A functioning, resilient Puget Sound ecosystem is defined to include marine sediment quality that supports functioning, healthy communities of sediment-dwelling invertebrates. The sediment (gravel, sand, silt, and clay) on the floor of Puget Sound forms a unique habitat that is home to clams, marine worms, burrowing shrimp, bottom-dwelling fish, and thousands of other unique species. In turn, these animals form a critical part of the marine food web, are instrumental in mixing and oxygenating the sediments, and they process the sediments allowing nutrients to cycle between the sediments and the overlying waters.

The Marine Sediment Quality Vital Sign tells us about the level and toxicity of chemical contaminants in Puget Sound sediment and the ability of this bottom habitat to support aquatic life. The Vital Sign also helps understand whether efforts to reduce pollutants to marine waters are effective.

While there are sediments burdened with chemical contaminants in some locations in Puget Sound, we know that other environmental pressures, including those associated with climate change, ocean acidification, and nutrient loading, are affecting the composition of sediment-dwelling biota. Declines occurring in invertebrate community condition despite low and declining sediment contaminant levels point to the influence from these other pressures. Revisions have been made to the Puget Sound Sediment Monitoring Program to better understand these relationships, and revisions to the Marine Sediment Quality Vital Signs that reflect these additional sediment quality stressors are currently under development.

### Key Messages

Recent measurements from an expanded suite of Puget Sound Sediment Monitoring Program parameters indicate:

- **Organic matter matters** – There is strong spatial concordance between locations with high levels of organic matter in sediments and adversely affected benthic communities.
- **Terminal inlets accumulate organic matter** - Spatial patterns measured for sediment biogenic silica, total organic carbon, total nitrogen, and particle size indicate that organic matter accumulates more in terminal inlets than in other areas of Puget Sound.
• **Oxygen matters** – There is also strong spatial concordance between areas of low dissolved oxygen in sediments, as seen in the Salish Sound Model, and adversely affected benthic communities. These areas again include terminal inlets.

• **Benthic communities are impacted in terminal inlets** - The benthic invertebrates in Puget Sound's weakly flushed depositional terminal inlets have lower taxa richness, impacted biomass, and are characterized as adversely affected more frequently than in other areas of the Sound.

• **Pressures projected to intensify** - Projected effects of climate change and nutrient loading pressure on Puget Sound include longer water residence time, increased water temperature, and increased phytoplankton growth and die-off in the water column. All have the potential to concentrate organic matter and harmful decomposition by-products and lower dissolved oxygen in the bottom water and sediments. Terminal inlets and other areas already influenced by these pressures will likely see further decline in water and sediment quality, negatively affecting benthic communities.

Three decades of monitoring sediment chemistry, toxicity, and benthic invertebrates indicate:

• **Sediment chemistry** - The majority of Puget Sound sediments sampled from 1997-2015 do not have elevated levels of measured chemical contaminants. Highest concentrations were near population and industrial centers, with improvements seen in these areas over time.

• **Sediment toxicity** – 88 percent of Puget Sound sediments measured from 1997-2015 were non-toxic. Sediments with low, moderate, or high toxicity were located near urban and non-urban terminal inlets and areas with poor circulation, low dissolved oxygen, and high sulfides.

• **Benthic invertebrates** – Significant declines in total abundance and taxa richness occurred in sediment-dwelling invertebrate assemblages in Puget Sound regions and bays sampled from 1997-2015. Declines were also noted for these stations grouped by harbor, urban, passage, and rural characteristics.

• **Little correspondence between measures** – Statistical analyses revealed low correspondence between the sediment chemistry, toxicity, and invertebrate community characteristics measured in sediments throughout Puget Sound from 1997-2015.

• **Alternative environmental pressures** – Declines occurring in invertebrate community condition despite low and declining sediment contaminant levels point to stresses from other environmental pressures, for example climate change, ocean acidification, nutrient loading, which should now be examined.

**Strategies, Actions, And Effectiveness**

• **Actions proposed in the Action Agenda** that advance this Vital Sign: *(let us know if we missed any!)*:
  - Measurement of Pharmaceuticals, Personal Care Products, and Perfluoroalkyl Substances in Budd Inlet and Port Gardner Bay sediments
  - Monitoring pollutants in benthic invertebrates and their associated sediments in Puget Sound urban bays
  - Ephemeral Sediment Data Collection to Establish Baseline Sediment Conditions for NRDAR
  - Suspended sediment-bound toxic chemical fluxes from large rivers to Puget Sound
  - Suspended sediment-bound toxic chemical fluxes from the Snohomish and/or Stillaguamish River to Puget Sound

**Background Documents**

• Leadership Council Resolution 2011-19, Adopting a 2020 ecosystem recovery target for marine sediment quality
• Toxics in Sediments Target Options
• Toxics in Sediments Target Briefsheet

**Other Resources**

• Articles related to sediment quality in the Encyclopedia Of Puget Sound
• Eyes Under Puget Sound flickr site
• Critter of the Month posts at the Department of Ecology

**Contributing Partners**