

Urban Waters Initiative 2007: Sediment Quality Changes in Elliott Bay Since 1998

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A New Initiative for Puget Sound's Urban Bays

The Washington State Department of Ecology's (Ecology's) *Urban Waters Initiative* (UWI) was established in 2007 to reduce toxic inputs to, and prevent contamination or re-contamination of, sediments in several of Washington's urban bays.

In support of the UWI, Ecology is assessing sediment quality throughout the urban bays of Puget Sound. This assessment began with Elliott Bay and the adjoining waterways of the lower Duwamish River in 2007.

Surface sediments for the Urban Bays study (Figure 1) were analyzed to measure sediment chemistry, sediment toxicity, and community composition of benthic (bottom-dwelling) organisms. These three sediment quality indicators were then combined into Ecology's Sediment Quality Triad Index.

The sampling design follows that developed for the Puget Sound Assessment and Monitoring Program (PSAMP) Sediment Component, allowing comparison of data between the two programs.

Study Objectives

The objectives of the June 2007 study in Elliott Bay and adjoining waterways were to:

1. Assess the current conditions in the area, particularly the overall extent of sediment contamination.
2. Determine whether there have been changes in sediment quality over time.
3. Compare the extent of sediment quality degradation in Elliott Bay and adjoining waterways with regional and Puget Sound-wide levels of degradation.

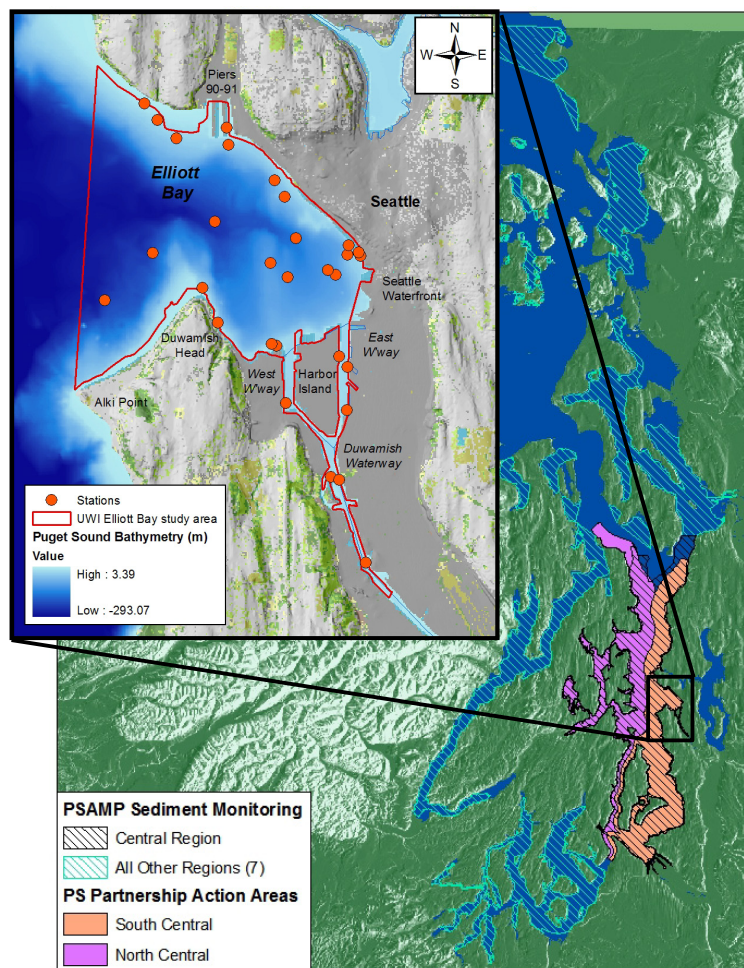


Figure 1. 30 random sediment stations sampled in Elliott Bay in 2007 and 1998, nested within the PSAMP Sediment Component Central Region. Also shown is the overlap with the marine portion of the Puget Sound Partnership's South Central Action Area.

What Did We Find?

Sediment Conditions in Elliott Bay - 2007

Chemical Contamination

- Approximately 33% of the total study area was chemically contaminated, as indicated by chemical concentrations not meeting Washington State Sediment Quality Standards (SQS). Most stations not meeting SQSs did so for three or fewer chemicals or chemical groups in any given sample.
- Among all 30 stations monitored, the SQSs were not met for 17 of 41 chemicals or chemical groups for which there are state standards. SQSs were not met most frequently for:
 1. Bis(2-ethylhexyl)phthalate, a common plasticizer.
 2. Mercury.
 3. Total polychlorinated biphenyls (PCBs).
 4. Polycyclic aromatic hydrocarbons (PAHs).
- PCB concentrations were highest at the Duwamish and East Waterways monitoring stations.
- Metals and PAH concentrations were generally highest near the Port of Seattle piers, near the Denny Way Combined Sewer Overflow, and in southeast Elliott Bay.

Sediment Toxicity

- Based on the results of the sublethal toxicity test, only 1.6% of the area (one station) had toxic sediments in 2007.

Benthic Invertebrate Communities

- More than half of the stations and study area had adversely affected benthic invertebrate communities.
- Pollution-tolerant species were far more abundant than pollution-sensitive species.
- Benthic invertebrate communities at the stations in the waterways of the lower Duwamish River

often had large numbers of pollution-tolerant species and low species diversity.

- Low total invertebrate abundance or low species count, or both, characterized some other stations.

Sediment Quality Triad Index (SQTI)

The SQTI combines the chemical contamination, toxicity, and benthic invertebrate data into a 4-level scale from high to degraded.

- **High**
No chemistry, toxicity, or benthos degradation
- **Intermediate/High**
One triad element degraded
- **Intermediate/Degraded**
Two triad elements degraded
- **Degraded**
All triad elements degraded

Figure 2a shows the 2007 results for Elliott Bay.

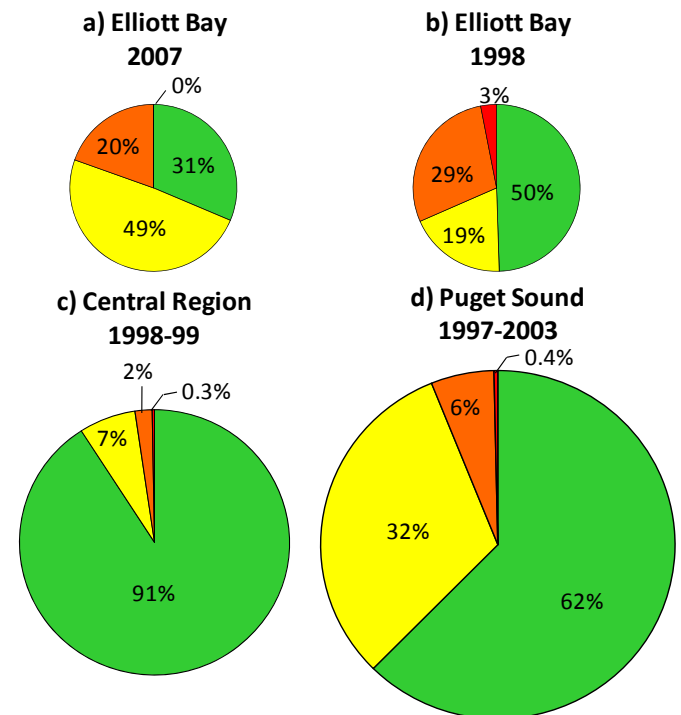


Figure 2. Overall sediment quality, as determined by the Sediment Quality Triad Index. Percentage of area is shown.

Comparison to 1998 Conditions

Most measures indicated slight improvements in sediment quality on a bay-wide scale, though some indicated no change or decline in conditions (Table 1). Some newer types of contaminants, such as perfluorinated chemicals, were not included in this survey.

Table 1. Summary of bay-scale changes from 1998 to 2007 in individual parameters measured in Elliott Bay sediment.

| |
|---|
| <p>Improvements</p> <p>Metals: Lead, Mercury, Silver, Tin</p> <p>Many LPAHs¹</p> <p>Most HPAHs²</p> <p>Most PCBs³</p> <p>Sediment Toxicity</p> <p>Benthic Communities</p> |
| <p>No change</p> <p>Metals: Arsenic, Cadmium, Chromium, Copper, Nickel</p> <p>Some LPAHs¹</p> <p>HPAHs²: Chrysene, Perylene</p> |
| <p>Deterioration</p> <p>Metals: Zinc</p> <p>LPAHs¹: Acenaphthylene, Retene</p> <p>Bis(2-ethylhexyl)phthalate⁴</p> |

¹ Low Molecular Weight Polycyclic Aromatic Hydrocarbons

² High Molecular Weight Polycyclic Aromatic Hydrocarbons

³ Polychlorinated Biphenyls

⁴ A common plasticizer; also known as DEHP

Sediment Contamination

- *Metals:* Lead, mercury, silver, and tin levels decreased significantly. Zinc levels increased. There were no significant changes in levels of arsenic, cadmium, chromium, copper, or nickel.
- *PAHs:* Levels of most low-molecular-weight PAHs (LPAH) decreased or stayed the same, but two (acenaphthylene, retene) increased. Levels of most high-molecular-weight PAHs (HPAH) decreased, but two (chrysene, perylene) displayed no change.
- *PCBs:* Most individual PCB congener levels decreased, as did total PCB Aroclors.
- *Phthalates:* Bis(2-ethylhexyl)phthalate levels increased.

- *Comparison to sediment-quality standards:* The number of chemicals not meeting their respective SQS decreased.

Sediment Toxicity

- Sediment toxicity decreased significantly, from seven stations representing 9% of the study area in 1998, to one station representing 1.6% of the area in 2007.

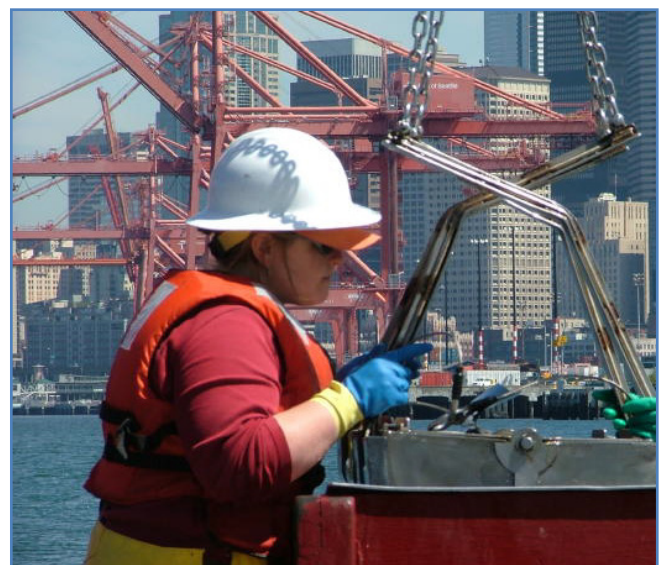
Invertebrate Communities

- Some measures of benthic invertebrate community health improved from 1998 to 2007. However, the total number of stations and amount of area with adversely affected benthos remained almost unchanged.

Sediment Quality Triad Index

Figure 2 shows changes in the SQTI in Elliott Bay from 1998 to 2007 (Figure 2a,b).

- Sediment quality, as measured by the SQTI, improved for 24% of the study area, remained the same for 46%, and declined for 30%.
- All of the improvements were at stations in the waterways and inner portion of Elliott Bay.
- Sediment quality in the outer portion of the bay remained high or declined slightly.



Sediment sampling in Elliott Bay.

Sediment Quality at Different Spatial Scales

The 2007 Elliott Bay study area is nested within the PSAMP Sediment Component's Central Region and within the marine portion of the Puget Sound Partnership's South Central Action Area (Figure 1). The PSAMP Central region study area is, in turn, nested within the entire Puget Sound sampling area.

This nested series of sampling areas enables assessment of sediment quality at multiple geographic scales using the SQTI:

- A much smaller proportion of the Elliott Bay study area had high sediment quality compared to the Central Region or all of Puget Sound (Figure 2).
- The proportion of area with intermediate sediment quality was much higher in Elliott Bay than in the Central Region or all of Puget Sound, both with high proportions of sediments collected from relatively less contaminated areas (Figure 2).

Relevance to the PS Partnership

The UWI sediment monitoring program is a new tool for use by the Puget Sound Partnership (PSP), environmental managers, and other stakeholders.

Results from this survey, together with the existing PSAMP sediment monitoring work, provide information addressing key components of the PSP Action Agenda, including:

- **Status-and-trends monitoring:** PSAMP and UWI monitoring provide baseline and current sediment conditions for determining change.
- **Effectiveness monitoring:** UWI bay-scale assessments provide information to determine whether *collective* localized cleanups and source control improve conditions throughout the bay.

- **Indicators:** Indicators of sediment chemistry, toxicity, and benthic community structure, as well as the combined multivariable SQTI, are used to quantify the extent of sediment quality degradation in Puget Sound.
- **Coordinated regional monitoring:** Nested sampling areas allow sediment quality assessment at different geographic scales. Since the sample areas align with PSP Action Areas (marine portions), monitoring results can be used to inform management decisions.
- **Science:** The PSAMP and UWI sediment monitoring studies have incorporated accepted, state-of-the-science methods for study design and statistical analyses.
- **Communication:** The PSAMP and UWI sediment monitoring studies provide information on sediment-quality status and trends to the PSP and other stakeholders.

Future UWI Sediment Monitoring

Ecology sampled sediment in Commencement Bay in 2008 and in the Bainbridge Basin (Sinclair and Dyes Inlets) in 2009. Bay-scale sediment monitoring will be expanded to include Bellingham Bay in 2010, Budd Inlet in 2011, and Port Gardner/ Everett Harbor in 2012.

This paper is based on the report:

Partridge, V., S. Weakland, E. Long, K. Welch, M. Dutch, and M. Jones, 2009. Urban Waters Initiative, 2007: Sediment Quality in Elliott Bay. Washington State Department of Ecology. Publication No. 09-03-014.
www.ecy.wa.gov/biblio/0903014.html

General information and all data generated for this report can be accessed from Ecology's Marine Sediment Monitoring website:
www.ecy.wa.gov/programs/eap/psamp/index.htm

If you have special accommodation needs, contact Joan LeTourneau at 360-407-6764 (voice) or 711 or 1-877-833-6341 (TTY).



Elliott Bay and Seattle waterfront.