the Oregon coast won passage in the Legislature.[1]

At the 2009 LWVOR convention, League members proposed an expansion of the original study to look at other issues impacting the natural resources of the coastline with particular emphasis on marine reserves and wave energy. The current report provides an overview of these topics and information on many other issues impacting the Oregon coast.

Oregon's Coastline and Coastal Zone

The Coastal Zone in Oregon is a watershed-based area that was defined by the Oregon Legislature in 1971 and again in 1973. The Oregon Coastal Management Program applies to all land and water areas within this zone, except lands owned by the federal government or those held in trust under Indian tribal jurisdictions; it is structured around all watersheds in Oregon that drain to the Pacific Ocean.[2]



Map 1. Coastal Zone and Coastal Non-Point Pollution Control Program

The Oregon coastline stretches approximately 360 miles from the Washington to California borders. The tidal shoreline measures 1,410 miles and is defined as bodies of water within the state's territorial waters that are subject to ordinary tides, whether navigable or not, and usually excludes harbors and lakes. As recognized by federal law, the state jurisdiction extends three nautical miles seaward. The designated Oregon Coastal Zone extends from the three mile limit onto the shore and rises rapidly inland to the crest of the coastal mountain range except in three locations where it extends to the downstream end of Puget Island on the Columbia River, to Scottsburg on the Umpqua River, and to Agness on the Rogue River. The Coastal Nonpoint Pollution Control Program Area boundary extends beyond the defined Coastal Zone to include the entire Umpqua and Rogue River Basins.[3, 4]

The coastland combines geological features including basalt, mudstone and sandstone cliffs, as well as beaches and sand dunes. Precipitation varies from as much as 200 inches of annual rain at some points at the crest of the coastal range to approximately 60 inches on the shoreline. The moisture encourages tree growth that has resulted in the historically important timber industry.

Oregon's coastline is seismically active. The continental shelf off the Oregon coastline is at the edge of the Cascadia Subduction Zone, in which the continental shelf is moving over an ocean plate and thus rising. An interesting phenomenon is occurring in Oregon. The speed of rising is significantly higher on the south coast below Coos Bay than on most of the northern coast above Coos Bay. In fact, on the south coast, the coastline rise is faster than the rise of sea level, and thus more land is being made. On much of the north coast the rise is slower than the rise of sea level, and land is being lost.[5,6]

The ocean off Oregon is habitat to many species of plants and animals and serves as an important migratory route. The Oregon Ocean Resources Management Plan and the international ocean protection organization, Oceana, have both identified more than 30 particularly important ecological areas off the Oregon Coast that should be managed to ensure relatively intact ecosystems. These areas range from Tillamook Head in the north to Goat Island in the south.[7]

Coastal Regulation

Management of the Oregon Coast involves a complex weave of treaties, laws, agency regulations and plans at international, federal, state and local levels.

International

The United States participates in many international agreements such as the four 1958 Geneva Conventions on the Law of the Sea. The United States has not ratified the 1982 United Nations Convention on the Law of the Sea because of objections to some

deep-sea mineral provisions. However the United States recognizes as international law all of its other provisions. In governing the areas of the ocean under their jurisdiction, states must comply with international law as part of US law.[8]

Federal

National involvement in ocean management affecting the coastal states falls into several categories, primarily:

1. Coastal planning
2. Pollution control and other environmental measures
3. Fishery and wildlife management
4. National refuges and wilderness designations

The **Coastal Zone Management Act of 1972,** (16 USC 1451 -1464) amended 1990**,** established a voluntary program of coastal management. Coastal states are encouraged to develop programs which are then reviewed and approved by the Secretary of Commerce through the National Oceanic and Atmospheric Administration (NOAA). When the plan is approved, a state is eligible to receive federal matching grants to assist in administering the plan. ***Once approved, state plans become the management program within that state's boundaries, and all federal policies and actions must be consistent with any mandatory provisions of the state program.***

> Each Federal agency activity within or outside the coastal zone that affects any land or water use or natural resource of the coastal zone shall be carried out in a manner which is consistent to the maximum extent practicable with the enforceable policies of approved State management programs.[9]

In 1977, Oregon's Coastal Management Program was the second state program to be approved by NOAA.[10]

National Ocean Policy

On July 19, 2010, President Barack Obama issued an Executive Order, *Stewardship of the Ocean, Our Coasts, and the Great Lakes*, adopting the recommendations of the Interagency Ocean Policy Task Force. The order establishes the National Ocean Council consisting of Cabinet members, agency administrators, and assistants to the President, among others. It also establishes a Governance Coordinating Committee consisting of 18 officials from state, tribal and local governments, and Regional Advisory Committees.

> This order establishes a national policy to ensure the protection, maintenance, and restoration of the health of ocean, coastal, and Great Lakes ecosystems and resources, enhance the sustainability of ocean and coastal economies, preserve our maritime heritage, support sustainable uses and access, provide for adaptive management to enhance our understanding of and capacity to respond to climate change and ocean acidification, and coordinate with our national security and foreign policy interests.
>
> This order also provides for the development of coastal and marine spatial plans that build upon and improve existing Federal, State, tribal, local, and regional decision making and planning processes. These regional plans will enable a more integrated, comprehensive, ecosystem-based, flexible, and proactive approach to planning and managing sustainable multiple uses across sectors and improve the conservation of the ocean, our coasts, and the Great Lakes.[11]

For planning, the U.S. coasts are divided into nine regions with California, Oregon, and Washington forming one region. A draft action plan to implement this policy can be found at http://www.whitehouse.gov/administration/eop/oceans/policy.

Regional

Several regional regulatory and management programs exist for federally managed resources. For Oregon, however, a voluntary partnership with California and Washington through the West Coast Governors Alliance on Ocean Health provides for regional coordination and action on issues of mutual concern. This 2006 agreement led to a cooperative action plan to improve the health of the ocean. An Executive Committee established Action Coordination

Teams of experts to accomplish objectives in the following areas:

1. Climate change
2. Polluted runoff
3. Marine debris
4. Integrated ecosystem assessments
5. *Spartina* eradication
6. Renewable ocean energy
7. Ocean awareness and literacy
8. Seafloor mapping
9. Sediment management
10. Sustainable communities

Details of the final work plans can be found at http://westcoastoceans.gov.[12]

State

In 1913, to ensure tidelands remained in public ownership, Governor Oswald West and the Oregon Legislature designated the ocean shore between low and ordinary high tide to be a public highway. In 1967, when some property owners asserted ownership of dry sand beaches, Governor Tom McCall and the Legislature passed the "Beach Bill," and declared a public recreation easement across private dry sand beach areas. The Oregon Coastal Conservation and Development Commission, established in 1971, began to plan for management of the Oregon Coast. In 1973, the Legislature established the Land Conservation and Development Commission (LCDC) and directed it to develop statewide planning goals to guide state agencies and local government programs. In 1976, as part of 19 statewide land-use planning goals, LCDC adopted 4 specific coastal planning goals.

Goal 16: Estuarine Resources -"To recognize and protect the unique environmental, economic, and social values of each estuary and associated wetlands; and to protect, maintain, where appropriate develop, and where appropriate restore the long-term environmental, economic, and social values, diversity and benefits of Oregon's estuaries."

Goal 17: Coastal Shorelands – "To conserve, protect, where appropriate, develop and where appropriate restore the resources and benefits of all coastal shorelands, recognizing their value for protection and maintenance of water quality, fish and wildlife habitat, water-dependent uses, economic resources and recreation and aesthetics. The management of these shoreland areas shall be compatible with the characteristics of the adjacent coastal waters; and to reduce the hazard to human life and property, and the adverse effects upon water quality and fish and wildlife habitat, resulting from the use and enjoyment of Oregon's coastal shorelands."

Goal 18: Beaches and Dunes - "To conserve, protect, where appropriate develop, and where appropriate restore the resources and benefits of coastal beach and dune areas; and to reduce the hazard to human life and property from natural or man-induced actions associated with these areas."

Goal 19: Ocean Resources - "To conserve marine resources and ecological functions for the purpose of providing long-term ecological, economic, and social value and benefits to future generations."[13]

The Ocean Resources Management Act of 1987/1991 (Oregon Revised Statutes (ORS) 196.405 – 196.515) provides the legislative and policy framework for Oregon's Ocean Program. It establishes the Oregon Resources Management Program and the Ocean Policy Advisory Council (OPAC). The act also mandates an Ocean Resources Management Plan (known as the Ocean Plan) and a Territorial Sea Plan as part of the Oregon Coastal Management Program, which is administered by the Department of Land Conservation and Development (DLCD). The program combines the state's coastal management statutes into a unified program. The three principal elements are statewide planning goals, state natural resource laws, and city and county comprehensive plans.

Funding for the program comes mostly from federal funds appropriated for NOAA and awarded annually. The principal policies of the Oregon Ocean Plan address:

- Ocean stewardship area (the entire continental margin from mean high water, across the continental shelf and to the bottom of the continental slope)
- Ocean resources conservation

- Ocean fisheries
- Marine birds and mammals
- Intertidal plants and animals
- Recreational and cultural resources
- Marine water and air quality
- Oil and gas
- Oil spills
- Marine minerals[14]

OPAC's mission is to provide coordinated policy advice and to develop a Territorial Sea Plan to govern Oregon's ocean resource planning and management. OPAC includes governor-appointed members from ocean users, local governments, and non-voting members from seven state agencies and Oregon Sea Grant (Oregon State University's coastal extension program administered through NOAA). Appointed members are confirmed by the Oregon Senate.

The Council has no authority to regulate, manage resources or enforce its plans and policies. However, once approved by LCDC as part of the Oregon Coastal Management Plan, its plans and policies must be followed by state agencies. The Territorial Sea Plan (TSP), covering state and federal programs and activities within the 3-mile strip of the Territorial Sea, was adopted in 1994 and amended in 2001 and 2009. The goal of the plan is to "conserve the long term values, benefits, and natural resources of the nearshore ocean and continental shelf."[15]

In 2005, the potential for ocean energy and "energy clusters" began to be explored. In 2006, the Federal Energy Regulatory Commission (FERC) issued preliminary permits. Applications for wave energy projects grew exponentially due to simple applications and a small filing fee.[16]

In its document, *About Ocean Planning in Oregon*, the Oregon Coastal Zone Management Association noted:

> The potential impacts on fisheries and other marine resources became increasingly apparent. Many agreed Oregon's Territorial Sea Plan needed to become a "spatial plan." That meant the existing plan would have to be changed to work something like a zoning map, where, in advance, sites or places in the ocean would be identified where renewable energy would be encouraged. Those places or multiple use zones, in turn, would guide: (a) the leasing program administered by the Department of State Lands (overseen by the State Land Board) and, (b) the licensing program of the Federal Energy Regulatory Commission (FERC).[17]

To achieve the TSP goals, Oregon began to map its coast, gathering information about the ocean and its uses for both state and federal waters. Marine spatial planning is a decision support tool initially funded by Oregon Department of Fish and Wildlife (ODFW) and the David and Louise Packard Foundation and subsequently by a number of public and private sources.[18] The maps include information about fishing grounds, bathymetric sonar analysis of the ocean floor, ecological mapping layers of birds, mammals and sea life, recreational uses, etc. Only Rhode Island and Massachusetts have comparable mapping tools. The work of these three states influenced the direction of Obama's National Ocean Plan.

In November 2009, LCDC approved the addition of Part 5 of the TSP: Use of the Territorial Sea for the Development of Renewable Energy Facilities or Other Related Structures, Equipment or Facilities. Further amendments to the TSP, which will include spatial overlays, will be added with a target of fall 2012 for completion. [19, 20]

Coastal management is also impacted by requirements of both the federal and state Endangered Species Acts (ESA). In 1997, in response to these requirements, Oregon adopted the Oregon Plan for Salmon and Watersheds to focus work on recovery of endangered salmonid populations through watershed restoration. Water quality standards and much of the water monitoring performed in the state support the goals of this plan.[21] Recent state activity has involved the establishment of 5 marine reserves/marine protected areas.

Local government

The comprehensive plans and land-use ordinances of coastal counties and cities are important elements in implementing coastal management. These plans and ordinances do not have any authority over the

Territorial Sea, but any offshore development may impact local land use. Federal regulations and the TSP require consistency with comprehensive plans and consultation with local governments affected by any major offshore development. The TSP provides procedures for resolving disagreements between the local government and a federal or state agency. [22]

Coastal Environment Characteristics

Estuaries: the water exchange zone

> Twice each day…sinuous channels, branching and winding across the broad mud flats, are filled with incoming ocean waters. As the channels fill, the rising tide spreads slowly across the flat mud. The ever-deepening waters lift the eelgrass, fill the myriad burrows of little creatures, and creep into tiny channels that penetrate the fringing salt marshes. Finally, the waters surge upstream to the edge of the forest…. The estuary is full.
>
> For a moment, the drama pauses. Then as the earth turns, the ocean's push becomes a pull, and the waters of the estuary recede. Before long, logs at the edge of the salt marsh are grounded on the mud, the eelgrass lies limp and flat, and tiny creatures are stranded in isolated pools of water warming in the sun. Clam diggers move carefully across the muddy flats toward the edge of the winding channel. But in a short time, the cycle will begin again.[23]

South Slough

An estuary is a "semi-enclosed body of water, connected to the ocean, where salt water is measurably diluted with fresh water from the land." A tidal and seasonally affected wetland transition between the marine-dominated systems of the ocean and the upland river systems, an estuary blends both into an intense biologically productive area.[24] Estuaries are habitat for many fish and wildlife species, including salmon, crabs and other shellfish, mammals, and birds.[25] Estuarine wetlands serve as nurseries for more than 75% of all fish and shellfish harvested in the U.S. The wetlands filter the water, extract excess nutrients, especially nitrogen and phosphorus, and recycle them.[26] This impressive contribution to the food web is largely due to highly productive wetland plants. These areas provide wintering habitat for waterfowl and migration/stopover sites for shorebirds.[27] Other benefits to the ecosystem include contributions to biodiversity, in the form of genetic resources and refuges for desirable species. Coastal wetlands provide an array of recreational opportunities. Many estuaries are considered to have aesthetic value.[28]

Coastal wetlands moderate the damage caused by storms and tsunamis.[29] Wetlands that are associated with streams spread flood volumes over a large, flat area, which in turn decreases runoff velocity, reduces flood peaks and distributes storm flows over longer periods. The flat topography allows flooding in the tributary and main streams of the braided channels to peak at different times.[30] Intact estuarine vegetation reduces erosion by stabilizing sediments, absorbing and dissipating wave energy, and intercepting and

reducing wind. However human developments that interrupt the continuous nature of a coastal wetland can reduce its effectiveness.[31] When wetlands are destroyed, streambanks collapse, channels widen or deepen, and the estuarine sediment sink can become a sediment source. [32]

Over time, the size, shape and ecological functions of Oregon's estuaries have been greatly altered due to human activities, such as dredging, diking and filling to support agricultural, industrial, and urban development. Diverting of water has altered the amount and timing of freshwater inputs. The result is inundation of the floodplain, increased sedimentation and decreased residence time of water -- all of which reduce the filtering benefits of estuaries, alter the fish community dynamics and increase stress on juvenile fish and other animals. In addition, hydrological changes can make wetlands more vulnerable to invasive species.[33]

Runoff from human and agricultural activity can degrade water quality by increasing bacterial and nutrient loads above the ability of the system to process them. Invasive marine invertebrates and plants can affect estuarine food webs and depress native populations such as Dungeness crabs, mussels, and oysters, including those in aquaculture operations.[34]

As the result of forestry and human development activities, the number of large-diameter logs that wash down streams during flooding has decreased. In the past, these logs have created long lasting habitat providing pools, perches, wind protection, shade, and hiding places for different species.[35]

Oregon has 22 major estuaries and many other minor estuaries extending along the coastline from the Columbia River to the Winchuck River. The planning/management responsibilities for these estuaries are found at all levels of government. Counties have the overall responsibility for preparing management plans for their respective estuaries in coordination with cities and port authorities. Plans are administered as part of overall comprehensive planning responsibilities. Statewide Planning Goal 16, Estuarine Resources, sets out the detailed requirements for planning and management of Oregon's estuaries.[36]

Because of the geological structure of Oregon's coastline, the estuaries of Oregon have less acreage than those on the Atlantic coast; however they are extremely important coastal habitats. The largest estuary is the lower Columbia River Estuary. Significant restoration is in process in this estuary on both the Oregon and Washington sides of the river. For example in the last ten years, restoration activities by over 100 partners have impacted over 16,000 acres. Lower Columbia River Estuary Partnership funding has restored or protected over 3300 acres of habitat and 58.4 stream miles and reconnected 754 acres of tidal influence.[37]

The Salmon River Estuary portion (about 1250 acres) within the Cascade Head Scenic Research Area has been an area of significant restoration and research activity since the 1970s. Three dikes have been removed and scientists are studying estuary recovery with emphasis on tidal salt marsh vegetation and fish use.[38]

The Coos Bay Estuary comprises 13,348 acres. It is classified as Deep Draft Development estuary under the Oregon Estuary Classification system. The over 4800-acre South Slough National Estuarine Research Reserve is found in the upper reaches of the estuary. The Reserve was established in 1974 as the nation's first National Estuarine Research Reserve. The reserve continues to grow through land purchases. Reserve restoration efforts include the removal of dikes and re-growth of forest. On-going scientific research has followed the impacts of restoration efforts. Today the reserve is both a research and educational center.[39]

Because wetlands have both economical and ecological value, their restoration is desirable. Successfully restored wetlands have been found to offer as much as 93% of their pre-damaged "economic value".[40] However, attempts at wetland restoration have not always succeeded, and evaluation of effectiveness is an important research component. Monitoring is often done for only 5 years. Now, many

authorities have recommended a much longer period of time, 20 to 30 years, for determining whether a "restored" wetland is truly functioning.[41, 42, 43] In any case, sufficient funding for restoration efforts, and also for adequate monitoring periods can be problematic.

Since many jurisdictions and agencies are involved in management of estuaries, the Oregon Department of Fish and Wildlife notes, "Coordination among agencies is a high priority. Because estuarine issues are complex, clear identification and communication of conservation issues should precede management actions, ensuring that all interests are considered."[44]

Columbia River Plume The Columbia River Plume is an enormous discharge of freshwater and nutrients into the Pacific. Typically it extends the full length of the Oregon Coast onto the continental shelf of California in the summer, and onto Washington's shelf in the winter, although reversals are common. The plume has a distinct demarcation physically, chemically, and visually. The front of the plume (the interface between the Columbia River outflow and more purely oceanic waters) may have greater seasonal concentrations of zooplankton and forage fish (two of the bases for marine food webs) than those commonly found in nearby shelf waters. It may provide a valuable food source for many fish, including juvenile salmonids that are in transition from fresh to marine waters. Concentrations of feeding fish and seabirds have been observed along the plume/oceanic interface. Thus, this interface also has a distinct biological edge. These habitats are ephemeral, recurring on a tidal cycle.[45]

Dead Zones

The dead zones that occur in summer off the coast of Oregon affect the health of marine life and can have a significant economic impact on fisheries. Research indicates that these dead zones differ from those seen in areas with significant runoff from onshore activity. They are not from agricultural nutrient runoff. The formation of these hypoxic (low oxygen) zones is due to an upwelling of water from an ocean layer, referred to as the Oxygen Minimum Zone (OMZ). The OMZ is a middle layer of water beyond the continental shelf and below the zone where light penetrates.

Upwelling off Oregon occurs when winds from the north push surface water off shore and cause the lower oxygen, high nutrient water to rise from the depths of the continental shelf and to well up near shore. The high nutrient content of this water encourages algal blooms that die, fall to the bottom and decompose, further reducing oxygen.[46]

The situation is complicated by a recently observed expansion, both horizontal and vertical, of the OMZ layer, with a decrease in the dissolved oxygen within, above and below the zone. When persistently northern winds push surface water offshore, the expanded size of the OMZ increases the possibility for these very low oxygen waters to be drawn onto the continental shelf and ultimately to contribute to the production of dead zones.[47]

Scientists have not determined if the increase in dead zone occurrence is the result of climate change, in part due to lack of historic information. In the 1960s, hypoxic regions were reported on the continental shelf, but, prior to 2002, dead zones were not identified and studied on the inner continental shelf (waters less than 9 meters deep).[48] While scientists are careful not to make any definitive statements, warming reduces water's capacity to hold oxygen. Surface warming also increases layering of water by temperature, which in turn discourages mixing of oxygen rich surface water with the cold, deeper waters. Researchers are working to develop methods for better identifying when, why and where these dead zones occur. This is especially important for spatial planning, including location of fisheries and placement of marine reserves.[49]

Natural features, weather, seismic activity and the built environment

The cliffs of the Oregon coastline and the steep rise to the coastal mountain range limit habitat for human development. Only one road (Highway 101) travels the

length of the coast and arterial access is scattered. Less than 5% of the coastal area is zoned for residential, commercial or industrial development. More than 80% is zoned for forest use. Much of the coastal flatland is zoned for farm use, mostly as pasture, but also for bulbs and cranberries.[50]

The coastal area is continually under attack from the forces of nature. Ocean tides, rising sea level, storm action and rivers filled from heavy rains erode the land. Additional impacts are occurring due to observed increases in air temperatures and the changing pH of waters. Seismic activity and the possibility of earthquakes and tsunamis are on-going threats, with current data indicating a significant possibility of a major seismic event in the next 50 years. Oregon State Planning Goals 7, 17 and 18 restrict development in identified hazardous areas, unless appropriate precautions are taken. The developer must prepare a detailed report outlining the hazards and steps to be taken to safeguard both the development and neighboring properties. The plans are reviewed and determination is made to allow development only when the plan demonstrates that the hazards have been addressed.[51]

Coastal cities are required to have flood plans to address storms and rain events. Plans must specify a shoreline boundary and include special zoning requirements, in order to set aside lands for uses that need shoreline and to protect the natural fringes between land and water. The coastal shoreline begins at the average high water mark. The shoreland zone is usually a minimum of 50 feet landward from the shoreline. However it can extend further inland at sites with identified special resources, coastal hazards, riparian vegetation, or sites with water dependent uses and public access.[52]

The Oregon Beach Act has played a significant role in protecting Oregon's shore by identifying this habitat as continuous state property to be managed in the public trust and allowing access. All land within sixteen vertical feet of the average low tide mark belongs to the public. There is also a perpetual easement to use the dry sand beach up to the statutory vegetation line or established vegetation whichever is more inland. Oregon Parks and Recreation Department (OPRD) manages the public rights.

Significant development has occurred beyond the reserved areas; in many cases, these developments are subject to hazards from erosion. Prior to 2004, development decisions may have been made without accurate geological data, resulting in structures sited in hazardous areas. In 2004,

> the Oregon Department of Geology and Mineral Industries began measuring the response of beaches and bluffs to storm waves … in order to provide up-to-date scientific information on the changes (erosion and accretion patterns) taking place on the Oregon coast. These data are now being used … to assist with the design and placement of new property along the coast, as well as (by) Oregon Parks and Recreation Department as part of their effort to better manage the beach.[53]

With increased understanding of the ocean and the behavior of currents and storm surges, as well as better knowledge of the geology of the shore and new mapping, future development decisions can reduce hazards to property. Hard decisions are being made to balance safety, natural environment, aesthetics and economic needs, including addressing actions taken prior to the current regulatory environment.

For example, on the north coast, Tillamook County has experienced flooding almost every winter, culminating in the great flood of 1996. The county experienced over $60 million in flood loss from 1996 to 2000.[54] Tillamook, the "land of many waters," has embarked on a long term effort to move structures out of its floodplain that forms where five rivers flow to the bay. It has initiated a program to address flooding by restoring some of the floodplain's historic ability to absorb

excess water. Buildings have been elevated or removed from the plain. "Restoring the natural functions of the Tillamook floodplain not only helps alleviate the worst impacts of current flooding, but will also mitigate the impacts of climate change."[55]

Using modeling by Oregon State University, Cannon Beach is designing a new City Hall that is more earthquake- and tsunami-resistant. The design includes a top platform described as "over 30 feet high with space for over 1,000 people, most of the population."[56] "With steel cables and reinforced concrete pillars standing at least 15 feet high, the evacuation building can 'take very large forces, not just water with sand, but also parts of buildings and cars coming and slamming into the building,'" according to Yumei Wang, an engineer with the Oregon Department of Geology and Mineral Industries. The design team hopes these types of structures placed in low lying coastal communities will reduce risk to residents and tourists alike.[57] The emergency structures are expensive, and the cost can be an issue when experts are unable to definitely predict the size, timing and nature of future earthquake and tsunami events.

The unpredictability of seismic and major storm events is recognized in coastal planning at the state, federal and local levels. A 2008 study that evaluated tsunami management planning capacity on the U.S. Pacific Coast examined 43 plans from 73 coastal counties. The study noted, "Most plans have a weak factual basis, unclear goals and objectives, weak policies, and few coordination and implementation mechanisms." The researchers added:

> "This evaluation suggests that these jurisdictions need to build a solid factual basis about tsunami hazards, set appropriate goals and practical objectives, expand the array of tools used by planners, enhance interdisciplinary and interorganizational coordination mechanisms, and improve their mechanisms for plan implementation."[58]

Some of Oregon's planning has been updated in the very recent past after completion of this 2008 study. The Tsunami Chapter of Oregon's Natural Hazards Mitigation Plan describes the interconnected state and federal plans for tsunamis.[59] In addition, as noted in the 2008 study reported above, plans must include steps to be taken in the aftermath of a disaster. Those would entail additional costs to coastal communities for air transport (including landing areas), emergency water stores, communication links in protected areas and safe areas for emergency workers.

The People and Economy

The coastal region is basically rural with a population of slightly over 200,000 in 2010. The population continues to grow at a slower rate and has a higher retirement population than the rest of Oregon and the nation. Early 2010 census figures indicate only limited population growth along the coast in the last ten years.[60] Younger people move out of the coastal area following graduation and are replaced with retirees.[61]

Reflective of the older population, almost half of the personal income on the coast comes from investments and pensions. Traditional natural resources industries, including forestry and fishing, account for approximately 15% of income. The lower income service sector of the economy is growing because of the demands of an older and second-home population.[62] In Tillamook and Lincoln Counties over 20% of the housing stock is second homes. The demand for second homes and coastal rentals makes housing unaffordable to those employed in these service sectors of the economy. Consequently, employers have difficulty finding and maintaining staff. The very limited land available for construction and high construction costs complicates the problem.[63]

The growth of the retired segment has helped maintain significant income in the coastal community. The dollars from earned personal income (employee compensation and proprietor income) have not increased. The report, *An Ecological Economics Approach to Understanding Oregon's Coastal Economy and Environment,* notes:

> This trend suggests a substantially different set of public policy implications for the coastal region than if natural resource extraction still dominated the economy. We say this because the quality of life and environment are large factors that attract people to the coast—these

people bring transfer payment income with them.[64]

These demographic changes on the coast shift the coastal prospective from using resources to maintaining and improving the natural features that attract individuals to the coast. Future planning may need to balance the traditional coastal patterns and the desires of the new demographic for scenic preservation.

Working Waterfronts – Coastal Ports

> The term "working waterfront" means real property (including support structures over water and other facilities) that provides access to coastal waters to persons engaged in commercial fishing, recreational fishing business, or other water-dependent coastal-related business and is used for, or that supports, commercial fishing, recreational fishing, or other water-dependent coastal-related business.[65]

Oregon has 23 ports. Each port is different. Upper Columbia River ports are centers for Oregon's international agricultural trade. The Ports of Portland, Coos Bay and Astoria are international gateways. Many of the smaller coastal ports are important for both commercial fisheries and recreational uses. One in six Oregon jobs depends on ports. Oregon's ports transport much of the $20 billion of exports that leave Oregon each year. While initially Oregon primarily exported raw materials, such as wheat and timber, the ports now transport more manufactured, value added products.[66]

Coos Bay, the only deep draft port on Oregon's southern coast, was once the largest forest products port in the United States and one of the largest in the world. The amount of cargo dropped sharply from a volume of 5.8 million metric tons in 1990 to 1.6 million metric tons in 2001. Since then the volumes have steadied and increased slightly. The future of coastal ports is in part dependent on timber and fisheries. However, energy imports and exports may add to the mix. Several coastal ports are currently involved in projects to support energy source transport, including liquefied natural gas (LNG)[67] and coal.

Oregon's ports have mixed financial conditions. The economic downturn has worsened their overall financial situation. Ports with possible cash flow issues include Coos Bay and Astoria. In 2010, over 60% were operating by using cash reserves, and many were operating with less than six months of cash reserves. Many have deferred both maintenance and infrastructure improvement projects for a number of years. The combined port-identified infrastructure needs exceed $500 million, which include jetty repairs, marine facilities rehabilitation, dredging, and cargo dock reconstruction projects. "Deferred maintenance is a current concern, and likely an even greater future financial issue for many of the smaller, coastal ports."[68] Particularly problematic, Brookings Harbor suffers from a high debt-to-asset ratio. The recent damage to the harbor as the result of the March, 2011 tsunami is estimated for Federal Emergency Disaster Assistance (FEMA) at $6.7 million. The request for emergency assistance through FEMA has been granted by the federal government.[69]

By definition, working waterfronts are located at sites that link coastal habitats and human activity. They are sited to take advantage of the relatively calmer waters of estuaries and the transportation linkages provided by rivers. Ports have always been a first priority in the development of human communities. To make the waterfronts more functional, the natural characteristics of the sites are altered, wetlands removed, bottoms disturbed by dredging and pile driving, and entrances changed to better serve shipping. During the first 100 years of Oregon settlement, recognition of the impact of these activities on habitat was limited. In the 1970s, this changed when Oregon developed planning goals that recognized the importance of protecting habitat in planning, but also acknowledged the need for working waterfronts.

Shrimp boat Newport Harbor

Oregon's Statewide Planning Goals contain components to protect working waterfronts. Goal 5 relates to historic and scenic preservation aspects of ports; Goal 9 relates to economic development; Goal 12 relates to the transportation function of ports, and Goals 16 through 19 focus on "the unique characteristics of Oregon's land mass interface with the Pacific Ocean, estuaries and wetlands." Goal 17, …Water–Dependent Shorelands, … recognize(d) the significant economic changes experienced by coastal communities from the early 1980s to 2000… the term water-dependent use was more specifically defined, and a new formula was created for determining the amount of water dependent shoreland that should be protected by each community.[70]

Working waterfronts must navigate a complex regulatory framework in order to perform the maintenance and infrastructure development necessary to insure their future success. For example, in 2010, a community-supported effort by the Port of Newport was successful in obtaining the Pacific Coast NOAA research fleet previously housed in Washington State. A group of community leaders worked continually to complete the permits and initiate building so that the port might be completed on time in 2011. However, on November 1, 2010, progress came to a halt because permits for dredging and pile driving could not be issued until the National Marine Fisheries Service (NMFS) Biological Opinion (BiOp) was complete. The window for dredging is limited to the period from November 1 to February 15 to avoid salmon runs. The community, with the aid of U.S. Senator Wyden, worked with the federal agencies to ensure the completion of the necessary opinion and dredging began.[71]

The 2010 Strategic Business Plan for Oregon's Ports lists a number of regulatory concerns expressed by the coastal ports including:

- The potential effect of state-sponsored Marine Reserves on Pacific fisheries and commercial fishing ports;
- The environmental issues that complicate Newport's ability to reconstruct its deep draft cargo dock;
- Lack of state support for and community controversy regarding LNG proposals in Coos Bay and Astoria;
- Prevalent local opposition to growth and change in Coos Bay.[72]

The dynamic coast: Mapping

University researchers, government agencies and other interested parties are mapping the Oregon coast and the ocean off its shores. Projects range from mapping the distribution and migratory patterns of marine life, to complex modeling of the sand depth on the beaches adjacent to projected wave energy farms. This will allow for future monitoring of the impacts of wave flow diversion. Maps created also assist in identifying and preparing for coastal hazards.

A focus on spatial planning in the oceans is supported by President Obama's Executive Order in July, 2010, establishing a National Ocean Policy.[73] The Oregon MarineMap being compiled by DLCD is the first step in identifying the geographic locations of ocean resources that must be protected according to Oregon's Statewide Planning Goal 19 and the Territorial Sea Plan.[74] The interactive maps created serve as a foundation for a marine version of land use planning. Potential locations for wave energy facilities will be adopted as an amendment to the Territorial Sea Plan.[75] Coastal mapping resources and more information on Coastal and Marine Spatial Planning can be found online at LWVOR.org studies site.

Current Natural Resource Topics

Fisheries

"You don't manage fish. Fish swim and they do their own thing. You manage people. Managing ecosystems is really about managing people and understanding what motivates them and their behaviors."[76]

Fishing is one of the few remaining commercial hunter/gatherer enterprises. Wild Oregon fish stock is collected and sold as the native tribes of the West Coast did many years ago. However, the techniques for collecting fish have been industrialized.

> These innovations included the invention of steam and diesel engines, the onboard manufacturing of ice, and blast freezing, all of which expanded the range of industrial fishing vessels. This expansion was followed by the incorporation of an enormous array of electronic devices facilitating fish detection, including radar and acoustic fish finders on fishing vessels, culminating in the introduction of GPS technology and detailed seabed mapping at the end of the cold war. These technologies … also allowed fishers to aim for specific places with high fish abundances, places that once were protected by the depths and vastness of the oceans.[77]

Fish farming, a controlled fish production system, is on the increase worldwide. According to the Food and Agricultural Organization of the United Nations fisheries report, it soon will reach 50% of the tonnage of harvested fish. Concerns exist about the methods and technology of fish farming and their potential impacts on wild species, but to meet worldwide demand, farming is expected to grow.[78] Many experts feel that fish farming will remain limited in the United States due to lack of a federal policy, the permit process and negative real and perceived public perceptions. For example, eight different Oregon government departments are involved in the permitting process.[79]

At present, fish aquaculture in Oregon is limited to fish hatcheries and oyster farming. The Department of Fish and Wildlife in Oregon operates over 30 fish hatcheries and pools. "These facilities raise salmon, steelhead and several species of trout. Salmon make up more than half the number of fish raised."[80] Risks to natural fish populations from fish hatcheries include genetic, ecological and behavioral, as well as concerns with overfishing and fish health.[81] Planning for the future, Oregon Sea Grant recently hired an aquaculture specialist.

Fish are in demand as a worldwide source of protein. According to the World Health Organization:

> The total food fish supply and hence consumption has been growing at a rate of 3.6% per year since 1961…. The proteins derived from fish, crustaceans and mollusks account for between 13.8% and 16.5% of the animal protein intake of the human population.… The per capita availability of fish and fishery products has therefore nearly doubled in 40 years, outpacing population growth.[82]

The increased consumption of fish has put pressure on the natural supply. (See Figure 1.)

> Most …of the top ten species, …about 30 percent of world marine capture fisheries production in terms of quantity, are fully exploited or overexploited. Overall, 80 percent of the world fish stocks… are reported as fully exploited or overexploited and, thus, require effective and precautionary management. … (T)he maximum wild capture fisheries potential from the world's oceans has probably been reached, and a more closely controlled approach to fisheries management is required, particularly for some highly migratory, straddling and other fishery resources that are exploited solely or partially in the high seas."[83]

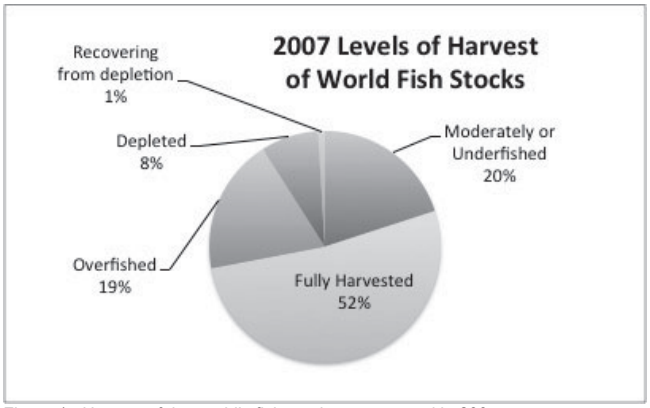


Figure 1. Harvest of the world's fish stocks, as reported in 2007[84]

Seven groundfish species (cowcod, bocaccio, yelloweye rockfish, canary rockfish, darkblotched rockfish, Pacific ocean perch, and widow rockfish) found on the U. S. Pacific Coast have been identified as overfished. Additionally, in 2009, petrale sole were identified as overfished. All are under rebuilding plans. Improvement is occurring but in some cases with very long time lines for successful rebuilding. The development of marine reserves in Oregon prioritizes protection of fish habitat into the planning process. Ultimately this may aid in the restoration of some overfished species like the yellow eye rockfish, which has a relatively small home range and is found in Oregon's nearshore.[85, 86]

In order to aid in the protection of fish stocks, the Marine Stewardship Council (MSC) has established a Certified Sustainable Fisheries standard that reflects fisheries practices that ensure a sustainable fishery for a given species. To qualify, the fishery is measured against three principles: 1) it has reliable data on the age and gender patterns of the fish population to prevent the catch of too many young and breeding size fish, 2) measures are in place to limit bycatch (living creatures caught unintentionally) and 3) the vessel owners have signed a Code of Conduct.[87] A fishery applies and, if determined to be in compliance with these good practices, is approved to sell its fish harvest with the "MSC eco label". Having this label may command a higher price and improve demand. The certification is valid for five years. In Oregon, the pink shrimp fishery and the Dungeness crab fishery (announced in December 2010 after a seven year application process) have received the designation. In the Northern Pacific, the American Albacore Fishing Association and Western Fishboat Owners Association have each received MSC certifications for Pacific Albacore. The Pacific hake mid-winter trawl in the Northern Pacific has also received this designation. The certification process adds to protection of fish, but, recently, the process has undergone criticism for some specific cases of incomplete MSC review and potential conflict of interest. Scientists have cited incidents where species have been overfished following certification.[88]

Commercial landed (brought to local docks) fisheries remain an important source of income for Oregon's coastal communities. In 2009, the estimated total personal income generated by the Oregon commercial fishing industry, including both onshore and distant water fisheries, was $398 million. These fisheries represent about 12,000 jobs. The 2009 numbers represent a 7% decrease in contribution over the previous 5 years and represent about one-half percent of all Oregon net earnings.[89] The numbers do not include shellfish aquaculture that is typically classified as an agricultural product. The Oregon Department of Agriculture (ODA) reports that income from aquaculture (oysters) accounted for $2.748 million in value in 2008.[90]

Although fisheries are not a major income source for the entire state of Oregon, the socio-economic culture of the coastline is highly entwined with this activity. Some inland recreational fisheries (salmon and steelhead) are dependent on fish migrating upstream from the ocean. Tourism, recreation and even aesthetic appreciation of the coast rely heavily on fisheries. But with recognized damage to the coastal ecosystem and eight species identified as overfished, the future of the commercial industry may be in question. In planning for the future management of the coastline, conflicts can exist between the fishermen and other interest groups. For example in *Portland Monthly Magazine* online, a charter fisherperson was interviewed and noted that the actions of environmental advocates have made fisheries management "more precautionary" than ever before, adding "I'd rather deal with wave energy developers over environmentalists any day."[91]

ODFW regulates both commercial and recreational fisheries in state waters. ODA also contributes to regulation of aquaculture and to onshore aspects of commercial fisheries. Commercial and recreational fisheries in federal waters (from 3 to 200 nautical miles) off the Washington, Oregon and California coasts are regulated by NOAA. All commercial fishermen must abide by both state and federal regulations that set requirements for equipment, fishing location, fishing season, catch size and reporting.[92] During a tour of Dock 5 at the Port of Newport, one commercial fisherman was asked whether he thought the fish would be there in 50 years. He observed that he thought so but added if they were not there it would not be the American commercial fishermen's fault, as they complied with many regulations to protect the fish population.[93]

In 2011, the Pacific Fisheries Management Council introduced the West Coast Groundfish Fishery and Trawl Catch Share Program, supported by the states of Oregon, California and Washington. Under the program each permit holder is issued a share of the allowable trawl harvest of each species. Each year the council establishes a total allowable catch, and permit holders can plan, based on their share. Permit holders may trade quota. However, if they exceed their quota, they must purchase quota shares on the open market or risk not being able to fish in future years. These regulations are designed to encourage planning and better fishing methods. The Catch Program is already operational in other areas, including Alaska.[94]

Future fisheries in Oregon must address many issues. The 2009 Briefing Report on Commercial Fisheries in Oregon notes that, to be viable, fisheries are more industrialized with fewer vessels participating, and use expensive technologies, thus requiring higher annual revenues. With increased centralization of processing, fewer local landings are taking place, and less local labor is used.

The increased cost of fuel and expensive industrial equipment challenge Oregon fishermen. In addition, fishers are seeing their hunting grounds limited by areas set aside for marine reserves and for anticipated new ocean activities, such as wave energy. The 2009 Briefing Report outlines issues including:

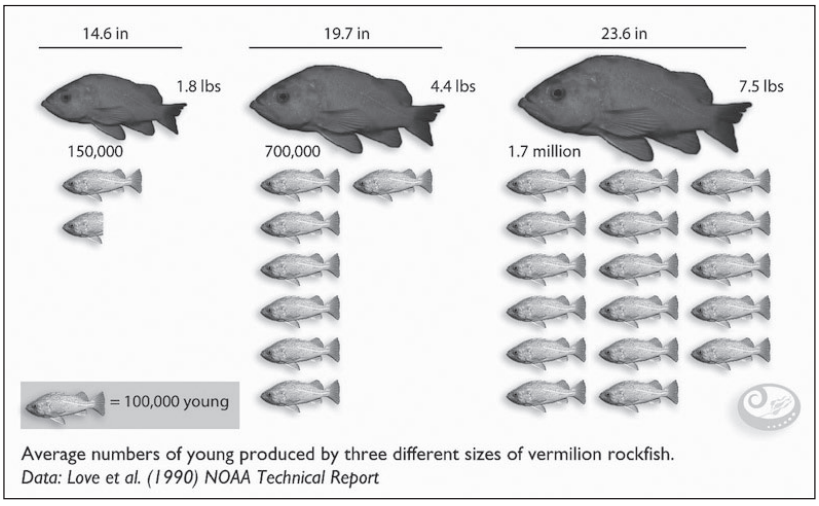
- court decisions requiring habitat protection,
- social pressure from other user groups,
- restrictions on catch, and types of equipment that can be used as the result of increased scientific understanding of negative impacts of fisheries,
- increased permitting,
- impacts of treaties and international compacts,
- inability to meet quotas because of impacts of fishing on other overfished species that share fishing areas,
- requirements for upgrading of equipment to meet permitting standards,
- implementation of the 2006 Magnuson-Stevens Act, which requires new definitions and processes for avoiding species overfishing.[95]

Oregonians enjoy the bounty of the ocean. Fishing was an economic and survival pursuit long before European settlers arrived. Modern fishermen are proud of their activity. Future policy will involve decisions on sustaining fish as a food, fish as a recreational resource and the cultural and economic value of fisheries.

Oregon Marine Reserves and Marine Protected Areas

Marine reserves, defined as "ocean areas that are fully protected from activities that remove animals and plants or alter habitats, except as needed for scientific

monitoring" have been established in many areas of the world, both tropical and temperate, but as of 2006 covered only O.O1% of the ocean.[96] More common are Marine Protected Areas, which offer lower levels of protection.



Average numbers of young produced by three different sizes of vermilion rockfish.
Data: Love et al. (1990) NOAA Technical Report

Scientists studied 124 marine reserves (as of 2006) ranging in size from 0.002 to 310 square miles. These studies showed an increase in biomass (the mass of animals and plants), density of plants and animals, body size and species diversity.[97] Heavily fished species showed the most benefit. By providing fish with a protected area, species that spend most of their time within the reserve grow to a larger size. Discussing the benefits of marine reserves, an Ocean Shores article refers to BOFFF – big old fat fertile female fish.

> A big old fat fertile female fish produces many more eggs than a young female fish. Further, the eggs of the BOFFF contain a significantly larger oil sac of nutrition which allows the newly hatched young to survive as they are adrift in the big, inhospitable ocean environment during those first few weeks when they are most vulnerable. Marine reserves serve as a way to set aside "nurseries" where the big females can safely mature and produce lots of healthy babies that will help to reseed the ocean.[98]

Reserves can have a spillover effect, increasing the population of fish outside the reserve. Fish may migrate out of the reserve when they need a different environment for part of their life cycle. The response of species varies depending on many factors such as growth rate, mobility, age of onset of reproduction, local predators, etc. Some species may even decrease in abundance as a predator increases.

Design of a marine reserve must take a number of factors into account and goals must be clearly stated. OPAC, in August 2008, stated Oregon's Marine Reserve Goals:

- Protect and sustain a system of fewer than ten marine reserves in Oregon's Territorial Sea to conserve marine habitats and biodiversity; provide a framework for scientific research and effectiveness monitoring; and avoid significant adverse social and economic impacts on ocean users and coastal communities.
- A system is a collection of individual sites that are representative of marine habitats and that are ecologically significant when taken as a whole.[99]

Some ecological factors include:

- Location – Does the area include the necessary habitats to achieve the desired results? Are the boundaries enforceable?
- Size – Is the reserve large enough to protect the species within it? Small reserves can be effective, particularly if part of a linked network of reserves. Greater protection is provided in reserves with a small ratio of boundary to total area.[100]
- Number of reserves and distance between reserves – To work as a network, reserves must be close enough together and include habitats to allow mobile species to move from one to another.

Socio-economic considerations

The greatest opposition to reserves comes from fishermen who object to the perceived loss of traditional fishing grounds. Commercial fishermen object to the expense of longer travel distances to unprotected areas, fearing loss of their livelihood. Recreational fishermen and charter boat owners also

object to loss of traditional areas. Coastal communities may fear economic hardship if commercial fisheries and recreational activities are affected. However, in Oregon, some coastal communities have supported the designation of individual marine reserve sites in addition to the development of a system of marine reserves by the passage of coastal city resolutions in Cannon Beach, Lincoln City, Yachats, and Port Orford, as well as Lane County. These communities perceive benefits from non-extractive recreational activities, such as swimming, scuba diving, and kayaking, which are generally still permitted in marine reserve areas. The presence of marine reserves may also attract scientists and educators to an area to conduct studies and educational programs in these undisturbed habitats.

> Given that it takes several years for reserve benefits to filter through to fishing grounds, fishers will likely feel some short-term hardship after reserves are established…. In the northeast USA, fishers are being compensated for lost fishing opportunities due to the large scallop closures established there in 1994. In California, fishers are also to be compensated for the establishment of no-take zones in the Channel Islands National Marine Sanctuary…The compensation provided is to pay fishers to help scientists to study the effects of the reserves... By getting involved with monitoring, fishers are able to use their skills in support of resource protection, rather than having their boats lie idle… By bringing fishers and managers closer together, it also helps foster greater understanding between these groups.[101]

Researchers Roberts and Hawkins suggest that cash compensation be offered for around five years with annual decreases in amount given. Compensation size should be related to the percentage of fishing grounds lost to reserves. They also note that it may be difficult to determine who should receive such compensation. The Partnership for Interdisciplinary Studies of Coastal Oceans notes, "In a matter of years, the growth and reproduction of fishes and invertebrates in a marine reserve may boost fishing revenues."[102] Fishers might also be assisted in finding alternative employment. "Economic support can be offered to fishers, such as through grants to self-help savings groups, loans, or improved access to existing sources of credit, complemented by training."[103]

Additional socio-economic factors include cultural values, ease of compliance and enforcement, scientific monitoring of effects, and community support.[104] As noted by Wynn Cudmore, Northwest Center for Sustainable Resources:

> Marine reserves are not the final answer to fisheries decline and marine conservation in general. They should be established as part of a broad ecosystem-based management plan that also includes other, more conventional management tools such as quotas, reduction in fishing effort, gear restrictions and seasonal closures.[105]

Marine Reserves in Oregon

In August 2002, OPAC reported to then Governor Kitzhaber, recommending the establishment of "a limited system of marine reserves in order to test and evaluate their effectiveness in meeting marine resource conservation objectives."[106] In March 2008, Governor Kulongoski issued Executive Order 08-07 calling for the selection of 9 or fewer sites to be established as Marine Reserves. ODFW working with OPAC was authorized to develop a list of possible sites for further evaluation to be forwarded to the governor by December 2008.

Recommended sites were to be "individually or collectively... large enough to allow scientific evaluation of ecological benefits, but small enough to avoid significant economic or social impacts…" Priority was to be given to nominations developed by coastal community nominating teams comprised of coastal community members, ocean users and other interested parties. [107]

Groups and individuals submitted 20 proposals to OPAC for consideration. Proposals included descriptions of the site—size and location, habitat and species types present, ease of enforcement, value for potential research, community support, and avoidance of significant adverse social and economic impact. In

late November 2008, after review, OPAC recommended six sites for further consideration.[108] The 2009 Legislature passed House Bill 3013, amending ORS 196.405, 196, calling for the implementation of OPAC's recommendations by:

(1) Adopting rules to establish, study, monitor, evaluate and enforce a pilot marine reserve at Otter Rock and a pilot marine reserve and a marine protected area at Redfish Rocks;
(2) Studying and evaluating potential marine reserves at Cape Falcon, Cascade Head and Cape Perpetua; and
(3) Supporting the development of a marine reserve proposal at Cape Arago-Seven Devils.[109]

The bill further called for ODFW, "in consultation with members from the scientific and technical advisory committee established under ORS 196.451, other relevant marine and fishery scientists, relevant state agencies, ocean users and coastal communities (to) develop a work plan to implement these actions."[110]

The work plan should include:

- Biological assessment
- Socioeconomic assessment
- Formation of community teams with diverse and balanced stakeholder representation
- Information on process and data available to public
- Development of scientifically based goals specific to the sites
- Provision of baseline data
- Development of an enforcement plan
- Use of communities and volunteers to assist in implementing the work plan

The bill directed the Department of State Lands to transfer $1million from unobligated settlement funds left over from the *New Carissa* removal to ODFW for the biennium beginning July 1, 2009. For up to an additional $1 million, "The State Department of Fish and Wildlife may accept only gifts, grants or contributions from any source for deposit in the State Wildlife Fund…"[111] This qualification allows the state to accept additional outside funding to ensure program continuity. Relevant agencies must commit to pursuing long term funding necessary to enforce prohibitions, support research and monitoring and to provide for public education. If sufficient funding is not available, agencies are to make recommendations to ODFW and the legislature to scale down or suspend fisheries prohibitions in the marine reserves.

Community teams involved nearly 100 volunteers who represented eight specific stakeholder groups including recreational and commercial fishing, conservation, marine scientists, local government, watershed councils as well as non-consumptive recreation and non-fishing industry. These representatives[112] met and gathered testimony, investing over 25,000 volunteer hours. These teams for the three recommended sites (Cape Falcon, Cascade Head and Cape Perpetua) submitted proposals in November 2010. After review, ODFW made final recommendations on these three sites and submitted them to the Legislature on February 3, 2011. Because of strong community support, the recommendations of ODFW follow those of the community teams. The Cape Falcon site was more contentious and required compromises from all sides of the community.[113]

All of the final recommendations significantly reduced the size of the marine reserves recommended by OPAC and added adjacent marine protected areas to minimize socio-economic effects. Restoration of opportunities for commercial salmon and crab fisheries within the marine protected areas were the most significant changes, with some improvements of opportunities for recreational fishing, particularly on-shore fishing.[114]

A community team led by the International Port of Coos Bay was considering a possible additional site at Cape Arago. The team's process was very different from the state-sponsored discussions at the other sites. In March 2011, the team voted against a reserve, and in January 2012, the Port of Coos Bay Board of Commissioners voted unanimously to accept the team's recommendation against establishment of any reserve or protected area in the Territorial Sea from Bandon to Reedsport. They further stated that "any further discussion regarding marine reserves in this area be taken up after the state of Oregon has

completed implementation, study and reporting on the ecological and socio-economic impacts of the five newly established and proposed pilot marine reserves."[115]

The proposed sites would provide a network of reserves and protected areas from the mouth of the Columbia River to Humbug Mountain. With the exception of the 170 km (105.6 miles) gap between Port Orford and Cape Perpetua, the reserves lie within a recommended guideline distance of 50 to 100km (32 to 65 miles) between individual sites.[116] In a letter to coastal legislators, ODFW notes:

> This combination represents distinct ecological regions, includes and replicates key seafloor types, includes important oceanographic features, and areas of high biodiversity…this combination of six sites provides Oregon with a reasonable system in which to evaluate marine reserves as a potential management tool.

ODFW also made additional recommendations discussing periodic reviews and evaluation, commitment to funding, community engagement, monitoring and research of sites and comparison areas, and mitigation of effects on impacted users.[117]

In the next stage of implementation, the 2011 Legislature reviewed ODFW funding for marine reserves and considered new legislation.[118] The 2011 Legislature approved $1.5 million in funding for reserves. On July 1, 2011, ODFW announced a delay of implementation of the Redfish Rocks and Otter Rocks reserves from June 30, 2011 to January 1, 2012 in order to collect additional baseline data to improve future monitoring.[119] This data was collected and harvest restrictions were imposed in these two reserves/protected areas in January 2012, creating Oregon's first full-fledged marine reserves.[120]

On July 18, 2011, Governor Kitzhaber and Newport State Representative Jean Cowan, Chair of the Coastal Caucus, issued a press release announcing that Oregon would adopt the recommendations of OPAC and establish marine reserves at Otter Rock, Redfish Rocks, Cape Perpetua, Cascade Head, and Cape Falcon.[121] The 2012 Oregon Legislature passed Senate Bill 1510 amending ORS 196.540 and authorizing the establishment of the five marine reserves and protected areas. On May 21, 2012, Governor Kitzhaber signed this bill, completing the process he had initiated in 2002. Baseline data is required before prohibitions may be established at Cape Perpetua, Cascade Head and Cape Falcon. Typically, this data would be collected within about two years of designation of reserve boundaries.[122]

Ocean Energy

The world's climate scientists attribute the greater part of observed global climate changes over the past 200 years to the emissions of carbon dioxide that are released when we burn fossil fuels.[123] A suggested action to slow the pace of climate change is a shift from carbon dioxide –producing fossil fuels to alternative renewable energy sources.

Oregon is one of 30 states, plus the District of Columbia, that have adopted a Renewable Portfolio Standard (RPS) to address concerns about energy independence and greenhouse gases, and to take advantage of opportunities to grow their economies. By requiring utilities to purchase renewable energy, even though that energy may cost more than energy derived from other resources, an RPS supports research, development, and production of renewable energy.

> The Oregon RPS was enacted in 2007 through Senate Bill 838 (ORS 469A). The bill directs Oregon utilities to meet a percentage of their retail electricity needs with qualified renewable resources. For Oregon's three largest utilities (Portland General Electric, PacifiCorp and the Eugene Water and Electric Board), the standard starts at 5% in 2011, increases to 15% in 2015, 20% in 2020, and 25% in 2025. Other electric utilities in the state, depending on size, have standards of 5% or 10% in 2025.[124]

Wind and solar are familiar renewable energy sources; they have reliable technologies and some established markets. Ocean energy, including thermal, tidal, and wave energy, is a renewable technology still in the development stages. It faces uncertainties in cost and

viability. However, the development and commercialization of ocean energy also presents a major economic opportunity for the Oregon coast and the rest of Oregon.

Wave Energy

Uneven solar heating of the earth's surface causes wind. Waves are generated by wind blowing over a distance of water - a fetch. The wave energy resource is stronger on the west coast of landmasses because of "westerlies," the prevailing west to east global winds found in both the Northern and Southern hemispheres between 30 and 60 degrees latitude.

Wave power varies with the square of wave height (trough to crest) and the wave period. Compared to wind energy, wave energy has higher availability, lower hourly variation, and higher power density. Also, wave energy has excellent forecastability. Since ocean waves propagate with little attenuation across the ocean, they could be detected hundreds of miles off shore to provide good forecasts up to 48 hours in advance. WaveWatch III, the existing NOAA wave forecasting system, can predict wave height and wave period with a mean absolute error of 15%.[125] Wave energy off Oregon varies with the season. In winter the waves are larger and the average wave power resource is approximately 50kW/mcl, (kilowatts per meter of crest length). In summer the average is 10kW/mcl. This is a good match for coastal Oregon power demand, where winter heating requirements far exceed summer cooling requirements.[126]

The World Energy Council has estimated that approximately two terawatts (two million megawatts (MW)) – about double the current world electricity production -- could be produced from the oceans via wave power.[127] The Electric Power Research Institute (EPRI) estimates that 18,000 MW of rated (or maximum) capacity from ocean energy is available off the U.S. West Coast, enough to power 5 million households.[128] A 2004 EPRI report identified seven areas off the coast of Oregon that could accommodate 100-MW commercial scale wave parks.[129] OSU engineers estimate that development of these seven sites could provide about half the renewable energy required under Oregon's RPS for 2025.[130] Oregon is well suited to develop its wave energy resource because it has several ports and harbors to fabricate and maintain wave energy installations, an established coastal electrical grid with excess capacity, and nearby population centers with electricity demand.[131]

Other Forms of Ocean Energy

Ocean thermal energy conversion uses the difference between cooler deep and warmer shallow waters to run a heat engine. It works best with a temperature difference of at least 36 Fahrenheit degrees, such as occurs in the tropics.[132]

Tidal power has potential for electricity generation only at a limited number of sites with sufficiently high tidal ranges (> 16 ft) or flow velocities. EPRI has identified and studied a number of sites in the Puget Sound area, and at the Golden Gate in California, but none in Oregon.[133]

Wind technology is well developed, but wind power density is much less than that of wave power, and wind power is less available and more variable. Almost all existing offshore wind projects world-wide have been located in shallow water, with the tower anchored to the sea floor, but Oregon's sea floor drops off sharply, and any wind turbines would require floating platforms. Environmental concerns in siting wind turbines on the ocean are similar to those of wave energy conversion devices. Construction and maintenance costs of these turbines can be expected to be higher than those for land-based devices.[134]

Existing Wave Energy Technologies

Wave energy technology is still in its infancy and, much like wind technology 20 years ago, many wave energy conversion (WEC) devices have been developed but no single technology has been proven superior. Only a handful of full-scale devices have been deployed in the world. Development and testing of a variety of devices is being carried out in many locations world-wide, including in Oregon.[135]

As technology testing unfolds, the field will narrow based on:

- the comparative cost of manufacture and maintenance of the devices,

- the ability of the devices to withstand the harsh marine environment,
- the efficiency of the devices in extracting the energy resource and
- the need to minimize environmental damage.

There are currently four general technology categories and hundreds of different prototypes. These devices convert the power of the waves into electricity, which is then transported via seafloor cables to a power station on the shore.[136]

Point absorbers are bottom-mounted or floating structures that capture energy from the "up and down" motion of the waves. They may be fully or partially submerged. The size can vary. For example, a structure might rise 10 feet above the surface and extend 150 feet below. Examples include 1) The Finavera AquaBUOY which sank off Newport in 2007 after completing a two-month test, 2) Ocean Power Technologies (OPT) PowerBUOY which is to be installed at the Reedsport Wave Power Station, 2.5 miles off Reedsport, in the first commercial wave park in the U.S., and 3) the OSU/CPT L10 buoy, a direct drive WEC device.

Point Absorber (diagram and picture from NNMREC)

An oscillating water column acts as a piston on trapped air. The air is channeled through a turbine generator to produce electricity. An example is the Wavegen Limpet facility located in Scotland.

Overtoppings funnel waves over the top of the structure into a floating reservoir and the collected water turns the turbine as it flows back out to the sea. The surface area might be as large as 700 by 1200 feet.

Attenuators, sometimes called linear absorbers, are devices oriented in the direction of incoming waves. The waves cause articulated multiple structures to rotate relative to each other and drive generators. An example is the Pelamis "wave snake" device off Scotland which is about 500 feet long, has 4 segments, and is anchored to the sea floor at one end.[137]

Aquamarine Power's Oyster is yet a different technology. It is deployed near shore in depths between 24 and 48 feet. Each wave activates a pump which delivers high pressure water via a closed-loop sub-sea pipeline to the shore. The high-pressure water is converted to electrical power onshore, using hydro-electric generators.[138] The U.S. Department of Energy's Marine and Hydrokinetic Technology Database contains a comprehensive list of existing and developing technologies and companies involved in marine renewable energy, both in the U.S. and around the world.[139]

Environmental Impacts of Wave Energy Devices

The deployment of wave energy devices can impact the environment in which they are sited primarily by:

1) removing energy from the ocean, making less available for natural processes at the site, and
2) introducing many large, hard structures, thus creating new and different habitat types.

Reductions in nearshore ocean energy may change ocean current patterns and water mixing. This can affect organisms by changing the availability of food, the mixing of eggs and sperm, the dispersal of spores and/or larvae, and temperature variation throughout the water column. By changing water movement, it can affect how sand is moved along the coast, thus affecting sediment grain size distribution and the distribution of organisms. Modeling of the Oregon coast by potential device developers concluded that their projects would have little or no effect on erosion/accretion at the shoreline.[140]

Because WEC devices are large and likely to be deployed in large groups, their mere presence may alter current flows, having effects similar to those described above. The devices will introduce hard materials (buoys and anchors) and cables, into sandy

bottom habitats that had little vertical structure. This will change the biological community of the area. It might be looked at as a positive change (artificial reef effect), or a negative one (displacing original species by new ones).[141]

Larger and migratory species may be at risk for entanglement in cables associated with the structures. Noise from the devices may affect navigation and communication of marine mammals. Magnetic and induced electric fields may affect navigation of salmon, crabs, other fishes, sharks and rays. Lighting of the surface elements of the devices may affect sea birds.[142]

Other Concerns related to Developing Wave Energy

There is a great deal of uncertainty in WEC development both in regard to the competitiveness of the cost of wave energy and possible environmental effects. Despite three decades of research and development effort, as yet there is no commercial wave power connected to a power grid. With limited funds available, many argue that we should concentrate our investment in renewable energy on resources that can provide commercially available power in the near future. Coastal residents are concerned that wave energy parks would be closed to all fishing. It is expected that wave parks would be located in areas over sandy bottoms - Dungeness crab habitat. The Dungeness crab fishery is a sustainable fishery and currently provides the highest value landings on the Oregon coast. Lincoln County Commissioner Terry Thompson questioned whether we want to sacrifice renewable food for renewable energy.

The economic impact on coastal communities of development of wave energy is yet to be determined. Would wave energy create only a few local jobs, such as ferrying and maintaining devices, while threatening a net loss to the marine food resource and employment in fishing and recreation? If WEC devices were to be manufactured in Oregon, they would most probably be made in the Willamette Valley. Moreover, existing law prevents coastal governments from getting franchise fee revenue from wave energy.[143]

Wave Energy Maturity

The development of wave energy can be compared to that of wind energy.

> To encourage this same level of deployment aggressive economic incentives will likely be needed; the modest production tax incentives that motivate wind energy deployment today are not likely to work for less mature marine energy systems. … In general, marine energy systems will have to be at a higher state of maturity than wind energy systems in the early stages of development in the early 1980's, because siting will take place on public waterways and oceans where there will be a higher level of scrutiny over design function and performance, and a lower tolerance for failures.[144]

Permitting and Licensing Process

The Federal Energy Regulatory Commission (FERC) has authority under the Federal Power Act, originally enacted in 1920, to regulate hydrokinetic projects in all navigable waters of the United States. FERC has exclusive jurisdiction over wave energy projects located in Oregon's Territorial Sea. Until recently there was confusion about regulatory authority over wave energy development on the outer continental shelf. In April 2009 the Department of the Interior (DOI) and FERC signed a Memorandum of Understanding clarifying jurisdiction. The agencies agreed that DOI has exclusive jurisdiction over the production of energy from non-hydrokinetic projects. For hydrokinetic projects, FERC will issue licenses (and exemptions) after the applicant has obtained a lease, easement, or right-of-way from DOI for the site. The agencies also agreed to work together to develop processes to address hybrid (wind/hydrokinetic) projects and projects that straddle the boundaries between state waters and the outer continental shelf. [145]

Before seeking a license from FERC, developers of wave energy projects in state waters have the option of applying for a Preliminary Permit, valid for up to three years. A preliminary permit (or a license) must be obtained before placing a device in the water, but the permit does not authorize construction, nor allow connection to the interstate electricity grid. The permittee must submit periodic status reports to FERC. Along with the FERC Preliminary Permit or license,

applicants would also typically seek a Temporary Use Permit or license from the Oregon Department of State Lands to use a specific area of state-owned submerged or submersible lands for placement of monitoring equipment or energy conversion devices for the project.[146]

The Standard FERC Hydropower License is good for 30-50 years and requires an application process that can take five or more years. Without changes in law, FERC has been interpreting its authority to simplify licensing procedures and encourage the testing of new hydrokinetic devices. In July 2007, FERC announced a new Hydrokinetic Pilot Project License that would allow transmission of power into the national electric grid and for which the complete licensing process would take only six months. This Pilot Project license is intended for small (5 MW or less) demonstration projects whose purpose is to test new technologies or determine appropriate project sites. It would be issued for a short term (five years or less) and the project would need to be removable or shut down on short notice.[147]

Oregon Wave Energy Development

On March 28, 2008, Oregon signed a Memorandum of Understanding (MOU) with FERC concerning permitting and licensing of wave energy projects in Oregon's Territorial Sea. With respect to wave energy projects, FERC and Oregon agree that:

- Each will notify the other when one becomes aware of a potential applicant for a preliminary permit, pilot project license or license. This will allow for the start of coordinated efforts to review the project.
- They will agree upon a schedule for processing applications as early as possible. ... They also will encourage other federal agencies and stakeholders to comply with the schedules.
- They, along with the prospective applicant and other participants, will work together to identify potential issues, and to determine what information is needed and what studies must be conducted to permit the Commission [FERC] and Oregon to undertake required reviews of proposed projects.
- Oregon intends to prepare a comprehensive plan for the siting of wave energy projects in state waters off the coast of Oregon. FERC agrees to consider, to what extent, proposed projects are consistent with the plan.
- Any pilot project license or other license issued by FERC must include conditions to protect and mitigate potential damage to fish and wildlife resources.[148]

On the same day that he signed the MOU, Governor Kulongoski issued Executive Order No. 08-07 "Directing state agencies to protect coastal communities in siting marine reserves and wave energy projects." The executive order directed DLCD to seek recommendations from OPAC for amendments to Oregon's Territorial Sea Plan reflecting comprehensive plan provisions on wave energy siting projects and to provide the final recommendations to LCDC. Any comprehensive plan provisions incorporated into Oregon's Territorial Sea Plan shall be submitted to NOAA for approval as enforceable policies of Oregon's Coastal Management Program under the federal Coastal Zone Management Act (CZMA). OPAC is directed to work with Oregon Sea Grant and the Oregon Coastal Zone Management Association to provide outreach and public education to coastal communities concerning the potential positive and adverse impacts of wave energy. [149] The CZMA requires the Department of Interior's leasing action in federal waters off Oregon to be consistent with Oregon's Coastal Zone Management Plan, once that plan is approved.[150]

Territorial Sea Plan, Part 5

The first phase of the Territorial Sea Plan amendment process was stewarded by two planning bodies, OPAC's Territorial Sea Plan Working Group and LCDC's Territorial Sea Plan Advisory Committee who collaborated to create a new Part 5 "Uses of the Territorial Sea for the Development of Renewable Energy Facilities or Other Related Structures, Equipment or Facilities." The guiding principles require state agencies making decisions about renewable energy facilities to:

- Maintain and protect marine renewable resources from adverse effects caused by the renewable energy facility,
- Promote direct communication and collaboration between an applicant and affected ocean users and coastal communities, including and especially prior to formally requesting authorization to initiate a project,
- Limit the potential for unanticipated adverse impacts by requiring, as necessary, the use of pilot projects and phased development, and
- Encourage the research and responsible development of ocean-based renewable energy sources that meet the state's need for economic and affordable sources of renewable energy.[151]

The second phase of the amendment process, currently underway, is to conduct a spatial analysis, or mapping, of ocean uses, including commercial and recreational fishing, marine ecosystems and ecological resources.[152]

Federal Financial Support

Alternative energy has received support from the U.S. government in the form of tax credits, grants, and loans, but ocean energy receives only a small portion. Moreover, the U.S. Department of Energy's (DOE) budget request for FY 2011 shows a 22% increase in requested funds (over FY 2010 appropriations) for solar energy, a 53% increase for wind energy, and a **19% decrease** for water power energy.[153]

In September 2010, DOE selected 27 marine and hydrokinetic energy projects for a total of more than $37 million in funding. Energy Secretary Steven Chu said, "This funding represents the largest single investment of federal funding to date in the development of marine and hydrokinetic energy technologies." One project selected was OPT's Reedsport deployment of a full-scale 150kW Powerbuoy. The total project value was listed as $4.8 million with DOE funding of $2.4 million.[155]

Oregon Wave Energy Trust

The Oregon Wave Energy Trust (OWET), a nonprofit public-private partnership, provides grants in support of wave energy development.

> Its mission is to support the responsible development of wave energy and ensure Oregon maintains its competitive advantage or the economic development potential of this emerging industry. OWET focuses on a collaborative model for getting wave energy projects in the water. OWET's goal is to have ocean wave energy producing 500 megawatts of power by 2025.[156]

In 2007, the Oregon State Legislature provided $4.2 million in lottery funds to OWET for development of wave energy projects and research. In April 2010, the U.S. DOE made funding available for wave energy development. In response, OWET announced the availability of $400,000 in matching grants to any successful applicant who performs a significant portion of their proposed U.S. DOE project in Oregon. The OWET matching grant will be equal to 20 percent of the U.S. DOE grant, up to $100,000.[157]

OWET has provided funding to many studies requisite to the development of Oregon's wave energy resource. Studies include environmental research (baseline studies of marine mammals. seabirds, crab and fish populations), market development, policy and regulation, marine mapping, and applied research.

Northwest National Marine Renewable Energy Center (NNMREC)

NNMREC was established in 2008 and is a partnership between Oregon State University (OSU) and the University of Washington (UW). OSU focuses on wave energy. UW focuses on tidal energy. NNMREC's objectives are to:

- Develop facilities to serve as an integrated, standardized test center for U.S. and international developers of wave and tidal energy. NNMREC is also developing the first U.S. Ocean Test Berth off Newport to provide infrastructure required to test WEC devices.

- Evaluate potential environmental, ecosystem, and human dimension impacts of wave energy.
- Study and consult on device and array optimization, improve wave energy resource forecasting, and increase reliability and survivability of marine energy systems.[158]

Community Participation

As the state deliberates on how best to create a marine spatial plan, the two planning bodies appointed for the creation of the TSP Chapter Five have been re-engaged to assist in this marine spatial plan. As with the creation of Chapter Five, OPAC's working group will take the first review and encourage ample public comment and engagement. In 2012, the LCDC group will take the lead by reviewing all that OPAC created and either accept the OPAC work or move to create their own recommendation. Each group has statutory authority to recommend a detailed plan to the LCDC. A final recommendation is expected in the fall of 2012.

The Oregon marine renewable energy process calls for early involvement of affected ocean users. Groups have organized all along the coast.[159] During a September 16, 2011 meeting in Newport, coastal government representatives warned the Territorial Sea Plan Working Group that not fully engaging the public on nearshore wave energy sites could keep these representatives from supporting the amended TSP. One relatively new area of concern in these discussions is protection of viewsheds. Allowing large arrays of wave energy buoys or other large WEC devices has some coastal residents very concerned.[160]

Current status of proposed WEC projects

In 2007, a gold rush for hydrokinetic energy preliminary permits occurred along the west coast. According to Steve Kopf, a consultant working for OPT, many companies applied for permits to study sites largely in the hopes of locking other companies out of ocean territory, a process called "site banking." Those preliminary permits expired in 2010, and there was speculation as to which, if any, of the projects would go forward. In Oregon, most of the permit holders have surrendered their permits, having found their proposed projects infeasible, or preferring to concentrate their efforts elsewhere. A new preliminary permit for the Coos Bay OPT Wave Park project with an authorized capacity of 100 MW was issued in August 2010 after the original permit expired. Similarly, a new preliminary permit for the Douglas County Wave and Tidal Energy project, a 3 MW oscillating water column collecting system to be situated at the mouth of the Umpqua River, was obtained after the original permit expired. Both projects are preparing to file for licenses. The 1.5 MW Reedsport OPT Wave Park license is pending.[161]

In August, 2006, Steve Kopf reported that the first 150 kW buoy would be deployed during the summer of 2007 followed by an additional 13 buoys the next year. Today that Reedsport project is progressing and is the furthest advanced WEC project with the number of buoys reduced to 10 and deployment of the first buoy, repeatedly postponed, and now scheduled for Spring 2012. The first buoy has been constructed, and contracts have been awarded to manufacture the mooring systems and power take-offs, and to tow the buoy into place.

Invasive or Introduced Species

Invasive and introduced species, including plants, fish, amphibians, invertebrates, mammals and microbes, have entered Oregon both accidentally and intentionally. They spread via neighborhood diffusion or long-distance migration.[162] Once established and no longer subject to the competition or predation found in their native habitat, alien species can spread at exponential rates with succeeding generations.[163] Invasive species may take over or alter habitat and resources on which native species depend, prey on native species or introduce disease. Invaders account, at least in part, for the decline of threatened species.[164, 165]

Although discovering their presence and potential for damage may take years, control is more feasible during early phases of a spread.[166] Annually, invasive species cost the state millions of dollars in lost productivity and for control efforts.[167] In 2008, over $26 million was spent in Oregon on invasive species

management, with the funding provided by the federal government, Oregon state agencies, local governments, nonprofits, industry, and academic and other institutions.[168] These figures do not include the increased costs of timber harvesting, managing harvestable fish and wildlife, or managing endangered or other declining species whose recoveries are complicated by the presence of invasives.

Examples of the effects of invasive or introduced species

Many different invasives have been identified and have had significant impacts on the Oregon coastline. These include gorse, scotch broom, purple loosestrife, and nutria. Other specific examples include:

Griffens Isopod (Orthione griffenis): This isopod is a parasitic aquatic crustacean that is threatening to decimate the mud shrimp populations of estuaries. Researchers, in 2005, estimate an overall infestation as high as 45% of the mud shrimp population and believe that as much as 80% of the breeding size adults may be infested. Once the shrimp is infested, reproduction is virtually halted. Loss of mud shrimp will substantially impact estuaries. Mud shrimp play an important role in the sediment dynamics of estuaries. They also provide food for birds, fish and other animals. Mud shrimp may filter as much as 80% of the water per day in some estuaries.[169]

East coast Spartina ("cordgrass"): Cordgrass has been introduced to the Northwest in various ways - for example, as packing for oysters. In wetlands, *Spartina* alters the balance of marsh to mudflat by converting most of the mudflat to high marsh.[170] When mudflats are lost, so are crucial feeding areas, nursery areas for birds, mammals and fish, migratory bird resting sites and shellfish production areas. Additionally, cordgrass can dominate and exclude all native vegetation from the high marsh and cause serious reductions in waterfowl food production and plant species diversity. Stands of this aggressive plant can clog creeks, increasing the risk of upland flooding.[171]

Japanese knotweed *(Polygonum cuspidatum)*: This aggressive plant outcompetes all native vegetation, can penetrate asphalt, grows up to ten feet tall and spreads underground up to 60 feet. It can sprout from small root fragments and has reduced pastureland and wildlife habitat, especially on the north half of the Oregon Coast.[172] Local Soil and Water Conservation Districts are working with landowners to address this challenging problem in coastal streams.

Introduced species that may harm salmonid populations: Deliberately introduced fishes such as walleye, smallmouth bass and channel catfish may prey upon salmon. The removal of native plankton species by introduced fish or competition from non-native plankton is of concern because juvenile salmonids depend on plankton for food. Invasive invertebrate species may alter the food web to the detriment of native fish. Introduced salmon may also breed with native species, producing offspring less adapted to local conditions or with the ability to outcompete natives. Novel diseases and parasites to which native fish have little or no resistance can be introduced to the marine and fresh water environment from hatcheries.[173]

Ballast water discharge and biofouling

Ballast water is taken into the hull of a ship to help balance the vessel as it transports cargo. The discharge of ballast water, an operation necessary for vessel stability and safety, is widely recognized as a pathway for transporting aquatic species into habitats outside their native range, resulting in the introduction and proliferation of invasive species in Oregon waters.[174] Zebra and quagga mussels, and the North American comb jelly are examples of aliens found in ballast water that have had devastating impacts on the environments they have colonized.

In 2007, the Oregon Legislature allocated funding for the first Department of Environmental Quality (DEQ) employee to design and enforce ballast water regulations, an important step to reduce the risk of introducing non-native species in Oregon waters. This one employee faced multiple demands on his time and was able to inspect only 3.9% of ship arrivals to Oregon in 2009.[175]

In a different manner, ships may spread invasive species as organisms colonize (or 'biofoul') surfaces of

the vessels and release offspring or become dislodged in new waters. Since January 2003, the application of tin-based anti-fouling paint systems has been banned by the International Maritime Organization (IMO) because of harm caused by tin compounds to the marine environment. As vessels shift to different coatings without such effective abilities to prevent these "hitch-hikers," there are concerns that these species may be more likely to be transported.[176]

The U.S. has not yet ratified the IMO Convention on Ballast Water. Ballast water discharged in Oregon waters is regulated by federal and state treaties and law, and guided by best management practices. In 2011, Oregon Senate Bill 81 directed DEQ to collect fees from regulated vessels to fund a new half-time position, increasing ballast water inspections to a target of 12% of vessels arriving in the state.[177, 178]

Forestry

Oregon is the number one provider of timber in the United States.[179] The private, county, state, and national temperate forests of Oregon's coast make up 80% of the land area in coastal counties and grow a mixture of giant Sitka spruce, Douglas fir, hemlock, alder, and cedar.[180] These forests have developed because of the unique coastal climate where they receive from 60 to 200 inches of rain per year. In the summer season, the climate remains cool and cloud covered with the forest capturing 7 to 12 inches of precipitation from the fog.[181]

Much of Oregon's coastal history centers on timber. The first timber mill was established near Fort Vancouver in 1827 and the first shipment of timber to China occurred in 1833.[182] During Oregon's early history:

> The goals of the Forestry Service focused primarily on moving forests quickly toward "regulation." This regulation was the first step toward creating a "sustained yield" that would allow lumbermen to harvest trees at rates equal to their growth, thus providing a perpetual supply of timber….Because old growth forests were in a state of equilibrium where the amount of growth was equal to the amount of decay, they were considered wasteful and inefficient. The solution was to replace those old stands with vibrant young forests that were growing faster than they were decaying.[183]

In 1971, the Oregon Forest Practices Act (the first of its kind) was enacted. In 1976 the National Forest Management Act was passed. During the 1980s, regulations were introduced with particular emphasis on northern spotted owl habitat. With the inclusion of stormwater runoff in the Clean Water Act (CWA) in the 1990s, additional attention was placed on the impact of forest practices. Oregon has acted to improve forest management in line with environmental concerns. These actions are outlined in the Oregon Department of Forestry's *Strategies To Ensure Sustainable Forest Management*.[184]

The harvest of timber increased steadily throughout Oregon's history up to the 1990's. However, by 2003, timber was at 9% of the coastal economy, down from 12% in 1991.[185] Timber continues to be important to the coastal economy. The timber grown, harvested, and processed in the coastal counties generated an estimated $457 million in personal income in 2006. Coos and Clatsop Counties generated the largest amount. The actual harvesting of timber produced the largest part of this income and the most annual jobs.

In 1990, the Coastal Zone Act Reauthorization Amendments (CZARA) added Section 6217, which calls upon states and tribes with federally approved coastal zone management programs to develop and implement coastal nonpoint pollution control programs. The program is administered at the federal level jointly by EPA and NOAA.

In January of 2009, the Northwest Environmental Advocates (NWEA) sued NOAA and the EPA for violations of the CZARA. CZARA requires EPA and NOAA to withhold a percentage of the Clean Water Act and the Coastal Zone Management Act (CZMA) funds from states that do not submit approvable programs. NWEA filed the lawsuit alleging that although Oregon has failed repeatedly to submit an approvable coastal nonpoint program, the federal agencies had not

disapproved Oregon's overall coastal management program and had continued to grant the funds for over 13 years. NWEA alleged that Oregon did not improve its logging practices to protect coastal water quality.

The suit cited evidence that in 1998, and again in 2004 and 2008, the federal agencies found Oregon's plan deficient because Oregon Department of Forestry (ODF) logging practices cause water pollution. The agencies cited inadequate protection for riparian areas of streams and inadequate protection of high-risk landslide areas, and inadequate management of legacy logging roads.[186]

In July 2010, the Oregon Attorney General sent a legal opinion to the federal agencies that described the approach to developing CWA-required "implementation ready" Total Maximum Daily Loads (TMDLs) - scientifically-based pollution limits. The Oregon Coastal TMDL approach is a new process that will make TMDLs enforceable against forestry nonpoint sources, setting a national precedent. The legal opinion addressed whether DEQ has legal authority over logging given the state Forest Practices Act which puts the ODF in charge.

DEQ has outlined the following program:

1. Identify specific nonpoint sources, including logging, in each TMDL;
2. Identify the logging practices necessary to meet the TMDL load allocations;
3. Issue the load allocations as enforceable orders to significant landowners and agencies;
4. Provide a schedule (March 2011) for developing coastal TMDLs with the new approach;
5. Develop the Mid-Coast TMDLs by June 30, 2012, using the new approach in order to demonstrate that DEQ can and will use TMDLs to control water pollution from logging.[187]

A second significant recent court decision concerns whether logging roads in a forest can be considered as a stormwater system. In August 2010, the Ninth Circuit Court of Appeals announced a decision on ODF's management of logging roads and stormwater in the Tillamook State Forest. In this forest, the court found that ODF has allowed existing logging roads to channel and discharge sediment -polluted stormwater into coastal rivers and streams, suffocating salmon spawning beds and harming water quality. The timber industry and ODF have argued that logging activities are exempt from the CWA's permit program. The Ninth Circuit Court rejected that argument and maintained that ODF must have an EPA Permit under the CWA before discharging stormwater into rivers and streams.[188]

In 2011, Governor Kitzhaber announced that he will appeal the decision to the U.S. Supreme Court. Several federal legislators, both Republican and Democrat, have introduced legislation intended to reverse the ruling.[189]

Local communities dependent on timber production are also seeing economic impacts. As timber production has decreased, port shipping has declined, mills such as Weyerhaeuser in Coos Bay have closed, and jobs have been lost. Controls and regulations on export of timber has increased the impact.

Despite the decreasing contribution of logging, forestry continues to play a role in the coastal economy. The impacts of logging and the capacity of the Pacific NW forests to mitigate climate change are also factors to be considered in future policy.

Dredging

Functions of Dredging

Dredging is the excavation of material underlying either fresh or salt water. It involves gathering bottom rock, gravel, sediment, and bottom-dwelling (benthic) plants and animals, and moving them to another location. Dredging is used to deepen and widen shipping channels, to change the course of stream flow, to harvest crustaceans, to enrich eroding beaches, to harvest rocks, gravel and sand for construction, to extract minerals, to place underwater cables, to construct bridges and to develop waterfronts. The maintenance of navigation channels through dredging is crucial for viable ports.[190, 191]

Effects Of Dredging:

Water quality issues arise from the disturbance of riverbeds, estuaries and bays. During the decades of unrestricted river and harbor use, industrial effluent and toxic wastes (so-called "legacy" toxic pollution) settled to bay and river bottoms. The pollutants have been covered over by subsequent deposits of other sedimentary material sealing off the more toxic material below. Once dredging operations disrupt the architecture of the stream bottom, toxics are again suspended in the water.

One of the major environmental impacts of any dredging operation is turbidity (muddy water).[192] Suspended sediment can clog or abrade fish gills, impact filter-feeding invertebrates and interfere with predator-prey visibility. Silt may settle on spawning beds and smother the eggs. Benthic organisms that provide food for larger fish are destroyed by the act of dredging or may be buried by the sediment dispersed.

The actions of heavy equipment used in dredging can result in bank erosion, loss of tree cover and other vegetation, soil compaction, and loss of protective structures for young fish (submerged vegetation and natural features).[193, 194, 195] Finally, the destination and treatment of the dredged materials is of concern because it is difficult to accurately estimate the costs, the ultimate volume or contamination levels of the material.

Dredging of Navigable Waters

Dredging of the navigable waters of the U.S. is under the purview of the Army Corps of Engineers (Corps). Dredging requires permits which often must be preceded by environmental impact statements. In the words of the American Institute of Marine Underwriters, a "major hurdle in the permit process is to perform an environmental impact study. This can be a time intensive and onerous process, in which Federal (EPA), State and Local Authorities must review and approve the dredging plans and disposal of spoils."[196] In the course of water development projects, protection for species listed in the federal Endangered Species Act (ESA) can be time-consuming, expensive and controversial. The presence of salmonid species consistently adds expense to projects overseen by the Corps.[197]

Regional, state, and local governments have additional ordinances regulating development projects impacting the watersheds in their jurisdictions. The Coastal Zone Management Act requires federal agency activities affecting any coastal use or resource to be consistent with the policies of the state's federally approved coastal management program.[198] The Oregon "Department of Land Conservation and Development continues to work with coastal cities and counties to achieve consistency with revised Statewide Planning Goal 5 (Natural Resources) and the updated administrative rules (OAR 660-Division 23)".[199]

Suction Gold Mining in Coastal Watersheds

In the 19th and 20th centuries, miners used a variety of methods to send gold-bearing sediments from the river bottom and banks over sluices, where the heavier gold particles were separated from lighter sediments, using mercury. The mercury was incompletely recovered from this process and settled in the stream beds as "legacy pollution." Historic mining sites are now among the popular locations to work, and mercury may be re-suspended along with the gold-bearing sediments and delivered into the effluent.

In contemporary times, miners typically set up river rafts with gas-powered suction devices to vacuum gravel from the stream bottoms. The sediment passes over sluice boxes to sort out the gold and the tailings are discarded over other areas of the stream beds.[200]

In 2010, a ban on suction mining in California, coupled with the high price of gold and high unemployment, directed miners' attention to the streams of Oregon. In Oregon, about 3,000 active suction dredge (placer) miners are registered with the Department of State Lands (DSL), and in July 2010, about 2,000 of these miners were actively registered for National Pollution Discharge Elimination System (NPDES) permits with DEQ for use during that year (up from 934 in 2009).[201] In the coastal zone, both the Rogue and Chetco watersheds are mined by suction dredging.

Federal Regulations: Gold mining on federal lands is authorized under the General Mining Act of 1872, passed during the administration of President Ulysses S. Grant. Additional regulations updated in 2001 require permits and guarantees of reclamation.

In a January 2012 *New York Times* article, Hughes and Woody assert that the federal law governing gold mining makes it nearly impossible to block extraction, no matter how serious the potential impacts. "Federal agencies review the plans, but they are approved as a matter of course. Mining companies pledge to protect rivers threatened by their operations. But the industry's track record hardly inspires confidence."[201]

Increased mining pressures on the Chetco River have resulted in concerns for water quality degradation and damage to its fisheries. "At the request of members of the Oregon Congressional delegation, the Forest Service proposed to withdraw a portion of the Chetco River temporarily from the jurisdiction of the 1872 mining law while seeking additional protection." [203]

State Regulations: In order to operate small scale placer mining in Oregon, miners apply to DSL and receive a Placer Mining Authorization. To mitigate the impact of gold mining on both anadromous and resident fish populations, DSL permits in-water work only during specific months of the year, based on patterns of fish migration, spawning and rearing.[204] DSL requires permit holders to report their annual activities. Although mining is not permitted during salmon spawning season, other fish species can be reproducing when mining is allowed. Fish eggs and fry can experience 100% mortality if drawn through the dredging equipment.[205]

Permission to explore for placer minerals must also be received from the appropriate private, state or federal land manager. Rules limit the siting of suction mining in protected waterways (dredging is not allowed in State Scenic Waterways).[206,207] NPDES general permits must be obtained from DEQ, based on federal and state wastewater regulations. Discharge limitations require that the suction miner, often working alone and underwater directing the hose intake, must assess for turbidity 300 feet downstream.[208] In recent years, a number of lawsuits have sought to clarify DEQ's jurisdiction and the permitting process for suction mining.

Gravel Mining:

"Aggregate mining generally occurs within 30 to 50 miles of the intended market because the cost of transport is the primary expense in this industry (Meador and Layher 1998)." Most aggregate is used for construction purposes, and composes 90% of every highway. "Instream deposits of gravel are valuable because they are easily and cheaply accessible, well-sorted, and are generally free from fine sediments such as silt and clay." In the near future, gravel use is expected to increase as the Oregon Department of Transportation replaces Oregon's highway bridges.[209]

Environmental impacts specific to gravel mining: Gravel extraction removes streambeds; widens, straightens and destabilizes river channels; changes hydrology; eliminates pool and riffle structure; increases turbidity and sedimentation; causes bank erosion; and degrades or removes fish and wildlife habitat. Location of mining staging areas on the stream bank and activities of excavation can destroy riparian vegetation, raising water temperatures because of reduced shade. "The impacts can extend far beyond the mining site, and stream recovery can take decades."[210] For these reasons, the permitting proposals for gravel dredging projects generally protect the upstream one third of the bar from mining, and often include riparian protections and environmental remediation.[211]

Regional General Permits (RGP)*:* The gravel mining industry has sought an approach to streamlining the cumbersome multi-agency permitting process for gravel extraction. In July 2008, federal and state agencies (USFWS, NMFS, the Corps, EPA, DSL, DEQ, ODFW and DLCD) signed an agreement along with the gravel industry to engage in a process toward RGPs on coastal systems where gravel is removed. One of the first RGPs was sought for the mining activities of three companies operating on the lower reaches of the Chetco River. The intent was to simplify the application process for in-stream work and to provide a blueprint for future permits, in compliance

with the Oregon Coastal Management Program.[212] The permit proposal describes specific parameters and limitations of mining activities, including an adaptive management strategy, a monitoring plan and enhancement actions.[213]

Because of the implications for accelerating future applications, the Chetco River's RGP has captured the sustained attention of environmental groups, and has resulted in a U.S. Geologic Survey study of Chetco River gravel dynamics, to apply to this and to other river systems in Oregon.[214, 215] The RGP is requested for mining in a section of the Chetco River designated by NMFS as Threatened Southern Oregon/Northern California Coast (SONCC) Coho salmon habitat.

The Chetco River discharges directly into the Pacific Ocean, south of Brookings. For most of the 20th century, the Chetco was mined as a source for construction gravels.[216] Environmental concerns over gravel mining became more focused in the early 2000's, and resulted in the October 2006 cease-and-desist order issued by the Corps of Engineers against mining activities of two companies operating in the Chetco.[217, 218]

In requesting a biological assessment from NMFS, in June 2010, the Corps notes:

> Bar scalping and other gravel extraction methods could undermine the deltas of those lower river tributaries used as spawning areas, decrease water quality, and result in lost functions of side channels, pools, and backwater areas, and other adverse changes in channel morphology. Therefore, the Project may affect, and will likely adversely affect SONCC coho salmon.[219]

The NMFS Biological Opinion (BiOp) in September 2010 endorsed the permit, while reporting that the annual spawning population of SONCC Coho salmon in the Chetco River was an estimated 0.1% of historical populations (between 50-100 fish,) and that this low number represented a "negative feedback loop that accelerates a population toward extinction" because of "density-dependent factors such as failure to find mates." [220]

Public comment and a 2010 lawsuit by the Northwest Environmental Defense Center[221] stimulated the development of enhanced habitat protections in the permit and a new BiOp was issued by the NMFS in June 2011. The BiOp noted that though the overall extinction risk of the Chetco coho is high, "… the proposed action is not likely to jeopardize the continued existence of SONCC coho salmon and is not likely to destroy or adversely modify designated critical habitat for SONCC coho salmon."[222] A 5-year RGP for commercial gravel mining in the Chetco River was issued by the Corps on July 15, 2011.[223]

Chromite Mining

Oregon Resources Corporation (ORC), an American subsidiary of Industrial Minerals Corporation of Australia, has begun to extract chromite, zircon and garnet from open sand pits near Coos Bay. The chromite in Oregon is rounder than that from South Africa, the world's leading supplier, and thus fashions better molds for use in the aircraft and automobile industries. This mining operation will be the only U.S. supplier of chromite. [224] This planned 8-year project will mine 150 acres of vegetated land. The ancient beach sands are excavated from deep pits and trucked 19 miles to the Coos Bay production plant for extraction. The remaining sand will refill the holes before the land is leveled and replanted. ORC believes that its operation will create 70 to 80 jobs that earn a salary of $46,000 per year providing substantial economic benefit to Coos County.[225]

Some residents of Coos County, Oregon Shores, and other organizations unsuccessfully challenged the NPDES stormwater management permit. "DEQ approved the permit despite conceding 'the mining is likely to affect the quality and quantity of groundwater used by 200+ homes that obtain their water supply from water wells.' "[226] Oregon Shores and residents will continue to monitor the site for any harmful environmental damage and nuisance problems, such as truck traffic.

Ocean Acidification

The burning of fossil fuels pumps carbon dioxide into the atmosphere. About 50% of the carbon dioxide is taken up by the ocean, terrestrial plants or sediments.

In the ocean, increasing uptake of atmospheric carbon dioxide lowers the pH of the ocean (making it more acidic). Even a very minor shift in acidity can have significant effects. The lower pH shifts the chemical balance of the water, reducing available calcium carbonate. Consequently, less calcium is available for building the skeletons for organisms such as corals, shellfish and tiny organisms called foraminifera. These marine species are important in the ocean food web and provide habitat for fish and many other groups.[227]

On November 15, 2010, the federal EPA released a memorandum on "Integrated Reporting and Listing Decision Related to Ocean Acidification." This document calls for states to develop data and report on impairment of marine water as the result of ocean acidification, under provisions of the Clean Water Act. The requirements do not call for development of TMDLs (Total Maximum Daily Loads) that are required for other waters but request data on the condition of the oceans and the identification of impairments.[228]

Nonpoint Source Pollution: Water Quality

Both nonpoint and point source pollution contaminate our ocean, groundwater, streams, estuaries, lakes and aquifers. Point source pollution comes out of a pipe, culvert, or channel. Nonpoint source pollution comes from contamination of stormwater and other runoff water that collects pollutants from surfaces. These pollutants can include spilled oils, animal wastes, fertilizers and sediment.[229]

Coastal Nonpoint Pollution Control Program (CNPCP):

The CNPCP is divided by the DEQ into the North Coast, Mid-Coast, South Coast, Umpqua and Rogue administrative basins, which are in turn divided into sub-basins. The National Pollutant Discharge Elimination System (NPDES) permitting, assessment, and TMDL work has been aligned and prioritized according to these sub-basins. The basin coordinators take the lead role, as groundwater management and TMDL plans are developed and implemented. The types and extent of water quality impairments, as well as available resources and impediments, vary geographically.[230]

In addition to following federal and state regulations, the CNPCP is required to comply with NOAA's Coastal Zone Reauthorization Amendments of 1990 (CZARA). In 2009, the plan developed by DEQ and DLCD for the Coastal Zone did not receive full approval from NOAA and EPA for three components: 1) new development, 2) operating onsite disposal systems, and 3) forestry. Work has been ongoing in these areas.

Since May 2010, the EPA and NOAA have required "Implementation-Ready TMDLs" when DEQ conducts watershed analyses in the CNPCP zone. The DEQ is required to involve stakeholders and management agencies in the process at all levels. The resulting management plans define the sources of pollution and Best Management Practices for remediation, specific to the body of water studied. Timing and location of restoration projects and detailed strategies are directed to the landowners and appropriate agencies responsible for managing the activities causing the pollution. The TMDLs for the Mid-Coast Basin, due by June 30, 2012, are slated to be the first to be submitted in the "implementation-ready" format.[231, 232]

Septic System Failure:

In Oregon, over 30% of residences and businesses have septic systems, and the EPA estimates that 10-20% of all septic systems fail each year.[233] DEQ is responsible for the oversight of septic system rules which prescribe siting, installation, operation, maintenance, and monitoring the licensing of practitioners (system installers and pumpers). Onsite septic programs are administered directly through DEQ, or contracted through the individual counties in compliance with DEQ regulations.

With the exception of Alternative Treatment Technology (ATT) systems, DEQ's rules have not specified minimum standards for inspection of existing septic systems in Oregon. However, within the Coastal Nonpoint Pollution Control Program area (see map 1), the CZMA requires a septic system inspection program. A 2010 DEQ Advisory Committee Report proposed a time of property sale program to comply with federal regulations and water quality concerns.[234]

The 2011-2013 DEQ agency budget included property owner fees for reporting both time of transfer inspections and septic tank pumping for all septic systems in the coastal zone. Rulemaking began in the fall of 2011 for this and for improvements in the ATT program, as recommended by the advisory committee. DEQ's agreement with EPA is that rule adoption will occur no later than March 2013.

The Dunes City Septic Ordinances Example

Dune City residents source their drinking water directly from Woahink, Cleawox and Siltcoos Lakes and private wells. Wastewater is processed through septic systems. Oregon DEQ, in 2004-06, classified Siltcoos Lake as water quality impaired for algal and non-native plant growth.[235] In 2007, a health advisory was issued against the use of Siltcoos Lake for drinking and other domestic use as the result of potentially toxic blue-green algae. Residents dependent upon this lake were forced to find alternate domestic water sources for 52 days.

Dunes City adopted city septic tank ordinances in 2006 and 2010, mandating mapping of septic tank components and an evaluation of system integrity once every five years. They included provisions for system evaluation, mapping, and pumping at the time of sale or transfer of a property.[236] In 2007, the City Council limited the use of fertilizers and cleaning agents that contain phosphorus.[237]

During the time the ordinance was in effect, 69% of septic systems underwent some inspection or pumping activity. Of these, 12% had failed systems, or needed replacements or repairs.[238]

In 2011, an ordinance adopted by the newly configured city council repealed city oversight of septic systems, leaving water quality protection to Lane County and the State of Oregon. In place of mandated maintenance, the council established a septic education program for homeowners.[239]

Other coastal communities have explored the issue of local ordinances to protect water quality from septic system failures.[240] Because of the costs associated with mandated maintenance, and because algal blooms may be attributed to multiple sources, there can be considerable friction on the road to consensus.[241, 242]

Tillamook Estuary Example:
A Watershed-Based Program

Between 1999 and 2002, the Tillamook Estuary Partnership (TEP) worked with federal, state and local stakeholders (including the dairy industry) to develop Tillamook's Comprehensive Conservation and Management Plan, with the goal of improving water quality and habitat in the watershed.[243] Five types of pollution are of concern in this watershed: bacteria, dissolved oxygen, sediment, temperature, and toxics.[244]

Periodically, fecal pollution closes down the local shellfish industry and limits the use of the estuary for recreation. In 1998, *E. coli* data analyzed by the DEQ showed that all five of the main river systems in the Tillamook watershed were "water quality limited." A 2006 EPA/OSU study, using bacterial DNA markers, identified fecal bacteria from both livestock and human sources in the Tillamook basin.[245]

The Wilson River watershed is the largest of five main river systems feeding Tillamook Bay. The dominant land use in the watershed is state and federal forest. Dairy pastures and development pressures from the City of Tillamook affect the lower areas of the watershed.[246] In 1998, an 8.5-mile segment of the lower Wilson River was added to the state's list of impaired waters.

Beginning in 2002, the Tillamook Bay Watershed Council, the TEP and the Tillamook Soil and Water Conservation District began work with landowners to

initiate best management practices throughout the Wilson River watershed and beyond. These practices include riparian habitat enhancement through removal of invasives and planting native species to stabilize the streambanks. Livestock is excluded from the riverbanks by fencing and provided off-channel watering stations. Better manure management prevents water contamination. Improvements to wastewater treatment systems have reduced bacterial levels released to the river. The Wilson River has met water quality standards since 2005.[247]

Since 2001, TEP and partners have enhanced nearly 200 riparian miles in the Tillamook Bay Watershed. Volunteers have collected water samples for analysis since 1997, allowing a view of water quality over time. They have been the foot soldiers of riparian restoration. Management plans, developed with the involvement of affected stakeholders, foster community buy-in and have been instrumental in mitigating forest road run-off, in reducing "nutrient" run-off from dairy farms, in supplying "large woody debris" for fish habitat, and in developing the Tillamook Bay Wetlands Management Plan.[248]

This is just one example. Coastal watershed councils up and down the coast are involved in similar efforts with significant success.

Oregon Beach Monitoring Program

The Oregon Beach Monitoring Program monitors the waters along Oregon's coastline for the presence of fecal bacteria. Funded by a grant from the EPA, the program is administered by the Department of Human Services, and implemented in close conjunction with the DEQ and Oregon Parks and Recreation Department.[249]

Enterococcus bacteria is an indicator of the presence of human and animal waste and can enter marine waters from a variety of sources, such as storm water runoff, animal waste, failing septic systems, sewage spills, or boating waste. During the summer, surface water from 59 beaches, from Ft. Stevens to Harris Beach, is sampled and tested from once a week to monthly, based on the priority ranking of the beach. The priority is determined by beach use, pollution hazards, previous monitoring results, and input from coastal stakeholders. At time of sampling, 23 of the beaches are also surveyed for surfers, dogs, birds, and other beach users.[250]

The Oregon Health Authority (Public Health Division) receives the water quality data results from DEQ and determines whether a public health advisory is needed. If so, local officials are notified. The public is informed through signs posted at access points to the affected beach, press releases, the Oregon Public Health website (*www.healthoregon.org/beach*), a 24-hour phone hotline, and an email list serve to coastal stakeholders. Beach retesting occurs within 96 hours when the initial sample shows elevated *Enterococcus* levels.[251, 252, 253]

Trash

In March 2010, during their twice-yearly beach cleanups, Stop Oregon Litter and Vandalism (SOLV) volunteers "found a wide selection of household fixtures and items, including aluminum siding, a freezer, a mattress, a cooler, and a full kitchen sink." They collected 70,500 pounds of garbage. For the first time, the Yachats Fire Chief reported that they did not find a single six-pack yoke on the beach. Along with SOLV, the cleanup is coordinated by the Oregon Parks and Recreation Department and coastal garbage and recycling companies. An Oregon tradition started in 1969 by Governor McCall, the beach clean up is supported by a broad coalition of public agencies and private businesses.[254]

About 75% of the garbage collected comes from land-based activities. Plastics, including bags and Styrofoam, continue to dominate. Many sandy beaches now consist of a blend of sand, pebbles, shells and fragments of plastic measuring less than a quarter of an inch, too small to collect.

Scientists are now researching the impact on marine ecosystems of microplastics, defined as those fragments measuring 5mm and less. Consisting of fragments ground down from larger plastic products, microbeads used in cosmetic exfoliating products, and "nurdles" (ubiquitous plastic resin pellets, used as raw

material in the production of plastic goods), this debris is recognized as an increasing concern by the scientific community. Conferences held in Tacoma, Washington in 2008 and 2010, were convened to explore existing research and stimulate further study of ecological issues arising from these tiny particles. The concerns focus on two broad areas: the capacity of plastic particles to absorb pollutant chemicals in the ocean, and the potential harmful effects on marine life of ingested particles.[255, 256]

Reporting on the conference in *Terrain,* a publication of the University of Washington, Filiz Satir observed, "Various studies have suggested that plastic specks in water and sediment appear to absorb highly toxic and pervasive pollutants, such as PCBs (polychlorinated biphenyls) and pesticides such as DDT ... if the oceans' smallest organisms are dining on plastics dosed up with toxins, then highly concentrated chemicals could possibly accumulate up the food chain."[257]

Significant quantities of debris from the March 2011, Japanese tsunami are being tracked as they move across the Pacific Ocean. Computer models predicted significant debris could wash ashore on the West Coast in 2013.[258]

Ocean Noise Pollution

Pacific White-sided dolphins

Some marine animals rely on sound for communication, individual recognition, predator avoidance, prey capture, orientation, navigation, mate selection, and mother-offspring bonding. Loud background noise may mask natural sounds important to the survival and reproduction of many species. Other potential effects of extremely loud noise include injuries to neural tissue, loss of hearing and changes in behavior (e.g., fleeing normal habitat, exclusion from foraging areas, separation of mother-calf pairs, panic-stricken flight that can cause "the bends") and other lethal effects.[259, 260, 261 262]

Underwater noise produced by human activities has been implicated in harm to fish and in several mass stranding of marine mammals. Major human sources of sound include seismic surveys for oil and gas exploration and for scientific research; commercial shipping; and sonar systems for military purposes, fishing, and research. As the coastal population grows and other ocean-related human activities expand (including ocean energy devices), noise pollution will likely increase.[263, 264, 265]

Climate Change

"Climate is what we expect, weather is what we get." (Attributed to Mark Twain)

Two geographic factors strongly influence Oregon's coastal climate: the Pacific Ocean and the Coastal Range. In combination they moderate temperatures and encourage a moist environment. Oregon's basic coastal climate with mild wet winters and cool, drier summers varies due to "El Nino" and "La Nina" weather patterns. In an El Nino phase, the winters are generally warmer and drier, with the reverse for La Nina phases.[266]

Records of average air temperatures for the Pacific Northwest reviewed since 1920 indicate an increase of 1.5 degrees F. With this change has come a corresponding 25% decline in the Cascades' snowpack accompanied by a 2.5 degree F increase in the temperature during the cool season.[267] The most recent climate models from the U.S. Fish and Wildlife Service predict that there will be an additional 2 degree F increase by 2020, 3.2 degree F increase by 2040

and 5.3 degree F by 2080.[268] Regional climate models also predict increased rain in the western Cascades, the potential for more severe storms and reductions in the snowpack which, in turn, will impact the temperature and water quality of summer stream flows and raise winter stream flows.[269]

Although climate change is accepted, the predicted impacts vary. Recent studies published by a group of scientists, including a group from Oregon State University, using modeling combined with "extensive sea and land surface temperature reconstructions from the Last Glacial Maximum," predicts a smaller global effect from greenhouse gases. Their modeling indicates that global temperature rise will not be as great and will occur more slowly.[270] Oregon Sea Grant has an on-going program that studies the impacts of climate change.[271] OSU has developed a program, along the lines of the Master Gardener program, to help communities cope with climate change in their own environments.[272]

Wave Impact

In general, the Pacific Ocean creates bigger waves than the Atlantic because of the prevailing westerly winds, the narrow and steep continental shelf of the western U.S. and the ocean fetch.[273] Data from OSU indicate that the height of the largest waves recorded has increased by 3.75 inches each year since the mid-1970s. Increased wave height and wave run up, with a corresponding increase in sea level, create more coastal hazards that can be compounded by storm surges and can cause increased erosion and floods along the shoreline.[274] The landward intrusion of storm waters could contribute significantly to pollution accidents. In recent times, because of its buoyancy, a buried tank at an abandoned fuel station in Coos Bay erupted through the ground during a storm surge that flooded a previously dry site.[275]

Sea Level Rise

Sea level rise occurs as the result of changes in temperature and melting of glaciers and ice sheets. Recent estimates that include a heightened understanding of ice dynamics and their effects on glaciers give a range of predicted global sea level rise from 2.6 to 6.6 feet by 2100. According to Oregon Parks and Recreation Department's "Climate Change Response" report, global average sea level rose 6.7 inches during the 20th century. As a result, Cape Lookout State Park is already coping with erosion issues. With increases in temperature and the melting of glaciers and ice sheets around the world, sea levels will continue to rise.[276] A more extreme estimate has been made by Dr. James Hansen, NASA climatologist, who suggests that strong polar feedback in response to moderate additional warming will amplify the disintegration of ice sheets, resulting in a sea level rise much more dramatic than is currently anticipated. In that case, all of the changes discussed here would likely be more profound and occur sooner than is generally predicted.[277]

The predicted rise in sea level and weather-related changes in stream flows will adversely impact structures along coastal shorelines, bluffs, beachfronts and rivers, and may create additional landslides. Low-lying areas may experience more flooding.[278] Hwy 101 is already notorious for this. Due to a combination of heavy rainfall on saturated ground and high tides during winter storms, Tillamook has flooded eight times in the past 16 years.[279]

Other potential effects of climate change on shorelines include erosion and flooding of historical Native American middens; loss of parklands, forests, trails and campgrounds; reductions in sand along large stretches of the shore; erosion of natural features; and reduced recreational opportunities.

The Oregon Parks and Recreation Department predicts an increase in requests for hardened structures to preserve eligible properties, roads and sewer systems, especially, along the north and central coasts. Hardened structures include rip-rap, sea walls, breakwaters, reinforced dikes and headlands. These structures may work in the short term. However, they do have negative long-term effects that include reducing sand supply to neighboring shores; destabilizing of banks; loss of intertidal habitats; and the necessity for bulkheading of adjacent properties to maintain consistent shorelines.[280]

Salinity

As rain patterns change and sea water infiltrates deeper into wetlands, coastal ecosystems, such as the South Slough National Estuarine Research Reserve on the south coast near Coos Bay, will become more saline, altering these systems. Because plant distribution in estuaries is very dependent on the salinity of the water in the root zone, the vegetative community will change. Additionally, sewage treatment plants, freshwater intakes, industry and watercraft using reaches previously above the influence of saline waters would be subject to marine fouling organisms and the higher maintenance costs associated with more corrosive brackish waters.[281]

Movement of Habitats

In the face of the advancing salinity, a landward retreat of freshwater species and an up-estuary advance of marine and estuarine species will be likely. Estuaries that have been set aside as natural areas could be flooded and no longer functional as shallow water wetlands or mudflats. New estuaries may form further inland. Because of the rapid rise of Oregon coastline some habitats may totally disappear. The laws and regulations governing reserves will require adjustment to protect vulnerable species which may have migrated landward or been extirpated from their previous habitat. A variety of species including the salmon and smelt will be affected.

Forestry

As carbon dioxide levels increase, the capacity of forestland to store carbon becomes more important for mitigation. The Oregon Department of Forestry has documented that the capacity to store carbon in Pacific Northwest forests is among the highest in the world. It is even greater, per acre, than tropical rainforests. Carbon still increases in Oregon forests that are over 600 years old. [282]

Bureau of Land Management districts in Oregon now do a carbon calculation on their activities. Every timber sale environmental assessment determines how much carbon is released into the atmosphere through tree removal, soil disturbance, and fossil fuels used in growing and logging. The assessment also accounts for carbon storage through increased growth of retained and planted trees. This calculation provides an estimate of carbon loss or gain, and assigns a relative value for public land projects. In this way, the carbon impacts of forestry are opened to public discussion, scientific review and opportunities to look at ways to reduce carbon loss or increase sequestration. The Oregon Global Warming Commission also recommends carbon accounting for forest lands. "All timber management planning and public forest transactions (e.g., timber sales, offset sales) should include the net impact on Oregon's carbon account."[283]

Public Involvement

Oregon's ocean is managed in the public trust, so all citizens share responsibility for stewarding this resource. State Planning Goal 1 directs DLCD to create policy informed by public comment. The future for Oregon's coastline involves addressing the issues discussed in this paper and requires significant public input and support. Methods of reaching the public remain challenging. Shawn Rowe with the Hatfield Marine Science Center noted that groups often assign different meanings to the same word. He explained a word visualization process used in Port Orford at public meetings to assist members of the community to understand the impact of climate change by bringing all groups together to agree on the meaning and related effects of the terminology. Those participating in the meetings left with a better understanding and support for future action.

However, getting people involved is often difficult. Port Orford held public meetings to explain the need to update and improve their water system. Despite positive feedback from the meetings, the bond measures were defeated in June 2011. One resident observed in a letter to the editor:

> ... sometimes, as a community, we lack vision. I can understand voting against measures because the voter feels they are too expensive and that he/she – and other people – would not be able to pay the costs. What I can't understand is not attending the public meetings where everything was explained as well as the reasons for the proposals, then voting the measures down for lack of information and understanding.[284]

Oregon Sea Grant describes a public decision making process, "Structured Decision Making," that includes five critical steps: 1) identifying the problem, 2) clarifying decision-relevant objectives that explicitly include diverse values at stake, 3) identifying potential alternatives or solutions, 4) measuring the consequences, and 5) making the necessary tradeoffs.[285]

The marine reserves development plans and the Territorial Sea Plan include significant opportunities for public comment and participation. Oregon's Planning Goal 1 recognizes the value of diverse opinions and the wealth of information about natural resources that non-experts hold. It also acknowledges that "a nonconsulted public is often an angry one."[286] For a more complete description of how the public is involved in coastal resource planning, please see the Oregon Coastal Zone Management Association's FAQs at http://www.oczma.org/pdfs/FAQ%20Ocean%20Planning%202011%206-1-11_1.pdf

Conclusion

The natural resources of Coastal Zone in Oregon face many challenges. Future planning must incorporate both ecological and economic factors. In October 2011, the Shoreside Economic Analysis for the Oregon Territorial Sea Plan Final Report to the Oregon Department of Fish and Wildlife was published. This document provides an extensive look at these issues. In the face of the multiple issues discussed in this document, decisions must be made on how to protect essential habitats while maintaining a viable community for Oregon's residents. Since the coastal zone is impacted by many factors beyond Oregon territorial limits, future planning must take into consideration federal and international activity, as well as state and local needs. The necessity for public understanding of these issues and involvement in decisions about natural resources in coastal Oregon has never been greater. It is hoped that the overview in this report will help inform Oregonians' participation in the planning process.

REFERENCES

1. Murphy, Kim, "Oregon Legislature Extends Ban On Offshore Oil Drilling," Los Angeles Times, 2-18-10, accessed at http://latimesblogs.latimes.com/greenspace/2010/02/oregon-offshore-oil-drilling.html, on 1-20-12
2. Oregon's Coastal Management Program, Oregon's Coastal Zone, accessed at http://www.oregon.gov/LCD/OCMP/CstZone_Intro.shtml on 1-20-12
3. *Ibid.*
4. http://www.city-data.com/states/Oregon-Location-size-and-extent.html, accessed on 1-20-12
5. "Appraisal of Chronic Hazard Alleviation Techniques [Chapter 2]" accessed at http://www.oregon.gov/LCD/docs/publications/achatx.pdf?ga=t, on 1-20-12

6. Gilsen, Leland, "Modeling Upland/Lowland Adaptations & Oregon Coastal Prehistory (1996)" accessed at http://www.oregon-archaeology.com/theory/pocket_beach/?view=print, on 1-20-12
7. Oceana, Identifying and Protecting Important Ecological Areas Across the Coast of Oregon, August 2010, pp 3- 5.
8. Oregon Territorial Sea Plan: Part One, Ocean Management Framework, D. Laws and Other Legal Authorities Affecting Ocean Management, 5. International Law accessed at http://www.oregon.gov/LCD/OCMP/Ocean_TSP, on 1-20-12
9. Coastal Zone Management Act, 1972, p. 21 accessed at http://coastalmanagement.noaa.gov/about/media/CZMA_10_11_06.pdf, on 1-20-12
10. Oregon Territorial Sea Plan: Part One, Ocean Management Framework, D. Laws and Other Legal Authorities Affecting Ocean Management, 4.b., accessed at http://www.oregon.gov/LCD/OCMP/Ocean_TSP, on 1-20-12
11. "Executive Order: Stewardship of the Ocean, our Costs and the Great Lakes," July 19,2010, accessed at http://www.whitehouse.gov/files/documents/2010stewardship-eo.pdf, on 1-20-12
12. West Cost Governors Agreement on Ocean Health, "Executive Overview of the Action Coordination Teams Final Work Plans," May, 2010, accessed at http://westcoastoceans.gov/docs/WCGA_Executive_Overview_Final.pdf, on 1-20-12
13. Statewide Planning Goals accessed at http://www.oregon.gov/LCD/goals.shtml, on 1-20-12
14. Oregon Territorial Sea Plan, appendix g, accessed at http://www.oregon.gov/LCD/OCMP/docs/Ocean/otsp_app-g.pdf, on 1-20-12
15. Oregon Territorial Sea Plan, accessed at http://www.oregon.gov/LCD/OCMP/Ocean_TSP.shtml, on 1-20-12
16. Interview with Onno Husing, Director of the Oregon Coastal Zone Management Association, OCZMA. August, 2011
17. Husing, Onno, Frequently Asked Questions (FAQ): Ocean Planning In Oregon, p. 10.accessed at http://www.oczma.org/pdfs/FAQ%20Ocean%20Planning%202011%206-1-11_1.pdf, on 9/ 23/11
18. Husing interview, August 2011
19. Husing interview, August 2011
20. Husing, Frequently Asked Questions *op. cit.*
21. Oregon Nonpoint Source Pollution Program, 2009 Annual Report, accessed at http://www.deq.state.or.us/wq/nonpoint/reports.htm, on 1-20-12
22. Oregon Territorial Sea Plan, Part 2, accessed at http://www.oregon.gov/LCD/OCMP/Ocean_TSP.shtml, on 1-20-12
23. The Oregon Estuary Plan Book, Introduction, "Estuaries in Oregon," accessed at http://www.inforain.org/oregonestuary/index.html, on 1-20-12
24. *Ibid.*
25. Oregon Department of Fish and Wildlife, 2006, Conservation Strategy, "Habitat Conservation Summaries for Strategy Habitats: Estuaries, accessed at http://www.dfw.state.or.us/conservationstrategy/document_pdf/b-habitat_4.pdf, on 1-20-12
26. Cudmore, Wynn, *Wetlands: An Introduction*, "Background; What is an estuary?" 2011, NOAA, National Estuarine Research Reserve System, accessed at http://www.nerrs.noaa.gov/BGDefault.aspx?ID=403, on 1-20-12
27. Oregon Department of Fish and Wildlife, 2006, *Op cit.*
28. Cudmore, 2011, *Op. cit.*
29. Danielsen, Finn, et al., 2005, "The Asian Tsunami: A Protective Role for Coastal Vegetation", *Science,* Vol. 310, no. 5748, p. 643. 28 October 2005. Abstract accessed at http://www.sciencemag.org/content/310/5748/643, on 1-20-12
30. Carter, Virginia, 1997, "Technical Aspects of Wetlands: Wetland Hydrology, Water Quality, and Associated Functions", U.S. Geological Survey, National Water Summary on Wetland Resources, USGS Water Supply Paper 2425. Accessed at http://water.usgs.gov/nwsum/WSP2425/hydrology.html, on 1-20-12
31. Loder, Nicholas M, M. A. Cialone, J. L. Irish and T. V. Wamsley, "Idealized Marsh Simulations: Sensitivity of Hurricane Surge Elevation and Wave Height to Marsh Continuity," 2009, U.S. Army Corps of Engineers. ERDC/CHL CHETN-I-80, accessed at http://www.mvd.usace.army.mil/lcast/pdfs/chetn-i-80.pdf on 1-20-12.
32. Carter, 1997, *Op Cit*
33. Oregon Department of Fish and Wildlife, 2006, *Op.Cit..*
34. Oregon Department of Fish and Wildlife, 2006, *Op. Cit.*
35. Oregon Department of Fish and Wildlife, 2006, *Op Cit.*
36. Oregon's Coastal Management Program, Estuaries, accessed at http://www.oregon.gov/LCD/OCMP/Est_Intro.shtml, on 2-22-12
37. Lower Columbia River Partnership, 2011, Year in Review, accessed at http://www.lcrep.org/, on 2/24/12
38. Siuslaw National Forest, Resource Management, Salmon River Estuary, accessed at http://www.fs.usda.gov/detail/siuslaw/, on 2/24/12
39. Oregon Coastal Atlas, Coos Bay Estuary, accessed at http://www.coastalatlas.net/index.php?option=com_custompages&e-14&Itemid=68, on 2-24-12
40. Dodds, Walter K., *et. al.* 2008. " Comparing Ecosystem Goods and Services Provided by Restored and Native Lands." *BioScience* 58(9):837-845, abstract accessed at http://www.bioone.org/doi/abs/10.1641/B580909, on 1-20-12
41. Ruiz-Jaen, Maria C. and T. M. Aide, 2005, "Restoration Success: How is it being measured?" *Restoration Ecology*, Vol. 13(3):560-577, accessed at http://arbimon.uprrp.edu/weblab/Publications_files/Ruiz-Jaen%20and%20Aide%202005.pdf, on 1-12-20
42. NOAA Coastal Services Center, "Coastal Ecosystem Restoration, Monitoring and Adaptive Management. Innovative and Successful Monitoring; Adaptive Management Approaches", accessed at http://www.csc.noaa.gov/coastal/management/monitor.htm, on 5-16-11
43. Mitsch, William J. and R. F. Wilson, "Improving the Success of Wetland Creation and Restoration with Know-How, Time and Self-Design", 1996, *Ecological Applications* 6(1):77-83, Abstract accessed at http://www.jstor.org/pss/2269554, on 1-20-12
44. Oregon Department of Fish and Wildlife, 2006, *Op. Cit.* p. 263
45. Morgan, Cheryl A, A. DeRobertis and R. W. Zabel, 2005, "Columbia River Plume Fronts. I. Hydrography, Zooplankton Distribution, And Community Composition," *Marine Ecology Progress Series*, Vol. 299: 19-31, accessed at http://www.ottokinne.de/articles/meps2005/299/m299p019.pdf, on 1-20-12
46. "Dead in the Water", *Nature,* volume 466/12, August, 2010
47. *Ibid.*
48. Committee on Natural Resources, "Scientific Assessment of Hypoxia in U.S," Coastal Water Interagency Working Group on Harmful Algal Blooms, Hypoxia and Human Health, September 2010, pp108-109
49. "Dead in the Water", *Op. Cit*
50. "A Citizens Guide to the Oregon Coastal Management Program," Oregon Department of Land Conservation and Development, revised 6/01, accessed at http://www.oregon.gov/LCD/docs/publications/citzngid.pdf, on 1-20-12
51. *Ibid.*
52. *Ibid.*
53. Coastal Erosion Chapter: State Plan, p CE11, pdf accessed from http://csc.uoregon.edu/opdr/resources/coastalerosion, on 1-20-12
54. County of Tillamook Flood Information, accessed at http://www.co.tillamook.or.us/gov/ComDev/planning/flood.htm, on 1-20-12.
55. Heavy Weather Journal, Tillamook floodplain, accessed at http://mediaprojectonline.org/heavyweather/tillamook.html, on 1-20-12
56. McCarthy, Nancy, "If a tsunami was on its way I would die …", *Daily Astorian,* January 7, 2011, accessed at http://www.dailyastorian.com/news/local/article_4300b340-1a90-11e0-99b9-001cc4c03286.html, on 1-20-12
57. *Ibid.*

58. Tang, Zhenghong, M K. Lindell, C. S. Prater; and S. D. Brody, "Measuring Tsunami Planning Capacity on U.S. Pacific Coast" *Natural Hazards Review* , ASCE / May, 2008 / pp 91-100 accessed at http://archone.tamu.edu/epsru/pdf/Tsunami%20paper.pdf, on 1-20-12
59. Tsunami Chapter: State Plan, State of Oregon, Natural Hazard Mitigation Plan, Emergency Management Plan accessed at http://csc.uoregon.edu/opdr/resources/tsunamis, on 1-20-12
60. Hannah-Jones, Nikole, Oregon's 2010 Census shows striking Latino and Asian gains" *The Oregonian,* Wednesday, February 23, 2011, Updated: Thursday, February 24, 2011, accessed at http://impact.oregonlive.com/pacific-northwest-news/print.html?entry=/2011/02/2010_census.html, on 1-20-12
61. Oregon Wave Access Resource Education, Economies of the Oregon Coast | Geo 599 - Wave Energy p. 2, accessed at http://ppgis.science.oregonstate.edu/?q=economies on 7/8/10.
62. American Community Survey, accessed at http://www.census.gov/acs/www/data _documentation/2009_acs_maps/, on 1-2-12
63. Swedeen, P., D. Batker, H. Radtke, R. Boumans, C. Willer, "An Ecological Economics Approach to Understanding Oregon's Coastal Economy and Environment," 2008, Audubon Society of Portland, Portland, OR
64. *Ibid.*
65. HR3223, Keep Our Waterfront Working Act of 2007, accessed at http://www.opencongress.org/bill/110-h3223/text, on 1-20-12
66. Brinckerhoff, Parsons, "PORTS 2010, A New Strategic Business Plan for Oregon's Statewide Port System," April 2010, accessed at http://www.orinfrastructure.org/assets/docs/IFA/2010PortPlan.pdf, on 1-20-12
67. *Ibid*
68. *Ibid.*
69. "Brookings Harbor reopens, estimates tsunami damage at $6.7 million," *Oregon Live,* accessed at http://impact.oregonlive.com/pacific-northwest-news/print.html?entry=.../brookings_harbor_reopens_estimates_tsunami_damage_at_67_million.html, on 1-20-12
70. Brinkerhoff, *Op. Cit.* p. 24
71. Press release, Senator Ron Wyden, accessed at http://wyden.senate.gov/newsroom/press/release/?id=401eb6cc-be9c-4c96-9631-a23baf2b442b, on 1-20-12
72. Brinkerhoff, *Op. Cit.,* p. 24
73. The White House Council on Environmental Quality, Final Recommendations Of The Interagency Ocean Policy Task Force, July 19, 2010, accessed at www.whitehouse.gov/administration/eop/ceq/initiatives/oceans, on 1-20-12.
74. DLCD Coastal Management Program, "A Citizen's Guide to the Territorial Sea Plan Amendment Process," 8-1-11, accessed at http://www.oregon.gov/LCD/TerrSeaPlanAdComm.shtml#Citizens_Guide_to_the_TSP, on 1-25-12
75. Ecotrust, "Marine Fisheries Uses and Values Project", in support of the Oregon Territorial Sea Plan Revision, accessed at www.ecotrust.org/tsp/TSP_values_project.pdf, on 1-24-11
76. Fields, Helen, "Changing Oceans: Viewing Coral Reefs Through a Cultural Lens", quoting Joshua Cinner, Senor Research Fellow, James Cook University *Science*, Science Careers, 2010-06-18 accessed at http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2010_06_18/caredit.a1000061, on 1-24-12
77. Condition Working Group, *Millennium Ecosystem Assessment, Current State and Trends Assessment*, Marine Fisheries Systems Chapter 18, p 491 ,accessed at http://www.maweb.org/en/Condition.aspx, on 1-24-12
78. FAO Fisheries and Aquaculture Department, 2008 *The State of World Fisheries and Aquaculture*, "Part 1 World Review of Fisheries and Aquaculture" p7-9, accessed at http://www.fao.org/docrep/011/i0250e/i0250e00.htm, on 1-24-12
79. Marine Species with Aquaculture Potential, Aquaculture Regulations in the Pacific Northwest, accessed at http://hmsc.oregonstate.edu/projects/msap/abouttheSite.html, on 1-24-12
80. ODFW Visitors Guide *The Vital Role of Fish Hatcheries*, accessed at http://www.dfw.state.or.us/resources/visitors/hatcheries.asp, on 1-24-12
81. Northwest Fisheries Science Center, "Risk to Wild Populations from Hatchery Fish", accessed at http://www.nwfsc.noaa.gov/resources/salmonhatchery/risks.cfm, on 1-24-12
82. World Health Organization, "Nutrition, Global And Regional Food Consumptions Patterns And Trends. Availability And Consumption Of Fish," accessed at http://www.who.int/nutrition/topics/3_foodconsumption/en/index5.html, on 1-24-12
83. FAO Fisheries and Aquaculture Department, *Op. Cit.*
84. FAO Fisheries and Aquaculture Department, *Op. Cit.*
85. *Pacific Management Research Council*, "Rebuilding Overfished Ground Fish", p. 13, accessed at http://www.fisherycouncils.org/USFMCsections/USRFMCpfmc.pdf, on 1-24-12
86. Oceana, Identifying and protecting important ecological areas off the Oregon Coast, *Op. Cit.* p.10.
87. Marine Stewardship Council, MSC Environmental Standard for Sustainable Fisheries, accessed at http://www.msc.org/about-us/standards/standards/msc-environmental-standard#what-does-it-assess, on 1-24-12
88. Jolly, David, "Scientists Criticize System of Certifying Fisheries" 9-3-10 *NYTimes* blog, accessed at http://green.blogs.nytimes.com/2010/09/03/scientists-criticize-system-of-certifying-fisheries, on 1-6-11
89. "Briefing Report Oregon Commercial Fishing Industry Preliminary Economic Contributions in 2009, Version 1.1; January 2010," accessed at www.dfw.state.or.us/fish/commercial/docs/OR_Comm_Fish_Ec_Impacts_Prelim_2009.pdf, on 1-24-12.
90. ODA, *Oregon Agripedia Book Statistic 2008-09*, p. 103, accessed at http://www.oregon.gov/ODA/pub_agripedia.shtml, on 1-24-12
91. Gewin, Virginia, "Sea Changers", *Portland Monthly Magazine,* on line version, accessed at http://www.portlandmonthlymag.com/trave-and-outdoors/articles/thenextwater/#, on 11-11-10
92. Oregon Coast Commercial Fishing Information, Livestrong.com accessed at http://www.livestrong.com/article/252425-oregon-coast-commercial-fishing-information/ on 1-24-12
93. Personal communication, dock 5 tour, Newport, Oregon, August 9, 2011
94. Description of the West Coast Ground fish fishery and Trawl Share Program, accessed at http://www.westcoasttrawlers.net/, on 1-24-12
95. Briefing Report Oregon Commercial Fishing Industry, *Op.Cit*
96. Partnership for Interdisciplinary Studies of Coastal Oceans, 2007. *The Science of Marine Reserves,* 2nd Edition, United States Version, p.2
97. *Ibid.,* p.3)
98. Oregon Shores Ocean Program, Marine Reserves, accessed at http://ekerala.net/r.php?url=http://www.oregonshores.org/narrative.php5?nid=282&title=marine%20reserves&type=web, on 1-23-12.
99. Ocean Policy Advisory Council, OPAC's Letter to Governor Kulongoski and Oregon Marine Reserve Policy, accessed at www.oregon.gov/LCD/OPAC/, on 1-23-12.
100. Roberts, Callum M. and J. P. Hawkins, *Fully-protected Marine Reserves: a Guide,* p. 22, World Wildlife Fund, accessed at assets.panda.org/downloads/marinereservescolor.pdf, on 10/24/10
101. *Ibid.,* p. 37-38.
102. Partnership for Interdisciplinary Studies of Coastal Oceans, *Op. Cit.,* PISCO, page 17.
103. *Ibid.*
104. *Ibid.,* p. 14-17

105. Cudmore, Wynn W., *The Role of Marine Reserves in Ecosystem-based Fishery Management*, 2009, p. 42 accessed at www.ncsr.org/Downloads/fisheriesmarinereserves.pdf, on 1-23-12.
106. Report and Recommendation to the Governor: Oregon and Marine Reserves, accessed at http://www.oregon.gov/LCD/OPAC/docs/resources/Marinereservesrecommendations.pdf?ga=t, on 2-29-12
107. Executive Order 08-07, Govenor Kulongoski, March 2008, accessed at http://governor.oregon.gov/Gov/docs/executive_orders/eo0807.pdf, on 1-23-12.
108. Oregon Department of Fish and Wildlife, Oregon Marine Reserves Background, July 2009, accessed at http://www.oregonocean.info/index.php?option=com_docman&Itemid=19, on 1-23-12.
109. House bill 3013 (ORS 196.540), Oregon Legislature, 2009, accessed at http://www.leg.state.or.us/09reg/measures/hb3000.dir/hb3013.en.html, on 1-23-12.
110. *Ibid.*
111. *Ibid.*
112. Letter from ODFW to Coastal Legislators, Jan. 25, 2011, Final_ODFW_recommendations_&_enclosure_1.25.11-1 accessed at http://www.oregonocean.info/index.php?option=com_content&view=article&id=334:final-odfw-marine-reserve-recommendations&catid=4:sites-for-marine-reserves&Itemid=8, on 1-23-12.
113. *Ibid.*
114. Section1_Cape_Falcon_Recommendation_Analysis_12.17.10.pdf; Section1_Cape_Perpetua_Recemmendation_Analysis_11.3.10.pdf; Section1_Cascade_Head_Recommendation_Analysis_11.3.10.pdf, accessed at http://www.oregonocean.info/index.php?option=com_content&view=article&id=334:final-odfw-marine-reserve-recommendations&catid=4:sites-for-marine-reserves&Itemid=8, on 1-23-12.
115. Port of Coos Bay, Marine Reserve Recommendation Committee, accessed at http://www.portofcoosbay.com/marineres.htm, on 1-25-12.
116. Section_2z-system-wide_12.17.10-2.pdf accessed at http://www.oregonocean.info/index.php?option=com_content&view=article&id=334:final-odfw-marine-reserve-recommendations&catid=4:sites-for-marine-reserves&Itemid=8, on 2-27-12
117. Additional_recommendations_12-13-10.pdf, accessed at http://www.oregonocean.info/index.php?option=com_content&view=article&id=334:final-odfw-marine-reserve-recommendations&catid=4:sites-for-marine-reserves&Itemid=8, on 1-24-12.
118. FAQ_Eval_7-7-2010-1.pdf, accessed at http://www.oregonocean.info/index.php?option=com_content&view=category&id=181&Itemid=114, on 1/24/12.
119. Learn, Scott, "Deep Understanding," *The Oregonian*, July 8, 2011, page E2
120. " Harvest Restrictions Begin for Redfish Rocks and Otter Rock," accessed at http://www.oregonocean.info/index.php?option=com_content&view=category&layout=blog&id=4&Itemid=8, on 1-25-12.
121. July 18, 2011 News Release, "Oregon Marine Reserves Moving Forward," accessed at http://www.oregonocean.info/index.php?option=com_content&view=article&id=374:news-release-oregons-marine-reserves-moving-forward-governors-office-july-18-2011&catid=7:marine-reserves-news-articles&Itemid=7, on 1-24-12.
122. Status of marine Reserve Process, accessed at http://www.oregonocean.info/index.php?option=com_content&view=category&layout=blog&id=9&Itemid=2, on 2-29-12
123. Fight Global Warming, The Problem, Keep Oregon Cool, accessed at http://www.keeporegoncool.org, accessed on 1-24-12
124. Oregon Department of Energy: Renewable Energy, Summary of Oregon's RPS, accessed at http://www.oregon.gov/ENERGY/RENEW/RPS_Summary.shtml, on 1-24-12
125. Northwest Power and Conservation Council, presentation from Oregon Wave Energy Trust, 12/1/2010, accessed at http://www.nwcouncil.org/news/2010/12/4.pdf, on 1-24-12
126. McArthur, Shaun and T. Brekken, "Ocean Wave Power Data Generation for Grid Integration Studies," accessed at http://nnmrec.orgonstate.edu/documents, on 1-24-12
127. Ocean Wave Energy Trust, accessed at http://www.oregonwave.org/, on 8-15-11
128. Bedard, Roger, "Power and Energy from the Ocean Energy Waves and Tides: A Primer, 2007, accessed at http://www.oceanrenewable.com/wp-content/uploads/2009/05/, on 1-24-12
129. Hagerman, George, R. Bedard, and M. Previsic, "E2I EPRI Survey and Characterization of Potential Offshore Wave Energy Sites in Oregon," WP-OR-003, 2004, accessed at http://oceanenergy.epri.com/attachments/wave/reports/003_Oregon_Site_Report.pdf, on 1-24-12
130. Von Jouanne, Annette, T. Brekken, B. Paasch, S. Yim, and A. Yokochi, 2009, "Wave Energy Opportunities and Developments," [Powerpoint Slides], Retrieved from OSU Wallace Energy Systems and Renewables Facility, accessed at http://eecs.oregonstate.edu/wesrf/, on 1-24-12
131. Stevenson, John, "Mapping the Political Landscape of Wave Energy Development Off the Oregon Coast," accessed at http://ir.library.oregonstate.edu/xmlui/handle/1957/13498, on 1-24-12
132. Ocean Thermal Energy Conversion, accessed at http://www.energysavers.gov/renewable_energy/ocean/index.cfm/mytopic=50010, on 1-24-12
133. Bedard, Roger, "North America in Stream Tidal Power Feasibility Study: Final Briefing," accessed at http://oceanenergy.epri.com/attachments/streamenergy/briefings/060426_Final_West_Coast_Tidal_Briefing.pdf, on 1-24-12
134. Offshore Wind Energy, accessed at http://ocsenergy.anl.gov/guide/wind/index.cfm, on 1-24-12
135. Northwest National Marine Renewable Energy Center, Technology, accessed at http://nnmrec.oregonstate.edu/technology, on 1-24-12
136. *Ibid.*
137. Northwest National Marine Renewable Energy Center, Devices, accessed at http://nnmrec.oregonstate.edu/devices, on 1-24-12
138. "Funding secured for US wave energy study," accessed at http://www.aquamarinepower.com/news/funding-secured-for-us-wave-energy-study, on 1-25-12
139. Marine and Hydrokinetic Technology Database, accessed at http://www1.eere.energy.gov/water/hydrokinetic/default.aspx on 1-25-12
140. Northwest Natural Marine Reserve Energy Center, accessed at http://nnmrec.oregonstate.edu/environmental-effects, on 1-25-12
141. *Ibid.*
142. *Ibid.*
143. Thompson, Terry, Interview on 1/25/11
144. Musial, W., *Status of Wave and Tidal Power Technologies for the United States*, The Technical Report, NREL/TP-500-43240, August 2008
145. Memorandum of Understanding Between the U. S. Department of Interior and Federal Energy Regulatory Commission, accessed at http://www.boemre.gov/offshore/AlternativeEnergy/PDFs/DOI_FERC_MOU.pdf, on 1-25-12
146. Wave Energy Development in Oregon, Licensing & Permitting Requirements, by Pacific Energy Ventures on behalf of Oregon Wave Energy Trust; Scholars Archive at Oregon State University
147. Federal Energy Regulatory Commission Licensing Hydrokinetic Pilot Projects, accessed at http://www.ferc.gov/industries/hydropower.asp, on 1-27-12
148. FERC, "Oregon Sign Memorandum of Understanding for Wave Energy Projects," news release, accessed at http://www.ferc.gov/media/news-releases/2008/2008-1/03-27-08.pdf on 1-25-12
149. Executive Order No.08-07, State of Oregon, accessed at http://governor.oregon.gov/Gov/docs/executive_orders/eo0807.pdf, on 1-25-12
150. Federal Consistency Overview, accessed at http://coastalmanagement.noaa.gov/consistency/welcome.html, on 1-25-12
151. Oregon Territorial Sea Plan: Part Five, accessed at http://www.oregon.gov/LCD/OCMP/docs/Ocean/otsp_5.pdf, on 1-25-12
152. Oregon Territorial Sea Plan Amendment for Renewable Energy Development, accessed at http://cmsp.noaa.gov/activities/oregon.html on 1-25-12
153. Department of Energy, FY 2011, Congressional Budget Request, accessed at http://www.mbe.doe.gov/budget/11budget/Content/FY2011Highlights.pdf, on 1-25-12
154. Campbell, H.V., 2—9, "A Rising Tide: Wave Energy in the United States and Scotland," *Sea Grant Law and Policy Journal,* Vol. 2, No. 2 (Winter 2009/2010), pp, 29-48

155. "DOE awards millions for marine and hydrokinetic energy technology," accessed at http://www.hydroworld.com/index/display/article-display/5201764849/articles/hrhrw/regulationandpolicy/general/2010/07/doe-awards__37_million.html, on 1-25-12
156. Oregon Wave Energy Trust, accessed at www.oregonwave.org, on 1-25-12
157. "Oregon Wave Energy Trust Offers Industry Matching Grant Program," accessed at http://www.oregonwave.org/oregon-wave-energy-trust-offers-industry-matching-grant-program/, on 4-4-12
158. NNMREC objectives, accessed at http://nnmrec.oregonstate.edu/about, on 1-25-12
159. Husing, *op.cit.,* FAQs on Ocean Planning in Oregon. p. 8
160. Coonrod, Larry, "Government Gearing up for Wave Energy," *Newport News Times*, modified 10-5-2011, accessed at http://www.newportnewstimes.com/v2_news_articles.php?heading=0&page=72&story_id=30192, on 1-27-2012
161. FERC, hydrokinetic projects, accessed at http://www.ferc.gov/industries/hydropower/gen-info/licensing/hydrokinetics.asp, on 1-27-12
162. Shigesada, Nanako, K. Kawasaki and Y. Takeda, 1995, "Modeling Stratified Diffusion in Biological Invasions," *The American Naturalist* 146(2) pp. 229-251
163. Arim, Matias, S. R. Abades, P. E. Neill, M. Lima and P. A. Marquet. 2006, "Spread Dynamics of Invasive Species," *Proceedings of the National Academy of Sciences of the United States of America,* Vol. 103(2), pp. 374-378, accessed at http://www.pnas.org/content/103/2/374.full.pdf+html, on 1-25-12
164. Wilcove, David S. and L. Y Chen,. 2000. "Management Costs for Endangered Species," *Conservation Biology* 12(6) pp. 145-1407
165. Pimental. David, R. Zuniga and D. Morrison, 2005, "Update on the Environmental and Economic Costs Associated With Alien-Invasive Species in the United States," *Ecological Economics,* 52 (3), pp. 273– 288
166. Arim, *Op. Cit.*
167. ODFW, 2005 "Oregon Invasive Species Action Plan," accessed at http://www.oregon.gov/OISC/docs/pdf/oisc_plan6_05.pdf?ga=t, on 1-25-12
168. Oregon Invasive Species Council, 2009, Assessment of Invasive Species in Oregon, accessed at http://www.oregon.gov/OISC/statewide_mngt_assessment2010.shtml#Executive_Summary, on 1-25-12
169. " New invasive parasite raise concern for West Coast Estuaries," *Science Daily*, August 19, 2005, accessed at http://www.sciencedaily.com/releases/2005/08/050819123638.htm, on 2-25.12
170. ODA, Plant Division, Noxious Weed Control. Saltmeadow cordgrass (*Spartina patens*), accessed at http://www.oregon.gov/ODA/PLANT/WEEDS/profile_saltmeadowcordgrass.shtml, on 1-25-12
171. San Francisco Invasive Spartina Project 2008, Background, accessed at http://www.spartina.org/maps_findings.htm#bkgd, on 1-25-12
172. ODA, Plant Division, Noxious Weed Control, Japanese Knotweed, accessed at http://www.oregon.gov/ODA/PLANT/WEEDS/profile_japknotweed.shtml, on 1-25-12
173. Independent Scientific Advisory Board, July 2008, "Non-native Species Impacts on Native Salmonids in the Columbia River Basin ISAB 2008-4, accessed at http://www.nwcouncil.org/library/isab/isab2008-4.pdf, on 1-25-12
174. Hooff, Rian, DEQ, Fact Sheet: Oregon Ballast Water Management, updated 10/03/11, accessed at http://www.deq.state.or.us/lq/cu/emergency/ballast.htm, on 1-25-12
175. Hooff, Rian, Oregon Task Force on the Shipping Transport of Aquatic Invasive Species, "Shipping Transport of Aquatic Invasive Species," for the 2011 Oregon Legislature, DEQ, 2010, accessed at www.deq.state.or.us/lq/cu/emergency/staistaskforce.htm, on 1-25-12
176. *Ibid.*
177. DEQ, Oregon Environment Newsletter, accessed at http://www.deq.state.or.us/pubs/newsletter/OregonEnvironmentSummer2011.htm, on 1-25-12
178. Hooff, Rian, Ballast Water Program Coordinator, email communication, 7/21/11
179. Oregon Forest Resource Institute, Trees of Oregon's Forest, accessed at http://www.oregonforests.org/FactsAndResources/OnlineTreeGuide.html, on 1-25-12
180. McKittrick, Erin, "Temperate Rainforests of the Northern Pacific Coast," 2007, accessed at http://www.groundtruthtrekking.org/Issues/Forestry/TemperateRainforests.html, on 1-25-12
181. Wier, Rosanne, "Temperate Rainforest Ecosystems", accessed at *quest.arc.nasa.gov/projects/jason/xv/docs/TempRain.pdf, on 8-23-11*
182. OPB, History of Logging, *The Oregon Story*, accessed at http://www.opb.org/programs/oregonstory/logging/timeline.html, on 1-25-12
183. Vorderstrasse, Ron, "The Timber Industry and its effects on the Pacific Northwest, Senior Seminar:HST 499, Professor Lowe, Western Oregon University 6/14/06 accessed at *www.wou.edu/las/socsci/history, on 1-25-12*
184. Oregon Forests Report 2007-2009, OFR2007, accessed at http://www.oregon.gov/ODF/PUBS/docs/Oregon_Forests_Reports/OFR_2007.pdf, on 1-25-12
185. Oregon Coastal Zone Management, *A Demographics and Economic Description of the Oregon Coast, Update 2006*, ED landscape report2003_1., p 2. accessed at http://www.oczma.org/detail.php?item=30, on 1-25-12
186. Learn, Scott, "Settlement Requires Stricter Regulation of Oregon Coast Logging," *Oregon Live,* 10-28-2010, accessed at http://www.oregonlive.com/environment/index.ssf/2010/09/settlement_requires_stricter_r.html, on 1-25-12
187. Final Settlement Agreement, accessed at http://media.oregonlive.com/environment_impact/other/CZARA%20Fully%20Executed%20Settlement%20Agreement.pdf, on 1-25-12
188. Bloemers, Ralph, "Court Issues Landmark Ruling on Clean Water Act & Logging Roads," Crag Law Center website, 8/17/2010, accessed at http://crag.org/2010/08/17/court-issue-landmark-ruling-on-clean-water-act-logging-roads/, on 1-25-12
189. Hurley, Lawrence, "Water Pollution: Appeals Court Logging Ruling has Political Backlash." E&E Publishing LLC, accessed at http://www.eenews.net/public/Greenwire/2011/07/27/3, on 1-25-12
190. Oregon Coastal Ports Create Jobs, Pacific Northwest Waterways Association, accessed at www.pnwa.net/new/Articles/Oregon_Coastal_Ports_Create_Jobs.pdf, on 1-15-12,
191. Sickinger, Ted, "LNG sets sights on exporting to Asia," *The Oregonian*, July 17, 2011.
192. DEQ Fact Sheet, Reissued 700-PM General Permit for Small-Scale, In-Water Mining, Updated 8/19/2010, accessed at www.deq.state.or.us/wq/wqpermit/mining.htm#GeneralNPDES, on 1-25-12
193. R. C. Newell, L. J. Seiderer, N. M. Simpson, J. E. Robinson, 2004, "Impacts of Marine Aggregate Dredging on Benthic Macrofauna off the South Coast of the United Kingdom," *Journal of Coastal Research*: Volume 20 (1) pp. 115 – 125
194. Hoffman, Black, S. 1998, "A Comparison Of Two Macroinvertebrate Bioassessment Protocols In Fort Collins, Colorado Urban Drainages," M. S. Thesis, Colorado State University Fort Collins, CO
195. Harvey, Bret. C. and T. E Lisle, "Effects of Suction Dredging on Streams: a Review and an Evaluation Strategy," *Fisheries* Volume 23 (8), August 1998, pp. 8-17
196. American Institute of Marine Underwriters, AIMU Technical Services Committee, Dredging and Marine Contractors, May, 2006, accessed at www.aimu.org/Dredging%20&%20Marine%20Contractors.pdf, on 1-25-12
197. Henderson, Jim E. "Costs of endangered species – Do we know what to plan for?", Planning Community of Practice Conference, ERDC-EL, May 20, 2008, accessed at www.usace.army.mil/CECW/PlanningCOP/Pages/2008_plnconf.aspx, on 7-21-11
198. OCRM and NOAA, "State Jurisdiction and Federal Waters, State Coastal Management Programs, Ocean Management and Coastal Marine Spatial Planning," April 18, 2011, Accessed at *seagrant.gso.uri.edu/**coast**/cmsp_material/**state**_fed-**waters**.pdf, on 1-25-12*
199. OCMP, *Oregon Coastal Management Program, Coastal Zone Management Act §309 Assessment and Strategy 2011–2015*, November 1, 2010, accessed at http://www.oregon.gov/LCD/OCMP/, on 1-25-12.
200. Harvey, *Op.Cit.*

201. Learn, Scott, "Gold mine permits tougher," *Oregonian*, Wednesday, August 4, 2010.
202. Hughes, Robert M. and C. A. Woody, "A Mining Law Whose Time Has Passed", *New York Times*, 1-11-12, accessed at http://www.nytimes.com/2012/01/12/opinion/a-mining-law-whose-time-has-passed.html?_r=1&emc=eta1, on 1-25-12
203. *Ibid.*
204. ODFW, "Oregon Guidelines For Timing of In-Water Work to Protect Fish and Wildlife Resources," June 2008, accessed at http://www.dfw.state.or.us/lands/inwater/, on 1-25-12
205. Harvey, *Op. Cit,*
206. DEQ, Water Quality, Small Suction Dredges and In-Water, Non Motorized Mining Activities, accessed at http://www.deq.state.or.us/wq/wqpermit/mining.htm#GeneralNPDES, on 1-25-12
207. DSL, Recreational Placer Mining, accessed at www.oregon.gov/DSL/PERMITS/ga_placerinfo.shtml, on 1-25-12
208. DEQ, Water Quality Permit Program, Metal Mining Activities, General Permit Fact Sheet 700, accessed at http://www.deq.state.or.us/wq/wqpermit/mining.htm#700pm, on 1-25-12
209. US Fish and Wildlife Service, National Marine Fisheries Service, US Army Corps of Engineers, US EPA "Sediment Removal from Active Stream Channels in Oregon," accessed at http://www.fws.gov/oregonfwo/ExternalAffairs/Topics/GravelMining.asp, on 1-25-12
210. Packer, D. B., K. Griffin, and K. E. McGlynn, National Marine Fisheries Service National Gravel Extraction Guidance, NOAA Technical Memorandum NMFS-F/SPO-70 September 2005, accessed at *spo.nwr.noaa.gov/tm/tm70.pdf, on 1-25-12*
211. "WHITE PAPER, Freshwater Gravel Mining and Dredging Issues", Washington Dept of Fish and Wildlife, Washington Dept of Ecology, Washington Dept of Transportation, April 2002, accessed at *wdfw.wa.gov/publications/00056/wdfw00056.pdf, on 1-25-12*
212. Evaluation Report and Findings on the Application for Certification Pursuant to Section 401 of the CWA, Submitted by USACE and ODSL for Regional General Permit for Chetco River Gravel Mining, File #2008-00071, 9/21/10. Accessed at http://www.nwp.usace.army.mil/regulatory/home.asp, >Archived local notices> Chetco River gravel mining> Chetco-related documents and comments> Chetco Public Notice NWP-2008-0071, with modified draft 11-8-10 of DEQ evaluation and findings, on 1/26/12
213. Army Corps of Engineers, Regulatory Public Notices, file number NWP-2008-0071 accessed at www.nwp.usace.army.mil/regulatory/docs/notices/NWP-2008-0071.pdf, on 1/26/12
214. Wallick, J. Rose, S.W. Anderson, C. Cannon, and J. E. O'Connor, "Channel Change and Bed-Material Transport in the Lower Chetco River," Oregon, Scientific Investigations Report 2010–5065, U.S. Department of the Interior U.S. Geological Survey, accessed at http://pubs.usgs.gov/sir/2010/5065/, on 1-25-12
215. USGS,Oregon Water Science Center, Chetco River Gravel Transport Study, accessed at http://or.water.usgs.gov/chetco/, on 1-25-12
216. Evaluation Report and Findings on the Application for Certification *Op. Cit*
217. NEDC, "Scoping Comments on Regional General Permit for Chetco River Gravel Mining" ACOE No. NWP-2008-00071**,** March 10, 2008, from Northwest Environmental Defense Center addressed to the USACE, accessed *at legacy.lclark.edu/org/nedc/objects/Chetco_River_Scoping_Comments.pdf* , on 7/31/11
218. Chetco River gravel mining, U.S. Army Corps of Engineers Portland District, accessed at http://www.nwp.usace.army.mil/regulatory/home.asp, on 1-25-12
219. U.S. Army Corps of Engineers, "Biological Assessment Proposed Regional General Permit For Gravel Mining on the Chetco River, Curry County, Oregon," Action ID No. NWP-2008-00071 p. 32, accessed at www.oregon.gov/LCD/OCMP/docs/Public_Notice/BA_Chetco_02June2010_FINAL.pdf?ga=t, on 1-25-12
220. Endangered Species Act Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Conservation Recommendations for the Regional General Permit for Gravel Mining in the Chetco River (6th field HUC#s 171003120109 and 171003120111), Curry County, Oregon, (Corps No.: NWP-2008-71), Sep 3, 2010, NMFS No.: 2010/03523
221. NEDC, "Working to Protect Oregon's Chetco River," accessed at http://law.lclark.edu/live/news/11019-working-to-protect-oregons-chetco-river, on 1-25-12
222. Endangered Species Act, Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act, Essential Fish Habitat Conservation Recommendations for the Regional General Permit for Gravel Mining in the Chetco River, Curry County, Oregon (Corps No.: NWP 2008-00071), National Marine Fisheries Service, NW Region, June 28, 2011, accessed at https://pcts.nmfs.noaa.gov., on 1-25-12
223. Regional General Permit for Commercial Gravel Mining in the Chetco River, Curry County, Oregon (RGP-7)Permit No: NWP-2008-00071, U.S. Army Corps of Engineers, Portland District, accessed at https://pcts.nmfs.noaa.gov/pls/pcts-pub/sxn7.results?district_idin=3&permitin=200800071, on 1-25-12
224. Hill, Liezel, "First US Chromite Mine to Start Up Next Month", *MiningWeekly*.com, accessed at http://www.miningweekly.com/article/first-us-chromite-mine-to-start-up-next-month-2011-03-30, on 1-26-12
225. "Oregon Resources begin chromite-zircon mine construction," accessed at http://metalsplace.com/news/chromium/, on 1-26-12
226. "Chromite Mine Receives Permit Despite Environmental Threats," Oregon Shores, Land Use Program, accessed at http://oregonshores.org/narrative.php5?nid=708, on 1-26-12
227. Zimmer, Carl, ANALYSIS: "An Ominous Warning on the Effects of Ocean Acidification," 2010, Yale Environment 360, accessed at http://e360.yale.edu/feature/an_ominous_warning_on_theeffects_of_ocean_acidification/2241/, on 1-26-12
228. Keehner, Denise, 2010 Memorandum on "Integrated Reporting and Listing Decisions Related to Ocean Acidification," Office of Wetlands, Oceans and Watersheds, USEPA, accessed at http://water.epa.gov/lawsregs/lawsguidance/cwa/tmdl/oa_memo_nov2010.cfm, on 1-26-12
229. Oregon Coastal Management Program, Water Quality, accessed at www.oregon.gov/LCD/OCMP/WatQual_Intro.shtml, on 1-26-12
230. Oregon Nonpoint Source Pollution Program, 2009 Annual Report, p.6, accessed at http://www.deq.state.or.us/wq/nonpoint/reports.htm, on 1-26-12
231. *Yon, Don, Personal communication,* Water Quality Division Nonpoint Source Program*, Oregon DEQ, 3/22/11.*
232. Oregon Nonpoint Source Pollution Program, 2010 Annual Report, accessed at http://www.deq.state.or.us/wq/nonpoint/reports.htm*, on 1-26-12.*
233. OR DEQ Onsite Advisory Committee, "Final Report of Recommended Changes to Rules Governing Onsite Systems," 2/8/10, accessed at www.deq.state.or.us/wq/onsite/onsite.htm, on 10-4-10
234. *Ibid.*
235. Water Quality Assessment Data Base, Oregon's 2004-2006 Integrated Report, accessed at http://www.deq.state.or.us/wq/assessment/rpt0406/search.asp#db, on 1-26-12.
236. Dunes City Ordinance 173, accessed at www.dunescity.com/ord_docs/ordinance_173.htm, on 1-26-12
237. Dunes City Ordinance 190, accessed at http://dunescity.com/ord_docs/ORDINANCE%20NO.%20190.htm, on 1-26-12,
238. La Follette, Cameron, Land Use Director, Oregon Coast Alliance, Testimony, Nov. 9, 2011, Re: Proposed Dunes City Ordinances 210a and 211a, Dunes City Septic Ordinance Repeal, accessed at http://www.oregoncoastalliance.org/index.html, on 1-26-12
239. Siuslaw News Online, 11-12-2011, Dunes City Dumps Septic Ordinance, accessed at http://www.thesiuslawnews.com/v2_news_articles.php?heading=0&page=72&story_id=4910, on 1-26-12
240. Devils Lake Water Improvement District, accessed at www.devilslakeor.us/pdfs/SepticDLWID2410.pdf, on 1-26-12
241. Miller, Rich, M. Sytsma, and M. Chandler, in "Center for Lakes and Reservoirs to study Siltcoos Lake water quality and macrophytes ", *Lake Wise, A Voice for Quiet Waters*," March 2008, accessed at *www.oregonlakes.org/publications/lakewise/08_january.pdf, on 1-26-12*
242. The Dunes City Story, *Devils Lake Navigator*, accessed at http://dlakeoregon.wordpress.com/2009/12/11/the-dunes-city-story/, on 1-26-12
243. Oregon Nonpoint Source Pollution Program, 2009, Annual Report, *Op.Cit.*
244. Bay Watershed Health Report, 2010, Tillamook Estuaries Partnership, accessed at www.tbnep.org., on 1-26-12.

245. Shanks, O. C., C. Nietch, M. T. Simonich, M. Younger, D. Reynolds, and K. G. Field. 2006, "Basin-wide analysis of the dynamics of fecal contamination and fecal source identification in Tillamook Bay", *Oregon. Appl. Environ. Microbiol.* (72) pp.5537-5546.
246. Oregon Nonpoint Source Pollution Program, 2009 Annual Report, *Op. Cit*
247. *Ibid.*
248. Tillamook Bay Watershed Health Report, *Op.Cit.*
249. Oregon Beach Monitoring Program, accessed at http://public.health.oregon.gov/PHD/OEPH/RES/BEACH/Pages/index.aspx, on 1-26-12
250. Caton, Larry, Personal communication, ODEQ Lab, 2-1-11
251. "Find the Latest Water Quality Result for Your Beach," accessed at www.coastalatlas.net/index.php?Itemid=40&option=com_custompages, on 1-26-12
252. Frequently Asked Question Beach Water Quality, accessed at http://public.health.oregon.gov/HealthyEnvironments/Recreation/BeachWaterQuality/Pages/faqs.aspx, on 1-26-12
253. Ketterman, Jennifer, ODHS-HABS Program Coordinator, personal communication, 5/15/11,
254. Bartlett, Diana March 22, 2010, "Harmful Trash (Including the Kitchen Sink) No Longer on Oregon Beaches Thanks to SOLV Volunteers!," accessed at www.solv.org/newsroom/default.asp, on 1-27-12
255. "Effects of Microplastics on Marine Environment Focus of International Workshop at UW Tacoma, September 4, 2008." accessed http://www.noaanews.noaa.gov/stories2008/20080904_marinedebris.html, on 1-27-12
256. Arthur, Courtney, J. Baker, and H. Bamford, editors, *Proceedings Of The International Research Workshop On The Fate Of Microplastic Marine Debris*, September 9-11, 2008, University of Washington, Tacoma, WA, USA, National Oceanic and Atmospheric Administration Technical Memorandum NOS-OR&R 30, January 2009
257. Satir, Filiz, "Microplastics=Macroproblem, *Tiny particles of this man-made substance could mean big trouble in our oceans," Winter ,2009, Terrain,* accessed at http://www.tacoma.uw.edu/features/research/microplastic-macroproblem, on 1/27/12
258. "Frequently Asked Questions: Marine Debris Generated from the 2011 Japan Tsunami," NOAA Marine Debris Program, accessed at http://marinedebris.noaa.gov/info/japanfaqs.html#1, on 1-27-12
259. Marine Mammal Commission, 2007. *Marine Mammals and Noise: A Sound Approach to Research and Management. A report to Congress.* March 2007. Accessed at http://www.mmc.gov/reports/workshop/pdf/fullsoundreport.pdf on 1-27-12
260. Allen, Leslie. 2011. The Big Idea: Ocean Noise, *National Geographic Magazine*, vol.218(1) pp. 28-31
261. Andre, Michel, et. al. 2011, "Low-frequency Sounds Induce Acoustic Trauma in Cephalopods," *Frontiers in Ecology and the Environment* doi:10.1890/100124, accessed at http://www.lab.upc.es/frontiers/Andre_etAl_Frontiers_Cephalopods-2011.pdf, on 1-27-12
262. Pickrell, John. 2004, "U.S. Navy Sonar May Harm Killer Whales, Expert Says," *National Geographic News*, Oct. 28, 2010, accessed at http://news.nationalgeographic.com/news/2004/03/0331_040331_whalesincrisis.html, on 1-27-12
263. Marine Mammal Commission, *Op. Cit*
264. Malakoff, D., 2001, "A Roaring Debate Over Noise" *Science* vol. 291, pp. 516-578, accessed at http://www.sciencemag.org/content/291/5504/576.summary?sid=713f16db-1083-452f-8da5-9de3a6aa7026, on 1-27-12
265. Slabbekoorn, Hans, et. al., 2010, "A Noisy Spring: the Impact of Globally Rising Underwater Sound Levels on Fish. Trends in Ecology and Evolution," vol. 25(7) pp.419-427, accessed at http://www.sciencedirect.com/science/article/pii/S0169534710000832, on 1-27-12
266. Western Regional Climate Center. Climate of Oregon, accessed at http://www.wrcc.dri.edu/narratives/OREGON.htm on 1-27-12
267. *Climate Change Response – Preparedness and Action Plan*, State of Oregon Parks and Recreation Department, October 2010, accessed at http://www.oregon.gov/OPRD/NATRES/index.shtml, on 1-27-12
268. Climate Change In the Pacific Northwest, U.S. Fish and Wildlife Service, accessed at http://www.fws.gov/pacific/Climatechange/changepnw.html, on 1-27-12
269. Dello, K.D. and P.W. Mote (eds.), 2010, *Oregon Climate Assessment Report,* Oregon Climate Change Research Institute, College of Oceanic and Atmospheric Sciences. Oregon State University, Corvallis, OR, accessed at www.occri.net/OCAR, on 1-27-12
270. Schmittner, Andreas, et al. 2011,"Climate Sensitivity Estimated from Temperature Reconstructions of the Last Glacial Maximum," *Science* Vol. 334 (6061) pp. 1385-1388
271. Climate Change, Oregon Sea Grant, accessed at http://seagrant.oregonstate.edu/themes/climate/index.html, on 1-9-12
272. Eric Morteson, "Climate Masters classes teach families to reduce their carbon footprint," *The Oregonian*, April 17, accessed at http://www.oregonlive.com/environment/index.ssf/2009/04/climate_masters_classes_teach.html, on 1-9-12
273. "Why are the Waves on the US West Coast Larger than the Waves on the East Coast?" How Stuff Works, accessed at http://science.howstuffworks.com/environmental/earth/oceanography/question623.htm. 1-27-12
274. Sea Web, Ocean Update," Cold Conditions Affect Marine Wildlife, But Globally, the Warming Continues," accessed at http://www.seaweb.org/news/ou15_3.php, on 1-27-12
275. Graybill, Mike, pers. comm.
276. Climate Change in the Pacific Northwest, U.S. Fish and Wildlife Service, *Op. Cit.*
277. Hansen, James E and M. Sato, 2011, "Paleoclimate Implications for Human-Made Climate Changes," accessed at http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf , on 1-27-12
278. New Digital Flood Insurance Rate Maps, accessed at http://www.tillamookor.gov/images/2010_Floodplain_Info.pdf, on 1-27-12
279. "Coastal Towns Deal with Flooding: Crews Evacuate Some, Shut Down Roads," accessed at http://www.kptv.com/story/14814970/coastal-towns-deal-with-flooding-1-16-2011, on 1-27-12
280. U.S. EPA, 2009 *Synthesis of Adaptation Options for Coastal Areas,* Washington, DC, U.S. Environmental Protection Agency, Climate Ready Estuaries Program, EPA 430-F-08-024, January 2009.
281. U.S. EPA and the Delaware River Basin Commission, 1999, *"Greenhouse Effect, Sea Level Rise, and Salinity in the Delaware Estuary,"* EPA 230-05-86-010, 1986, accessed at http://www.epa.gov/climatechange/effects/downloads/delaware.pdf, on 1-27-12
282. Oregon Department of Forestry, *Forest Management And Carbon Storage*: *State of the Science Report*, June, 2010.
283. Oregon Global Warming Commission, *Forestry Roadmap to 2020*. Page 9. Agenda Item 9 at November 2010 Board of Forestry Meeting. Attachment 1, Page 9, at November 2010 Board of Forestry Meeting
284. Letter to the Editor, *Port Orford Today*!, Vol. 22 (23) June 15, 2011, p.8 accessed at http://www.mydfz.com/dfz-pot.htm#2011, on 1-27-12
285. Wilson, R. S. and J.L. Arvi, "Structured Decision Making," Sea Grant Oregon, ORESU-H-11-001, 2011 accessed at http://seagrant.oregonstate.edu/sgpubs/structured-decision-making, on 4-4-12
286. Rowe, Gene, R. Marsh and L J. Frewer. 2004. "Evaluation of a Deliberative Conference." *Science Technology Human Values* 2004; 29; (88) DOI: 10.1177/0162243903259194 p. 89 accessed at http://sth.sagepub.com, on 1-27-12

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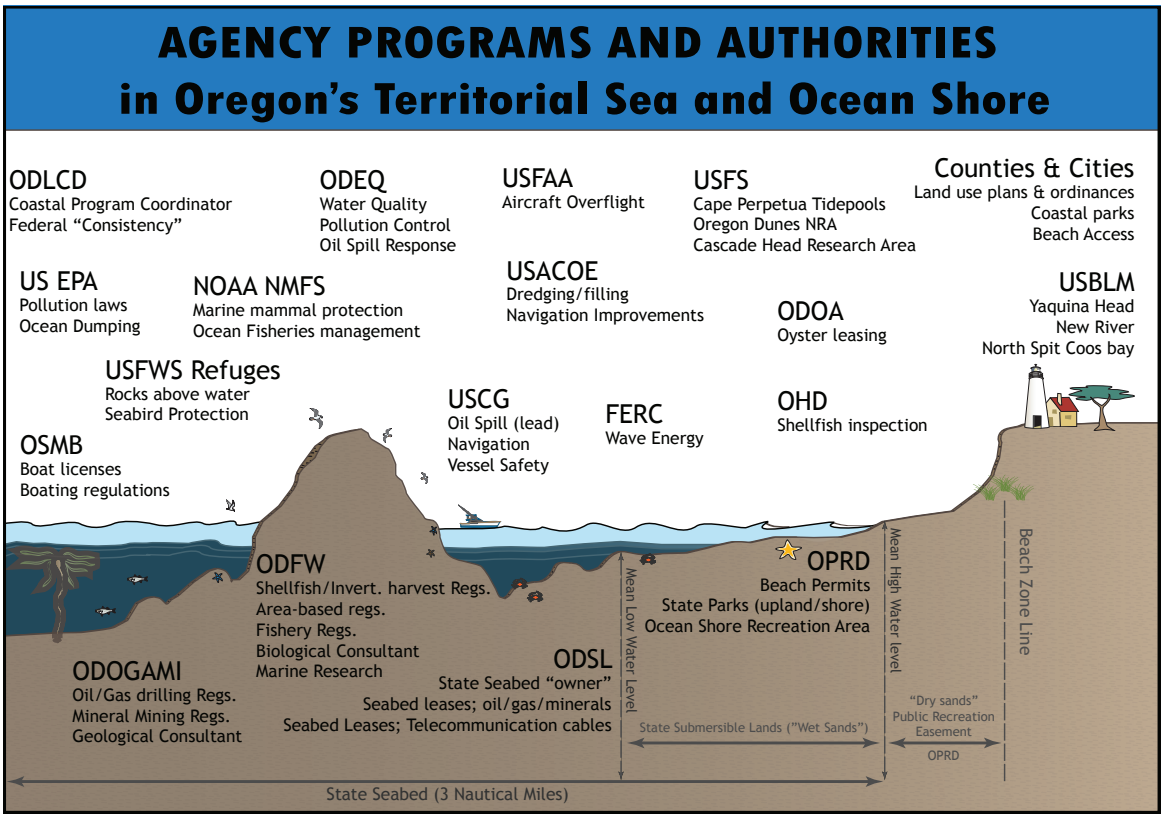

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ODEQ: Dept. of Environmental Quality
ODFW: Dept. of Fish and Wildlife
ODLCD: Dept. of Land Conservation and Development
ODOA: Dept. of Agriculture
ODOGAMI: Dept. of Geology and Mineral Industries
ODSL: Dept. of State Lands
OHD: Oregon Health Division
OPRD: Oregon Parks and Recreation Dept.
OSMB: Oregon State Marine Board

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