PUGET SOUND
VITAL SIGNS

VITAL Sign
MARINE WATER

Marine water quality refers to aspects of water such as temperature, salinity, oxygen, nutrient levels, organic matter, and pH. A functioning, resilient Puget Sound ecosystem also includes marine sediment quality that supports healthy communities of sediment-dwelling invertebrates. The Marine Water Vital Sign tells us about the condition of marine waters and sediment in Puget Sound.

Marine water and sediment quality is affected by many different factors including weather, climate and circulation patterns, offshore ocean conditions, inflow from rivers and streams, discharges from wastewater treatment plants and industries, erosion and stormwater runoff, and other sources of pollution.

Deception Pass in northwest Puget Sound.

VITAL SIGN > INDICATOR	PROGRESS	STATUS
Marine Water		
Sediment Chemistry Index	NO TREND	NO TARGET
Dissolved oxygen in marine water	INDICATOR TO BE DEVELOPED	NO TARGET
Ocean acidification	INDICATOR TO BE DEVELOPED	NO TARGET
Nutrient balance in marine water	INDICATOR TO BE DEVELOPED	NO TARGET
Marine water temperature	INDICATOR TO BE DEVELOPED	NO TARGET
Marine Benthic Index	GETTING WORSE	NO TARGET
Noise in marine water	INDICATOR TO BE DEVELOPED	NO TARGET
Primary production in marine water	INDICATOR TO BE DEVELOPED	NO TARGET

Related Strategies

- Awareness of Effects of Climate Change
- Climate Adaptation & Resilience
- Education Partnerships
- Funding
- Greenhouse Gas Emissions & Carbon Sequestration
- Oil Spills
- Research & Monitoring
- Stewardship & Motivating Action
- Stormwater Runoff & Legacy Contamination
- Strategic Leadership & Collaboration
- Submerged Aquatic Vegetation
- Toxic Chemical Pollution
- Wastewater Systems
- Water Pollution Source Identification & Correction
- Working Lands Runoff

Vital Sign Reporter

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KEY VITAL SIGN MESSAGES

Although Puget Sound may look beautiful from the surface, marine water quality has changed in many ways. Overall, the most recent 30-year period for the Puget Sound region is warmer and wetter than the previous climate normal (the World Metrological Organization recently updated its "normal" conditions to reflect measurements taken from 1991-2020). By maintaining scientifically-sound monitoring programs for water quality parameters, researchers can detect changes beyond this new normal and identify trends that enable them to predict what Puget Sound will be like for future generations.

Climate change is impacting the water cycle throughout Puget Sound, altering the timing of key chemical, physical, and biological processes including river flow, snow melt, and coastal upwelling. Puget Sound waters are experiencing stronger seasonal extremes, with each basin responding differently depending on local weather, basin topography, surface runoff, and the influence from deep offshore waters. These changes impact plants and animals in the Puget Sound ecosystem and how humans use Puget Sound marine resources.

Though many of the Marine Water Vital Sign indicators are new and awaiting development, decades of data exist from ongoing monitoring programs. Work is currently underway to compile data and report on primary productivity, with other indicators to follow. The indicators will provide an additional way to assess the status and trends of these processes in Puget Sound.

- Marine water quality continues to change throughout Puget Sound, as shown by measurements of oxygen, temperature, pH, and nutrient balances documented in the Marine Waters 2021 Overview. The conditions of marine waters in Puget Sound vary by region, depending on where basins are located.
- **Dissolved oxygen in marine water:** Dissolved oxygen levels in Puget Sound are typically low in autumn, with levels varying basin to basin. Hypoxic waters (waters with very low oxygen, <2 mg/L) are occupying larger portions of the water column and are more prevalent compared to the baseline (1998–2013) conditions. This trend corresponds with decreasing oxygen in Pacific Ocean source waters to the Salish Sea and anomalously warm waters (warmer water holds less oxygen). Low oxygen waters may stress or kill fish and shellfish, reducing food availability for other animals such as birds and marine mammals. In 2021, hypoxia persisted from May to November in South Hood Canal, where low-oxygen areas are common at certain times of the year.
- **Marine benthic communities**: The Marine Benthic Index tells us about the health of benthic invertebrate communities and helps us understand how human disturbance affects life at the bottom of Puget Sound. Excessive amounts of organic material reaching the sediments account for much of the human disturbance to benthic communities, especially in low-energy terminal inlets. Other research shows significant declines in total abundance and taxa richness occurred in sediment-dwelling invertebrate communities in Puget Sound sampled from 1997-2015. Since 2019 certain basins conditions have improved, but in others the condition of the invertebrate community continues to decline despite low or decreasing sediment contaminant levels. Additional stresses may be coming from environmental pressures such as climate change, ocean acidification, and nutrient loading.
- **Marine water temperature**: As the climate changes, so does temperature and salinity. Since 2014 Puget Sound waters have been seasonally warmer and saltier than average. Higher salinity is driven by decreased precipitation and low river flow into Puget Sound, while water temperature is driven by deep Pacific Ocean inflow and regional climate events. Warmer waters and extreme weather anomalies can impact the Puget Sound food web by changing the spawn time of shellfish, increasing bacteria and biotoxin production, reducing nutritional value of zooplankton, and slowing kelp growth. An unprecedented extreme heat event occurred in early July 2021, when air temperatures persisted above 100ºF for several days causing mass intertidal mortalities and very warm surface water. If extreme heat events become more common with climate change, impacts to communities will intensify with less time for slow-growing organisms to recover.
- **Nutrient balance in marine water**: Nitrogen is a naturally occurring marine nutrient that phytoplankton and seaweed need to grow. However, excess nitrogen from human sources can fuel macroalgae blooms that decompose and deplete oxygen from the water. In recent years, nitrate (a form of nitrogen) has been increasing in the surface water of some Puget Sound basins. However, phytoplankton blooms occurring in late spring and summer, coupled with a lack of freshwater input, have coincided with localized reductions in nutrient concentrations.
- **Primary production in marine water:** Marine phytoplankton are microscopic algae that form the base of the marine food web by capturing and storing carbon through photosynthesis. They are sensitive indicators of ecosystem health and respond rapidly to environmental changes. In recent years phytoplankton abundance and timing of blooms (peak growth) is changing. Biovolumes are somewhat higher than in previous years and the traditional pattern of two distinct blooms in late spring and mid-summer is moving toward a single peak in June. Phytoplankton growth has also begun ramping up in late winter and lasting into autumn.
- **Ocean acidification:** Ocean acidification refers to the chemical changes that occur when the ocean's surface absorbs excess carbon dioxide in the atmosphere. The absorption results in more acidic waters and corrosive conditions for calcifying organisms like shellfish. More acidic waters can also affect metabolic responses that control animal growth and reproduction. Ocean acidification is an increasing threat to Puget Sound and the Washington coast, where atmospheric carbon dioxide concentrations are higher than global averages.
- **Sediment chemistry:** Chemical contamination in sediment has generally been stable throughout the past 20 years. The highest concentrations of contaminants remain near population and industrial centers, however improvements in Elliott and Commencement Bays are noteworthy given their location in more urbanized and industrial landscapes.

BACKGROUND DOCUMENTS

Implementation Strategy

The Partnership and its affiliated network of researchers works with the three Strategic Initiative Lead Teams on Implementation Strategy development and operationalization. Please read more about these teams and our shared work at https://pugetsoundestuary.wa.gov/recovering-puget-sound/

- Stormwater Strategic Initiative
  - Marine Water Quality Implementation Strategy

Indicator Targets

- 2020 Ecosystem Recovery Targets
  - Leadership Council Resolution 2011-10: Adopting a 2020 ecosystem recovery target for dissolved oxygen in marine waters
  - Leadership Council Resolution 2011-19: Adopting a 2020 ecosystem recovery target for marine sediment quality
  - Marine Water Quality 2020 Target Briefsheet
  - Toxics in Sediments 2020 Target Briefsheet

OTHER RESOURCES

- Puget Sound Metrics Dashboard reporting on estuarine flow, temperature changes from surface heat fluxes, salinity changes from rivers and rain, water column dissolved oxygen, and ocean boundary conditions
- Marine Waters Overview by the Puget Sound Ecosystem Monitoring Program Marine Waters Work Group
- Puget Sound Marine Water Monitoring, Washington Department of Ecology
- Puget Sound Sediment Monitoring, Washington Department of Ecology

CONTRIBUTING PARTNERS

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