

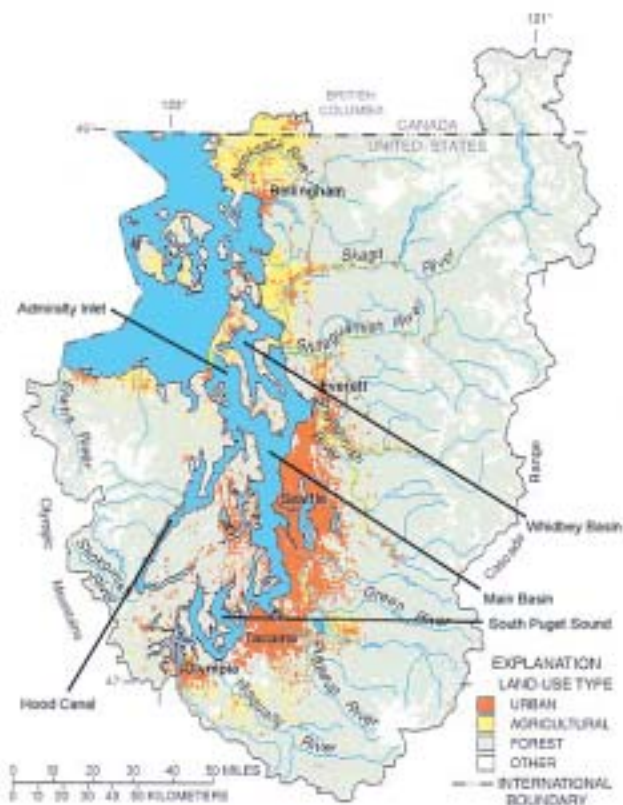
# 12 Puget Sound

## Overview

Puget Sound, located in northwest Washington State near the border of Canada and the United States, is part of a single large ecosystem that includes the Strait of Juan de Fuca and the Strait of Georgia. For this Guidebook, we have delineated the area of Puget Sound by the northern entrance of Admiralty Inlet.

Puget Sound is a fjord-like estuary with a series of deep basins and sills. These basins divides Puget Sound into four regions - Main Basin, Whidbey Basin, South Puget Sound, and Hood Canal.

## Location



### Basic information

Surface area : approx. 2,600 km<sup>2</sup>  
Volume : approx. 170 km<sup>3</sup>  
Average depth : approx. 65 m  
Maximum depth : 283 m

## Nature

### < Background >

The catchment area of Puget Sound is around 36,000 km<sup>2</sup> and is mainly comprised of mountains and coastal lowlands.<sup>5</sup>

The coastline of Puget Sound, consists of beaches, bluffs, deltas, mudflats, sandflats and wetlands. These areas play an important role for various land-based animals. Below the shoreline, extensive areas of seagrass and seaweed beds provide habitats to various marine species such as juvenile salmon.

< [http://www.psat.wa.gov/About\\_Sound/AboutPS.htm](http://www.psat.wa.gov/About_Sound/AboutPS.htm) >

### Climate

Puget Sound has a Mediterranean climate, with relatively cool dry summers and mild wet winters. Warm moisture-laden air masses from the Pacific Ocean keep air temperatures fairly even throughout the year and provide moderate to heavy rainfall from November through April. The annual precipitation is around 970 mm.<sup>1, 2</sup>

### Topography

The bottom topography of Puget Sound is characterized by a series of basins and sills, which were created by glacial action. A shallow sill (65m deep) at Admiralty Inlet separates the waters of the Strait of Juan de Fuca from Puget Sound proper. Puget Sound proper is divided into 4 interconnected basins (Main Basin, Whidbey Basin, South Puget Sound, and Hood Canal), and most of them are separated from each other by shallow sills. The largest and deepest basin is Main Basin, which is located south of Admiralty Inlet and extends southward for approximately 96 km. The maximum depth occurs north of Seattle at around 280 m.

South of Main Basin lies South Puget Sound. They are separated by a shallow sill of approximately 45 m depth. This basin is shallow and has numerous islands and inlets. North and east of Main Basin lies Whidbey Basin, but it is not separated by a sill. This basin is relatively deep, ranging between 100 and 200 m in depth.

The smallest of the four basins, in terms of area, is the Hood Canal, which branches from Main Basin, south of Admiralty Inlet, by a 50m deep sill. This basin is long and narrow, extending southward about 90 km. Except for the central region and entrance this basin is less than 40m deep.

< <http://www.nwfsc.noaa.gov/pubs/tm/tm44/Environment.htm> >

### Hydrology

The estuarine characteristic of Puget Sound is maintained by the input of seawater and fresh water. Typical of a fjord estuary, the net surface flow of Puget Sound is seaward.

Seawater is supplied by upwelling from the Pacific Ocean and through estuary-driven circulation. It intrudes into Puget Sound's main basin and further into the Sound's many passages, inlets and bays. These oceanic waters are rich in nutrients, relatively cold and have low oxygen content, and these factors have a strong influence on the Puget Sound ecosystem.

Freshwater is supplied from over 10,000 streams and rivers, with a daily inflow of about 3.4 trillion liters. The major input of freshwater comes from the Skagit and Snohomish Rivers located in Whidbey Basin.

The sea-surface temperature in Puget Sound is characterized by two patterns. In small, shallow bays and inlets that have limited vertical mixing, the sea-surface temperature shows high seasonal variation having high temperatures in summer and low temperatures in winter. In these areas, the ambient temperature influences sea-surface temperature. On the other hand, the sea-surface temperatures over the deep basins are cooler, show less seasonal variation and generally follow the oceanic water temperature. This is because cold oceanic waters are mixed into the surface water by turbulent tidal mixing.<sup>2</sup>

< [http://www.psat.wa.gov/About\\_Sound/AboutPS.htm](http://www.psat.wa.gov/About_Sound/AboutPS.htm) >

< <http://www.nwfsc.noaa.gov/pubs/tm/tm44/Environment.htm> >

## < Surrounding environment >

### Seagrass bed

Puget Sound has approximately 104 km<sup>2</sup> of seagrass. A significant proportion of the seagrass is found on flat bottoms, such as in large shallow bays and small pocket beaches. Close to one fifth of all the seagrass in Puget Sound grows in the Padilla Bay. Seagrass beds are also found as narrow fringing beds along steep shorelines, and this type of seagrass bed is commonly used as a migration corridor by salmon.<sup>3</sup>

### Wildlife

Puget Sound boasts one of the richest marine ecosystems in the world. The sheltered, current intensive, nutrient rich waters and the widely distributed kelp beds and seagrass meadows provide the basis of life for countless marine species. More than 220 species of fish species such as salmon, rockfish, herring and sole, as well as 26 species of marine mammals, including seals, sea lions, porpoises, killer whales, gray whales and minke whales, are found in the waters of Puget Sound. More than 100 seabird species also live in Puget Sound.

< <http://www.nwfsc.noaa.gov/pubs/tm/tm44/Environment.htm> >

### **Marine Protected Area**

Over 100 marine protected areas, designated by state and federal agencies, exist in Puget Sound for a variety of goals and objectives, with varying levels of restrictions.<sup>4</sup>

## *History and Culture*

### < **History** >

The oldest sites of human habitation in the region date back to 10,000 to 12,000 years ago, not long after the last glacial period. The earlier glacial people were gradually replaced by the Salish tribes. The Salish tribes relied heavily on native salmon for nutrition.

In 1792, Captain George Vancouver charted and explored the bays, harbors and islands of Puget Sound. Then, in the 1850's white settlers moved into the region, attracted by the abundant resources. Logging and fishing became popular industries until the 20<sup>th</sup> century.

(Source: Ack, B. 2003. Puget Sound Action Team)

### < **Culture** >

Salmon are a major icon of Puget Sound and have been central to the history and culture of the region. The native tribes geared their food-gathering cycle to the salmon runs and they traditionally celebrated the first salmon catch of the year with the First Salmon Ceremony. Nowadays, several organizations and tribes work together in the fall to put on a Salmon Homecoming festival on the Seattle waterfront. The festival celebrates the return of spawning salmon to the rivers and streams of Puget Sound.

(Source: Ack, B. 2003. Puget Sound Action Team)

## *Social Environment*

### < **Population** >

About 4 million people, or about 70% of the Washington State population live in the Puget Sound catchment area, mainly in the metropolitan areas of Seattle, Tacoma, Everett, Bellingham and Olympia. The population is now growing by about 50,000 people per year (1.5 % per year) and is expected to reach 5 million before 2020.

< <http://www.shs1.bham.wednet.edu/zodiac/Lessons/PugetSoundenvironcheck-2000.htm> >

### < **Land use** >

The catchment area of Puget Sound is comprised from mountains and coastal lowlands. Urban and agricultural lands cover about 9 and 6% of the catchment area, respectively, and are concentrated in the lowlands. Most parts of the catchment area are dominated by forestland concentrated in the foothills and mountains.<sup>5</sup> (Please refer to the location map in the beginning, for a visual representation of land use distribution.)

### < **Industry** >

Various industries are established in the Puget Sound region. Key industries in the region include aerospace (e.g. Boeing), advanced technology (e.g. Microsoft), international trade, general manufacturing, shipping and tourism. These industries are mainly concentrated in the urban areas. Major industries in the rural areas are fishing, oyster and salmon aquaculture, agriculture, forestry and wood products manufacturing.<sup>6</sup>

### **Fisheries**

The fishing and aquaculture industries are heavily dependent on the waters of Puget Sound. The aquaculture industries mainly cultivate salmon, clams and oysters. Oysters are particularly important, and the area is one of two major cultivation regions in the United States. Herring, cod, trout, perch, sole and flounder, as well as algae, sea urchin roe and sea cucumbers are also harvested from the Sound. In 1998, the total revenue

from commercial fish harvesting in Puget Sound was more than US\$12 million, and the industry employed nearly 900 people. Also revenues from commercial shell fishing in the same year hit the \$40 million mark, and the industry employed approximately 1,800 people. Furthermore, many tribes in the region rely on the harvest of fish and shellfish as an important part of their food supply and revenue.<sup>6</sup>

< [http://www.psat.wa.gov/About\\_Sound/Economic.htm](http://www.psat.wa.gov/About_Sound/Economic.htm) >

### Shipping

Seattle and Tacoma are the leading ports in the region. The two ports combined are second only to Los Angeles/Long Beach in container traffic for all U.S. ports. They are also the most diversified of the region's ports with key commodities ranging from wood products and grains to cars.

< [http://www.psat.wa.gov/About\\_Sound/Economic.htm](http://www.psat.wa.gov/About_Sound/Economic.htm) >

## Environmental Problems

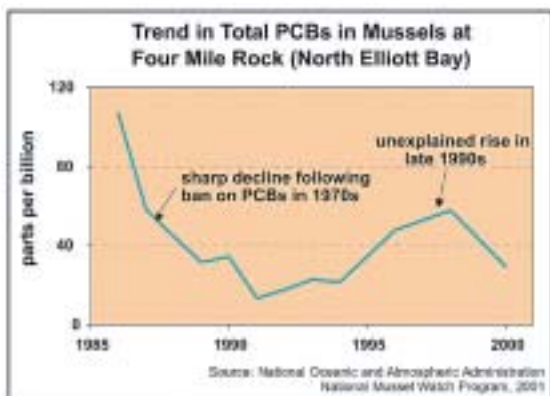
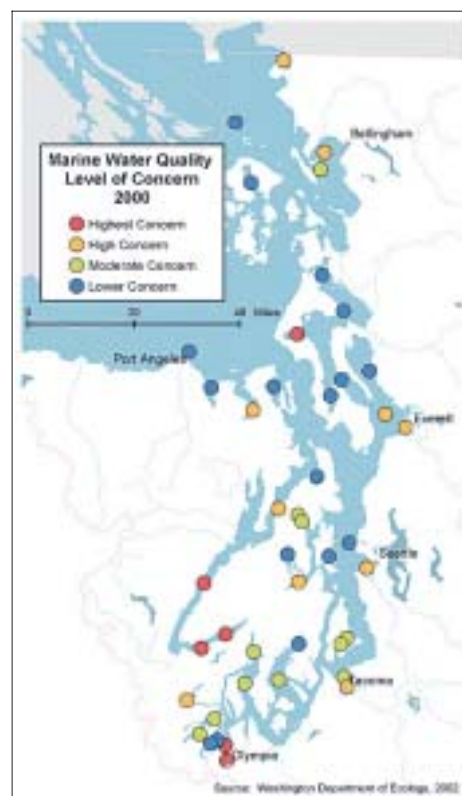
### < Water and sediment quality >

#### Water quality

According to the state Department of Ecology monitoring program, water quality in Puget Sound is reasonably good. However, several locations within Puget Sound have water quality problems associated with low dissolved oxygen and high fecal coliform bacteria contamination, and some areas are sensitive to eutrophication. These areas are generally located near urban areas and large rivers, and are characterized by having high river runoff, low mixing and anthropogenic inputs of nutrients and sewage. The areas of highest concern are in Southern Hood Canal, Budd Inlet, Penn Cove, Commencement Bay, Elliott Bay, Possession Sound, Saratoga Passage, and Sinclair Inlet.<sup>3</sup>

Another water quality problem found in Puget Sound is chemical contamination. As an indicator of chemical contamination, the toxic contamination levels inside mussels, harbor seals and English sole are monitored in Puget Sound. According to the mussel monitoring, concentrations of the long-banned pesticides, chlordane and DDT, and several metals such as lead and mercury, are declining.

Although the concentration of PCBs began declining after their ban in the 1970s, they showed a sudden rise in the mid-1990s at many monitoring stations. According to the NOAA's National Mussel Watch Program during 1997-98, PCB concentration of up to 533 ppb was detected at Four Mile



Rock (North Elliot Bay) near Seattle, the major source of PCBs for the region. Fortunately, the PCB concentration in Four Mile Rock started to decline again between 1999 and 2000.<sup>3</sup>

Within the same NOAA program, PAHs concentration in mussels were one of the highest in the United States.<sup>3</sup>

Monitoring of harbor seal blubber in 2002 showed high concentrations of PCBs and was significantly higher (approximately 8 times) compared to Strait of Georgia harbor seals. These differences probably reflect the high levels of industrial PCB usage in Puget Sound before its ban in the 1970's.<sup>3</sup>

#### Sediment quality

According to a survey conducted between 1997-1999 by the Washington State's Department of Ecology,



protection, spill prevention and response, storm water and combined sewer overflows.<sup>4</sup>

#### **Puget Sound Ambient Monitoring Program (PSAMP)**

To protect the water quality of Puget Sound, various state, local and federal agencies are involved in a wide range of monitoring programs through the Puget Sound Ambient Monitoring Program (PSAMP). The direction, scope and design of PSAMP are determined by the Puget Sound Water Quality Action Team and Puget Sound Council, and the results of the monitoring program are communicated back to the Puget Sound Water Quality Management Plan.

Monitoring includes fresh and marine water quality, sediment quality, fish and shellfish, nearshore habitat, marine birds, marine mammals and so on.<sup>4</sup>

#### **Puget Sound / Georgia Basin International Task Force**

Since the health of Puget Sound is interconnected with the inland waters of British Columbia (Strait of Georgia) and to ensure the protection, conservation and enhancement of these shared resources, a joint organization between Washington State and British Columbia Province was established in 1993, appropriately named as the Puget Sound/Georgia Basin International Task Force. The Task Force will research issues affecting the shared marine waters, adopt joint policies and implement actions, provide cross-border information exchange and organize workshops.<sup>4</sup>

#### **Related organizations and NGO**

- People for Puget Sound - A non-profit citizens group working to protect and restore the health of Puget Sound and the Northwest Straits through education and action < <http://www.pugetsound.org/> >
- The Association of National Estuary Programs (ANEP) - A non-profit organization dedicated to the preservation and restoration of the nation's bays and estuaries < <http://www.anep-usa.org/> >

## *References*

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