6 AFFECTED ENVIRONMENT

The Affected Environment section describes the setting in which Olympic Coast National Marine Sanctuary's (OCNMS) management plan will be implemented. This section focuses on those resources most likely to be affected by specific actions and regulatory changes being considered in the management plan alternatives. OCNMS' original Final Environmental Impact Statement/Management Plan (NOAA 1993) also contains an in-depth affected environment section, which is incorporated here by reference. The more recent OCNMS Condition Report (ONMS 2008) is also incorporated by reference.

6.1 PHYSICAL SETTING

The physical setting of the sanctuary is the structural and dynamic foundation for its biological processes. Through the physical setting and the linkages between its geography, geology and oceanography, regional and large-scale ecosystem processes connect with and directly impact local productivity and biodiversity patterns in the sanctuary.

OCNMS spans 2,408 square nautical miles (8,259 square kilometers) of marine waters and the submerged lands thereunder off Washington state's Olympic Peninsula coast (Figure 3). In the north, OCNMS lies at the western entrance to the Strait of Juan de Fuca, a large waterway between United States and Canada that connects the Pacific Ocean with the Salish Sea.

The sanctuary boundary, as defined in the OCNMS regulations (15 CFR 922, Subpart O), extends from Koitlah Point due north to the United States/Canada international boundary seaward to the 100 fathom isobath (approximately 180 meters depth). The seaward boundary of the sanctuary generally follows the 100 fathom isobath in a southerly direction to a point due west of the Copalis River, cutting across the heads of Nitinat, Juan de Fuca, and Quinault Canyons. The shoreward boundary of the sanctuary is the mean lower low water line when adjacent to American Indian lands and state lands. When adjacent to federally managed lands, the sanctuary includes intertidal areas to the mean higher high water line. The coastal boundary of the sanctuary cuts across the mouths of but does not extend up rivers and streams.

Extending seaward 25 to 40 nautical miles (46 to 74 kilometers), the sanctuary covers much of the continental shelf and the heads of three major submarine canyons, in places reaching depths of over 1,400 meters (750 fathoms or 4,500 feet). The sanctuary borders a largely undeveloped coastline, enhancing the protection provided by both the 104 kilometer-long (65 mile) coastal strip of Olympic National Park (ONP) that includes 87 kilometers (52 miles) of designated wilderness coast, as well as the approximately 600 offshore islands and emergent rocks within the Washington Maritime National Wildlife Refuge Complex.

OCNMS lies in the northern portion of the Oregonian biogeographic province extending from Point Conception, California, to Cape Flattery, Washington (Airame et al. 2003). The province is characterized by a narrow continental shelf, mountainous shoreline, steep rocky headlands, sandy pocket beaches with sea stack islands, many small and a few large rivers, and small

Figure 3 Olympic Coast National Marine Sanctuary

estuaries with barrier islands. The province is also noted as exhibiting the greatest volume of upwelling in North America. This nutrient-rich upwelling zone drives high primary productivity and supports a multitude of marine habitats. The sanctuary resides within the California Current System (CCS) and represents one of North America's most productive marine ecosystems.

6.1.1 Geography and Geology

The Olympic Coast is located at a tectonically active boundary known as the Cascadia Subduction Zone, where the edge of the North American continental plate meets and overrides the Juan de Fuca oceanic plate. The geologic activity in the area creates potential hazards such as earthquakes and associated submarine landslides, tsunamis and volcanic eruptions (McGregor and Offield 1986).

The continental shelf extends 7 to 35 nautical miles (13 to 64 kilometers) from the outer coast of Washington and provides a relatively shallow coastal environment between the near shore and the shelf break at about the 100-fathom (180-meter) contour. The majority of the sanctuary overlays the continental shelf. The shelf is composed primarily of soft sediment and glacial deposits of cobble, gravel and boulders, punctuated by rock outcrops. As described in section 6.2.4, the majority of the sanctuary seafloor has not yet been adequately mapped or characterized, so a full understanding of sediments and habitat distribution remains elusive (Intelmann 2006).

Sanctuary boundaries include portions of the Nitinat, Juan de Fuca, and Quinault submarine canyons that cut into the continental shelf along the western boundary of the sanctuary (Figure 3). The Quinault Canyon is the deepest, descending to 1,420 meters (777 fathoms or 4,660 feet) at its deepest point within the sanctuary. The Juan de Fuca Canyon Trough transects the northern portion of the sanctuary angling toward the Strait of Juan de Fuca. These canyons are dynamic areas where massive submarine landslides occur on the steep side walls and canyon bottoms collect sediment deposited from above. These canyons also serve as conduits for dense, cold, nutrient-rich seawater that is pulled toward shore into sunlight, an upwelling that feeds surface productivity at the base of the food web.

Broad beaches, dunes, and ridges dominate the coastline from Cape Disappointment, on the north side of the Columbia River, to the Hoh River, and rocky shores with smaller stretches of beach dominate to the north. Wave action has eroded the shoreline through time to form steep, tall cliffs at various places along the coast. Forested hills and sloping terraces are found near river mouths. In many places, a wave-cut platform, underwater with the tides, fronts the ocean where small islands, sea stacks, and rocks dot the platform's surface.

6.1.2 Oceanography

The area around the sanctuary is characterized by distinct patterns in oceanographic circulation, winter storms, water flows influenced by topography and land-sea interactions. Large-scale processes are the predominant controlling factors for seasonal upwelling-downwelling fluctuations that produce a highly dynamic oceanographic environment. Large-scale movements of oceanic water masses, such as the California Current, which flows southward beyond the continental shelf, connect the sanctuary with the broader seascape of the eastern North Pacific Ocean and influence climate and marine productivity for the region.

A general characterization of ocean climate and behavior for the sanctuary region was developed recently from satellite imagery (Pirhalla et al. 2009; Figure 4). Winter months (November-mid-February) are characterized by strong winds from the south (which forces downward transport of surface waters), heavy rainfall, and northward transport of the Columbia River discharge of fresh water and suspended materials. A spring transition period with variable conditions typically occurs in March. A spring/early summer bloom period occurs in April-June, when strengthened upwelling, increased surface water temperatures, and the Juan de Fuca outflow encourage increased plankton growth. During the summer/early fall period, offshore transport of surface waters, continued upwelling, increased light and temperature, with available nutrients out of the Juan de Fuca Strait combine to promote chlorophyll (phytoplankton) production along the entire Olympic Coast. A relaxation in upwelling, decrease in nutrients and chlorophyll, and shift toward northward flow of surface waters typify the fall transition period.

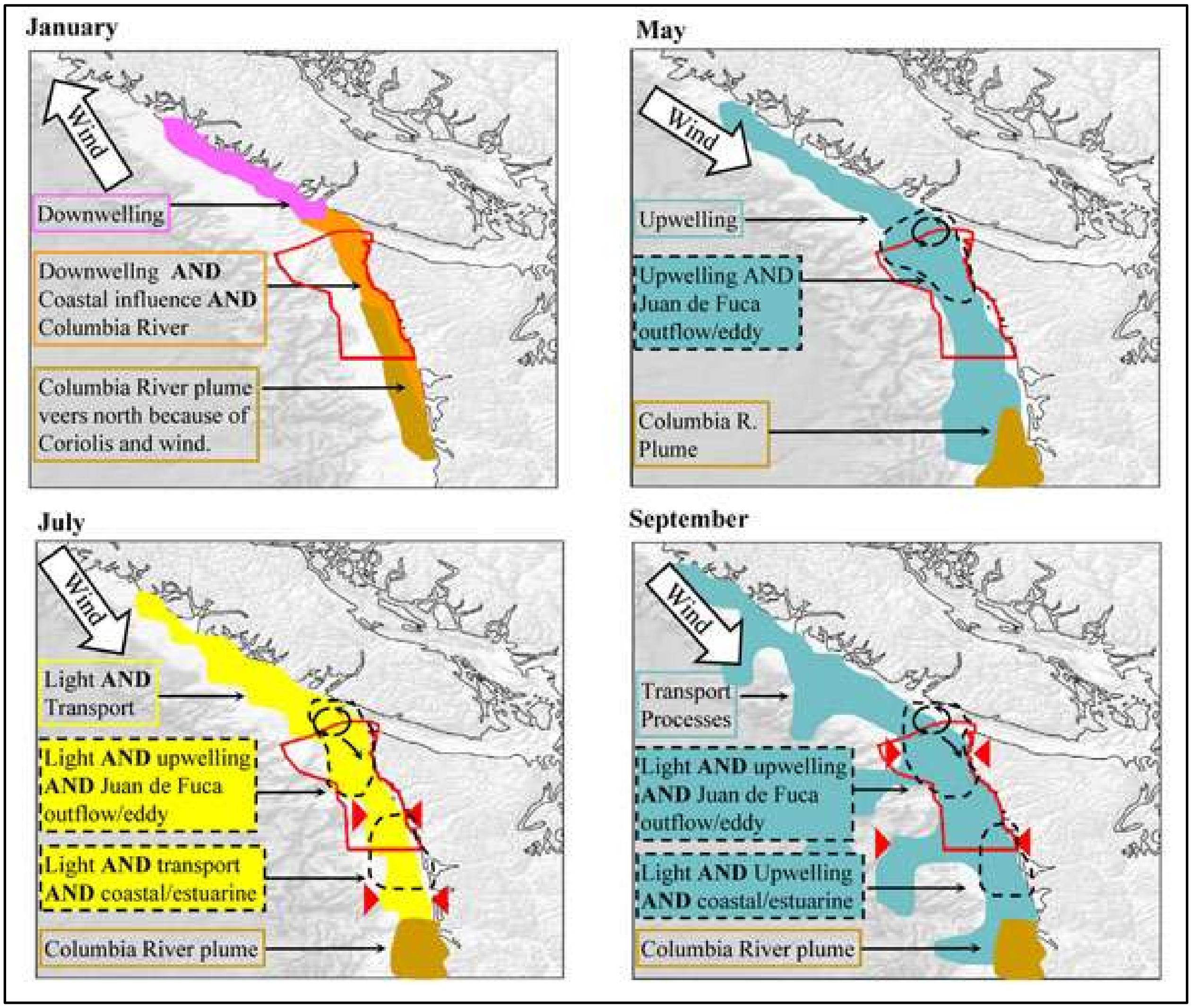

Figure 4 Schematic of general physical factors controlling ocean surface response during January, May, July, and September (from Pirhalla et al. 2009)

On shore, the visible rise and fall of tides follow a mixed, semidiurnal pattern with two high-water and low-water phases per day. A mixed pattern means consecutive highs and lows have different tidal heights. The tidal range on the outer coast of Washington is large, averaging about

11.5 feet (3.5m) between high and low tides. Ocean surface water temperatures average about 9°C (48°F) in winter and 15°C (58°F) in summer.

6.1.3 Water Quality

Water quality within OCNMS is largely representative of natural ocean conditions, with relatively minor influence from human activities at sea and on land (ONMS 2008). By conventional measures, marine water quality within OCNMS is not notably compromised, in part because there have been few point sources of pollution in the vicinity, such as sewage outfalls or industrial discharge sites, and because there are no large industrial developments or large population centers adjacent to OCNMS.

Stressors that may impact water quality in the sanctuary include hypoxic (low oxygen) conditions and harmful algal blooms. Results of increased water quality monitoring efforts in recent years indicate more frequent occurrence of hypoxic conditions as well as greater depression in oxygen levels than previously recorded (Chan et al. 2008; ONMS 2008), phenomena that have been tentatively linked to climate change impacts on ocean systems. Harmful algal blooms that impact wildlife and human populations are a naturally occurring phenomena subject to monitoring since the 1990s. There are limited data that define an increased frequency or geographical range of harmful algal blooms to human activities, such as nutrient inputs or factors related to climate change. A large-volume oil spill is generally considered the greatest threat to water quality in the sanctuary – a low-probability but high-impact threat. Another water quality concern is impact to nearshore habitats of increased sediment loading in rivers due to upland development, primarily road building and logging (see section 6.2.2).

Another source of pollutants with potentially negative water quality impacts is intentional discharges from vessels (e.g. sewage, graywater, ballast and bilge water). Vessel traffic volume through the sanctuary is high, as most vessels using the Strait of Juan de Fuca heading to the ports in Puget Sound and Vancouver, Canada, transit through OCNMS. Certain vessel classes, particularly cruise ships, are capable of generating wastewater quantities on par with small cities. The following sections evaluate vessel traffic in OCNMS and the quantity and types of vessel discharges in the context of existing regulations.

6.1.3.1 Vessel Discharges

Wastewater is generated on all vessels through their normal operation. The quantity generated and the types of discharges vary depending on vessel size, function, and condition. The following sections describe types of discharges incidental to vessel operation, review the regulatory context for vessel discharges to marine areas, and provide an analysis of the potential annual inputs of specific discharges produced by the range of vessel types that use the sanctuary. The potential direct and indirect environmental effects these discharges have on water quality and marine life within the sanctuary are described in section 8.

Sewage, also referred to as blackwater, is defined as human body wastes and the wastes from toilets and other receptacles intended to receive or retain body wastes 40 CFR 140.1(a). Sewage from vessels is generally more concentrated than sewage from land-based sources, as it is diluted with less water when flushed (e.g., 0.75 versus 1.5 - 5 gallons), and on many vessels sewage is not further diluted with graywater (NOAA 2008). Sewage generated on vessels should be directed to a marine sanitation device (MSD). MSDs, which are described in more detail below, may either a) hold untreated waste until it can be legally discharged into the ocean (e.g., beyond 3 nmi from shore) or pumped to a land based treatment facility, or b) treat the sewage by reducing bacteria concentrations through chemical means and reducing the amount of solids by mechanical maceration or microbial decomposition prior to its discharge as treated effluent. In the past decade, some large passenger vessels, or cruise ships, that transit through the sanctuary have installed and utilized advanced wastewater treatment systems (AWTS) to treat sewage and, on some vessels, graywater. AWTS are a type of MSD that typically utilize a combination of biological and chemical treatment, and additional system components to produce an effluent with substantially better water quality than a traditional MSD.

Graywater originates from a variety of sources, such as showers, sinks, galleys, food waste pulpers and laundry and, if untreated, often contains pathogen and nutrient concentrations equal to or higher than untreated domestic sewage (EPA 2008a). Graywater on vessels may be discharged immediately upon generation, diverted to a wastewater treatment apparatus (e.g., MSD) or pumped to a long term holding tank. An individual vessel's ability to hold or treat wastewater can be highly variable, and capacities for various vessel types have not been accurately characterized in available literature.

Bilgewater is the mixture of fresh water and seawater, oily fluids, lubricants, cleaning agents, paint and metal shavings and other similar materials that accumulate in the lowest part of a vessel from a variety of different sources including the main and auxiliary engines; boilers, evaporators and related auxiliary systems; equipment and related components; and other mechanical and operational sources found throughout the machinery spaces of a vessel. Bilgewater may also originate from onboard spills, wash waters generated during the daily operation of a vessel, or waste water from operational sources (e.g., condensate from air coolers, etc.) that collect in the bilge (EPA 2008a).

Ballast water is water intentionally taken on board and stored in ballast tanks to provide stability under a range of vessel loading scenarios. Ballast water may contain a variety of marine organisms that can be transported and discharged outside their native range where they can pose a risk to local ecosystems.

Sewage, graywater, and other vessel discharges are regulated through a complex framework of overlapping international treaties and standards, national laws and regulations, and local and area-specific rules. In general, the purpose of such rules and regulations is to protect water quality. The International Convention for the Prevention of Pollution from Ships (MARPOL) was created in 1973 to regulate marine pollution including oil, chemicals, harmful substances in package form, and sewage and garbage that enter the marine environment from either accidental or operational causes. State and federal laws also regulate certain types of discharges from vessels under authority of the Federal Water Pollution Control Act, also informally called the Clean Water Act (CWA; 33 U.S.C.1251 et seq.), and other regulations.

In the U.S., all non-recreational vessels 79 feet or greater in length may not discharge substances to marine waters without operating under a National Pollutant Discharge and Elimination System vessel general permit (VGP). This permit allows and sets effluent limits for most discharges incidental to the operation of large vessels, including desk wash, bilgewater, ballast water, boiler blowdown, chain locker effluent, elevator pit effluent, graywater, distillation and reverse osmosis brine, and more. Sewage discharges, however, are not covered by the VGP but are subject to the applicable local, state, federal jurisdictional regulations. The geographic extent of coverage of the VGP extends to 3 miles from shore, so the guidance and regulations therein do not pertain to the majority of the sanctuary. However, the VGP does recognize national marine sanctuaries as "waters federally protected wholly or in part for conservation purposes" and includes more restrictive provisions addressing various wastewater sources that apply in OCNMS and other national marine sanctuaries. Fishing and commercial vessels under 79 feet long are exempt from VGP coverage based on a moratorium extending through December 2013. Certain discharges from these vessels, such as ballast water, are not exempt even during the moratorium. Recreational vessels and all military vessels are exempt from the VGP permanently, or until the law changes.

The OCNMS boundary lies between 25 and 40 nmi from shore, with approximately 83% of the sanctuary's area beyond 3 nmi from shore. Thus, Washington State regulations and the VGP apply in near shore waters that comprise less than one fifth of the sanctuary. As outlined below, under current federal, state, and local regulations and agreements, treated or untreated sewage and graywater discharges by recreational and commercial vessels are allowed under current regulations throughout a large portion of the sanctuary.

Regulatory Context for Vessel Discharges - Sewage

Internationally, sewage discharges are regulated under the authority of Annex IV of MARPOL, adopted in 2003. These regulations and revisions now apply to all vessels over 400 gross tons (GT) or certified to carry more than 15 persons, require an approved sewage treatment system, and prohibit discharge of treated sewage within three nmi from shore and untreated sewage within 12 nmi from shore (IMO 2002). Although the United States did not ratify MARPOL Annex IV, it does apply to most foreign flagged ships. In 2009, 74% of the vessels included in the analysis of sewage discharges below (Table 6) were foreign flagged. U.S. flagged vessels are not subject to MARPOL Annex IV regulations, but they must comply with the CWA, VGP or other state laws when operating in waters within 3 miles of shore.

The U.S. regulates sewage discharges from all vessels under the CWA. Collectively, CWA Section 312 and its implementing regulations require all vessels with toilet facilities to have operable MSDs, allow discharges of treated sewage any distance from shore (except where a no discharge zone has been established), and allow discharges of both untreated and treated sewage beyond three miles from shore or at land based pump-out facilities. CWA Section 312 requires federal performance standards for MSDs, which have been described by the U.S. Coast Guard (33 CFR Part 159). Standards for discharge from MSDs were developed by the U.S. EPA and are described in 40 CFR Part 140. Larger vessels, such as cruise ships, may combine sewage (blackwater) with graywater prior to treatment and discharge. Combined discharges of this sort are subject to graywater effluent limits set forth in the VGP rather than MSD (sewage) effluent standards.

Under the authority of the CWA states may establish No Discharge Zones (NDZs) in which the discharge of sewage from vessels is prohibited if any of the following three criteria are met:

1. The state determines that the water body requires greater environmental protection, and EPA finds that adequate pump-out facilities are available (commonly known as a 312(f)(3) NDZ).
2. EPA, upon application by the state, determines that the protection and enhancement of the water body requires establishment of an NDZ even if pump-out facilities are not reasonably available (commonly known as a 312(f)(4)(A) NDZ).
3. EPA, upon application by a state, will, by regulation, prohibit the discharge of sewage from vessels within a drinking water intake zone (commonly known as a 312(f)(4)(B) NDZ).

Table 6 Potential gallons of sewage discharges in OCNMS in 2009

Vessel Classification	Number of Transits through OCNMS	Number of People Aboard	Vessel Days in OCNMS	Sewage Discharge Volume (low) [a]	Sewage Discharge Volume (avg) [b]	Sewage Discharge Volume (high) [c]	Percent Contribution
Commercial Fishing Vessel	3,006	4	1,577	34,694	94,620	189,240	9.5%
Charter Fishing Vessel	1,148	11	287	16,732	45,633	91,266	4.6%
Recreational Fishing Vessel	10,351	3	2,588	39,851	108,686	217,371	10.9%
Commercial Vessel < 300GT	249	4	34	752	2,052	4,104	0.2%
Commercial Vessel 300-1599 GT	65	12	10	653	1,782	3,564	0.2%
Commercial Vessel > 1600 GT	4,272	15	280	23,117	63,045	126,090	6.3%
Passenger Vessel < 300 GT	14	300	1	1,320	3,600	7,200	0.4%
Passenger Vessel 300-1599 GT	9	500	1	2,200	6,000	12,000	0.6%
Passenger Vessel > 1600 GT	280	2,921	14	231,343	630,936	1,261,872	63.3%
Public Vessel < 300 GT	16	2	2	23	63	126	0.0%
Public Vessel 300-1599 GT	75	8	10	458	1,248	2,496	0.1%
Public Vessel > 1600 GT	157	15	17	1,427	3,893	7,785	0.4%
Tank Vessel	1,401	15	145	11,996	32,715	65,430	3.3%
Tug with tank barge	189	4	35	779	2,124	4,248	0.2%
TOTAL	**21,232**	**N/A**	**5,003**	**365,345**	**996,396**	**1,992,792**	**100%**

a. Low sewage discharge volume estimate is based on a waste generation rate of 5.5 gallons/person/day.
b. The average sewage discharge volume estimate is based on a waste generation rate of 15 gallons/person/day.
c. The maximum sewage generation rate is based on a 30 gallon/person/day.

Historically, NDZs have not distinguished between vessel categories and apply to all vessels regardless of size or purpose. However, the EPA and the State of California are in the process of establishing a NDZ for the length of the California coast, based on criteria 2 (above), which will prohibit sewage discharge, whether treated or not, and will apply only to commercial passenger vessels 300 GRT or larger, and commercial vessels larger than 300 GRT with two or more days of sewage holding capacity. The proposed rule (40 CFR 140) was signed in 2010 and finalization of the regulation is pending.

In Washington State waters, vessel discharges must meet state water quality standards (per Chapter 90.48 RCW and Chapter 173-201A WAC), yet most traditional MSDs and, in some cases, AWTS do not meet those standards. Thus, Washington State guides vessels to onshore pumpout treatment facilities or to withhold discharges until outside of state waters via general outreach measures or by documented guidance, such as agreements.

In Washington State, cruise ships are subject to the same regulations as other large vessels. However, in 2004, a memorandum of understanding (MOU) was developed between the North West & Canada Cruise Association (NWCCA), Port of Seattle and the Washington Department of Ecology (WDE), prohibiting sewage and graywater discharges within state waters (which extend north to the border with Canada in the Strait of Juan de Fuca and 3 nautical miles offshore from the Olympic Peninsula) from cruise ships not utilizing AWTS. This MOU is a voluntary agreement with NWCCA member organizations. Cruise ships utilizing AWTS may attain permission to discharge in Washington State waters if effluent limits and monitoring constraints of the NWCCA MOU are met. Cruise ships without AWTS or without approval to discharge are not allowed to discharge treated wastewater and all untreated wastewater is prohibited in state waters. In 2007, this MOU was modified to eliminate any discharge into waters of OCNMS of residual solids from either a Type II MSD or an AWTS (WDE 2009). However, there are no provisions in the NWCCA MOU related to discharge of treated sewage from MSDs or AWTS in OCNMS waters. In 2010, OCNMS proposed amendment of the MOU to prohibit all discharges from cruise ships into waters of the sanctuary, but this amendment was opposed by the cruise ship industry, which wanted to avoid complicating the MOU with multiple boundaries subject to differing MOU provisions. In 2010, representatives from the NWCCA confirmed that affiliated vessels currently avoid all wastewater discharges in OCNMS, a practice consistent with regulatory requirements in national marine sanctuaries in California (John Hansen, former President, NWCCA).

Cruise ships, as described in the discharge analysis below, have the potential to generate and discharge greater quantities of sewage and graywater than other vessel categories. In light of this fact, various jurisdictions have adopted regulatory and voluntary measures to mitigate environmental impacts of sewage discharges from cruise ships. In 2001, The Alaska Department of Environmental Conservation (ADEC) developed the Commercial Passenger Vessel Environmental Compliance Program under Alaska Statute 46.03.460. This program set effluent limits and sampling requirements for the discharge of blackwater and graywater from cruise ships. Since then, additional measures have been instituted by ADEC to further regulate discharges from cruise ships. Beginning in 2003 all blackwater and graywater discharges from cruise ships in Alaska were subject to stricter water quality standards, with a requirement for treatment by an approved AWTS. Cruise ships discharging treated sewage into Alaska state waters are now required to operate under a State vessel general permit, which sets stringent effluent limits for sewage and graywater discharges (ADEC 2010b).

There is a precedent for limiting sewage discharges from large vessels (greater than 300 GT), and in some cases explicitly cruise ships, from national marine sanctuaries or other waters protected for conservation purposes on the West Coast. The four national marine sanctuaries off California, Cordell Bank, Gulf of the Farallones, Monterey Bay, and Channel Islands, have instituted rules prohibiting vessels 300 GT or larger from discharging treated or untreated sewage regardless of sanitation device type (15 CFR 922 Subparts G, H, K, and M). Cruise ship discharges are expressly prohibited within Glacier Bay National Park through the U.S. National Park Service's concession contract with large cruise ships for entry into the park.

Existing OCNMS regulations allow for MSD-treated sewage discharges from all vessel types, although discharge of untreated sewage is prohibited under the CWA in state waters. In addition, the Area to be Avoided (ATBA), a voluntary vessel traffic routing measure that applies to vessels above 1600 GT and those carrying petroleum and hazardous materials as cargo, indirectly prevents sewage and other vessel wastewater discharges from approximately 70% of OCNMS. The ATBA routes these vessels 25 nmi off the coast except at the approach to the Strait of Juan de Fuca (Figure 8; see section 6.4.2). Compliance with the ATBA is routinely monitored, and compliance rates have been consistently near 98%. Thus, the majority of the discharges from large commercial vessels estimated in Table 6 and Table 7 would take place in the 30% of the sanctuary that is outside the ATBA.

Marine Sanitation Devices
The CWA requires that any vessel with installed toilet facilities must have an operable MSD. Three general types of MSDs are available and in use. Type I MSDs rely on maceration and chemical disinfection for treatment of the waste prior to its discharge into the water, and are only legal in vessels under 65 feet in length (EPA 2010a). Type II MSDs utilize aeration and aerobic bacteria in addition to maceration for the breakdown of solids. As with Type I MSDs, the waste is chemically disinfected, typically with chlorine, ammonia or formaldehyde, prior to discharge. Type II MSDs are legal in any size class of vessel, and there are a variety of different types (EPA 2008b). Type III MSDs are storage tanks, may contain deodorizers and other chemicals, predominantly chlorine, and are used to retain waste until it can be disposed of at an appropriate pump-out facility or at sea. Most MSDs do not have the same nutrient removal capability as land-based treatment plants. Thus, even treated vessel wastewater can have elevated nutrient concentrations.

Advanced wastewater treatment systems (AWTS) are a complex form of Type II MSD that meet a higher standards and testing regime as set out in federal law, and utilize techniques such as reverse osmosis, ultrafiltration and ultra violet (UV) sterilization to provide more effective treatment. AWTS have been installed and operational on more than half (9 of 15) larger passenger vessels that will transit the sanctuary in 2011 and on these vessels blackwater and graywater are combined (WDE 2011). AWTS have been installed on some of the other passenger vessels; however, due to equipment and operating challenges, they are not functioning properly and are not being used (Amy Jankowaic, WDE, personal communication). These vessels are therefore currently using traditional (Type II) MSDs. The treatment capabilities of AWTS for certain constituents (e.g. nutrients and metals) vary by design and manufacturer, but overall, the performance of these units far surpasses the performance of traditional (Type II) MSDs if functioning properly. For example, suspended solids, residual chlorine, and fecal coliform concentrations in AWTS effluent are typically zero (ADEC 2010b). Because of the varying treatment capabilities of the different AWTS systems, ADEC established technology based effluent limits, similar to the methodology used by the EPA for issuing municipal wastewater permits. The NWCCA MOU specifies effluent limits for conventional pollutants, including organics, solids, pH, fecal coliform and residual chlorine for discharges from AWTS, and does not include limits for ammonia, metals or other pollutants. The MOU also does not differentiate between AWTS types.

Table 7 Potential gallons of graywater discharges in OCNMS in 2009

Vessel Classification	Number of Transits through OCNMS	Number of People Aboard	Vessel Days in OCNMS	Graywater Discharge Volume (low) [a]	Graywater Discharge Volume (avg.) [b]	Graywater Discharge Volume (high) [c]	Percent Contribution
Commercial Fishing Vessel	3,006	4	1,577	227,088	422,636	750,652	11.2%
Charter Fishing Vessel	1,148	11	287	Graywater potential discharges were not estimated for charter and recreational fishing vessels, due to uncertainties about vessel equipment and practices.			
Recreational Fishing Vessel	10,351	3	2,588				
Commercial Vessel < 300GT	249	4	34	4,925	9,166	16,279	0.2%
Commercial Vessel 300-1599 GT	65	12	10	4,277	7,960	14,137	0.2%
Commercial Vessel > 1600 GT	4,272	15	280	151,308	281,601	500,157	7.5%
Passenger Vessel < 300 GT	14	300	1	8,640	16,080	28,560	0.4%
Passenger Vessel 300-1599 GT	9	500	1	14,400	26,800	47,600	0.7%
Passenger Vessel > 1600 GT	280	2,921	14	1,514,246	2,818,181	5,005,426	74.9%
Public Vessel < 300 GT	16	2	2	151	281	500	0.0%
Public Vessel 300-1599 GT	75	8	10	2,995	5,574	9,901	0.1%
Public Vessel > 1600 GT	157	15	17	9,342	17,387	30,881	0.5%
Tank Vessel	1,401	15	145	78,516	146,127	259,539	3.9%
Tug with tank barge	189	4	35	5,098	9,487	16,850	0.3%
TOTAL	**21,232**	**N/A**	**5,003**	**2,020,986**	**3,761,280**	**6,680,482**	**100%**

a. Low graywater discharge volume estimate is based on a waste generation rate of 36 gallons/person/day.
b. The graywater average discharge volume estimate is based on a waste generation rate of 67 gallons/person/day.
c. The maximum graywater generation rate is based on a 119 gallon/person/day.

Regulatory Context for Vessel Discharges - Graywater
Currently, there are no existing or proposed international regulations regarding graywater. In the U.S., graywater discharge from ships is regulated under the VGP. The VGP graywater rules include guidance to minimize production and discharge while in port, include different requirements for medium (100-499 berths) and large (500 or more berths) cruise ships, prohibit discharge within 3 miles of shore within a national marine sanctuary for vessels with graywater storage capacity, allow for discharge from vessels greater than 400 gross tons if the effluent meets treatment standards or if the vessel is underway more than 1 nmi of shore, and include special considerations for nutrient impaired waters. Treated graywater must meet strict standards for fecal coliform and chlorine concentrations that far exceed standards for traditional MSD effluent (EPA 2008b). The VGP does not have treatment requirements for large vessels when discharging underway (i.e., greater than 1 nmi from shore and when traveling faster than 6 knots).

Current OCNMS regulations allow discharge of graywater as "water generated by routine vessel operations". Under voluntary measures defined in the MOU between the North West and Canada Cruise Association, Port of Seattle, and WDE, cruise ships represented by the association will not discharge graywater (treated or untreated) in Washington State waters, with an exception for discharge of treated graywater from vessels with AWTS.

Regulatory Context for Vessel Discharges - Ballast Water
The discharge rate and constituent concentrations of ballast water from vessels will vary by vessel type, ballast tank capacity, and type of deballasting equipment. Volumes of ballast water discharged are large and can be several hundred or thousand cubic meters of water. For instance, passenger vessels have an average ballast capacity of about 2,600 cubic meters (about 686,850 gallons), and ultra large crude carriers have an average ballast capacity of about 93,000 cubic meters (about 24,568,000 gallons) (EPA 2008b). Ballast water exchange volume for each of the vessel classes was not computed for further analysis, as the risk that ballast water poses to the sanctuary has more to do with the manner (i.e., location) that ballast water is exchanged rather than the volume of exchanges.

Ballast water from ships has been a major source of non-native species introduction around the world. The current best practice for managing ballast water is an at-sea exchange of ballast water, wherein coastal water taken at or near a port is replaced with less biologically productive open oceanic water. Fewer organisms are present in open ocean water than in coastal waters. This practice is not 100% effective as some non-native organisms can survive until discharged in a foreign port or coastal area (NOAA 2008).

OCNMS is partially protected from the introduction of non-native species through existing federal, state and international regulations associated with ballast water management. In July 2004, the U.S. Coast Guard published a final rule changing the nation's voluntary Ballast Water Management Program to a mandatory one requiring all vessels equipped with ballast water tanks and bound for ports or places of the United States to conduct a mid-ocean ballast water exchange (more than 200 nmi offshore), retain their ballast water onboard, or use an alternative, environmentally sound, ballast water management method approved by the USCG (69 FR 44952). The state of Washington's regulations have this same requirement for mid-ocean exchange that applies to vessels 300 gross tons or larger that have traveled outside the economic exclusion zone (EEZ). For vessels that do not leave the EEZ, ballast water exchanges must be conducted beyond 50 nmi from shore (WDFW 2009). These measures substantially reduce the risk of invasive species introductions into sanctuary waters. Washington State ballast water management regulations only apply to vessels bound for American ports; however, Canada has adopted the 2004 IMO International Convention for the Control and Management of Ship's Ballast Water and Sediment (Transport Canada 2010). This agreement provides the same restrictions as Washington State regulations, and all ships calling on Canadian ports are required to comply (IMO 2004). The VGP requires vessels to avoid discharge of ballast waters within 3 nmi of shore within a national marine sanctuary. In summary, these regulations and agreements prohibit discharge of all ballast water that originates from distant nearshore areas but allow discharge into the sanctuary beyond 3 nmi from shore and other Washington State waters of ballast water that originates from an open ocean exchange.

Regulatory Context for Vessel Discharges – Bilgewater

Bilgewater is the mixture of fresh water and seawater, oily fluids, lubricants, cleaning fluids and other wastes that accumulate in the bilge, or lowest part of a vessel hull, from a variety sources including leaks, engines and other parts of the propulsion system and other mechanical and operation sources found throughout the vessel (EPA 2008a). All vessels accumulate bilgewater through their normal operation, but the generation rates depend on a variety of factors including hull integrity, vessel size, engine room design, preventative maintenance and the age of the vessel (EPA 2008a; EPA 2010b). In addition to oil and grease, bilgewater may also contain a variety of other solid and liquid contaminants, such as rags, metal shavings, soaps, detergents, dispersants and degreasers (EPA 2008a). Estimates of bilgewater discharges to the sanctuary are not available for most classes of vessels. Data for bilgewater generation from cruise ships were available, with an estimated volume of 25,000 gallons produced per week (3,500 gallons per day) on vessels with 3000 passenger/crew capacity (EPA 2008b).

Several national and international regulations govern allowable discharges of bilgewater in an effort to reduce oil contamination of the oceans. These regulations require ships to have in operation oily-water separating equipment, and discharges may not exceed 15 parts per million oil. The VGP prohibits discharge of treated or untreated bilgewater from vessels 400 gross tons or more within 3 mi of shore in a national marine sanctuary. OCNMS regulations prohibit all discharge of oily waste from bilge pumping. Because sanctuary regulations do not specify a limit, this has been interpreted by ONMS as prohibiting any detectable amount of oil as evidenced by a visible sheen (EPA 2008a; 73 FR 70488). Under current OCNMS regulations, discharge of bilgewater not leaving a visible sheen is allowed.

Regulatory Context for Vessel Discharges – Other Discharges

Several discharges incidental to the normal operation of a vessel covered by the exclusion in 40 CFR 122.3 are also eligible for coverage under the VGP. Below is a list of these discharges:

- Anti-fouling hull coatings
- Boiler blow-down
- Cathodic protection
- Chain locker effluent (anchor wash)
- Controllable pitch propeller and thruster hydraulic fluid and other oil to sea interfaces…
- Distillation and reverse osmosis brine

- Elevator pit effluent
- Firemain systems
- Freshwater layup
- Gas turbine water wash
- Motor gasoline and compensating discharge
- Non-oily machinery wastewater,
- Refrigeration and air condensate discharge
- Seawater cooling overboard discharge (including non-contact engine cooling water, hydraulic
- System cooling water, refrigeration cooling water
- Seawater piping biofouling prevention
- Boat engine wet exhaust
- Sonar dome discharge
- Underwater ship husbandry discharges
- Welldeck discharges

The volume and contents of the above listed discharges are presumed to be similar for similarly sized vessels and are not dependent on the vessel purpose (EPA 2008b). With the exception of graywater and pool and spa discharges from cruise ships, oily discharges, including oily mixtures, and residual biocide limits from vessels utilizing experimental ballast water treatment systems, numeric effluent limitations are not feasible to calculate for vessel discharges in VGP. Therefore, the EPA establishes effluent limits based on Best Practical Control Technology Currently Available (BPT) or Best Available Technology (BAT) rather than specifying specific effluent limits. Existing OCNMS regulations include an exception to the discharge prohibition for water generated by routine vessel operations, which includes those mentioned above.

Discharge Volume Estimation Methods

In order to evaluate the potential for water quality impacts to the sanctuary from vessel discharges, estimates of discharges generated by classes of vessels were calculated based on the time a given vessel class spent in the sanctuary during 2009 (vessel days) and published waste generation rates. Vessel days for a given vessel class was calculated by determining the cumulative time individual vessels of a specified class were within sanctuary boundaries. Sewage generation rates used for estimates provided in Table 6 were based on information from MSD manufacturers. Additional details regarding discharge volume estimation methods can be found in Appendix K.

Although many vessels do have wastewater holding tanks and may not discharge while operating in the sanctuary, it is not possible to accurately characterize the times, locations, and volumes of sewage and other discharges that actually occur in the sanctuary. For the purpose of this document, analysis was conducted on the potential to discharge to sanctuary waters based on estimated waste generation rates and residence time (vessel days) in the sanctuary. Potential discharge volumes are proportional to waste generation rates, which can be considered a worst-case scenario because discharges may or may not occur in waters of the sanctuary. One factor influencing wastewater discharges into waters of the sanctuary is average transit time. Large, commercial vessels complying with the ATBA (vessels >1,600 GT, and tugs with tank barges) would transit waters of the sanctuary only at the western approach to the Strait of Juan de Fuca

(Figure 8). In OCNMS regulations, cruise ships are defined as vessels with 250 or more passenger berths for hire. However, the following analysis is based on categories of vessels used by the vessel traffic system under which cruise ships are classified as passenger vessels >1,600 GT. For cruise ships, the average transit time in OCNMS is 74 minutes (1.2 hours; Table 11). By comparison, commercial vessels of various sizes average about 170 minutes in OCNMS, and public vessels and tank vessels average roughly 200 minutes in OCNMS (Table 11). While the estimated potential wastewater discharge volumes from all ships represent a threat to water quality, actual discharges may not occur or impact OCNMS water quality because transit times provide relatively short windows of opportunity for wastewater discharges to occur in OCNMS.

Cruise Ship Wastewater Discharges

The cruise ship industry is rapidly expanding in the Pacific Northwest, with the number of passengers through the Port of Seattle increasing from 120,000 to nearly 900,000 between 2000 and 2009 (WDE 2010). In 2009, there were 280 cruise ship transits in OCNMS (VEAT 2009), representing 14 vessel days in sanctuary waters (see Passenger Vessels >1,600 GT in Table 6). If the passenger numbers on these cruises continue to increase, there will be a proportional increase in wastewater generation. The largest cruise ships are capable of carrying a combined population of about 4,000 passengers and crew (WDE 2009).

Estimates of potential wastewater discharges from cruise ships (i.e., passenger vessels >1,600 GT) presented in Table 6 and Table 7 assume an average of 2,921 passengers and crew on board, the average reported for cruise ships using the Port of Seattle (WDE 2009). Despite cruise ships spending relatively little cumulative time in the sanctuary compared to other large vessel classes, the potential sewage discharge volume from cruise ships is higher than that estimated for all other large vessel classes and represents 63% of all potential sewage discharges in the sanctuary (Table 6). The average graywater generation rate of 67 gallons/person/day (EPA 2008a) could potentially result in millions of gallons of graywater discharged from cruise ships into the sanctuary annually, which dwarfs potential discharges from all other vessel classes and represents 75% of the all potential graywater discharges in the sanctuary (Table 7).

The quality of potential blackwater and graywater discharges from cruise ships, hence risk to sanctuary resources, is difficult to characterize based on existing data. Data from the 2011 Washington Department of Ecology discharge status report (WDE 2011) indicate that 15 cruise ships are scheduled to call on the Port of Seattle for a total of 195 port calls, corresponding to 390 transits through or near the sanctuary. Whereas more than half (9 of 15) of the cruise ships calling on the Port of Seattle have installed AWTS for blackwater and/or graywater treatment, 35% of the port calls will be completed by vessels that have traditional MSDs for blackwater treatment and no treatment system for graywater (WDE 2011). Furthermore, only 2 of the 15 vessels have met effluent standards and monitoring requirements set forth in the NWCCA MOU and have requested and gained authority to discharge while underway in Washington state waters (WDE 2011). Only vessels that are authorized to discharge per the NWCCA MOU are required to monitor and submit results, and are required to submit documentation that they have 24 hour continuous monitoring for treatment system performance and disinfection, as well as the ability and procedures to automatically shut down if continuous monitoring of treated effluent indicates high turbidity or a disinfection system upset. Therefore, it cannot be assured that the AWTS performance controls or effluent monitoring otherwise required by the VGP or NWCCA MOU are performed on most ships. Some vessels only operate their AWTS when in certain areas where it is required and use a traditional MSD for other discharges. Given the uncertainties in the type and performance (operational performance and frequency of system upset) of the treatment systems installed on board cruise ships, it is impossible to accurately estimate the quantity (i.e., mass load) of contaminants potentially deposited into the sanctuary.

In open waters of the sanctuary, concern for localized and acute effects of wastewater discharges from a cruise ship in transit is reduced by the free exchange of waters and dilution that occurs in the ship's wake. Rapid dilution of wastewater (blackwater and graywater) discharged from MSDs has been documented to occur when discharged from cruise ships under way. Loehr et al. (2006) showed that under a worst case scenario (i.e., lowest dilution factor possible and high discharge rate) that the dilution factor for discharges from large cruise ships is 1:50,000 when traveling at 6 knots discharging at 200 cubic meters per hour. Loehr et al. (2006) further documented, based on sampled effluent concentrations from 21 cruise ships using traditional MSDs, that priority pollutants (metals and organics) were rapidly diluted to many times below Alaska water quality standards. In Washington State, mixing zones have not been applied to cruise ship discharges. Mixing zones are typically established for stationary discharges where a particular location and receiving water can be evaluated and applied with a discharge permit.

Commercial (non passenger) Vessels Wastewater Discharges
The typical composition of sewage and graywater discharges from non-passenger vessels has not been as extensively studied as cruise ship discharges. Most commercial, non-passenger vessels are equipped with Type I or Type II MSDs, so the composition of sewage discharges in terms of constituents and concentrations are likely to be similar to the cruise ship discharges evaluated by the EPA (2008a), except for cruise ships equipped with AWTS. The estimated total amount of sewage discharged in the sanctuary by non-passenger carrying, commercial vessels (including commercial fishing vessels, commercial vessels and tank vessels) is between 71,991 and 392,676 gallons per year (Table 6). In sum, these vessels produced about 20% of the potential sewage and 23% of the potential graywater discharges into the OCNMS in 2009.

Although the number of transits and vessel days for non-passenger vessels are many times greater than that of cruise ships, the total combined discharge volume from non-passenger vessels is much less because these vessels have substantially fewer passengers.

Charter and Personal Recreational Vessel Wastewater Discharges
OCMNS is a popular recreational fishing area in the Pacific Northwest spanning Washington Department of Fish and Wildlife marine management units 2, 3, 4 and 4B. Private and charter vessels using the sanctuary originate primarily from the ports of Neah Bay, La Push, and Westport. In 2009, there were over 40,000 angler trips to the sanctuary. Of these trips about half were conducted on small private or charter vessels typically carrying 6 or fewer passengers. The remaining trips were conducted on larger charter vessels that carried an average of 10-13 passengers. Reliable data regarding the type(s) of MSDs (if any) installed on these vessels is unavailable. The majority of these vessels are under 65 feet, so they could use any approved Type I, II, or III MSD, or could have no MSD of any type.

The annual sewage discharge estimates for recreational and charter fishing vessels are between 56,583 and 308,637 gallons based upon waste generation rates used for other vessel classes

(Table 6). Thus, these vessel classes potentially could contribute as much as 15.5% of sewage discharged to sanctuary waters. This likely overestimates true sewage discharges because these vessels are typically on day trips and may hold waste using a Type III MSD until it can be discharged at a shore-side pump-out facility. Waste generation rates may also be substantially lower due to the estimated short duration of fishing trips (six hours). Graywater discharge estimates were not calculated for recreational fishing vessels, as most would not have galleys or sinks, and therefore would not generate sizeable volumes of graywater.

6.1.4 Climate/Meteorology

The maritime climate off the Olympic Coast is influenced by topography, location along the windward coast, prevailing westerly winds, and the position and intensity of high and low pressure centers over the North Pacific Ocean (Phillips and Donaldson 1972). The strong oceanic influence creates a climate of western Washington characterized by relatively mild winters and moderately dry, cool summers. In the late spring and summer, westerly to northwesterly winds associated with the North Pacific high pressure system produce a dry season. In late fall and winter, southwesterly and westerly winds associated with the Aleutian low pressure system provide ample moisture and cloud cover for the wet season beginning in October. Moist air transported across the ocean rises and cools on the windward terrestrial slopes, giving rise to relatively high rainfalls in western Washington. Annual rainfall amounts greater than 100 inches (254 cm) per year on the western portions of the Olympic Peninsula contribute to seasonally high inputs of river waters to the marine system.

Large-scale oceanographic and atmospheric events across the Pacific basin also influence of Olympic Coast waters. For example, the El Niño-Southern Oscillation is primarily driven by sea surface temperatures along the equatorial Pacific Ocean and is a major source of inter-annual climate and ecosystem productivity variability in the Pacific Northwest, with events lasting 6 to 18 months. Likewise, the Pacific Decadal Oscillation, a long-term cycle in ocean temperature with warm or cool phases that can each last 20 to 30 years, influences the climate in the Pacific Northwest. Climatic cycles such as these are natural events and often are associated with strong fluctuations in weather patterns and biological resources.

6.1.5 Climate Change

Over the next century, climate change is projected to profoundly impact coastal and marine ecosystems on a global scale, with anticipated effects on sea level, temperature, storm intensity and current patterns. At a regional scale, we can anticipate significant shifts in the species composition of ecological communities, seasonal flows in freshwater systems, rates of primary productivity, sea level rise, coastal flooding and erosion, and wind-driven circulation patterns (Scavia et al. 2002). Rising seawater temperatures may give rise to increased algal blooms, major shifts in species distributions, local species extirpations, and increases in pathogenic diseases (Epstein et al. 1993, Harvell et al. 1999). A better understanding of ocean responses to global scale climatic changes is needed in order to improve interpretation of observable ecosystem fluctuations, such as temperature changes, hypoxic events and ocean acidification that may or may not be directly coupled to climate change.

6.2 BIOLOGICAL SETTING

Habitats are where organisms make their lives, where they survive, find food, water, shelter, and space. The collected habitats of an area create the place for the living ecosystem. Healthy marine habitats are the foundation of healthy communities of marine life.

OCNMS is comprised of a broad diversity of habitats, some we can see from land, others hidden beneath the water, including rocky shores, sandy beaches, nearshore kelp forests, sea stacks and islands, open ocean or pelagic waters, as well as the continental shelf seafloor and submarine canyons. In addition to aquatic habitats in the sanctuary, islands and pinnacles, or sea stacks, along the coast provide nesting and resting sites for California and Steller sea lions, harbor and elephant seals, and thousands of seabirds.

6.2.1 Intertidal Habitats

Most accessible to people is the intertidal zone, a habitat alternating between the dry and wet worlds where rock benches, tide pools and surge channels are formed amid boulders and rocky outcrops. These substrates provide both temporary and permanent homes for an abundance of "seaweeds" (e.g., macroalgae and seagrasses), invertebrates such as sea stars, hermit crabs, nudibranchs, snails, and sea anemones, and intertidal fish. Between rocky headlands are numerous sand-covered beaches and mixed rock/cobble benches hosting an array of intertidal invertebrates and fishes – food for both shorebirds and humans. Surf smelt spawn at high tide on sand-gravel beaches where surf action bathes and aerates the eggs.

Natural conditions in intertidal habitats of the Pacific Northwest challenge their inhabitants with extreme fluctuations in temperature, salinity and oxygen, along with powerful physical forces such as wave action and sand scouring. Yet, rocky shores of the Olympic Coast have among the highest biodiversity of marine invertebrates and macroalgae of all eastern Pacific coastal sites from Central America to Alaska (Suchanek 1979; Dethier 1992; PISCO 2002; Blanchette et al. in press). Macroalgae or seaweeds are highly diverse in the region, with an estimated 120 species thought to occur within the sanctuary rocky intertidal zone (Dethier 1988).

With limited exceptions, nearshore and intertidal habitats in the sanctuary are remarkably undisturbed by human use and development (e.g., armoring, wetlands alteration, dredging, and land-based construction) that have modified shorelines in more urbanized areas. The remote location, low levels of human habitation, protections provided by the wilderness designation of Olympic National Park's coast, and restricted access to tribal reservations have allowed these coastal habitats to persist largely intact. At the few locations where shoreline armoring has been employed or where human visitation has focused on intertidal areas for food collection and recreation, impacts do not appear to be dramatic or widespread (Erickson and Wullschleger 1998; Erickson 2005).

Monitoring conducted by Olympic National Park since 1989 indicates these habitats are healthy and do not appear to be changing substantially in response to human influences. Large-scale disturbances related primarily to extreme winter weather cause periodic damage to mussel beds (Paine and Levin 1981) and other intertidal species. Coastal ecologists recently have designed studies to better detect changes resulting from effects of global climate change, such as sea level rise, increasing acidity and temperatures, and changes in storm frequency and magnitude. Local trends in these parameters are uncertain, however, and no definitive results have yet been published.

Relatively few nonindigenous or exotic species have been reported in the sanctuary, and, of those, only a few are invasive and therefore threatening to community structure and function (ONMS 2008). OCNMS-led rapid assessment intertidal surveys in 2001 and 2002 and a larvae settlement study (deRivera et al. 2005) identified a few nonindigenous species. One invasive species of concern, the green crab, has been found at sites both north and south of the sanctuary, but no green crab have be found through routine monitoring near the sanctuary. A program to prevent introduction and spread of invasive species is managed by Washington Department of Fish and Wildlife.

Degradation of intertidal habitats, in the form of marine debris, is visible to even the casual visitor to the shore. The majority of this debris is plastic ranging from large floats to beverage bottles to tiny fragments the size of sand particles. Much of the debris originates from commercial fisheries, both international and domestic.

6.2.2 Nearshore Habitats

In nearshore areas, canopy kelp beds form a productive, physically complex and protected habitat with a rich biological community association of fish, invertebrates and sea otters. Annual monitoring and quantification of the floating kelp canopy has been conducted since 1989 by the Washington Department of Natural Resources and in collaboration with OCNMS since 1995. Although the canopy changes every year, these kelp beds are generally considered stable, and the area covered by floating kelp has been increasing along the outer coast and western portion of the Strait of Juan de Fuca (Figure 5). This increase may be due in part to a growing population of sea otters and subsequent decline in grazing sea urchins or may be influenced by changes in oceanographic conditions. In contrast, extensive logging of the Olympic Peninsula, an area of very high rainfall, has markedly increased sediment loads in rivers in the past. Long-term residents along the coast have noted a reduction in kelp beds near river mouths, which may have been associated with siltation of nearshore habitat and reduced light penetration (Chris Morganroth III, personal communication in Norse 1994). Recently documented, widespread hypoxic, or low oxygen conditions in nearshore areas off Oregon and Washington coasts have stressed and killed marine life. Such hypoxic conditions appear to be increasing in severity and frequency and may result from anomalous weather and oceanographic patterns.

Nearshore habitats off sand beaches occurring all along the outer Olympic Coast and dominate the southern shores of the sanctuary tend to be less diverse, lacking macroalgae and physically complex substrate. These are high energy environments where the inshore shelf is relatively shallow. Nutrients delivered by upwelling currents support phytoplankton biomass that is grazed and recycled by zooplankton. Wind and wave action support transport and retention of productive waters near shore, which sustains sand beach infaunal communities of amphipods, worms, and razor clams.

Relatively few exotic or nonindigenous species have been reported in the sanctuary and, of those, only a few are invasive and therefore threatening to community structure and function in the nearshore. Observations by coastal ecologists from Olympic National Park and OCNMS of increased amounts of the invasive brown algae *Sargassum muticum*, the documented range expansion of invasive ascidians (tunicates or sea squirts) (deRivera et al. 2005), and the encroachment of the invasive green crab to areas both south and north of the sanctuary all suggest negative impacts from nonindigenous species may increase in the future.

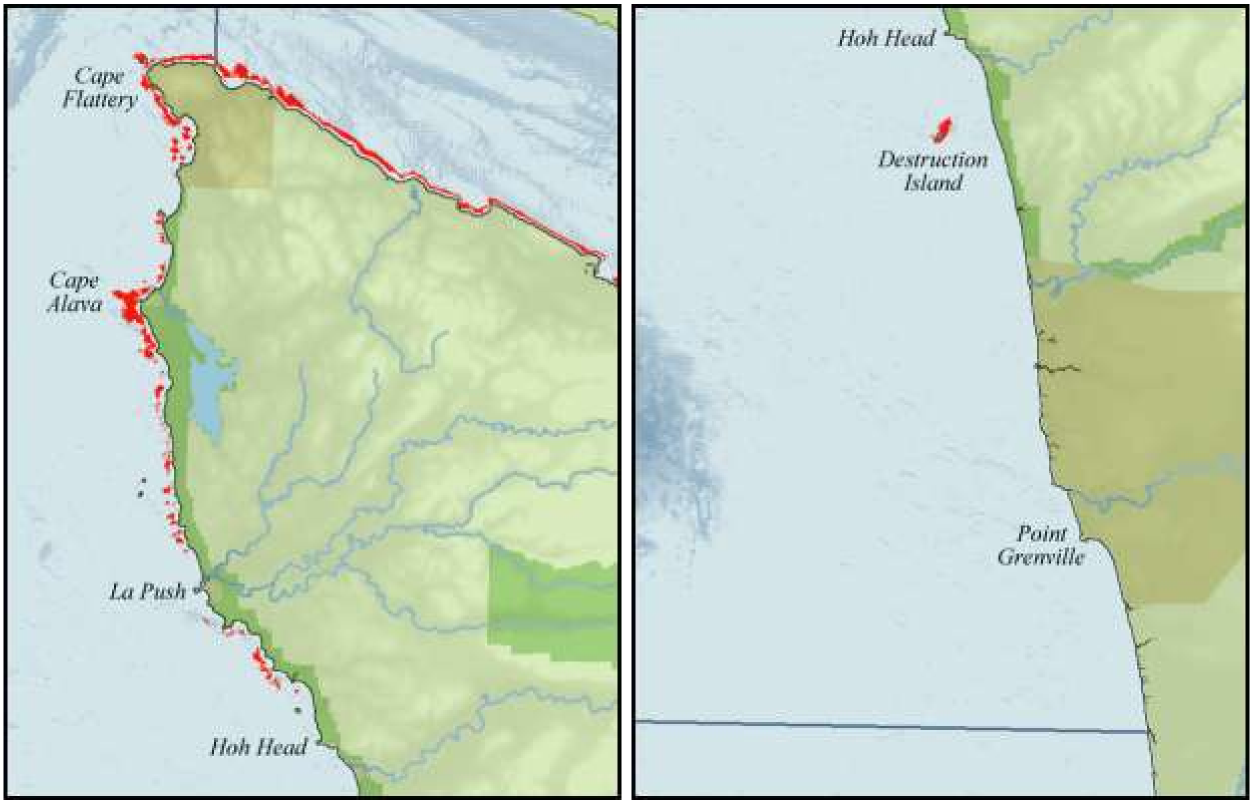

Figure 5 Kelp distribution

6.2.3 Pelagic (Water Column) Habitats

The pelagic habitat, or water column of the open ocean, is the most extensive habitat of the sanctuary. Many fish, seabird, and marine mammal species are pelagic and have relatively little association with seafloor or nearshore habitats. Phytoplankton at the base of the food web is most abundant in the euphotic, or sunlit, layer near the surface of the water column. This primary productivity supports a food chain based on grazing zooplankton, fish, and marine bacteria. Ocean productivity can be nutrient limited and is influenced by large-scale oceanographic currents and cycles. Seabirds can serve as indicators of productivity - poor survival of one year's young can indicate nutrient poor and low productivity cycles in the coastal marine system. Naturally occurring harmful algal blooms of plankton put humans and some marine wildlife at risk of biotoxin poisoning, either from plankton or from shellfish consumption.

In some marine areas of the world, pelagic habitats have been degraded by chemical contaminants and wildlife conflicts with vessel traffic and noise pollution. Whereas variability in contaminant concentrations complicates characterization of water column pollutants, contaminants in animal and plant tissues can provide an integrated measure of bioavailability of compounds present at low or variable levels in the marine system. In the sanctuary, chemical concentrations were recently measured in a variety of invertebrates and sea otters for a study of sea otter health (Brancato et al. 2009), the West Coast Environmental Monitoring and Assessment Program, and for NOAA's Status and Trends, Mussel Watch Program. Contaminant concentrations were found to be low in all organisms, with very few exceptions (ONMS 2008).

The potential for contamination of pelagic habitats by petroleum products is a concern reinforced by experience and justified by the volume of large vessel traffic at the western end of the Strait of Juan de Fuca. Four of the five largest oil spills in Washington state history have occurred in or moved into the area now designated as the sanctuary. In the decade before sanctuary designation, two major oil spills released more than 325,000 gallons of petroleum products impacting marine ecosystems and human communities on the outer Washington coast.

Noise pollution, or the cumulative acoustic signature of human activities, is an aspect of the pelagic habitat of OCNMS not currently well characterized or evaluated for potential impacts on wildlife in the sanctuary.

6.2.4 Seafloor Habitats

The ocean floor of the sanctuary covers over 3,300 square miles and is comprised of a variety of physically and biologically complex habitats. These habitats are shaped by the geology and topography of the seafloor and enhanced by living organisms like corals and sponges. Prior to development of remote sensing techniques, water depth measurements and bottom samples provided spot data that was extrapolated to create crude seafloor maps. Modern exploration and detailed habitat mapping involves carefully planned and costly surveys from large vessels using sophisticated technology. Thus far, OCNMS has completed high resolution habitat mapping for about 25 percent of its seafloor, while information on remaining areas lacks resolution and specificity for development of accurate seafloor habitat maps (Figure 6). As a result, generalizations about the sanctuary's seafloor habitats and their biological communities are difficult to make.

The northern portion of the sanctuary is dominated by the Juan de Fuca Canyon and trough (the shallower extensions of the canyon closer to the Strait of Juan de Fuca), which are complex, glacially carved features containing a mixture of soft sediments, with significant cobble and boulder patches and scattered large glacial erratics (boulders) deposited during ice retreat. High-relief, submerged topographic features serve as fish aggregation areas. Low-resolution surveys have revealed a generally wide and featureless continental shelf in the southern portion of the sanctuary dominated by soft substrates (sand and mud bottoms, to pebble and cobble) with scattered areas of rock outcrop and spires. The head of the Quinault Canyon also lies within the sanctuary boundary.

Detailed information on historic and current conditions in the sanctuary's seafloor habitats is limited because technological challenges and expense have limited the areas that have been directly viewed. Thus, to a large extent the current condition of seafloor habitats must be inferred. The most widespread anthropogenic impact to seafloor habitats is likely to have resulted from the bottom trawl fishery using gear known to reduce complexity, alter the physical structure of seafloor habitats, and damage biogenic habitat, or habitat formed by living organisms, such as corals and sponges (NRC 2002; Auster et al. 1996, Auster and Langton 1999, Norse and Watling 1999, Thrush and Dayton 2002). Bottom trawling and long-line fishing has occurred widely throughout OCNMS for several decades, likely over all but the roughest of seafloor habitats. Where biologically-structured habitats existed on the sanctuary seafloor, it is likely they have been altered by fishing practices, except perhaps in the roughest of terrain fishermen avoided. Recovery of biologically-structured habitats is expected to occur very slowly, even in the absence of future pressures, due to low growth and reproductive cycles of the habitat-forming organisms such as corals.

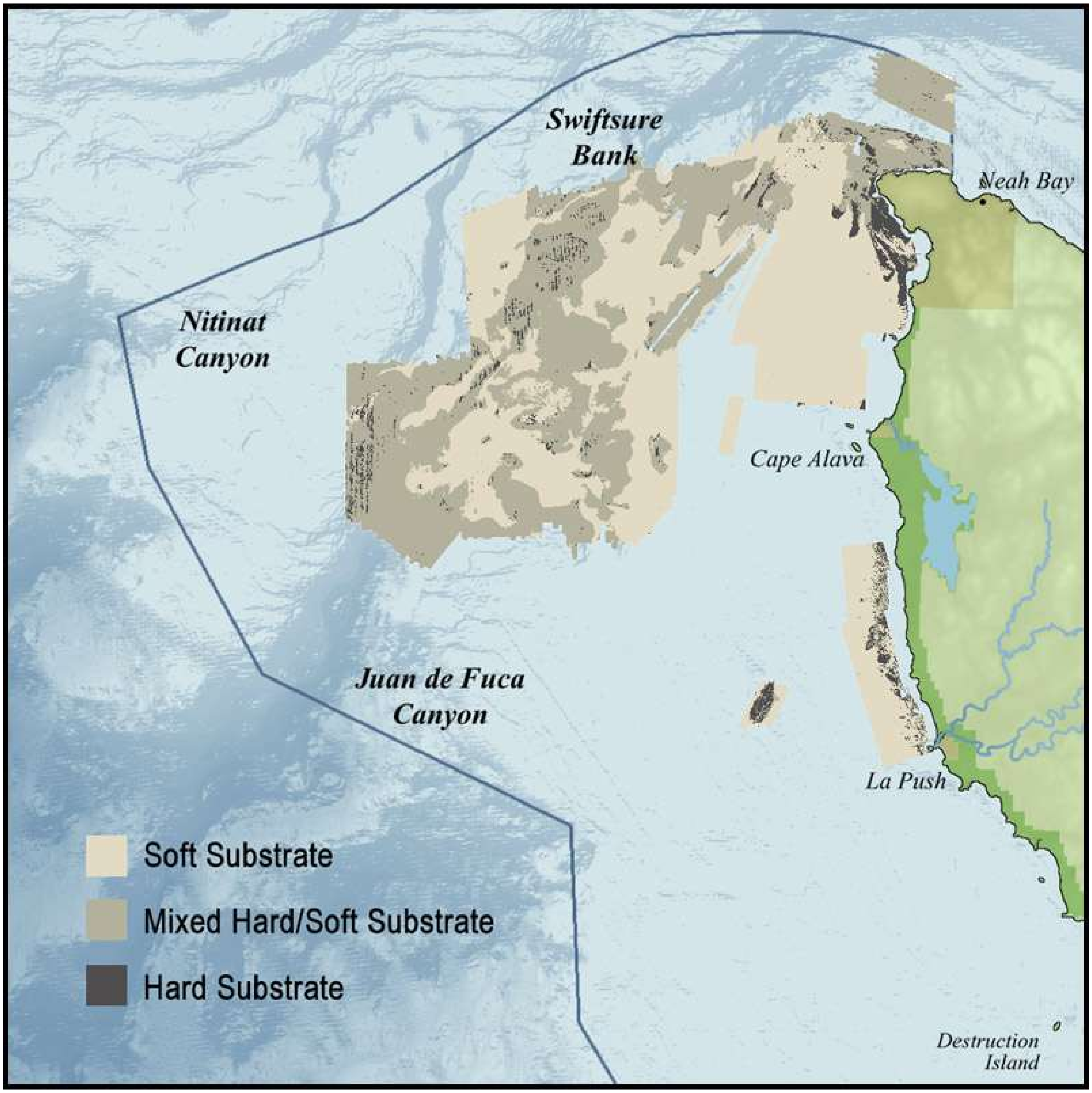

Figure 6 Habitat map

In recent years, fishery management measures restricting footrope gear size and limit areas open to bottom trawlers, and in some places long-line and pot gear, have mitigated widespread seafloor impacts of bottom trawling and focused trawl effort more toward soft seafloor substrates where gear impacts on the physical habitat are less of a concern.

Analysis of seafloor habitat data used for groundfish Essential Fish Habitat (EFH) designation indicates that approximately six percent of the sanctuary is hard substrate with potential to host biologically structured habitat. Of this, 29 percent lies within the Olympic 2 EFH conservation area (Figure 7). Recent surveys by OCNMS researchers have documented corals and other biologically-structured habitat in other areas (Brancato et al. 2007), which indicates this analysis may underestimate the historic or current distribution of biologically-structured habitat.

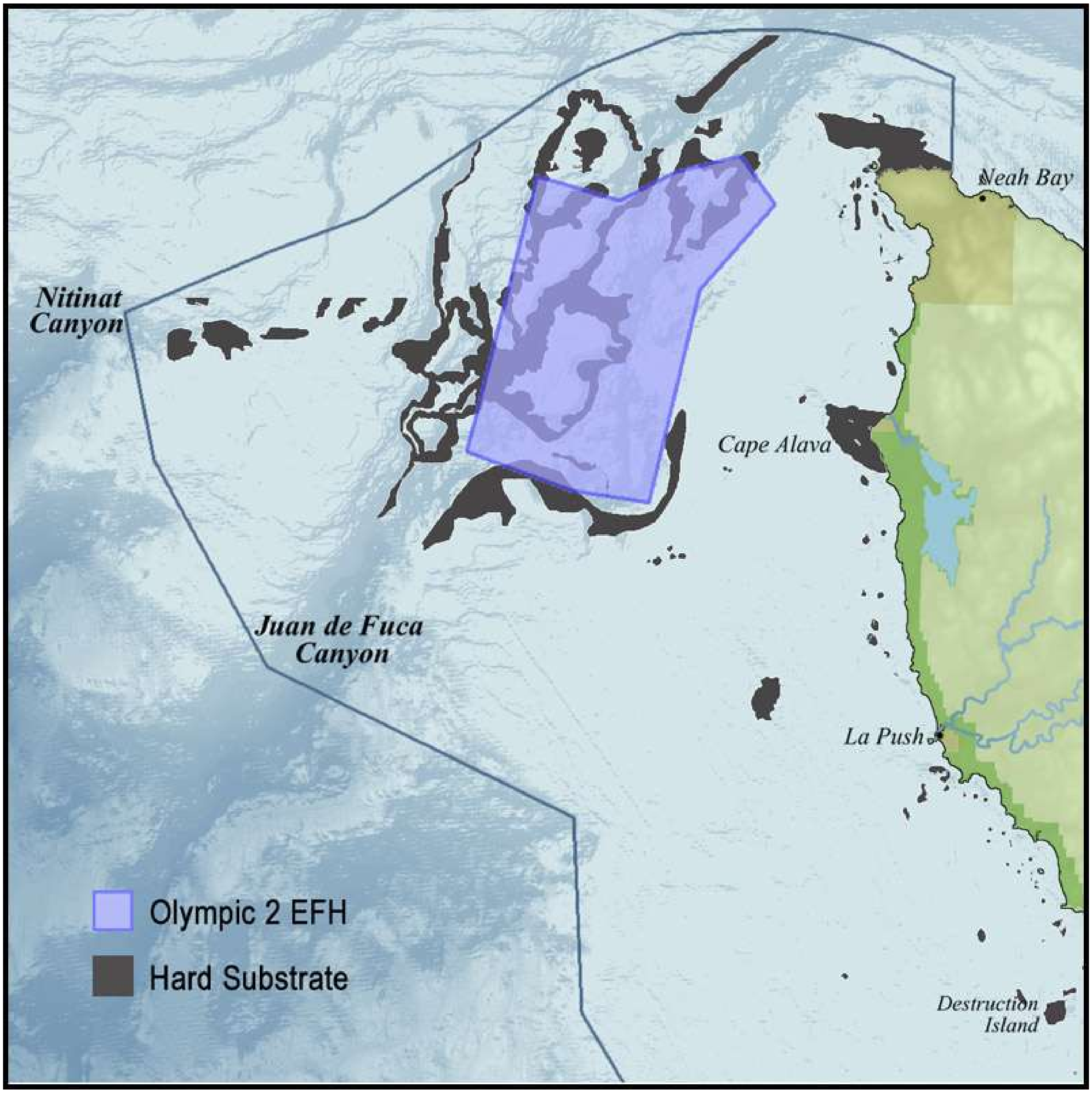

Figure 7 **Potential historic distribution of biologically structured habitat associated with hard substrate overlaid on Olympic 2 EFH Conservation Area (data from Curt Whitmire, NOAA)**

Submarine cable installations in OCNMS have been monitored and shown to cause acute and localized seafloor impacts, short-term habitat disturbance in soft sediments and more persistent physical disturbance in hard substrates (Brancato and Bowlby 2002). Cable trenching, however, impacts a very small portion of the sanctuary seafloor.

Sediment contaminant levels (i.e., heavy metals and organic pollutants) in OCNMS are generally low and do not appear to be increasing (ONMS 2008). Marine debris does compromise seafloor habitat quality, but its impacts in OCNMS are not well-documented. Rough waters and complex seabed features increase the potential for fishing gear entanglement and loss. Studies from Puget Sound and beyond reveal that abandoned fishing gear can remain for decades, potentially entangling and killing species encountering the gear (NRC Inc. 2008). Assessment of derelict fishing gear on the seafloor has been limited to coastal areas around Cape Flattery and sites viewed for characterization of seafloor habitat and seafloor community studies. These later studies have documented lost fishing gear, most commonly long-line gear entangled on seafloor features and corals (Brancato et al. 2007).

6.2.5 Benthic Invertebrates

The majority of the sanctuary's seafloor where bottom dwelling, or benthic invertebrates live is composed of sand and mud. This submerged habitat is home to a variety of invertebrates similar to those found in intertidal areas – brittle stars, sea urchins, worms, snails, and shrimp. Dungeness crab and razor clams have long sustained commercial and recreational harvest off the Olympic Coast.

Hard-bottom substrates harbor rich invertebrate assemblages, including deepwater coral and sponges (Brancato et al. 2007). These living organisms with branching, upright structure are, in turn, habitat where other invertebrates and fish find hiding places, attachment sites, food sources, and breeding and nursery grounds in relatively inhospitable and otherwise featureless environment (Whitmire and Clarke 2007). The distribution of such deepwater communities, as well as their species richness and basic biology, are not well documented but are currently under scientific investigation.

Human activities impacting seafloor habitats (described in section 6.2.4) can also harm benthic invertebrates. Submarine cable installation and buoy anchors can physically disturb and displace benthic invertebrates, but the cumulative area of impact is relatively small given small size of most anchors and the narrow path of disturbance and relatively few cables installed in the area (Brancato and Bowlby 2002). The most widespread human impact to benthic invertebrates likely results from bottom contact fishing gear, especially bottom trawl fisheries with footropes and roller gear repeatedly traversing relatively wide swaths of the seafloor.

6.2.6 Fishes

Among the many species of fish inhabiting OCNMS are commercially important ones including at least 30 species of rockfish, 15 or more species of flatfish, Pacific halibut, Pacific whiting (or hake), sablefish, and salmon. Five species of Pacific salmon (chinook, sockeye, pink, chum and coho) occur along the outer coast of Washington and breed in the Olympic Peninsula's rivers and streams. Three similar salmonid species found in freshwater systems (sea-run cutthroat trout, bull trout, and steelhead) spend portions of their lives in nearshore marine waters. Nearshore habitats of the sanctuary presumably are important for salmon spawning in adjacent streams and rivers, but juvenile salmon use of nearshore habitats off the Olympic Coast is not well understood. The sanctuary also is part of the migration corridor of both juvenile and adult salmonids from California, Oregon, British Columbia, and Washington rivers beyond the Olympic Peninsula.

Migratory species, such as sharks, albacore, sardines, mackerel, and anchovies, are important resources for tribal and non-tribal fishers that are found in the sanctuary seasonally.

Federal and Washington state listings of candidate, sensitive, threatened, or endangered species are definitive indicators that some fish populations are not healthy. Olympic Coast populations of Ozette sockeye and bull trout have been on the federal list of threatened species in 1999. Thirteen species of rockfish are identified as state species of concern, and three of these are also federal species of concern. In recent decades**,** West Coast groundfish stocks and fisheries were in crisis, with steep declines in commercial ex-vessel value, overcapitalization, and several groundfish stocks depleted by a combination of fishing and natural factors (NMFS 2002). Four species of rockfish found in the sanctuary have been classified as overfished by the NMFS Service (NMFS 2006a). And there have been increasing concerns about our limited ability to forecast groundfish production from single species investigations is missing important natural and fishery-induced changes in the ecosystem and will not be able to forecast truly sustainable harvest policies (NMFS 2002). For example, age structure, an important measure of population integrity, has been affected by fisheries. Some rockfish populations have been shown to have reduced numbers of larger, older fish, a factor that could affect their recovery rate (PFMC 2008a). Older rockfish produce more eggs and more robust juveniles (Berkeley et al. 2004). However, in most cases, the status of the larger, older fish within the population is unknown because it has not been determined whether the older fish are simply missing because they have been removed from the population, or are not fully represented in fishery or stock assessment surveys.

However, professional fisheries managers generally are optimistic sustainable fisheries off the outer coast of Washington are possible under new management regimes following these historical stock declines. Recent fishery management measures implemented to reduce fishing effort, monitor and minimize bycatch, and reduce impacts to habitat appear to have assisted initial recovery of some overfished groundfish stocks and provide evidence for an improving trend (ONMS 2008).

6.2.7 Seabirds

Seabirds are the most conspicuous members of the offshore fauna of the Olympic Coast. Sea stacks and islands provide critical nesting habitat for 19 species of marine birds and marine-associated raptors and shorebirds, including seven alcid species (including murres, puffins, and murrelets), three cormorant species, four gull and tern species, two storm-petrel species, two raptors and one shorebird, the Black Oystercatcher. Productive offshore waters also attract large feeding aggregations of marine birds that breed in other regions of the world but travel great distances to “winter” in sanctuary waters. The Sooty Shearwater, for example, breeds off New Zealand and Chile in the austral summer and congregates along the Pacific coast in its non-breeding season. Black-footed and Laysan Albatross travel far from their breeding grounds in Hawaii and Japan to forage in the eastern Pacific. Nearer to shore, sand and gravel beaches are foraging areas for shorebirds, crows, gulls and a host of other birds. The coastline also forms an important migratory pathway for millions of birds that pass through each year, guiding waterfowl, cranes, shorebirds and raptors toward northern breeding areas during the spring and southward as winter approaches.

Seabirds are relatively numerous, conspicuous, and forage across multiple habitat types and trophic levels. For these reasons, they are often considered indicators of ocean conditions, and the status of their populations provides insight into ecosystem health (Parrish and Zador 2003, Piatt et al. 2007). Many feed on forage fish, a critical link in the food chain, which are difficult to quantify by direct observation or sampling. Populations of five species of marine birds breeding in the sanctuary are declining in the area, which has led to their inclusion on federal or state species of concern lists: Common Murre, Marbled Murrelet, Tufted Puffin, Cassin's Auklet, and Brandt's Cormorant. Trends and common concerns for these seabirds are long-term declines in their population sizes (Wahl and Tweit 2000, Wahl et al. 2005, Raphael 2006); vulnerability to human disturbances such as oil spills, habitat disruption and fisheries bycatch (Piatt et al. 2002, Raphael 2006); and susceptibility to natural disturbances such as ENSO events (Graybill and Hodder 1985, Wilson 1991, Piatt et al. 2002, Wahl et al. 2005). Although some population levels appear to be stabilizing at values lower than historical levels, a longer time series is needed to determine a trend (Lance and Pearson 2008).

A closer examination of the Common Murre population provides insight into some factors affecting the status of all seabirds on the Washington coast. The murre population declined dramatically in 1982 and 1983, coinciding with a severe El Niño-Southern Oscillation (ENSO), and has not recovered to pre-1983 levels since that time (Warheit and Thompson 2004). Aside from declines associated with ENSO events, it has been suggested the population has not recovered due to a combination of oil spills, disturbance at breeding colonies (e.g., historic Naval bombing practices), and gillnet mortality (Warheit and Thompson 2004). During the *Nestucca* spill in 1988 and *Tenyo Maru* spill in 1991, over 70% of bird carcasses recovered were Common Murres, mortalities that represented a sizable proportion of the total Washington state Common Murre population (The *Tenyo Maru* Oil Spill Natural Resource Trustees 2000). Although the Common Murre population showed signs of recovery through the 1990s, the number of birds has diminished greatly relative to pre-spill numbers, and modest declines have been found in recent years (Manuwal et al. 2001). At the breeding colony on Tatoosh Island, Common Murre populations have also been affected by an influx of avian predators, including Bald Eagles, Peregrine Falcons and nest-depredating Glaucous-winged Gulls (Parrish et al. 2001). These multiple stressors affecting the sluggish recovery of Common Murres may be indicative of the challenges facing the long-term recovery of other seabirds.

Age structure and mortality rates are also in question in some bird populations on the coast. Common Murres on Tatoosh Island have experienced documented breeding failures during recent years, partially attributed to oil spills and observed heavy predation by raptors and gulls, but also possibly due to low food supply during critical breeding periods (Parrish et al. 2001, Warheit and Thompson 2003). Because they are long-lived, an occasional year of poor productivity may not impact the population significantly, but multiple years or successive years of breeding failure would likely have future impacts on the population. Recent demographic studies of Marbled Murrelets in the region have indicated they have had low nesting success in recent years (Raphael and Bloxton 2008), which may inhibit their recovery or at least slow the rate of recovery.

6.2.8 Marine Mammals

Twenty-nine species of marine mammals have been sighted in Olympic Coast National Marine Sanctuary. Whales, because of their size, abundance and visibility, are commonly seen in the sanctuary. Sea otters, harbor and elephant seals, and Steller and California sea lions aggregate along the shore and haul out on land at many locations along the coast throughout the year. The humpback whale and the killer whale (also called orca) forage offshore, and some 20,000 gray whales travel through the sanctuary on their annual migrations between breeding and calving grounds off the Baja Peninsula and summer feeding grounds in the northern Pacific. Eleven marine mammal species are on either federal or state species of concern lists across their range (Washington Department of Fish and Wildlife 2008).

The sea otter is often considered a keystone species because of the strong top-down influence they have on the nearshore kelp ecosystem. Sea otters are of high scientific interest because they were extirpated from Washington state by commercial pelt hunters by 1911, then were reintroduced in 1969 and 1970 (Lance et al. 2004). This population has been counted annually since 1989 and has shown increases the past few years, with a peak of 1,121 animals in 2008 (Jameson and Jeffries 2008). The rate of population growth, however, has been slower than expected (Laidre et al. 2002; Lance et al. 2004). The sea otter remains a federal species of concern and an endangered species within Washington state, and the population remains vulnerable because of its small size, limited genetic diversity, existing exposure to pathogens, and extreme risks to oil spills.

Most wildlife populations in the sanctuary are relatively healthy and unburdened by contaminants, pathogens or related maladies. There are, however, notable exceptions. Although no negative health effects have been documented, the sea otter population has been shown to carry several potentially lethal pathogens - 80 percent of the otters tested positive for the distemper viral complex *Morbillivirus* and 60 percent tested positive for the protozoan *Toxoplasma gondii* (Brancato et al. 2009). Fat-soluble contaminants are generally considered to bioaccumulate or increase in concentration when moving up the food web (Cockcroft et al. 1989). Overall, tissue concentrations of assayed contaminants were relatively low in Washington sea otters (Brancato et al. 2009). However, other top predators in the region, such as killer whales, have been shown to carry high contaminant loads (e.g., PCBs and PBDEs) in their blubber (Ross et al. 2000, Ross 2006), though the population effects of such high contaminant loads are unknown.

6.3 CULTURAL AND HISTORICAL SETTING

Olympic Coast National Marine Sanctuary has a rich maritime heritage where lives, languages, communities and cultures are continuously shaped by the sea. The native Makah, Quileute, Hoh and Quinault peoples traditionally lived at the water's edge, thriving on the riches of the ocean plants, fish, shellfish, seabirds and marine mammals. The waters off the Washington coast linked native peoples along the coast as they traveled by canoe. These waters were highways that were traversed by canoes and, more recently, ships supporting communities and industries along the shores of the Strait of Juan de Fuca and Puget Sound and beyond. Historically, local maritime activity ranged from fur hunting, whaling and fishing, to coastal trade with smaller coastal communities. The rugged Olympic Coast could be treacherous, especially during winter storms when high winds and strong currents pushed ships dangerously close to the rocky islands, reefs and shoreline. Fog, too, led to collisions with disastrous results. Over 180 ships were reported wrecked or lost at sea in or near sanctuary waters in the years between 1808 and 1972.

6.3.1 American Indian Cultural Resources

The modern shoreline of the Olympic Peninsula contains dozens of late prehistoric archaeological sites rich in materials documenting the character of the maritime environment and the use of this environment by the region’s native peoples. Nearshore coastal forests adjacent to the sanctuary contain mid-Holocene shorelines and older prehistoric archaeological sites. These older sites are rich in materials documenting the character of maritime paleo-environments, the history of environmental change, and the record of use of these environments by the region’s native peoples.

The earliest dated archaeological site on the Washington Coast occurs adjacent to the sanctuary on the Makah Indian Reservation, establishing human presence for the last 6,000 years. The recent investigation of paleoshoreline sites on the Makah Reservation reveals high sea-stand village sites inland along the Sooes and Waatch river valleys, in some cases greater than 10 meters above current sea level and kilometers from the current ocean shore (Wessen 2003). These sites indicate complex interactions with marine resources of the period and yield important clues to large-scale ocean and climate regimes, marine wildlife and fish populations, habitat distribution and cultural patterns of marine resource use. The Makah Cultural and Research Center in Neah Bay houses an extraordinary collection of artifacts from the Ozette archaeological site, a Makah village that was partially buried by a mudslide nearly 500 years ago and excavated in the 1970s.

Other tangible records of prehistoric human occupation include petroglyphs both above the intertidal zone and within it, middens of shells and other discarded domestic materials, and canoe runs, or channels cleared of boulders to facilitate landing of dugout watercraft. Research and preservation of coastal native languages, traditional cultural properties, and traditional practices of song, dance and activities like whaling also enhances awareness in native and non-native peoples of the region’s rich ocean-dependent heritage. The recent resurgence of the canoe culture in the annual “Tribal Journeys” celebration transfers knowledge and understanding of coastal culture to new generations.

6.3.2 Historical and Archaeological Resources

Historical-era resources are generally affiliated with archaeological remains of the western cultures that appeared in the region by the mid-nineteenth century.* A combination of fierce weather, isolated and rocky shores, and thriving ship commerce have made the Olympic Coast a graveyard for ships of many descriptions.

6.3.2.1 Historical Contexts

Early European-led visits to the Pacific Northwest were explorations to map the coast, assess marketable natural resources, and stake claim to lands. Juan Perez, a Spaniard, sailed from Mexico on the first European exploration of the Pacific Northwest in1774, an expedition that extended as far north as the Alaskan panhandle. In 1778, James Cook explored the coast between Oregon and Alaska. By the 1790s, Spain attempted to use the region as a buffer against encroaching Russian and English fur hunters. In 1792, the Spanish established a short-lived palisaded settlement known as Nunez Gaona near the mouth of the Strait of Juan de Fuca in Neah Bay to support their main base on Vancouver Island. This Spanish settlement lasted less than a year.

As the British settled Canada's Pacific Northwest, Americans also continued their westward migrations into the United States northwestern territories of Washington and Oregon. A need for timber to support the population explosion resulting from California's 1849 Gold Rush led to the settlement and exploitation of the timber resources around Puget Sound and the Olympic Peninsula. An increase in shipping around Cape Flattery resulted in an increase in ship losses. The U.S. Lighthouse Board built lighthouses at both Destruction Island and Tatoosh Island to reduce the hazards to the increased shipping.

The encroachment of settlers had a profound impact on the native tribes' traditional way of life. The United States pressured the tribes to move to reservations in order to make way for American settlement. In 1855, the Treaty of Neah Bay set aside land at Cape Flattery as a reservation for the Makah tribe. Tatoosh Island was appropriated for the lighthouse and was not returned to the tribe until 1984. In 1855-1856, the ancestors of the Hoh Tribe, Quileute Tribe and the Quinault Indian Nation signed the Treaty of Olympia with the U.S. Government. The Hoh and Quileute reservations were subsequently established by Executive Order.

Throughout the 1850s and 1860s, settlers moved onto lands formerly used by American Indians. The remoteness and lack of access roads to areas near the coast prevented an influx of large numbers of settlers, but small western communities, such as Port Angeles and Port Townsend began to appear near American Indian communities that persisted in Neah Bay, La Push, and Taholah. Grays Harbor, too, became a center of timber export. By the last quarter of the nineteenth century, small sailing vessels and steamers used for fishing, whaling and local commerce were commonly seen alongside native canoes.

Since the mid-1990s, NOAA's Office of National Marine Sanctuaries has compiled and periodically updated a database of historic ship and military aircraft losses that includes known

* The term "historical" refers to cultures with written language.

archaeological resources in the vicinity of Olympic Coast National Marine Sanctuary. Approximately 207 historic ships have been documented as lost in what is now the sanctuary between the early-nineteenth and mid-twentieth centuries (Schwemmer 2008). As the rate of shipping increased with the growing regional economy and settlement, so too did the rate of shipwreck increase off the Olympic Peninsula. An assessment of the database indicates the majority of losses were weather-related, including founderings, collisions and groundings. Many ships simply vanished after sailing past Tatoosh lighthouse, their resting place never known.

Ship types ranged from clippers and multi-sail rigged windjammers, to steam freighters, small gasoline powered fishing boats and barges. There are a number of ships that have entered local lore and are still remembered by local citizens of the peninsula. Examples include:

SS *Skagway* - On December 16, 1929, the Dollar line steam freighter, *Skagway*, caught fire and drifted into the rocks around Fuca Pillar at Cape Flattery. The rocks where she went down have since been referred to as Skagway Rocks.

W.J. Pirrie - The five-masted iron ship *Pirrie* had been reduced to a sailing barge after almost forty years of sailing when it hit the rocks during a storm on November 11, 1920. Sixteen crew (including the captain's wife and young child) drowned and were washed ashore around Cape Johnson. Because the ship had Chilean registry at the time of its sinking, she became known as the "Chilean Wreck" and is so commemorated by a monument at the site where most of the bodies were recovered.

SS *Pacific* - Perhaps one of the greatest shipwreck mysteries of the Olympic Coast involves the sidewheel steamer *Pacific*, lost in 1851. The ship was steaming for Panama out of Victoria and reportedly carrying miners from the British Columbia gold fields when she collided with another ship. Only two of almost three hundred passengers survived. Treasure salvors have sought the ship in the past in the belief the miners on board may have been carrying unreported gold in their baggage and on their persons. The ship has not yet been located.

Two locally well-known wrecks (among several others) occurred in the vicinity of La Push. One of the earliest recorded local wrecks was the Russian brig *St. Nicholas* on Rialto Beach in 1808. Several of the crew were captured by Native Americans and their ordeal was a well-told story. The earliest steam shipwreck in the sanctuary region was the *Southerner* in 1854. A wooden sidewheel steamer built in 1846, *Southerner* served as a passenger steamer when it sprang a leak and the captain was forced to run her ashore at First Beach at Quillayute (now La Push). The large island situated at the mouth of Quillayute River, originally called Alekistet Island by the Quileute tribe, was renamed James Island by the white settlers to honor Francis W. James who scaled it in order to watch over the remains of the ship and protect it from illegal salvage (Terrell no date).

6.3.2.2 Archaeological Resources

In compliance with Section 110 of the National Historic Preservation Act, OCNMS undertook five surveys to document historical shipwrecks between 1995 and 2001. Utilizing acoustic and magnetic remote sensing and diver target identification, the research design identified areas of high probability for finding historically-reported shipwrecks near the southern shore of the Strait of Juan de Fuca, the vicinity of Tatoosh Island, Cape Flattery to Portage Head, as well as select areas at Cape Alava, La Push/Quilleyute Needles and Destruction Island.

Often searching in difficult and dangerous nearshore areas, the teams were able to locate remains associated with at least eight historic shipwrecks. A draft final report was compiled and a draft manuscript is presently on file at OCNMS. The report concludes the majority of the wreck remains in nearshore waters have been severely degraded due to heavy storm and wave impact. Several of the sites, which were found using sidescan sonar, could not be safely dived or documented by marine archaeologists.

Thus far, two historic shipwreck sites have been documented by the OCNMS. The remains of the World War II/Korean War troopship *General M.C. Meigs* at Portage Head was examined by diving archaeologists in 1997. Although scattered and broken in half, much material remaining should be documented further. Also, in 1997 a team investigated the nearshore remains of a nineteenth-century bark, the *Austria* at Cape Alava. Almost all wooden remains have been destroyed by the environment, but the team was able to locate the orientation of the wreck by the locations of significant objects such as the ship's anchor, anchor chains and hawseholes. The site subsequently has been used as an educational tool to teach students about the maritime heritage resources of the sanctuary.

Final recommendations in the report included further study of several sites, and focus of OCNMS' future efforts towards locating historical shipwreck remains in deeper water. The lack of exposure to winter storms suggest a better probability of preservation of submerged archaeological remains (Terrell no date).

6.3.2.3 Maritime Cultural Landscape

The National Historic Preservation Act directs federal agencies like NOAA to inventory and manage heritage resources, and, if appropriate, to nominate those properties to the National Register of Historic Places. The act also recommends agencies interpret the cultural landscape of a region. A search of National Register listings indicate three properties adjacent to the OCNMS. They are:

- Ozette Indian Village Archaeological Site
- Tatoosh Island
- Wedding Rock Petroglyphs

In addition to archaeological remains exhibiting the tribes' relationship with the sea, the region's Indian cultural landscape may contain (among other things) such elements of culture as stories, dances, traditional knowledge and practices, traditional place names and language. Even the tribe's renewed interest in canoe construction and navigation and whaling represent the prehistoric and tribal maritime cultural landscape.

So it is with historic maritime cultural landscapes. Archaeological remains of shipwrecks are but one component. Historic structures on land, while technically outside of sanctuary boundaries, remain as important tangible fragments of the past and provide insight into past human interactions with the ocean. These include historic lighthouses at Tatoosh and Destruction islands, lifesaving station remnants at Waadah Island and La Push, wartime defense sites at Cape

Flattery and Anderson Point, and sites of coastal patrol cabins scattered along the Olympic Coast. Homesteads, resorts, graves, and memorials also reflect a human dimension to the coast now largely reclaimed by time, the forest, or the sea. The oral traditions, stories, fishing practices and local lore also are components of the historical maritime cultural landscape.

6.4 HUMAN/SOCIOECONOMIC SETTING

The Olympic Peninsula has a rich history supporting diverse commercial, recreational, cultural, research and education activities. Western and American Indian populations alike, including the Hoh, Makah, Quileute, and Quinault peoples, utilize plant, fish, and shellfish resources, as well as the access and transportation routes within and adjacent to the sanctuary as an integral part of economic and socioeconomic activities. This section describes the character of the sanctuary and adjacent areas, including the population, overall economy, employment and housing. For the purposes of this analysis, the discussion of the affected environment is focused on those areas immediately adjacent to the sanctuary. Additional discussion focuses on the commercial activity dependent on the sanctuary area.

6.4.1 Population, Housing, Income, and Employment

Table 8 shows information on population, housing, poverty and income in counties immediately adjacent to the sanctuary. Despite the recent economic recession, populations, housing and incomes in Clallam, Grays Harbor and Jefferson counties have increased over the last decade. However, the percentage of the population with an income below the poverty level in each county has also increased over same period.

Table 8 Population, housing and income for counties adjacent to OCNMS

	Clallam County		Grays Harbor County		Jefferson County	
	2000	2009	2000	2009	2000	2009
Population	64,525	71,413	67,194	71,797	25,953	29,676
Housing Units	30,683	33,972	32,489	34,692	14,144	16,291
Area in Square Miles	1,739	1,739	1,917	1,917	1,814	1,814
Total Population Density per sq. mi.	37.1	41.1	35.1	37.5	14.3	16.4
Median Household Income	$37,420	$47,537	$34,724	$41,787	$39,519	$50,463
Poverty Status (% below poverty level)	12.1%	13.6%	15.0%	15.9%	10.7%	12.4%

Source: U.S. Census Bureau 2000; Washington State Office of Financial Management 2009.

Table 9 shows information from the 2000 census on population, housing, poverty and income in American Indian communities in the vicinity of the OCNMS. All Coastal Treaty Tribes have experienced, and in many cases still experience, high unemployment and poverty rates. Much of the tribal culture and economy is resource-based and focused on commercial fishing, timber, and tourism.

Employment opportunities on American Indian reservations are much less diverse, given the smaller populations, and cultural and geographic isolation from major population centers. Much of the mainland adjacent to the sanctuary consists of sparsely populated areas under federal or tribal management, as well as sizeable tracts of privately-owned timberlands. The public areas outside tribal reservations are managed by the National Park Service, or administered by state or county governments.

Table 9 Population, housing and income for American Indian Tribes adjacent to OCNMS

Population, Housing and Income	Makah Tribe	Quileute Tribe	Hoh Tribe	Quinault Nation
Population	1,356	371	102	1,370
Housing Units	534	128	33	406
Area in Square Miles	47.0	1.6	0.7	316.3
Total Population Density	28.9	236.6	137.1	4.3
Median Household Income	$24,091	$21,750	$21,875	$26,488
Poverty Status (% below poverty level)	26.8%	34.5%	42.0%	31.5%

The Coastal Treaty Tribes are dependent economically, culturally and spiritually upon natural resources found on their reserved lands and within their usual and accustomed hunting, fishing and gathering areas. Much of the tribal economies are resource-based, focused on commercial fishing, timber and tourism. Commercial fishing is one of the mainstays of the tribal economies, with emphasis on Dungeness crab, groundfish, salmon and steelhead, blackcod (sablefish) and razor clams (see section 6.4.3).

As with the rest of the Olympic Peninsula, while natural resources continue to support the area economy, tourism is growing in importance for the Coastal Treaty Tribes, particularly recreational fishing, nature viewing and active water sports (surfing and kayaking; section 6.4.8). The Quinault Indian Nation runs a successful casino in Ocean Shores. The Quileute Tribe runs a very popular resort and marina, and more recently with the overwhelming success of the Twilight books and movies has become a popular tourist destination. The Makah Tribe also runs an important regional marina and one of the most popular museums in Washington state, the Makah Cultural and Historical Center.

The following sections describe the importance the resources within the boundaries of the sanctuary play in the economic and socioeconomic lives of the coast's residents, residents of Puget Sound, as well as the wider community dependent on sanctuary access. The potential for effects on the human/socioeconomic setting derive mostly from these activities.

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Table 10 shows information on 2008 employment in counties adjacent to OCNMS. The government service, wholesale/retail trade, manufacturing and healthcare sectors dominate employment in the three counties, providing 68 percent, 71 percent and 71 percent in Jefferson, Clallam, and Grays Harbor counties, respectively. By contrast, only 1 percent, 2.8 percent and 3.6 percent of employment relies on the agriculture, forestry, fishing, and hunting sector in Jefferson, Clallam and Grays Harbor, respectively. Tourism, driven by the natural beauty and resources of the Olympic Peninsula, is a growing economic driver, and its impact is spread across several of the employment sectors shown, including fishing and hunting, retail trade, arts, entertainment and recreation and accommodation and food service.

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Table 10 Employment in counties adjacent to OCNMS (2008)

	JEFFERSON COUNTY		CLALLAM COUNTY		GRAYS HARBOR COUNTY	
	Avg. # of Employees (Percent of Workforce)	Wages Paid (Percent of Total)	Avg. # of Employees (Percent of Workforce)l	Wages Paid (Percent of Total)	Avg. # of Employees (Percent of Workforce)	Wages Paid (Percent of Total)
Agriculture, Forestry, Fishing & Hunting	1.2%	1.0%	2.4%	2.8%	3.6%	3.6%
Mining	0.6%	0.8%	0.0%	0.1%	0.3%	0.3%
Utilities	0.7%	1.6%	0.1%	0.1%	0.0%	0.0%
Construction	6.9%	7.8%	5.7%	6.2%	5.8%	7.2%
Manufacturing	8.3%	11.9%	6.1%	8.2%	16.4%	20.6%
Wholesale/Retail Trade	12.6%	10.3%	16.7%	13.9%	14.0%	11.9%
Transportation & Warehousing	0.7%	0.6%	2.0%	2.1%	2.4%	2.4%
Information	1.6%	1.9%	1.3%	1.4%	0.9%	1.0%
Finance, Insurance, & Real Estate	3.9%	3.5%	3.4%	3.1%	3.5%	3.4%
Professional & Tech. Services	2.6%	2.7%	2.4%	2.6%	1.5%	1.8%
Management of Companies & Enterprises		0.0%	0.7%	1.4%	0.2%	0.3%
Administrative & Waste Services	1.7%	1.2%	1.9%	1.3%	2.0%	1.7%
Educational Services	1.7%	1.1%	0.3%	0.1%	0.0%	0.0%
Health Care & Social Assistance	15.7%	14.3%	11.2%	9.2%	9.0%	9.5%
Arts, Entertainment,& Recreation	1.3%	0.8%	1.0%	0.5%	0.9%	0.4%
Accommodation & Food Services	12.2%	5.2%	9.6%	4.0%	8.7%	3.5%
Other Services, except Public Administration	5.1%	3.7%	4.9%	3.0%	5.5%	2.7%
Government	23.3%	31.5%	30.3%	40.0%	25.2%	29.5%
Not Elsewhere Classified					0.1%	0.1%

The following sections describe the importance the resources within the boundaries of the sanctuary play in the economic and socioeconomic lives of the coast's residents, residents of Puget Sound, as well as the wider community dependent on sanctuary access. The potential for effects on the human/socioeconomic setting derive mostly from these activities.

6.4.2 Maritime Transportation

Maritime transportation within the sanctuary includes both vessels in transit, simply passing through the sanctuary under way to another destination, and vessels within the boundaries of the sanctuary for a particular purpose. An understanding of vessel activity is necessary for sanctuary management for a number of reasons, both from a perspective of potential impacts from vessel activities and also from a more general perspective of characterizing human activities within the sanctuary. In very broad terms most vessels found within the sanctuary can be described as large commercial vessels, commercial fishing vessels and recreational vessels.

The sanctuary lies at the entrance to the Strait of Juan de Fuca, a major international waterway linking the important North American ports of Seattle, Tacoma, and Vancouver, Canada, with trading partners all around the Pacific Rim. Every year, approximately 10,000 large commercial vessel transits occur at the western end of the Strait of Juan de Fuca. The uses of sanctuary waters for maritime transportation, along with commercial fishing, are the most significant commercial uses of the sanctuary. The total number of transits of vessels participating in the Cooperative Vessel Traffic Service (CVTS) off the Olympic Coast in 2009 are summarized in Table 11, along with the duration of their transit. These data were derived from observations by the Canadian Coast Guard Marine Communications and Traffic Services (MCTS) Tofino Radar facility. Public vessels are those engaged in work for the government or public institutions (e.g., Coast Guard, research, spill response).

Cruise ship operations generally utilize the sanctuary for purposes of transit, simply passing through the sanctuary inbound to the Ports of Seattle and Vancouver, Canada or outbound to Alaska and other cruise destinations in the Pacific or other U.S. or foreign ports. However, the economic impact of the cruise ship industry in the region is substantial, and includes spending and jobs related to ship supplies, repairs and maintenance, fuel, stevedoring, port costs, pilotage, hotel accommodations for passengers and crew, local tours and shopping, restaurants, buses, taxis and air transportation. The Port of Seattle estimates the cruise industry in 2008 produced 1,955 direct jobs, 1,125 induced jobs, and 701 indirect jobs in the Puget Sound area alone from ships transiting the sanctuary. The Port of Seattle also estimates the cruise industry generated $312.5 million in business revenue and $16.1 million of state and local taxes in the Puget Sound (POS 2009). The North West and Canada Cruise Association estimates in British Columbia alone, the estimated spending by the ships, passengers and crew is in excess of $500 million (Canadian) per year. The Association estimates similar numbers for Alaska, where recent studies cite more than $700 million (US) in annual economic benefits directly tied to the industry.

Vessel traffic in northern portion of the sanctuary is managed through a 1979 formal agreement between the Canadian and United States Coast Guards. This agreement created the Cooperative Vessel Traffic Service (CVTS). The purpose of the CVTS is to provide for the safe and efficient movement of vessel traffic while preventing collisions and groundings, and therefore minimizing the risk of environmental damage that would follow.

Table 11 All Cooperative Vessel Traffic Service (CVTS) vessel transits in 2009. For transits in OCNMS, the cumulative time and average transit time in OCNMS for all vessels of a given classification combined is provided for each vessel class.

Vessel Classification	Total Transits	OCNMS Transits	Cumulative Time (minutes)	Cumulative Time (days)	Avg Time (hours)
Commercial Vessel < 300 GT	354	249	49,272	34.2	3.3
Commercial Vessel 300-1599 GT	246	65	14,229	9.9	3.6
Commercial Vessel > 1600 GT	6,449	4,272	403,534	280.2	1.6
Fishing Vessel < 300 GT	915	243	37,927	26.3	2.6
Fishing Vessel 300-1599 GT	146	63	11,814	8.2	3.1
Fishing Vessel > 1600 GT	125	81	15,431	10.7	3.2
Passenger Vessel < 300 GT	15	14	1,208	0.8	1.4
Passenger Vessel 300-1599 GT	9	9	1,170	0.8	2.2
Passenger Vessel > 1600 GT	451	280	20,727	14.4	1.2
Public Vessel < 300 GT	42	16	3,064	2.1	3.2
Public Vessel 300-1599 GT	227	75	14,926	10.4	3.3
Public Vessel > 1600 GT	291	157	24,912	17.3	2.6
Recreational Vessel < 300	29	13	1,454	1.0	1.9
Recreational Vessel 300-1599	42	36	3,813	2.6	1.8
Tank Vessel	1,734	1,401	209,360	145.4	2.5
Tug with tank barge-laden	104	94	29,447	20.4	5.2
Tug with tank barge-unladen	100	95	21,568	15.0	3.8
TOTAL	11,279	7,163	863,856	599.9	2.0

As part of the agreement, Tofino Traffic in Canada provides CVTS coverage for the offshore approaches to the Strait of Juan de Fuca and along the Washington State coastline from 48 degrees north. Seattle Traffic in the U.S. provides CVTS coverage for both the Canadian and US waters of Strait of Juan de Fuca (http://www.uscg.mil/d13/cvts/purposeandobjective.asp). In addition to the marine communications and traffic services provided by the Canadian Coast Guard, the main features of the CVTS within the boundaries of the sanctuary are a number of International Maritime Organization (IMO) vessel routing measures. These include a traffic separation scheme with western and south-western approaches, a recommended route for smaller, slower moving vessels that normally do not use the traffic separation scheme, and an Area to be Avoided (ATBA) (Figure 8).

When the sanctuary was designated in May 1994, NOAA worked with the U.S. Coast Guard to propose that the IMO approve and adopt an ATBA off the Olympic Coast. This ATBA, which went into effect in June 1995 and was updated in 2002, advises operators of vessels above 1600 gross tons and those carrying petroleum and hazardous materials as cargo to maintain a 25-mile buffer from the coast. This distance narrows as the vessel traffic lanes converge at the entrance to the Strait of Juan de Fuca. It is important to note that the boundaries of the ATBA and of the Sanctuary are not contiguous. The ATBA compliance rate has consistently been very high and was estimated to be 98.9% in 2009 (WDE 2010). OCNMS works with the USCG to notify non-compliant vessels with a formal letter requesting that they adhere to the ATBA in the future.

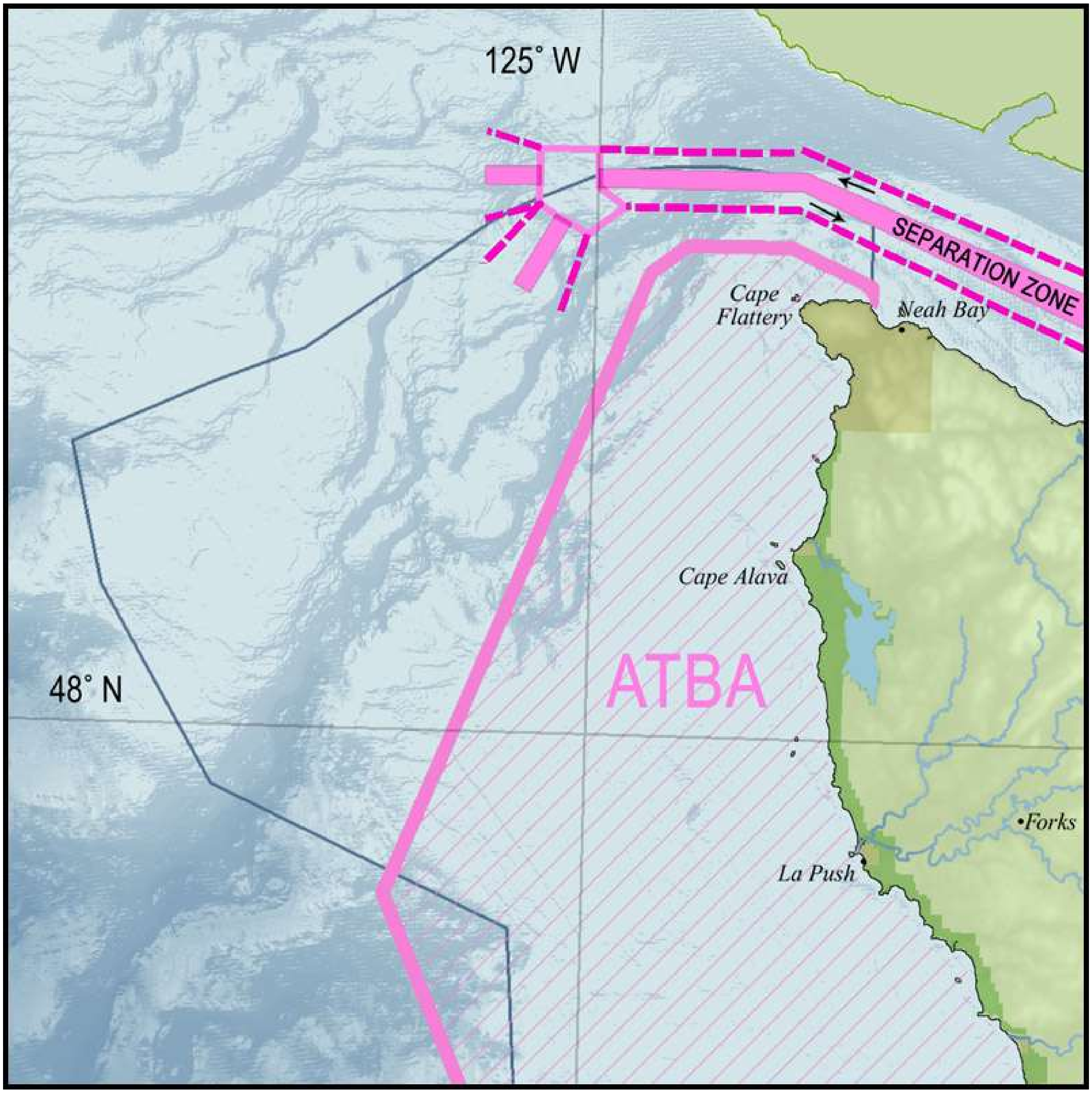

Figure 8 Vessel traffic management system

Just as marine transportation forms a vital economic link for Pacific Rim trade, the sanctuary forms a vital link among resource management agencies, enforcement organizations and the maritime transportation industry.

6.4.3 Commercial Fishing

Commercial fisheries within the sanctuary are major components of the coastal economy and provide valuable food resources to the Northwest and beyond. Commercial and tribal fishers, as well as the business supporting these fisheries, are significant stakeholders in the health of the fisheries.

The commercial fishing industry in Washington state is structured around a multi-species fishery. Groundfish, halibut, albacore, salmon and shellfish are all major species groups important to the industry. In 2006, non-tribal commercial fishing generated nearly $100 million in personal income and supported over 3,500 direct and indirect jobs in Washington state. These figures include only fisheries conducted off the coast of Washington and do not include commercial fishing by Coastal Treaty Tribes. When these segments are added, the harvest value is nearly $150 million. Though not directly correlated to the boundaries of the OCNMS, the Washington coast accounted for over 60% of the harvest value of commercial fisheries in 2006. Including in-state processing, the wholesale value of fishery products caught in Washington waters was an estimated $101 million in 2006 (WDFW 2008a).

Relative to uses of the OCNMS, commercial fishing activity can be described in two categories: commercial fishing vessels transiting through the area on way to their fishing grounds, home port or to another port for services; and those conducting operations in the sanctuary. Commercial fishing activity in the sanctuary includes both tribal and non-tribal fleets. The Makah, Quileute and Quinault fishers work respectively from the ports of Neah Bay, La Push and Grays Harbor. The Hoh Tribe does not currently have an ocean fishing fleet. Non-tribal fishermen work out of both Oregon and Washington ports.

Some groundfish species have been depleted in the past and have recovered quickly (e.g., English sole, Pacific whiting, and lingcod), while others are rebuilding more slowly (e.g., Pacific ocean perch) (PFMC 2008a). For depleted species, rebuilding programs are in place, with anticipated stock recovery period from several to over 80 years for different species. All species considered depleted are on track to be rebuilt by their respective schedules, which take into account their different life histories. Recent fishery management measures implemented to reduce fishing effort, monitor and minimize bycatch, and reduce impacts to habitat appear to have assisted initial recovery of some overfished groundfish stocks and provide evidence for an improving trend.

There are some indications the biomass off Washington of several rockfish species is high (per unit area) compared to Oregon and California, and this information has been taken into account for the management of some stocks (e.g., black rockfish). Survey data collected during NMFS trawl surveys have not been quantitatively analyzed to determine if other groundfish stocks off Washington or in the sanctuary are more abundant than those off Oregon and California.

The commercial Dungeness crab fishery has over 200 Washington coastal commercial Dungeness crab license holders. Dungeness crab landing data back to 1950 shows a large fluctuation in landings, averaging 4,300 metric tons (9.5 million pounds) per year, with variability likely due to varying ocean conditions including water temperature, food availability and ocean currents. A fishery for pink shrimp off Washington peaked in 1988, with landings just over 18 million pounds and about 100 vessels involved. Within a few years, a dramatic decline in local abundance drove many fishers out of the fishery. Since 2000, the Washington coastal fishery has been stable, with landings of seven to eight million pounds annually and about 25 fishers participating. Most shrimp and crab fishing occurs off the central and southern coast of Washington.

The Pacific halibut female spawning biomass is estimated at three to four times above the historical minimum in the mid-1970s, indicating that the halibut population is in good condition (NMFS 2004). Catch limits in Area 2A (Washington, Oregon and California) for commercial, treaty and recreational halibut fishing are approximately double limits imposed in the early 1990s.

Chinook and coho salmon are the main salmon species managed by PFMC and American Indian tribes off Washington's outer coast. In odd-numbered years, fisheries are also conducted near the Canadian border for pink salmon, which are primarily of Frasier River origin. Managing ocean salmon fisheries is an extremely complex task, due to the wide oceanic distribution of the salmon, wide variability and difficulty in estimating population sizes, and significant differences between model estimates and actual returns. In the past decade, landings from the ocean troll fishery off Washington (excluding the area south of Willapa Bay) varied five-fold for chinook and nine-fold for coho between low and high catch years, but no clear trends in landings are evident (PFMC 2008b). Salmon at all life history stages are affected by a wide variety of natural and human-caused factors in the ocean and on land, including ocean and climatic conditions, habitat degradation and loss, and predators (including humans). Other challenges to a sustainable salmon fishery off the Washington coast include judging the effects of different regional fisheries on salmon stocks, recovering salmon under the Endangered Species Act, dividing the harvest fairly, impacts from salmon aquaculture, competition between wild and hatchery salmon, and restoring freshwater habitat (PFMC 2008b).

Fisheries management policies enacted on the West Coast and within the sanctuary have been progressive steps to incorporate ecosystem-based fishery management concepts and improve trends toward restoring historical population levels. A variety of recent fishery management actions off the Washington coast, such as trawl footrope gear restrictions, low-rise nets that reduce bycatch, monitoring of bycatch, protection of Essential Fish Habitat, implementation of stock rebuilding plans, and establishment of temporary area closures (Rockfish Conservation Areas) to promote recovery of species under rebuilding plans, have provided early indications that depleted stocks can recover and these fisheries can be sustainably practiced. OCNMS' role in this management regime has been development of detailed seafloor habitat maps and participating in evaluation of essential fish habitat designations for groundfish.

6.4.4 Developed Environment

The shoreline and submerged lands of the sanctuary are largely undeveloped, but there are a number of manmade structures that do exist within or immediately adjacent to the sanctuary.

The La Push harbor at the mouth of the Quillayute River is the only port immediately adjacent to the sanctuary. The La Push marina is managed by the Quileute Tribe and supports their tribal fishers, as well as other non-tribal commercial and recreational fishers. The entrance to the harbor is maintained by the U.S. Army Corps of Engineers (USACE) as part of the Quillayute

River Navigation Project. Activities related to this project include the maintenance of the entrance channel, the boat basin and a protective jetty (USACE 2009). OCNMS regulations include an exception to allow for continued harbor maintenance associated with this project (15 CFR 922.152(a)(4)(iv).

There are several submarine cables that have been installed within the sanctuary, many of which were in place at the time OCNMS was designated in 1994. Since 1994 three fiber optic cables have been installed in the sanctuary (Figure 9). When OCNMS was studying the recovery of the seafloor habitat following the 1999 installation of the two Pacific Crossing cables (PC-1), sections of the cables were found to be exposed and suspended above the seafloor. In response to concerns about long-term cable integrity and conflicts with fisheries, PC-1 cables were recovered throughout the sanctuary and reinstalled in 2006 in an effort to comply with permit conditions, minimize risk to the cables, and reduce conflicts with fisheries.

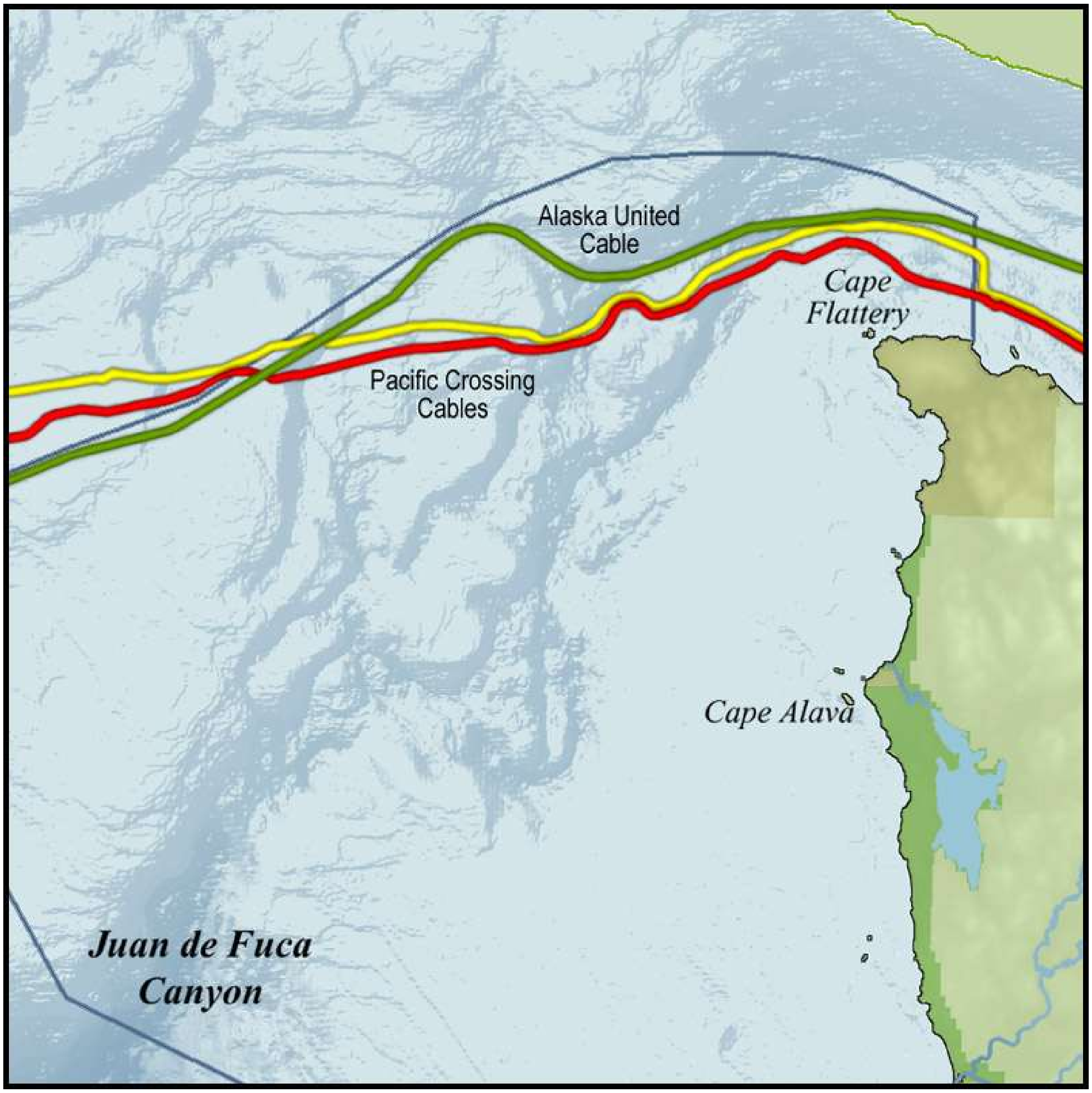

Figure 9 Location of the Alaska United and Pacific Crossing fiber optic cables

There are several year round and seasonal buoys within OCNMS, primarily navigational aids and monitoring/research buoys. The U.S. Coast Guard maintains navigational aids within the sanctuary; the National Data Buoy Center maintains weather observation platforms; and various agencies and academic institutions deploy research moorings.

In today's world, there is evolving and expanding interest in development of coastal marine waters, supported by technological advancements and in response to emerging social and economic needs. While current managers may not be able to anticipate development that might be proposed a decade or two in the future, access to physical forces in the ocean has emerged as development feasible in the immediate future as a source of renewable energy from a domestic source, without combustion of fossil fuels and exacerbation of climate change impacts. In fact, Makah Bay in OCNMS was the site of the first federal license issued to an ocean energy project intended to supply the public electricity grid. Beginning in 2000, AquaEnergy sought partnerships for the Makah Bay Wave Energy Pilot Project and was successful in gaining interest and agreements with several groups, including the Clallam County Public Utility District in Washington State and the Makah Tribe. Finavera Renewables, Inc. acquired AquaEnergy in May 2007, and the Federal Energy Regulatory Commission issued the first ocean energy license in the U.S. to this project in December 2007. Finavera eventually rescinded this license, and the pilot project was never constructed. From a resource protection perspective, this project was a challenge to OCNMS during this FEC licensing process for several reasons. At the time when OCNMS was required to define environmental concerns and monitoring requirements to evaluate potential natural resource impacts, no functional wave energy buoys of similar design had ever been constructed and field tested. Data for environmental impacts of similar projects anywhere in the world was sparse. Specifications for design of anchors, cables and power transmission lines had not been developed. In addition, this project was a new example of tradeoffs between potential localized environmental impacts and development of the ocean for renewable energy and, perhaps, sustainable human habitation of the planet. It is likely that consideration of similar projects and similar tradeoffs will be in the future for ONMS.

6.4.5 Department of Defense Activities

In or adjacent to the sanctuary, the military has pre-established surface and subsurface ocean operating areas, including two warning areas (W-237A and W-237B) and two military operation areas (MOAs Olympic A and B) that are identified in OCNMS regulations (Figure 10). Military activities in these areas consist of subsurface, offshore surface, aerial training activities, and other military operations, which were described in general terms in the sanctuary's original environmental impact statement (NOAA 1993) and have been analyzed in more detail in recent Navy NEPA documents (U.S. Navy 2010a and b).

Whereas OCNMS regulations include several prohibited activities (15 CFR 922.152(d)), they also provide an exception for the following military activities within W-237A, W-237B, and MOAs Olympic A and B:

- Hull integrity tests and other deepwater tests
- Live firing of guns, missiles, torpedoes and chaff
- Activities associated with the Quinault Underwater Tracking Range, including the in-water testing of non-explosive torpedoes
- Anti-submarine warfare operations

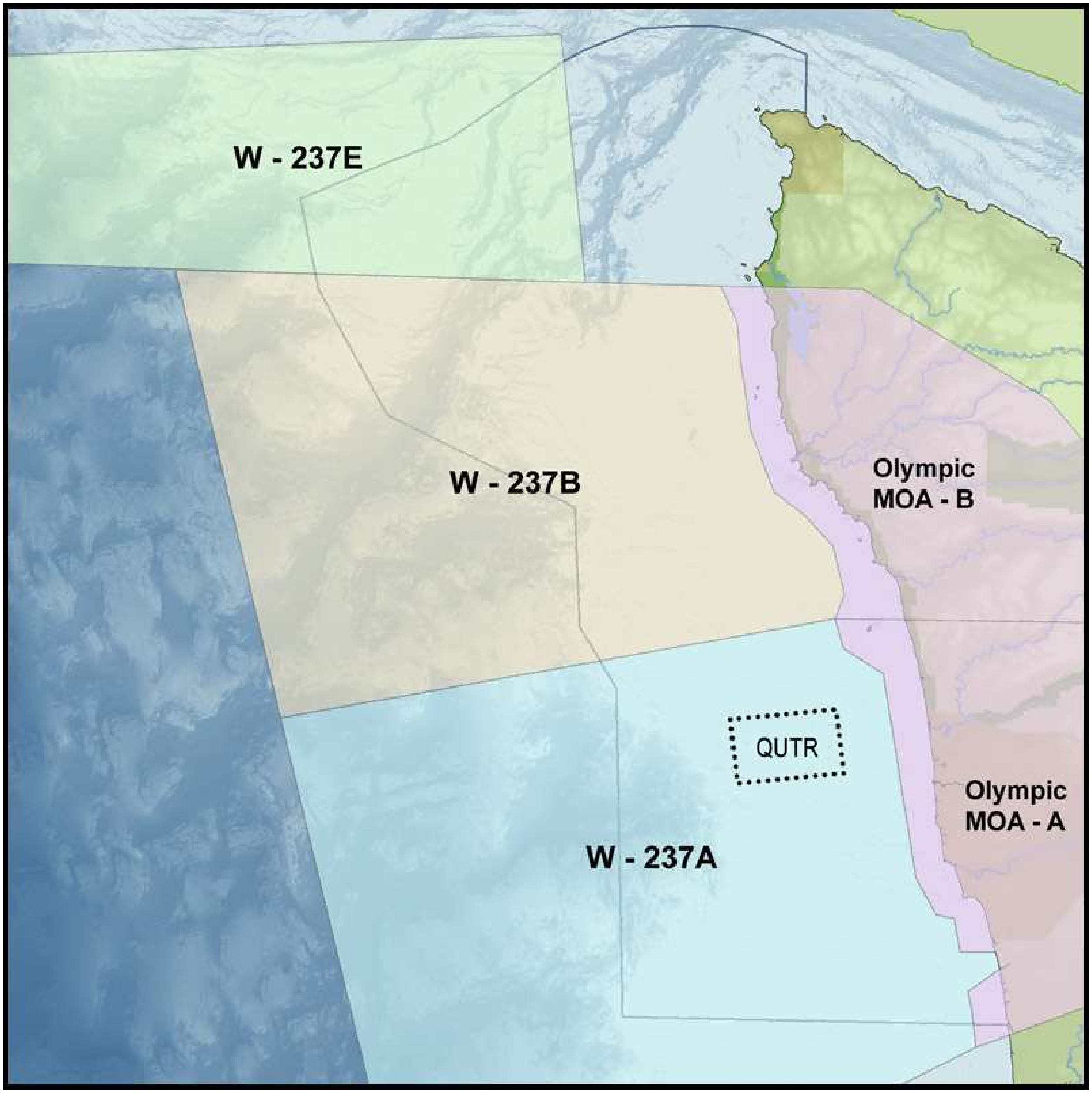

Figure 10 Military Operating Areas

Navy activities associated with technology research, development, testing and evaluation conducted in the Quinault Underwater Tracking Range (QUTR), and fleet training exercises in the Northwest Training Range Complex (NWTRC) recently have been described in considerable detail, and their potential effects evaluated in separate environmental impact statements (EIS) via the National Environmental Policy Act (NEPA) process. The Navy's Underwater Warfare Center (NUWC) Division Keyport operates and maintains the QUTR located in Navy Operations Area W-237A. The Navy has conducted underwater testing at the QUTR since 1981 and maintains a control center at the Kalaloch Ranger Station. This range is instrumented to track and test surface vessels, submarines and various undersea vehicles. Research work involves testing of equipment and technologies, including mobile targets, torpedoes, underwater mine shapes, and autonomous vehicles. The Navy has proposed expansion of this range's area more than 50-fold to support existing and future needs in manned and unmanned vehicle programs development (U.S. Navy 2010a). The preferred alternative in the final EIS expands this range's boundaries to coincide with the existing W-237A Military Warning Area boundary and adds a surf-zone access site at Pacific Beach (Figure 10). To minimize cetacean disturbance, it is the policy of NUWC Division Keyport not to test when cetaceans are known to be present. The Navy was issued a Letter of Authorization under the Marine Mammal Protection Act (MMPA) for use of sound sources for Keyport activities in May 2011. The Navy does not plan to expand any permanent bottom-mounted instrumentation, but has proposed temporary (up to two years) installations on the seafloor. In its comments during EIS development in consultation with Navy representatives, OCNMS requested avoidance of hard substrate areas that might support biogenic habitat and minimization of military expendable materials use.

Navy fleet training activities were evaluated under a separate NEPA process that addressed the Northwest Training Range Complex that covers large areas of the ocean off Washington, Oregon and northern California (U.S. Navy 2010b). During scoping for these NEPA analyses, the OCNMS Advisory Council requested the NEPA analysis consider a wide variety of issues, including disturbance to birds, fish and mammals from increased activity and noise; damage to seafloor habitats and wildlife from cables, anchors, targets, torpedoes and unmanned undersea vehicles; accidental discharges of pollutants; interference with tribal fishing and subsistence harvest activities; and restrictions on the ability of sanctuary and affiliated scientists to conduct research. Within this area, the Navy conducts a variety of training activities, including anti-surface warfare, anti-submarine warfare, electronic combat, mine warfare, strike warfare, and special forces training. The preferred alternative in the Navy's 2010 EIS included a relatively small percentage increase in use of various ordnances and expendables. In comments submitted during EIS development in consultation with Navy representatives, OCNMS raised concerns with impacts to disturbance-sensitive biogenic seafloor habitats and contributions to marine debris from military expendable materials, and requested development and use of biodegradable materials for expendable equipment. The Navy was issued a Letter of Authorization under the MMPA for use of sound sources for NWTRC activities in November 2010.

6.4.6 U.S. Coast Guard/Homeland Security Activities

The U.S. Coast Guard (USCG) protects U. S. coastlines by enforcing Federal law related to vessel safety, fishing, entry of illegal immigrants, drug trafficking and ocean dumping. The USCG also conducts search and rescue operations, assumes the lead in responding to spills of oil and hazardous waste into marine waters, and responds to complaints of improper conduct and vessel operation. USCG coverage of the sanctuary is shared by the 13th Coast Guard District's Sector Puget Sound and Sector Columbia River.

Sector organization allows complementary Coast Guard assets to be coordinated under one command, focused on the primary areas of prevention and response. Sector Commanders fulfill a number of functions, such as Captain of the Port, Federal Maritime Security Coordinator, Federal On-Scene Coordinator, Officer-in-Charge of Marine Inspection, and Search and Rescue Mission Coordinator. Sector Puget Sound combines the legacy Vessel Traffic Service, Group, and Marine Safety Office into one consolidated organization with missions that include maritime safety, maritime security, protection of natural resources, maritime mobility and national defense.

OCNMS also works closely with USCG Air Station/Sector Field Office Port Angeles, which is responsible for Neah Bay and Quillayute River Small Boat Stations; the 110-foot Patrol Boat USCGC Cuttyhunk; and seven 87-foot Patrol Boats. In addition, the Air Station/Sector Field Office Port Angeles maintains three MH-65C Dolphin short-range rescue helicopters. Certain activities carried out by the USCG necessary to respond to emergencies threatening life, property, or the environment, or necessary for law enforcement purposes are exempt from the prohibitions set forth in sanctuary regulations (15 CFR 922.152 (c) and (d)). However, other activities such as routine maintenance of aids to navigation and training exercises are not exempt from sanctuary regulations. Recognizing many of these routine activities as necessary to support OCNMS management objectives and ensure safe navigation at sea, the USCG and OCNMS have entered into a Memorandum of Agreement, which establishes a consultation process whereby USCG and OCNMS mutually agree upon procedures for conducting activities to support the sanctuary's mission that might otherwise be prohibited by sanctuary regulations.

6.4.7 Recreational Fishing

Recreational fisheries within the sanctuary are major components of the coastal economy, providing valuable recreational opportunity and food resources to the Northwest and beyond. Recreational fishers, as well as the business supporting these fisheries, are significant stakeholders in the health of the fisheries. Recreational fisheries in the sanctuary include shore-based (surf casting, razor clamming and intertidal collection) and vessel-based activities managed primarily by Washington Department of Fish and Wildlife and Olympic National Park. In the entire state of Washington, recreational fishing, including finfishing and shellfishing, supported nearly 12,000 direct and indirect jobs in 2006, producing over $390 million in personal income in 2006. In 2006, recreational fishing in Washington state produced about $355 million in trip-related spending and $549 million in equipment expenditures, which includes the personal income generated. Of the jobs supported by recreational fishers, state residents accounted for more than 90 percent of the spending supporting these jobs (WDFW 2008b).

Vessel-based recreational fishers typically operate in the sanctuary from marinas and boat launch ramps in La Push and Neah Bay, or farther afield in Westport and Seiku. The sanctuary overlaps WDFW marine management areas 2, 3, 4, and 4B. In 2009, nearly 100,000 angler trips were documented in these areas, of which about 60% were on private vessels and 40% on charter vessels (WDFW Ocean Sampling Program data).

6.4.8 Recreation and Tourism

Over three million visitors are drawn to the Olympic Peninsula each year, attracted by beautiful scenery, the wilderness character of the landscape, spectacle of wildlife and the opportunity to challenge themselves in a natural environment. Many of these visitors reach the 65 miles of coastline the sanctuary shares with Olympic National Park. Nature viewing, hiking, camping and surfing are popular pursuits along this coastal wilderness strip. Wildlife watching is superb, with rewarding birding and whale watching opportunities available year round. In addition, Cape Flattery, on the Makah Indian reservation is the northwestern-most point in the lower 48 United States, and a spectacular and very popular destination.

Most recreational boating in the sanctuary is sport fishers conducting day trips from the Neah Bay and La Push marinas. Other marinas supporting smaller vessels frequenting the sanctuary include Westport, Seiku and Snow Creek. Other recreational boating activity is associated with the non-consumptive uses such as diving, kayaking, wildlife viewing and sightseeing. Most recreational activity takes place during summer months, with recreational fishing largely concentrated around limited fishery openings managed by the Washington Department of Fish and Wildlife. Active water sports include sea and surf kayaking and surfing. Recreational use of OCNMS is not well characterized, but due to the remoteness and occasionally harsh conditions along the Olympic Coast, these recreational uses are relatively less common than in other coastal areas. A few dive charter operators serve the Olympic Coast, but ocean conditions and isolation require advanced skills and open-water experience.

Another recreational activity in the sanctuary is overflight from private pilots. An overflight is broadly defined as an aircraft (helicopter, plane, or other type of aircraft) that flies over sanctuary waters. Low overflights have the potential to cause wildlife disturbance. In order to protect nesting seabirds and marine mammals from disturbance from low flying aircraft, OCNMS has a regulation prohibiting aircraft from flying below 2,000 feet within one nautical mile of the shoreline or the offshore islands (15 CFR § 922.152(a)(6). Low overflights are the most frequently observed violation of sanctuary regulations.

The socioeconomic importance of recreation and tourism on Washington's coastal communities is substantial. Statewide in Washington in 2008, travel and tourism generated over $14 billion in direct spending and over 145,000 tourism-related jobs, approximately 3 percent of all jobs and 2 percent of all earnings in the state. Over 80 percent of 2008 traveler trips had some form of leisure or recreation as the main purpose of the trip, and over half of those trips focused on something other than visiting relatives or friends. While direct correlation of recreation and tourism spending to the national marine sanctuary cannot be determined, it is known travel and tourism generated over $1 billion in direct spending in the coastal region of the state. In addition, travel and tourism represent a much higher proportion of overall spending and employment in Washington's rural counties, including the coastal counties adjacent to OCNMS, than in urban counties (DOC 2009).

6.4.9 Research and Monitoring

Characteristics identifying the Olympic Coast National Marine Sanctuary as a candidate for sanctuary designation also make it an important resource and site for scientific investigations. These characteristics include relatively undeveloped shoreline, high ecosystem productivity and high biodiversity. Research in the sanctuary is conducted by numerous governments, tribes, agencies and academic institutions for a variety of purposes. Much of this research is "basic" research to gain understanding of marine populations and systems, yet some efforts relate to resource management issues, such as fishery management. Emergent issues, such as hypoxic conditions and ocean acidification, are receiving increased attention, for which the sanctuary may become a focus area for research.

OCNMS' research program focuses on and supports scientific investigations to improve our understanding of the sanctuary's marine ecosystems and historical and cultural resources in order to provide managers with the information necessary to make informed decisions. In 2002, OCNMS staff and members of the Sanctuary Advisory Council drafted a Science Framework document intended to guide the sanctuary in prioritizing and implementing a sound research and monitoring strategy.

OCNMS promotes and helps coordinate research programs in partnership with federal and state agencies, academia and tribal governments across multiple habitat ecosystems and geographic/oceanographic features. This includes accessible areas such as intertidal sites to more difficult monitoring locations, such as deep-sea environments and pelagic environments.

OCNMS support for research and monitoring ranges from limited financial support to access to research vessels, either OCNMS or NOAA ships. Expertise from sanctuary staff is available, and logistical support is made available on a case-by-case basis.

6.4.10 Education and Outreach

OCNMS is an important regional educational asset. It is used as a living classroom by many regional school groups and a training ground for many local educators. Part of the Sanctuary's mission is to organize and present educational resources reflecting what we know about this place. We strive to improve the understanding of future generations of citizens - students - now in school classrooms. We assist teachers educating tomorrow's scientists and endeavor to help people in local communities and around the globe see their role in enjoying and protecting the Sanctuary.

Education is essential in protecting marine sanctuaries. We teach the science of protecting marine resources. We encourage people who live both near and far from the ocean to take appropriate actions. We introduce young people to the skills required to become ocean citizens, perhaps even to pursue ocean–related careers.

Olympic Coast National Marine Sanctuary regularly conducts unique education events and programs as well as ongoing outreach events in communities throughout the region. Each OCNMS staff has expertise in some aspect of science, education and marine protection that is regularly shared through informative and current presentations on topics of local interest.

Olympic Coast Sanctuary education programs use a wide range of media to present information. We offer our services to teachers and students of all ages; we use the Internet, print media, video and other high-tech ways of presenting our messages. We also assist others, offering training to naturalists and accurate information to print and broadcast media. It has been said the greatest threat is not what we put into the ocean or take out of the ocean. The greatest threat to the seas is our ignorance, and our brightest hopes hinge on expanding our understanding.

6.4.11 Passive Users

Economists have long recognized a special class of non-market economic values for natural resources and the environment referred to generally as nonuse or passive use economic value. These values are widely accepted as legitimate values to include in benefit-cost analyses of environmental regulations and in damage assessment cases. The term passive use, instead of nonuse, has become more popular because it is recognized that for people to have value for something they must have some knowledge about what they are valuing. People learn about natural resources or the environment they are asked to value through books, newspapers, magazines, newsletters, radio, television and other media sources. The people do not actually visit the sites and directly use the resources protected themselves, they consume them passively through the many indirect sources. The values have been referred to in the literature as option value, bequest value and existence value to clarify people's underlying motives for their willingness to pay. In other words, people have been shown to place a value on the ecological status and "health" of places they only know indirectly through various media and other channels, not through direct visitation or consumptive use.